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 II: MAIN REPORT

DECEMBER 2001

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

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In this report, project costs are estimated based on May, 2001 prices with an exchange rate of

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THE STUDY

ON

SANITATION IMPROVEMENT

FOR

THE NIAMEY CITY

IN

THE REPUBLIC OF NIGER

FINAL REPORT

CONSTITUENT VOLUMES

VOLUME	I	SUMMARY REPORT
VOLUME	II	MAIN REPORT
VOLUME	III	APPENDIX
VOLUME	IV	DRAWINGS

ABBREVIATION

BAD	African Development Bank
BEEEI	Office of Environmental Evaluation and Impact Studies
BOD	5-Day Biological Oxygen Demand
CNEDD	National Council of Environment for Sustainable Development
COD	Chemical Oxygen Demand
CSI	Integrated Health Centres
CUN	The Urban Community of Niamey
DHP	Public Hygiene Division
DO	Dissolved Oxygen
EIA	Environmental Impact Assessment
EPS	Health Education Division
F/S	Feasibility Study
GDP	Gross Domestic Product
GNP	Gross National Product
GOJ	Government of Japan
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
lpcd	Liters per capita per day
MED	Ministry of Environment and Prevention of Desertification
MEN	Ministry of National Education
MET	Ministry of Equipment and Transports
MOP	Master Plan
MP	Ministry of Planning
MHE	Ministry of Water Resources
MSP	Ministry of Public Health
NIGETIP	Agence Nigerienne des Travaux d'Intêret Public
NGOs	Non-Governmental Organizations
NOP	Non-Profit Organization
O&M	Operation and Maintenance
OJT	On the Job Training
PNEDD	National Plan of Environment for Sustainable Development
PRIU	Project of Urban Infrastructure Rehabilitation
PSE	Water Sector Project
RON	Republic of Niger
SNE	National Society of Water Supply
ST	Septic Tank
TOR	Terms of Reference
T/T	Technology Transfer
UASB	Up flow Anaerobic Sludge Blanket
UNICEF	United Nations Children's Fund
UNDP	United Nations Development Program
WHO	World Health Organisation
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

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CHAPTER 1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The concentration of population in Niamey city has been increasing rapidly since 1980s. In 1997, the population is reported to be 650,000 with an annual growth rate of 4.0%. The rapid growth of urban population has considerably deteriorated the sanitary environment of the city. Wastewater from dwellings and marketplaces is particularly causing nuisance and health hazard. It is discharged directly into the drainage facilities and further into the river Niger without treatment. The obvious consequences of these practices are exposure of ground and river water to contamination. The same river water is used for drinking purpose at the downstream. A part of the wastewater is also utilized for irrigation of horticulture and vegetables, with anticipated adverse effects on health of people in the form of parasite and other infectious diseases.

To cope with worsening sanitary environment, the Niamey City sewerage Master Plan (M/P) consisting of wastewater treatment, runoff water drainage and solid waste management was formulated in 1981 with the aid of African Development Bank. While some of these components were undertaken, the City's sanitation environment improvement was not achieved.

In 1998, a project formulation mission from the Government of Japan (GOJ) visited Niamey to identify the problems and confirm necessity and urgency of Japan's cooperation in the sanitation sector of Niamey city. In response to the request from the Government of the Republic of Niger (GON), a Study Team was dispatched by Japan International Cooperation Agency (JICA) and agreed on the Minutes of Meetings of the Inception Report (IC/R) for the Study on the Sanitation Improvement for the Niamey City (The Study) on 28 July 2000.

1.2 OBJECTIVES OF THE STUDY

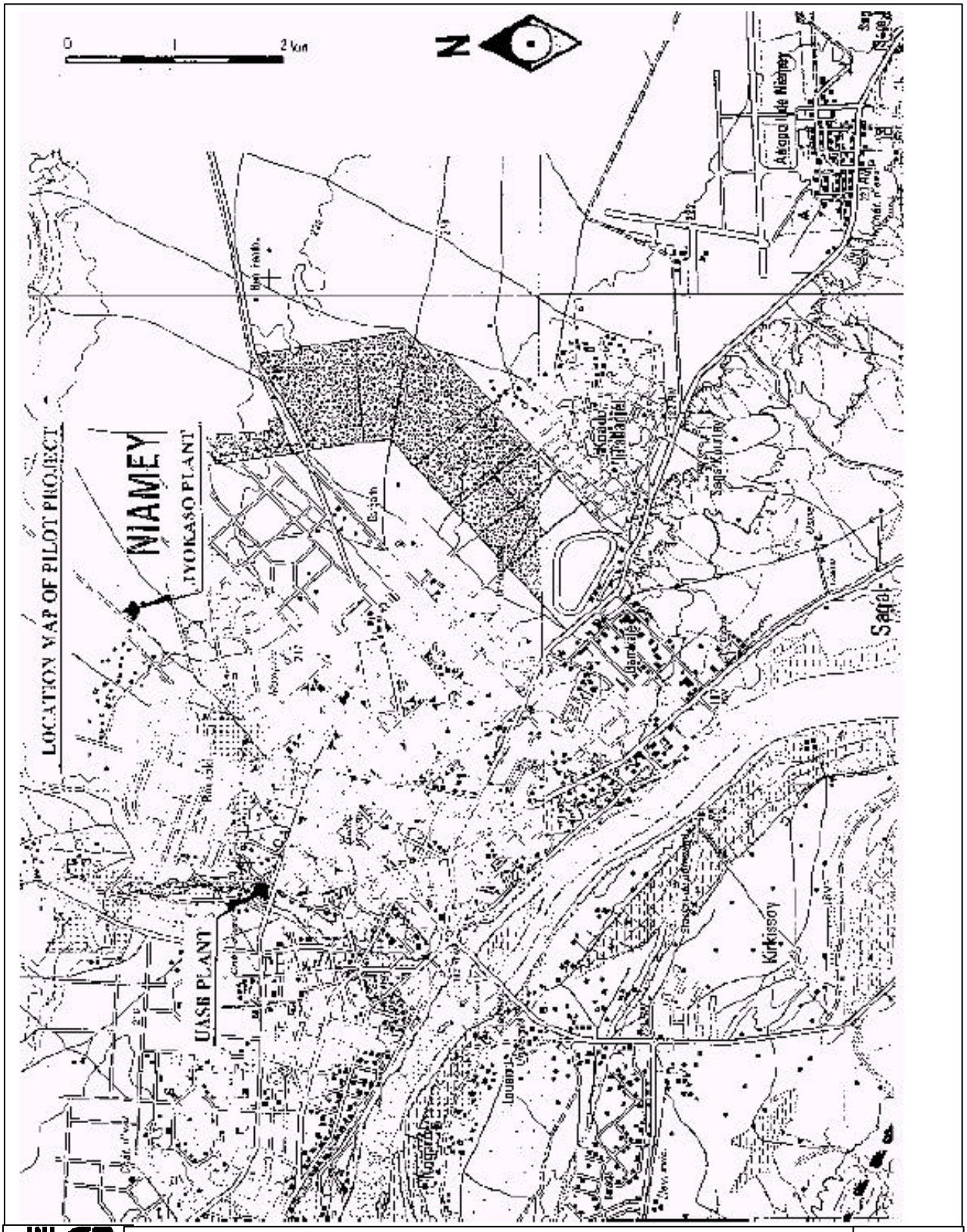
The Objectives of the Study are:

(1) To formulate the Master Plan (M/P) related to the sanitation improvement of Niamey City with main focus on the improvement of drainage and sewerage system, and solid waste management;
(2) To conduct the Feasibility Study (F/S) for the priority projects proposed under M/P, and to transfer technology to counterpart personnel in the course of the Study.
(3) To carry out the technology transfer (TT) and the on-the-job-training (OJT) to expedite the Nigerien self-sustainability and capacity.

1.3 SCOPE OF THE STUDY

1.3.1 Study Area

The Study will be conducted in the Niamey City, which consists of three communes, and its vicinity as shown in the Figure 1.1-1 and Table 1.1-1



The Study on Sanitation Improvement for the Niamey City in the

Figure 1.1-1

STUDY AREA OF MASTER PLAN

Table 1.1-1 STUDY AREA

Unit: ha

Name of Commune	Urban Planning Area	Administrative Area
1. Commune I	4,981	8,282
2. Commune II	5,209	11,908
3. Commune III	1,021	3,726
Total	11,211	23,916

1.3.2 Target Year

In order to determine the Target year for this Project, the Study Team has worked out the justification of relevant Study based on the preliminary Study Report published by JICA in March 2000. The Team has observed that the Target year for priority urgent rehabilitation project shall be year 2005 and that of long-term project shall be year 2015.

1.3.3 Contents of the Study

The contents of the Study are as follows:

Phase I : The Formulation of the Master Plan

(1) Basic Study

A. Data Collection
   1) Natural condition
   2) Social and economical condition
   3) National, regional, and urban development plans
   4) Policies and regulations related to the Study
   5) Present institutions, organisations, and administration related to the Study
   6) Sanitary condition and health-related data

B. Field Reconnaissance
   a. Present condition of drainage and sewerage system
   b. Present condition of solid waste management
   c. Present condition of O/M for drainage and sewerage and solid waste management
   d. Present condition of the related projects conducted by the other donors

(2) The Formulation of the Master Plan

1) Review of the past development studies and on-going projects
2) Determination of the socio-economic framework
3) Implementation of the pilot-projects
4) Cost estimation
5) Organisation and institutional plans
6) Implementation plan
7) Selection of priority projects
8) Initial Environnemental Examinateur (IEE)
9) Evaluation (economic, financial, and social aspects)

Phase II: The feasibility Study for the Priority Projects

1) Supplemental data collection
2) Determination of planning network
3) Preliminary design of facilities and equipment
4) Cost estimation
5) Environment Impact Assessment
6) Evaluation (economic, financial, and social aspects)
7) Formulation of construction plan
8)Formulation of procurement plan for machinery and materials
9) Formulation of operation and maintenance plan
10) Formulation of organisation, institution and human resources development plan
11) Preliminary cost estimates
12) Formulation of financial plan
13) Environment impact assessment
14) Project evaluation

1.4 UNDERTAKING OF THE STUDY

Ministry of Equipment and Transports (MET) accords privileges, immunities and other benefits to the Study Team, and through the authorities concerned, taken necessary measures to facilitate smooth conduct of the Study. The Government of Japan (GOJ), through JICA, has taken necessary measures to dispatch the Study Team to the Republic of Niger (RON) and to perform technology transfer to the RON counterpart personnel in the course of the Study. The Study Team commenced the work in Niamey on 25th July 2000, starting with the fieldwork upon arrival and discussions with MET and UCN on the following day.

The work for the stage I of the Study will be completed at the end of March 2001, and the Interim Report will be submitted in June 2001. Steering Committee (S/C) will also be held in the beginning of June 2001 at MET.

Following the discussion and confirmation of the Progress Report (P/R), and in particular identification of the first stage programme up to March 2001, the Study Team commenced the second fieldwork for the Feasibility Study (F/S), which duration will be from June to October 2001.

1.5 ACKNOWLEDEMENTS

The courtesy and cooperation extended to the JICA's Advisory Committee and the Study Team during the course of the Study by the following agencies that are gratefully acknowledged.

- Ministry of Foreign Affairs, Cooperation and African Integration
- Ministry of Equipment and Transports (MET)
- The Urban Community of Niamey (UCN)
- Ministry of Planning (MOP)
- Ministry of Public Health (MOPH)
- Ministry of Environment (MOEn)
- Ministry of Water Resources (MOWR)
- Ministry of Education (MOE)

CHAPTER 2. REVIEW OF RELEVANT PLANS

CHAPTER 2. REVIEW OF RELEVANT PLANS

2.1 TREND OF OTHER DONOR COUNTRY AND AID AGENCY

There are several on-going projects, which are related to the Sanitary Improvement for Niamey City. In this context, these studies and projects shall be reviewed and justified for the JICA's Sanitation Improvement Project. The Figure 2.1-1 shows the map of relevant on-going projects in Niamey City.

The following on-going Relevant Plans of donor organisations are to be reviewed:

* Bilateral O.D.A Project
* International Financial Institution
* United Nation (UN)
* Non Governmental Organisation (NGO's)

2.2 INTERNATIONAL FINANCIAL INSTITUTION

2.2.1 World Bank

(1) Project for Rehabilitation of Infrastructure (PRI)

The Project for Rehabilitation of Infrastructure (PRI), which is financed by the World Bank, is a multi-sector project directly related to the Prime Minister. The project, which was started in 1998 and will be completed in 2002, is executed under the general supervision of the CNEDD and with the assistance of the Direction of Environment as vice-president and the Direction of Urbanism as secretary.

The project aims at eradicating poverty in urban areas through creating employment, reinforcing municipality with infrastructures, and promoting the development of local potentials, namely local enterprises, use of labour intensive method, and use of local materials. The institutional supporting component of the project has led to the preparation of the strategy for urban environment management.

1) Financing Agency: World Bank (WB)
2) Responsible Agency: Prime Minister Office
3) Receiving Agency: CNEDD
4) Implementing Agency: NIGETIP

The strategy of urban environment management is one of the six programs set forth by the CNEDD, according to the basic orientations defined in the National Plan of Environment for Sustainable Development (PNEDD), which has been adopted as the national environmental policy of Niger by the Government in 1998. Accordingly, the urban environment management plan will be the national basic reference for improving the urban and living environment in Niger.

The first phase of the strategy project consisted of data collection and evaluation studies. Twelve separate reports were prepared in the first phase. These reports covered the following studies:

- Waste water sanitation: Individual toilet in peripheral areas and technical / financial assistance to private investments;

- Solid waste management: Privatisation of preliminary collection of waste, sorting out of waste materials at the level of urban quarters (sand, putrescible materials, plastics, and ultimate materials), and establishment of reuse / recycling channels;
- Rain water management: Tertiary system to control runoff water through retention and infiltration.
- Environmental management of open areas: protected areas to control runoff water, better management of leisure and greenery designated places, protection of areas of natural environment such as wetland.

The 12 studies prepared by the PRI project are listed as below:

1) Urban Hydrology and other Scientific Data
2) Sanitary Conditions of Population of Urban Community of Niamey and Evaluation of Realised Sanitation Prevention Programs
3) Access to Drinking Water
4) Assessment of Sanitation of Public and Public Receiving Institutions
5) Households Practices in the Field of Urban Sanitation and Households Survey about Behaviour and Expectations.
6) Control of Water Runoff
7) Management of Solid Waste
8) Management of Non-constructed Urban Areas
9) Dangerous and Insalubrious Establishments
10) Municipalities Practices in the Field of Financial Management and Human Resources Management in Relationship with Urban Environment
11) Emerging Actors and Practices in the Urban Environment Sector
12) Institutional, Regulatory and Financial Diagnostic of the Urban Environment Sector

The above studies have been executed with the assistance of concerned ministries, technical support of the working committees, and through the co-ordination of the PRI project office. The second phase of the urban environment strategy project will prepare action plans based on sector-based studies.

(2) The Water Sector Project (PSE)

The Water Sector Project (PSE) is a project under the Minister of Water Resources and financed by the World Bank. The project aims at improving access to potable water for the population countrywide, and improving the water management sector. The main components of the project are:

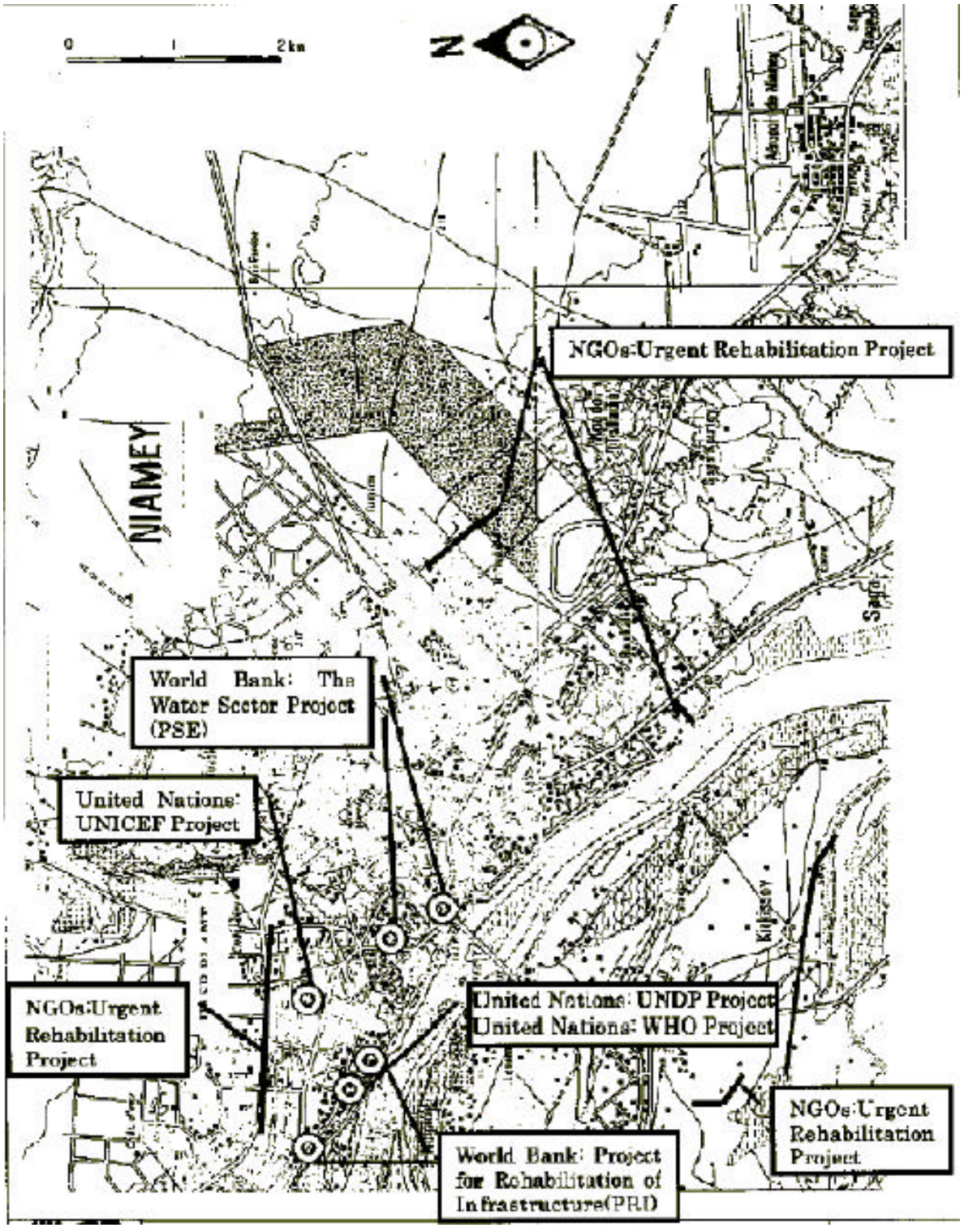
- Institutional reinforcement of the water management sector;
- Water supply and sanitation of the rural areas;
- Water supply of the main cities of Niger, namely *Agadez, Diffa, Dosso, Maradi, Niamey, Tahoua, Tillabéry,* and *Zinder*, together with 43 towns;
- Improvement of sanitation in urban areas by pilot projects development.

