Ministry of Energy and Water Resources
Water Supply Division (WSD)
The Republic of Sierra Leone

PREPARATORY SURVEY REPORT
ON
THE PROJECT
FOR
THE ESTABLISHMENT OF RURAL WATER SUPPLY SYSTEM IN KAMBIA TOWN
IN
THE REPUBLIC OF SIERRA LEONE

January 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

Eight-Japan Engineering Consultants Inc.

GED
JR
11-008

Preface

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey on the Project for the Establishment of Water Supply System in Kambia Town in the Republic of Sierra Leone, and organized a survey team headed by Mr. Kazumi Matsuda of Eight-Japan Engineering Consultants Inc. between April 22, 2010 and June 6, 2010.

The survey team held a series of discussions with the officials concerned of the Government of Sierra Leone, and conducted a field investigation. As a result of further studies in Japan, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Sierra Leone for their close cooperation extended to the survey team.

January, 2011

Shinya Ejima
Director General,
Global Environment Department
Japan International Cooperation Agency

Summary

(1) Outline of the Country

The Republic of Sierra Leone (herein after referred to as “Sierra Leone”) has a territory of 71,740km^2 and a population of approximately 6 million (2008) and annual growth ratio of 2.8%. Sierra Leone borders on Guinea on the north and Liberia on the south, and the country can be classified into two major geographic features, the plains in the west at an altitude of less than 100m and the hilly or mountainous region in the east at an altitude between 100m to 1,950m. The geographical features have been formed by nine major river systems which are originated from the east or northeast mountainous region and spread over the country and finally flow into the Atlantic Ocean. Sierra Leone is in the tropics and has a climate of high temperature and high humidity. The annual rainfall ranges from 1,800mm in the northeast to 5,000mm in the capital, Freetown. There are two seasons, the rainy season from May to October and the dry season from November to April.

Per capita GDP of Sierra Leone is US$900 (2009) and GDP of primary, secondary and tertiary industries is 49%, 31% and 20%, respectively. Sierra Leone has a high export capacity of primary products such as diamond, gold, iron ore, bauxite, cacao and coffee beans, etc. These products are the country’s major sources of foreign exchange, however, the eleven-year civil war depressed the economy severely. Since the war was over in 2002, international society has been assisting Sierra Leone in the fields of economy, administrative and financial reform, development of local communities, etc. At present, because of restoration of agriculture and mining industries the country has been recovering its economy favorably. The economic growth ratio between 2004 and 2006 hit 7% level and the ratio in 2007 and 2008 was 6.4% and 5.5%, respectively. These figures shows reduction of the speed of economic growth in recent years, however, the economy of Sierra Leone is generally favorable so far.

(2) Background of the Project

According to “Sierra Leone Vision 2025”, improving quality of life of the nation is one of the supreme policies of the country. For water and sanitation sector, “The Poverty Reduction Strategy Paper, 2005 and 2008” and “National Water and Sanitation Policy, 2008” are the national policies of the sector. These policies say that water and sanitation is one of the priority problems of the nation to be solved and have a target to improve the present coverage of water supply of 37% by 74% in 2015.

Since the war was over, eight years have passed and Sierra Leone is at present proceeding to the developing stage from the urgent restoration and rehabilitation of the country. The scars of the war are, however, very serious and almost of the infrastructures damaged during the war have not

been rehabilitated even now. In the case of water supply sector, water supply facilities which were constructed in the 1970s to 80s in major rural towns (about 40 towns) with the cooperation of the World Bank and the French Government were also destructed completely during the war. Most of theses facilities have not been rehabilitated and are not in operation so that the people of the towns are not able to access to safe water.

Under the circumstances, Japan International Cooperation Agency (herein after referred to as "JICA") conducted a technical cooperation programme; "The Project for Establishment of Water Supply Management System in Kambia District" from 2006 to 2008 in order to restore the existing water supply facilities in Rokupr which were constructed in 1990 under Japan's Grant Aid and destroyed during the war.

In the project, rehabilitation of the water supply facilities including the conversion of the existing water treatment system, i.e. rapid sand filtration system into slow sand filtration system was conducted. Further, establishment of the operation and maintenance organization based on a bye-law of the local government and development of a water tariff, etc. were conducted in the project in accordance with the decentralization and self-reliance policy of the Sierra Leonean Government after the war so as to develop a prototype of water services in rural towns.

The Government of Sierra Leone intends to disseminate the experience and know-how which were obtained in the above-mentioned project to the other rural towns in the country as a method of improving their existing water supply facilities and water services. Under these circumstances, the Sierra Leonean Government requested the Government of Japan to improve the existing water supply facilities in Kambia town, the headquarters town of the Kambia District under Japan's Grant Aid.

(3) Results of the Survey and Contents of the Project

In response to the request, the Government of Japan decided to conduct a Preparatory Survey for the Project and JICA sent the Survey team to Sierra Leone from April 22 to June 6, 2010. The Survey team conducted, in Sierra Leone, confirmation of the requested contents, field survey on the site, investigation of operation and maintenance system, examination of facilities plan and so forth, through discussions with the Ministry of Energy and Water Resources (ME&WR) and Water Supply Division (WSD). After returning to Japan, the Survey team undertook the outline design, and compiled the results into a draft report. Thereafter, JICA sent again the Survey team to Sierra Leone from October 17 to October 22, 2010 for explaining the draft report as well as for deliberation on the contents of the outline design with the counterpart officials concerned.

Based on the requested contents of the Government of Sierra Leone and a result of the field survey and the discussions with the officials concerned of the Sierra Leonean Government, the outline design of the Project has been prepared in accordance with the following policies:

1) The target year of the Project has been set at 2016, considering the anticipated completion year of the Project. The beneficial population in the target year will be 30,000 and safe treated water is to be supplied to the people.
2) The water supply area of the Project is the old town located in the north of Kambia town and the new developing area located along the international road of the town.
3) Basic concepts of the outline design for the proposed facilities are as follows:
   (a) Raw water will be taken from the Kolenten River and the swamp alternatively considering their seasonal variations of water quality and quantity intending to take sufficient amount of water of low turbidity through the year.
   (b) Slow sand filtration which has been proven as a viable technology for rural towns in the technical cooperation programme in Rokupr will be applied as a unit process of the Project. A plain sedimentation process will be installed as a pre-treatment process of the slow sand filtration. The treated water will be disinfected using bleaching powder.
   (c) Planned design capacity of the Project will be calculated using the planned served population of 30,000, per capita consumption of 36 lcd (litter per capita per day) and water leakage ratio of 10%.
   (d) The treated water will be transmitted from the water treatment plant to an elevated tank, and then water will separately be distributed to the old town and the new town by gravity.
   (f) Water will basically be supplied to the people through public taps. Private connections will be installed by the Sierra Leonean side and at its own expense except for the connections to the Kambia Hospital, Kambia District Council and Resources Centre.
4) The construction work of the Project will be done by a Japanese Contractor. Local subcontractor(s) will also be employed and participate in the work under the supervision of the Japanese Contractor.
5) An appropriate construction schedule of the Project will be prepared on condition that the construction work is suspended for two months between the middle of July and the middle of September due to heavy rain in the rainy season.
6) The Kambia District Council will establish a public entity (KWSSB) for the operation and maintenance of the water supply facilities to be constructed under the Project based on its bye-law. Training for building the capacities of the staff of KWSSB is expected to be done under a JICA's technical cooperation scheme.

Under the Project, construction of the water supply facilities and establishment of the operation and maintenance organization will be done. As a result, access to safe water of the people is expected to be improved. Of the above-mentioned activities, construction of the water supply facilities will be carried out under Japan's Grant Aid scheme. Outline of the facilities are as shown in the table below:

Outline Design of the Japanese Assistance

Items	Contents (scale, specifications, etc.)
1. Water intake facility	Intake pump 0.84m^3/min×14.8m×3.7KW×2 sets (Kolenten) Intake pump 0.84m^3/min×17.5m×3.7KW×2 sets (Swamp)
2. Raw water conveyance facility	Conveyance pipe: DCIP ϕ 150mm×100m (Kolenten-Waterworks) Conveyance pipe: DCIP ϕ 150mm×400m (Swamp-Waterworks)
3. Water treatment facility	Capacity 1,200m^3/day Receiving well 22m^3×1 basin Sedimentation basin 400m^3×2 basins Slow sand filter 60m^2×4 basins Clear water reservoir 150m^3 Sand wash and dry 84m^2×1 no. Sand washer 1 set Chlorination device 2 sets Sludge & drainage basin 9m^3×1 basin Generator 60KVA×3 sets Lighting device 1 Ls. (outdoor and indoor)
4. Water transmission facility	Transmission pump 0.42m^3/min×60.9m×11KW×3 sets Transmission pipe DCIP ϕ 200mm×1,715m (Waterworks-El. tank)
5. Water distribution facility	Elevated tank 400m^3×1 no. Distribution pipe ϕ 250mm-75mm×29km Public tap 100 places (3-faucet type) Private connection 3 places (Kambia Hospital, Kambia District Council and Resource Centre)
6. Buildings	Pump house 2 buildings (3.0m×5.0m) Generator room 1 building (10.0m×7.0m) Store 1 building (12.0m×6.0m) Staff quarter 1 1 building (18.0m×7.5m) Staff quarter 2 1 building (22.0m×8.2m)
7. Procurement	Water meter ϕ 40mm×30 sets Piping material 1 Ls. (for the pluming work of the above water meters) Tools 1 set (for plumbing work) 1 set (for electrical work) 1 set (for mechanical work)

(4) Implementation Schedule and Project Cost

The Project will be implemented as a single phase grant aid scheme of the Government of Japan. The construction period required is, about 3.5 months for the detailed design and 18 months for water supply facilities construction, totaling to approximately 21.5 months.

Of the estimated project cost, construction cost for the water supply facilities will be borne by the Government of Japan. The Government of Sierra Leone will bear the cost for site clearance at the existing facilities and the initial operation and maintenance cost for KWSSB, amounting to approximately 676 million Leones.

(5) Project Evaluation

The water supply facilities in the rural towns in Sierra Leone were destructed completely during the war and they have not been rehabilitated even now. The existing water supply facilities in the Project site, Kambia town were also destroyed during the war and are not in operation. Approximately 84% of the people in the town are, therefore, not able to access to safe water and they are fetching insanitary water of unprotected dug wells and of the river or stream. Remaining 16% of the people are using protected dug wells with hand pumps that are seemed to be relatively safe, however, as a result of the water analysis groundwater in Kambia town are likely to be contaminated by sewage. Further, as a result of the questionnaire survey, approx. 30% of the people replied that member(s) of the family got water born diseases for the last one year. In the circumstances, the people, especially children and women are taking on the burden of fetching water.

The Project will improve the above-mentioned inferior situation of water supply and sanitation in the town and the stability and quality of life of the people. The Project is, therefore, expected to be materialized urgently from the point of view of basic human needs. The direct-benefited population of the Project will be 30,000 of the people in Kambia town and 36 lcd (litter per capita per day) of treated safe water will be supplied to the people. The safe and stable water supply will improve the sanitation of the people, and will reduce the disease rate of water born diseases and ease the children and women's burden of fetching water.

The Project will introduce slow sand filtration system as a process of water treatment which enables simple and low cost operation and maintenance. The system has been proven in the JICA's technical cooperation programme in Rokupr as a viable method for rural towns and is able to maintain using the human resources and skill in Sierra Leone. As for the operation and maintenance of the Project, a nonprofit organization, KWSSB will be established as a same manner as the programme in Rokupr. By doing so, in a small scale and low profitable water business in rural towns it will make water rate affordable for the people and the business sustainable and self-reliance.

As a result of the examination of a screening format of the Project and a site survey conducted by Sierra Leone Environmental Protection Agency (SLEPA), the Agency has judged that the Project will have no significant or adverse impact on the environment and has given an environmental license to the Project. Further, it can be judged that the Project have no particular problems for the implementation under Japan's Grant Aid scheme.

