No.

JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF EQUIPMENT AND TRANSPORTS
REPUBLIC OF NIGER

THE STUDY
ON
SANITATION IMPROVEMENT
FOR
THE NIAMEY CITY
IN
THE REPUBLIC OF NIGER

FINAL REPORT
VOLUME I: SUMMARY REPORT

DECEMBER 2001

TOKYO ENGINEERING CONSULTANTS CO., LTD.
YACHIYO ENGINEERING CO., LTD.

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FCFA 100 = FRF 1.00 = JPY 16.66

THE STUDY

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FINAL REPORT

CONSTITUENT VOLUMES

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PREFACE

In response to a request from the Government of Republic of Niger, the Government of Japan decided to conduct The Feasibility Study on Sanitation Improvement for The Niamey City in The Republic of Niger and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team to Niger three times between July 2000 and October 2001. The study team is headed by Mr. Kaoru Suzuki of Tokyo Engineering Consultants Co., Ltd. and associated with Yachiyo Engineering Co., Ltd. In addition JICA set up an advisory committee headed by Pr. Dr. Masahiro Murakami, Department of Infrastructure System Engineering, Kochi University of Technology between July 2000 and September 2001, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Niger and conducted field surveyors at the study area. Upon returning to Japan, the team conducted further studies and prepared the final report.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Niger for their close cooperation extended to the Team.

December 2001

Takaaki Kawakami
President
Japan International Cooperation Agency

THE STUDY ON SANITATION IMPROVEMENT FOR THE NIAMEY CITY
IN THE REPUBLIC OF NIGER

Mr. Takaaki Kawakami
President
Japan International Cooperation Agency

December 2001

LETTER OF TRANSMITAL

Dear Sir,

We are pleased to submit you the final report entitled “THE STUDY ON SANITATIONIMPROVEMENT FOR THE NIAMEY CITY IN THE REPUBLIC OF NIGER”. This report has been prepared by the Study Team in accordance with the contracts signed on 11 July 2000, between Japan International Cooperation Agency and Tokyo Engineering Consultants Co., Ltd. and Yachiyo Engineering Co., Ltd.

The report examines the existing conditions concerning wastewater systems and solid waste management in Niamey city, and present a feasibility study on a priority project selected from the master plan.

The report consists of the Summary Report, Main Report, Appendix and Drawing.
The Summary Report summarizes the results of all studies. The Main Report presents the results of whole study including background conditions, formulation of the master plan, selection of the priority project and the feasibility study on the priority project. The Appendix describes in detail of the contents of the Main Report.

All the members of the Study Team wish to acknowledge gratefully to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Embassy of Japan in Ivory Coast, and also to the officials and individuals of the Government of Niger for their assistance extended to the improvement of the wastewater systems and the solid waste management development in Republic of Niger.

Yours faithfully,

Kaoru Suzuki
Team Leader

EXECUTIVE SUMMARY

MASTER PLAN

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MASTER PLAN

1. OBJECTIVE OF THE STUDY

Because of the rapid population growth of urban area of Niamey City, the environmental circumstance of Niamey City has been deteriorating year by year past ten (10) years. In addition, the necessity of review of present Sewerage Master Plan formulated in the year 1981 was under taken to the Authority. In response to the request from Government of Niger (GON), the Study Team dispatched by Japan International Cooperation Agency (JICA) commenced the Study on Sanitation Improvement for the Niamey City in the Republic Of Niger.

At the first step of the study it was discussed and agreed that the core concept of the study is to make a practical master plan of environmental improvement in countries, which are under harsh natural environment and economical conditions. It means that the mission in this study is to make environmental model countermeasures under the restricted resources and conditions.

The study area of M/P is encompassed with about 23,900 ha and its target year of the project is the year 2015, and for the F/S about 250 ha and 2005, respectively. Ministry of Equipments and Transports (MET) is undertaking this project in GON. The contents of the Study consist of M/P, Phase I and Feasibility Study, Phase II.

2. EXISTING CONDITIONS AND IDENTIFICATION

The Study area, Urban Community of Niamey (CUN), is the autonomous political unit that has an equal administrative standing as the other seven Departments in Niger. It is divided into three Communes, each of which also has its own mayor and an administrative body in charge of providing public services to the citizens.

In 1994, the Direction of Population made population projections for the nation as well as the departments, including Niamey. According to this, the population of Niamey in 2000 is projected to be about 650,000.

The total area of CUN is about 23,900 ha, of which about 8,800 ha have been already urbanized. The rest of the area is rural and used primarily for agriculture and raising livestock. Most framers in Niamey produce food for their own consumption. Although Niamey's agriculture is far from self-sufficient in terms of food supply, it is an important means of life for many people.

There is no existing sewerage system in the public area. Only institutions and major industries have facility to treat their wastewater. However, many of these plants are non-functional or poorly managed. Discharge pattern of domestic wastewater in the City is to be categorised into three types, namely urbanised area, high residential area and low residential area.

The present situation of the domestic waste management in Niamey can be summarized by a precarious situation. It is sufficient to walk in streets of Niamey, except the big arteries of the

center city; one recognizes that the domestic waste collection isn't properly done. This insufficiency is very striking at the peripheral districts of Niamey.

As a result of deficiencies in sanitation facilities and services, and inappropriate hygiene practices and behaviour, solid and liquid waste generated by households are now a serious source of insalubrity and nuisances in Niamey. Waste generated by industries, hospitals and other institutions are additional sources.

3. BASIC PLANNING CONDITIONS

The future population of Niamey can be forecast by using the share of Niamey in the national total (Table S5.1). The Ministry of Plan provides official projections of the national population for every five years from 2005 to 2025. The population of Niamey were projected 757,000 in 2005, 871,000 in 2010 and 993,000 in 2015 respectively.

Based on the overall assumptions and analyses, the area of CUN continues to expand toward the year 2015. Total area of Commune is calculated about 23,900 ha, urbanized area is about 11,200 ha and residential area is 7,800 ha in the year 2015.

4. MASTER PLAN OF SEWERAGE AND DRAINAGE

Based on the fundamentals, sewerage facility planning area is divided into 15 sewerage/drainage zones. In the center of the city, storm water drainage already exists. Combined sewer system which collects both wastewater and storm water in a single channel is recommended in this area utilizing existing drainage. Interceptor shall be provided with the existing drainage to collect the sewage. Construction cost of this system will be lower because of utilization of the existing drainage. Area of C1 to C4 is categorized in this system.

The separate sewer system which collects waste water and storm water in the separate conduit/pipes respectively will be planned for the area where neither the existing drainages are well organized nor exist such as in the future residential area. Area S1 – S11 is categorized in this collection system. Based on the framework described in previous Chapter, design sewage flow in the year 2015 estimated as below.

(1) Planning Area : 7,600 ha
(2) Sewerage Population : 793,700
(3) Design Sewerage Flow : 41,400 m^3 / day (Daily Average Flow)
: 53,800 m^3 / day (Daily Maximum Flow)

Existing drainage capacity was initially checked. If the capacity of the existing drainage is not adequate, additional drainage was planned along with the existing drainage. In addition, new drainage facility was planned in the area where existing drainage does not exist

For the combined sewer system zones, interceptors were planned to collect and introduce sewage in the existing drainage into the wastewater treatment plant. The interceptors are designed to accommodate the three-time flow of the hourly maximum flow in case of rain. The storm water flow more than the interceptor capacity will be discharged to the adjacent drainage/river. For the separate sewer system zones, new sewer pipes were planned in addition to the storm water drainage facility.

UASB plant shall be located in each sewerage zone except for S11. For S11 zone, stabilization pond system shall be applied as the WWTP area is available near the zone and therefore no long transfer line is necessary. Energy consumption for the stabilization pond itself is less than the UASB process. Location of the WWTP in each zone is selected to keep the gravity collection of the sewage as much as possible.

Total Design Capacity of WWTP is calculated 54,200 m^3 / day with 14 UASB WWTP and 3,300m^3 / day with one (1) stabilization Pond System.

5. MASTER PLAN OF SOLID WASTE MANAGEMENT

To solve the problem, the following summarized actions have been planned.

(1) The new collection system that is analyzed in Alternative Study.
(2) The present system shall keep the capacity at 21% of generated waste.
(3) Container shall be provided and industrial solid waste collection service shall be introduced.
(4) Infectious waste shall be collected separately from household similar waste.

In taking into account the composition of waste, which presents a high component of sand, it is recommended to forecast that in recycling centers, sand is recycled. Sand can be screened manually and put at the disposal of municipal services, which should take in charge the transport of remaining waste towards the municipal dumping site. The recycled sand can be used by municipal services as backfilling equipment to fill rainwater erosions; this will enable to put an end to the present method of waste removal, which consists in using waste like filling raw materials.

Total annual waste quantities were calculated about 207,200 ton/year in 2005, 238,500 ton/year in 2010 and 272,000 ton/year in 2015 respectively.

Actually CUN and the three belonging Communes have a capacity to collect and transport approximately 21% of generated waste. This capacity of 21% shall be kept for the population that will not be served by the new system. The collection rate will increase and will be covered by new system whose cost is lower for CUN and Communes.

It is recommended that the services for solid waste management shall be carried out by the CUN. These services are making container available, transporting regularly waste, and disposing it properly at the landfill site.

On the other hand, the total quantity of hospital waste amounts to 1,796 ton/year for the year 2005 and 2,356 ton/year for the year 2015. The amount of infectious waste that necessitates individual treatment is about 359 ton/year for 2005 and 471 ton/year for the year 2015.

6. PROJECT COST FOR PLANNING HORIZON

Total Project Cost for planning horizon is estimated FCFA 47,927 Millions for Sewerage / Drainage field and FCFA 5,327 Millions for Solid Waste Management till the year 2015. On the other hand, the Operation and Maintenance cost is estimated CFAF 598 Millions per year for Sewerage / Drainage and CFAF 1,412 Million per year for Solid Waste Management.

7. INSTITUTIONNAL SET-UP

International best practices may serve as a guide to design the most suitable O&M organization or the service provider. Successful water and wastewater enterprises worldwide operate under a common set of enabling conditions and share a number of common characteristics. They tend to have:

(1) Autonomy in all aspects of managing the enterprise and operation of drainage and waste water systems,
(2) A clearly defined regulatory framework by Government, which hold the companies to high standards of efficiency,
(3) Financial self-sufficiency from the collection of tariffs sufficient to meet all financial needs.
(4) A strong sense of public service and consumer orientation to render service of best quality for minimal cost,
(5) Access to credit for financing investments, and
(6) Reliance on a strong, competitive private sector to provide quality support service.

Represented in the Board of Directors are Ministries of Equipment and Transport, Water Resources and Public Health, Urban Community of Niamey, the water supply company, the private initiative (NGO) and the beneficiary initiative. The Board shall be convened to prepare the creation of the Urban Drainage and Sewerage Society. The private initiative and the beneficiary initiative particularly are expected to introduce and encourage the public participation from the early stage of the organization building.

8. HYGIENE EDUCATION PLAN

On the ground of the basic concepts of hygiene education, the actors shall consider an annual plan and each term plan. Especially, MSP as the leading entity of hygiene education has important role to coordinate the multi-sectarian cooperation among actors for considering such plans. In addition to this, the following effort and actions are necessary to the consideration.

(1) Before the start of each term, related activities such as hygiene campaigns shall be conducted with the community participation approach for identifying targets and considering necessary actions of each term.
(2) At the final stage of each term, evaluation shall be implemented for feeding back every achievement and lesson to the next term with the community participation approach.

In accordance with the discussion, the JICA study team in cooperation with each actor plans a hygiene campaign as a pilot project. The principal purpose of the campaign can be summarized as follows:

(3) To instruct how to use of toilet to the schoolchildren at the pilot project sites,
(4) To present know how of hygiene education to all actors,
(5) To present know how of community participation approach to all actors, and
(6) To make good relationship between the public sector and the private sector.

9. PILOT STUDY FACILITY CONSTRUCTION

JICA Study Team has been carrying out the developing Study in Niamey since July 24th 2000. The aim of this Study is to improve sanitation condition in Niamey City. Many sectors are involved in this study that consists:

(1) To elaborate a Master Plan in order to improve sanitation in the city. Household refuse treatment, improvement of rain and wastewater are basically concerned by this Master Plan,
(2) To manage the Feasibility Study which fix the Master Plan's priority target. This is for making technology transfer to a counterpart Nigerian staff.
(3) To construct two pilot plants for Wastewater Treatment which involve different technologies in two different sites. The aim of those two Pilots Stations is to test functioning techniques in Niamey climatic conditions.
(4) To improve the sanitation condition, Hygiene Education Campaign is more significant for the residents.

This Hygiene Education Project consists followings issues:

(5) Treatment capacity of this Up-flow Anaerobic Sludge Blanket (UASB) plant is 100m^3/day. This technology is used for the first time in Africa. It has already achieved some success in India and Colombia regarding urban effluents. The main benefit of this system is a utilization of low energy capacity for operate and methane gas production.
(1) The second can be considered as septic tank improvement. This system is used for wastewater treatment in Japan's isolated areas where wastewater drainage is not existed. It is baptized "Jyokaso" over there. The system has been set up in Bandabari II primary school, which is located in commune II. The treatment capacity of Jyokaso is 10m^3/day. Constructions are actually ended and inauguration ceremony will take place on March 9th at 10 hours in morning at the site.
(2) Treatment techniques will be evaluated through this plant, which could be vulgarized in public places.
(3) The Study Team to residents as Public Involvement (PI) and Resident/Community participation project carried out hygiene Education Campaign.
(4) The Team is going to try the possibility of natural recycle system by using Eco-pond for water reuse and recycling the sludge cake for irrigation purpose.

10. FINANCIAL ANALYSIS

The total investment cost is 53 billion CFAF over 15 years. Implication of this investment scale may be suggested, if it is compared with the scale of national capital expenditure, which consists of all the development projects.

In the case that the annual project budget would be 90 billion through the year 2001 to2015, the project cost of 53 billion accounts for 3.9 percent of the total national projects. If the budget would be 100 billion, the project costs will account for 3.5 percent.

To offset imbalance of the initial years (2006 to 2015), tariff has to be set slightly higher than 754 CFAF (the per head operation cost in the year 2016 at the 2001 price). A simple comparison of accumulated tariff revenue and operation costs is tried with assumed tariff levels of 900, 1,000 and 1,200 CFAF per served population.

The Master Plan suggests that the drainage and sewerage tariff shall be collected as a surcharge onto the water bill. Simplest way is to add a certain percentage onto the water charge. The total operation cost at the target year is 598.7 million CFAF. This is the 2001 price, and should be escalated, most likely, by 3 percent per year. Then, 933 million (1,175 per head) plus the 19 percent value added tax, if generally applicable, would come to the total sewerage bill of 1,110 million. If effective tariff revenue of water supply in Niamey will be assumed as 6,000 million in 2016, then 18.2 percent would be added to the water bill.

In the calculation of financial internal rate of return, therefore, it is assumed that flow of the full operation costs and only 10 percent of capital cost should be compared with flow of tariff revenue. Based on the proper assumption, Internal Rate of Return is calculated 6.1% in case of CFAF 200 and 11.3% in case of CFAF 1,600 respectively.

The solid waste management projects consist of component operated by the municipality and component operated by the private pre-collectors. Cost of the municipality component is expected to finance by the national and municipal budgets. In the absence of revenue or cash inflow, the return will not be generated. Internal Rate of Return is calculated 6.4% in case of FCFA 1,000 and 32.8% in case of CFAF 1,200.

11. PROJECT EVALUATION

In addition to sewerage/drainage and solid waste management, several scheme of Urban Sanitation such as low cost sanitation (LCS) and sanitation campaign are to be proposed together with above major scheme toward the target year. The inadequate present capacity of the drainage system, therefore, represents a major potential constraint to the implementation of the M/P.

For the drainage and sewerage projects the society's financial position will be firm, even if it shall pay 10 percent of the capital and replacement costs. If the per-head tariff is set to 1,200 CFA francs per year that is 0.5 percent of per-capita GDP inflated by 3 percent, its financial rate of return through the 60 year project span will be fairly positive.

For the solid waste management the annual operation cost will be 350 million CFA Francs or approximately 353 CFA francs per resident have to be born by the municipalities within the target year 2005. This will be equivalent to some 10 percent of the municipality's annual current expenditure in 1996 thru 1998 (Urban Community of Niamey and 3 communes inclusive). This operating cost also has to be subsidized or transferred by the national government to the municipality, should it not be easily internally generated.

Based on the preliminary design of M/P, project costs have been estimated for each field and the financial aspects were analyzed for implementation of the sanitation improvement works. In this section, priority projects shall be chosen as a possible urgent rehabilitation projects for short period which is targeted at the year 2005. The following schemes are to be selected as the priority projects:

1) Sewerage/drainage system in the C3 sewerage zone.
2) Procurement two trucks and 10 containers for model area.
3) Soft component for Hygiene Education and Environmental Evaluation.

12. RECOMMENDATIONS

Identifying areas and issues requiring most urgent enhancement conducted the Master Plan study on sanitation improvement for the Niamey City. As consequence of the comprehensive study including review of other existing and ongoing projects, the following recommendations are hereby made to the related officials and the Republic of Niger (RON).

In the absence of the urban development master plan in Niamey City, the study team carried out a population projection and a most likely scenario of urban development on bases of the most reliable information. Design population in 2015 is 993,724 and future city area is 23,916 ha.

Planned population for the sewerage facility is to be about 583,000 in the year 2005, and about 794,000 in the year 2015. The following recommendations are formulated for planning framework:

(1) Combined drainage and sewerage system was selected for urbanized area.
(2) For intermediate term, the separate system is recommended in the recently urbanized areas.
(3) A smaller scale wastewater treatment plant is installed in each of multiple numbers of small sewerage zones.
(4) Up-flow Anaerobic Sludge Blanket (UASB) treatment method is adapted for most treatment sites.

The improvement of solid waste management in the city of Niamey is considered for different links in the chain of waste collection, waste transport and waste disposal. According to the results of the alternatives analysis new household waste collection system shall be introduced and extended. The system is based on privatization of the pre collection services and operation of sorting centers in determinate areas.

It is recommended to launch an education campaign during the second stage of the JICA study, after completion of the pilot projects, in order to practice the above-mentioned principles within the scope of the UASB and Jyokaso pilot plants. The campaign will be multi-targeted and will involve the active coordination of the concerned agencies. Community participation is also expected.

The project costs for the master plan that the national government shall finance over 15-year period are approximately 54 billion CFA francs. In the waste management sector, preliminary collection and recycling services be the private enterprises are proposed. These services will be sustainable or even reasonably profitable, if the average tariff of 1,200 per head per year is collected. In view of the profit margin, which can be earned even if the 17 percent market loan is invested, the services will be propagated with encouragement by the municipality.

Capacity building of the population would mean, in the master plan context, enhancement of people's awareness, sensibility or comprehension on hygiene, sanitation and health status of their daily environment. If their awareness is improved, they will know what they should do and what they should ask for. Thus population will be demanding more of the sanitation infrastructure. This would build a public consensus on the necessity of the projects.

FEASIBILITY STUDY

13. SEWERAGE / DRAINAGE SYSTEM

The Feasibility Study area is covers the already developed and highly urbanized zones of Boukoki I to Boukoki IV and Lyceo Kosai quartiers named C3 treatment district in the Master Plan. The wastewater treatment plant in the Feasibility Study area, UASB method will be adopted.

14. SOLID WASTE MANAGEMNT

(1) Proposed collection system for household waste

Each selected zone shall have one recycling centre, where sand shall be sorted out. The recycling centre shall have a second function; it may be used as a transfer point. Sand shall be manually sorted out from household waste. Remaining waste shall be stored in containers belonging to CUN. Municipal services shall be in charge for removing remaining waste container to the landfill site.

For remaining waste transport from recycling centre to the landfill site 9 containers are necessary in 2005, 18 containers and 24 containers in 2010 respectively 2015. One truck shall be provided per 6 containers since the truck is capable to transport the container 6 times per day (6 trips per day). Therefore the required number of truck is 2, 3 and 4 in the year 2005, 2010 and 2015 respectively.

(2) Construction and operation of the municipal landfill sites

For the new landfill sites at Koubia and Bengale Torombi, infrastructures constructed.

Furthermore a Shade of Bulldozer shall be constructed at the landfill site Koubia. The planed landfill area at the site Koubia is over 10ha and at Bengale Torombi 7ha, these areas are enough for about 10 years operation. In order to utilize the land efficiently, zoning was designed according to the required capacity.

For the proper operation of the landfill sites the following equipment is required:
One Bulldozer (165HP Class) shall be provided by 2005
One wheel loader (2 m^3)
2 dump trucks (15t)

The equipment shall be operated 5 days a week at the landfill site Koubia and one day a week at Bengale Torombi landfill site.

15. PROJECT AND OPERATION/MAINTENANCE COST

(1) Sewerage/Drainage System

The investment cost of the priority projects is 1,679 million CFAF. Of the total project cost, 1,455 million CFAF or 87% is the local currency component, and the remaining 224 million CFAF or 13% is the foreign currency component.

The annual operation and maintenance cost for the sewage facilities in the Feasibility Study area after the completion of the construction is estimated at 50 million CFAF for the trunk sewer facilities and sewage treatment plants.

(2) Solid Waste Management

1) Private Sector for Proposed Collection System

Capital Cost
Direct Cost: 66,225 (×1,000 FCFA)
Contingency: 9,934 (×1,000 FCFA)
Total: 76,159 (×1,000 FCFA)

Operation and Maintenance Cost
2005: 35,048 (×1,000 FCFA)
2010: 66,081 (×1,000 FCFA)
2015: 90,824 (×1,000 FCFA)

2) CUN for Proposed Collection System

Capital Cost
Direct Cost: 366,000 (×1,000 FCFA)
Engineering Cost: 36,000 (×1,000 FCFA)
Contingency: 60,390 (×1,000 FCFA)
Total: 462,990 (×1,000 FCFA)

Operation and Maintenance Cost
2005: 57,844 (×1,000 FCFA)
2010: 86,224 (×1,000 FCFA)
2015: 99,940 (×1,000 FCFA)

3) Disposal Site
Capital Cost: 4,818,803 (×1,000 FCFA)
Operation and Maintenance Cost
2005: 26,325 (×1,000 FCFA)
2010: 100,702 (×1,000 FCFA)

16. ORGANIZATIONS AND OPERATION

(1) Sewerage/Drainage System

The proposed organization for the Sewerage Operations after the completion of the Feasibility Study project is as follows;

Manager:	1
Treatment Plant Operation and Maintenance Section:	7
Sewage/Drainage Operation and Maintenance Section:	7
Water Quality Section:	3
Total:	18

(2) Solid Waste Management

The required role of CUN is summarized as follows for solid waste management.

- To monitor and direct all the activity of waste collection and disposal in Niamey.
- To assist the private companies for new system introduction.

Actually the private companies contribute, in some portion, to keeping the city clean through waste pre-collecting activity. This activity shall be linked to the introduction of new waste collection system. Furthermore the private companies shall create the management system of recycled sand.