The urban water supply component includes the following objectives:

- Rehabilitation of the existing production and distribution infrastructure;
- Extension of the production and distribution capacities;

The urban sanitation improvement component includes the following pilot projects objectives:

- Improvement of sanitary conditions in the areas where an extended coverage of potable water supply is available, with construction of private and community toilets;



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

Figure 2.1-1

PROJECT MAP OF SANITATION INPROVEMENT

2.3 UNITED NATIONS

2.3.1 United Nations Environment Programme

UNEP Headquarter, which is located in Kenya, is reconsidering an appropriate project on sanitation improvement for the Niamey city.

2.3.2 United Nations Children's Fund (UNICEF) Project

UNICEF has just commenced the Sanitation project for entire Republic of Niger. UNICEF has conducted several projects aiming at Action Plan for women and children, small community and/or families.

UNICEF's Sanitation Projects consist of several Sanitation Improvement scheme. The following schemes are for Niamey City.

* Collection of solid waste.
* Low Cost Sanitation (LCS) such as the Sam Plat System, which was proposed by Switzerland consultants group as one of the sustainable sanitation programmes.
* Formulation of education programme for NGO's.

1) Financing Agency: United Nations (UN)
2) Responsible Agency: CUN
3) Receiving Agency: CUN
4) Implementing Agency: NGO's

2.3.3 United Nations Development Program (UNDP) Project

UNDP has been implementing Action Plan all over the Republic of Niger for Poverty alleviation.

1) Financing Agency: United Nations (UN)
2) Responsible Agency: Ministry of Public Health (MPH)
3) Receiving Agency: CUN and Rural Authority
4) Implementing Agency: NGO's

2.3.4 World Health Organization (WHO) Project

WHO has been taking actions mainly for epidemic and/or plaque disease to protect the Nigeriens life.

1) Financing Agency: United Nations (UN)
2) Responsible Agency: Ministry of Public Health (MPH)
3) Receiving Agency: CUN
4) Implementing Agency: Ministry of Public Health (MPH)

2.4 NON-GOVERNEMENTAL ORGANIZATIONS (NGOs)

2.4.1 Nigetip Project

Nigetip is a public agency to promote and expedite the employment in the Republic of Niger. On-going projects in the Niamey City are mainly urgent rehabilitation of urban drainage for each commune.

2.4.2 FABA Project

FABA is not Public agency. It is an Economic Interest Group, which is also carrying out similar projects as Nigetip. FABA has been involved in PRI and PSE projects.

2.4.3 GANO

GANO is also an Economic Interest Group similar to FABA. GANO has been trying to improve the habitants' life in low-income residential area.
Since the end of 2000, GANO is carrying out a Project to collect door-to-door solid waste in Kouara Kano quartier. The source of funding is CUN and self-funding.

2.4.4 ABC-Ecologie

ABC-Ecologie is an Association for collective behaviour and Ecology.
This NGO is involved in household solid waste collection, its disposal and reuse in only part of Yantala and part of Issa Beri quartiers. ABC-Ecologie purpose is:

- To improve environmental and living conditions of the habitants
- To apply intensive methods for hygiene, salubrity and sanitation
- To inform and educate habitants against insalubrity risks and poor hygiene for health
- To organize communities for cleaning of quartiers

However, ABC-Ecologie has been trying to find the funding agency. As of end of 2000, there is no on-going project in these quartiers.

2.4.5 JADE

JADE (Jeunesse, Action, Développement) was established by young men association aim to carry out planting and cleaning the sceptic tanks, roads and drains in Yantala district.
JADE has recently applied to the foreign donors to seek the funds for the Projects. At present, there are no on-going projects under JADE.

CHAPTER 3. EXISTING CONDITIONS AND IDENTIFICATION OF PROBLEM

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3.1 GENERAL CONDITION OF NIAMEY CITY

City of Niamey is situated in the west part of Niger along the Niger River. The city of Niamey encompasses an area of approximately 23,900 hectares, which is 0.02% of the Republic of Niger. The administrative population was about 650,000 persons in year 2000, which is 6.5% of the National Population.

Niamey Urban Community consists of three communes, namely Commune I, II & III. Each Commune has its own administrative body for the quartier, which is divided into 54 divisions. Figure 3.1-1 shows an entire view of Urban Community of Niamey.

3.2 CURRENT STATUS OF URBAN COMMUNITY OF NIAMEY

3.2.1 Administrative Structure

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.

Each Commune is further divided into smaller administrative units, quartiers. In principle, each quartier has a chief responsible for tasks supporting the mayor of the Commune to which he or she belongs. The definition of the quartier is, however, rather vague and ambiguous. The boundaries often change as new quartiers constantly emerge. For example, the number of quartiers identified by the Ministry of Equipment is different from that by CUN. Moreover, the boundaries defined by the Census office are different from the administrative ones, which obviously introduces inefficiencies and confusions among public institutions. For the sake of analysis in this Study, therefore, the boundaries of the quartiers are determined by taking into account both administrative and statistical aspects, which has been confirmed by the Counterpart. Figure 3.2-1 shows the administrative boundaries of the three levels of the administrative units in Niamey. Large public spaces are included in a separate category from the residential quarters. There are 96 quartiers (residential and non-residential) identified. A more detailed map and a list of the quartiers are provided in Appendices F.1 and F.2.

3.2.2 Population

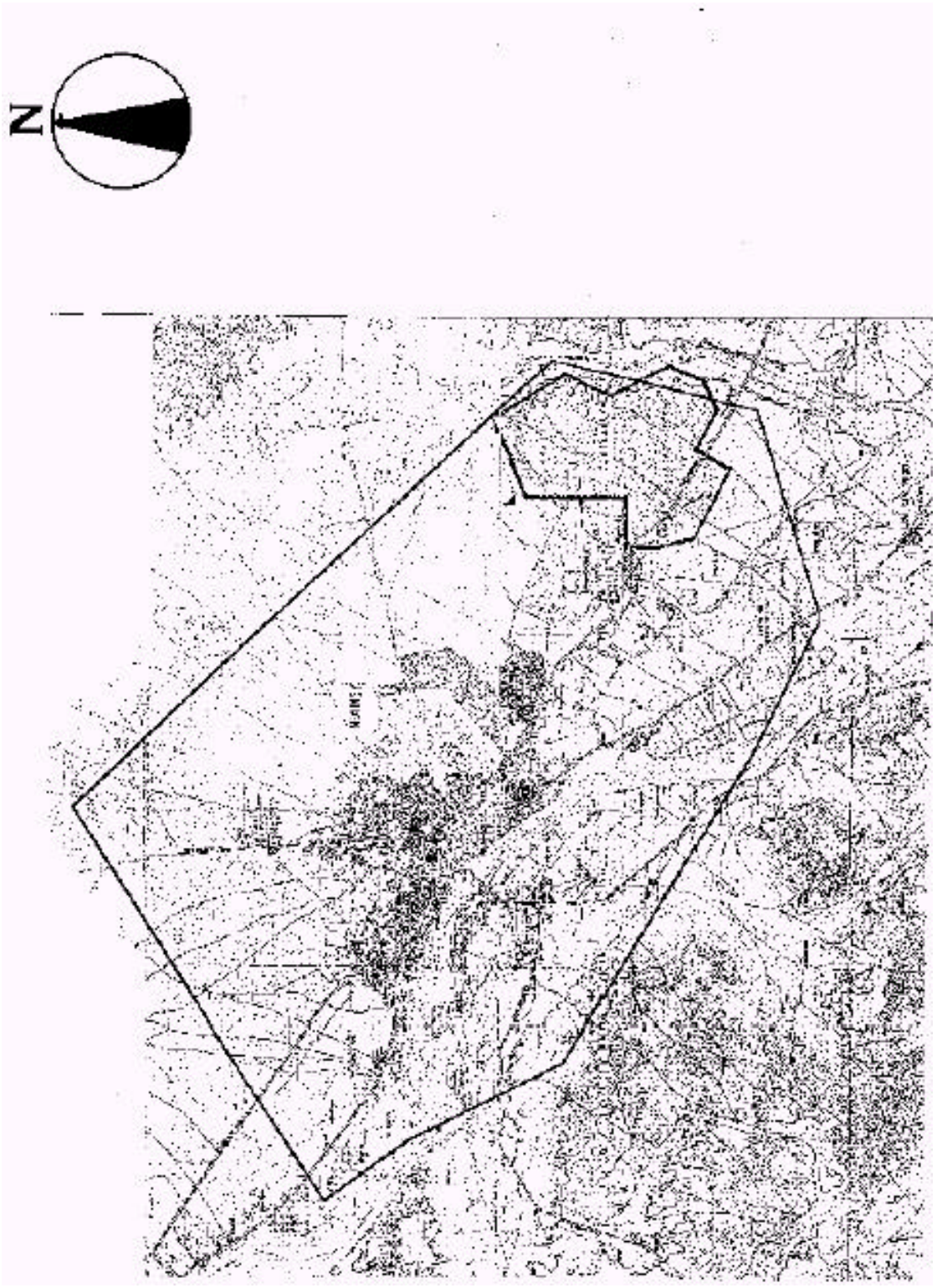
(1) Population of CUN and its Communes

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 3.2-1). From the previous Census in 1988, it increases constantly, though the speed of growth has recently slowed down.

Table 3.2-1 POPULATION OF NIAMEY

Year	1988*[1]	1989	1994	1995	1996	1997	1998	1999	2000
Total Population	391,876	420,859	515,851	536,259	557,869	580,215	603,386	627,431	652,401
Annual Growth Rate		5.84%	4.51	3.96%	4.03%	4.01%	3.99%	3.99%	3.98%

Source: *[1]Donnes Definitives du Recenssement de la Population de 1988. Direction de la Population. May 1994. Data after 1989: Projections Demographiques 1994-2025. Direction de la Population. November 1994.



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

Figure 3.1-1

URBAN COMMUNITY OF NIAMEY

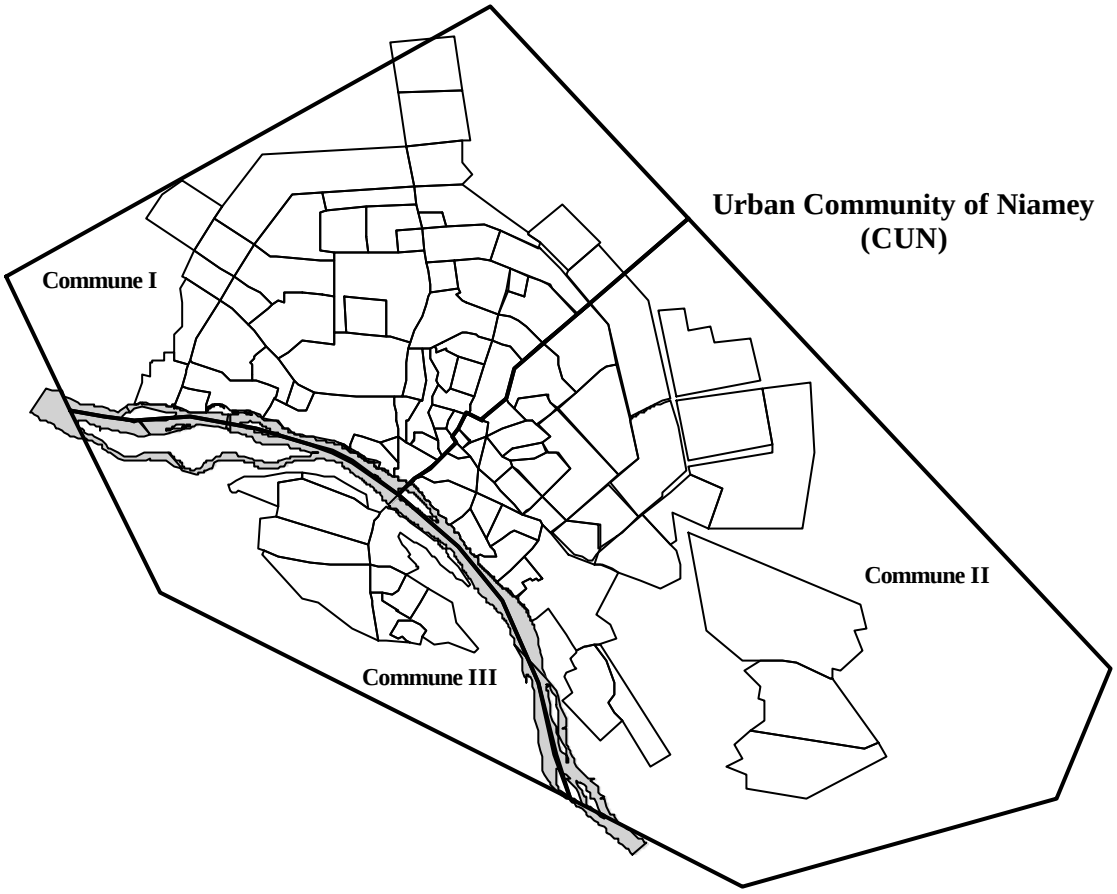


Figure 3.2-1 THREE LEVELS OF ADMINISTRATIVE UNITS IN NIAMEY

This population projection is supported by another data source. The Office of Census under the Ministry of Plan conducted a preliminary census from 1998 to 1999[1]. The results are shown in Table 3.2-2 with the numbers of population for Niamey as well as each Commune, compared to those of the 1988 Census. It is important to note that the results by the 1999 Pre-Census show that the estimated population falls between the projected figures for 1998 and 1999 in Table 3.2-1. This is a strong support to argue that the 1994 projection fairly accurately predicted the actual demographic situation. The future population is also projected with the same data sources and will be discussed in Chapter 5.

Table 3.2-2 POPULATIONS OF CUN AND ITS COMMUNES (Share of each Commune)

Year	Commune I	Commune II	Commune III	Total
1988 Census	157,178 (40.1%)	197,255 (50.3%)	37,443 (9.6%)	391,876 (100.0%)
1998 Pre-Census	305,075 (50.2%)	246,190 (37.8%)	56,128 (12.0%)	607,393 (100.0%)
Growth, 1988-99	94.10%	16.32%	94.62%	55.00%
Annual growth rate	9.41%	1.63%	9.46%	5.50%

Source: Same as Table ***.

[1] The results are not made official. The use of the data is decided on the discretion of the Study team.

(2) Population of Quartiers

From the preliminary Census, the population of each quartier is identified and shown in Appendix F.3 together with other data. Note that the data from the Census office have been reprocessed to fit into the actual socioeconomic conditions in Niamey since there are no definitive boundaries of the quartiers as explained in the section above.

3.2.3 Land Use

(1) Overview

Table 3.2-3 summarizes the existing land use in Niamey.

Table 3.2-3 LAND USE IN NIAMEY (HECTARE)

	Total Area	Agricultural land*[1]	Urbanized Area in 1998*[2]	Residential Area*[3]	Population (1998)	Gross Pop Density	Residential Pop Density
Commune I	8,282	-	3,462	2,834	305,075	78.01	104.73
Commune II	11,908	-	4,325	1,952	229,448	69.81	109.34
Commune III	3,726	-	1,021	699	72,870	84.02	98.10
Total	23,916	15,785	8,808	5,485	607,393	75.49	105.52

*[1]Source: Rapport Annuel d'Activites Agricoles d'Hivernage 1999. Ministere du Developpment Rural.
*[2]Includes large-scale public facilities, e.g. the green belts and the airport.
*[3]Residential areas also include public spaces like roads, schools, hospitals, and others.
Note: The Study Team with GIS software estimates the surfaces of Urbanized and Residential Areas.