As above delineated, considerable effects are expected in the implementation of the Project. At the same time, as the Project will extensively contribute to the improvement of basic human needs of the people as well as stabilization of the livelihood, the appropriateness of the implementation of the Project under Japan's Grant Aid scheme can be confirmed.

On the other hand, it might be considered that human resources and financial resources of the Government of Sierra Leone be adequate in undertaking the operation and maintenance of the Project. Nevertheless, now that JICA's technical cooperation scheme be provided for assisting the activities of the Sierra Leonean side, establishment of KWSSB and capacity building of the staff, the Project is to be implemented more smoothly and efficiently.

Contents

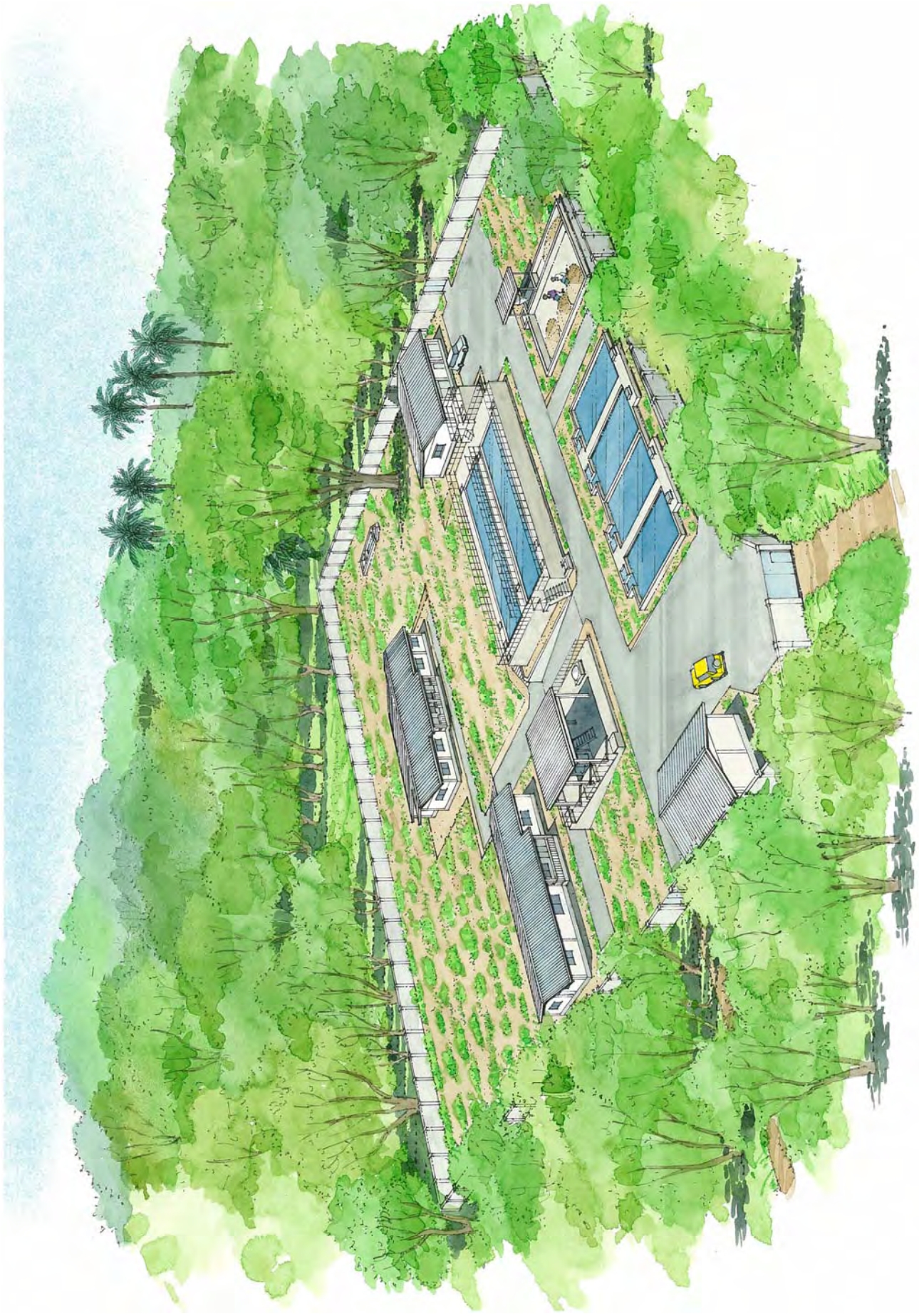
［Appendices］

Location Map

Map No. 3902 Rev. 5 UNITED NATIONS
January 2004

Department for Peacekeeping Operations
Cartographic Section

Perspective



List of Figures & Tables

Abbreviations

A/P	Authorization to Pay
AfDB	African Development Bank
B/A	Banking Arrangement
BHN	Basic Human Needs
DCIP	Ductile Cast Iron Pipe
DF/R	Draft Final Report
DFID	Department for International Development
E/N	Exchange of Notes
EIA	Environmental Impact Assessment
EOJ	Embassy of Japan
EU	European Union
EWRA	Energy and Water Regulatory Authority
F/R	Final Report
G/A	Grant Agreement
GOJ	Government of Japan
GOSL	Government of Sierra Leone
GST	Goods and Service Tax
GVWC	Guma Valley Water Company
IC/R	Inception Report
JICA	Japan International Cooperation Agency
KDC	Kambia District Council
KWSSB	Kambia Water Supply and Sanitation Board
lcd	liter per capita per day
ME&WR	Ministry of Energy and Water Resources
MOFED	Ministry of Finance and Economic Development
MOFIC	Ministry of Foreign Affaires and International Cooperation
NWRB	National Water Resources Board
OJT	On the Job Training
PVC	Polyvinyl Chloride Pip
RWSSB	Rokupr Water Supply and Sanitation Board
SALWACO	Sierra Leone Water Company
SGP	Steel Galvanized Pipe
SLEPA	Sierra Leone Environment Protection Authority
SLFO	Sierra Leone Field Office
UNICEF	United Nations Children’s Fund
WSD	Water Supply Division

Chapter 1 Background of the Project

(1) Background of the Project

Since the eleven-year civil war was over, eight years have passed and the Republic of Sierra Leone (herein after referred to as "Sierra Leone") is proceeding to the developing stage from the urgent restoration and rehabilitation of the country. The scars of the war are, however, very serious and almost of infrastructures damaged during the war have not been rehabilitated even now. In the case of water supply sector, water supply facilities which were constructed in the 1970s to 80s in major rural towns (approx. 40 towns) with the cooperation of the World Bank and the French Government were destructed completely during the war. These facilities are not in operation and the people of the towns are not able to access to safe and clean water and have a hard time.

Under the circumstances, Japan International Cooperation Agency (herein after referred to as "JICA") conducted a technical cooperation programme, "The Project for Establishment of Water Supply Management System in Kambia District" from 2006 to 2008 in order to rehabilitate water supply facilities in Rokupr which were constructed in 1990 under Japan's Grant Aid and destroyed during the war.

In the project rehabilitation of the existing water supply facilities including the conversion of the existing treatment system into slow sand filtration system which enables simple and low cost operation was conducted. Further, in the project JICA has been developing a prototype for improving water services in rural towns which includes establishment of an operation and maintenance organization based on a bye-law of the local government, development of a water tariff, etc. in accordance with the decentralization and self-reliance policy of the water supply and sanitation sector of the Government of Sierra Leone after the war.

Based on the experience and know-how obtained in the above-mentioned project, the Project is expected to improve the water services in Kambia town, the headquarters town of the Kambia District.

(2) Overall Goal and Project Purpose

According to "Sierra Leone Vision 2025", improving quality of life of the nation is one of the supreme policies of the country. For water and sanitation sector, "The Poverty Reduction Strategy Paper (2005 and 2008)" and "National Water and Sanitation Policy (2008)" are the national policies of the sector. These polices say that water supply and sanitation is one of the priority problems of the nation to be solved and have a target to improve the present coverage of water supply of 37% (urban: 47% and rural: 32% in 2008) by 74% in 2015.

The Project will contribute to the efforts of the Government of Sierra Leone for achieving the

above-mentioned target through the construction of water supply facilities and establishment of operation and maintenance organization which will materialize sustainable water services and supply safe and clean water to the people. The objectives of the Project are as mentioned below:

1) Overall Goal: Poverty is reduced by providing efficient and improved water services and improving quality of life of the people in the Project area.
2) Project Purpose: Access to water services is improved in the Project area.

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

In order to achieve the objectives of the Project, construction of the water supply facilities and establishment of the operation and maintenance organization will be carried out in the Project. As a result, the water supply facilities in Kambia town are to be rehabilitated and improved and proper operation and maintenance of the facilities is expected to be done. Of the above-mentioned activities, construction of the water supply facilities will be carried out under Japan's Grant Aid scheme.

The inputs and activities of the Project and expected outputs to achieve the objectives of the Project are as mentioned below:

(1) Inputs of the Project

Japanese Side

[Construction of the Facilities]

1) Water Intake Facility

- Intake pump $0.84m^3$/min×14.8m×3.7KW×2 sets (Kolenten)
- Intake pump $0.84m^3$/min×17.5m×3.7KW×2 sets (Swamp)

2) Raw Water Conveyance Facility

- Conveyance pipe DCIP ϕ 150mm×100m (Kolenten-Waterworks)
- Conveyance pipe DCIP ϕ 150mm×400m (Swamp-Waterworks)

3) Water Treatment Facility

- Capacity $1,200m^3$/day
- Receiving well $22m^3$×1 basin
- Sedimentation basin $400m^3$×2 basins
- Slow sand filter $60m^2$×4 basins
- Clear water reservoir $150m^3$
- Sand wash and dry $84m^3$
- Sand washer 1 set
- Chlorination device 2 sets
- Sludge & drainage basin $9m^3$×1 basin
- Generator 60KVA×3 sets
- Lighting device outdoor (mercury lump) and indoor, 1 Ls.

4) Water Transmission Facility

- Transmission pump $0.42m^3$/min×60.9m×11KW×3 sets
- Transmission pipe DCIP ϕ 200mm×1,715m (Waterworks-Elevated tank)

5) Water Distribution Facility

- Elevated tank $400m^3$×1 no.
- Distribution pipe PVC ϕ 250mm-75mm×29km
- Public tap 100 places (3-faucset type)
- Private connection 3 places (Kambia Hospital, Kambia District Council, Resource Centre)

6) Buildings

- Pump house 2 buildings (3.0m×5.0m)
- Generator room 1building (10.0m×7.0m)
- Store 1 building (12.0m×6.0m)
- Staff quarter 1 1 building (18.0m×7.5m)
- Staff quarter 2 1 building (22.0m×8.2m)

7) Procurement

- Water meter ϕ 40mm×30 sets
- Piping material for installation of the above water meters, 1 Ls.
- Tools for plumbing, electrical and mechanical work, each 1 set

[Human Resources]

- Japanese consultant
- Japanese contractor and local sub-contractor(s)

Sierra Leonean Side

[Site Clearance]

- Site clearance at the existing waterworks (removal of the existing facilities and buildings)
- Site clearance at the existing elevated tank (removal of the existing elevated tank)

[Human Resources]

- Counterparts of the Ministry of Energy and Water Resources (WSD)
- Counterparts of the Kambia District Council
- Kambia Water Supply and Sanitation Board (Board members, technical and administrative staffs and water rate collectors)

[Local Cost]

- Project management cost of the Ministry of Energy and Water Resources
- Project management cost of the Kambia District Council
- Initial working capital for the operation and maintenance of KWSSB
- Expenses for custom clearance and tax exemption, if necessary

(2) Activities of the Project

[Construction of the Facilities]

- Removal of the facilities at the existing waterworks and the elevated tank.
- Construction of the water supply facilities of the Project.