17. FINANCIAL AND ECONOMIC EVALUATION

(1) Financial Evaluation

For the drainage and sewerage projects, the financial rate of return (FRR) is negative, if all the initial and operation cost is compared with the possible or affordable revenue as surcharge onto water tariff. However, only 10 percent of the initial and replace costs are to be borne by the project beneficiaries and the external donors donate 90 percent. FRR will be positive, if such assumption is met.

For the solid waste management projects, the initial costs are compared with the expected revenue, which is based on the willingness-to-pay. Survey. Financial rate of return (FRR) for all the pre-collection operation in private sector projects will be very prospecting.

(2) Economic Evaluation

For the drainage and sewerage projects, the economic rate of return (ERR) is slightly lower than the desirable value, however the secondary benefit such as improved quality of discharged water through open outfalls into Niger River will bring the unprecedented benefits to the City of Niamey.

The solid waste management projects are sound and feasible in economic terms, if all the assumptions are met.

18. ENVIRONEMENTAL IMPACT ASSESSMENT

The project has generally a positive impact on the environment, for example the welfare and the quality of life of the inhabitants of Niamey. The problem of negative impacts concerns the local communities living on the project sites.

The impacts are considered critical for the local community of the Bengale-Torombi site. This community will be exposed to the pollution and other harmful effects of the project. The women will be seriously affected by the project through the loss of amenities, as the possibilities of crossing and easy access through the site.

The Dezeibon site poses the social problem of loss of employment for 5 gardeners presently working on the place planned for the execution of the project. This project has also some effects on the natural environment, such as the loss of precious tree species, et by its contribution to the urbanization and to the degradation of the landscape potential of the banks of the Gounti Yéna.

As the environmental benefit of the project for the salubrity and health of the population of Niamey is evident, a few measures have been proposed to solve the identified problems. These measures, which are mainly preventive, softening and curing measures, aim to make the impacts acceptables for the local community and respectful of the inhabitants' right to enjoy a healthy environment.

19. EVALUATION OF THE PILOT STUDY

UASB and Jyokaso pilot plant achieved efficiencies of more than 90% BOD reduction and 85% coliform reduction.

The pilot plants are landmark of the Niamey City as the first household wastewater treatment plant based on the most appropriate technology for Niamey and should also be continued to use for hygiene education for mass awareness to improve the sanitation environment of Niamey.

20. HYGIENE EDUCATION CAMPAIGN

In place of the study team, Campaign Committee was organized and they discussed and evaluated from preparation to implementation of the campaign.
Based on the evaluation and discussion, the committee recommended as follows.

- The campaign committee shall be sustained to implement further actions concerned.
- A meeting room shall be prepared for the committee activities.
- The awarded drawings shall be utilized for an educational tool.
- The public sector shall be involved in the further actions concerned at every level (for participatory approach).
- A voluntary entity to take care of the UASB shall be set up at community level.
- Training in the field of the hygiene and wastewater shall be done to the actors of the private sector.

21. RECOMMENDATIONS OF FEASIBILITY STUDY

(1) SEWERAGE / DRAINAGE SYSTEM OUTLINE

It is proposed to implement the trunk sewer/drainage network for the Feasibility Study area for newly construction (L_1 = 6,625 m) and rehabilitation/repairing/cleaning (L_2 = 7,810 m)

The design capacity of the Feasibility Study WWTP is 2,500 m^3/day based on daily maximum flow, and the treatment process adopted is UASB technology followed by polishing pond.

Water quality of river and ground water in Niamey would be considerably improved with the implementation of sewerage/drainage and on-site treatment schemes. By utilizing the treated wastewater for irrigation in view of the nutrient value of the treated wastewater, water quality will further improved especially during lean flow months.

(2) SOLID WASTE MANAGEMENT

1) Pre-Collection and Sand Recycling

Private operators in close cooperation with CUN and Communes shall carry out pre-collection and recycling sand activities. CUN shall make effort to introduce the proposed system and support the private operators.

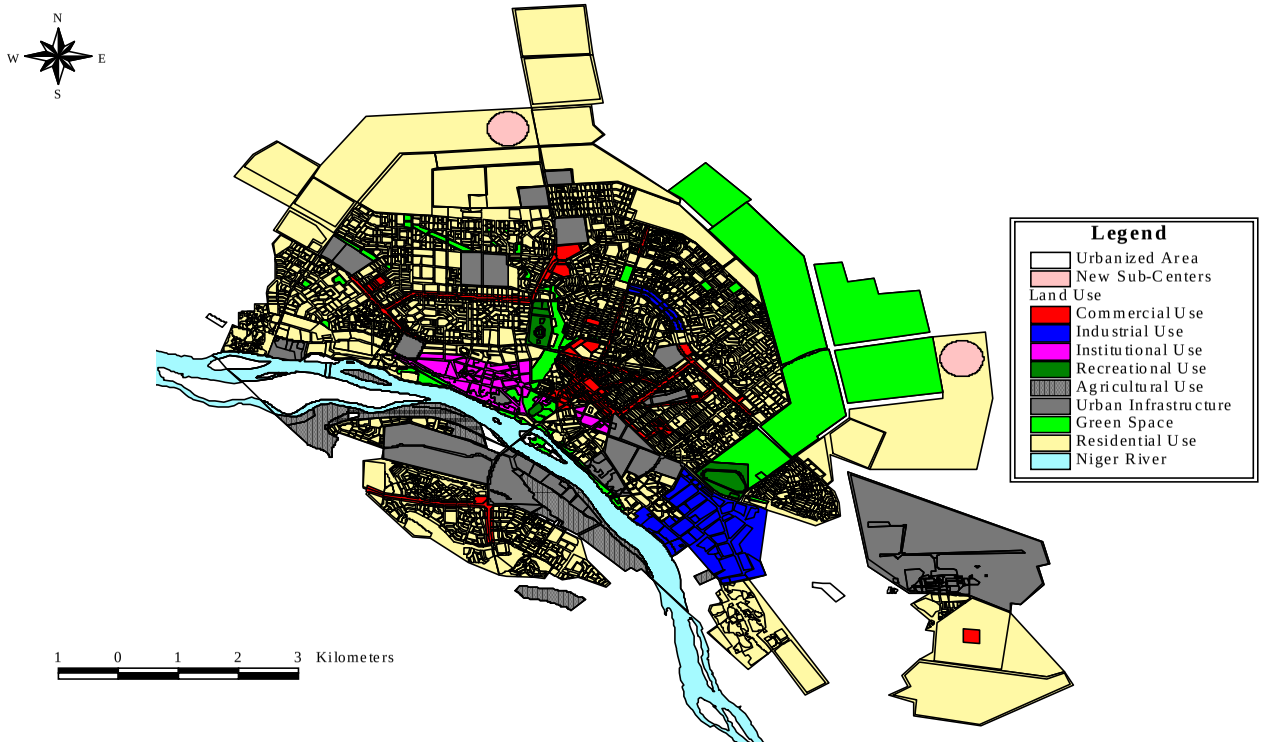
The recycled sand is useful for reclamation, base of construction and protection of underground facilities such as water and sewer pipelines.

2) Landfill Site

The detail design and construction of new landfill site as developed in the Feasibility Study shall be urgently undertaken. Although 2 landfill sites has been designed taking into account future development and further consideration for environment protection.

Table ES.1 STUDY OUTLINE FOR STAGE WISE

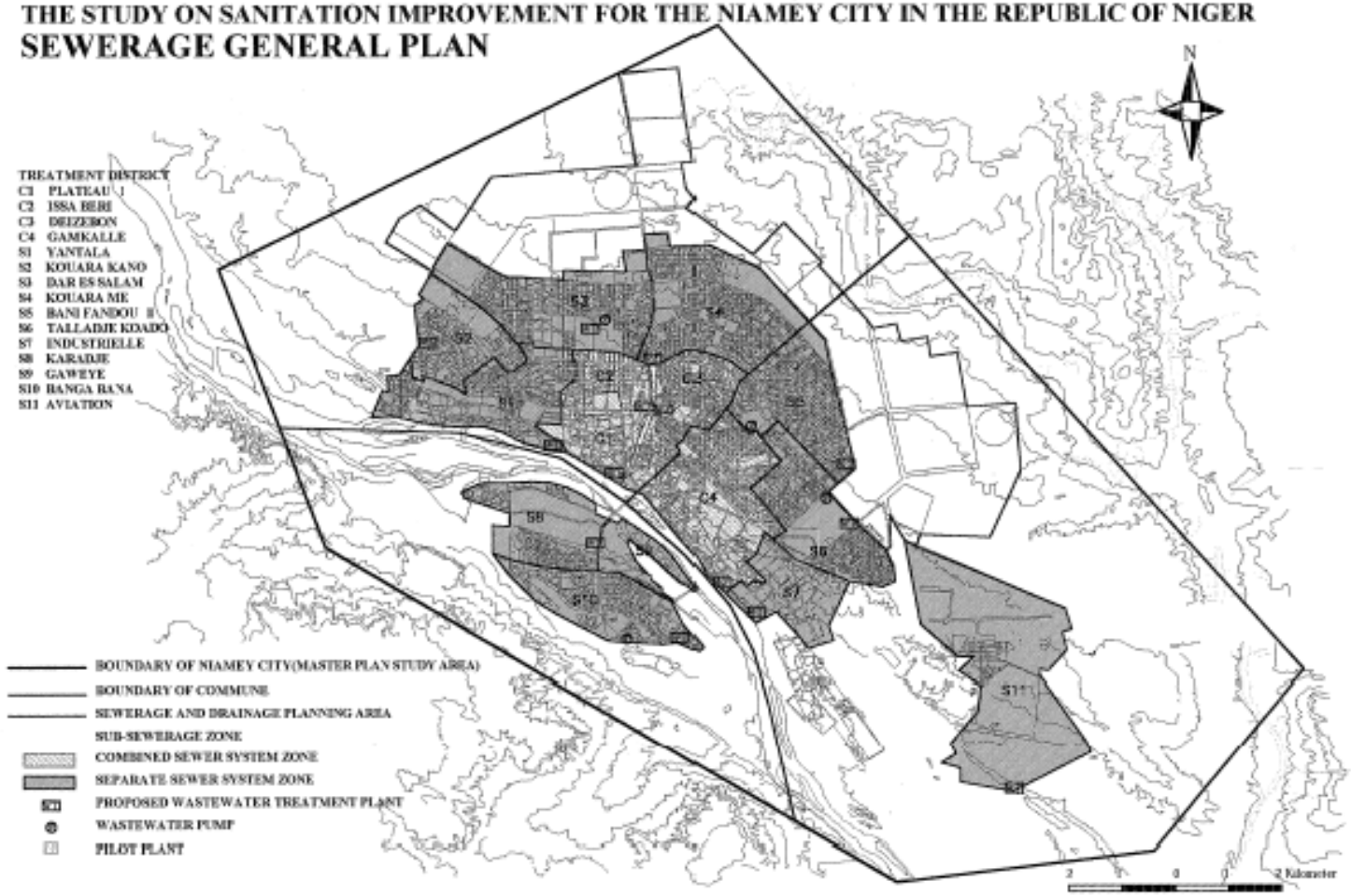
		M/P	F/S
	Target Year	2015	2005
Sewerage/Drainage	Study Area	11,210 ha	255 ha
	Population	993,700	757,000
	Sewerage Area	7,630 ha	255 ha
	Sewerage Population	793,700	43,000
	Design Waste Water Flow (daily maximum)	54,000 m^3/ day	2,500 m^3/day
	Construction of Main Drainage	258 km	6.6 km
	Construction of Wastewater Treatment Plant	15 plants	1 plant
	Construction of Intermediate Pumping Station	6 stations	
	Project Cost	47.9 billion FCFA	1.7 billion FCFA
Solid Waste Management	Quantity of Household Waste	272,000 ton/year	238,500 ton/year
	Construction of Final Disposal Site	2 sites	2 site
	Project Cost	15.2 billion FCFA (Waste)	5.3 billion FCFA (Waste)



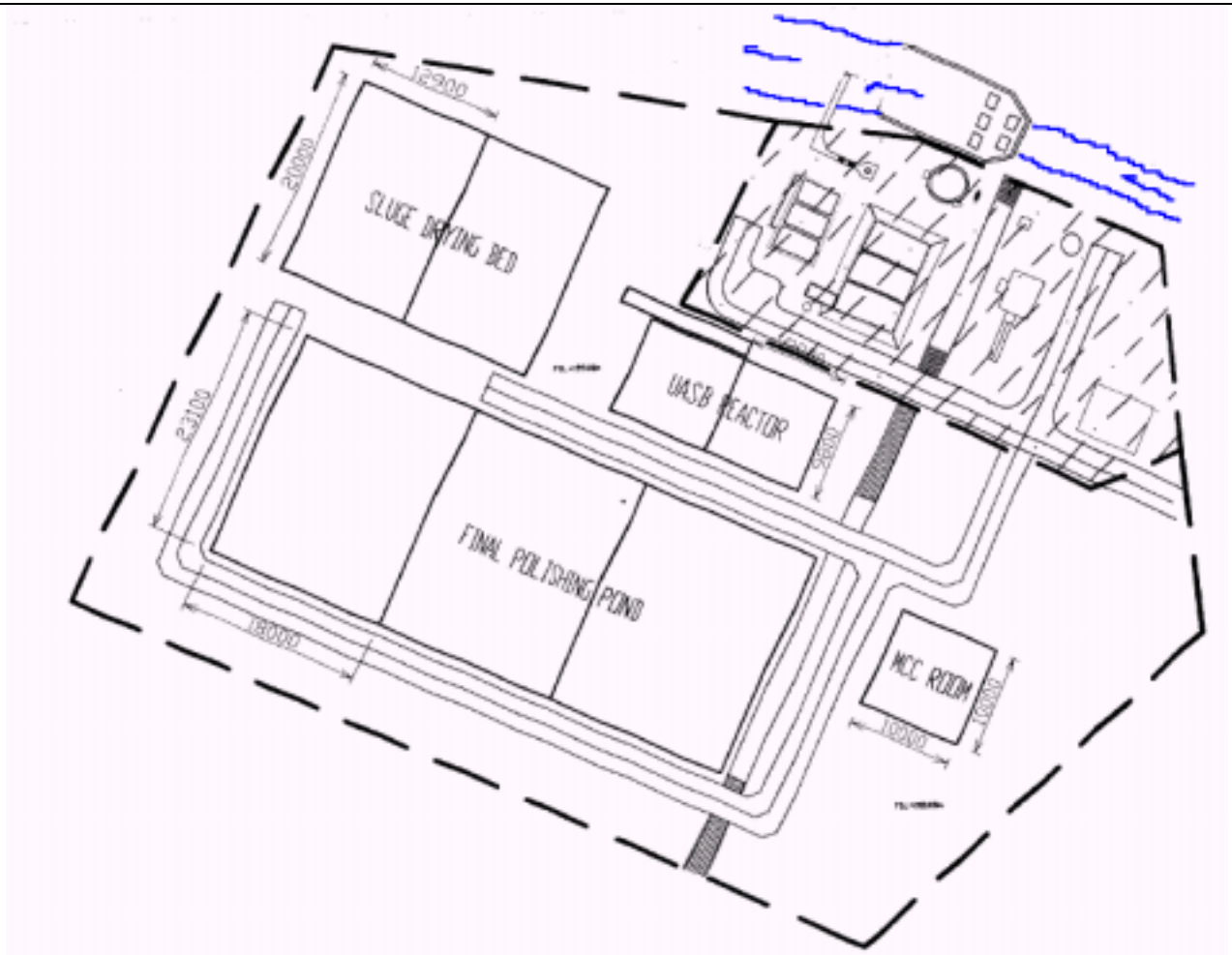
The Study on Sanitation Improvement for the Niamey City in the Republic of Niger

FigureES.1

FUTURE LAND USE IN 2015



	The Study on Sanitation Improvement for the Niamey City in the Republic of Niger	**FigureES.2**
	SEWERAGE GENERAL PLAN	



	The Study on Sanitation Improvement for the Niamey City in the Republic of Niger	**FigureES.3**
	GENERAL LAYOUT PLAN OF WWTP	

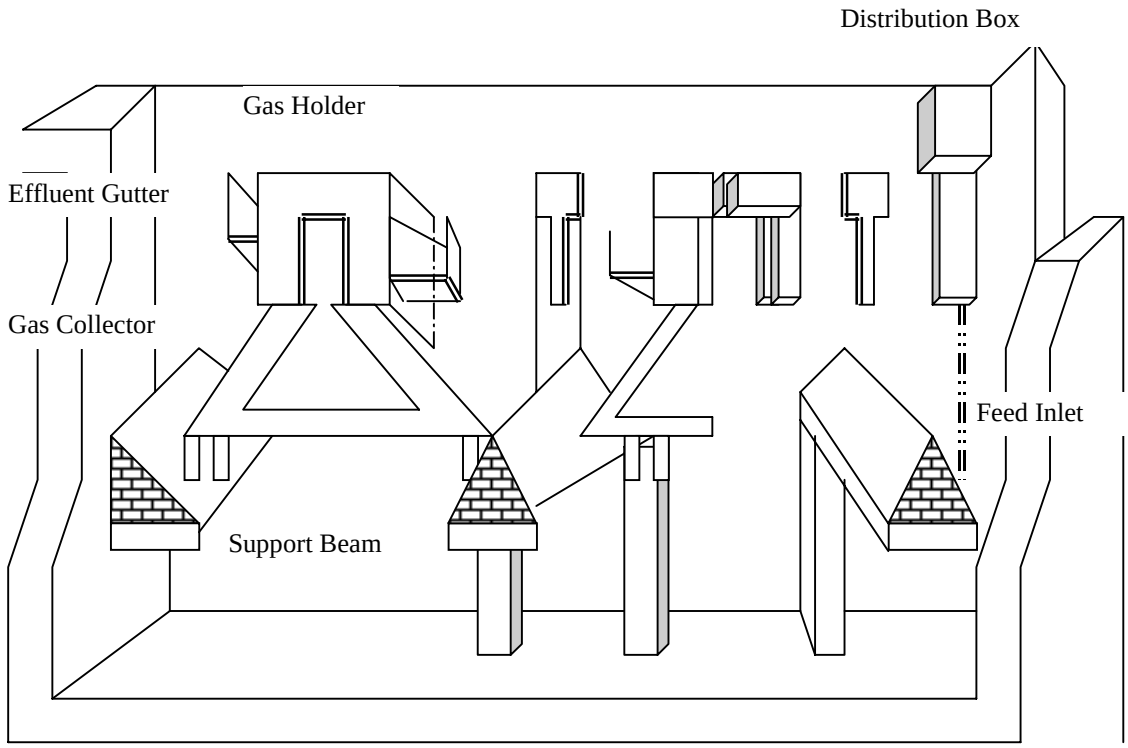


Figure ES.4 MODEL OF REACTOR

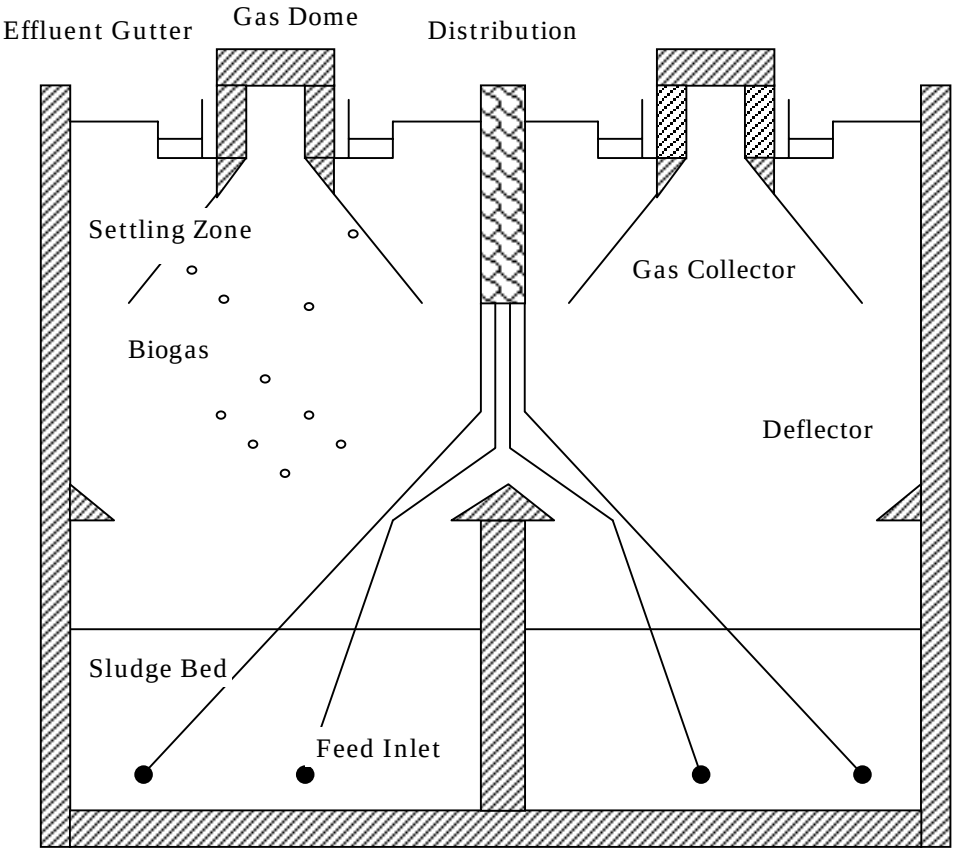


Figure ES.5 TYPICAL SECTION OF UASB REACTOR

UASB REACTOR AND BIO-TOWER

ECO-POND AND SLUDGE DRYING BED

Photo ES.1 UASB PILOT PLANT

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MASTER PLAN

CHAPTER S1. INTRODUCTION

S1.1 BACKGROUND OF THE STUDY

Because of the rapid population growth of urban area of Niamey City, the environmental circumstance of Niamey City has been deteriorating year by year past ten (10) years. In addition, the necessity of review of present Sewerage Master Plan formulated in the year 1981 was under taken to the Authority. In response to the request from Government of Niger (GON), the Study Team dispatched by Japan International Cooperation Agency (JICA) commenced the Study on Sanitation Improvement for the Niamey City in the Republic Of Niger.

In countries, which are under harsh natural environment and economical conditions, the priorities of the project are given to poverty reduction programmes. However, it is gradually cleared that the development can exist as a creator of environment and as system to keep and make harmony of environment and human activities.

At the first step of the study it was agreed that above mentioned concept should be the core of the study directions. Therefore, the distinct character of this project is to make a practical master plan of environmental improvement in countries, which are under harsh natural environment and economical conditions. It means that the mission in this study is to make environmental model countermeasures under the restricted resources and conditions.

S1.2 OBJECTIVES OF THE STUDY

The purpose of the study is to make out a Master Plan and Feasibility Study based on it, and the concepts of the study are as follows.

For the sanitation improvement of the Niamey City a system should be based on the principle that construction coexist with natural environment. And suitable method should be adopted with consideration of economical situation, technical capability and natural conditions. Also low energy consumption, low cost and utilization of exiting local materials, those will lead to reduce environmental load yielded by development.