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, that agricultural land is encroached by new developments in each year. The residential use accounts for more than 60 percent of the urbanized area.

(2) Existing Land Use

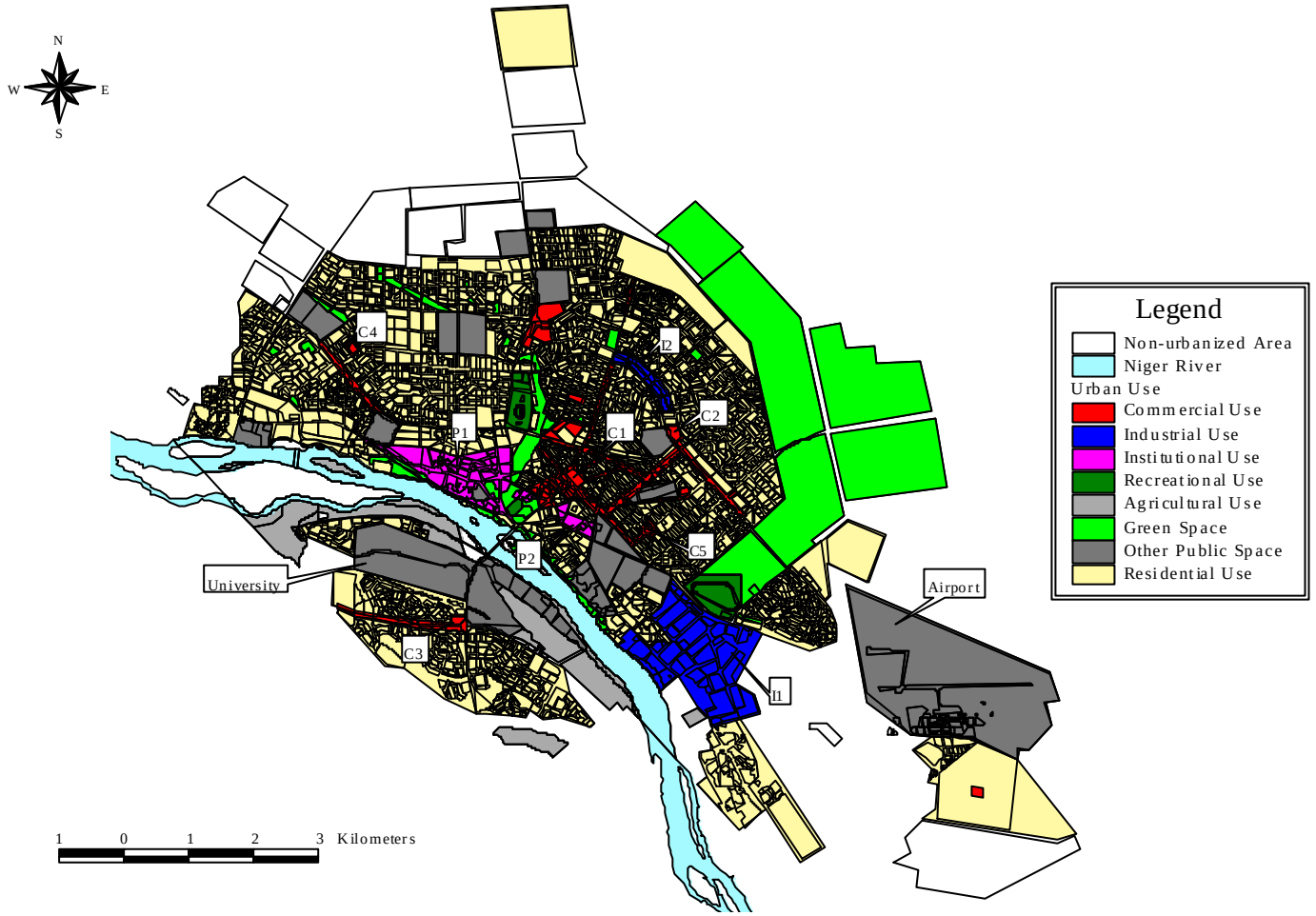
The existing land use of Niamey is shown in Figure 3.2-2.

1) Residential Use

Residential use accounts for the majority of the urbanized area. Since residential areas are diverse in physical as well as socioeconomic characteristics, a more detailed classification is developed and will be discussed in the subsequent section. In Figure 3.2-2, however, only two distinctions are made for residential use: (1) urbanized areas and (2) transition areas expected to urbanize within 15 years. In Table 3.2-3, the latter is not included as part of Residential Area because it has not been developed yet.

2) Commercial Use

Most residential areas are mixed with some commercial space because people shop in their neighborhoods on a daily basis. Many small shops are located in residential areas, which cannot be illustrated in Figure 3.2-2. However, the most important commercial zone in the city is the triangular area with its points composed of Grand Marche, Petit Marche, and Katako Marche (C1 on Figure 3.2-2). In this area, there are many individual stores, and the increasing demand for commercial space has begun to convert the remaining residential areas into commercial use. Other major commercial zones include (C2) Wadata, (C3) Karadje, (C4) Yantala, and (C5) Nouveau Marche with some extensions along the roads. It is important to note that these areas also include a large number of informal activities and are also mixed with many houses.



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

Figure3.2-2

EXISTING LAND USE

3) Industrial Use

There are basically two types of industrial activities in Niamey: (1) modern industry located in Industrial Zone (I1) and (2) handcraft and small-scale industries scattered around the city just like small stores. An exception to the latter exists in some areas. For example, there is a small agglomeration of handcraft industries in the north (I2) and another planned in Sari-Koubou.

4) Institutional Use

Most public institutions are concentrated in Plateau I (P1). This is a triangular area with its base as Niger River, surrounded by Avenue de L'Uranium and Avenue du De Gaulle. It contains multi-floor modern buildings of governmental institutions. Another smaller administrative area is located to the east of Plateau I, called Niamey Bas (P2). It contains four national ministries, the city hall, the national museum, the national assembly, and other offices of public as well as private entities.

5) Open and Green Space

Small green spaces scatter around the city, some of which are given special statuses and protected by law. The most important of all in the city is probably Gounty Yena, which carries urban storm water and wastewater out of the city into Niger River. The green belts surrounding the city in the north are also important and define the limits of the city. New housing developments are, however, planned outside the green belts. Some small green spaces are used for small-scale horticulture and fruits production.

(3) Typology of Residential Use

A classification system of diverse residential areas has been developed to group them by similar socioeconomic and cultural characteristics. This typology has important implications in formulating the Master Plan by allowing policy decision-makers to see different approaches necessary to address problems particular to each group. Problems are also often diverse, and vague understanding of the characteristics of residential areas could result in inappropriate policy choices.

Socioeconomic characteristics used to develop this system include densities, locations in the city, incomes, main housing materials and types, times of establishment, and implicitly, culture. Most notable generalizations are as follows.

- Older areas tend to be denser.
- The closer to the center, the denser the area.
- Housing materials (straws, clays, mixed-clays, or concrete) and types of house (single-detached or compound) imply the income of the residents.

Based on these observations, residential areas in Niamey can be grouped into eight major types as shown in Table 3.2-4, including areas that exist only on plan today, PLN. The locations of each type are also illustrated on Figure 3.2-3. The list of the quartiers by type is provided in Appendix F.4. Figure 3.2-4 shows the population densities of the quartiers. Note that the levels of density are consistent with the residential types.

Table 3.2-5 summarizes physical characteristics of these residential groups. Although their surface areas are separated from public spaces, each group still contains roads, schools, and other non-residential elements. Thus, it should be understood that the actual net population densities of these areas are much higher, probably at least 1.5 to 1.6 times higher than the figures shown in the table.

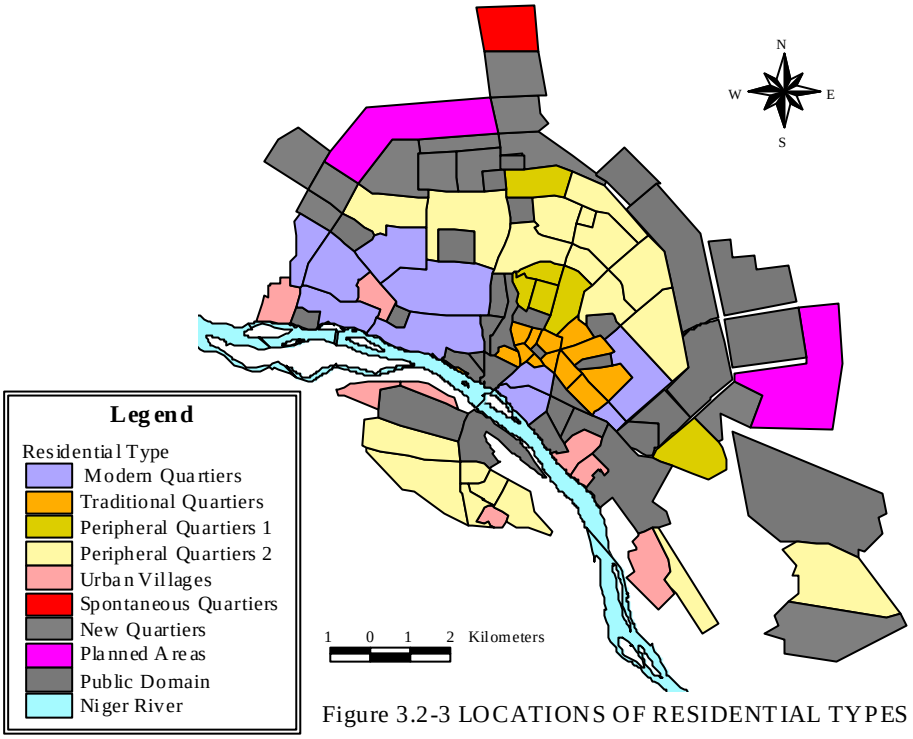


Figure 3.2-3 LOCATIONS OF RESIDENTIAL TYPES

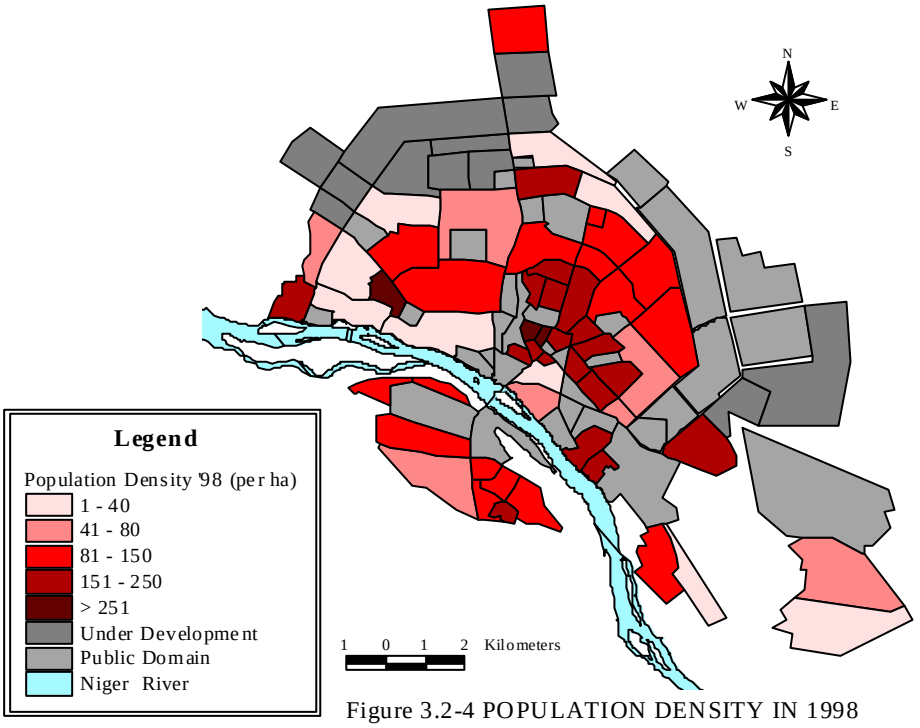


Figure 3.2-4 POPULATION DENSITY IN 1998

Table 3.2-4 CLASSIFICATION OF RESIDENTIAL AREAS IN NIAMEY

Type of Quartier	Density	Location	Income	Main Housing Type/Material	Time Established	Remarks
1. Modern quartiers (MDQ)	Low Mostly 30-50/ha	Former colonial sites	Highest	Single-detached	Origin in the colonial era	Extensions included.
2. Traditional quartiers (TRD)	Very high 200-300/ha	Center	Low-Medium	Compounds-clay, mixed	Colonial era	Former "black" areas
3. Peripheral quartiers 1 (PRP1)	Higher 180-200/ha	Fringe of the center	Medium	Compounds-clay, mixed	In the 1960s	Beginning of "urban sprawl"
4. Peripheral quartiers 2 (PRP2)	Underdeveloped < 100/ha	Periphery	Mid-high	Compounds-mixed, cement	After the 1970s	Plots sold, but few houses.
5. Urban villages (UVL)	Mid to high 100-350/ha	Scattered	Lower	Compounds-clay, mixed	Before Niamey	Autonomous villages before.
6. Spontaneous quartiers (SPT)	Above avg. >120/ha	Far from the center	Lowest	Straw houses	Fairly recent	Former temporary area
7. New quartiers (NWQ)	Developing now	Farthest from the center	Mid-high	Mixed	After 1990	Plots sold, but few houses.
8. Planned areas (PLN)	Undeveloped yet	Farthest from the center	Mid-high	Mixed	Under plan	Planned by CUN

Table 3.2-5 PHYSICAL CHARACTERISTICS OF EACH RESIDENTIAL TYPE IN 1998

Types of Quartier	Population		Surface Area		Avg. Density	Density Range	
	Total	Share	Total (ha)	Share		Low	High
1. Modern quartiers (MDQ)	83,302	14.16%	1,424	12.70%	52.38	12.23	125.26
2. Traditional quartiers (TRD)	74,531	12.67%	353	3.15%	243.79	160.32	405.12
3. Peripheral quartiers 1 (PRP1)	95,479	16.23%	539	15.72%	180.89	157.77	205.90
4. Peripheral quartiers 2 (PRP2)	215,887	36.70%	2,507	35.54%	95.47	14.48	150.73
5. Urban villages (UVL)	84,303	14.33%	507	4.52%	176.94	92.20	387.29
6. Spontaneous quartiers (SPT)*[1]	25,318	4.30%	155	1.38%	*	*	128.54
7. New quartiers (NWQ)	8,847	1.50%	1,518	13.54%	2.84	0.00	24.05
8. Planned areas (PLN)	0	0.00%	885	7.89%	N/A	N/A	N/A
9. Public Domain (ZDS)	650	0.11%	3,323	29.64%	0.07	0.00	2.14
Total	588,317*[2]	100.00%	11,211*[3]	100.00%	N/A		

*[1]The boundaries of some spontaneous settlements cannot be defined, and the surface areas are unidentifiable.
*[2]Not including the population of the outlying villages of Niamey.
*[3]The total area should be regarded as a future urbanized area because it includes areas on plan as well.

The origin of the Modern Quartiers can be traced to the Colonial era. They were first built to provide housing for the Europeans. Today, they include the extensions of these original areas, but the income is still the highest in the city, and the densities are the lowest. Traditional Quartiers are also very old, constructed around Grand Marche for the indigenous population during the Colonial era. The areas are now very crowded, and the incomes are lower. There are two types of Peripheral Quartier. PRP1 are older, low-income areas, established during the 1960s. PRP2 are located outside PRP1 and relatively new, most of which are constructed during the 1980s to absorb the rapid population growth. This group occupies the largest surface area on the fringe. Urban Villages are special areas that had existed long before the foundation of Niamey. They still keep their traditional forms of living style, which can be observed on narrow, winding streets. The population density is very high as well, and the housing materials imply lower incomes. Now they receive a large influx of immigrants into the villages as well as adjacent areas, which make up extension areas. Spontaneous quartiers are not permanent settlements, and land titles are not officially established. Most housing materials used are straws, which shows a very low level of income.

New Quartiers, similar to PRP2, are still under development and to be urbanized in near future. Most parcels have been sold, but very few residents have actually moved into the areas because of inadequate infrastructure as well as the financial shortage among landowners. Planned Areas only exist on plan, but it is most likely that they will be developed in several years. Indeed, some of the parcels have already been sold. Finally, Figure 3.2-3 includes Public Domain, areas for public facilities, such as administrative buildings, green spaces, the airport, and others. There are some residents in Industrial Zone.

3.2.4 Trend of Urban Development to Date

(1) Brief Historical Development

Niamey was established in 1926 and became an autonomous administrative unit, Urban Community of Niamey (CUN), in 1988. Its brief demographic history is described below.

1905-1950: Population growth was not so strong, 4.17% on average, but Niamey experienced a large number of immigrants when France founded its colonial capital in 1926 (10.6%).