[Establishment of the Operation and Maintenance Organization]

- KWSSB is established based on the bye-law of the Kambia District Council
- Board members are appointed and staffs of KWSSB (technical and administrative staff and water rate collectors) are employed.
- Capacity development of the staffs of KWSSB is conducted.

Of the above-mentioned activities, site clearance and establishment of the operation and maintenance organization will be carried out by the Sierra Leonean side as per the Minutes of Meetings of the Project.

(3) Outputs of the Project

- The water supply facilities in Kambia town are rehabilitated and improved.
- The water supply facilities are properly operated and maintained under the management of the Kambia District Council and the Ministry of Energy and Water Resources.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy

The water supply area of the Project is Kambia town, the headquarters town of the Kambia District and consists of the old town (Kambia 1) and the new town (Kambia 2) which is located along the international road and being developed recently. The Project is to improve people's access to safe water in the area.

The Ministry of Energy and Water Resources (MW&WR) is the responsible organization of the Project. The Kambia District Council is responsible for the operation and maintenance of the water supply facilities to be constructed under the Project. The Council will establish Kambia Water Supply and Sanitation Board (KWSSB) based on its bye-law. KWSSB will provide water services to the people under the supervision of the Council.

In response to the request from the Government of Sierra Leone, water supply facilities including water intake facilities which take water from the Kolenten River and the swamp, water treatment facilities equipped with slow sand filtration system and water distribution facilities of an elevated tank and public taps to supply water to the people will be constructed under the Project.

The construction work of the above-mentioned facilities of the Project will be carried out under Japan's Grand Aid. While, the Sierra Leonean side is responsible for the establishment of the operation and maintenance organization of the facilities in which employment and training of the staff of KWSSB, etc. will be conducted at its own expenses.

The construction work will be done by a Japanese Contractor. Local subcontractor(s) will also be employed and participate in the construction work under the supervision of the Japanese Contractor in order to maximize the outputs within the limit of inputs of the Project. Construction supervision will be conducted by a Japanese consulting firm and consultancy services such as controlling quality and schedule of the work, etc. will be provided.

(2) Natural Conditions

1) Climate

Annual rainfall in the Project site is approx. 3,000mm. About a half of the year between May and October is the rainy season and specially during the period between the middle of July and the middle of September it rains 500mm to 800mm per month. Road in and around the Project site are unpaved and at some sections of the roads become difficult to pass heavy vehicles the sections during the rainy season.

In the Project, approx. 30km of the water distribution pipes are planned to be installed in the

Kambia town, however, it can be judged that the installation work which include excavation of trench for installation of the pipes is difficult to continue in such months of having heavy rains. Further, other construction works are also difficult to carry out and their efficiency will be very low during the months. Therefore, all the construction works are to be suspended in these months.

2) Soil and Geological Condition

The Project site is located on the left bank of the Great Scarcies River and covered by laterites layer of 10 to 20m in thickness on the base rocks of metamorphic and granite. As a result of boring surveys conducted during the field survey, construction sites of the water treatment plant and the elevated tank are covered by hard laterites layer with N-value of 70 or more up to 3.5m below the surface of the ground. Therefore, it can be judged that the construction sites have a sufficient load capacity and the spread foundation is applicable for the facilities.

Of the route of the transmission pipe, base rock is appeared at some part (approx. 200m) where the elevation is low, and at approx. 1km of the route of the distribution pipes in the new town it was found that there is laterites rock. Trench excavation work at the above-mentioned parts will be carried out by using an excavator together with a giant breaker.

3) Hydro-meteorological Condition and Water Quality

Water of the Kolenten River and the swamp will alternatively be taken as a raw water of the Project in consideration of seasonal variations of their discharge and turbidities. There is no gauging station and rainfall observing station in and around the Project site so that no hydro-meteorological data is available, however, as a result of flow measurement of the Kolenten River conducted on May 15, 2010 by JICA Survey Team, the river discharge was 2.40m^3/sec.

The river discharge in May when the measurement was conducted is usually the smallest through the year. The planned intake amount of the Project is 0.84m^3/min, equivalent to 14 liter per second, is approx. 0.6% of the above-mentioned river discharge measured so that the planned intake amount can be taken in plenty and impact to water use in the downstream can be negligible. Taking water from the swamp is also no problem because the water source is used only in the rainy season when there is abundant water in the swamp.

Because there is no source of contamination toward water such as factories, etc. in the catchment area of the Kolenten River and the swamp, it can be judged that there is no problem for the safety of the water resources in respect of quality of water. As a result of quality analysis of the water resources conducted during the field survey, there is no problematic item for water resources of water supply and the conventional water treatment process is applicable for getting an appropriate quality of water in accordance with the standards of Sierra Leone.

4) Environmental and Social Considerations

In Sierra Leone, environmental assessments of all the development projects shall be conducted in accordance with "The National Environmental Protection Act, 2008". The concrete procedures are provided in "The Environmental Impact Assessment procedures, 1999" and Sierra Leone Environmental Protection Agency (SLEPA) will categorize the projects into three classes as mentioned in Table 2-2-1 below based on screening formats to be submitted to SLEPA by developers of the projects.

Table 2-2-1 Project Classification

Classification	Examples
Class A (Full EIA is required)	Full EIA is required. A project will be categorized as Class A if it is determined that the proposed project will have significant and adverse impact on the environment.
Class B (Additional information is required)	Additional information on the project is required. A project will be categorized as Class B if it has doubt that the proposed project will have significant and adverse impact on the environment. Based on the examination of the additional information, the Director will order to conduct full EIA if the project will have significant and adverse impact on the environment and mitigation measures will be taken, and may grant environmental approval to the project if the project will have no significant or adverse impact on the environment.
Class C (Full EIA is not required)	Full EIA is not required. A project will be categorized as Class C if it is determined that the proposed project will have no significant or adverse impact on the environment. The Director may grant environmental approval to the project without further analysis.

Source: The Environmental Impact Assessment Procedures, 1999/the Ministry of Lands, Housing, Country Planning and the Environment

According to the above-mentioned procedures, a project for improving the existing water supply facilities will generally be categorized into Class C that is not required to conduct Environmental Impact Assessment (EIA), however, SLEPA categorize all the projects based on the screening formats.

In cooperation with JICA Survey Team, WSD has prepared a screening format of the Project and submitted it to SLEPA during the field survey. SLEPA has categorized the Project into Class C as a result of the examination of the screening format and a field survey at the Project site and has issued a letter of "Environmental Permit" for the implementation of the Project to WSD.

In the next procedures, WSD shall submit an environmental control plan which involves a plan for mitigating environmental impacts in the pre-construction stage and in the construction stage

of the Project and for their monitoring plan. Items involved in the plan for mitigation and monitoring are shown in Table 2-2-2 below:

Table 2-2-2 Proposed Mitigation Measures and Monitoring Items for the Project

Items		Mitigation Measures
Social Environment	1. Resettlement (or loss of properties)	[Pre-Construction stage] - Basic Design Stage 1-1 Holding stakeholder meetings for information disclosure and confirmation of the agreement with stakeholders. 1-2 Proponent shall prepare agreement documents between the Government and land owners. - Detailed Design Stage 1-3 Detailed measurement survey shall be done. 1-4 Proponent shall complete land acquisition and compensation as required. [Construction Stage] Not required.
	11. Public sanitation	[Pre-Construction stage] - Basic Design Stage 11-1 Installation of a drainage around the public tap.
	12. Infectious diseases such as HIV/AIDS	[Construction Stage] 12-1 Healthcare education for workers and inhabitants. 12-2 Health check of construction workers.
	13. Traffic accidents	[Construction Stage] 13-1 Staffing of traffic control in the construction site.
Natural	19. Flora, fauna and biodiversity	[Construction Stage] 19-1 The contractor must set up the markings of the boundaries of construction areas.
Pollution	23. Air pollution	[Construction Stage] 23-1 Sprinkling of water near residential areas to reduce dusts as required.
	24. Water pollution	[Pre-Construction stage] - Basic Design Stage 24-1 Installation of a drainage around the public taps 24-2 Installation of drainage basin for sedimentation of sludge [Construction Stage] 24-3 Set up of treatment facilities for sedimentation of turbid water and discharged water from base camp during construction as required. Additionally adequate drainage shall be set up in construction area not to make puddles or unsanitary conditions.
	27. Noise and vibration	[Construction Stage] 27-1 Adjustment of work time in residential area (limit the working hours to daytime)

Environmental items required in the EIA procedures of the Sierra Leonean Government include the items in the fields of natural and social environments, pollution, etc., which are the same items as the JICA guideline on environment and social considerations. Environmental checklist which is prepared in accordance with the JICA guideline is shown in Table 2-2-3 below:

Table 2-2-3 Environmental Checklist: 18. Water Supply (1)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	① Have EIA reports been officially completed? ② Have EIA reports been approved by authorities of the host country's government? ③ Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? ④ In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	A1: A full EIA is not required as per the judgment of the Sierra Leone Environmental Protection Agency (SLEPA). A2: EIA report is not required. A3: EIA report is not required. A4: No.
	(2) Explanation to the Public	① Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? ② Are proper responses made to comments from the public and regulatory authorities?	A1: A basic consensus was formulated in JICA's SHM, May 2010. A2: Opinions in SHM will be considered in the basic design. Comments from SLEPA will also be considered.
2 Mitigation Measures	(1) Air Quality	① Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	A1: No, there is not. It is not likely to give adverse effect on human body due to small scale facility. The Government of Sierra Leone does not have the standard value, however a working environment will be managed in appropriate way.
	(2) Water Quality	① Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?	A1: Periodical maintenance such as filter sand cleaning will discharge turbid water without hazardous matter. However it is not likely to give significant impact on target stream quantitatively and qualitatively because of the small scale facility.
	(3) Wastes	① Are wastes, such as sludge generated by the facility operations properly treated and disposed of in accordance with the country's standards?	A1: Some sludge diluted by abundant water is discharged from sedimentation basin periodically. However it is not likely to give significant impact on surrounding streams quantitatively and qualitatively because of the small scale facility.
	(4) Noise and Vibration	① Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	A1: Sierra Leone does not have any noise standards. There are not residential areas nearby pump stations. Further, the pumps will be set in the pump room with sound proof wall. Thus operation noise does not give impact on human noise environment.
	(5) Subsidence	① In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	A1: No, there is not extraction of groundwater.
3 Natural Environment	(1) Protected Areas	① Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	A1: No, there are not any protected areas in the Area.

Table 2-2-3 Environmental Checklist: 18. Water Supply (2)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
3 Natural Environment	(2) Ecosystem	① Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g. coral reefs, mangroves, or tidal flats)? ② Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? ③ If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? ④ Is there a possibility that the amount of water (e.g. surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	A1: There are not any precious natural areas in the site. A2: There are not any designated and protected habitats for considerable species. A3: No serious impacts regarding ecosystem are forecasted. A4: Rate of intake water volume and river flow is less than 1%, thus it is not likely to give serious impact on aquatic life.
4 Social Environment	(1) Resettlement	① Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? ② Is adequate explanation on relocation and compensation given to affected persons prior to resettlement? ③ Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? ④ Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? ⑤ Are agreements with the affected persons obtained prior to resettlement? ⑥ Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? ⑦ Is a plan developed to monitor the impacts of resettlement?	A1-A7: There are not any resettlements in this project. However public taps and pump station near swamp are to be located in community or private land, thus agreement document has been issued by the Kambia District Council in November 2010.
	(2) Living and Livelihood	① Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? ② Is there a possibility that the amount of water used (e.g. surface water, groundwater) by the project will adversely affect the existing water uses and water area uses?	A1: No, there is not. A2: No, there is not. Rate of intake water volume and river flow is less than 1%, thus it is not likely to give serious impact on this item.
	(3) Heritage	① Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	A1: No, there is not. There are not any precious cultural heritages in the site.
	(4) Landscape	① Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	A1: No, there is not. There are not any considerable landscapes in the site.