S1.3 SCOPE OF THE STUDY

The study area is encompassed with about 1,200 ha for urban area and its target year of the project is the year 2005 for the priority Urgent Rehabilitation Work (URW) and 2015 for the M/P. The contents of the Study consists two Phases. Phase I is M/P and Phase II is Feasibility Study and Urgent Rehabilitation Work (URW).

S1.4 UNDERTAKING OF THE STUDY

Ministry of Equipment and Transports (MET) will undertake this Project to carry out the Study, and this Project will take long run till end of the year 2001.

S1.5 ACKNOWLEDGEMENTS

The courtesy and Cooperation extended to the JICA Advisory Committee and the Study Team during course of the Study by the member of Steering Committee that are gratefully acknowledged.

CHAPTER S2. REVIEW OF RELEVANT PLANS

S2.1 TREND OF OTHER DONOR COUNTRY AND AID AGENCY

There are several on going Projects that are related to the Sanitation Improvement for Niamey City. In this context, these studies and projects were reviewed and justified by the JICA Study Team.

S2.2 INTERNATIONAL FINANCIAL INSTITUTION

Recently, World Bank (WB) has been carrying out the Sanitation Project in Niamey which was represented for "Project for Rehabilitation of Infrastructure" (PRI) and " The Water Sector Project" (PSE).

S2.3 UNITED NATIONS

United Nations (UN) is now under taking the UNICEF for women and children, UNDP for poverty project, WHO for public health, and UNEP for the environment program.

S2.4 NON-GOVERNEMENTAL ORGANIZATIONS (NGO'S)

There are one public and several NGO's, which is economic interest group for carrying out the sanitation project in Niger.

CHAPTER S3. EXISTING CONDITIONS AND IDENTIFICATION OF PROBLEMS

S3.1 GENERAL CONDITIONS OF NIAMEY CITY

City of Niamey is located in the west part of Niger along with the Niger River. City of Niamey encompasses an area of approximately 23,900 hectares, having about 0.02% of the Republic of Niger. Present administrative population is about 650,000 persons at the year 2000, which is 6.5% of National Population.

S3.2 CURRENT STATUS OF URBAN COMMUNITY OF NIAMEY

The Study area, Urban Community of Niamey (CUN), is the autonomous political unit that has an equal administrative standing as the other seven Departments in Niger. It is divided into three Communes, each of which also has its own mayor and an administrative body in charge of providing public services to the citizens.

In 1994, the Direction of Population made population projections for the nation as well as the departments, including Niamey. According to this, the population of Niamey in 2000 is projected to be about 650,000 (Table S3.1).

Table S3.1 POPULATION OF NIAMEY

Year	1994	1995	1996	1997	1998	1999	2000
Total Population	515,851	536,259	557,869	580,215	603,386	627,431	652,401
Annual Growth Rate	4.5%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%

The total area of CUN is 23,916 hectare (ha), of which about 8,800 ha have been already urbanized. The rest of the area is rural and used primarily for agriculture and raising livestock. Most framers in Niamey produce food for their own consumption. Although Niamey's agriculture is far from self-sufficient in terms of food supply, it is an important means of life for many people. It is a serious concern; therefore, that agricultural land is encroached by new developments in each year. The residential use accounts for more than 60 percent of the urbanized area.

S3.3 EXISTING WATER SUPPLY FACILITIES

The water supply service area of Niamey water supply comprises not only the Niamey City proper but also three communes. According to the geography and topographic conditions, there are as many as 7 distribution zones for the service area. The system has two Water Treatment Plant (WTP) having two reservoirs and seven elevation tanks, which can be operated as per designing for six tanks out of seven.

Total Design Capacities of two plants are 80,000 m3/d to 85,000 m^3/d respectively, and actual total water production is 52,652 m^3/d at average amount of the year 1999. SNE has been operating the WTPs for 24 hours.

Number of water consumer are calculated 24,000 meters at the year 1999 including 500 water meters of the stand pipe which was installed by SNE. At present, SNE has been delivering the water bill to the all above consumers. The ratio of effective paid water is more than 90% of effective water.

S3.4 SANITATION (TOILET, NIGHT SOIL MANAGEMENT)

The distribution of households using the different types of excreta disposal system is as follows: 25% use improved toilets, 67% traditional latrines and the remaining households do not have any access. Therefore, these households comprise by bushes, open area, drainage, or river. According to a PSE Study, in the most impoverished 12 quarters of Niamey almost 70% of households have latrines, against 5% with modern toilets, and about 26% without access to toilets.

The usage rate of latrines in compounds is estimated to be around 93% for adults and 86% for children, which means that 7% and 14% of them respectively practice open defecation. In the case of impoverished quarters, in 36% of the households having access to toilet or latrines, children are not allowed to use them (PSE Study).

The disposal of night soil is generally done either by desludging in the case of septic tanks or by digging a new pit in the case of pit latrines. 5 or more families share the compound latrine, which is some form of pit latrine. When the tank is full, pit is covered and another tank is dug in the area until it eventually become saturated. To avoid this type of situation, deeper pits are dug, about 8 to 20 meters, eventually contaminating the groundwater.

S3.5 SEWERAGE AND URBAN DRAINAGE

There is no existing sewerage system in the public area. Only institutions and major industries have facility to treat their wastewater. However, many of these plants are non-functional or poorly managed. Discharge pattern of domestic wastewater in the City is to be categorised into three types, namely urbanised area, high residential area and low residential area.

The importance of the drainage and a flood plain is not fully recognized by the habitants and administrations, for example, maintenance of existing drainage is not well done and drainage is almost planned for only new developed peripheral area.

Annual precipitation is not so much (approx. 600mm), however, with intensity of 50 to 100 mm/h once or twice a year during the rainy season which causes flood around the city.

Peripheral area of the city that is newly developed to cope with increasing population suffers damages as a result of flooding due to the following reasons.

1) Heavy rain on the flat ground without drainage causes stagnation of water.
2) Flow of small rivers and drainages are cut off by developed land and roads.
3) Residential area is developed in flood plain and low-lying ground.
4) Catchment characteristics have changed and natural reservoirs have disappeared due to residential land development.

S3.6 SOLID WASTE MANAGEMENT

The present situation of the domestic waste management in Niamey can be summarized by a precarious situation. It is sufficient to walk in streets of Niamey, except the big arteries of the center city; one recognizes that the domestic waste collection isn't properly done. This insufficiency is very striking at the peripheral districts of Niamey.

In order to get some reliable data on generation rates of domestic waste, a campaign survey on sampling and measuring of waste generation is being currently in progress. According to studies lately elaborate on the urban waste management in Niamey, estimation on waste generated and removed by the municipal has been established. Below the Table S3.2 summing up these estimations data on quantities of urban waste and their evacuation.

Table S3.2 ESTIMATION OF DOMESTIC WASTE QUANTITIES

	Commune I	Commune II	Commune III	Total
Generated waste (m^3/year)	120,631	151,280	29,141	301,052
Removed waste quantity (m^3/year)	68,141	51,542	20,966	140,649
Frequency of container emptying Container/week	1.2	2.7	3.4	1.7
Removal rate	56 %	34 %	72 %	47 %

In certain districts (Quartiers) of Commune I (Quartier of Maourey, Gandatché, Zongo, Deizeibon, Lazaret, Boukoki and Lazaret) and of Commune II, the pre-collection exists. It consists to pickup domestic waste of concessions from door-to-door, to carry it toward containers or designated transfer points.

The Communes of the city of Niamey arrange containers that are distributed, in priority, in the commercial, administrative and residential zones of the center of the city. They also arrange official transfer points, that are create in dialogue with chiefs of districts having for goal, normally, to palliate to the insufficiency of the number of containers. It exists a number however very important of non-officially designated transfer point, said wild transfer point. The number of the wild transfer points is in continual growth, what shows that the number of containers and the official transfer points are insufficient.

S3.7 SOCIAL AND ENVIRONMENTAL CONDITIONS

As a result of deficiencies in sanitation facilities and services, and inappropriate hygiene practices and behaviour, solid and liquid waste generated by households are now a serious source of insalubrity and nuisances in Niamey. Waste generated by industries, hospitals and other institutions are additional sources.

The description of environmental practices of households, industries and institutions, focusing on the sanitation conditions, is based on the results of the JICA study team questionnaire surveys launched in October 2000. The questionnaire sheets contained 51 questions addressed to households and 64 questions addressed to industries and institutions. The field visits and collection of data of both surveys have been conducted during mission of JICA study team in 2000. The performances of the questionnaire survey done within the scope of the PRIU project in 2000 have been taken into account for the preparation of the JICA questionnaire, in order to avoid duplication of work.

S3.8 ECONOMIC, FINANCIAL AND INSTITUTIONAL SITUATION

Export of uranium has been decisive factor in Niger's export since its exploitation in 1968. From 1980's, continuous decline of the uranium demand in the international market adversely affected the growth of GDP. Another factor to deteriorate economy is unsteady rainfall. Being dependent solely on rain fed irrigation, livestock raising and crop cultivation are definitively influenced by progress of desertification and macro-climatic change, which are reportedly induced partly by growth of population. Since 1970's import of food became persistent burden of the growth in addition to that of energy.

At national level, Ministry of Equipment and Transportation is in charge of construction and maintenance of sewerage and drainage, and removal of solid wastes. However, no significant sewerage work is maintained even in the national capital and largest population center of Niamey. This ministry, like others, is undergoing transition under structural adjustment policy.

S3.9 PUBLIC EDUCATION ON SANITATION

General concepts of the sanitation policy are determined by the "*Plan of Sanitation Development 1994-2000*" and the "*Declaration of Health Sector Policy* (1995)", which have stressed the importance of preventing actions like information and awareness heightening, and improvement of environmental sanitation. Within the concepts, the "*National Policy on Health Education*" states that the education for health is considered as the major strategic tool to prevent diseases. Main objectives of the education mentioned in this national policy are summarised here:

(1) Contributing to improve the hygiene manner of people.
(2) Contributing to reduce morbidity and mortality of communicable and parasitic diseases.
(3) Strengthening the community participation.
(4) Strengthening the cooperation with other partners in the field of health education.
(5) Training the staff involved in health education.
(6) Evaluating the results of the actions taken.

In general, reviews of health situation are necessary for planning and preparing a suitable hygiene education plan based on infectious and parasitic diseases prevailing in the target areas of developing countries. The attempts were made, therefore, to get a basic understanding of health situations in Niamey, on the limited available data and information on morbidity in CUN and precipitation/diseases.

From the evaluation and appraisal of the initial study and review on the present situation of public awareness on sanitation, it could be considered that following items would be at least important keys for preparing a plan on hygiene education.

(7) Policies and Plans
(8) Organizations and Systems
(9) Preparation and Research

CHAPTER S4. PROGRESS OF FIELD SURVEY

S4.1 TOPOGRAPHIC SURVEY

The topographic survey was completed on the end of November 2000 with following dedicated sites:

1) WWTP sites (3 ha)
2) UASB site (1 ha)
3) Jyokaso site (1 ha)
4) 10 km for the trunk main sewerage pipe.

S4.2 SOIL INVESTIGATION

The soil investigation was carried out on middle of November 2000. The following proposed sites are selected for the boring:

1) WWTP site (3 points)
2) UASB site (2 points)

S4.3 PUBLIC AWARENESS SURVEY

The state of home sanitation and sanitary uses in terms of excreta disposal, waste water disposal, night soil and solid waste disposal have been previously evaluated through an important set of questionnaire and observation surveys within the scope of PRI and PSE projects. The results of the PRI survey on practices and behavior of people, which is a very comprehensive one, are analyzed and summarized. The PRI and PSE surveys have shown that inappropriate use and deficiency of home and public sanitation are a major cause of insalubrities in Niamey.

The households survey is a questionnaire survey on practices and perceptions of households in the field of hygiene and urban sanitation. The questionnaire has been launched as a preliminary questionnaire to the survey of waste quantity generated by households. This survey is under achievement and will provide the data of 324 households distributed among 93 compounds. Sampling has been done to reflect the much as possible the average conditions of Niamey, together with the waste quantity evaluation survey, through the selection of 6 quarters: *Lacouroussou, Gaweye, Lamordé, Yantala, Kourakano,* and *Bandabari*.

S4.4 WATER QUALITY SURVEY

Drainage wastewater contained organic, inorganic and bacteriological contaminants. The pathogen indicator microorganism known as coliform bacteria was in the order of 10^6 to 10^7. This wastewater is discharged into the river Niger untreated. It should also be noted that drainage wastewater is widely used for growing vegetables in the city. As a result of contact with contaminated water directly or indirectly, parasitic infections and various waterborne diseases are common in Niamey City.

According to our survey result, an average discharge of wastewater from 11 drainage discharge points into the Gountou drainage was about 5,676 m^3/d. On the other hand, the Gountou drainage discharged only about 4858 m^3/day of wastewater into the river. This means, there was 14.4% water loss into the Gountou drainage, which was mainly due to evaporation and groundwater penetration. The direct discharge into the river from discharge points no. 13 to 20 could be in the order of 6,000 m^3/day.

The water quality at the downstream of Niamey was tested for physical, chemical and bacteriological parameters. The river water pH was in the range of 7.3 to 7.5. As shown below, river water at both the locations was contaminated with bacteria and organics, and thus was not suitable for bathing purposes.

Location	TC (MPN/100 ml)	BOD_5 (mg/l)	TN (mg/l)
Saga bathing (1)	$93 .10^3$	10	0.01
Saga bathing (2)	$74 .10^3$	10	0.01

S4.5 SOLID WASTE AMOUNT SURVEY

In order to get representative results on quantities of waste generation as well as their composition, it is indispensable to choice the zones for the survey in a manner that permits a real extrapolation on the all districts of the city. According to the bibliographic research on the type of housing and districts in the CUN and on the base of the 7 existing zones for different types of housing, 6 districts distributed in 4 zones have been chosen.

During the investigations done by the households, a precise census is made on number of persons living in the different households, in order to be able to determine ratios of quantities of domestic waste generated. Plastic bags are also distributed to households where waste should be collected.

Table S4.1 summarizes the whole results obtained during the weighing phase.

Table S4.1 MEASURED GENERATION RATES

District	Number of households	Number of persons	Waste quantity (gram)	Generation rates (gpcd)
Lacouroussou	58	313	2,315	1.05
Lamordé	52	437	2,550	0.83
Gawéye	50	328	1,136	0.49
Kouara Kano	52	349	1,771	0.72
Yantala	57	353	1,945	0.78
Total	269	1,780	9,717	0.9

CHAPTER S5. BASIC PALNNING CONDITIONS

S5.1 POPULATION FORECAST

The 1994 Projection has, been found to be reliable. From the above data, it is possible to calculate the share of Niamey in the national population of 1989 and from 1994 to 2000. According to this calculation, the share of Niamey in 1994 is about 6.07% and continues to increase afterwards. This increase is almost linear, and a liner regression model can be developed to tell the shares after 2000.

As a result, the future population of Niamey can be forecast by using the share of Niamey in the national total (Table S5.1). The Ministry of Plan provides official projections of the national population for every five years from 2005 to 2025. The population of Niamey can be projected against these national figures.

Table S5.1 POPULATION PROJECTIONS ADOPTED IN THE JICA STUDY

Year	2005	2010	2015
Population of Niamey	757,192	871,346	993,724
Share (Niamey/Niger)	6.6%	6.7%	6.8%
Growth rate	3.2%	3.0%	2.8%

S5.2 FUTURE DIRECTION OF URBAN DEVELOPMENT

Based on the overall assumptions and analyses, the area of CUN continues to expand toward 2015. The future land use forecast has been made in Table S5.2.

Table S5.2 FUTURE OUTLOOK OF NIAMEY IN 2015

	Total Area (ha)	Urbanized Area (ha)	Residential Area (ha)	Population
Commune I	8,282	4,981	4,354	528,258
Commune II	11,908	5,209	2,835	332,694
Commune III	3,726	1,021	699	132,772
Total	23,916	11,211	7,888	993,724

S5.3 CONTRAINTS OF INSTITUTIONAL SUPPORT

In the World Bank financed Water Sector Project following the four preliminary studies, a pilot project with estimated cost of USD 2.4 million is envisaged. In its cost estimation, a certain amount is allocated to "*Social Engineering*."

It is understood that in West Africa or in the French speaking sub-Saharan countries, NGO's were mobilized to institute organizations to operate and maintain the social infrastructure projects. In the process of such institution building, NGO's have developed a participatory approach in that they tried to encourage and organize the project participants through a process

of *sensibilisation* and *animation*. Their activities are summarized in a brief history of the water supply development projects in comparison to the governments' activities.

S5.4 AVAILABLE SITE FOR SANITATION FACILITIES

According to the comparison of each nominated site, the Team chose each one proposed site among the nominations with careful consideration thinking of advantages and disadvantages. The following are the selected proposed sites:

(1) UASB Plant
The site is a farm field, which is next to Deizeibon primary school and part of dumpling area. With the total hydraulic losses reducing, this busy area is selected for the Pilot Study of facilities Construction.

JYOKASO Plant
Due to the circumstances of characteristics of JYOKASO, Bandabari Primary School II was chosen for the Pilot Plant with implementing the Hygiene Education.

For these two proposed sites, MET, MOE, UCN and the Study Team have arranged the coordination meeting regarding the demarcation and undertaking of Nigerian Side.

CHAPTER S6. PILOT STUDY FACILITY CONSTRUCTION

S6.1 OBJECTIVES OF THE PILOT STUDY

The ultimate goal of these pilot plants is realization of full-scale plants in the long term to provide improved sanitation environment to people of Niamey City. Health condition of people will be improved with the decrease in water borne diseases (diarrhea, dysentery, hepatitis, cholera and typhoid fever).

In addition to reviewing the effectiveness of treatment methods, pursuing ways to utilize treated water and checking the treatment efficiency of the plants should be implemented in this study. Concretely treated water and distracted sludge agricultural use experiment should be done at plant sites.

During operation of pilot plants, counterparts will directly manage and maintain the treatment plants, and technology transfer to counterparts will be implemented under direction of JICA Study Team. Such as OJT or T/T would promote capacity building efforts of the counterparts.

S6.2 INTEREST OF UASB AND "JYOKASO" TREATMENT TECHNOLOGY

UASB Treatment Technology for Niamey City has following additional advantages:

(1) The efficiency of UASB is increasing with the temperature.
(2) UASB process needs a small quantity of energy to operate.
(3) This process needs very simple operation and maintenance.
(4) It is very economical in construction because it requires only a small super structure.
(5) At last, it produces very mineralised sludge.
(6) Production of methane gas that can be used.

A "Jyokaso" Plant will permit a full treatment of domestic wastewater and is well adapted to treat the communities' wastewater as on-site sewage treatment plant. Domestic wastewater in the proposed Jyokaso plant means night soil (actually flush toilet wastewater) and grey wastewater (miscellaneous wastewater) but in some district Jyokaso may be applied for restaurants, organic wastewater from small or household factories and so on.

S6.3 SELECTION OF SITES AND CONSTRUCTION CONTRACTOR

The UASB plant site, Deizeibon, is situated at the end of one of the 11 drainage followings into the "Gounté Yena" natural drainage. This site is located near a primary school. The wastewater of this outfall is highly polluted and concentrated. Therefore, from point of view of hygiene education and public awareness selection of this site is appropriate. A local contractor has been selected as the construction contractor and approved by JICA. The Jyokaso equipment was imported from Japan at the cost of JICA.

S6.4 INTRODUCTION OF TREATMENT PROCESS

<u>UASB Treatment Process</u>

UASB treatment process has the following advantages and disadvantages.

(1) The advantages of the UASB technology based on the anaerobic degradation of organic matter.

1) Low energy consumption because no aeration is required
2) Production of biogas.
3) Low production of excess sludge with good dewatering characteristics.
4) No mechanical and rotating equipment.
5) Lower capital costs and 30% lower O&M costs comparing to activated sludge process.
6) Land area requirement is small comparing to the conventional aerobic treatment process.

(2) The disadvantage of the UASB technology

1) BOD removal efficiency is limited to 70 – 80 %
2) Only applicable for the wastewater with higher temperature.
3) Initial starting up takes a little bit long time.
4) Low removal of nutrients and pathogens.
5) Need for secondary treatment facilities like polishing pond.

Jyokaso Process

Since the latter half of the 1950's, Jyokaso system has been constructed in Japan because of delays in the construction of sewerage and a strong demand for flush toilet. In the early stage, Jyokaso treated only the wastewater from flush toilets. That is so called separate type Jyokaso. On the other hand, recently, in the request of quality conservation in water environment, Jyokaso system has been widely constructed to treat domestic gray water as well as wastewater from flush toilet. That is so called combined type Jyokaso system.

S6.5 PROCESS DESIGN OF PILOT PLANTS

UASB Process Flow

Figure S6.1 shows the process flow of 100m^3/day at Deizeibon Pilot Plant. The plant consists inlet work and UASB reactor as primary treatment, trickling filter as secondary treatment, eco-system pond as natural recycle system, and sludge drying bed as sludge treatment.

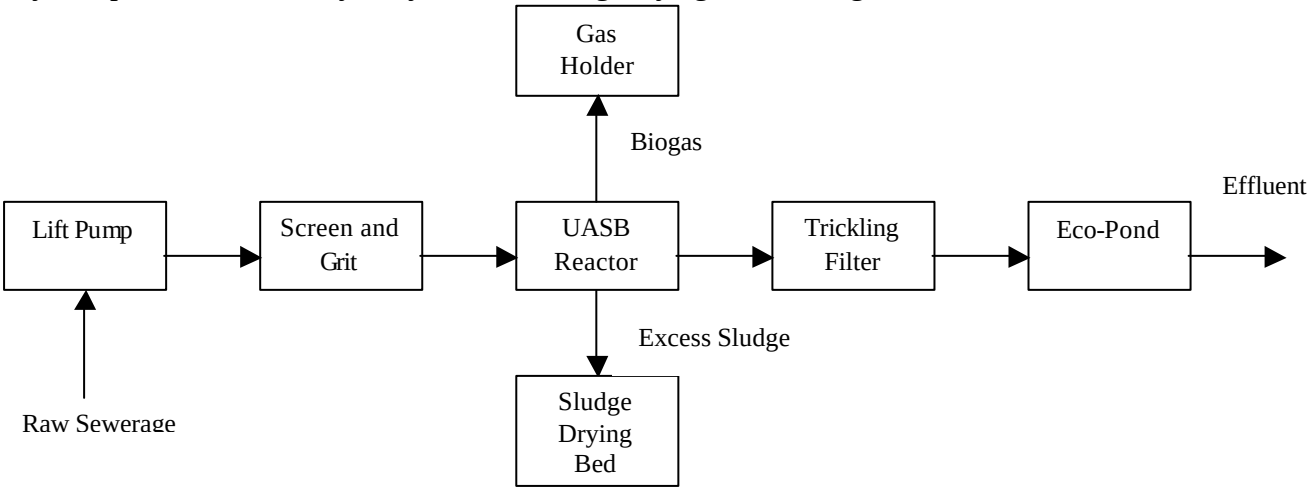


Figure S6.1 PROCESS FLOW OF UASB PLANT

Jyokaso Process Flow

A flowchart for the sedimentation / separation – contact aeration method is shown in Figure S6.2 Influent flows successively through the sedimentation / separation tank, the contact aeration tank, the sedimentation tank, and the disinfection tank before discharge.