1950-1960: The population increased from 11,790 in 1952 to 33,816 in 1960. The annual average rate of population growth was 12%, of which 10% accounted for immigration.

1960-1972: In 1960, Niger became independent, and Niamey was designated as the capital city. During this period, the annual average growth rate exceeded 10%, and the population reached 108,000 in 1972.

1972-1988: In 16 years, the population increased by 3.2 times or to 391,876 in 1988. In other words, 18,141 persons were added each year, of which about 12,000 were immigrants. The social growth rate was 5 to 7%, whereas the natural growth rate ranged from 3 to 3.5%.

(2) Recent Urban Development

Urban growth in Niamey in the 1980s and 90s has been absorbed in one of the three ways: (1) expansion of the urbanized area, i.e. "urban sprawl," (2) densification of the existing urban centers, and (3) emergence of squatters.

First of all, the municipality has aggressively developed new residential areas partially because it seeks easy revenues from selling parcels. It has resulted in the rapid expansion of the city area. As shown in Figure 3.2-5, the rapid expansion of urbanization is a fairly recent phenomenon. During the 1990s, a large area of land was developed for residential use. There is a criticism that the revenues from the sales are not used for on-site improvements but for other purposes such as paying salaries of municipal employees. As a result, there are a large number of new development areas with inadequate basic infrastructure. It is a serious concern, therefore, that houses will not be built, and these new areas will not have so much capacity of absorbing population growth as expected by CUN. In fact, those areas developed during the 1990s have actually been built with very few houses to date.

Instead, the population has kept being absorbed in the existing urbanized areas. These areas are equipped with a minimum level of basic infrastructure, namely accesses to water and markets. This population increase has taken place without vertical expansion and reduced the floor area available to each resident. As a consequence, the densification has led to further deterioration of living conditions. This was an inevitable outcome, of course, in that it was impossible for these areas to maintain a good sanitation environment with insufficient capacity and knowledge of treating wastewater or solid waste.

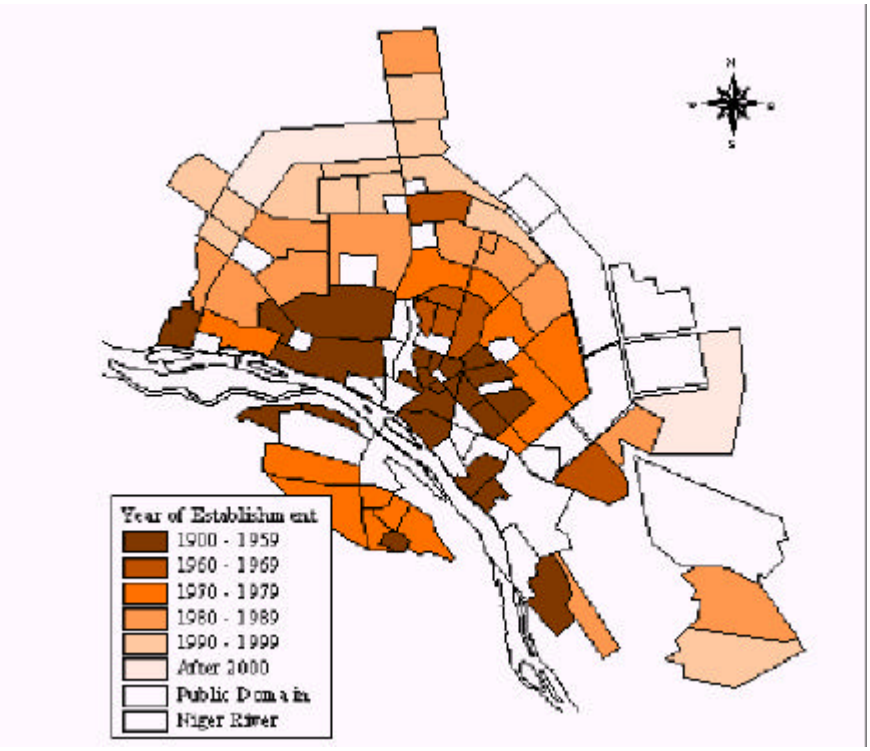


Figure 3.2-5 RAPID EXPANSION OF URBAN IN RECENT YEARS

The third type of urban development in Niamey is the emergence of illegal settlements, or squatters. As in other developing countries, squatters are the home of many people either on a semi-permanent or seasonal basis (Figure 3.2-6). In the past, the municipality has often ended up with recognizing squatters as official residential sites after some time of their creation. Such an example includes Talladje. It is probably reasonable to assume some of the existing squatters, e.g. Pays Bas and Koubia, will be incorporated into CUN as well. Until then, however, squatters are left with no basic infrastructure and suffer from severe living conditions.

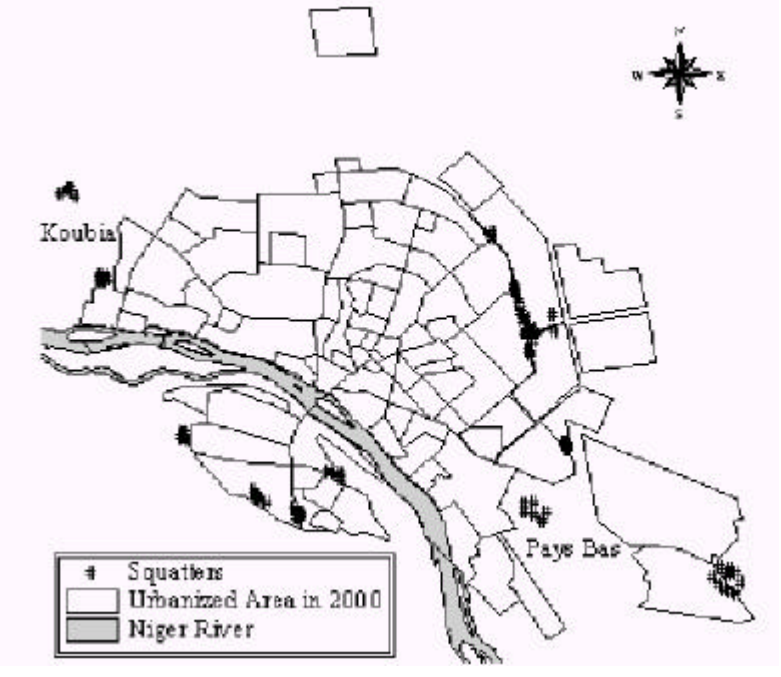


Figure 3.2-6 LOCATIONS OF ILLEGAL SETTLEMENTS

(3) Identification of Problems with the Current Urban Development

An overview of the problems associated with the current pattern of urban development in Niamey can be schematically expressed as in Figure 3.2-7. There seem to be three fundamental problems. They are the rapid population growth, the chronic shortage and mismanagement of public funds, and the lack of planning and enforcement. They all lead to uncontrolled urban development. "Uncontrolled" here means the three recent urban phenomena stated above. As a result, the urbanized area continues to expand, and the density of the center increases to such a level as to aggravate the living conditions of the residents. Since housing constructions have not taken off, the population continues to flow into the central areas. At the same time, squatters keep increasing on the urban fringe.

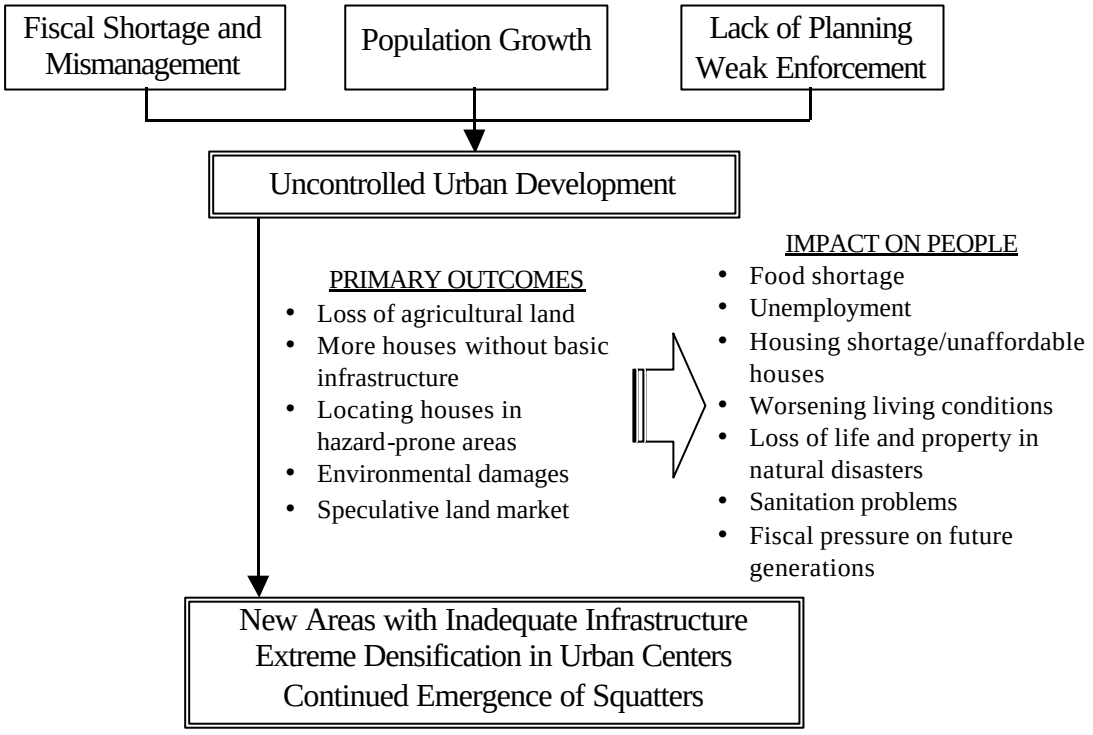


Figure 3.2-7 SCHEMATIC VIEW OF URBAN DEVELOPMENT PROBLEMS

This series of urban phenomena inevitably creates many prominent problems that are translated into significant negative impact directly affecting the population. Sanitation degradation in the center is increasingly becoming an alarming issue. Many properties and even lives are lost because houses are being built on flood areas, knowing that they would be inundated. Uncontrolled new developments encroach upon agricultural land and endanger the lives of many farmers. The lack of affordable housing is ironic because of the presence of vast lands sold for the construction of new houses, which has not taken off so far. Once the municipality recognizes all these problems, it is too late to deal with because financial resources required for new infrastructure amounts to an astronomical figure. In the end, all the problems become heavy burdens on future generations.

It is necessary, of course, to recognize the reality that the population growth cannot be completely stopped. Thus, the expansion of the city must be guided and controlled. Some measures must be proposed to achieve this goal.

3.3 EXISTING WATER SUPPLY FACILITIES

3.3.1 General

The water supply system of Niamey serves the entire area of Niamey city including three communes and surrounding area of the communes. According to the geography and topographic conditions, there are as many as 7 distribution zones in the service area. The system has two Water Treatment Plants (WTP) having two reservoirs and seven elevated tanks. Table 3.3-1 shows the analysis of piped water supply in Niamey.

The present status of population served in Niamey is as shown below:

*	Individual supply	327,500 persons
*	Stand pipe	120,000 persons
*	Well supply (small quartier)	17,500 persons
*	Well	10,000 persons
	Total	475,000 persons

Source: SNE Annual Data (1995)

The total population served by SNE is 475,000 habitants through its distribution network system.

3.3.2 Existing Water Sources

The Niger River is the major source of water supply in Niamey. Two water treatment plants (WTP) are located at Yantala and Goudel, respectively. The total maximum capacity of the intake water pumps is 0.925 m^3/sec. There also are wells in some urban villages. The water quality of the sources is considered to be satisfactory although there is certain anxiety from potential pollution by the domestic wastewater.

Table 3.3-1 ANALYSIS OF SUPPLY AMOUNT OF NIAMEY SUPPLY WORKS

Status: As of year of 1999(Yearly Average)

<table>
<tr><td rowspan="10">WTP Intake
60,184m^3/d
100.0%</td><td rowspan="9">Water Delivery
(Supply Amount)
52,652m^3/d
87.5%</td><td rowspan="6">Effective
water
38,181m^3/d
63.5%</td><td rowspan="3">Effective Paid
Water
35,503m^3/d
59.0%</td><td>Paid Water
35,503m^3/d
59.0%</td></tr>
<tr><td>Supply Water to the other Area
0m^3/d
0%</td></tr>
<tr><td>Fire Hydrant & Others
0m^3/d
0%</td></tr>
<tr><td rowspan="3">Effective
Non-Paid Water
2,678m^3/d
4.5%</td><td>Non-Sensitiveness of Meter
0m^3/d
0%</td></tr>
<tr><td>Water Authority Use
0m^3/d
0%</td></tr>
<tr><td>Others
2678m^3/d
4.5%</td></tr>
<tr><td rowspan="3">Wastage Water
14,471m^3/d
24.0%</td><td colspan="2">Settled Amount Water
0m^3/d
0%</td></tr>
<tr><td colspan="2">Leakage Water
14,471m^3/d
24.0%</td></tr>
<tr><td colspan="2">Others
0m^3/d
0%</td></tr>
<tr><td>Water Drain &
Usage in WTP
7,532 m^3/d
12.5%</td><td colspan="3"></td></tr>
</table>

Source: SNE Monthly Paid Water Consumption Data, 1999.
Note: Exclude Well Water Supply in Urban Village.

3.3.3 Water Treatment Plants

Total Design Capacity of two WTPs are 80,000 m^3/d to 85,000 m^3/d, respectively and actual total water production was 52,652 m^3/d in 1999 on average basis. WTPs are operated 24 hours by SNE. . WTP-wise capacity of the plants is given as in Table 3.3.2.

Table 3.3-2 CAPACITIES OF WTPs

Name of WTP	Design capacity	Remarks
Yantala	17,944 m^3/d 27,160 m^3/d	Daily average Daily Maximum
Goudel	34,708 m^3/d 40,640 m^3/d	Daily average Daily Maximum

3.3.4 Transmission Main and Distribution Network

The present distribution system consists of two supply areas, namely Goudel supply area and Yantala supply area. The details of Transmission Main and Distribution Network is as in Table 3.3-3..

Table 3.3-3 TANSMISSION MAIN AND DISTRIBUTION NETWORK

Supply Area	Transmission Main	Distribution Network
Goudel	ϕ 400 – 800 mm dia. 10,000m	ϕ 100 – 250 mm dia. 100,000 m
Yantala	ϕ 300 – 800 mm dia. 10,000 m	ϕ 100 – 250 mm dia. 100,000 m

3.3.5 Pumping Station and Service Reservoir

There are two delivery pumping station and seven elevated tanks in the served area. Apart from these seven elevated tanks, there are another two elevated tanks (N° 1 and N° 4). These two tanks are not being operated because of some reason in the network system.

3.3.6 Service and Metering

Number of water meters was 24,000 in 1999 including 500 meters for the standpost installed by SNE. At present, SNE has been delivering the water bill to all the consumers. The ratio of effective paid water is more than 90%.

During 1960's public standpost were free of charge. After 1970's SNE installed the meter with each standpost and changed to the contract supply.

The illegal connections are continuously exposed and are installed with water meter by SNE. At present, there seems to be no illegal connection.

3.4 SANITATION (TOILET, NIGHT SOIL MANAGEMENT)

3.4.1 Toilet Access

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. In the specific areas like Pays Bas, Golf, and Koira Tégui quarters, more than 50% of households have no access to toilets. Among 12 impoverished quarters, which has low living conditions, half of the quarters have no access to public toilets and 4 quarters had only one public toilet.

The use of sceptic tanks with soak pit is adopted by about 15% of households. The use of improved latrines or septic tanks is higher in modern residential habitat (63% of households) than in traditional habitat (13%).

The construction of latrines is made without consideration of the number of users in the house or compound. There are no guidelines to decide the size of the latrines. The only recommended criteria for the construction of latrines is minimal distance between latrine and well used for drinking water. This minimal distance is generally recommended to be 10 m, however, more than 56% of latrines are constructed at a distance less than 10 m from the well.

3.4.2 Use of Toilets and Problem of Excreta

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 open defecation practice is the highest for those families that are living in compounds free of charge (32%). In the case of excreta of babies, 31% of households throw it in surroundings, namely streets, gutters or waste deposits.

3.4.3 Collection of Night Soil

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.

It is very often that desludging is not done until overflow of toilet wastewater into the yard (about 40% of households according to a PRI Study) or return of wastewater into the pan (27% of households). The sludge of the septic tanks by private or municipal desludging trucks is disposed of commonly at places such as roadside, open area, which is not far from inhabitants (pictures in Appendix D.3).

3.4.4 Main Issues

Main issues for improving the night soil problem are:

- Public awareness would help to improve toilets and use conditions, by a) making the people aware of the health risk generated by excreta and badly maintained toilets, and b) making them aware of the existing technical alternatives.
- Improving the regulation criteria of construction of toilets and reinforcing the control by

sanitary police.
- Low cost public toilets where open defecation is widely done should be provided.
- Training the craftsmen involved in the construction of toilets
- Setting up the suitable management conditions for the collection and disposal of night soil without harmful effects on health and environment.