Table 2-2-3 Environmental Checklist: 18. Water Supply (3)

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
4 Social Environment	(5) Ethnic Minorities and Indigenous Peoples	① Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples? ② Are considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples?	A1: There are no laws regarding ethnic minorities and indigenous peoples. A2: There are any considerable ethnic minorities and indigenous people.
5 Others	(1) Impacts during Construction	① Are adequate measures considered to reduce impacts during construction (e.g. noise, vibrations, turbid water, dust, exhaust gases, and wastes)? ② If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? ③ If construction activities adversely affect the social environment are adequate measures considered to reduce impacts? ④ If necessary, is health and safety education (e.g. traffic safety, public health) provided for project personnel, including workers?	A1: Mitigation measures against public pollution are planned in environmental management and monitoring plan in the IEE report based on the JICA's Guidelines. A2: This project does not impart serious direct impacts to the natural area. However, general mitigation measures and environmental management and monitoring plans are prepared. A3: Infection disease may be spread by construction worker during construction. Thus mitigation measures are planned in the environmental management and monitoring plan (EMMP). A4: Environmental education and health care education for workers and inhabitants will be conducted during construction period.
	(2) Monitoring	① Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? ② Are the items, methods and frequencies included in the monitoring program judged to be appropriate? ③ Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? ④ Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	A1: A proponent will conduct the EMMP based on the JICA's Guideline during construction. A2: If WSD adopts JICA's recommendations, it is reasonable. A3: Generally environmental monitoring will be carried out by contractor. A4: The environmental monitoring reports are submitted together with supervision reports to WSD once a month, then this report is forwarded to SLEPA.
6 Note	Note on Using Environmental Checklist	① If necessary, the impacts to transboundary or global issues should be confirmed (e.g. the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	A1: This project does not give significant impact to this item.

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are made, if necessary.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan' experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

According to the above-mentioned checklist, there is no significant or adverse impact on each environmental item. The Project is, therefore, categorized into “B” as per the JICA guideline, and based on the categorization WSD shall conduct monitoring during the construction stage using the monitoring form shown in Table 2-2-4 and periodically report the result of the monitoring to authorities concerned of the Project.

Table 2-2-4 Monitoring Form

1. Pre-Construction Stage

(1) Permissions/Stakeholder Meetings

	Monitoring Item	Proponent	Method	Duration	Monitoring Results
1	No required item SLEPA has issued the Environmental Approval Letter for the Project to WSD on November 01, 2010*.	-	-	-	

Note *: Please refer to Appendix 5

2. Construction Stage

(1) Resettlement

	Monitoring Item	Standards	Method	Duration	Monitoring Results
1	Acquisition of the land	None	At the sight	Over the construction period	

(2) Infectious diseases, HIV/AIDS, etc.

	Monitoring Item	Standards	Method	Duration	Monitoring Results
1	Health conditions of the construction workers	None	Hearing from the Contractor	Over the construction period	

(3) Traffic Accident

	Monitoring Item	Standards	Method	Duration	Monitoring Results
1	Occurrence of the traffic accident	None	Hearing from the Police	Over the construction period	

(4) Air Pollution

	Monitoring Item	Standards	Method	Duration	Monitoring Results
1	Occurrence of the dust	None	At the sight	Over the construction period	

(5) Water Pollution

	Monitoring Item	Standards	Method	Duration	Monitoring Results
1	Discharge of turbid water and sewage from the construction site and base camp	None	At the sight	Over the construction period	

(3) Socio-economic Conditions

1) Infrastructure

The Project site and the capital city Freetown are being connected with national road network, and the distance is approx. 180km along the road. Of the road between the Project site and Freetown, approx. 100km is unpaved road (laterites road) and it takes four hours by vehicles. Improvement work of the above-mentioned unpaved road is in progress from the Kambia side in cooperation with the European Union (EU), however, condition of the road is bad and four-wheel drive vehicle is essential for moving on the road.

Commercial power supply is not available in Kambia town. A generator is, therefore, need for supplying power. Water service is also not provided in the town. A facility which involves a borehole, pump, roof tank and pipes shall be provided in order to secure safe and clean water in the Project site.

There is an accommodation (lodge) of private business in Kambia town. However, it is difficult to stay in the lodge for long time in respect for its facilities and measures for preventing malaria diseases, etc. Accommodations and offices equipped with power and water supply facilities are essential for staying the Project site during the construction stage of the Project.

Cell phone networks of multiple private companies are available in and around Kambia town. Internet connection service via a cell phone is available in the Project site.

2) Socio-economic Condition

The Kambia District is in the Northern Province of the country and its population is approx. 280,000. Kambia town is a headquarters town of the Kambia District. The District borders on the Republic of Guinea on the west. The international road between the countries pass through Kambia town and the town has important roles for an international trading centre. There are administrative offices such as the District Council, District hospital, police headquarters, Army barracks, etc. in the town, and therefore the town is a political and economical centre of the District.

Kambia town can be divided into two parts, one is the old town on the north and another is a new town located along the international road and being developed in recent years. Present population of the town is estimated to be approx. 20,000. About 3% of the settled population is foreigners with nationalities out of Sierra Leone. Considerable number of unsettled population is seemed to be living in the town who visit the town for trading.

Major ethnic group (language group) in Kambia town is Temne, Limba and Susu with a portion of 71%, 13% and 9%, respectively. For the people’s educational background, graduation of primary, secondary and tertiary school is 29%, 14% and 2% respectively and 51% are illiterate.

There are approx. 3,200 houses in Kambia town. Single family house is approx. 69% and apartment and compound house is 24%. 81% of the people own the houses they live, 13% is house rent and others are rent free dwelling.

For major sources of income, 33% of the people are self-employed, 24% are salaried workers and 21% are pretty traders trading with Gunnies. As for amount of monthly income, 43% of the people are less than Le. 100,000, 27% are between Le. 100,000 and 200,000. Approx. 70% of the households get monthly income of less than Le. 200,000.

3) Water Supply and Sanitation

There are water supply facilities in Kambia town which were constructed in 1970s. The existing facilities were, however, destroyed during the war and are at present not in operation. As a result of the field survey, approx. 44% of the people are using unprotected dug wells and 16% of the people are using dug well with hand pump (there are 38 wells in the town). Approx. 40% of the people are, however, not able to access to safe water and they are fetching insanitary river or stream water. Though the people who are using wells, because some wells are to dry up in the latter half of the dry season, the people take burden of fetching water during the period.

As for coverage of sanitation facility, approx. 21% of the people are using private toilet and 70% are using common pit. There is no sewerage system in Kambia town and therefore sewage is infiltrated into underground. As a result of water analysis conducted during the field survey, high concentrations of Nitrate-Nitrogen which exceed limit of the quality standards were detected from the samples of dug wells. The result shows that the groundwater is likely to be contaminated by sewage of the people.

Further, according to the result of questionnaire survey, approx. 30% of the people replied that member(s) of the family got water born diseases in a year. The Project is, therefore, expected to be materialized in order to improve such conditions of water supply and sanitation in the town.

4) Water Supply Method and Willingness to Pay

As a result of the questionnaire survey during the filed survey, 16% of the people expect to get water through public taps and 80% of the people are through private connections. Of the people who expect to connect private connections, approx. 43% and 37% of the people are expected to connect yard taps and full plumbing, respectively. With regard to willingness to pay, 80% of the people respond “Yes”, 10% of the people replied “No” and others say “Don’t know yet”. As for water tariff, amount of willing to pay for public tap, yard tap and full plumbing is Le. 5,000, Le. 10,000 and Le. 20,000, respectively.

Because the questionnaire survey was conducted in the preparatory stage of the Project and without showing water tariff to the people, many people are expecting connect private connections to their houses though the tariff will be considerably higher than that of public taps.

In order to prepare an appropriate water tariff which will have People's satisfaction of paying water rate, contents and anticipated water services of the Project shall be explained to the people.

Community meetings for explaining the water services to the people and sensitization meetings for pay for water will, therefore, be held and consensus between the people and KWSSB will be formed for water tariff and the services to be provided in the Project so that sustainable water services in Kambia town will be materialized.

(4) Construction and Procurement Conditions

1) Related Law, Standards and Regulations

In Sierra Leone, related law, standards and regulations for construction works have not been well established, therefore, designs and construction works have, therefore, been conducted based on the international and/or donor's standards and regulations. The designs and construction work of the Project will also de carried out in accordance with the international and/or Japanese standards and regulations respecting for those in Sierra Leone, if any.

2) Local Construction Company

Construction companies in Sierra Leone have been registered with the Ministry of Works, and they are categorized into some classes based on applicable amounts of tendering for public works. The highest class companies are called "Primer" and almost all the companies are owned by Lebanese. Of the lower class companies, there is like a broker that gathers equipment and labors only when he gets a job. Therefore, it is recommendable to employ a primer class company as a subcontractor of the Project in respect of its technical and financial capability and stability.

3) Capability of Workers

There is a socio-economical blank in Sierra Leone due to the eleven-year civil war. As for human resources in the field of construction work, skill is not succeeded to younger generation properly and it is difficult to employ sufficient number of skilled artisans such as carpenter, plasterer, re-bar bender, plumber, etc. Experienced common labors are also very few and foreman shall control them every time. The cost estimation of the Project will, therefore, be carried out in consideration of the skill and capability of the labors.

4) Quality and Procurement of Equipment and Materials in Local Market

There is few construction materials being manufactured in Sierra Leone and only cement, aggregate and re-bar for concrete work can be procured in the local market. Generators and steel panel type elevated tank can be procured in Freetown through agents of manufacturers including their spar parts and maintenance services of the equipment. Other materials and equipment such as materials for civil works to be used in the construction work of the Project shall be procured from Japan or other countries.

(5) Employment of Subcontractors

After the war, the Government of Sierra Leone has been conducting large scale civil works such as an improvement of national roads, etc. in cooperation with the international organizations and donors. Because contractors of the works have been selected through international competitive biddings, foreign companies usually get jobs so that local construction companies in Sierra Leone have few experience in large scale civil works even though Prime class companies. The local construction companies have, therefore, low capacities in respect for their skill of the work, control of procurement and schedule.

In order to achieve the expected outputs of the Project within the limited inputs, a local construction company will be employed in the Project. The local construction company is to participate in the construction work of the Project as a subcontractor under the supervision of a Japanese Contractor in order to ensure the required quality of the work, procurement of equipment and materials and anticipated construction schedule.

(6) Operation and Management of the Project

1) Establishment of Operation and Maintenance Organization

An organization which will operate and maintain the water supply facilities to be constructed under the Project needs to be established. After the war in accordance with the decentralization policy of the Government of Sierra Leone, the local governments are responsible for providing water services to the people. In the case of the Project, the Kambia District Council is responsible for the duty.

The Kambia District Council is scheduled to establish the operation and maintenance organization of the Project, Kambia Water Supply and Sanitation Board (KWSSB) as per its bye-law and based on the experience and know-how obtained in the project for "Establishment of Water Supply Management System in Kambia District" conducted by JICA between 2006 and 2008, in which the Council established Rokupr Water Supply and Sanitation Board (RWSSB) for water services in Rokupr and subsequent technical cooperation for dispatch of JICA Expert between September 2009 and January 2010.

2) Staff of KWSSB

Based on the experience in Rokupr, KWSSB will be composed of the Board members and technical and administrative staff including water rate collectors. Water Supply Division (WSD) of the Ministry of Energy and Water Resources, which is only the organization in the country of having the know-how of operating waterworks, will dispatch its staff to KWSSB as the technical staff of KWSSB. The administrative staff with experience and capacity of doing their duty will be employed by the Kambia District Council through its formalities.

The above-mentioned dispatch staff of WSD and the employment of the administrative staff will be carried out in accordance with “Roadmap” of the Minutes of Meetings (see Annex-8) signed between the Ministry of Energy and Water Resources, the Kambia District Council and JICA Preparatory Survey Team on April 29, 2010.

3) Budget

One of the basic policies of the Project is “Self-reliance”. The water services of the Project will, therefore, be provided by revenues of water rates to be paid by the people. The management costs of the Project which will be necessary for establishing KWSSB such as personnel cost, allowance, etc. of the staff of WSD and the Kambia District Council shall be born by the respective organizations.