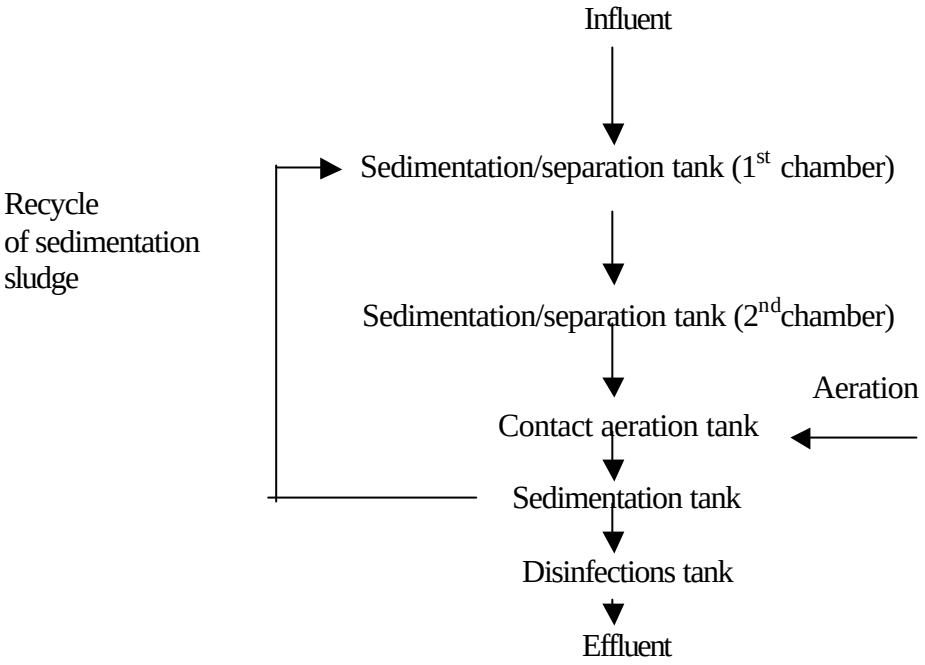


Figure S6.2 FLOW CHART OF JYOKASO PROCESS

S6.6 NIGERIEN OBLIGATION AND UNDERTAKINGS

CUN has taken the necessary action to get the dedicated land for UASB Plant at Deizeibon area. CUN and landowner have already agreed to take over the proposed site with "Land Property Exchange Agreement" dated 2nd January 2001. Second of all, CUN shall take over the O&M for both Pilot Plants after the Study Team does training of Pilot Study. CUN shall dispatch the technicians who are in charge of electricity & machine and casual workers such as guardian and sweeper. CUN shall also deploy engineers to the Bandabari primary school to supervise the O&M.

MET shall dispatch O&M engineers to the UASB plant site to supervise the O&M of the plant. MET shall install the new connection of power supply from NIGELEC and water supply from SNE. MET also shall pay the electric bill and water bill from the Authority after the completion of OJT&T/T.

MOE together with CUN Education Committee shall build fences and access gate for the Bandabari primary school. MOE shall request to NIGETIP to construct the fences and access gate for the security purpose.

S6.7 IMPLIENTATION OF THE PILOT PLANTS

UASB Process Equipment

Following UASB process equipment shall be imported from Bumbai, India to Niamey via Cotonou, Benin for UASB mechanical equipment.

- Screens (coarse & fine) in the inlet channel
- Pumps in pump pit
- Weir in outlet of grit channel
- Three phase separator in UASB reactor
- Media for trickling filter
- Rotating mechanism for trickling filter
- Plant lighting
- Recirculation pump
- Gasholder
- Flare and gas flow meter
- All interconnecting piping/valves
- Electrical motor control panel
- Electrical cabling, earthening

Jyokaso Process Equipment

Jyokaso is a package type domestic waste water treatment plant, which consists of sedimentation/separation tanks, contact aeration tank, sedimentation tank and disinfection tank. Jyokaso itself and supplemental equipment listed as below were also imported from Japan via Cotonou, Benin.

- Body of Jyokaso
- Blower
- Compressor
- Operation panel
- Motor set
- Electric valve
- Spare parts

Once Pilot Plants have been commissioned, routine monitoring should be done. Routine monitoring of the water quality is not only for checking whether the effluent is complying with the local discharge or recycle but also for taking the immediate and efficient action against operational malfunction.

CHAPTER S7. BASIC POLICY AND MASTER PLAN CONCEPT

S7.1 BASIC POLICY AND STRATEGY OF IMPROVEMENT

For the sanitation improvement of the Niamey City a system should be based on the principle that construction coexist with natural environment. And suitable method should be adopted with consideration of economical situation, technical capability and natural conditions. Also low energy consumption, low cost and utilization of exiting local materials, those will lead to reduce environmental load yielded by development.

It is clear that policy and strategy shall be established and executed immediately. Adequate organization shall be established as soon as possible. It is very important that Niger side show strong intention and actual effort to all related international organization to obtain financial support to improve sanitation.

CUN and residents of Niamey are poor. Sanitation condition shall be improved under this constraint. It may be necessary to obtain financial support from international organization. However, operation and maintenance cost shall be born by Niger side, central government, CUN and residents. In order to operate and maintain facilities and equipment, Niger side shall have technical and management capability and also resident participation. But technical and management capability is quite insufficient at present and shall be developed.

Financial constrain will be main issue in the Master Plan. Therefore, sanitation improvement shall be step by step considering priority and urgency. First step shall limit the scale within building up of operation and maintenance capability of Niger side. Also, each step shall start from model steps then expanded to similar area. It shall be recognized that it is impossible to draw up realistic plan without financial support, especially operation and maintenance cost should be borne by Niger side.

S7.2 CONCEPT OF MASTER PLAN

Primarily, the Master Plan shall be done on the concept of Master plan of Sewerage/Drainage and Solid Waste Management by proposing the possible Plan for the near future. The field reconnaissance and survey including sub-contract works for six categories has been carried out. Based on the out come of field survey, most appropriate plan will be selected for the target year.

The concept of the Master Plan work will cover mainly following topics:

- To meet increasing planning population to all the Study Area.
- To rectify the situation of Sanitary Improvement of Niamey City.
- To formulate the Master Plan for Sewerage/Drainage and Solid Waste management.
- To build two Pilot Plants and to campaign the Hygiene Education.
- To evaluate the most appropriate sewerage treatment process for the Republic of Niger.

S7.3 PLANNING FRAMEWORK FOR SEWERAGE SYSTEM

(1) Planning Area

Sewerage planning area shall be the urban planning area in the CUN. The sewerage planning area is further classified into sewerage facility planning area and on-site treatment area. Table S7.1 shows the details of sewerage planning area.

Table S7.1 SEWERAGE PLANNING AREA

Commune	Area(ha)
Commune I	3,341
Commune II	3,267
Commune III	1,021
Total	7,629

(2) Sewerage Population

Sewerage planning population shall be the population in the sewerage planning area, that is the urban planning area in the CUN. The sewerage planning population is further classified into sewerage facility planning population and on-site treatment population according to the classification of the sewerage planning area. Table S7.2 shows the details of sewerage planning population

Table S7.2 SEWERAGE PLANNING POPULATION

Commune	2000	2005	2010	2015
Commune I	292,835	333,257	355,116	389,662
Commune II	211,778	232,180	253,576	271,263
Commune III	78,412	91,334	113,419	132,776
Total	583,025	656,771	722,111	793,701

(3) Sewerage Flow

Daily average flow of sewage is estimated based on the projected sewerage population, unit water consumption for domestic use and commercial/industrial water consumption, and collection ratio.

Daily maximum flow shall be 1.3 times of daily average flow based on the water production data. The daily maximum flow shall be applied to design of water treatment plant.

Hourly maximum flow is usually between 1.5 and 2.0 times of hourly average flow depending on the population served. As actual measured data is not available, hourly maximum flow shall be calculated as 1.8 times of hourly average flow. The hourly maximum flow shall be applied for the design of sewage conduit/pipe and pumping station.

(4) Pollution Load

BOD concentration at the discharge point is estimated as 150 mg/l taking the pollutant runoff coefficient of 0.6 into consideration. 0.6 is chosen as the medium value of urban area.

COD concentration is also estimated as 360 mg/l from the actual Katako data of 216 mg/l and runoff coefficient of 0.6 same as BOD. 360 mg/l is 2.4 times of BOD, that shows same tendency for other analysis data.

SS concentration is assumed as 600 mg/l as weighted average of the actual analysis data as little purification through drainage is expected for SS.

S7.4 SOLID WASTE MANAGEMENT

(1) Solid Waste Quantities

Within the framework of this study, a survey for solid waste survey was carried out. It aimed at getting data on the quantity and composition of domestic refuse in 6 neighborhoods at the level of 300 households representative of Niamey Urban Community. The figures of refuse quantity enabled, after extrapolation to the other neighborhoods of the capital, to define the quantity of domestic refuse produced per capita per day and the total quantity of domestic refuse generated in Niamey Urban Community.

For the design of the landfill and the estimation of the waste quantities, as determinates in the survey, shall be taken as average value for the further design criteria in The Master Plan for solid waste management in Niamey.

Within the framework of the solid waste survey, the composition of household waste was equally defined for the various neighborhoods taken into account. The broken down results are compiled in the support report on base figures. According to future projections of waste quantities were calculated 272 ton/year at the year 2015.

(2) Development Stages

The system of solid waste management is generally developed through different stages as shown in Figure S7.1 and based on design criteria as mentioned in the preceding chapter. The policy of alternative formulation differs with current stages where the SWM implementing bodies and current public practices belong.

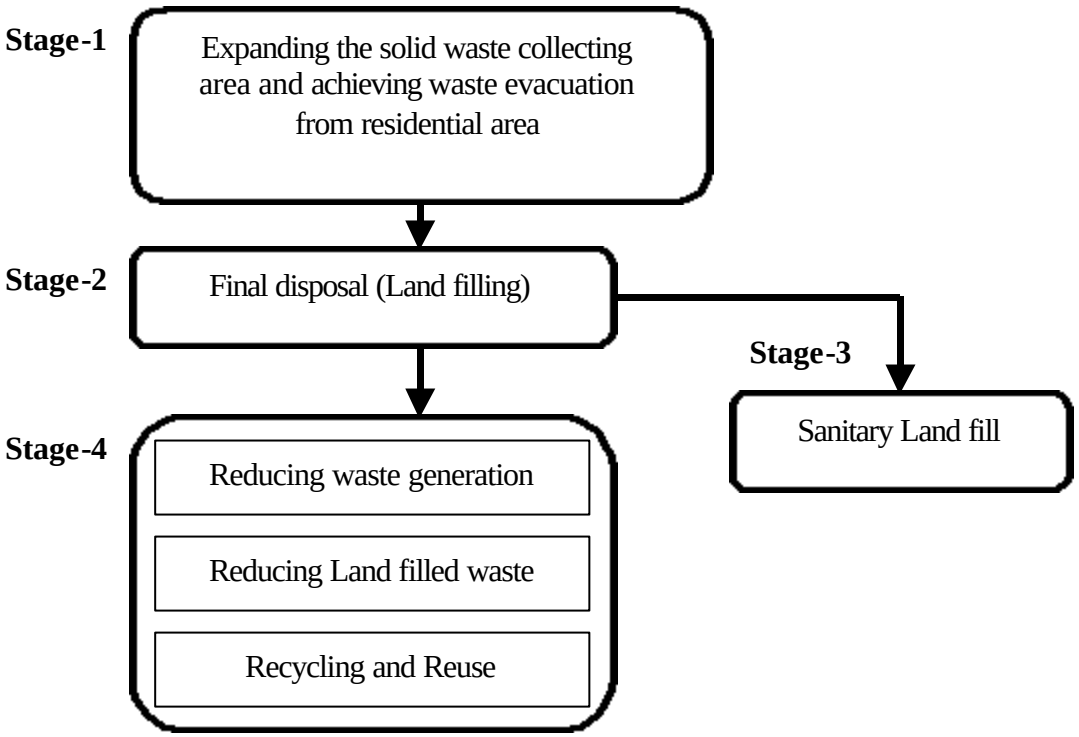


Figure S7.1 SOLID WASTE MANAGEMENT DEVELOPMENT STAGES

S7.5 RESIDENT COOPERATION

It is sinequanon for necessity of public participation and/or resident cooperation through carrying out the Pilot Study. MET and CUN should play an important role for showing good leadership as a model case of sanitation improvement project in Niger. This project is to be a "Landmark" act as first attend for resident cooperation.

It should be considered that the purpose of resident cooperation is to be a communication with residents and citizens. This consideration is kind of factor to formulate the target of the project.

The following realization shall be noted for the Authorities and residents.

(1) For the durability of project performance, it would be necessary to motivate the recipients directly concerned by the continuous public health service, maintenance, financing and support. Among the various ways to motivate, the a financial support will be included.

(2) Participative approach can keep the effect of the project for a short and medium – term period, but it may encounter limitations in the long run. The pilot study will therefore draw up the sustainable approach to develop and improve the quality of the service over a long period.

(3) The recipient entity and the recipient residents should know how to keep the quality of the service offered by the project together with its feasible effect.

CHAPTER S8. MASTER PLAN OF SEWERAGE AND DRAINAGE

S8.1 SEWERAGE / DRAINAGE ZONE

Based on the fundamentals, sewerage facility planning area is divided into 15 sewerage/drainage zones. Zoning of wastewater and storm water is not different. Table S8.1 shows each treatment zone with area and population in year 2015.

S8.2 COLLECTION SYSTEM

In the center of the city, storm water drainage already exists. Combined sewer system which collects both wastewater and storm water in a single channel is recommended in this area utilizing existing drainage. Interceptor shall be provided with the existing drainage to collect the sewage. Construction cost of this system will be lower because of utilization of the existing drainage. Area of C1 to C4 is categorized in this system.

The separate sewer system which collects waste water and storm water in the separate conduit/pipes respectively will be planned for the area where neither the existing drainages are well organized nor exist such as in the future residential area. Area S1 to S11 is categorized in this collection system.

S8.3 DESIGN SEWERAGE FLOW AND RAINFALL FLOW

Based on the framework described in previous Chapter, design sewage flow is estimated in the Table S8.1.

Table S8.1 DESIGN SEWERAGE FLOW IN 2015

No.	Treatment Zone	Area (ha)	Population (2015)	Wastewater Daily Ave. Flow (m^3/d)	Wastewater Daily Max Flow (m^3/d)
C1	Plateau I	304.1	10,995	1,131	1,470
C2	Issa Beri	162.4	10,609	753	980
C3	Deizebon	254.9	43,042	1,904	2,480
C4	Gamkalle	840.4	96,529	6,152	8,000
S1	Yantala	570.4	55,107	2,510	3,260
S2	Kouara Kano	389.9	19,059	1,188	1,540
S3	Dar Es Salam	710.8	97,973	4,471	5,810
S4	Kouara Me	777.5	134,602	5,523	7,180
S5	Bani Fandou Ⅱ	515.7	93,269	3,810	4,950
S6	Talladje Koado	448.7	53,947	2,539	3,300
S7	Industrielle	342.0	7,386	2,322	3,020
S8	Karadje	435.1	44,959	3,288	4,270
S9	Gaweye	135.1	0	NA	NA
S10	Banga Bana	450.9	87,817	3,293	4,280
S11	Airport	1,290.8	38,407	2,527	3,290
	Total	*7,628.7	793,701	41,411	53,830

*) Excluding peripheral green zone area from the urbanize area with 8,800ha

S8.4 FACILITY PLANNING / PRELIMINARY DESIGN

(1) Trunk Drainage Facility

Existing drainage capacity was initially checked. If the capacity of the existing drainage is not adequate, additional drainage was planned along with the existing drainage. In addition, new drainage facility was planned in the area where existing drainage does not exist

(2) Trunk Sewer Pipe

For the combined sewer system zones, interceptors were planned to collect and introduce sewage in the existing drainage into the wastewater treatment plant. The interceptors are designed to accommodate the three-time flow of the hourly maximum flow in case of rain. The storm water flow more than the interceptor capacity will be discharged to the adjacent drainage/river. For the separate sewer system zones, new sewer pipes were planned in addition to the storm water drainage facility.

(3) Waste Water Treatment Plant

UASB plant shall be located in each sewerage zone except for S11. For S11 zone (the WWTP is the plant will be constructed in Agrhymet site), stabilization pond system shall be applied as the WWTP area is available near the zone and therefore no long transfer line is necessary. Energy consumption for the stabilization pond itself is less than the UASB process. Location of the WWTP in each zone is selected to keep the gravity collection of the sewage as much as possible.

Design capacity is standardized based on the daily maximum flow as in Table S8.2

Table S8.2 LIST OF WASTE WATER TREATMENT PLANT

No.	Treatment Zone	Design Capacity (m^3/d)	Treatment Process
C1	Plateau I	1,600	UASB
C2	Issa Beri	1,000	UASB
C3	Deizebon	2,500	UASB
C4	Gamkalle	8,000	UASB
S1	Yantala	3,500	UASB
S2	Kouara Kano	1,600	UASB
S3	Dar Es Salam	6,000	UASB
S4	Kouara Me	8,000	UASB
S5	Bani Fandou II	5,000	UASB
S6	Talladje Koado	3,500	UASB
S7	Industrielle	3,500	UASB
S8	Karadje	5,000	UASB
S10	Banga Bana	5,000	UASB
S11	Airport	3,300	Stabilization Pond

CHAPTER S9. SOLID WASTE MANAGEMENT MASTER PLAN

S9.1 CONCEPT FOR THE SOLID WASTE MANAGEMENT MASTER PLAN

To solve the problem, the following summarized actions have been planned.

(1) The new collection system that is analyzed in Alternative Study. It shall be introduced for household waste. The new system shall consist of 2 components, one is privatized pre-collection and sand recycle and other is container transportation to be done by CUN and Communes.
(2) To help the new system, the present system shall keep the capacity at 21% of generated waste. Where the new collection system will be introduced, it will replace the existing collection system.
(3) Container shall be provided and industrial solid waste collection service shall be introduced.
(4) Infectious waste shall be collected separately from household similar waste. Infectious waste has to be incinerated, Ash from the incineration shall transport as well as household similar waste from the hospital to landfill site.

S9.2 DOMESTIC WASTE

In taking into account the composition of waste, which presents a high component of sand, it is recommended to forecast that in recycling centers, sand is recycled. Sand can be screened manually and put at the disposal of municipal services, which should take in charge the transport of remaining waste towards the municipal dumping site. The recycled sand can be used by municipal services as backfilling equipment to fill rainwater erosions; this will enable to put an end to the present method of waste removal, which consists in using waste like filling raw materials.

Given the fact that farmers also request fermentiscibles, it is equally recommended to manually sort out the vegetal components in the household waste and to sell them to farmers.

Table S9.1 shows waste quantities and Composition.

TABLE S9.1 WASTE QUANTITIES AND COMPOSITION

	Component	Quantity (ton/year)		
		2005	2010	2015
1	Paper et Cardboard	2,329	2,680	3,056
2	Plastic	6,944	7,991	9,114
3	Textiles & rag	1,103	1,269	1,447
4	Leather & rubber	0	0	0
5	Wood	1,518	1,747	1,992
6	Organic	39,599	45,569	51,969
7	Fines (<5mm)	147,347	169,561	193,375
8	Metal	1,209	1,391	1,587
9	Glass	132	151	173
10	Stones	7,101	8,172	9,319
	Total	207,281	238,531	272,032

Actually CUN and the three belonging Communes have a capacity to collect and transport approximately 21% of generated waste. This capacity of 21% shall be kept for the population that will not be served by the new system. The collection rate will increase and will be covered by new system whose cost is lower for CUN and Communes. The improvement of waste collection according to the introduction of new system will be as shown in Figure S9.1 when this master plan is executed.

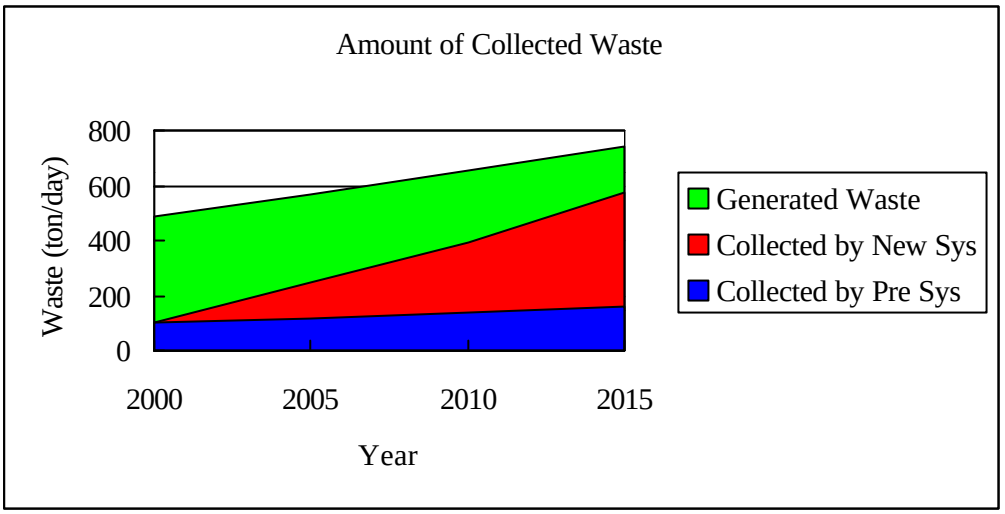


Figure S9.1 INCREASE OF WASTE COLLECTED AMOUNT

S9.3 INDUSTRIAL WASTE

It is recommended that the services for solid waste management shall be carried out by the CUN. These services are making container available, transporting regularly waste and disposing it properly at the landfill site.

It is furthermore recommended that the cost for industrial waste management shall be borne by the industry.

S9.4 HOSPITAL WASTE

The total quantity of hospital waste amounts to 1,796 ton/year for the year 2005 and 2,356 ton/year for the year 2015. The amount of infectious waste that necessitates individual treatment is about 359 ton/year for 2005 and 471 ton/year for the year 2015.

As an efficient treatment method for infectious waste, the incineration method is recommended. The National Hospital of Niamey, the biggest hospital in Niamey, shall be equipped with an incinerator. The capacity of the incinerator, 200 kg/h, is designed to be sufficient for all the target project period. All infectious waste shall be central incinerated at the National Hospital.

S9.5 PROJECT LIST

As result of the detailed analyze for the required works to carry out the master plan, the following Table S9.2 presents the total equipment needed for the solid waste management in Niamey.