To improve the sanitation conditions, appropriate control measures should be introduced in the construction of latrines, such as control of fly, odors and contamination of groundwater, and with proper ventilation and light. This can be achieved if:

- Air contact between excreta storage and latrine compartment is blocked
- Excreta storage is isolated from external atmosphere
- Ventilation of the latrine compartment and the excreta storage is accelerated
- Over-flow is discharged properly.

Moreover, the improved latrines should be cheap and much simpler, adaptable to the conditions and needs of the area. The improved latrines should also:

- be convenient for use
- be acceptable to users without contradiction to their beliefs and custom.
- have privacy
- have cleaner surroundings
- use local materials and know-how to reduce costs and get the interest of beneficiaries
- be easy to maintain
- be flexible i.e., able to be modified to meet various requirements
- be cheap, and correspond to economic situations of population.

Proper ventilation system will reduce bad odors, and screening the end of the vent pipe will keep away flies. Latrines with flushes can be installed indoors, because of the hydraulic siphon separating the tank from the basin. Pouring with 1-2 litter of water after each use in order to flush the excrements is sufficient. The siphon prevents bad odors and insects from penetrating the latrine through the flush.

3.5 SEWERAGE AND URBAN DRAINAGE

3.5.1 Sewerage

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

(1) Urbanized Area

The amount of wastewater discharged from this area directly goes into the existing drainage/channel with rubbish and plastic bags. The catchment area of some of the drainage consists of two communes such as Deizeibon trunk drainage.

(2) High Residential Area

High Residential Area surrounded by urbanized area are mainly located at the right bank side of Gountou Yena River namely Issa Beri, Plateau I & II, Yantala Haut, Kouara Kano and part of Terminus. Wastewater from these areas goes into the individual Septic Tank (ST) and soak pit. Therefore, there seems to be no wastewater from these areas because of infiltration into the sub-soil through soaks pits.

(3) Low Residential Area

Household wastewater from these areas goes into simple pit or hole, which is dug out along the wall of each individual house. Some of the houses discharged the domestic wastewater directly to the road with pipe. This practice has been causing serious deterioration in the sanitary environment.

3.5.2 Urban Drainage

(1) Overview

Niamey City is located on the both banks of Niger River. The left bank of the Niger River, where governmental administrations and commercial institutions are concentrated, consists of two tributaries with catchment area "Gountou Yena" and "Ouallam", and small drainages directly discharge to the Niger River. The land slopes gently towards the river

On the other hand, right bank, where university and comparatively modern housings are located consists of plateau with approx. 260 m height from the sea level, alluvial fans of small tributaries flowing from the plateau to Niger river and low-lying ground which are flooded at the time of high water level.

Soil on both the banks is covered with laterite and topsoil is easy to be eroded. Due to flat geographical features and topsoil conditions few natural drainage exits, as rainfall is limited to only few days during the rainy season. Gountou Yena and Ouallam are recognised as only the tributaries of the Niger River.

The importance of the drainage and 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.

(2) Characteristics of precipitation and condition of flood damage

Annual precipitation is not so much (approx. 600 mm), however, with intensity of 50 to 100 mm/h once or twice a year during the rainy season which causes flood around the city. Central area of the city, downstream of Gountou Yena and Terminus, is not flooded, as it is located on the slope and developed with well-planned drainage system since early days.

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.

- Heavy rain on the flat ground without drainage causes stagnation of water.
- Flow of small rivers, and developed land & roads cut off the drainages.
- Residential area is developed in flood plain and low-lying ground
- Catchment characteristics has changed and natural reservoirs has disappeared due to residential land development.

The flooding is also causing serious sanitation problem due to untreated sewage.

(3) Existing Facilities

Existing drainage facilities are studied by ENPC/CEREVE-KRB in June 2000. This study shows that the sectional dimension, material and usage condition of the drainage. Total 533 segments of drainage with 107,384 m length are classified as follows. Drainage under 150 mm width occupies more than 70 % of the total length.

Table 3.5-1 CLASSIFICATION OF EXISTING DRAINAGE

Rank	Width (cm)	No. of segment	Length (m)
Rank 1	～ 50	94	13,581
Rank 2	～100	257	44,708
Rank 3	～150	92	19,357
Rank 4	～200	28	6,200
Rank 5	～250	18	7,160
Rank 6	～300	11	2,316
Rank 7	～350	6	2,243
Rank 8	～400	2	910
Rank 9	～450	2	567
Rank 10	～500	1	90
ND	-	22	10,252
Total		533	107,384

Table 3.5-2 CONDITIONS OF EXITING DRAINAGE

Unit: Number of blockages

	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
Sand accumulation	13	43	9	48	6
Dumping of garbage	43	105	95		
Damping of excreta	46	38	6		
Breakage of drainage	16	-	-	-	-
Breakage of manhole	25	-	-	-	-
Abnormal grit	46	-	-	-	-
Abnormal connection	6	-	-		-
Un-accessible	56	-	-	-	-
Good condition	26	-	-	-	-
Others	5	-	-	-	-
Under construction	33	-	-	-	-
Planned	2	-	-	-	-

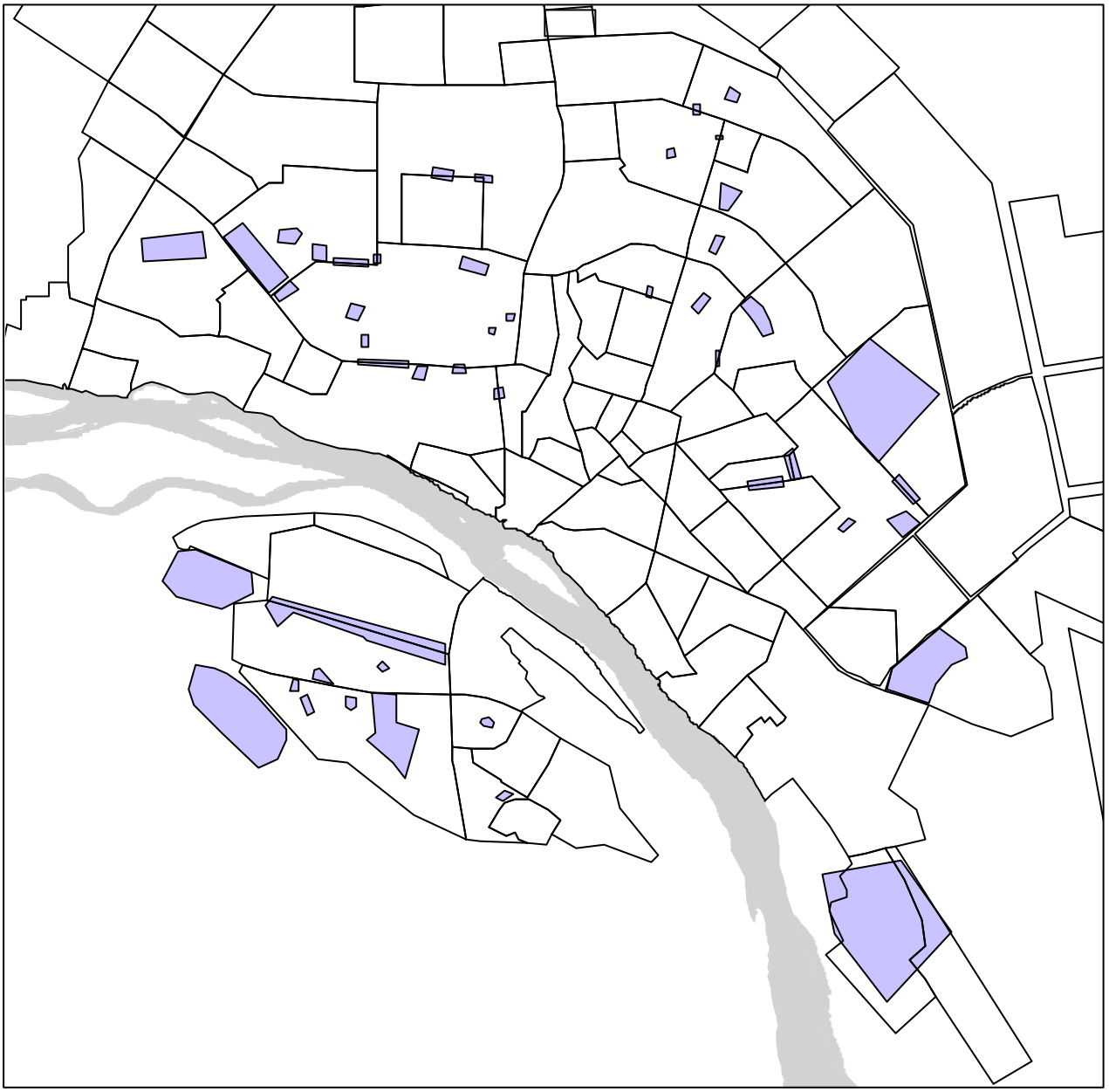
(Note): With the increase in Rank, the severity of blockage of drainage also increases. For example Rank 5 means drainage completely filled with sand and Rank 1 means drainage slightly accumulated with sand.

(4) Flooding conditions and problems to be solved

Flooding conditions and their causes are classified as follows.

- Drainage is cut off due to construction of the roads.
- Development of the residential area has changed the drainage conditions.
- The land, which should be utilized as river are illegally occupied. For example, a flood plain along the river and natural reservoir is used as residential area.
- Development or elevation of land and roads is inappropriate.
- Maintenance of the existing drainage is poor. The habitants and administration do not recognize the importance of the maintenance.

Areas damaged from frequent flooding are shown in Figure 3.5-1



FLOODING DAMAGED

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

Figure 3.5-1

MAP OF FLOODING DAMAGED AREAS

3.5.3 Individual Sanitary Facilities

Existing household toilet facilities in Niamey city are in general classified into the following five types.

Type-A: Pit Latrine (PF) with infiltration bed; *Latrine à Fossé*
Type-B: Double-Vault Compositing Toilet (DVC); *Latrine à Conpost*
Type-C: Pour-Flush Toilet (PF); *Latrine à Siphone Hydrqulique*
Type-D: Septic Tank with a Soakaway; Fossé Septique
Type-E: Vault Toilet and Cartage; *Fossé Etanche et Camion-Vidange*

The abstract images of the five types of sanitary facilities are shown in Figure 3.5-2.

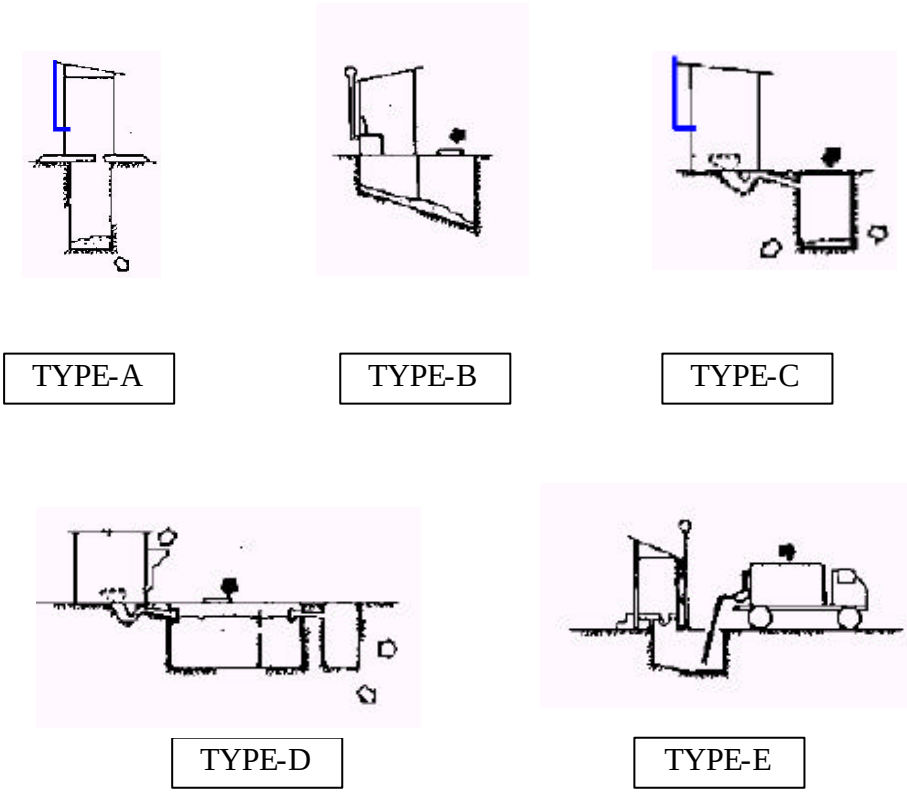


Figure 3.5-2 ABSTRACT IMAGES OF SANITARY FACILITIES

3.6 SOLID WASTE MANAGEMENT

3.6.1 General

The city of Niamey is confronted to an expansion accompanied by urbanization due to a relatively elevated demographic growth. The development of land for urban dwelling is becoming necessary and different types of solid waste generation are proliferating. The uncontrolled diffusion of these wastes is causing in deterioration of the quality of the natural environment and thus constitute a risk for the public health.

The services of waste collection and transport is continuously deteriorating in the city of Niamey and has become distinctly visible.

Several actions and efforts are indispensable. The cooperation of the NGOs, that participates in the cleaning of the main streets of the center of the city, is an encouraging action.

Within the 6 Programs of environment protection defined in the National Plan of Environment for a Durable Development (PNEDD), the waste management generally and particularly municipal waste management is focused in the 6th Program of the National Strategy of Urban Environment of Niger.

Several studies have been done within the Project of Urban Infrastructure Rehabilitation (or PRIU), in which the diagnosis of the environmental situation of Niamey is assessed and a plan of action is proposed containing the immediate measures, recommendations and activities for the 2nd following phase of the project.

These results, for the solid waste management, in briefly are as below:

The complete diagnosis of the urban environment of the city of Niamey, based on the 12 existing reports, a synthesis report was published in July 2001 (this report was unfortunately not available at the time when the our Study progress report was elaborated.)

The exploration of the strategic principles of the urban environment in Niger that led to 5 sectarian Items and for each of these Items as well as pilot operations as studies should be elaborated and conducted. The five sectarian Items are:

Wastewater treatment,
Solid waste management,
Rainwater management,
Management of environmental non-constructed areas,
Environmental management in other cities of Niger

The identification of actions to launch in the phase 2 and their official interlocutors (focal points) are proposed for the sectarian item Solid Waste Management:

Pilot operations on the privatization of the pre-collection of domestic waste and the sorting of the domestic waste at the level of districts as well as the setting up of valorization circuit.

Some technical studies have to also be undertaken and that should lead to Priority Investment Programs (PIP).

3.6.2 Present Situation of the Domestic Waste Management

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

(1) Waste generation

In order to get some reliable data on generation rates of domestic waste, a campaign survey on sampling and measuring of waste generation was conducted (chapter 4.5 of the present report).

According to studies lately elaborate on the urban waste management in Niamey, estimation on waste generated and removed by the municipal has been established. In Table 3.6-1 waste quantities and removal rate has been estimated.

Table 3.6-1 ESTIMATIONS OF DOMESTIC WASTE QUANTITIES

	Commune I	Commune II	Commune III	Total
Generated waste (m^3/an)	120.631	151.280	29.141	301.052
Removed waste quantity (m^3/an) *	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 %

*) Volume estimated on the base of Commune agents. According to our experiences of urban waste management in similar countries, the resulting waste removing rates seem to be high.

The city of Niamey is organized and subdivided in 3 administrative Communes (see Appendix 3.6-1), Commune I, II and III. All Communes form The Urban Community of Niamey (CUN). Each Commune is supposed to be responsible and to manage the urban waste of its administrative entity. It must assure their collection, transport and elimination. The technical services of the Commune must also assure the management of human and materials resources in order to be able to collect transport and eliminate properly waste generated in the city of Niamey.

The urban waste collection is organized in each of Commune in mesh of pre-collection, collection and transport.

(2) Pre-collection
In certain districts (Quartiers) of Commune I (Quartier of Maourey, Gandatchés, Zongos, Deyzeybons, Lazarets, Boukokis and Lazarets) and of Commune II (districts of center city) the pre-collection exists. It consists to pickup domestic waste of concessions (group of families living shearing one house) from door-to-door, to carry it toward containers or designated transfer points (dépotoires).

This mesh of pre-collection is not organized, sometimes in a informal manner. One finds many private operators there (Society GANO, JADE, CDR and FEFAM), associations and NGOs that deal with the collection (pre-collection) of domestic waste. The associations, NGOs or private operators consider waste collection as only one part of their activities.

These activities related to the pre-collection seem to have a legal non-clarified problem. Operators wanting to exercise an activity of pre-collection must be authorized from the municipal authority. It will allow them to collect “taxes” for waste removing directly from the households. In reality it isn’t a tax but rather a charge for a service that is rendered.

The pre-collection is a very important element in the chain of the waste management. The existing potentialities for this link must be encouraged by a better clarification of institutional procedures of this activity type, of the statute of the private enterprises exercising this activity, of tasks to distribute between Communes, the CUN and the private sector and of the financial or material supports.

(3) Collection and transport
The stored temporarily waste, either in containers or in the designated transfer points (dépotoirs),

must be removed regularly. The collection actually consists to remove the stored waste and transport to final discharge (of preference a controlled discharge).

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 (dépotoirs), 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 (wild dépotoirs). 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.