Further, personnel costs during the training period of the staff of KWSSB prior to the commercial operation and initial working capital of the Project shall be born by the Sierra Leone side.

4) Technical Cooperation Scheme

The Government of Sierra Leonean has promised to make its utmost efforts for establishing the operation and maintenance organization of the Project. The Sierra Leonean side has submitted a request for the technical cooperation programme to the Japanese side intending to get assistance and advice for establishing KWSSB and training of its staff.

Japan’s Grant Aid scheme has a technical cooperation programme named “Soft component”, however, the programme shall be conducted within a validity of the Exchange of Notes (E/N). In the case of the Project, the operation and maintenance organization shall be established newly and capacity of the staff of KWSSB shall be developed in terms of both technical and administrative aspects. Further, the training of staff needs to be continued even after the commencement of water services when the validity of the E/N is expired. The soft component of Japan’s Grant Aid scheme is, therefore, not appropriate as a technical cooperation scheme of the Project.

The technical cooperation for establishing KWSSB and training of the staff is expected to be conducted by JICA’s technical cooperation programme (Dispatch of JICA Expert or project type technical cooperation programme) collaborating with the efforts of the Sierra Leonean side. Japan’s Grant Aid will, therefore, only cover the construction of the water supply facilities of the Project.

(7) Grade of Facilities and Equipment of the Project

The water supply facilities to be constructed under the Project shall be satisfied with the following conditions:

(a) To have sufficient durability against the natural conditions in the Project site.

(b) To be constructed by methods and skills of local subcontractor(s) under the supervision of a Japanese contractor.

(c) To be operated and maintained by skills and knowledge of the technical staff who will be dispatched by WSD.

(d) To coincide with demands of the people for water services in terms of quality and quantity of water, water pressure, supply hours and distance between public taps and their houses, etc. and to be able to form consensus of the people for pay for water.

(e) To be operated and maintained in low cost and to make the tariff affordable for the people.

(8) Construction and Procurement Method and Period

1) Methods of Construction and Procurement

The facilities of the Project will be constructed using conventional construction methods and collaborating common construction machines and manpower. As for procurement of materials and equipment for the construction work, materials for civil and building works such as cement, re-bar, aggregate for concrete work will be procured in Sierra Leone and piping materials will be procured in an European country or South Africa in consideration of their quality, required period of procurement and availability in the local market. Water treatment equipment and devices will be procured in Japan. Generators and steel panel type elevated tank will be procured through agents of manufacturers in Sierra Leone.

2) Construction Period

The construction work of the Project consists of concrete work of the water treatment facilities, assembly of the steel panel type elevated tank, piping work and building work for staff quarters, etc. Critical pass of the construction work will be the piping work which includes installation of pipe of approx. 30km in length and procurement of the piping materials from overseas. The piping work will, therefore, be conducted by multiple working parties and the required number of the parties will be examined in consideration of construction periods of other works.

The construction schedule will be prepared on condition that the construction work is suspended for two months between the middle of July and the middle of September due to heavy rain in the rainy season.

2-2-2 Basic Plan

2-2-2-1 Contents of the Project

The contents of the Project which have originally been requested by the Government of Sierra Leone and the revised ones which have been mutually agreed between the Sierra Leonean side and JICA Preparatory Survey Team during the field survey are shown in the Table 2-2-5 below.

Table 2-2-5 Contents of the Original Request and Mutually Agreed

Items	Contents of the Original Request	Contents Mutually Agreed
1. Water supply area	Kambia town	The old town (Kambia 1) and the new town (Kambia 2) as described in the Minutes of Discussions.
2. Target year	2018	2016 - The anticipated completion year of the Project, 2013 plus three years.
3. Served population	30,500 - Present population (2007): 25,000. (Settled population: 20,000 and transient population: 5,000) - Population growth ratio: 2.04%	30,000 - Present population (2010): 20,768 as a result of the socio-economic survey. The settled population of the Request, 20,000 is likely to be collect. Transient population is 5,000 - Population growth ratio: 2,04%
4. Per capita consumption	50 lcd (liter per capita per day)	36 lcd (liter per capita per day) - Public tap: 20 lcd - Private connection 60 lcd - Portion of users: Public 60% and Private 40%
5. Planned water supply amount	2,000m^3/day - Served population 30,500, per capita consumption 50 lcd and leakage ratio 30%.	1,200m^3/day - Served population 30,000, per capita consumption 36 lcd and leakage ratio 10% (leakage from the system and water used in the water treatment plant)
6. Water source and treatment process	Slow sand filtration - Raw water is taken from the river and the swamp alternatively in consideration of the seasonal variations of their turbidity.	Sedimentation and slow sand filtration - Plain sedimentation basin will be added as a pre-treatment of slow sand filtration in consideration of stability of water sources in transition periods.
7. Construction sites	- Water treatment plant: In the vicinity of the existing elevated tank. - Elevated tank: 1 no. each in the old town and the new town. - Public tap: not decided yet.	- Water treatment plant: In the compound of the existing waterworks. - Elevated tank: 1 no. at the place of the existing elevated tank. Water is supplied from a new tank to both the old and the new towns. - Public tap: The anticipated 100 locations of the public taps have been decided during the field survey with the people's consent.

8. Facilities and equipment	[Water intake] Intake pump: 2 sets (Kolenten) - Intake pump: 2 sets (Swamp) - Generator 34KVA×4 sets [Raw water conveyance facility] - Conveyance pipe: DCIP ϕ 200mm ×2.0km [Water treatment facility] - Capacity 2,000m^3/day - Slow sand filter 135m^2×3 basins - Clear water reservoir 700m^3 - Sand wash and dry 1 no. - Chlorination device 2 sets - Generator 22KVA×2 sets - Lighting device 1 Ls. [Water transmission facility] - Transmission pump: 2 sets - Transmission pipe DCIP ϕ 200mm ×2.0km [Water distribution facility] - Elevated tank 150m^3×2 nos. - Distribution pipe: ϕ 200mm-50mm ×40km - Public tap 100 places [Buildings] - Pump house 2 buildings - Generator room 1 2 buildings - Generator room 2 1 building - Office 1 building - Store 1 building - Staff quarter 6 buildings [Procurement] - Water meter 200 sets - Piping material 1 Ls. - Tools 3 sets	[Water intake facility] - Intake pump: 0.84m^3/min×14.8m ×3.7KW×2 sets (Kolenten) - Intake pump: 0.84m^3/min×17.5m ×3.7KW×2 sets (Swamp) [Raw water conveyance facility] - Conveyance pipe: DCIP ϕ 150mm ×0.5km [Water treatment facility] - Capacity 1,200m^3/day - Receiving well 22m^3×1 basin - Sedimentation 400m^3×2 basins - Slow sand filter 60m^2×4 basins - Clear water reservoir 150m^3 - Sand wash and dry 1 no. - Sand washer 1 set - Chlorination device 2 sets - Generator 60KVA×3 sets - Lighting device 1 Ls. [Water transmission facility] - Transmission pump: 0.42m^3/min ×60.9m×11KW×3 sets - Transmission pipe DCIP ϕ 200mm ×1.7km [Water distribution facility] - Elevated tank 400m^3×1 no. - Distribution pipe: ϕ 250mm-75mm ×29km - Public tap 100 places - Private connection 3 places [Buildings] - Pump house 2 buildings - Generator room 1 building - Store 1 building - Staff quarter 2 buildings [Procurement] - Water meter 30 sets - Piping material 1 Ls. - Tools 1 set (plumbing work) 1 set (electrical work) 1 set (mechanical work)
9. Operation and maintenance organization	The Kambia District Council and the Ministry of Energy and Water Resources will establish the operation and maintenance organization.	The Kambia District Council will establish KWSSB based on its bye-law. KWSSB will be composed of the Board members and the technical and administrative staff. The Sierra Leonean side has submitted a request for technical cooperation to the Japanese side.

The contents of the Project will be examined based on the results of topographic survey, geotechnical survey and socio-economic survey conducted during the field survey and be finalized as optimum and rational plan to achieve the purposes of the Project. As for the above-mentioned contents of the Project, reasons for the modifications of the plans and alternative plans are described in the next section.

2-2-2-2 Basic Plan

(1) Water Supply Area

The water supply area of the Project is the old town (Kambia 1) located in the north of Kambia town and the new town located along the international road. JICA Preparatory Survey Team had discussions with the Sierra Leonean side and both sides agreed that the southern end of the water supply area of the new town which has been developing and expanding its area recently, is to the extent of the Army barrack (refer to Annex-7 of the Minuets of Meetings).

(2) Population in the Water Supply Area

The present population and number of houses in the area mentioned in (1) above have been counted in the socio-economic survey conducted during the filed survey. Results of the survey are as follows:

	No. of houses	Population
Kambia 1	1,231	9,892
Kambia 2	1,962	10,876
Total	3,193	20,768

According to the original request of the Project, the settled population in the year 2007 (the base year) is 20,000. Population of the year 2010 is to be approx. 21,000 if it is estimated based on figures of the population growth ratio of 2.04% and the settled population of the base year of the original request. The estimated population of 21,000 is consistent with the results of the socio-economic survey. Therefore, it can be judged that both the population of the base year and the population growth ratio of the original request are reasonable.

(3) Target Year and Served Population

The target year of the original request is the year 2018. During the field survey, the JICA Team offered the Sierra Leonean side that the target year of the Project should be set in the year 2016, three years after the anticipated completion year of the Project in consideration of the proper scale of the Project, and the Sierra Leonean side agreed on it.

The planned served population can be estimated according to the formula below and based on the verified figures of the original request, i.e. the population of the base year (settled population of 20,000 and transitional population of 5,000 in 2007) and the population growth ratio.

$$\text{Served population} = \text{Population of base year} \times (1 + r)^{n}$$
$$= 25{,}000 \times (1+0.0204)^{9}$$
$$= 29{,}983 \ (\fallingdotseq 30{,}000)$$

Where; r = population growth ratio (2.04%),
n = 2016-2007 = 9

(4) Per Capita Consumption

During the discussions, the Sierra Leonean side explained the JICA Team that among the rural towns, relatively big towns such as a district headquarters town shall be categorized into "Urban town" and per capita consumption of 45 lcd is applicable for the towns according to the National Water and Sanitation Policy 2008.

The per capita consumption of 50 lcd in the original request is likely to be adopted based on the Policy. However, in consideration of the present water supply in Kambia town and the experience in Rokupr, its per capita consumption is between 22 and 23 lcd, it can be judged that the figure of 50 lcd is not reasonable.

According to a draft National Water and Sanitation Policy prepared in 2007, per capita consumption of public tap and private connection is 20 lcd and 60 lcd, respectively. The above-mentioned actual per capita consumption in Rokupr is consistent with a figure that can be estimated using the per capita consumptions of the draft Policy and portions of public tap users and private connection users in Rokupr, i.e. 90% and 10%, respectively. Therefore, planned per capita consumption of the Project will be calculated using the figures in the draft Policy and portions of public and private connection users.

The JICA Team explained the Sierra Leone side the above-mentioned idea and both parties agreed that per capita consumption of public tap and private connection is 20 lcd and 60 lcd and portion of public tap and private connection users is 60% and 40%, respectively. The portions are applicable for towns with their population of more than 30,000 as per the draft Policy. The Planned per capita consumption of the Project can, therefore, be calculated as below:

$$\begin{aligned} \text{Per capita consumption} &= 20 \text{ lcd} \times 60\% + 60 \text{ lcd} \times 40\% \\ &= 36 \text{ lcd} \end{aligned}$$

According to the results of the socio-economic survey, approx. 80% of the people expect to connect private connection to their houses. In reality, the portion will not reach to such a high ratio because tariff of private connections is considerably higher than that of public taps. The portion of private connection users of 40% used in the above estimation of the planned per capita consumption is, therefore, reasonable and appropriate.