Table S9.2 PROJECT LIST FOR SOLID WASTE MANAGEMENT

No	Project	Quantity or Construction			
		By 2005	By 2010	By 2015	Total
1.	**PRESENT SYSTEM: Equipment Purchased by CUN and Communes**				
1.1	5.5m^3 Container Truck	3	5	1	9
1.2	5.5m^3 Container	54	28	46	128
2.	**NEW SYSTEM: Equipment Purchased by CUN and Communes**				
2.1	5.5m^3 Container Truck	8	7	4	19
2.2	5.5m^3 Container	52	48	61	161
2.3	15t Dump Truck	2	1	2	5
2.4	2m3 Wheel Loader	1	1	1	3
3.	**RECYCLING CENTER: to be financed and managed by private pre-collectors**				
4.	**DISPOSAL SITES: to be managed by CUN**				
4.1	Construction of Final Disposal Site CU1&2	Phase 1	Phase 2	Phase 3	
4.2	Construction of Final Disposal Site CU3	Phase 1	Phase 2	Phase 3	
4.3	Equipment Purchase for Disposal (Bulldozer)	1: 165HP		1: 135HP	2
5.	**INDUSTRIAL WASTE: to be financed by factories**				
5.1	Purchase of 5.5m^3 Container Truck	0.34			0.34
5.2	Purchase of 5.5m^3 Container	10			10
6.	**MEDICAL WASTE: to be financed by hospitals**				
6.1	Purchase of 5.5m^3 Container Truck	0.66			0.66
6.2	Purchase of 5.5m^3 Container	11			11
6.3	Construction of Incinerator (200kg/h)	1			1

CHAPTER S10. PROJECT COST AND IMPLEMENTATION SCHEDULE

S10.1 SEWERAGE SYSTEM

(1) Project Cost

Based on the preparation work, total Project Cost was estimated in Table S10.1. Cost per beneficiary for the total investment cost is adopted as the cost efficiency index for the sewerage facilities. According to the analysis, zone C3, Deizebon, shows the most cost effective and then C4, Gamkalle, is next. This is because total investment cost in the combined sewer system zones, where existing drainage is already installed, is lower than that in the separate sewer system zones where new sewer/drainage is to be constructed.

On the other hand, cost per beneficiary in C1 and C2 zones are rather higher, even they are in the combined sewer system zones. This is because inhabited population in C1 and C2 zones is smaller as public administrations are concentrated in these zones. To construct sewerage/drainage facilities in such public administrative zones is also effective from the viewpoint of infrastructure development.

Therefore, priority for implementation shall be combined sewer system zones, C1 to C4, and then separate sewer system zones. Among the combined sewer system zones, C3 Deizebon zone shall be the first priority zone and selected as the urgent rehabilitation work by 2005.

(2) O&M Cost

O&M Cost is estimated CFAF 570 Millions per year at the year 2015, and 336 Millions CFAF per year at the year 2010.

(3) Implementation Schedule

Main assumptions given to the implementation schedule are as follows.

1) The first stage is to implement the project for C3 sewerage zone by 2005, which includes the installation of the sewer pipe, drainage pipe and wastewater treatment plant, and land acquisition.

2) The second stage is to implement the projects for the other combined sewer system zones such as C1, C2 and C4 sewerage zones by year 2007.

2) The third stage is to implement the projects for the separated sewer system zones of S1 to S11 by year 2015.

Table S10.1 SEWERAGE ZONE WISE PROJECT COST

Description	C1	C2	C3	C4	S1	S2	S3	S4	S5	S6	S7	S8	S10	S11	Total
Direct Construction Cost	1,555	1,051	833	2,938	3,392	2,100	4,230	5,352	4,438	2,998	1,637	2,269	3,242	1,199	37,234
Engineering Cost	155	105	83	293	339	210	423	535	443	299	163	226	324	119	3 ,717
Sub-Total	1,710	1,156	916	3,231	3,731	2,310	4,653	5,887	4,881	3,297	1,800	2,495	3,566	1,318	40,951
Contingencies	256	173	137	484	559	346	698	883	732	494	270	374	535	197	6,138
Land Acquisition	25	16	40	126	55	17	66	63	40	27	55	56	40	190	816
Total	1,991	1,345	1,093	3,841	4,345	2,673	5,417	6,833	5,653	3,818	2,125	2,925	4,141	1,705	47,905

(Unit: Million CFAF)

S10.2 SOLID WASTE MANAGEMENT

(1) Project Cost

The total Project Cost is estimated for household waste management, Industrial waste and medical waste in Table S10.2

(2) O&M Cost

O&M Cost is estimated CFAF 1,412 Million per year till year 2015.

Table S10.2 PROJECT COST FOR SOLID WASTE MANGEMENT

(Unit: Million CFAF)

Description	Household Waste	Industrial Waste	Medical Waste
1. Present System	895	-	-
2. New System	2,349	-	-
3. Recycle Center	252	-	-
4. Disposal Site	1,608	-	-
Sub-Total	5,104	53	170
Total	5,327		

(3) Priority for Implementation

The master plan shows and presents the schedule for the introduction of the collection new in quartiers. This is based on the income class of the quartiers and the capability to bear the pre-collection cost as well as population density that lead to an environment impact made by scattered waste. However the quartiers where the new system is planed to introduce have been evaluated with cost/beneficiary (C/B) and current pre-collection activity since the C/B is varied according to the area population and population density.

Generally the areas having less population density require higher C/B. The evaluated C/B does not include the transport cost from the recycling centers to the final disposal sites that are to be born by CUN and Communes since the evaluation aims is, to estimate the cost that will be paid directly to pre-collector by the resident. In addition to the introduction schedule shown in master plan, this priority index shall be utilized for each introduction phase (Stage 1: to introduce by 2005, Stage 2: to introduce 2010, Stage 3: to introduce by 2015).

CHAPTER S11. INSTITUTIONAL SET-UP

S11.1 INSTITUTIONAL REQUIREMENTS

In the drainage and wastewater sector, newly constructed drains and sewage treatment plants are expected to operate by the Municipality. It is reckoned that a single sewage treatment plant requires approximately 15 working staff for the proper operation. If all of the proposed 14 plants are in operation, operation of treatment plants alone requires some 200 staff, which consists of engineers, technicians, workers, etc.

The facilities envisaged in the master plan frame are expected to generate the defined benefits or impacts that are desirable. In order to keep this scheme running, suitable institution and organization should be envisaged. Here, distinction between "institution" and "organization" has to be given in the narrow sense. Taking a simple sport analogy, institution will be well understood as "rule of game" against organization, which may be seen as "team of players." Thus, institutions are a set of formal and informal rules and distinct from organizations.

Niamey City is launching a systematic drainage and sewerage service in the near future. Due to the scale of investment and magnitude of the operation and maintenance cost, maintenance of the service may not be financed from the Municipality budget alone as has been insufficiently done for the existing service. Some measures for cost recovery from the service users should be instituted. Should the public service be provided for the fee from the beneficiary, a consensus that may be articulated in the following four principles should be sought for:

1) Single management
2) Efficient operation / Least cost
3) Transparent cost
4) Financial autonomy

Volume of wastewater is derived from the consumed water. In Niamey city, water supply connections are metered. It is strongly recommended to set the sewerage tariff as a surcharge onto the water charge. This will require cooperation of the water supply company, which is in the course of privatization negotiation with a French operator. Volume of the drainage water, however, is originated partly from rainfall and partly from watering to the house garden, car washing, etc. In the central areas of the City, a combined drainage and sewerage system is proposed. Therefore, the public will reasonably accept surcharge to the water bill.

S11.2 REQUIREMENTS TO THE PROJECT IMPLEMENTATION AGENCY

The implementing agency shall prepare the terms of reference to define these duties of the consultant for consent of the lender. In consultation with the lender, the implementing agency shall also proceed with the employment of the consultant that includes engineering services.

S11.3 PROPOSED ORGANIZATION AND ITS DEVELOPMENT

Successful water and wastewater enterprises worldwide operate under a common set of enabling conditions and share a number of common characteristics. They tend to have:

1) Autonomy in all aspects of managing the enterprise and operation of drainage and wastewater systems,
2) A clearly defined regulatory framework by Government, which hold the companies to high standards of efficiency,
3) Financial self-sufficiency from the collection of tariffs sufficient to meet all financial needs,
4) A strong sense of public service and consumer orientation to render service of best quality for minimal cost,
5) Access to credit for financing investments, and
6) Reliance on a strong, competitive private sector to provide quality support service.

Represented in the Board of Directors are Ministries of Equipment and Transport, Water Resources and Public Health, Urban Community of Niamey, the water supply company, the private initiative (NGO) and the beneficiary initiative. The Board shall be convened to prepare the creation of the Urban Drainage and Sewerage Society. The private initiative and the beneficiary initiative particularly are expected to introduce and encourage the public participation from the early stage of the organization building.

S11.4 LEGAL ARRANGEMENTS FOR THE DRAINAGE AND SEWERAGE SERVICE AND SOLID WASTE MANAGEMENT

1) Obligation of connect to sewer
2) Enforceable service charge
3) Urban Development Plan and Integrated Flood Control
4) Sewerage Low and Sewerage Facilities Law
5) Control of groundwater exploitation
6) Legal status of private pre-collectors

S11.5 COMMUNITY PARTICIPATION

Success of sanitation improvement is mostly depending on the level of the population's awareness and sensitivity on their sanitary environment. To propagate the awareness raising activities, various parts of the community need to be mobilized.

1) Participation of residents – assumed beneficiaries
2) Participation of women – main actors of sanitary behavior
3) Participation of Non-Government Organizations (NGOs)
4) Participation of schoolchildren through hygiene education

CHAPTER S12. FINANCIAL ANALYSIS

S12.1 PROPOSED SCALE AND SCHEDULE OF INVESTISEMENT

The capital cost indicated in each target year is to be invested in the years up to the target year. Annual operation costs in the target years are those for every target year. These costs may be divided into two groups:

a) The municipality portion consisting of procurement of equipment for present system and new system, preparation of disposal sites and operation and maintenance of them and
b) The private pre-collector's portion that consists of costs for recycle centers and their operation and maintenance.

Costs for the former (a) shall be borne by the municipality, while the latter (b) shall be invested by the pre-collectors own risk and eventually are recovered from the contracted service-users or beneficiaries.

The total investment cost is 53 billion CFAF francs over 15 years. Implication of this investment scale may be suggested, if it is compared with the scale of national capital expenditure, which consists of all the development projects.

In the case that the annual project budget would be 90 billion through the year 2001 to2015, the project cost of 53 billion accounts for 3.9 percent of the total national projects. If the budget would be 100 billion, the project costs will account for 3.5 percent.

S12.2 OPERATION AND MAINTENANCE COSTS

Drainage and sewerage service is a new and unknown undertaking in Niger. Concept of the drainage and sewerage service provider was proposed and the cost to run the services was estimated. Total daily operating cost is calculated is CFAF 570 Millions.

In the Master Plan, recovery of operation and maintenance cost alone is expected. The per head operating cost in the year 2016 is 754 CFA francs at the 2001 price. This is approximately 0.5 percent of the per capita GNP (USD 190), and definitely affordable level. The per-head operation costs are given in the cases of 3 percent inflation: 1,175, and 5 percent inflation: 1,568.

To offset imbalance of the initial years (2006 to 2015), tariff has to be set slightly higher than 754 CFA francs. A simple comparison of accumulated tariff revenue and operation costs is tried with assumed tariff levels of 900, 1,000 and 1,200 CFA francs per served population.

S12.3 TARIFF AND COLLECTION

The Master Plan suggests that the drainage and sewerage tariff shall be collected as a surcharge onto the water bill. Simplest way is to add a certain percentage onto the water charge. The total operation cost at the target year is 598.7 million CFA francs. This is the 2001 price, and should be escalated, most likely, by 3 percent per year.

Then, 933 million (1,175 per head) plus the 19 percent value added tax, if generally applicable, would come to the total sewerage bill of 1,110 million. If effective tariff revenue of water supply in Niamey were assumed as 6,000 million in 2016, then 18.2 percent (i.e. 1,100/6000) would be added to the water bill.

S12.4 SOURCE OF FUND AND REPAYEMENT

The present master plan encompasses global improvement of the basic sanitation infrastructures for Niamey city. Social and environmental benefits will be diverse. Poorer parts of residents, who are directly affected by the deteriorating sanitation environment, will be greatly relieved from the fear of diseases and inundation. However, capital costs are hardly recovered from the beneficiaries, and the national treasury may confront difficulties to finance them. It is, therefore, suggested to seek external public finance, which should be in the form of grant aid or a credit with concessional terms of lending. The following terms of credit is assumed here:

- No interest rate
- Service charge: 0.75 percent/year
- Commitment fee: 0.50 percent/year
- 50-year repayment period, including 10-year grace period.

S12.5 FINANCIAL INTERNAL RATE OF RETURN

(1) Sewerage / Drainage

Drainage and sewerage components of the project shall be constructed by the National Government and the proposed service provider, i.e., the Urban Drainage and Sewerage Society, shall undertake its operation and maintenance. In the calculation of financial internal rate of return, therefore, it is assumed that flow of the full operation costs and only 10 percent of capital cost should be compared with flow of tariff revenue. Based on the proper assumption, Internal Rate of Return is calculated 6.1% in case of CFAF 200 and 11.3% in case of CFAF 1,600 respectively.

(2) Solid Waste Management

The solid waste management projects consist of component operated by the municipality and component operated by the private pre-collectors. Cost of the municipality component is expected to finance by the national and municipal budgets. Its revenue is virtually nothing, while communes under the municipality are gathering the nominal garbage tax. In the absence of revenue or cash inflow, the return will not be generated. Internal Rate of Return is calculated 6.4% in case of CFAF 1,000 and 32.8% in case of CFAF 1,200.

CHAPTER S13. HYGIENE EDUCATION

S13.1 GENERAL

Based on the present situation on public awareness and education on hygiene and sanitation of Niamey reviewed, it is pointed out that followings are the critical issues to be overcome for preparing effective plans and necessary actions on hygiene education for Niamey.

(1) Lack of a suitable policy and plan on hygiene education specially prepared for Niamey.
(2) Lack of clear multi-sectarian cooperation systems for hygiene education among related ministries, local authorities, private entities, NGOs and communities.
(3) Lack of preparation of specific budgets, basic data, research and development for methodologies of hygiene education activities.

In order to avoid leading out of the focus of discussing point, consequently, it is necessary to give a clear definition of "hygiene education". For instance, when a health authority considers an education plan on a communicable disease, in case that the plan focuses on expanding immunization practices among population, then it can be defined as "health education". However, in case that the plan focuses on human behavior like defecation manner of people, then it can be defined as "hygiene education". Of course, some fields involved in every term are overlapped with each other as conceptualized in Figure S13.1.

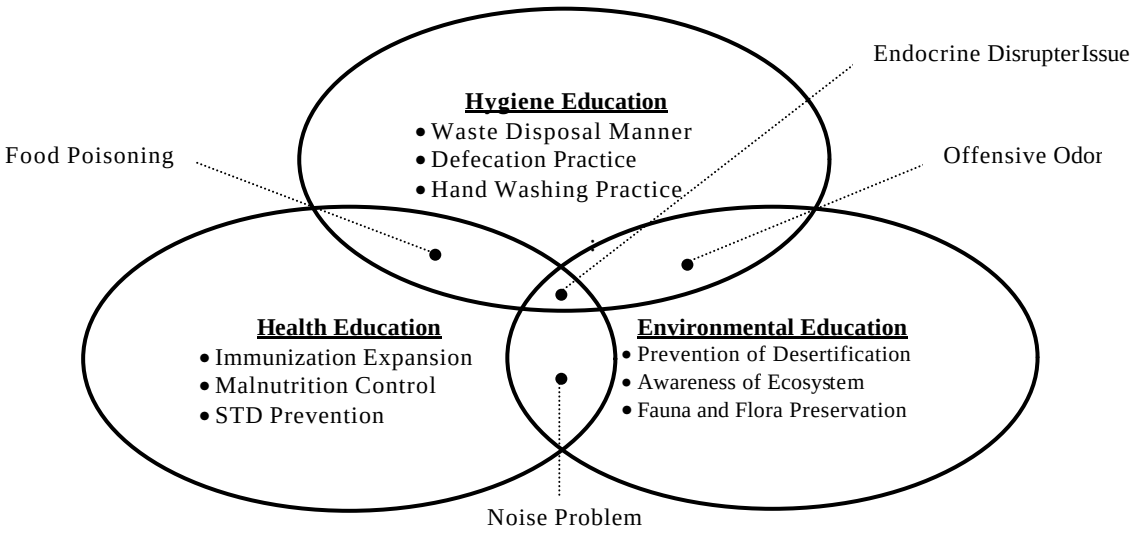


Figure S13.1 EDUCATION ON HYGIENE AND HEALTH

S13.2 BASIC CONCEPT OF HYGIENE EDUCATION

(1) First Step (Short Term Target)

The first step shall be the initiation stage to heighten the health and sanitation notion. Namely in the short term, the population in Niamey shall identify more specifically the link between health and sanitation as individual issues.

(2) Second Step (Middle Term Target)

The second step shall be the term of mutual understanding among all actors involved. Population in Niamey and related official authorities shall identify each other that not only the individual effort, but also cooperation among actors concerned can attain improvement of the sanitation as community issues.

(3) Third Step (Long Term Target)

The third step shall be the final stage to heighten awareness on urban environment protection. Namely in the long term, the plan shall reach a concept of "healthy city" by reducing every load on environment caused by wastewater and solid waste with reasonable systems in cooperation with all actors.

S13.3 HYGIENE EDUCATION PLAN

On the ground of the basic concepts of hygiene education, the actors shall consider an annual plan and each term plan. Especially, MSP as the leading entity of hygiene education has important role to coordinate the multi-sectarian cooperation among actors for considering such plans. In addition to this, the following effort and actions are necessary to the consideration.

(1) Before the start of each term, related activities such as hygiene campaigns shall be conducted with community participation approach for identifying targets and considering necessary actions of each term.

(2) At the final stage of each term, evaluation shall be implemented for feeding backs every achievement and lesson to the next term with the community participation approach.

S13.4 HYGIENE CAMPAIGN

In accordance with the discussion, the JICA study team in cooperation with each actor plans a hygiene campaign as a pilot project. The principal purpose of the campaign can be summarized as follows:

(1) To instruct how-to use of toilet to the schoolchildren at the following pilot project sites
(2) To present know how of hygiene education to all actors
(3) To present know how of community participation approach to all actors
(4) To make a good relationship between the public sector and the private sector

Campaign sites shall be selected at the pilot project sites;

(1) Pilot Project 1: *Jyokaso* Construction Site.
(2) Pilot Project 2: UASB and Trickling Filter Construction Site.

CHAPTER S14. INITIAL ENVIRONMENTAL EXAMINATION

S14.1 ENVIRONMENTAL PROTECTION

(1) Institutions

There are several related authorities such as Ministry, Council and Agency to deal with Environmental Examination.

1) Ministry of Environment and Prevention of Desertification
2) National Council Of Environment for a Sustainable Development
3) Regional Direction of Environment
4) Bureau of Environment Evaluation and Impact Studies

(2) Legislative Framework

The constitution of 1999 and Frame Law of Environment Management of 1998 provide that every body has a right to live in a healthy environment such as living environment, natural environment, land escape and cultural patrimony, natural and technological risks and community participation.

(3) Environmental Plans

There are several local and national frame plans that need consideration within the scope of environmental evaluation. Such plans are presented below. One of them is the Project for Rehabilitation of Urban Infrastructure (PRIU), which is of primary concern for environmental evaluation, but is not considered below because of presentation. This project will provide in 2002 the National Plan for Management of Urban Environment.

(4) Environmental Conventions

The Niger government has signed or ratified several international conventions pertaining to environmental protection. The follow-up of conventions initiated by the Rio Conference of 1992 is the duty of the CNEDD, which has been designated as the *focus point*, in charge of coordinating technical commissions composed of concerned ministers.

The Direction of Fauna of the Ministry of Environment has presidency of the technical commission set up for the Convention on Biological Diversity. Technical commissions established for the Convention for Combating Desertification and for the Convention on Climate Change are presided by the Direction of Environment and by the Direction of Meteorology (Ministry of Equipment) respectively.

(5) Environmental Standards

There are no ambient quality standards for environment in Niger. Emission standards are only those for wastewater, as established by Ministerial order N°014 of 1 November 1976, which gives prescriptions for the conformity of Dangerous,

Insalubrious and Inconvenient Establishments of 3rd class. The Ministry of Environment and Prevention of Desertification presently study a project of law about water quality standards.

(6) Environmental Authorization System

The environmental authorisation system is essential in order to get an integrated protection of environment on the side of management of activities. These legal requirements are reviewed below. They are however overlapping each other about the nuisance issue, and it seems reasonable to consider that environmental authorisation strictly speaking should follow the requirement of the Ministry of environment. The aspects related to the security conditions are clearly subject to requirements of the Ministry of Mines and Energy.

S14.2 EXAMINATION OF ENVIRONMENTAL EFFECTS

The Initial Environmental Examination (IEE) is useful in order to find out the possible negative effects of the master plan project on the social and natural environment. This IEE is a procedure, which is recommended by JICA, and which follows official checklists established for the solid waste management sector and wastewater management sector. The purpose of IEE is to clarify the needs and targets for further environmental assessment within the scope of EIA.

The full IEE process includes the evaluation of the initial state of environment and of the institutional organisation for the protection of environment, as this is done in 3.7 and in this chapter. The output of the IEE is an evaluation of the main expected orientations and issues to be focused on in the EIA study. IEE is performed below through the review of the project components and potential impact sources, and the screening and ranking of possible negative effects.

Implementation of the master plan is based on the installation of solid waste and liquid waste collection and treatment units, which will change the present conditions of evacuation of waste in the environment and improve the sanitation conditions of Niamey. Sitting, construction and operation of these units are however potential sources of undesirable impacts, which need consideration in order to avoid negative feedback effects on social or natural environment.

The purpose of the Environmental Impact Assessment (EIA) study is to make sure that sanitation improvement will not result into transferring pollution and nuisances from the urban area to the natural area, or from one community to the other, according to the new conditions of evacuation of waste water and solid waste.

The output of the EIA study will be the evaluation of the expected impacts of the master plan and the definition of an environmental management plan intended to define a frame for taking into account environment and sustainability factors in the project. Some recommendations will be made and measures taken for reinforcing the identified positive effects.

CHAPTER S15. PROJECT EVALUATION

S15.1 TECHNICAL EVALUATION

In addition to sewerage/drainage and solid waste management, several scheme of Urban Sanitation such as low cost sanitation (LCS) and sanitation campaign are to be proposed together with above major scheme toward the target year. The inadequate present capacity of the drainage system, therefore, represents a major potential constraint to the implementation of the M/P.

It is understood that dedicated proposed site has been selected and proper maintenance personae have been deployed for both pilot plants. O&M is carried out together with JICA Study Team for the project monitoring and evaluation. This sustainable OJT&T/T can be applied for the self-effort of MET/CUN Authorities so as to keep Authorities sustainable efforts.