For waste management services the city of Niamey counts, according to the CUN, 292 containers and 312 official transfer points, whereas the number of the wild transfer points is not known. The recent Basic Study on Solid Waste Management in Niamey, within the frame of the Project of Infrastructure Rehabilitation (PRI), apprised the number of wild transfer points to about 500.

The present human and materials resources available for waste collection and in the city of Niamey are summed in the following Table 3.6-2:

Table 3.6-2 HUMAN AND MATERIAL RESOURCES OPERATING FOR THE WASTE COLLECTION AND TRANSPORT

	Commune I	Commune II	Commune III	CUN	Total
Staff	114	270	35	59	478
Containers in operation	173	61	20	-	254
Official transfer points	33	17	72	-	122
Wild transfer points	353	84	0*	-	437
Container trucks	6	5	2	8	21
Tippers	1	-	-	-	1
Loader	1	-	-	-	1

*) This number, provide by the Commune, seem not much reliable. In the Commune III some wild transfer points have been noted, whereas they are not counted officially.

A list of the vehicles and heavy equipment of the municipalities are annexed in 3.6-2 (not all the equipment listed is in operation).

For the transport of urban waste, different type of materials is used. Households respectively concessions use cardboard boxes, plastic bags, buckets and sometimes barrows for the transfer of theirs waste toward containers or transfer point. The NGOs use carts with manual traction. Those that recover waste components generally use big bag of rice. The private operators possess pick up vehicles (of type Peugeot 504), of skips and carts, whereas Communes have trucks and Container trucks.

(4) Disposal of urban waste

The controlled landfill sites are usually implanted on a suitable site after demand and authorization of the competent administration. Generally this authorization can be delivered after an analyze and survey on its environmental impact, particularly on the impact of all pollution dangers can result and after designing the landfill plant that should and the operation mode of the landfill.

The exploitation of controlled dumping sites takes place, when it is made according to standards and norms, in accordance with a fixed operation plan and submitted to the authorization of the competent administration.

At the end of exploitation of the dumping site (usually after a period of more than 15 years of exploitation) the site is restored and integrated in its natural environment.

The city of Niamey doesn't possess such a landfill site currently. Only the municipal landfill site that is on the road of Ouallam has undertaken measures control and risk prevention. As consequent of these results the dumping site was officially closed.

Contrary to the controlled landfill sites, the wild dumpsites are created in contravention of regulations, on which some citizens or even agents of the municipality discharge their waste without any precaution. The picture of these landfill sites is given by these amassing of waste that rise to a mountain of waste and malodorous, developing a disaster for the environment, generating risks of fire, of proliferation of agents pathogens with all consequences.

The landfill sites of Koubia, Old career of the Cité Caisse, Road of Filingué, Banga Bana, Karadjé, Gaweye, Kirkissoye, Lamordés are also wild dumping sites. This method of urban waste landfilling for the city of Niamey is still tolerated and admitted by the Administration of CUN. These sites are generally old careers and waste serve as embankments for filling the cavities.

The state of these wild landfill sites is alarming. Waste is discharged in an anarchical manner, often burnt. The waste collection trucks, when they reach the site, throw the waste anywhere, on the way, no places are marketed out for the discharging.

Collected waste is often not transported to the landfill sites (even if they are wild dumping sites) but sold
either to farmers who are using domestic as fertilize
or to habitants in the city of Niamey who are using the waste load as material of embankments for filling in eroded zones in their vicinity (district of Bandabari).

(5) Market waste

Several public markets exist in Niamey. These are:

- Grand Marché (Big Market),
- Petit Marché (Small market),
- Ecogare Market,
- Commune III Market,
- Yantala Market and
- Katako Market.

Only the Big Market is managed by the SOCOGEM society. The remainder is under the responsibility of the Communes as well as their waste management.

The Big Market is not a market with typical vegetal goods. The biggest part of its activities is trades another one that vegetables and fruits. West generation and composition of this market

won't be taken therefore typically as organic component (more of 60% are plastics). The treatment of this waste is not to be confused with composting. The waste generation estimated for the big market is appraised daily to about 11m^3 (2 containers to 5.5 m^3).
The waste generation in the small market, estimated in previous and recent studies, rise also to about 11 m^3 per day.

(6) Hospital waste

The main medical establishments of Niamey are:

- The National Hospital
- Lamordé Hospital (University hospital)
- Maternity Hospital Issaka Guazobi

It also exists several small medical center (dispensaires) and small clinics.
Waste generation in those medical centers estimated in the previous and recent studies, rise to about:
10.5 m^3 for the National hospital and 0.7 m^3 for Lamordé hospital are generated per day respectively.

(7) Industrial waste

Waste coming from the small industries and commercial areas as the slaughterhouse, the tannery, the restaurants, stations of gas and garages, the hotel services etc. are analyzed in recently published reports. The waste generating from the small industry and commercial area belongs to the urban solid waste and the municipal services must remove it. It is clear that the service of waste collection and transport for the small industry and commercial areas should be totally charged to the generators.

The estimated industrial waste quantities coming from the most important small industries in Niamey is summarized in the following Table 3.6-3:

Table 3.6-3 INDUSTRIAL WASTE QUANTITIES

Industry	Quantity of waste	Remarks
Tannery	2 m^3/day	-
Brewery (Braniger)	1.5 m^3/day	3 containers in 2 weeks
Enterprise of chemical products (SPCN)	100 kg/day	6.6 tons/year are incinerated and 13 tons/year of sludge
Textiles (Enitex)	100 kg/day	-
Slaughterhouse	-	Waste is incinerated

3.6.3 Identification of Weakness and Problems of Waste Management

Weaknesses and problems in the chain of waste management in Niamey exist at all levels.

The number of containers serving to pre-collection of domestic waste is not sufficient, it explains the growth of the number of wild transfer points within districts. The location of the containers is

not always based on real cases but rather on theoretical estimations made by the municipal services of municipal service evaluations.
The wild transfer points replace sometimes any container that has been out of operation and not been replaced.

Several peripheral districts are served by waste collection at all, nor by containers, nor by the official transfer points.

The equipment has on average, 5 to 10 years for containers and 13 years for skips and container trucks. This equipment requires of numerous and frequents repair and maintenance, a budget must be affected to these purposes.

Some equipment, supposed to be available for waste collection and transport, are out of use, in repair or reformed.

The restricted resources, especially of the material, are badly organized. A control system for services of collection or transport doesn't exist.

The contribution of the different intervening parties of the NGOs or private operators in the collection and transport of solid waste is not encouraged, on the contrary, they are either blocked or disrupt by difficulties of inefficient bureaucracy.

Waste management within the Communes is not organized nor controlled. The wild dump sites number is not counted. The sector of recycling and waste resource recovery always remains casual and let to him even.

Very few worries and actions are undertaken against the toxic wastes that are very often mixed to domestic where certain house pets look for and find their food.

3.7 SOCIAL AND ENVIRONMENTAL CONDITIONS

3.7.1 Sources of Pollution and Insalubrity

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.

(1) Domestic Solid Waste

According to existing surveys, only one third of the households are living in an area with a waste collection service in operation. Especially in the most impoverished quarters of Niamey, more than half the population have neither containers nor authorised waste deposit sites for the collection of domestic waste. This situation has led to the constitution of a big number of wastes deposit "black spots" throughout the city. A large amount of collected waste is never evacuated outside the city, but rather simply discharged in streets of the peripheral inhabited quarters.

(2) Domestic Waste Water

As shown by the PRIU survey, washing waste water are mostly evacuated in streets and gutters, and secondarily in pits lying street side in front of the living compounds, while shower waste water are mostly evacuated in these outside pits (57%). Domestic wastewater stored in pits directly flow out of the pit in rainy season. On a whole, about 73% of households are discharging wastewater directly in the street.

(3) Night Soil and Excreta

The lack of public and domestic toilets in several quarters of the city contributes to the presence of human excreta in streets and public places. People's behaviour is also a major cause for such unhealthy conditions, especially on the side of sensitive population like families located free of charge and children who go outside for defecation. Babies' excreta are considered as standard waste and are disposed of as such in streets, street gutters or waste deposits. In compounds, overflowing of night soil in the yard and street is common when latrines have become full. Night soil is mostly collected by municipal or private services, to be generally discharged roadside around the city without any environmental consideration.

(4) Street Gutters

Street gutters are used by more than 11% of households as pits to throw away their domestic refuse and used water (PRIU survey). Gutters cannot fulfil their function of drainage of rainwater because of the accumulation of waste. The PRIU study has shown that these badly maintained gutters retain stagnant water for long periods leading to the development of malaria vectors.

(5) Stagnant Pools of Water

During the rainy season, pools of water are formed by the drastic changes in the morphology of streets, as a result of the strong micro-actions of natural runoff and individual human measures against erosion and flooding. Wastewater and leach ate generated by waste deposits are also drained to these stagnant pools of water, which are both a nuisance for the living environment and a source of insalubrity (bacterial pollution and malaria vectors).

(6) Other Major Sources of Insalubrity

- Sludge accumulated in street gutters is excavated for cleansing and collected by the communes to be disposed of as domestic waste materials.

- Liquid and solid wastes from industries are almost discharged without treatment, while in the best case sludge or solid toxic wastes seem to be stored in-situ waiting for a future treatment alternative.
- Liquid and solid waste from hospitals and clinics are almost discharged without treatment. Solid waste are almost collected without separation between domestic or medical origin and their final disposal is often done together with other municipal waste, somewhere in the city, in cultivated fields, and at best in quarries sporadically used for waste disposal.
- Liquid and solid wastes from institutions are discharged in the same conditions as for domestic waste. There are however prominent black spots like markets, informal sector activities, car repair workshops and car spare parts workshop, among others. Most of the establishments classified as insalubrious and harmful in Niamey are small units mostly belonging to the informal sector and generating waste materials.
- Excreta from herd cattle are an additional source of unsanitary conditions. The herd cattle of CUN is made of cows, sheep, and goats, with more than 21,000, 58,000, and 35,000 heads respectively, which is more than 100,000 heads in total (source: Regional Plan of Social and Economic Development of CUN 2000-2004).

3.7.2 Environmental Practices of Households, Industries and Institutions

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, which are in Appendix C3, contained 51 questions addressed to households and 64 questions addressed to industries and institutions. The FABA association has conducted the field visits and collection of data of both surveys during mission of JICA study team in 2000. Methods and conditions of the JICA surveys, as well as the synthesis of quantitative results are provided in Appendices N and O. 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. This is explained in section 4.3. Then, the Appendix M provides a summary and analysis of the results of the PRIU survey in order to complete the understanding of households' practices and perceptions in the field of sanitation.

The purpose of this section is to give an outline of the results of the surveys focusing on the environmental practices of households and the awareness and intention trends of industries and institutions. All the additional results given by the households survey are discussed elsewhere in the report, particularly in sections 3.7.3, 3.7.4 and 3.9.3. A short summary of the most relevant aspects is however provided in this section.

(1) Households

The sampling area has included 6 urban quarters, 2 per commune, which are *Kouara Kano, Lamordé, Yantala, Lacouroussou, Bandabari,* and *Gaweye*. These quarters are representative of the following 4 types of quarters, as classified by the JICA team: Modern, Traditional, Peripheral type 2, and Urban Village. Sanitation and living conditions in the urban village type areas are contrasted. Sampling in such area is representative of poor conditions in *Yantala (Yantala Haut*), in contrast with mixed conditions in *Lamordé. Lacouroussou, Bandabari,* and *Gaweye* are traditionnal housing areas and have no or bad sanitation facilities and unsanitary living environment. *Kouara Kano* has a good coverage of facilities and good living conditions.

Within the sampling area on a whole, only 15.7% of households have a service for the collection of waste, the most generally through public containers (more than 14% of households), and more

than 98% have toilets in the compound. As regards to the perception of solid waste, more than 75% of people consider that they can be used again after their evacuation, primarily for enrichment of cultivated fields (more than 50% of households) and secondarily for filling in the street ravines during the rainy season (about 22%). The view that waste can still be used represents a lower rate in Koura Kano (27%), as expected, but still 25% of surveyed households in this quarter consider that waste is useful as material for street embankment. However, almost 94% of households said that they have never bought waste for such purpose of filling in street ravines, which is surprising. This result may be partly justified by the fact that this environmentally damageable practice of waste disposal might be taken solely at the initiative of municipal drivers, and partly by the fact that people are well aware of the inappropriate nature of such practice and do not want to recognise it.

One of the most surprising results of the survey is the low priority given to the problem of waste water by the people, when they rate the most important problems to solve in order to improve their conditions of life. On average, only 3% consider wastewater as raising important problems, against 17% for solid waste. In quarters like *Bandabari* and *Kouara Kano*, this rate is 0%. The low priority given to waste water within the perception of citizens might be partly explained by the fact that nuisances induced by wastewater discharge in streets are mostly experimented during the short rainy season. Whatever the case, this perception raises the problem of serious gap between authorities and people as regards to the understanding of wastewater issue. Filling the gap will be a necessity in order to ensure sustainability of the wastewater related sanitation projects.

In the field of practices and perception, some selected results of the households survey are summarised below in Table 3.7-1. The main results of the households survey are however discussed in sections 3.7.3, 3.7.4 and 3.9.3.

(2) Industries

The JICA survey has covered 12 major industrial units, mostly settled in the industrial zone (9 units) and partly (3 units) outside this zone but located on the Niger river banks.

1) Solid Waste

The main types of solid waste materials generated by these industries are plastics and PVC (one third of the units), papers and cardboard, and sludge (one fourth each), and various other waste. About 75% of industrial units generate 2 or 3 types of solid waste, and only one unit, Enitex, generates 9 types of waste materials among the 14 proposed in the questionnaire. One third of the industries interviewed generate dangerous or toxic substances in their waste.

Table 3.7-1 SUMMARY OF FEW SELECTED RESULTS OF THE QUESTIONNAIRE SURVEY FOR HOUSEHOLDS

	Average conditions (6 quarters sampling area)	Observations (Geographical disparity)
Satisfaction for sanitation services (27)	31% feel satisfied, against 51% not satisfied by urban sanitation, which mainly concerns waste collection in both cases. Wastewater collection is a point of dissatisfaction for 30%.	There are very different rankings according to quarters: Highest level of dissatisfaction for waste collection in *Bandabari* (81%), highest level of satisfaction in *Yantala* (84%) Highest level of dissatisfaction for waste water collection in *Kouara Kano* (92%); but not perceived as priority problem in this quarter!
Priority needs (20,26)	98% consider that good collection of waste and proper disposal is a priority for improving sanitation. However in ranking the most priority problems to solve for better life, 56% mention unemployment, and 17% waste collection. Collection of waste water: 3%; Drainage of rain water: 10%	In *Kouara Kano*, unemployment keeps the third position after drainage of rainwater and collection of waste. In *Lacouroussou* unemployment keeps the highest position with 86%, while all 3 sanitation aspects keep very low levels (2% respectively). Collection of waste water is never perceived as a high priority compared with others (0% in *Bandabari* and *Kouara Kano*).
Role of women and children in waste bin handling / disposal and sanitation maintenance (15, 37, 49)	Waste disposal is the duty of children (70%) and women (9%), when not done by servants (high status households) . In 100% of cases, the housewife has the role of maintaining / improving good health of the family (mainly through hygiene education). Participants in cleaning campaigns are basically by the housewife (99%)	The role of children and women increases in poorest quarters (up to 80% for children, and 18% for women)
Participation, cooperation with authorities (29,33, 35, 36, 37, 43, 46)	49% have participated in cleaning campaigns in the past, and 46% who never did are ready to participate. 99% think that campaigns are useful and should be strengthened. 80% are ready to pay for improving sanitation conditions. 78% consider that they never did receive advice from city officials about hygiene and salubrity. Only 6% have complained to the municipality (mainly for flooding, secondly solid waste problems), and 70% consider complaining as useless.	Complaining is a more common practice in *Kouara Kano* (12%) and *Gaweye* (18%). The absence of advice from city officials about hygiene and salubrity is particularly stressed for *Bandabari* (98%), while Lacouroussou is in better position (52% did not receive advice).
Perception of waste (18, 19, 47)	75% think that waste is a useful material having potential for reuse. 53% think about enrichment of field crops and 22% for filling in street ravines in rainy season.	In a quarter like *Kouara Kano*, only 27% consider such usefulness of waste, but 25% mention possibility of use for filling in street ravines in rainy season.
Health effects and nuisances (47, 48)	100% are aware of the heath effects of waste water discharged in streets. 100% are aware of the heath effects of waste deposits in streets.	The comparison with PRIU results and a detailed discussion is given in 3.9.3. The conclusion is that: a) People are aware of disease effects of garbage and waste water; b) People are strongly aware of the relationship between rain water, waste water, and malaria; c) Women are strongly aware of the relationship: excreta / disease

% means % of surveyed households

Half the units have declared to make pre-treatment method like separation of special waste (25%) or recycling / reuse (about 17%). More than 65% of them evacuate waste through the municipal system, being equally containers and direct transportation to disposal place authorised by the municipality. However only 17% of them benefit from a collection system, mainly municipal, which seems consistent with the fact that 25% of industries declared to use containers lying in public place. Other methods of disposal or final treatment are disposal somewhere without authorisation, disposal in storm drains, and incineration (burning).