(5) Planned Water Supply Amount

As per the examinations in (3) and (4) above, amount of water consumption of the Project is 1,080m^3/day (=30,000×36lcd÷1,000). When designs of the facilities of the Project such as pumps, water treatment facilities, pipelines, etc. are conducted, their design capacity, the planned water supply amount, shall be decided in consideration of the above-mentioned water consumption and water leakage from the system, etc.

According to the original request, water leakage ratio is 30%, however, the figure may be two big because almost all the facilities of the Project will be constructed newly and there is few water leakage from the system.

The JICA Team explained the Sierra Leone side the above and both parties agreed that the water leakage ratio is set at 10% in which water leakage from the system and amount of water used in the water treatment process such as scraping and washing of filter sand, drainage of sludge from the sedimentation basin, etc. are included, and the planned design capacity will be calculated as mentioned below:

$$\begin{aligned} \text{Planned design capacity} &= \text{Water consumption} \div (1 - \text{leakage ratio}) \\ &= 1{,}080\text{m}^3/\text{day} \div (1 - 0.10) \\ &= 1{,}200\text{m}^3/\text{day} \\ &= 50\text{m}^3/\text{hr} \\ &= 0.84\text{m}^3/\text{min} \end{aligned}$$

(6) Water Source and Treatment Process

Slow sand filtration is being requested as the process of water treatment of the Project. During the field survey, the JICA Team conducted a survey on the water treatment plant in Rokupr. As a result of the survey, it was found that the plant equipped with slow sand filtration system has been operated and maintained properly and the slow sand filtration is applicable as the process of water treatment of the Project.

There is a limitation of quality of raw water, i.e. turbidity on introducing the slow sand filtration system. According to the original request, raw water will be taken from the Kolenten River and the swamp alternatively in consideration of their seasonal variations of turbidity intending to take water of low turbidity through the year. The method of water intake seems to be appropriate, however, during the transition periods between the rainy season and the dry season it may occur problems that discharge of the swamp does not increase sufficiently though turbidity of the river water is increasing in the rainy season or discharge of the swamp is decreasing rapidly though turbidity of the river is still high in the dry season.

The JICA Team explained the Sierra Leone side these problems and the Team recommended to construct a plain sedimentation basin as pre-treatment process of the slow sand filtration from the point of view of stability of water sources and both parties has confirmed the necessity of the pre-treatment.

As a result of water analysis on water of the Kolenten River and the swamp, there is no problematic quality item for water treatment. The flow of water treatment of the Project will, therefore, be the conventional treatment process which includes plain sedimentation, slow sand filtration and chlorination of the treated water for disinfection using bleaching powder.

(7) Water Supply Method

In the Project, water will basically be supplied to the people through public taps. Private connections will be installed by the Sierra Leonean side at its own expense and be installed in consideration of the per capita consumption and the portion of users mentioned in (4) above in order to prevent negative impact against the public taps. In response to the request of the Sierra Leone side made during the field survey, private connections to the Kambia Hospital, Kambia District Council and Resource Centre will be installed within the scope of Japan's Grant Aid.

(8) Possibility of using the Existing Facilities

In Kambia town, there are the existing water supply facilities such as water intake, waterworks, elevated tank, pipelines and public taps which were constructed in 1970s. As a result of the field survey, it has been confirmed that almost all the facilities are difficult to use in the Project due to destruction during the war and serious deterioration because of no maintenance for many years.

Of the existing facilities, there is a possibility that raw water intake channel and pump pit of the existing water intake facility at the Kolenten River are used in the Project if the channel is improved as a paved one and the screen and gate of the pump pit are replaced.

There are staff quarters and a store which were destroyed during the war in the site of the existing waterworks. As a result of the field survey, it was found that they are difficult to rehabilitate due to severe destruction and deterioration of them. Only the foundations of these buildings can be used and new buildings will be constructed on the foundations in the Project.

(9) Proposed Construction Sites of the Facilities

1) Water Treatment Plant

According to the original request of the Project, proposed construction site of a new water treatment plant is located in the vicinity of the existing elevated tank. As a result of the field survey, it was found that there are many houses around the elevated tank and it is difficult to secure the land for the water treatment plant which requires relatively wide area at the proposed site.

The Sierra Leonean side and the JICA Team had discussions on the matter and both parties have come to the conclusion that the new water treatment plant is to be constructed in the site of the existing waterworks where land acquisition is not required.

The modification of the construction site can get rid of the land acquisition and enables supplying power to both the intake pumps and water transmission pumps from a generator located in the water treatment plant because the plant is to be constructed adjacent to the water intakes at the Kolenten River and the swamp. By doing so, energy efficiency is improved very much because intensive arrangement of generators is realized.

2) Elevated Tank

According to the original request of the project, treated water is transmitted to elevated tanks in the old town and the new town, respectively and once water is stored in the tanks, water is distributed to the respective water supply areas by gravity. The method of water distribution has been examined based on the elevations at the proposed construction sites of the tanks and their water supply areas which were measured in the topographic survey conducted during the field survey. As a result of the examination, it was found that the most desirable method of water distribution is to supply water from an elevated tank to be constructed at the site of the existing elevated tank by gravity through respective pipes to the old town and the new town from the view point of energy efficiency and minimizing the construction cost. The JICA Team explained the Sierra Leonean side the above and both parties agreed that an elevated tank is to be constructed newly at the site of the existing elevated tank.

3) Public Taps

According to the original request of the Project, 100 public taps (3-faucet type) are constructed in Kambia town. In the field survey, the JICA Team conducted a survey on the locations of the existing roads, schools, hospitals, markets and other institutional facilities and distributions of population in the water supply area. Based on a result of the survey, the JICA Team prepared a planning map in which public taps are arranged at about 200m interval following the experience in Rokupr. Subsequently, the JICA Team visited the proposed sites of the public taps and set wooden pegs at the sites after consultations and getting approval of the people. As a result of the above-mentioned works, 41 and 59 proposed sites of the public taps have been selected in the old town and the new town, respectively.

4) Present Situation of the Sites

Because the proposed water treatment plant and the elevated tank are to be constructed in the sites of the existing facilities, land acquisition for the proposed facilities is not required. In the field survey, the JICA Team conducted site recognizance and topographic survey in order to know the size of land and the topographic conditions. Further, boring survey, plate bearing test and test pit survey were conducted in order to know the geotechnical conditions of the sites. As a result of the surveys, it was found that the proposed facilities of the Project are able to be arranged within the sites of the existing facilities and a plain foundation is applicable for the proposed facilities because the sites have sufficient load capacity.

As mentioned above, land acquisition will not be required in the Project. However, the existing facilities in the sites such as water treatment facilities, elevated tank, etc. need to be removed. The JICA Team explained the Sierra Leonean side that the work for removing the existing facilities shall be carried out by the Sierra Leonean side as an obligation of the recipient country. The Sierra Leonean side agreed to do the work at its own expense.

(10) Proposed Pipeline Routes

1) Raw Water Conveyance Pipe

Raw water conveyance pipes between the water intakes and the proposed water treatment plant located in the existing waterworks will be installed under the existing roads. There is no house along the pipeline routes so that resettlement of people does not occur. However, because asbestos concrete pipes are being laid under the road between the water intake at the swamp and the water treatment plant, the proposed pipeline shall be installed in parallel with the asbestos pipes in order for not disturbing them.

2) Water Transmission Pipe

Water transmission pipe between the water treatment plant and the elevated tank will also be installed under the existing road and there is no problem for resettlement of the people in connection with the work. Along the route of the transmission pipe, base rock is found at some part where the elevation is low. Therefore, a work method for trench excavation needs to be examined and additional cost for the excavation work shall be taken into consideration.

3) Water Distribution Pipe

The routes of water distribution pipes and their networks are decided in consideration of the rationality for delivering water to the 100 public taps in Kambia town. In the old town, there is a great difference (approx. 50m) between the elevation around the existing elevated tank (approx. 65m) and the elevation of land near the river (approx.16m). The water supply area will, therefore, be divided into two areas, “higher area” and “lower area”, and water is distributed separately from the view point of stability of water supply. On the other hand, because the water supply area of the new town is being divided into two areas by the international road, the water supply area of the new town will be divided into two water supply blocks, “East” and “West”, and water is distributed separately.

The distribution pipes will generally be installed under the existing roads. In the old town asbestos concrete pipes are being laid, new pipes will, therefore, be installed along the routes which do not disturb them. In the new town, at approx. 1km of the route of the distribution pipes rock excavation is needed.

(11) Facility Layout Plan

A general layout plan of the facilities of the Project which is prepared based on the examinations mentioned-above, is shown in Fig. 2-2-1. Locations of the public taps in the old town and the new town and their water distribution networks are described in Fig. 2-2-2 and Fig. 2-2-3, respectively.