S15.2 FINANCIAL EVALUATION

For the drainage and sewerage projects the society's financial position will be firm, even if it shall pay 10 percent of the capital and replacement costs. If the per-head tariff is set to 1,200 CFA francs per year that is 0.5 percent of per-capita GDP inflated by 3 percent, its financial rate of return through the 60 year project span will be fairly positive.

For the solid waste management the municipality components of the solid waste management are not financially balanced, as the revenue on the services is virtually nothing. Generation of the capital costs needs to depend on the aforementioned credit, which shall be subsidized by the national government.

The annual operation cost born by CUN will be 350 million CFA francs or approximately 353 CFA francs per resident. This will be equivalent to some 10 percent of the municipality's annual current expenditure in 1996 thru 1998 (Urban Community of Niamey and 3 communes inclusive). This operating cost also has to be subsidized or transferred by the national government to the municipality, should it not be easily internally generated.

S15.3 SOCIO-ECONOMIC EVALUATION

All the wastewater are to be treated, i.e. solids removed, BOD and COD reduced and remaining water disinfected, and ultimately discharged into the River. At present, wastewater treatment is not made in the City except a few experimental cases. Contaminants flowing into the River would be, while not measured, sizeable amount. Once the master plan projects are implemented, pollutant load to the River, which will be generated by the 700 thousand residents, will be much less and easily removed in the natural process. This will largely remove the environmental hazards in the River basin.

Taking all the direct and indirect impacts into consideration, the projects need to be implemented to improve the present health, pathological and environmental conditions of Niamey City.

S15.4 SELECTION OF PRIORITY PROJECTS

Based on the preliminary design of M/P, project costs have been estimated for each field and the financial aspects were analyzed for implementation of the sanitation improvement works. In this section, priority projects shall be chosen as a possible urgent rehabilitation projects for short period which is targeted at the year 2005.

(1) Sewerage / Drainage

According to table of evaluation and other various factors that contribute to the sanitation improvement, significant schemes are to be selected and incorporated into the priority project for sanitation improvement for the Niamey City. This priority project will be further studied to identify its feasibility in the coming stage of feasibility study.

The following schemes are to be selected as the priority projects for the URWs:

1) Sewerage/drainage system in the C3 sewerage zone
   A comprehensive combined drainage and sewerage system shall be installed in the C3 sewerage zone.
2) Rehabilitation of the existing wastewater treatment plant at the National Hospital
   The plant is fairly well structured, but not operable due to several reasons. Rehabilitation will be proposed in the feasibility study.
3) Rehabilitation and improvement of the existing trunk drainage in Plateau I area
   A few trunk drainage in Plateau I are strategically located. Enhanced capacity of this drainage will benefit and reduce flood risks in the wider area

(1) Solid Waste Management

The quartiers where the new system is planed to introduce have been evaluated with cost/beneficiary (C/B) and current pre-collection activity since the C/B is varied according to the area population and population density. Generally the areas having less population density require higher C/B. The evaluated C/B does not include the transport cost from the recycling centers to the final disposal sites that are to be born by CUN and Communes since the evaluation aims is, to estimate the cost that will be paid directly to pre-collector by the resident.

In addition to the introduction schedule shown in master plan, this priority index shall be utilized for each introduction phase (Stage 1: to introduce by 2005, Stage 2: to introduce 2010, Stage 3: to introduce by 2015).

CHPATER S16. RECOMMENDATIONS

Identifying areas and issues requiring most urgent enhancement conducted the Master Plan study on sanitation improvement for the Niamey City. As consequence of the comprehensive study including review of other existing and ongoing projects, the following recommendations are hereby made to the related officials and the Republic of Niger (RON).

S16.1 URBAN PLANNING AND DEVELOPMENT

In the absence of the urban development master plan in Niamey City, the study team carried out a population projection and a most likely scenario of urban development on bases of the most reliable information.

1) Design population in	2005:	757,192
	2010:	871,346
	2015:	993,724
2) Future City Area	:	23,916 ha
3) Administrative Population	:	993,724

S16. 2 SEWERAGE/DRAINAGE

Planned population for the sewerage facility is to be about 583,000 in the year 2005, and about 794,000 in the year 2015. The following recommendations are formulated for planning framework:

- Combined drainage and sewerage system was selected, since it will be most appropriate sewerage system in the already urbanized area and especially in the priority project area.
- For intermediate term, the separate system is recommended in the recently urbanized areas, where drainage systems are only sporadically developed.
- A smaller scale wastewater treatment plant is installed in each of multiple numbers of small sewerage zones that represent drainage basins.
- In the master plan, Up-flow Anaerobic Sludge Blanket (UASB) treatment method is adapted for most treatment sites.
- Communal latrines with sewerage are proposed in poorer quarters where households have no proper facilities.
- A packaged combination of communal latrines, dispersed sewerage system in every small sewerage zone and solid waste management therein shall be developed step by step in Niamey City.
- Wastewater treatment plant should be in the cycle of ecosystem through effective usages of treated water and distracted sludge.

S16.3 SOLID WASTE MANAGEMENT

The improvement of solid waste management in the city of Niamey is considered for different links in the chain of waste collection, waste transport and waste disposal.
According to the results of the alternatives analysis new household waste collection system shall be introduced and extended. The system is based on privatization of the

pre collection services and operation of sorting centers in determinate areas. The following Table S16.1 is summarizing the target population that is expected to serve by the new system.

TABLE S16.1 EXPECTED POPULATION BE SERVED BY THE NEW SYSTEM

Commune	2005	2010	2015
	Served population	Served population	Served population
Commune 1	91,245	187,930	306,855
Commune 2	43,358	91,755	164,367
Commune 3	34,169	57,859	85,533
Total	168,771	337,545	556,755

10 Containers shall be provided for collection waste generated in the industrial establishments. Industrial waste transport shall be undertaken by the municipal services where the cost is fully recovered by the industry.

A separation of infection waste shall be introduced in all hospitals and clinics in order to reduce the risks of any contamination. Household similar waste shall be removed by using 11 containers.

Separated infectious waste shall be incinerated. One incinerator with a capacity of 200kg/hour is to be installed for infectious waste generated in all hospital establishments.

For landfill site exiting local clay should be used as impermeable layer materials, those will lead to reduce environmental load yielded by development.

S16.4 INSTITUTIONAL SET-UP

Representatives from Ministry of Equipment and Transport, Ministry of Water Resources, Ministry of Public Health, Urban Community of Niamey, the water supply company, the private initiative (NGO) and the beneficiary initiative should be convened, and should work together to define everyone's role in creation of the service provider. Requirements to this service provider are basically given in this report.
However, since the drainage and sewerage service is a new public utility in Niger, following the electric power supply, the drinking water supply and the telecommunication service, lessons learned through years of operation by these preceding utilities should be duly taken into account in establishing the new service provider. Private and beneficiary initiatives shall also give strong voices and play leading role in designing the utility, by which they are to be serviced.

S16.5 HYGIENE EDUCATION

It is recommended to launch an education campaign during the second stage of the JICA study, after completion of the pilot projects, in order to practice the above-mentioned principles within the scope of the UASB and Jyokaso pilot plants. The campaign will be multi-targeted and will involve the active coordination of the concerned agencies. Community participation is also expected.

The crucial issues for hygiene education have been identified as follows:

- Hygiene Education consists of three (3) categories/fields (hygiene education, health education and environmental education).
- The authorities have basic responsibility to develop in the field of hygiene awareness heightening.
- As regards to the involvement of local communities, the following public awareness has been observed by the study/survey.
- Based on the concept of Hygiene Education, the concrete education plan shall be implemented by participants together with "Hygiene Campaign".

S16.6 ENVIRONMENT

It is recommended to launch an EIA study at the feasibility stage, which is expected to provide a clear understanding of the environmental impacts and their importance, as well as the environmental management plan of the Master Plan. The IEE has shown the necessity of such detailed environmental evaluation, while the Niger regulations require a full EIA for planning project.

S16.7 FINANCIAL IMPLICATION OF MASTER PLAN

The project costs for the master plan that the national government shall finance over 15-year period are approximately 54 billion CFA francs, which consists of:

- 47.9 billion for construction of drainage and sewerage facilities
- 1.6 billion to recover the initial imbalance of the drainage and sewerage services
- 4.9 billion to help the municipality in realigning its waste management.

In the waste management sector, preliminary collection and recycling services be the private enterprises are proposed. These services will be sustainable or even reasonably profitable, if the average tariffs of 1,200 per head per year are collected. In view of the profit margin, which can be earned even if the 17 percent market loan is invested, the services will be propagated with encouragement by the municipality.

S16.8 CAPACITY BUILDING

Capacity building of the population would mean, in the master plan context, enhancement of people's awareness, sensibility or comprehension on hygiene, sanitation and health status of their daily environment. If their awareness is improved, they will know what they should do and what they should ask for. Thus population will be demanding more of the sanitation infrastructure. This would build a public consensus on the necessity of the projects.

Hygiene education and the public awareness raising activities are proposed in many places in this study and in the other donor-funded studies. These activities require many experts working at the grass-root level. Participation of Non-Governmental Organizations (NGOs) that have such experts and are already working on these aspects would, therefore, invite success of the awareness raising and in turn participation of more people in sensitizing more of their neighborhoods.

FEASIBILITY SUDY

CHAPTER S17. SEWERAGE/DRAINAGE SYSTEM

S17.1 PLANNING PRINCIPLE

The Feasibility Study area, Deizebon Zone (C3) that covers Boukoki area has been selected as priority project area is shown in Figure S17.1; the area covers the already developed and highly urbanized zones of Boukoki I to Boukoki IV and Lycée Kossai quartiers.

For wastewater treatment plant in the Feasibility Study area, UASB method will be adopted. The frameworks of the Feasibility Study (population, wastewater quantities, rainfall intensity, etc.) are as shown in Table S17.1. The design criteria as proposed in the Master Plan are appropriate for the Feasibility Study.

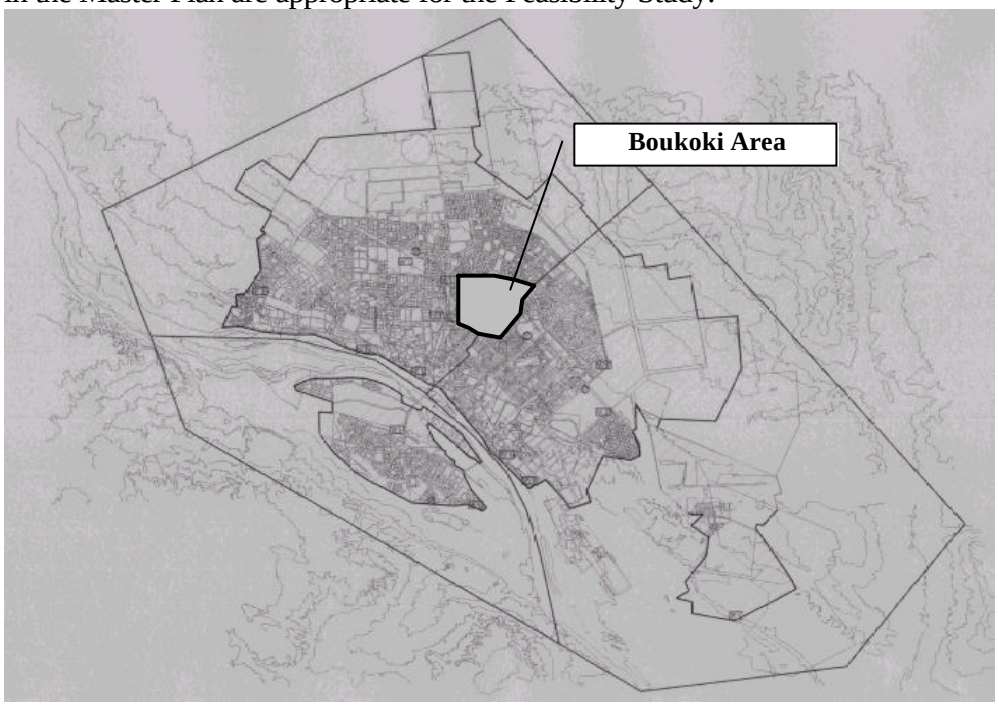


Figure S17.1 LOCATION OF FEASIBILITY STUDY AREA

Table S17.1 PLANNING FRAME OF FEASIBLITY STUDY AREA

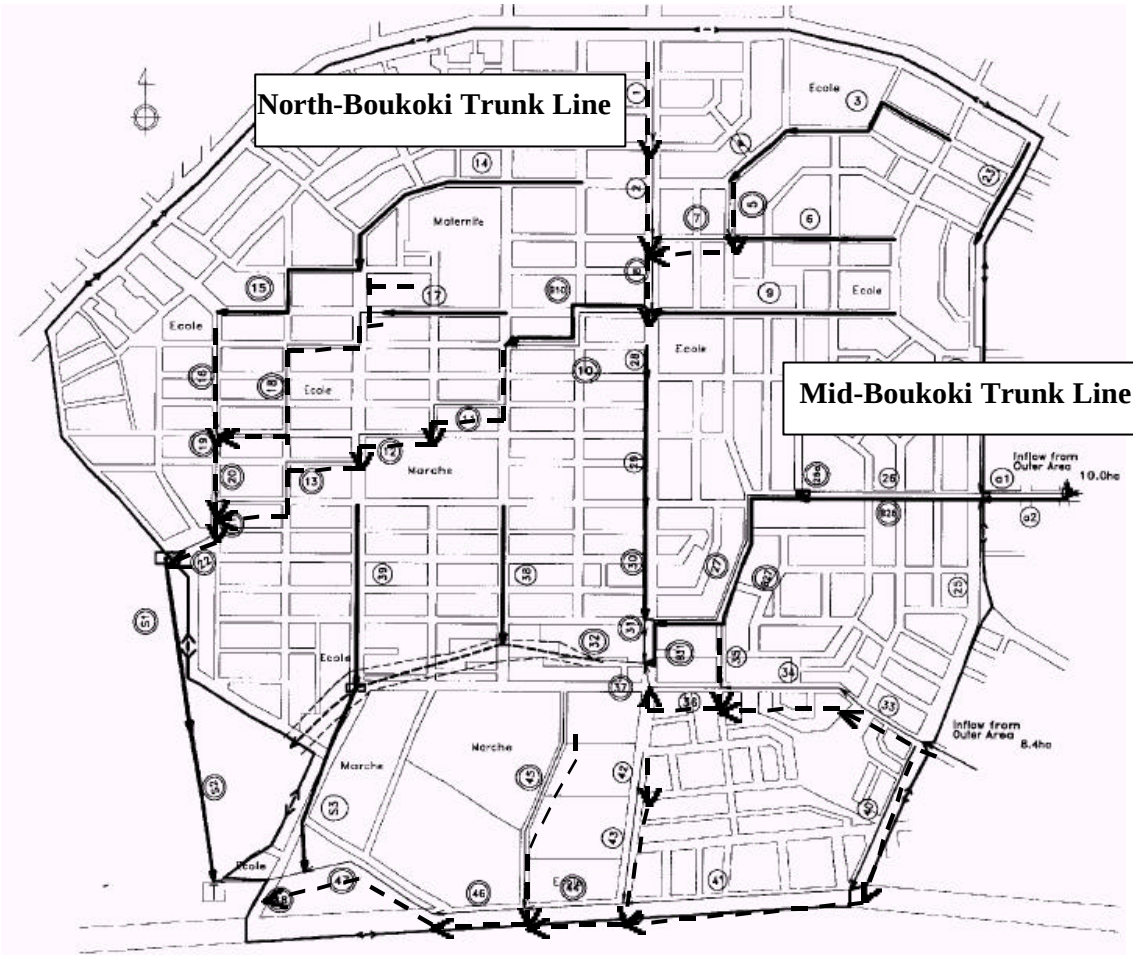
Year	Population (Person)	Wastewater Quantities			Remarks
		Daily Average (m^3/day)	Daily Maximum (m^3/day)	Hourly Maximum (m^3/day)	
2000	40,933	1,746	2,270	3,143	254.9ha
2005	43,346	1,865	2,425	3,357	
2010	42,984	1,878	2,441	3,380	
2015	43,042	1,904	2,480	3,427	
Design Capacity of WTP (m^3/day)		1,923	2,500	3,456	
Rainfall Intensity Formula			Runoff Coefficient Rate		
$I = 360\ t^{-0.5}$ (mm/hr)			0.66		

S17.2 SEWER LAYOUT

Only those existing facilities, which do not contain enough capacity to drain wastewater and storm water, would be supplemented with new drainage along the existing one. The sewer network layout is as shown in Figure S17.2.

S17.3 WASTEWATER TREATMENT PLANT

The site of the proposed wastewater treatment plant is located southward of the UASB pilot plant in the Deizebon quarter. The proposed wastewater treatment plant is as an extension of the existing UASB pilot plant. The general plan of UASB wastewater treatment plant is as shown in Figure S17.3.



Existing Channel

Existing Channel + Newly Construct Channel

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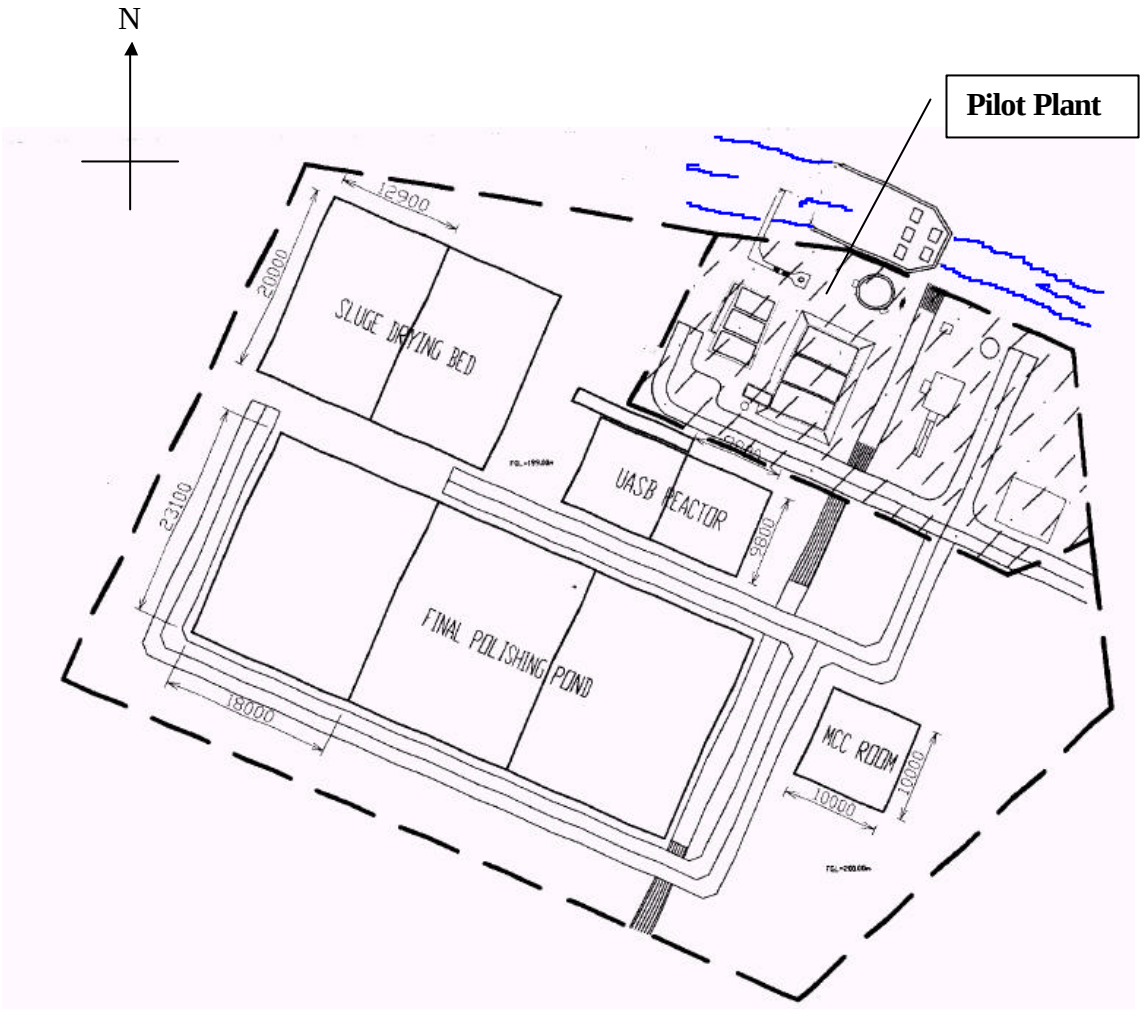
Figure S17.2

SEWER NETWORK LAYOUT



	CAPACITY	PLANT AREA
C3 UASB PLANT	2,400 m^3/day	5,350m^2
PILOT PLANT	100 m^3/day	1,070m^2

The Study on Sanitation Improvement for the Niamey City in the Republic of Niger

Figure S17.3

GENERAL PLAN OF UASB WASTEWATER TREATMENT PLANT

CHAPTER S18. SOLID WASTE MANAGEMENT

Feasibility phase shall consider and analyze in detail the recommended alternative for solid waste management in the Master Plan report. These are:

- Introduction and extension of the services for household waste pre-collection in 16 Quartiers of Niamey city that are distributed in 9 zones and classified in 3 areas;
- Set up of recycling centers in order to sort out sand contained in collected domestic waste.
- Pre design of 2 municipal landfill sites.

S18.1 NEW COLLECTION SYSTEM FOR HOUSEHOLD WASTE

(1) Demographic data and evolution of solid waste generation

The introduced demographic data that are presented in the main report remain valid for the whole city of Niamey. The evolution of the population of the sixteen chosen Quartiers for the detailed analyze in the feasibility as well as waste generation are summarized in the following Table S18.1:

Table S18.1 DEMOGRAPHIC EVOLUTION AND WASTE GENERATION IN THE SELECTED QUARTIERS

Zones	Quartier	Population considered			Household waste (t/year)		
		2005	2010	2015	2005	2010	2015
High Income Class- Area (1)							
(1), (2), (3)	Terminus, Niamey Bas, Cite Faycal, Poudriere South and North	10,200	15,500	17,500	2,800	4,200	4,800
Middle Income Class- Area (2)							
(4), (5), (6)	Dar Es Salam East and West, Bani Fandou I	24,400	35,500	52,800	6,700	9,700	14,500
Low Income Class- Area (3)							
(7), (8), (9)	Zongo, Maourey, Gandacthe, Deizebon, Boukoki I, II, III and IV	0	17,200	30,700	0	4,700	8,400
Total		34,600	68,200	101,000	9,500	18,600	27,700

(2) Pre collection System and sand Recycling

In the 9 selected zones new pre collection of household waste shall be introduced. Based on Authorization, issued by the municipality, the private service providers shall contract directly households and manage the regular collection of their generated domestic waste. For these services households will directly settle their account with the service providers.

Taking account waste composition, sand quantities are expected to amount to 5,700 t in 2005, 11,200 in 2010 and 16,600 t in 2015.