The main measures taken to avoid possible sanitary effects of waste disposal are cleansing around the container, arrangement with municipality for proper evacuation, and to a lower extent selection of appropriate disposal site outside the city. The questions made about recycling or reuse conditions in the factory show that in most cases it is not practised. It must be noted however that industrials did probably not consider reuse of by-products in the production process when responding to the questions, although it was explicitly mentioned in the questionnaire.

2) Liquid Waste and Sludge

One third of the respondents make pre-treatment of the wastewater before discharge, but more than 40% did not answer to this question. Pre-treatment is mainly physical. The main method of waste water discharge is directly into the Niger river (more than 30% of respondents; more than 40% did not answer this question). Only 25% of the industrial units recognised that sludge waste is generated (50% did not answer the question).

3) Perceptions and Intentions

About 42% of industrial units have declared to know their obligations for proper disposal of waste, and more than 30% have been informed in some way by the authorities about the available methods for appropriate disposal. 25% do follow the recommendations made.

Half the units know that wastes are a potential source of nuisance. Types of nuisances considered by industrials are mainly unpleasant smell, and water pollution of the Niger river. About half the units said to pay some fee for solid and liquid waste but only 25% considered it justified and about 17% find it excessive. The degree of satisfaction for the disposal of liquid or solid waste is good for 17% of respondents, while 42% want to improve their waste management practice, mainly through decreasing waste quantity and through decreasing toxicity or hazardous nature of waste. 67% of respondents feel responsible for the proper disposal of their solid waste, but this rate reaches 83% for liquid waste.

(3) Institutions

In the survey of institutions, the following groups should be distinguished: Hospitals, markets, services and institutions. In services are included various and common services which are 4 hotels and 8 restaurants, 1 cinema, 2 craftwork shops, 3 gasoline stands, 8 garages and 2 supermarkets. Institutions are limited to a military unit, an university, and a post office. The case of markets (7 cases) has been considered separately. The group of hospitals and clinics include 7 units and 1 pharmacy.

1) Hospitals

Hospitals mainly generate mixed garbage, food waste, papers and cardboard, plastics and PVC. More than 60% of these hospitals generate each at least 4 types of waste. 75% of the surveyed hospitals generate toxic or infectious waste. The pre-treatment method is mainly separation at source of toxic / infectious waste (38%), but only 50% of the units do practice pre-treatment. For about 90% of the respondents, waste is disposed of in containers, before collection generally

made daily (half respondents) by municipality or secondarily by private collectors. Half the hospitals do take measures of protection against insalubrity effects, which are cleansing around containers and arrangement with municipality for the proper transportation of containers. 25% of the respondents have said that there was some form of wastewater treatment in their unit, but nobody answered to the question about present operation of such treatment process. About 13% of the surveyed units directly discharge their used water into the Niger river.

As regards to the degree of satisfaction for the waste collection service as perceived by the hospitals, only 25% find it good, while 63% are not satisfied. The lack of regular collection is mentioned as the main point of dissatisfaction. 38% of units do not know their obligations for proper disposal of waste, while 63% did not answer the question. This situation certainly reflects the lack of management policy in the field of waste and more specifically medical waste. 38% of respondents have received information guidelines about sanitary management, from the sanitary authorities. The fact that wastes are a source of nuisance (insalubrity) is mentioned by 88% of the respondents. 63% of respondents said to pay a fee for solid waste disposal, against 25% for liquid waste. 25% estimated that the objective of the fee is waste collection, but 50% did not answer this question. 88% want to improve the conditions of evacuation of waste. The main aspects of improvement are decreasing the toxicity and hazardous nature of waste (50% respondents), and improving the waste collection conditions (63% respondents). The introduction of treatment plant and development of disposal site are also considered as important solutions by 63% of respondents all together. All respondents feel responsibility in suitable solid waste management, and most of them (88%) in wastewater management.

2) Markets

Markets generate several types of solid waste, which are mainly collected by the municipal services (57% of respondents), followed by private collectors (14%) and direct transportation to an unauthorised disposal site (14%). Such dumping sites are generally located outside the city in an opened public land, according to the respondents' opinion. The main sanitation measure taken on markets is to ensure collection of containers, which is effectively regularly made on a daily rate basis.

Accordingly, 86% of markets respondents have expressed satisfaction for the waste collection service, and 57% have ranked satisfaction level as good. 71% of respondents have never been informed about directives for proper disposal of waste, but 57% declared to know their obligations for proper disposal of liquid and solid waste. For 14% respondents having received some form of information and directives, the awareness heightening initiatives were coming from the sanitary authorities and cleansing associations. About 30% of respondents consider that they actually apply the directives received.

All respondents are aware of the nuisances generated by waste, which are mainly considered to be unpleasant smell. 86% said to pay a fee for disposal of solid waste, and 71% for liquid waste, with 57% of all respondents considering this fee justified and 29% excessive. 71% have expressed satisfaction for their own present practices for waste handling and evacuation, but all respondents have declared their will to improve conditions, through better performance of waste collection (100% of all respondents) and decreasing waste quantity (43%). A total of 86% feel responsible for proper disposal of their waste, against 100% for liquid waste.

3) Services

The most frequently mentioned types of waste generated by services are paper, cardboard, plastics, food waste and oil waste. Only 11% of respondents are aware that they discharge toxic

or dangerous waste, while one third of the sampling is in fact constituted of garages or gasoline stations. There is no any pre-treatment system to reduce waste and while 60% of waste generators or more have their waste collected, 20% of these generators assume direct transportation to some disposal site and about 7% make waste deposit on-site in street, including the practice of filling in street ravines with waste. About 18% of the waste generating services has declared to reuse or recycle materials, while in most cases this is done through selling materials to recycling companies.

In response to the questions about the perception of the waste collection services, 57% of the respondents have declared to be satisfied, against 32% not satisfied, and 46% have defined satisfaction level as good. 36% have declared that they know their obligations for proper waste disposal conditions, but only 7% have received directives or information from municipal officers. 50% of the services have said to know that waste is a source of nuisance (mainly unhealthy conditions). Half the respondents who are aware of nuisances did not define the type of nuisance they are thinking about. 46% of respondents said to pay a fee for solid waste and for liquid waste equally, 25% finding it justified and 7% excessive. The degree of satisfaction for their own handling and management practices reaches 75%, while the will to improve management practices concerns 64% of respondents, mainly through decreasing waste quantity and improving collection. 93% feel that they are responsible for the good disposal of solid waste, against 79% for liquid waste.

4) Institutions

Institutions generate urban waste, mainly paper and cardboard, which are collected by municipal services. However, only one institution (post office) benefits from regular collection of waste at a daily rate. The same institution also practices reuse or recycling of waste materials and by-products.

5) Conclusion

The questionnaire survey on industries and institutions has been prepared with the purpose of covering various target groups at the same time. As a consequence, the questions were more or less pertinent according to the case. However it seems that the respondents have often provided responses without consideration of the pertinence of the question for them. For example, about 10% of the services have answered that they will improve waste management conditions through disposal site or treatment plant, which is not consistent. It however shows that in general respondents have a will to improve the situation although they have no idea on how to do it.

The general conclusion is that most of respondents feel themselves responsible for the good handling and evacuation of their waste and are ready to improve present conditions. It shows that there is basically an intention to do better. However, not only they do not know how to realise their intention, but also they do not know what are their obligations, if any. The lack of awareness heightening or information from the authorities is obviously strengthening these trends. At the same time, respondents are generally well aware of the nuisance potential of bad practices for evacuation of waste, especially for health. Respondents do not clearly know if they pay a fee for solid / liquid waste management, and for which purpose. The fact that the degree of self-satisfaction for their own method of handling waste is generally high among the respondents, which is however more or less in contradiction with other responses to the questionnaire, certainly reflects that they consider themselves as fulfilling their duties.

Table 3.7-2 below is a summary of the main results of the survey on industries and institutions as regards to practices and perception.

Table 3.7-2 SUMMARY OF FEW SELECTED RESULTS OF THE QUESTIONNAIRE SURVEY FOR INDUSTRIES AND INSTITUTIONS (PERCEPTION ASPECT)

Items (with indication of question numbers)	**Industries**	**Hospitals**	**Markets**	**Services**
Number of surveyed units (respondents)	(12)	(8)	(7)	(28)
Satisfied with the waste collection service (41)	17	25	86	57
Have ranked their degree of satisfaction as: Good (42)	17	13	57	46
Self satisfaction for their own practice of solid / liquid waste evacuation / disposal (54)	50	38	71	75
Will to improve conditions of handling / evacuation of solid / liquid waste (55)	42	88	100	64
Aware of their obligations for a good practice of evacuation / handling of solid or liquid waste (44)	42	38	57	36
Have received guidelines from authorities about proper waste handling / disposal (45)	33	38	14	7
Do perceive the generation of waste as a source of nuisance (48)	50	88	100	50
Main category of nuisance which is given by respondents (49)	Unpleasant smells, water pollution	Insalubrity	Unpleasant smell	Insalubrity, unhealthy conditions
Among those perceiving nuisances, ratio of those who have designated the category of nuisance (49)	(50)	(87)	(100)	(50)
Feel responsibility for the good disposal of waste (57)	67	100	86	93
Feel responsibility for the good disposal of waste water (58)	83	88	100	79

Numbers are % of surveyed respondents in each of the 4 categories of industries / institutions, at the exception of those given in parenthesis.

3.7.3 Natural and Social Conditions of Sensitivity

(1) Morphological Constraints and Soils

Niamey lies at the contact between the upper urbanised plateau at 220m of altitude and the lower Niger River valley at 185m of altitude (upper terrace), along the steep *Corniche* hillside which is about 20m to 30m height. Several ravines called koris, which drain runoff water during the rainy season from the plateau to the river, cut the hillside. These *koris* are strongly affected by gully erosion and several sabo works have been established to attenuate this action. The largest *kori* is the *Gounti Yéna* valley, which morphologically divides the city of Niamey into western and eastern parts.

The *Plateau* area is constituted of limestone strata recovered with superficial tropical ferrugineous soils. Their texture may be sandy or superficially encrusted. Water retention is then variable according to local conditions. This encrusted soil constitutes a large morphological glacis resulting from climatic actions within a context of overgrazing.

The Niger River valley constitutes the major natural area of Niamey. The river bed is directly in contact with the geological substratum as it can be observed from the Kennedy bridge. River terraces provide fertile soils, which are used for agriculture.

(2) Climatic Constraints and Water Drainage

The Niamey area belongs to the Sahelo-soudanian climate, which is characterised by 400 to 600mm yearly precipitation during a short rainy season, with multi-annual and spatial variations. The annual average precipitation period is about 50 days, with possible heavy rains over 100mm within few hours. The average yearly precipitation is 560mm, with a yearly maximum of 939mm in 1909 and a minimum of 298 in 1915 (reported in the PRIU report based on records of Niamey city from 1905 to 1999). There are 3 seasons: Cold season from November to January, dry season from February to May, and rainy season from June to September. The *Harmattan* wind blows from October to April.

The yearly average flow of the Niger River (1929-1999) has been estimated at 862m3/s (PRIU report). The high water flow is observed from October to February, with a maximum during December / January which is between 1500 and 2000m3/s. The low water flow is in June, with less than 80m3/s on average during the last 4 decades.

The Niger River tributaries in the Niamey area are almost constituted by *koris*, which are small hydrographic units, sometimes-deep ravines, which are draining the excess water runoff during strong rains. These water bodies have strong erosive and sanding effects. There are several sanding *koris* on the right bank of the Niger River in Niamey, affecting Commune III. The only few *koris* lying on the left bank, of small size accepted the *Gounti Yena* valley, have prominently an erosive action.

(3) Natural Habitats and Fauna

1) Habitats

The Niger valley, which extends on 14km long and 2km large (flooding plain) in Niamey, provides semi-natural aquatic habitats for wildlife, specially birds and fishes, and important mammals. Besides the Niger River, there are several ponds permanently or seasonally flooded. The 2 biggest natural ponds are those of *Kongou Gorou* (17km length) and *Banga Mana* (30ha), with permanent water. The smaller ponds are those of *Saguia (3), Karadjé (2), Kirkissoye, Goudel, Tondibia, Gorou-Béri, Bossey-Bangou, Saga-Gorou.* Some of them are old quarries like at *Kirkissoye* (which is site with archaeological remains). Others are used for cultivated fields or pasture. Although these ponds have often been the objects of studies for agricultural development projects, there is neither ecological study of them nor any location map. They are just considered as a major source of proliferation of mosquitoes in Niamey.

2) Mammals

The river is a potential habitat for important mammals species like *Lamentin* and *Hippopotamus*, which are on the Red list of IUCN. There is however no recent investigation nor observation showing the possible presence of *Lamentin* in the Niamey area. The nocturne presence of several *Hippopotamus* during the rainy season is mentioned by the inhabitants of *Neini* Island, in Niamey, where they are in conflict with fishermen and cultivators (causing the death of 2 persons

in 1999). This shows that the territory of *Hippopotamus* living upstream has extended to Niamey because of the critical degradation of their natural habitat.

3) Fishes

There is no recent study of fishes in the Niger river. The main study available is the study of a survey made in 1987 about the diversity of fish species, within the scope of the fishing development project of FAO. This study was based on the observation of catches in several areas, of which an ecological area defined as 270 km long, from Sirba to Mekrou confluence, and to which Niamey belongs. According to this study, there are 68 species of fishes distributed among 22 families in this area. Most important families of fishes found are *Cichlidae, Bagridae, Mochocidae*, *Cyprinidae, Characidae,* and *Mormyridae*. The distribution of species in terms of number and weight quantity catched in 1987 in the Niger river area is described in Table 3.7-3 below, showing that only 21 species are generally present in the fishermen catches.

Table 3.7-3 MAIN FISH SPECIES OF NIGER RIVER INVENTORIED IN THE ECOLOGICAL AREA OF NIAMEY

Families	Ration (%) in total number of fishes	Species	% in weight of fishes
Mormyridae	12.2	Hyperopisus bebe occidentalis	1.4
		Mormyrus rume	3.5
		Mormyrops spp	3
Characidae	11.7	Hydrocynus spp	4.3
Citharinidae	4.1	Distichodus spp	1.7
Cyprinidae	13.3	Labeo senegalensis	8.7
		Labeo coubie	4.8
Clariidae	2.1	Clarias spp	1.9
Schilbeidae	5.4	Schilbe niloticus	0.4
Bagridae	15.8	Bagrus Bajad	2.6
		Bagrus docmak	4.2
		Chrysichthys spp	4.9
		Auchenoglanis spp	2.2
Mochocidae	18.8	Hemisynodontis membranaceus + Brachysynodontis batensoda	1.7
		Synodontis schall + Synodontis gambiensis	1.1
		Synodontis gobroni	3.6
Cichlidae	13.5	Sarotherodon galilaleus	1.6
		Oreochromis niloticus	5.8
Centropomidae	2.6	Lates niloticus	19.9
Remaining species	0.5	Remaining species	22.7

4) Birds

The Niger valley provides good habitats for waterfowl. The diversity of birds in this area has not been studied, but a yearly check of observed species is made by the Ministry of Environment and Prevention of Desertification and registered for Wetlands International. These information sources have been summarised in Table 3.7-4 with status of the waterfowl in terms of migratory patterns. The area considered is the Niger valley in and around Niamey. As a result, it is assumed

that there are at least 30 waterfowl species of birds along the river in Niamey, of which 8 are exclusively sedentary, and the others being Palearctic migratory species, at the exception of one species which is African migratory species. The list given in Table 3.7-4 is well representative of the species living in the Niamey area.

5) Vegetation

Riverside vegetation is in principle constituted of species like *Acacia nilotica*, *Acacia sieberiarana*, *Ficus sycomorus*, *Mitragyna inermis*, *Pterocarpus santalinoïdes*, and palm trees like the *Doum Palm tree* (*Hyphaene thebaica*) and *Roniers Palm tree* (*Borassus flabellifer*). Presently the most common species in river valley are the *Doum Palm tree*. Other main tree species in the humid depressions and valley are *Tamarindus indica, , Parkia biglobosa, and Detarium senegalensis.* The herbaceus stratum in hydromorphic zone of river is mainly constituted of the *Bourgou* grassland (*Echinocloa stagnima*). For the herbaceus stratum in the river terrace zone, the following species have been mentioned: *Aristida Mutabilis, Cenchrus biflorus, Andropogon gayanus, and Eragrotis tremula*. However, all this vegetation has been generally replaced by cultivated species while *Water Jacynth* tends to substitute for *Bourgou* grassland in the riverbed.

On the Plateau, the natural vegetation is mainly inherited from the woody stratum of the dry forest, with species selected by people among those like *Ziziphus jujuba, Bauhinia rufescens, Combretum micranthum, C. nigricans, C. glutinosum, Balanites aegyptiaca, Acacia albida, Guiera senegalensis, Anona senegalensis.* The forestry cover has been however replaced by cultivated fields and the actual peri-urban landscape around Niamey looks like a semi-arid steppe.