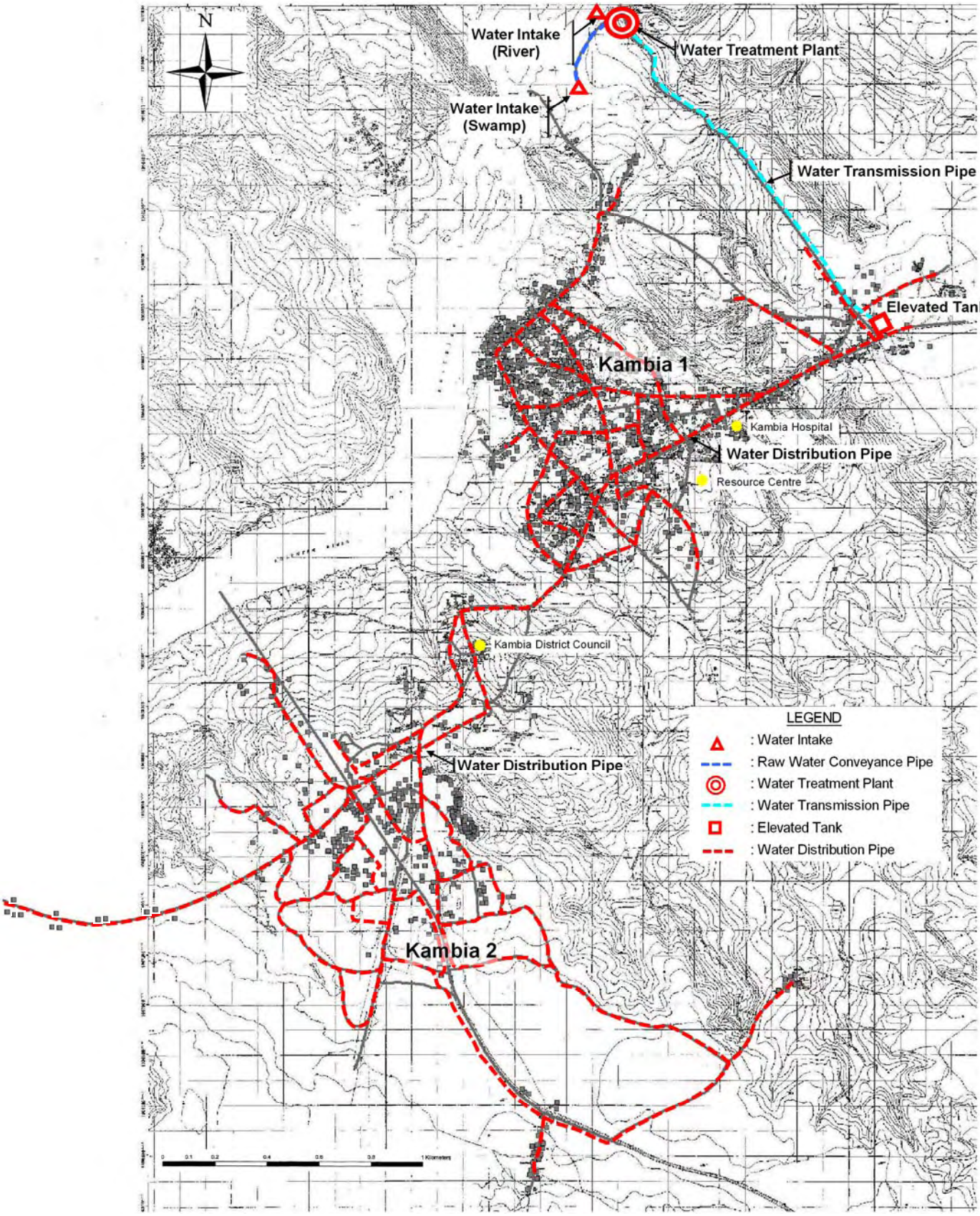


Fig. 2-2-1 General Layout of the Water Supply Facilities of the Project

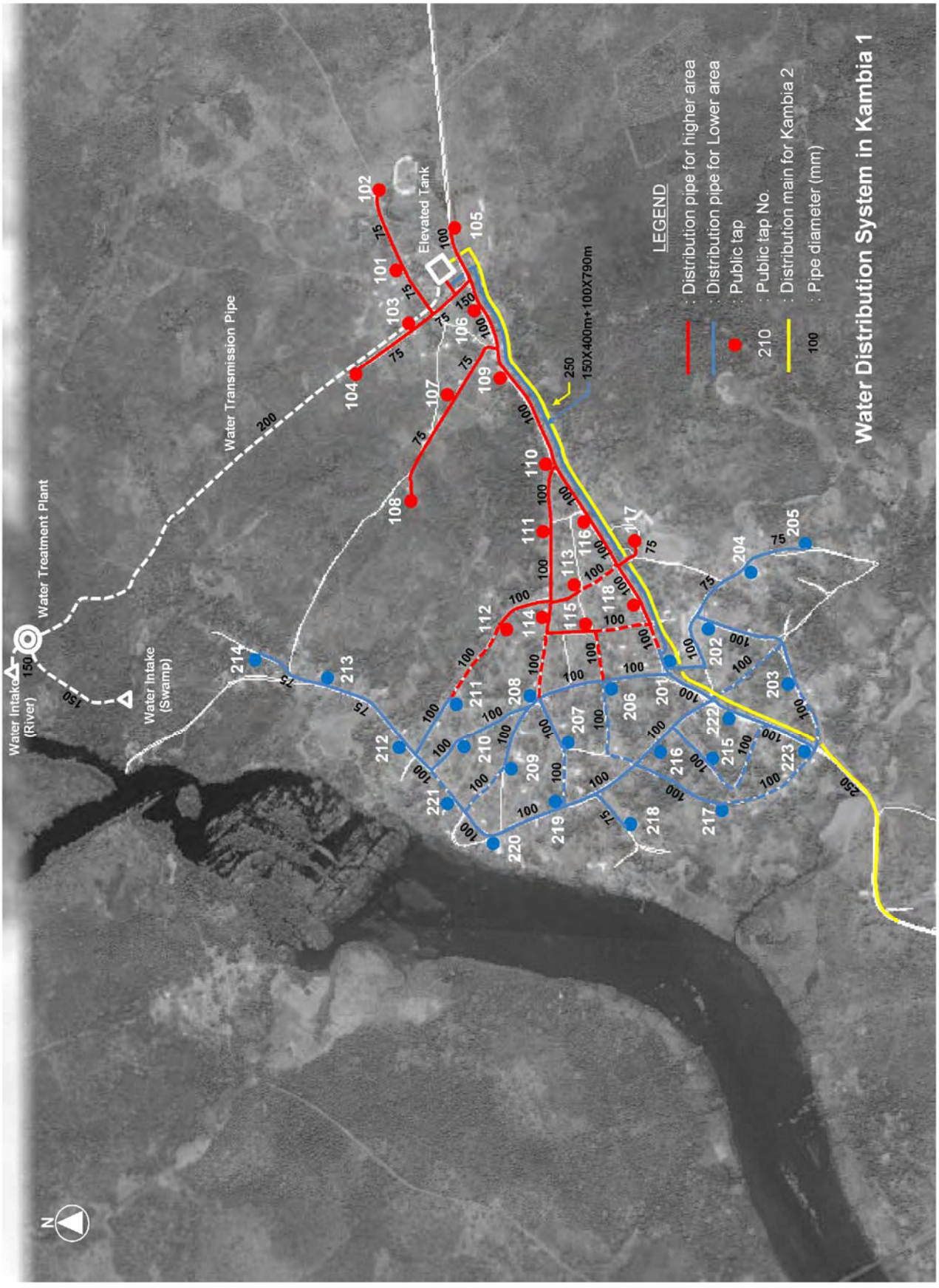


Fig. 2-2-2 Water Distribution System in the Old Town (Kambia 1)

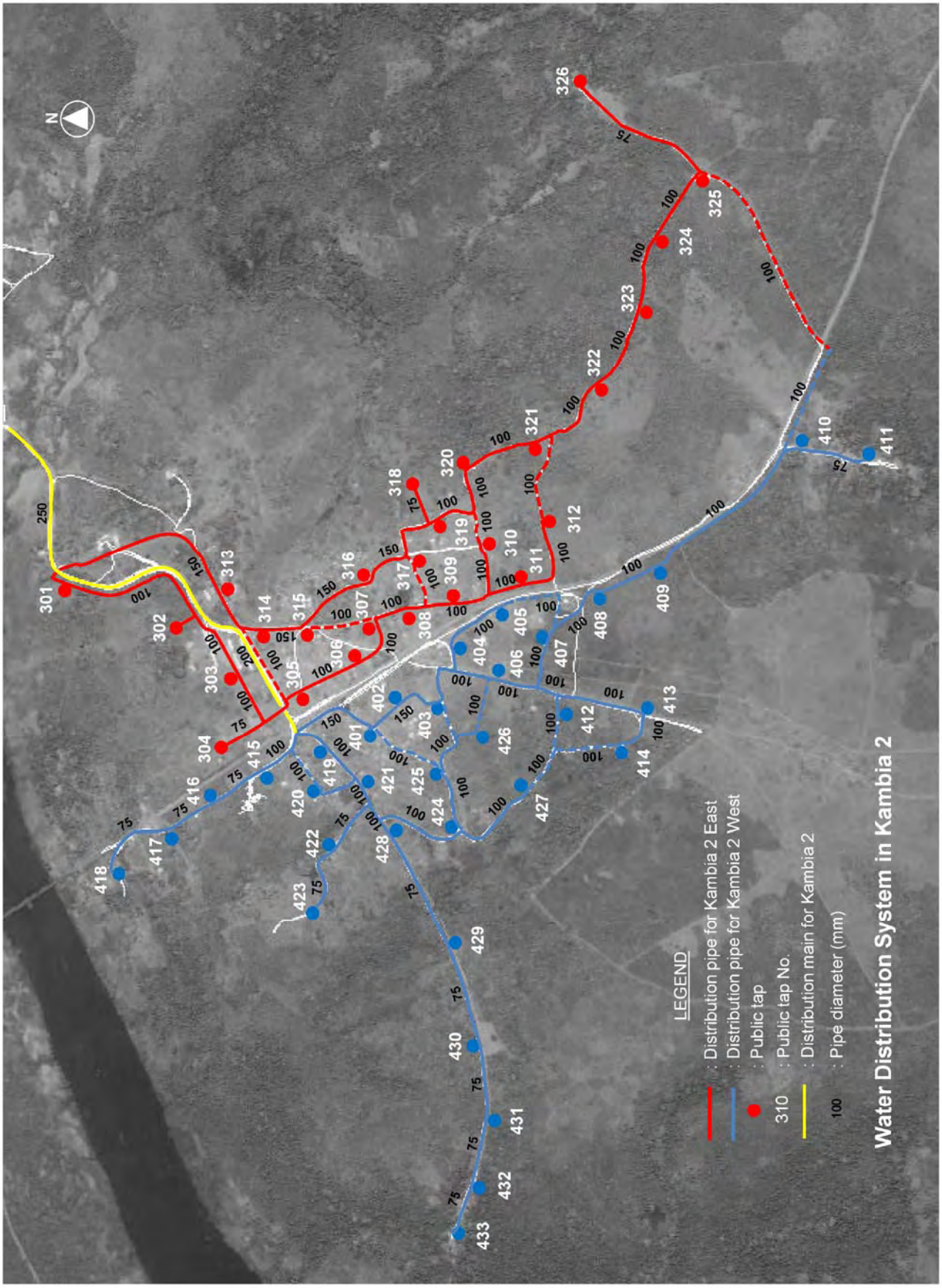


Fig. 2-2-3 Water Distribution System in the New Town (Kambia 2)

2-2-2-3 Basic Design

The outline designs of the Project have been prepared in accordance with design criteria of "Design Criteria for Waterworks Facilities, Japan Water Works Association, 2000" and "Waterworks Business Practice Handbook, Small Scale Waterworks Association, 2010". Equipment and materials of the Project have been selected as per standards of Japan Industrial Standards (JIS) and International Organization for Standardization (ISO). Design conditions, scale and specifications of the respective water supply facilities to be constructed under the Project are examined below:

(1) Water Intake Facility

1) Intake Pump (Kolenten River)

The existing intake facilities at the Kolenten River such as raw water intake channel and pump pit are rehabilitated and raw water is taken using these facilities. Design conditions and the planned facility are as follows:

[Design conditions]

- Elevation: Bottom of the channel: EL=13.88m; Receiving well: EL=28.00m (HWL)
- Length (L): 100m (length of raw water conveyance pipe)
- Velocity coefficient (C): 110 (DCIP)
- Diameter (D): 150mm
- Pumping rate (Q): $0.84m^3$/min
- Head loss: 0.683m ($=10.666\times C^{-1.85}\times D^{-4.87}\times Q^{1.85}\times L$)
- Total head: 14.8m (=28.00m-13.88m+0.683m)

[Planned facility]

- Intake pump: $0.84m^3$/min×14.8m×3.7KW×2 nos. (Centrifugal pump, 1 no. standby)
- Accessories: Foot valve, sluice valve, check valve, pressure gauge

2) Intake Pump (Swamp)

A new intake facility is constructed in order to take raw water from the swamp. Design conditions and the planned facility are as follows:

[Design conditions]

- Elevation: Bottom of the swamp: EL=13.20m; Receiving well: EL=28.00m (HWL)
- Length (L): 400m (length of raw water conveyance pipe)
- Velocity coefficient (C): 110 (DCIP)
- Diameter (D): 150mm

- Pumping rate (Q) $0.84m^3/min$
- Head loss 2.731m ($=10.666\times C^{-1.85}\times D^{-4.87}\times Q^{1.85}\times L$)
- Total head 17.5m (=28.00m-13.20m+2.731m)

[Planned facility]

- Intake pump $0.84m^3/min\times 17.5m\times 3.7KW\times 2$ nos. (Centrifugal pump, 1 no. stand-by)
- Accessories Foot valve, sluice valve, check valve, pressure gauge

(2) Raw Water Conveyance Facility

Raw water conveyance pipes between the water intakes and the water treatment plant are installed. According to the above-mentioned examinations, the planned facilities are as follows:

[Planned facility]

- Conveyance pipe DCIP ϕ 150mm×100m (Kolenten River-Water treatment plant)
- Conveyance pipe DCIP ϕ 150mm×400m (Swamp-Water treatment plant)

(3) Water Treatment Facility

1) Receiving Well

Receiving well is provided to stabilize fluctuations of water level of raw water taken from the water intakes so as to enable the following treatment process of sedimentation accurate.

[Design conditions]

- Detention time 1.5 min or more (in the case of scale facility, surface area is $10m^2$ or more)
- Freeboard 60cm or more

[Planned facility]

- Receiving well 2.50m×4.0m×H2.8m (effective depth: 2.2m, capacity: $22m^3$)

2) Plain Sedimentation Basin

Plain sedimentation basin is provided to remove suspended solid by gravitational settling action so as to reduce burden to the following slow sand filtration.