Each selected zone shall have one recycling center, where sand shall be sorted out. The recycling center shall have a second function; it may be used as a transfer point. Sand shall be manually sorted out from household waste. Remaining waste shall be stored in containers belonging to CUN. Municipal services shall be in charge for removing remaining waste container to the landfill site.

Within complementary field surveys, a demand survey for recycling sand has been carried out. According to the results, high interest does exist for the reuse of recycling sand by construction enterprises.

The recycling center shall be equipped with the following facilities:

- Fence and Gate;
- Sand Sorting Yard;
- Sand Stock Yard;
- Control House;

Taking into account the required area of the facilities and space that is required for the truck, 2 sizes for recycling center have been selected:

- $400m^2$ for zones require no more than 3 containers in 2015.
- $600m^2$ for zones require no less than 4 containers in 2015.

The pre collection of waste, made by private organization, shall lead to concentrate waste at the recycling centers. The municipal services should make containers available at the recycling centers as well be responsible for their transport to the disposal site. Costs of solid waste transport from the recycling center to the disposal site must be met by the municipal services.

For remaining waste transport from recycling center to the landfill site 9 containers are necessary in 2005, 18 containers and 24 containers in 2010 respectively 2015.

One truck shall be provided per 6 containers since the truck is capable to transport the container 6 times per day (6 trips per day). Therefore the required number of truck is 2, 3 and 4 in the year 2005, 2010 and 2015 respectively.

S18.2 CONSTRUCTION AND OPERATION OF THE MUNICIPAL LANDFILL SITES

(1) Introduction

2 sites have selected for design and realization of two municipal disposal sites. The site at Koubia shall be for land filling waste generated in Commune 1 and 2 and the site at Bengale Torombi shall be reserved for waste generated in Commune3.

As detailed and additional analyze for the design of disposal sites, the following works and facilities were included in addition to the planned works in master plan. Although the target works by 2005 is only to designate the sites and start controlled

dumping in the master plan, the additional works take into account future development of Niamey City and environmental protection measures. These are:

1) Grading (excavating) the bottom of cavities and banking the dike surrounding the cavities.
2) Leachate collection and gas exhaust facilities.

(2) Topographical survey and soil investigation

Complementary field works have been carried out within the current feasibility study. Among other topographic survey and soil investigations have been done on the 2 chosen landfill sites.

(3) Landfill construction

For the new landfill sites at Koubia and Bengale Torombi, the following infrastructures constructed:

- Access Road
- Fence and Gate
- Operation Road
- Control House

Furthermore a Shade of Bulldozer shall be constructed at the landfill site Koubia.

The planed landfill area at the site Koubia is over 10ha and at Bengale Torombi 7ha, these areas are enough for about 10 years operation. In order to utilize the land efficiently, zoning was designed according to the required capacity as shown in the following Table S18.2 and S18.3.

TABLE S18.2 REQUIRED CAPACITY OF LANDFILL (2015)

Landfill site	Waste to be land-filled (m^3)	Covering Soil (m^3)	Total (m^3) (Required Capacity)
Site Koubia	708,421	86,501	794,922
Site Bengale Torombi	90,899	11,298	102,197

TABLE S18.3 AREA OF LANDFILL ZONE (2015)

Area	Zone 1	Zone 2
Site Koubia	30,000m^2	72,000m^2
Site Bengale Torombi	4,500m^2	15,600m^2

Note:In order to ensure a minimum of environmental protection, measures have been planed such as reinforcement of the ground with compacted clay layer as leachate protection measures, leachate collection, leachate pond, Rain water drainage and gas handling installations.

CHAPTER S19. PROJECT COST AND CONSTRUCTION PROGRAM

S19.1 SEWERAGE/DRAINAGE WORKS

(1) Project Cost

The total project cost is 1,679 million CFAF with the breakdown as shown in Table S19.1. Of the total project cost, 1,455 million CFAF or 87% is the local currency component, and the remaining 224 million CFAF or 13% is the foreign currency component as shown below.

Table S19.1 PROJECT COST FOR SEWERAGE/DRAINAGE WORKS

(Unit: 1,000CFAF)

Item	Total	Local Currency	Foreign Currency
Construction Cost			
Drainage Facilities	1,030,598	911,549	119,049
Treatment Plant	233,677	128,355	105,322
Total	1,264,275	1,039,904	224,371
Engineering Service	149,795	149,795	0
Contingency	212,111	212,111	0
Land Acquisition	53,500	53,500	0
Total	1,679,681	1,455,310	224,371

(2) Operation and Maintenance Cost

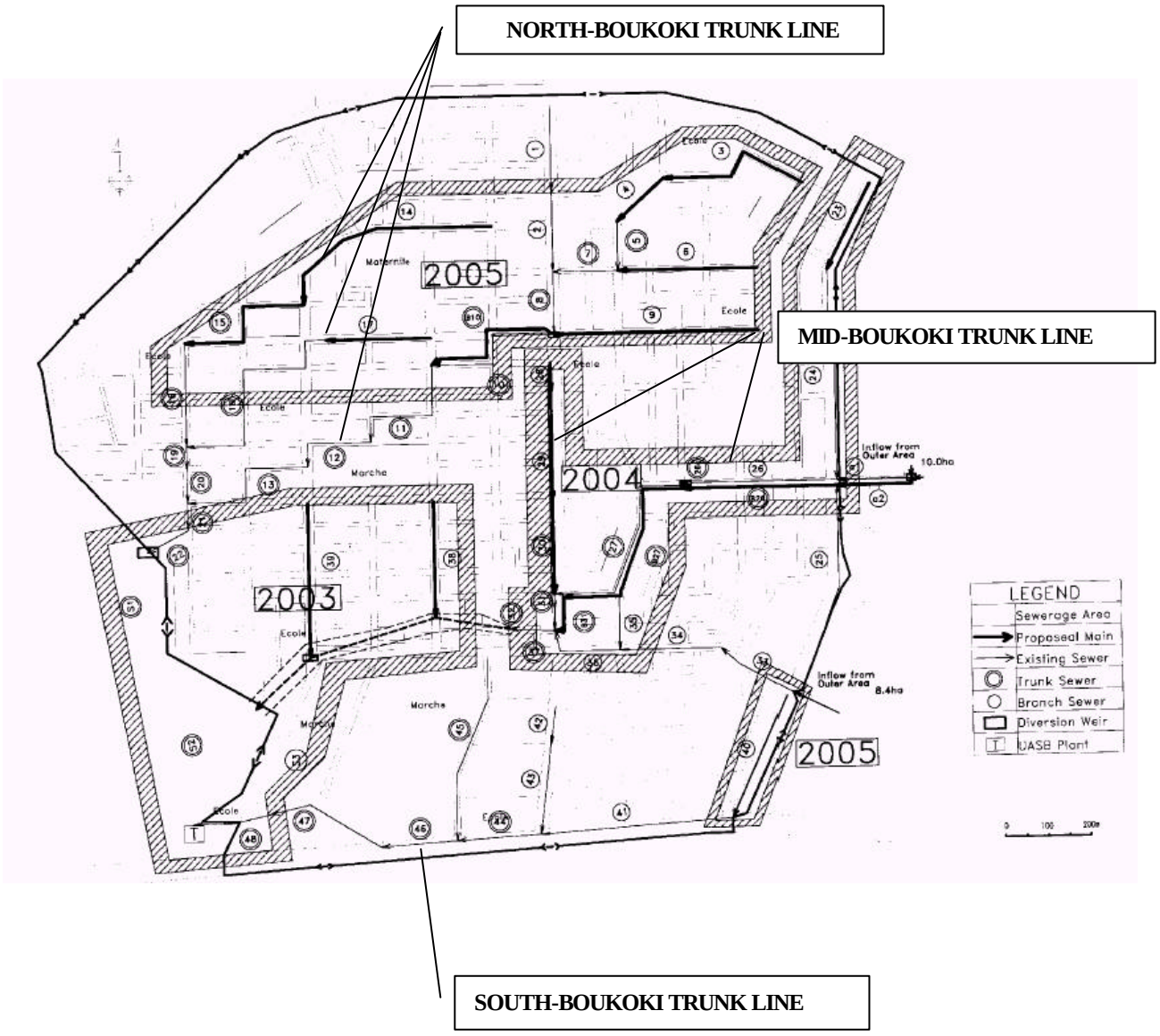
The annual operation and maintenance cost for the sewage facilities in the Feasibility Study area after the completion of the construction is estimated at 50 million CFAF for the trunk sewer facilities and sewage treatment plants.

S19.1.3 Implementation Schedule for Sewerage/Drainage

1) Trunk Sewer Construction
The image of the trunk sewer network construction implementation schedule is shown in Figure S19.1.

2) Wastewater Treatment Plant Construction
The construction works will start in the following year, in 2003 with land leveling works of the site. Operation of the plant will start immediately after the complementation of the construction works at the end of 2005.

3) Project implementation and Disbursement Schedule
The project implementation and disbursement schedule of the Feasibility Study Project is shown in Table S19.2



The Study on Sanitation Improvement for the Niamey City in the Republic of Niger

Figure S19.1

TRUNK SEWER NETWORK CONSTRUCTION IMPLEMENTATION SCHEDULE

Table S19.2 PROJECT IMPLEMENTATIONS AND DISBURSEMENT SCHEDULE

(Unit: 1,000CFAF)

Project Item		2002	2003	2004	2005
Trunk Sewer Construction	Design				
Mid-Boukoki	Construction				
North-Boukoki	Construction				
South-Boukoki	Construction				
Wastewater Treatment Plant	Land Acquisition				
	Design				
Land Leveling					
Civil Works					
Equipment Works					
Disbursement Schedule	Total Cost				
Construction Works	1,264,275	0	152,306	459,661	652,308
Engineering Service	149,795	43,980	12,398	39,191	54,226
Contingency	212,111	6,597	24,706	74,828	105,980
Land Acquisition	53,500	53,500	0	0	0
Annual Disbursement	1,679,681	104,077	189,410	573,680	812,514

S19.2 FACILITIES AND SYSTEM OF SOLID WASTE MANAGEMENT

(1) Introduction of Proposed Waste Collection System

The cost is divided into 2 portions, which is for the private sector and for the municipality.

1) Capital Cost for the proposed system introduction

TableS19.3 CAPITAL COST OF PRIVATE SECTOR

(Unit: 1,000CFAF)

Area	Item	Local Currency	Foreign Currency	Total
Area 1	Direct Cost	20,355	1,920	22,275
	Contingency	3,053	288	3,341
	Sub Total	23,408	2,208	25,616
Area 2	Direct Cost	25,515	1,920	27,435
	Contingency	3,827	288	4,115
	Sub Total	29,342	2,208	31,550
Area 3	Direct Cost	20,355	1,920	22,275
	Contingency	3,053	288	3,341
	Sub Total	23,408	2,208	25,616
Total		76,159	6,624	82,783

Table S19.4 CAPITAL COST OF CUN

(Unit: 1,000CFAF)

Item	Local Currency	Foreign Currency	Total
Direct Cost	0	366,000	366,000
Engineering Cost	0	36,600	36,600
Contingency	0	60,390	60,390
Total	0	462,990	462,990

2) Operation and Maintenance Cost for the proposed system introduction

Table S19.5 O&M COST OF PRIVATE SECTOR

(Unit: 1,000CFAF)

	Year										
Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Area 1	10,243	10,674	10,674	12,663	12,663	17,138	17,138	17,569	17,569	18,000	18,000
Area 2	24,805	26,099	27,392	29,117	30,411	31,704	33,860	36,016	39,034	41,190	43,345
Area 3	0	0	0	0	0	17,239	17,670	18,533	18,533	19,395	29,478
Total	35,048	36,773	38,066	41,780	43,074	66,081	68,668	72,117	75,136	78,585	90,824

Table S19.6 O&M COST OF CUN

(Unit: 1,000CFAF)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cost	57,844	72,034	72,034	72,034	72,034	86,224	86,224	86,224	86,224	86,224	99,940

(2) Construction of Disposal Site

1) Capital Cost

Table S19.7 CAPITAL COST FOR CONSTRUCTION OF DISPOSAL SITE

(Unit: 1,000CFAF)

Item		Local Currency	Foreign Currency	Total
Disposal Site Koubia	Direct Cost Zone 1	249,950	640	250,590
	Direct Cost Zone 2	2,244,344	27,750	2,272,094
	Engineering Cost	126,134	126,134	252,268
	Land Acquisition	225,000		225,000
	Contingency	431,314	23,179	454,493
	Total	3,306,742	177,703	3,484,445
Disposal Site Bengale Torombi	Direct Cost Zone 1	60,179	640	60,819
	Direct Cost Zone 2	604,068	8,260	612,328
	Engineering Cost	33,657	33,657	67,315
	Land Acquisition	50,250		50,250
	Contingency	112,223	6,384	118,607
	Total	860,377	48,941	909,318
Equipment Purchase	Direct Cost		336,000	336,000
	Engineering Cost		33,600	33,600
	Contingency		55,440	55,440
	Total		425,040	425,040
Ground Total		4,167,119	651,684	4,818,803

2) Operation and Maintenance Cost

Table S19.8 O&M COST FOR CONSTRUCTION OF DISPOSAL SITE

(Unit: 1,000CFAF)

Site	Zone	Year							
		2003	2004	2005	2006	2007	2008	2009	2010
Koubia	Zone 1	15,659	15,659	15,659					
	Zone 2				88,618	88,618	88,618	88,618	88,618
Bengale	Zone 1	10,667	10,667	10,667					
	Zone 2				12,083	12,083	12,083	12,083	12,083
Total		26,325	26,325	26,325	100,702	100,702	100,702	100,702	100,702

Table 19.9 IMPLEMENTATION SCHEDULE OF PROPOSED SYSTEM INTRODUCTION: PRIVATE SECTOR

Area	Item	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Construction Schedule															
Area 1	Zone 1								▬						
	Zone 2			▬											
	Zone 3			▬											
Area 2	Zone 4			▬											
	Zone 5			▬											
	Zone 6			▬											
Area 3	Zone 7								▬						
	Zone 8								▬						
	Zone 9													▬	
18.1 Disbursement Schedule															
Area 1	Local Currency			15,606					7,803						
	Foreign Currency			1,472					736						
	18.2 TOTAL			17,078					8,539						
Area 2	Local Currency			29,342											
	Foreign Currency			2,208											
	18.3 TOTAL			31,550											
Area 3	Local Currency								15,606					7,803	
	Foreign Currency								1,472					736	
	18.4 TOTAL		18.5						17,078					8,539	
Disbursement Total				48,628					25,617					8,539	

(Currency unit: 1000CFAF)

Table 19.10 IMPLEMENTATION SCHEDULE OF PROPOSED SYSTEM INTRODUCTION AND CONSTRUCTION OF DISPOSAL SITE: MUNICIPALITY

Area	Item	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Proposed System Introduction															
Equipment Purchase															
Construct Disposal Site Koubia															
Zone 1															
Zone 2															
Equipment Purchase															
Construct Disposal Site Bengale Torombi															
Zone 1															
Zone 2															
18.6 Disbursement Schedule															
New System Intro.	Local Currency														
	Foreign Currency			307,395					83,490					72,105	
	Total			307,395					83,490					72,105	
Dispo. Site Koubia	Local Currency	431,714	825,340	1,011,771	1,037,917										
	Foreign Currency	58,758	29,011	29,011	60,923										
	Total	490,472	854,351	1,040,782	1,098,841										
Dispo. Site Ben. T.	Local Currency	97,626	359,365	238,786	164,600										
	Foreign Currency	16,218	7,741	7,741	17,240										
	Total	113,844	367,106	246,527	181,841										
Dispo. Equip. Purchase	Local Currency														
	Foreign Currency				425,040										
	Total				425,040										
Disbursement Total		604,316	1,221,457	1,594,704	1,705,721				83,490					72,105	

(Currency unit: 1000CFAF)

CHAPTER S20. ORGANIZATION AND OPERATION STRUCTURE

S20.1 SEWERAGE/DRAINAGE SYSTEM

(1) Organizational Structure for Sewerage

The proposed organizational structure for the Sewerage service after the completion of the feasibility study project is shown in Figure S20.1.

(2) Sewerage/Drainage Operation and Maintenance Section

The sewer maintenance section is responsible for all sewer maintenance works, while the large-scale maintenance work such as new trunk sewer installations is to be contracted to the private sector.

- Installation of service connections: Sanitary chambers and sanitary connections.
- Daily recording of operation and maintenance activities.

(3) Wastewater Treatment Plant Operation and Maintenance Section

Under the control of the Operation Engineer for the wastewater treatment plant, a staff-working group is to be organized, for operation and maintenance of the wastewater treatment plant.

(4) Water Quality Control Division

At the first stage of the sewerage/drainage management the Water Quality Control Division should be charged of both inspection and examination of the quality of wastewater discharged into trunk/sub-trunk sewers and the effluent quality of discharge into the public water bodies.

(5) Planning and Project Division

In addition to the sewerage operation and maintenance organizational unit, support organization such as planning and works, technical service divisions are necessary.

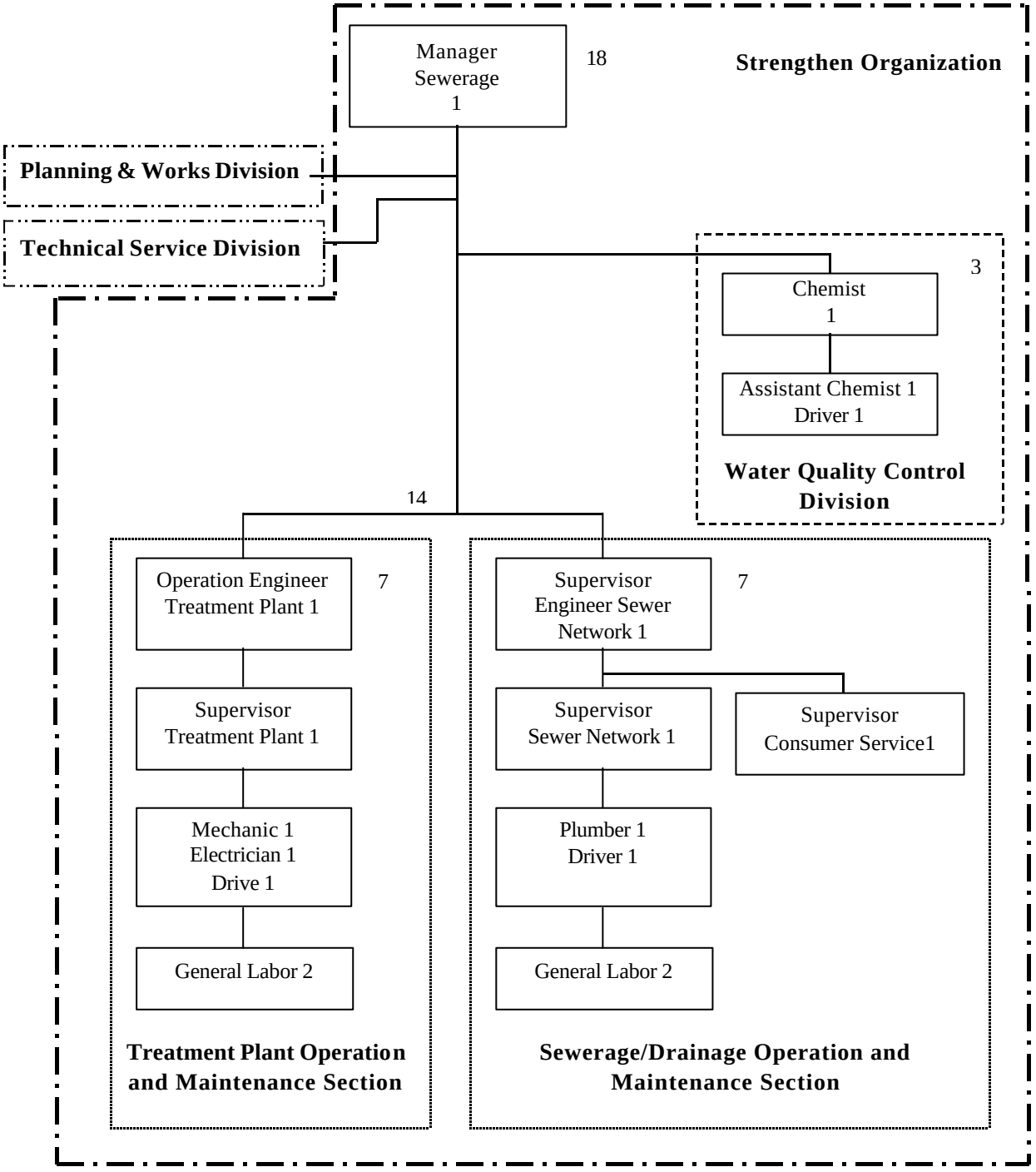
(6) Technical Service Division

At the beginning step of sewerage and drainage management existing urban infrastructures maintenance sections will carry out following works:
- Procurement of materials, machines, equipment, tools, etc., necessary for operation

(7) Considerations for Operation and Maintenance

Maintaining work records will help strengthen control over all works accomplished.
- Treatment plant inspection, operation and maintenance.
- Water quality inspection and examination.
- Stock in-out records.

-



The Study on Sanitation Improvement for the Niamey City in the Republic of Niger

Figure S20.1

ORGANIZATION CHART OF THE SEWERAGE/DRAINAGE OPERATION

S20.2 SOLID WASTE MANAGEMENT

(1) Management Structure of Priority Project

The proposed management structure is as shown in Figure S20.2 for the priority projects.

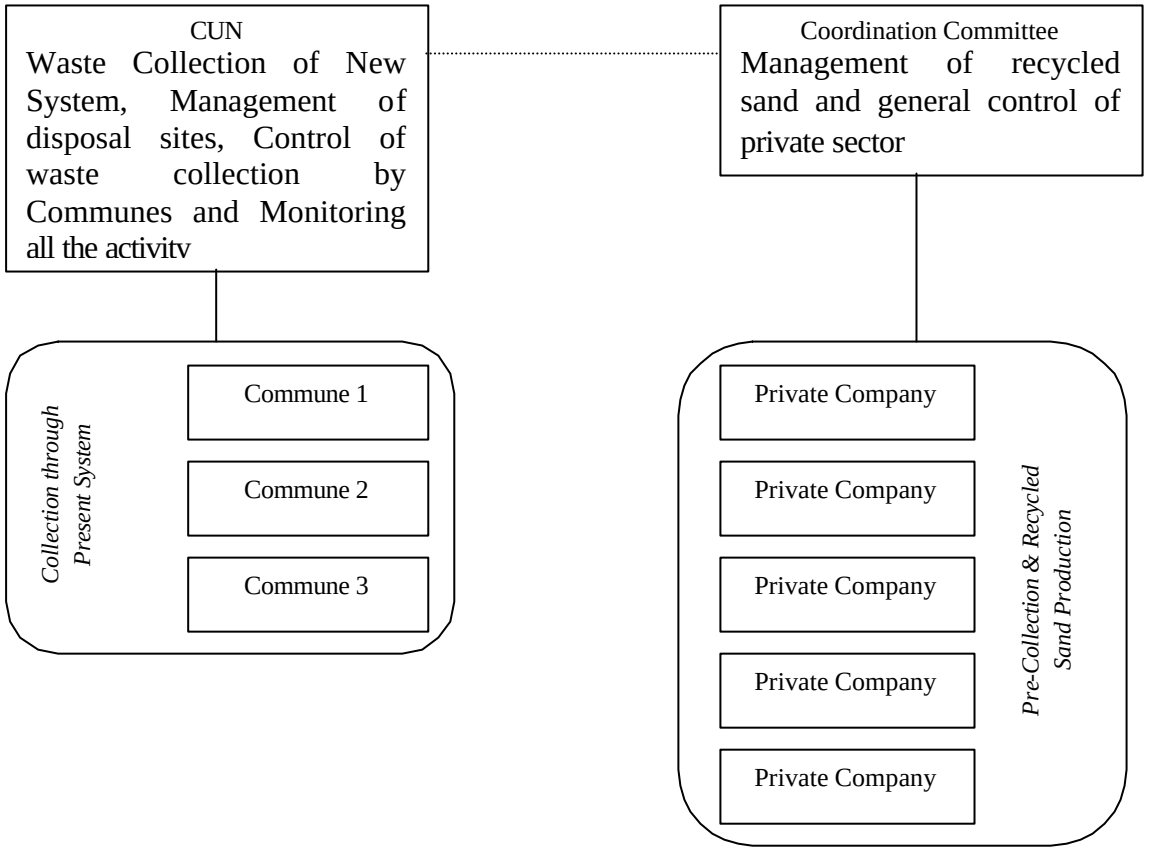


Figure S20.2 PROPOSED MANAGEMENT STRUCTURE

(2) Role of Municipality and Improvement

The required role of CUN is summarized as follows for solid waste management.

1) To monitor and direct all the activity of waste collection and disposal in Niamey.
2) To assist the private companies for new system introduction.

(3) Role of Private Sector and Improvement

Actually the private companies contribute, in some portion, to keeping the city clean through waste pre-collecting activity. This activity shall be linked to the introduction of new waste collection system. Furthermore the private companies shall create the management system of recycled sand.

CHAPTER S21. FINANCIAL AND ECONOMIC EVALUATION

S21.1 FINANCIAL FORECAST AND EVALUATION OF THE PRIORITY PROJECT

Drainage and Sewerage Scheme

(1) Investment Plan

The investment plan as shown in Table S21.1 is the first four years' investment plan of the Feasibility Study Project.

Table S21.1 INVESTMENT PLAN

(Unit: 1,000CFAF)

Cost	Total	2002	2003	2004	2005	After 2006
Construction Cost	1,264,275	0	152,306	459,661	652,308	-
Engineering Service	149,795	43,980	12,398	39,191	54,226	-
Contingency	212,111	6,597	24,706	74,828	105,980	-
Land Acquisition	53,500	53,500	0	0	0	-
Total Investment	1,679,681	104,077	189,410	573,680	812,514	-
Investment Share	167,968	10,408	18,941	57,368	81,251	-
Operation and Maintenance	Annual 50,140	-	-	-	-	50,140

(2) Water Tariff in the Project Area and Affordable Sewerage Tariff

Water tariff in the project area (C3 drainage zone) will be approximately 193.1 million CFA F at early 2006 and expected to be raised by 8.5 percent within that year. Water supply company had agreed to collect sewerage tariff as surcharge onto water tariff. If 30 percent of water tariff is collected, 62.9 million CFA F may be collected as sewerage tariff after 2006, which is sufficient for annual operation and maintenance cost.

(3) Financial Internal Rate of Return

Financial rate of return (FRR) is negative, if all the initial and operation costs are compared with the possible or affordable revenue as surcharge onto water tariff. As has been done in the other basic human needs projects, however, only 10 percent of the initial and replacement costs and full operation costs are to be borne by the project beneficiaries and the external donors donate 90 percent. FRR will be positive, if such assumption is met.

The beneficiaries are able to pay for operation costs and 10 percent of the initial and replacement costs.

Solid Waste Management

(1) Investment Plan

Purchase of transport equipment for the new waste collection system and construction of disposal sites should be done as municipality project. Total investment cost of the feasibility study project is shown in Table S21.2.

Table S21.2 INVESTMENT PLAN

(Unit: 1,000CFAF)

		2002	2003	2004	2005	2009	2014
Municipality Project	New System Introduction			307,395		83,490	72,105
	Koubia Disposal Site	490,472	854,351	1,040,782	1,098,841		
	Bengale Torombi Disposal Site	113,844	367,106	246,527	181,841		
	Equipment Purchase				425,040		
	Total	604,316	1,221,457	1,594,704	1,705,722	83,490	72,105
Private Sector Project	Area 1			17,078		8,539	
	Area 2			31,550			
	Area 3					17,078	8,539
	Total			48,628		25,617	8,539

(2) Financial Internal Rate of Return for the Private Sector Project

Among the priority projects, only the private sector project, that is pre-collection and sorting for recycling of the solid waste from the contracted beneficiaries, is generating revenues. Other public sector projects are not generating the revenues. Therefore, financial evaluation is applicable only to the private sector project.

The project life is assumed as 25 years. The initial costs and the operation costs are compared with the expected revenue, which is based on the willingness-to-pay survey. Financial rate of return (FRR) for all the pre-collection operation in Area 1, 2 and 3 are more than 20 percent. The private sector project will be very prospecting.

S21.2 ECONOMIC EVALUATION OF THE PRIORITY PROJECTS

Assumptions for the Economic Evaluation

Economic evaluation has been made through comparison of benefit and cost that are quantifiable.

- Costs of the project
  To obtain the economic costs of the project, all capital costs and operation and maintenance costs would be classified into imported goods, locally procured goods, unskilled labor and skilled labor. Each classification would be discounted by the rates that are used in the similar projects appraised by the World Bank.

- Benefits of the project
  Quantifiable benefits are those that are related with reduced medical costs and recovered cost of absence from labor. Recovered costs that result from less inundation frequency and duration, for example, increased days of commercial activities and revenue from such activities, are expressed as increase in land price.

Drainage and Sewerage Scheme

(1) Economic costs and benefits

To attain economic costs and benefits of the drainage and sewerage scheme, sets of assumptions were made to reflect the site situations as much as possible.

(2) Economic Internal Rate of Return

Economic Internal Rate of Return (ERR) with costs and benefits as calculated as above shows 10.95 percent, if all the assumptions are met. This value is slightly lower than the desired percentage of the opportunity cost of capital, i.e., 12 percent. Taking into consideration, however, the benefits that are not quantified, such as improved quality of discharged water through open outfall into Niger River, significance of the priority project will be clear. It is concluded that the project is feasible in economic terms, and will bring the considerable benefits to the City of Niamey.

(3) Sensitivity Analyses

Sensitivity analyses were made with less and more 10 percent cost and with less and more 10 percent benefit, and showed the following results:

ERR Summary		Cost		
		+10%		-10%
Benefit	+10%	10.95%	12.28%	13.87%
		9.71%	10.95%	12.43%
	-10%	8.42%	9.58%	10.95%

With the sensitivity analyses, it is learned that reduction in costs is more significant than increase in benefits. Also, the analyses showed that economic rate of return will be more than 8 percent; even if the costs are increased by 10 percent and the benefits are reduced by the same rate. Viability of the priority project is encouraging.

Solid Waste Management

Benefits for the solid waste management are expected to incur, if the private sector pre-collection service and the municipal collection service are coincidently undertaken. These benefits will incur even with the existing disposal method. The economic costs and benefits of the former two projects, therefore, have to be collectively evaluated.

(1) Economic Costs and Benefits

Economic costs for priority projects are calculated with the same assumptions as for the drainage and sewerage project.

(2) Economic Internal Rate of Return

Economic rate of return is 10.67 percent. The project is sound and feasible in economic terms, if all the assumptions are met.

(3) Sensitivity Analyses

Sensitivity analyses were made with less and more 10 percent cost and with less and more 10 percent benefit, and showed the following results:

ERR Summary		Cost		
		+10%		-10%
Benefit	+10%	10.67%	19.30%	29.78%
		0.70%	10.67%	20.23%
	-10%	3.82%	2.01%	10.67%

With the sensitivity analyses, it is learned that reduction in costs is more significant than increase in benefits. The analyses also showed that economic rate of return will be plus, even if the costs are increased by 10 percent and the benefits are reduced by the same rate. Viability of the priority project is encouraging.

CHAPTER S22. ENVIRONMENTAL IMPACT ASSESSMENT

S22.1 PRESENTATION OF EIA

The environmental impact assessment (EIA) of the project has been performed as part of the Feasibility Study. The project includes the following projects:

- Sewerage Network project of Boukoki
- Wastewater treatment plant project of Dezeibon
- Waste disposal site project of Koubia
- Waste disposal site project of Bengale Torombi

The EIA study has focused on the four aspects:

- Description of projects
- State of environment of project sites
- Evaluation of impacts of the project on the environment
- Measures

This EIA is the final step of the environmental evaluation study of the JICA study team, which constitutes together with the precedent step of environmental evaluation the full set of information required for complete EIA in the meaning of the decree requiring EIA in Niger.

S22.2 STATE OF ENVIRONMENT OF PROJECT SITES

The state of environment review, which is the most delicate aspect of the study, has been made from field observation, use of background data already processed in Interim report, and use of data collected by the local consultant on the field through social survey. JICA study team has subcontracted this work to a local consultant in charge of finding out the necessary data for establishment of the state of environment of project sites. Social survey has consisted into a survey about communities living close to the waste disposal project sites and a survey about urban communities in few streets concerned by the sewer network project of Boukoki. The later has been done on a sampling of 35 compounds, which explains that results of survey are not always representative of the studied community and need interpretation.

On a whole, the study has shown that social environment is particularly sensitive in the project. Sensitivity could be ranked as high in Torombi site and Dezeibon site, lower in Boukoki site, and quite moderate in Koubia site. The natural environment does not raise critical issues, although some important points have been stressed above.

1) Evaluation of impacts of the project on the environment

The range of possible impacts of the project on environment is large because of the diversity of projects, variety of issues, and ranking of the importance of impacts. Then, in a first step, only the most significant impacts are reviewed, and as a second step of evaluation, a checklist of impacts is provided. This checklist is very useful in order to identify and understand the more or less important impacts within a framework of important environmental issues, that have been identified and defined before, within the scope of the Initial Environmental Examination.

Only the list of proeminent impacts is proposed here. These impacts may be positive or negative according to the case. These impacts are however classified into 2 categories:
- Potential impacts
- Expected impacts

Main potential impacts are those impacts that would certainly occur if no measure was taken at the project design level, but that can be avoided through technical measures adopted with execution of the project. In such a case, the environmental receptor is sensitive but can be preserved to maintain initial conditions. These impacts are basically of negative nature.

Main expected impacts are those impacts that will necessarily occur with execution of the project without possibility of mitigation through technical design of the project. In such a case, initial conditions cannot be maintained. It is however possible to set up protection and / or compensation measures. In this case and at the difference of potential impacts, measures do focus on protection of the environment instead of conservation. It means that in some way measures are able to preserve an environmental value in spite of the loss of initial site. In such figure, new environmental value can also be created.

Main potential impacts identified are:
- Contamination of groundwater in waste disposal sites
- Threatening of livelihood of women in Boukoki area
- Worsening of endemic malaria in Dezeibon
- Exposure to pollution and nuisance (several patterns)

Main expected impacts identified are:
- Improvement of sanitation and health
- Improvement of surface water quality
- Threatening of women welfare
- Loss of environmental asset
- Loss of livelihood

2) Measures (environment management plan)

In order to fit with the above-mentioned classification of impacts, the following categories of measures have been identified:
- Precautionary measures (potential impacts)
- Remediation measures (expected impacts)
- Sustainability measures (to improve environmental objectives)

CHAPTER S23. EVALUATION OF PILOT STUDY

S23.1 BACKGROUND

In Niamey, household wastewater is a major polluter of water bodies of river and groundwater. The deterioration in water and sanitation environment was because neither sewerage system, which includes wastewater treatment and sewer network nor onsite wastewater treatment system was not constructed in Niamey. For on-site treatment, compact conventional mini wastewater treatment plant named "Jyokaso" in Japan followed by Natural Recycle System (NRS) and soak pit was installed at Bandabari Primary School II to treat wastewater of a common toilet complex, which was also constructed under this study. The capacity of the Jyokaso was 10 m^3/day for population equivalent of 200 according to the Niamey criteria.

Other pilot study is based on UASB (Upflow Anaerobic Sludge Blanket) technology followed by modified trickling filter, which was developed in Japan, and NRS. The capacity of the UASB is 100 m^3/day, which is equivalent to the population in 2000.

S23.2 OBJECTIVES

The objectives of evaluation of wastewater technology adopted for pilot study are to determine its effectiveness, impact, efficiency, relevance and sustainability under Niamey condition based on actual information obtained during implementation and operation of pilot study.

(1) Effectiveness

According to the Nigerian effluent discharge standard for receiving water body, the effluent shall not have BOD more than 40 mg/l and SS 30 mg/l. Jyokaso is generally applicable for on-site treatment of wastewater such as individual and community toilet, restaurants, hotels, and apartments. Fifth compartment consisted of settling tank, chlorination tank and effluent outlet. Because of attached growth in third and fourth compartment, the excess sludge in the settling tank is minimal.

UASB pilot plant, which consisted of UASB itself followed by trickling filter and NRS was commissioned in July 2001 and achieved effluent BOD of 40 mg/l or less and SS 30 mg/l or less for which it was designed (APPENDIX S.6) keeping in mind the effluent discharge standard of Niger. The above result obtained was as JICA Study Team expected with UASB, which is the most appropriate process for country, which has temperature more than 20^oC. Moreover, the UASB efficiency is highest when wastewater temperature was around 25^oC –30^oC, which is also the temperature range of Niamey.

Further more, with operation time of pilot plant, activity, settleability, and concentration of sludge in the blanket zone of UASB will increase as a result the effluent quality will improve further.

(2) Impact

UASB is the only cost effective technology for urban centers of Niamey in terms of initial investment, land requirement, O&M and cost recovery using the dried sludge as fertilizer, bio-gas as source of electricity generation.

On the other hand, effluent quality complied the effluent discharge standard of Niger.
In the case of UASB pilot plant, biogas is flared, as generation of electricity is not cost effective because of the scale of the pilot plant.
This condition applies to all types of wastewater treatment technologies involving biological treatment. The UASB plant's bacteriological performance with respect to coliform removal is less compared to activated sludge process, waste stabilization pond etc.

(3) Efficiency

UASB and Jyokaso pilot plant achieved efficiencies of more than 90% BOD reduction and 85% coliform reduction

Because of small scale of UASB pilot plant and first of this plant in Niamey, construction cost was approximately 120,000 CFAF for per m^3 of design flow, which is little higher compared to F/S cost. The construction and O&M cost of UASB for full-scale plant has been estimated in Chapter 10. Jyokaso was imported from Japan for this pilot study to transfer technology and concept in Niamey.

(4) Relevance
Based on the over all life cycle costs of various wastewater technologies including land and wastewater transportation cost, UASB technology has become the cost effective wastewater treatment technology for urban areas. Land requirement including polishing pond of 1 day is least i.e., 0.17 hectare/million litter per day wastewater.

On the other hand, areas where housing development is scattered and thus installation of costly sewerage system is not economically feasible, Jyokaso should be used as on site wastewater treatment system for toilet wastewater alone or combination of toilet, and kitchen and washing wastewater.

(5) Sustainability

The bio-gas power generation from the UASB plant is not only meets the need of UASB plant but also provides power for 3-4 hours in peak time to the wastewater pumping station.

There are no large rotating equipment needing skilled maintenance & operation costs in UASB plant, except screens & grit chamber, which are essential pre-treatment steps for all the types of wastewater treatment technologies.

S23.3 CONCLUSION

The ultimate goal of these pilot studies is realization of UASB and Jyokaso as per M/P of JICA Study by the Niger government from their own resources and know-how gained through the pilot study, to provide improved sanitation environment to the people of Niamey City.

The pilot plants are landmark of the Niamey City as the first household wastewater treatment plant based on the most appropriate technology for Niamey and should be continued to use for hygiene education for mass awareness to improve the sanitation environment of Niamey.

CHAPTER S24. HYGIENE EDUCATION CAMPAIGN

S24.1 PURPOSES

The principal purposes of the campaign are as follows:

- To instruct in how-to use a toilet of the *Jyokaso* system to schoolchildren.
- To present know-how of hygiene education to all actors concerned.
- To present know-how of the community participation approach to all actors concerned.
- To make a good relationship between the public sector and the private sector.

S24.2 PREPARATION

In place of the study team, the Campaign Committee was organized among the actors concerned to discuss the preparations and the implementation.

Table S24.1 MEMBERS OF THE CAMPAIGN COMMITTEE

The Private Sector	The Public Sector
- Chiefs of Quarters (*Bandabari* and *Deizebon*) - A president of PTA (*des parents d'éléves*) - NGOs (FABA, JADE, GANO, SHARRA, OXFAM) - A representative for *Tillabery* Bus Terminal - Representatives of land owners - Representatives of shopping streets	- Directors of *Bandabari* school II & *Deizebon* school - Teachers of *Bandabari* school II - Commune I, II, III - CUN - MSP (includes DS/CUN, CIS) - MEN - MED - MET

The Committee discussed and finalized the campaign program in accordance with the basic framework considered by the JICA Study Team in addition to following important points.

- To be a mutual cooperation between the private sector and the public sector.
- To be a mutual relationship between both campaign sites.

S24.3 RESULT AND EVALUATION

To evaluate the campaign and to identify the public opinion on executing such a campaign roughly, simple questionnaire surveys were implemented at the campaign sits every day.

At the 5th explanatory meeting, the Campaign Committee discussed and evaluated from preparation to implementation of the campaign.

1) The Preparation

- The schedule for the preparation was relatively tight.
- Information on the campaign in advance was rather not enough.
- Despite of the circumstances above, the preparation was relatively well organized.

2) The Implementation

- The cooperation between the private sector and the public sector was well established for the implementation.
- The interview surveys show that “solid waste” as well as “wastewater” is the most important theme for the next campaign in *Niamey*.

3) The Approach

- The participatory approach is positively evaluated for the first experience in *Niamey*.
- The approach may be adapted for future actions related to hygiene campaigns in accordance with social and cultural conditions of *Niamey*.

4) The Committee’s Recommendation

Based on the evaluation and discussion at the meeting, the committee made recommendation as follows:

- The campaign committee shall be sustained to implement further actions concerned.
- A meeting room shall be prepared for the committee activities.
- The awarded drawings shall be utilized for an educational tool.
- The public sector shall be involved in the further actions concerned at every level.
- Training in the field of the hygiene and wastewater shall be done to the actors of the private sector.

CHAPTER S25. RECOMMENDATIONS OF FEASIBILITY STUDY

S25.1 SEWERAGE / DRAINAGE SYSTEM OUTLINE

(1) Network of Sewerage/Drainage

It is proposed to implement the trunk Sewer/Drainage for F/S area such as following scheme:

Newly construction (L_1 = 6,625 m)
Rehabilitation/Repairing/Cleaning (L_2 = 7,810 m)

(2) Wastewater Treatment Plant

In the F/S area, Deizeibon located at Boukoki district is the proposed site for Wastewater Treatment Plant (WWTP). The design capacity of the Deizeibon WWTP is calculated as 2,500 m^3/day based on daily maximum flow, and the treatment process adopted is UASB technology followed by polishing pond.

(3) Appropriate Wastewater Treatment Process in Niger

According to the evaluation of Pilot Study, it is recommended that the UASB Process is the most appropriate for wastewater treatment system in Niger because of favorable climatic condition.

(4) Conserving Water Quality of Receiving Water Bodies

Water quality of river and ground water in Niamey would be considerably improved with the implementation of sewerage/drainage and on-site treatment schemes. By utilizing the treated wastewater for irrigation in view of the nutrients value of the treated wastewater, water quality will further improved especially during lean flow months.

(5) Management of Sewerage Project

The key to success of this investment plan lies in implementing a new tariff system and establishing the tariff collection system based on the water tariff. If the O&M costs are restricted to fall within the range proportional to the income, this investment plan is feasible and desirable.

In the Master Plan a new organization that will later become public service corporation is proposed. However, to be more realistic, the existing organization has been set-up for operating and maintaining the Pilot Plant.

However, the Study Team has already carried out the on the Job Training and Technical Transfer to MET's Engineers and CUN's Technicians, and they will acquire sufficient know-how of the plant operation through several months of pilot plant operation, the existing organization's number of staffs is not enough for operating the Wastewater Plant of the Feasibility Study. Then the existing organization should be expanded in accordance with future increase works in consultation with MET and CUN.

S25.2 SOLID WASTE MANAGEMENT

(1) Pre-Collection and Sand Recycling

As described in Chapter 21.2, the private operators in close cooperation with CUN and Communes shall carry out waste pre-collection and recycling sand activities. The pre-collection services shall certainly contribute to keep residential areas. Therefore it is recommended to introduce the new pre-collection system rapidly and extend to whole of Niamey city, as described in the Master Plan, as well as the construction and operation of recycling centers.

CUN shall make effort to introduce the new system and support the private operators. The new pre-collection system is financially sustainable and leads to reduce the municipal expenditures. The financial analysis shows a profitable internal rate of return for service fee of about 100 CFAF per person and month.

The recycled sand is useful for reclamation, base of construction and protection of underground facilities such as water and sewer pipelines. Further laboratory analysis have to be carried out for recycling use in order to determine appropriate use and develop applicable fields and demand.

(2) Landfill Site

The detail design and construction of new landfill site as developed in the Feasibility Study shall be urgently undertaken. Although 2 landfill sites has been designed in the present report taking into account the future development and further consideration for environment protection. The minimum project cost for the landfill site, as analyzed in the Master Plan, is shown in the following Table S25.1 and S25.2 as component (1). For additional measures such as Landfill base preparation and leachate drainage etc. investment costs have also been estimated and are shown in the same tables as component (2) and (3).

Table S25.1 PROJECT COST FOR DISPOSAL SITE

(1,000 CFAF)

Works	Land	Direct Cost	Engineering Cost	Contingency	Total
Construction as Master Plan	255,000	141,304	14,130	61,565	472,000
Addition 1 Grading and banking		1,214,850	121,485	200,450	1,536,785
Addition 2 Leachate and gas facilities		1,166,530	116,653	192,477	1,475,660
Total	255,000	2,522,684	252,268	454,493	3,484,445

Table S25.2 PROJECT COST FOR DISPOSAL SITE BENGALE

(1,000 CFAF)

Works	Land	Direct Cost	Engineering Cost	Contingency	Total
Construction as Master Plan	50,250	57,281	5,728	16,989	130,248
Addition 1 Grading and banking		496,600	49,660	81,939	628,199
Addition 2 Leachate and gas facilities		119,266	11,927	19,679	150,871
Total	50,250	673,147	67,315	118,607	909,318