[Design conditions]

- Surface loading 5 to 10mm/min (Detention time 8hours)
- Average flow speed 0.3m/min or less
- Flow rate $0.84m^3/min$
- No. of basin 2 basins or more
- Freeboard 30cm or more
- Sedimentation area $0.84m^3/min\div 5mm/min\times 1{,}000=168m^2$

[Planned facility]

- Sedimentation basin: B7.0m×L26.0m×H2.50m×2 basins (Effective depth: 2.2m)
  Sedimentation area=7.0m×26.0m=182m^2>168m^2
  Capacity=7.0m×26.0m×2.2m=400.4m^3>400m^3 (8 hours)
- Ancillary facility: Effluent trough, sludge drainage valve, washing valve

3) Slow Sand Filter

Slow sand filter is provided to treat suspended and dissolved matters in water by microbes that grow in and on the surface of the sand layer.

[Design conditions]

- Flow rate: 0.84m^3/min (=1,200m^3/day)
- Filtration rate: 5m/day (during scraping a filter: 8m/day or less)
- No. of filter: 2 basins or more
- Sand layer: 700 to 900mm
- Gravel layer: 400 to 600mm
- Depth of water: 90 to 120cm
- Freeboard: 30cm or more
- Filter area: 1,200m^3/day÷5m/day=240m^2

[Planned facility]

- Slow sand filter: B6.0m×L10.0m×H2.50m×4 basins (Effective depth: 2.2m)
  Filter area=6.0m×10.0m×4 basin=240m^2
  Filtration rate during scraping: 1,200m^3/day÷(3 basins×60m^2)
  =6.67m/day<8m/day
- Ancillary facility: Underdrain system (porous block type)

4) Clear Water Reservoir

Clear water reservoir is provided in the final stage of water treatment and to adjust imbalance between the the filtration volume and transmission volume.

[Design conditions]

- Flow rate: 0.84m^3/min (=50m^3/hr)
- Capacity: 1 hour or more of the flow rate
  In consideration of inflow from the slow sand filter when the operation is suspended (=240m^2×0.5m=120m^3, 240m^2: filter area, 0.5m: average water depth of the filters), the capacity is 3 hours of the flow rate (=50m^3/hr×3 hours=150m^3).
- No. of basin: 2 basis or more
- Freeboard: 30cm or more
- Bottom of reservoir: 15cm or more below the low water level (LWL)

[Planned facility]

- Clear water reservoir — B7.0m×L7.2m×H2.55m×2 basins (Effective depth: 1.60m)
  Capacity=7.0m×7.2m×1.60m×2 basins=161m^3>150m^3
- Ancillary facility — Transmission pump room

5) Sand Wash and Dry

Sand wash and dry is provided to temporarily store the scraped sand of the slow sand filter and to store the washed sand.

[Design conditions]

- Volume of scraped sand — 1.98m^3/time/basin (=60m^2×0.03m×1.1)
- Muddy sand stock yard — enough to store the volume of scraped sand of 4 basins
  Capacity=1.98m^3×4 basins=7.92m^3
- Clean sand stock yard — enough to store a half of total filter sand volume
  Capacity=0.70m×240m^2×1/2＝84m^3

[Planned facility]

- Muddy sand stock yard — B2.5m×L9.0m×H0.4m (average height of stored sand)
- Clean sand stock yard — B9.0m×L13.1m×H0.7m (average height of stored sand)

6) Sand Washer

Sand washer is provided to wash the scraped sand of the slow sand filter. It has a simple structure and the sand is washed by water pressure.

[Design conditions]

- Capacity — enough to wash the volume of sand in the muddy sand stock yard in 6-hour work in a day
  7.92m^3÷6 hours=1.32m^3/hr
- Water for washing — 10 to 15m^3/hr (pressure: 3.0kgf/cm^2)

[Planned facility]

- Sand washer — 1 no. (capacity:1.5m^3/hr>1.32m^3/hr)
- Ancillary facility — sand conveyor, rubber hose

7) Bleaching Powder Dissolution and Feeding Equipment

Bleaching powder dissolution and feeding equipment is provided to disinfect the treated water and to ensure safety of water supply.

[Design conditions]

- Flow rate — 1,200m^3/day
- Dosing rate — 1 to 5mg/l (as per the record in Rokupr of 2 to 3mg/l)
- Effective chlorine — 60% (Bleaching powder/Calcium hypochlorite)
- Concentration — 3%

- Specific gravity 1.05
- Maximum dosing rate $1,200m^3/day \times 5\ mg/l \times (100\%/60\%) \times (1/1.05) \times (1/24) \div 1000$
  $= 13.2little/hr$ (≒20 little/hr)

[Planned facility]

- Chlorination devices 2 sets (1 no. standby, gravity injection type)
- Ancillary facility dissolution tank (5-day capacity: 1,000 liters), agitator (0.2KW)

8) Sludge and Drainage Basin

Sludge and drainage basin is provided to temporarily store turbid water of the sedimentation basin and the sand washer and to reduce the turbidity prior to discharge the drainage to the river.

[Design Conditions]

- Drainage Plain sedimentation basin and sand washer
- Inflow rate Average rate for draining a pond of the sedimentation basin ($400m^3$) in 6 to 8 hours (67 to $50m^3/hr$) or discharge of sand washer (10 to $15m^3/hr$). Therefore, inflow rate is $60m^3/hr$.
- Surface loading 12m/hr
- Average flow speed 80m/hr
- No. of basin 1 basin
- Freeboard 30cm
- Sedimentation area $60m^3/hr \div 12m/hr = 5.0m^2$

[Planned facility]

- Sludge & drainage basin B1.5m×L5.0m×H1.5m×1 basin
  Sedimentation area=$1.5m \times 5.0m = 7.5m^2 > 5.0m^2$
- Ancillary facility Drainage pipes in the plant (PVC)

9) Generator

Generator is provided to supply power to the water intake pumps, transmission pumps and lighting devices in the plant.

[Design conditions]

- Standard Fire Service Law, 1976, Cabinet Office, Japan
- Formula $PG = ((PL-Pm)/0.85 + Pm \times \beta \times C \times PFs)/\cos\phi + PLs$

  Where;

  PG: Output of generator (KVA)
  PL: Power load (KW)
  Pm: Maximum motor output (KVA)
  β: KVA of motor per KW at starting (=7.2)
  C: Coefficient (direct: 1.0, Y-Δ: 0.67)
  PFs: Power factor at start (=0.4)

		cos ϕ : Power factor (=0.8)
		PLs: Single phase load (KVA)
-	Load	Transmission pump 1 11KW (Y-Δ)
		Transmission pump 2 11KW (Y-Δ)
		Intake pump 3.7KW (direct)
		Other load 3.0KW (lighting devices, etc.)
-	No. of generator	2 nos. or more
-	Output required	PG=51.1KVA

[Planned facility]

-	Generator	60KVA×3 nos. (1 no. standby)
-	Power load (pump)	3 phase, 400V, 50Hz
		2 generators are alternatively operated daily. 3 generators are therefore need including 1 standby.
-	Ancillary facility	fuel tank (2,000 little)
		Control board (intake pump: 2 nos., transmission pump: 1 no.)
		Cables for power supply

10) Lighting Device

Out door lamp is provided in the water treatment plant to operate and maintain the facilities in night time and for security. Lighting system of the buildings is also provided.

[Planned facility]

-	Outdoor lamp	Mercury lamp 200W
-	Indoor lamp	Fluorescent and incandescent lamp
		Lighting load: single phase, 230V, 50Hz

(4) Water Transmission Facility

1) Water Transmission Pump

Water transmission pump is provided to transmit the treated water of the water treatment plant to the elevated tank.

[Design conditions]

-	Elevation	Clear water reservoir: EL=23.00m (LWL)
		Elevated tank: EL=81.00m (HWL)
-	Length (L)	1,715m (length of water transmission pipe)
-	Velocity coefficient (C)	110 (DCIP)
-	Diameter (D)	200mm
-	Pumping rate (Q)	0.84m^3/min
-	Head loss	2.884m (=$10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L$)

- Total head 60.9m (=81.00m-23.00m+2.884m)

[Planned facility]

- Transmission pump $0.42m^3$/min×60.9m×11KW×3 nos. (Multi-stage centrifugal pump, 1 no. standby)
  In order to minimize the output of the generator, water is transmitted by 2 pumps of 11KW instead of a pump of 22KW.

2) Water Transmission Pipe

Water transmission pipe between the water treatment plant and the elevated tank is installed to transmit the treated water.

[Planned facility]

- Transmission pipe DCIP ϕ 200mm×1,715m (Water treatment plant-Elevated tank)

(5) Water Distribution Facility

1) Elevated Tank

The deteriorated existing elevated tank is removed and a new elevated tank is constructed at the same place of the existing tank.

[Design conditions]

- Capacity 8 to12 hours of the planned daily maximum water supply ($1,200m^3$/day)
- Depth 3 to 6m (effective depth)

[Planned facility]

- Elevated tank $400m^3$×1 no. (Height: 10m, effective depth: 3.1m, steel panel type), Steel panel (10×9×3 plates), 1.2m×1.2m per sheet
  $12.0m×10.8m×3.1m=401.8m^3>400m^3$
  Capacity is 8 hours of the planned daily maximum water supply in consideration of the period between 9 p.m. and 5 a.m. when there is little water demand. $50m^3$/hr×8 hours=$400m^3$

2) Water Distribution Pipe

Water distribution pipe is installed to supply water from the elevated tank to the town.

[Design conditions]

- Material of pipe PVC pipe is used at the normal part of the piping route where the pipes are installed underground and at the exposed parts such as river crossing, etc. DCIP pipe is used.
- Velocity coefficient C=130 (PVC pipe)
- Service pressure 10m ($1.0kgf/cm^2$) or more at each public tap

- Maximum hourly supply — the maximum hourly water supply is calculated at the hourly factor of 4.0.
- Diameter — Based on hydraulic calculations of the distribution pipes, diameter of pipe is decided securing the minimum service pressure at the respective public taps. The minimum diameter of the member pipes of making networks is 100mm or more.
- Water supply area — Water supply area of the old town is divided into two blocks, “Higher area” and “Lower area”. The new town is also divided into two blocks, “East” and “West”. Water is supplied to the respective blocks separately.
- Depth of pipe laying — Pipe is buried at 1.20m and 1.00m in deep under main rods and feeder roads, respectively in consideration of the traffic of heavy vehicles on the roads.

[Planned facility]

- Distribution pipe — 250mm-75mm×29km
  Water pressure at each public tap and diameter of the pipe are shown in Appendix 2.

3) Public Tap

Public taps are provided to supply water to the people.

[Design conditions]

- No. of tap — 1 place at each 200m (distance for fetching water is approx. 100m or less)
- No. of faucet at tap — 3-faucet type

[Planned facility]

- Public tap — 41 places in the old town and 59 places in the new town (100 places in total). Locations of the taps are in agreement during the field survey.

4) Private Connection

Private connections are provided at Kambia Hospital, Kambia District Council and Recourse Centre which are the institutional facilities for the whole Kambia District.

[Planned facility]

- Private connection — 40mm (with water meter)×3 places

(6) Buildings

Buildings are provided for the respective purposes and in consideration of the size of equipment and number of staff.

[Planned facility]

- Pump house 2 buildings (3.0m×5.0m)
- Generator room 1 building (10.0m×7.0m)
- Store 1 building (12.0m×6.0m)
- Staff quarter 1 1 building (18.0m×7.5m)
- Staff quarter 2 1 building (22.0m×8.2m)

(7) Procurement of Equipment and Materials

Water meters and their piping materials which are to be connected to the institutional facilities in Kambia town are procured. Tools for maintenance works of the water supply facilities are also procured.

[Equipment and materials to be procured]

- Water meter 40mm (with meter box)×30 sets
- Piping material 1 Ls. (Ferrule with saddle, pipe, valve, nipple, socket, etc)
- Tools For plumbing work 1 set
  For electrical work 1 set
  For mechanical work 1 set