(4) Groundwater Resources

The hydrogeological study of the PRIU project provides information on the groundwater of Niamey. This groundwater can be divided into 3 units:

- The aquifer of the Niger river alluvial plain, along the river and corresponding to Commune III;
- The aquifer of the sedimentary stratum of the Plateau, which is supplying water of individual wells in Commune I and II;
- The deeper aquifer of the substratum, which is used through 130 tube wells bored in Niamey in 1984-85.

The plateau aquifer has limited extension because of geological conditions, and is flowing into the Niger river. The river itself has cut through the sedimentary formations to reach the substratum in the riverbed. This aquifer is directly supplied by rainwater infiltration. The study of groundwater quality has shown that this superficial aquifer has a function of supplying the deeper aquifer of the substratum. Its contamination exposes people who use individual wells to health risks, especially those who have no other alternative supply.

Table 3.7-4 MAIN BIRD SPECIES OBSERVED IN 1997 AND 1999 IN THE NIGER VALLEY IN THE NIAMEY AREA

Species (Scientific name)	Species (Common name)	Migration Status	Saga 9km on left bank 1997 and 1999	Goudel 2km on left bank 1997 and 1999	Goudel, Saga, Liboré, Kollo, Sébéri 40km river bank 1999
Phalacrocoracidae	**Cormorants**				
Phalacrocorax africanus	African Cormorant	C	x	x	xx
Ardeidae	**Herons**				
Ardeola Ralloides	Squacco Heron	A / C	x	x	x
Bubulcus ibis	Cattle Egret	A / C	xx	x	xx
Egretta alba	Great White Heron	A	x		x
Egretta garzetta	Little Egret	A	x	x	x
Ardea cinerea	Grey Heron	A / C	x	x	xx
Ardea melanocephala	Black Headed Heron	C		x	xx
Ardea purpurea	Purple Heron	A / C	x	x	x
Ciconiidae	**Storks**				
Ciconia abdimii	Abdim's Stork	B		x	
Threskiornithidae	**Ibis, Spoonbills**				
Theskiornis aethiopicus	Sacred Ibis		x	x	x
Plegadis falcinellus	Glossy Ibis	C	x		
Anatidae	**Goose, Ducks**				
Dendrocygna viduata	White-faced Whistling Duck	C		xx	xx
Anas querquedula	Garganey	A	xx	x	xx
Rallidae, Jacanidae	**Jacanas**				
Porphyrio Porphyrio	Purple Swanphen				x
Gallinula chloropus	Common Moorhen	C		x	x
Actophilornis africana	African Jacana	C	xx	x	xx
Charadriidae	**Limicola**				
Vanellus spinosus	Spar Winged Lapwing	C	x	x	
Charadrius dubius	Little Ringed Plover	A	x		
Charadrius hiaticula	Common Ringed Plover	A			xx
Limosa limosa	Black Tailed Godwit	A	x		x
Tringa stagnatilis	Marsh Sandpiper	A	x		
Calidris minuta	Little Stint	A	x	x	
Tringa hypoleucos	Common Sand Piper	A	x		x
Tringa ochropus	Green Sand Piper	A			x
Philomacus pugnax	Ruff	A	xx		xx
Himantopus himantopus	Black-winged Stilt	A	x	x	xx
Glareolidae					
Pluvianus aegyptius	Egyptian Plover		x		
Accipitridae	**Birds of pray**				
Circus aeruginosus	Western Marsh Harrier	A	x	x	x
Milvus Migrans	Black Kite	A / C	x	x	x
Alcedinidae	**Kingfishers**				
Ceryle rudis	Pied Kingfisher	C	x		x

1. Places of observation are Irrigated Paddy Perimeters (Wetlands International, Waterfowl Census of West Africa); based on one day observation per site
2. (A) Palearctic migration, (B) African migration, (C) Sedentary
3. In observation status: xx = high number of individuals observed (above 100 units); x = observed
4. Sources: Based on birds counting data established for Wetlands International.

The alluvial aquifer of the Niger River is an important source of water for urban quarters lying in the plain like *Saga, Gaweye,* and *Lamordé*. This groundwater is supplied by river water and water storage in morphological depressions, and is then sensitive to surface contamination.

The deep aquifer in the substratum is certainly made of water pockets in joints, but has been divided by hydrogeologists into 2 water strata:

- The most superficial, sometimes at 10m under the surface, lying in the altered rocks of the substratum and being directly exposed to upper contamination.
- The deeper one, which is lying in the cracks of the substratum, but is however partly supplied by the upper aquifer. This aquifer strongly depends on water supplies from precipitation and on infiltration conditions.

(5) Rurality of Population and Dependence on Natural Resources

The urban population of Niamey is largely constituted of migrants from rural areas established for few years, as shown in the JICA households' survey. In most of the quarters of concern, a significant part of the settlers have been living in the same place for several years up to 5 years, and even up to 10 years especially in *Bandabari* and *Lamordé*. Commune III is however known to be the one that has the most rural character. More than half the respondents in *Lamordé* have declared to have cattle in their house, however this rate falls to 5% up to 21% in other quarters under survey, excepted in *Bandabari* where more than 30% of households have cattle. From the point of view of socio-professional categories of the households' chiefs, the results of the JICA survey have shown that *Gaweye* and *Lamordé* in Commune III have the highest rate of farming activity (10% and 3.8% respectively), followed by *Lacouroussou* (3.8%). In peripheral quarters of Niamey in general, families often cultivate millet fields for self-consumption.

The dependence on natural resources includes fuel wood, which is the main energy source of households, fodder to feed cattle, basic agricultural products like millet and sorghum, and river fish products. Besides these traditional activities, riverside areas have been developed into market gardening and irrigated paddy fields. Pluvial culture of paddy in the Niger valley was common but has dramatically decreased as a result of decreasing productivity.

The fishermen population of Niamey amounts about 160 households living in 6 camps. This population is particularly sensitive to sanitation conditions of Niamey since they have a high dependence on the Niger River for water consumption and for their income. Most of them are then particularly exposed to the consequences of the sanitation conditions of Niamey, since the Niger river is the final sink for all liquid and solid waste generated by the city. In addition, they are exposed to parasitic diseases of river water. The JICA team has visited 5 main fishermen camps established along the river in Niamey: *Saga, Kombo, Goudel, Gamkalé,* and *Neini*. Other camps are those of *Gaweye* and *Kirkissoye*.

Beside the traditional cultivation for self-consumption, there are also irrigation paddy fields along the Niger river, almost concentrated in the downstream part of the city. Irrigation perimeters are located in *Saga, Kirkissoye, Saguia, Lamordé, Goudel,* and *Kourtéré*. The total superficy is 700ha. Paddy plots have been attributed by state to farmers who have the duty to cultivate them and to participate to the financing of the irrigation system management.

Market gardening covers a surface of 358ha, almost located on the left bank of the Niger river. The joint cultivation of vegetables and fruit trees is made. In Niger valley, gardens are irrigated

with river water or well water. There are however punctual cases of irrigation with wastewater, specially along the *Gounti Yena* valley in the city.

(6) Housing Conditions

Housing is made of one or several households living in community inside the same compound. In the most common type of housing, which is characterised by the use of *banco* earth material for its construction, each household has its own private space and often share the opened space of yard with other residents. The yard is the main place of daily activities including cooking, eating, and also sleeping in hot season. The yard is also the place where are lying all the sanitation facilities like toilets and showers, mostly used in common by the residents. The soil in the yard is the most generally made of sand.

On average and according to the PRIU survey, there are 3 households per compound, equivalent to 16 persons. However in 41% of cases, one household occupies one compound. In 35% of cases, the compound is made of 2 to 4 households, and in 23% of cases, 5 households or more. In one third of the cases, one household is composed of 4 to 6 persons, and more than half the surveyed households (PRIU) had 7 persons or more. In total one third had more than 10 persons. As a result, there were compounds with more than 20 persons (one fourth of compounds), but about one third the compounds had less than 11 persons. In the JICA survey, the average number of persons per household was 6.6, which is more than the generally accepted value of 6.1, based on 1988 population census. The number of persons per household was within a range of 5.4 to 8.4 according to the quarters under survey. The number of households per compound surveyed by the JICA study team is less than 2, within a range of 1.1 to 2.9 per quarter under survey. This result is due to *Lamordé* (new part) and *Kouara Kano*, where one household occupies one compound in most cases. The PRIU survey found however a higher rate of households per compound.

On average, there are 3 persons sleeping in the same room, and the predominant number of bedrooms is 2 per household, based on the PRIU survey. This is also the result of the JICA survey, showing that outside *Lamordé* and *Kouara-Kano*, where about 45% of families live in more than 4 rooms, which is to correlate with high standard living, almost all surveyed households are living in 2 or 3 rooms only.

According to the PSE survey in impoverished quarters, 27% of households' accommodate free of charge family members or other persons. The same survey has provided that 44% of households are built with *banco*, which is the locally available soft building material, 14% have straw huts, and 42% have their houses built in hard or half-hard materials. Households having a floor in cement in their houses represent 74% of total, while 15% use tiles or wall-to-wall carpet. Only 10% of households are living in houses where the floor is made of earth or sand.

(7) Education

The National Report on Human Development (1999) reports that the schooling rate in 1998 amounted 50,7% (national average: 15,4%), with equivalent rates among boys and girls. The rate of alphabetisation was 60% in 1997, with a difference between men (67%) and women (53%), against 17% for the national level. Schooling rate in primary school in Niamey was estimated at 95.4%. According to the PSE survey, 50% of population in Niamey did not receive school education, 12% received education at Koranic schools, and 0,4% alphabetisation.

As shown by the households survey of JICA, the education level of women is generally low since 40% to 60% have not received school education, excepted at *Kouara Kano*, and 30 to 40%

have received education up to secondary school at best. However, *Kouara Kano* is an exception since more than half the housewives have received higher education (high school and university) in this quarter. The ratio of men with little education is high but remains lower than for women. The difference between men and women is particularly accentuated at the level of higher education, with a higher rate for men.

(8) Access to Drinking Water

There are several forms of access to drinking water: Municipal supply (SNE) as individual tap water to households or compounds or public water facilities (fountains), tube wells (120 units but apparently 20 or so remaining in operation in 1999), wells, and raw river water. According to the PSE survey, 67% of households on average are supplied with tap water. More than 50% of households are supplied with tap water of public facilities in half the surveyed quarters, up to 85% in the case of *Kouara Tégui*. The hygienic conditions of use of public water facilities are then decisive for health protection. The use of tap water sold by water vendors is the main mode of supply in quarters like *Boukoki*, *Bangabana*, and *Koubia*, representing from 86% to 66% of the water supply. As shown in the PRIU survey, well water supply is almost negligible in Niamey (less than 1% households supplied by private wells, less than 2% by public wells). There are certainly big geographical discrepancies in well water supply. According to the PSE survey, it represents 10% and 40% of households in *Koubia* and *Pays Bas*, respectively. The JICA team has observed this type of supply in *Bandabari* quarter. However, there would be 8% to 15% of the population supplied by groundwater in total. The use of surface water mainly concerns *Kirkissoye* for 2% of households, and is in principle restricted to washing use, including showering (PSE survey).

(9) Access to Health Care

The households surveyed by the JICA study team have considered (about 12%) the access to health care as one of the 4 main issues to be resolved for improving living conditions, after unemployment and lack of waste collection issues. Results by quarter have however shown that 28% and 29% of households are not satisfied with access to health care in *Bandabari* and *Lamordé*, respectively.

The health policy of Niger has however been oriented toward better access of population to basic health care, with objectives like district sanitary network, prevention, community participation, and access to essential medicines. At the sanitation district level, the system of Integrated Health Centres (CSI) provides basic health care for all the population. The concept of integration means that curative; preventive and promoting actions are given priority, in line with the policy trends of the health sector. For example, the impregnation of mosquito nets, family planning and education are all activities within the task of CSI, in addition to medical care itself. The CSI service is a set of health facilities that meet certain criteria of medical service and population served, with distinction of 2 levels in Niamey (Type I and II).

The health district network is made of 22 CSI of type I and 16 CSI of type II in Niamey. Commune III has the lowest coverage of health care facilities with 7 CSI and 1 District hospital in *Gaweye*, while Communes I and II have 18 CSI and 21 CSI respectively. The sanitary network is completed by 4 hospitals (2 national hospitals, 1 regional hospital and 1 district hospital) and 8 maternity hospitals. For more advanced health care of medical / surgery type, people can use the district hospital of *Gaweye*, in Commune III, and the national hospitals of *Lamordé* and Niamey. The network of private health care system, composed of private clinics and surgeries is more important in Communes I and II than in Commune III:

Commune I: 7 clinics and 7 surgeries, 12 health care rooms;

Commune II: 9 clinics, 3 surgeries and 12 health care rooms;
Commune III: 1 clinic and 4 health care rooms.

According to the evaluation made in 1992 for the Sanitation Development Plan 1994-2000, health care coverage in Niamey (CUN) is considered to be within the WHO standards with 1 medical doctor for 8,541 inhabitants, one pharmacist for 10,382 inhabitants, and 1 midwife for 720 women in age of procreation. The plan of social and economic development of CUN, launched in October 2000, mentions however different types of data: Only 1 medical doctor for 28,735 inhabitants, which is below WHO criteria, and 1 nurse for 3,253 inhabitants.

(10) Health Conditions

Health data in Niger are compiled by the SNIS which regularly receives reporting from the CSI every three-months. These data are presented according to the age ranks of patients. Data of national hospitals are not included. A detailed review of these health data has been made in paragraph 3.9.2 (Table 3.9-12), showing the number of cases reported for main diseases in Niamey: Malaria, respiratory infections and cold, and diarrhoea. Assuming a population of 652,400 persons in Niamey in 2000, the prevalence rates of malaria and diarrhoea have been around 13.6% and 2.7% respectively, in 1999. The occurrence of malaria and diarrhoea diseases is typically related to environmental conditions, which is more discussed in 3.7.4. The results of the analysis of the health data of CSI in quarters lying along the Niger river have shown the high prevalence of schistosomiasis (see 3.7.4).

Infant mortality is generally considered at 70/1000 in the urban community, against 123/1000 at national level. Mortality under 5 years old is 147/1000 in the urban community, against 123/1000 at national level. Within the total number of cases of mortality caused by malaria and by diarrhoea in Niamey, the mortality ratio of children under 5 years old is as high as 36.6% and 75.3%, respectively.

Malnutrition is an additional and aggravating factor of disease. Most common diseases directly induced by malnutrition are blindness (avitaminosis A and iodine deficiency), cornea disease, deafness (avitaminosis B), mental troubles. The rate of malnutrition is especially high among children under 5 years old, which focus 93% of total cases of malnutrition in Niamey. The total prevalence rate of malnutrition in Niamey can be estimated at about 4/1000 according to CSI health data.

(11) Poverty

The poverty thresholds have been set by the Ministry of Finance and Plan at 75,000 FCFA per year for poverty and 50,000 FCFA per year for extreme poverty, for urban areas. According to data of 1992, poverty has been estimated to concern 42% of population, while extreme poverty was estimated to be 18%, in Niamey. The income source is most generally from the informal sector, which has strongly developed together with impoverishment of the population.

According to the PSE survey performed in the impoverished urban quarters of Niamey, the average monthly income of the household chief was set at 63,000FCFA, and more than 10% of them had an additional source of income of 40,000FCFA on average.

The JICA survey has shown that monthly income of households is generally between 30,000 and 50,000 FCFA, with variations according to the quarters: *Lamordé* has an unexpected rank of 50,000 to 100,000 FCFA for 40% of households, due to the choice of a mixed sampling area in this quarter. *Kouara Kano* is as expected in the highest range with almost 80% of households

getting a monthly income over 100,000 FCFA.

There are strong relationships between poverty levels and conditions like number of persons in household (poor households have on average more than 8 persons) and the socio-professional status of the chief of household. In urban areas, households whose chief are unemployed or is working in the agriculture sector are considered to be the most concerned with poverty, up to 54% of them in each of these 2 categories. The highest level of unemployment found among the households surveyed by JICA was in *Bandabari* with 25% of the households' chiefs declaring themselves as unemployed. The lowest rate was unexpectedly found for *Lamordé*. As shown by the JICA households' survey, unemployment is considered as the most important problem to resolve in order to improve living conditions, with on average more than 55% of households raising the problem, up to 96% in *Yantala* and 86% in *Lacouroussou*.

(12) Women, Children and Young

More than 67% of population in Niamey is considered as having less than 25 years old (according to the Regional Development Plan of Niamey). Social insertion of young is generally done through NGO activities like JADE. Children are sensitive to sanitation conditions and malnutrition. They are however frequently involved in environmental quality tasks like discharge of waste bin outside the dwelling and transportation of water from the public tap water facility to the home.

Outside the national associations network, women groups in Niamey urban community are informal and mostly temporarily constituted for specific activities at quarter level. In poor households, women are often in charge of finding a source of income through informal jobs, in addition to their role in preventing disease effects of bad sanitary conditions in the family. In this context, the Niger government has developed a policy for improving women conditions, through the Declaration of Women Promotion Policy. The main objectives are:

- Setting up an appropriate institutional framework
- Improving the participation conditions of women in social and economic activities
- Improving the status of women and girls
- Improving the access of women to production means
- Promoting the health of mothers and children
- Promoting the access of women to credit
- Improving the conditions of education and training
- Improving the conditions of work and employment

Institutional improvement of the national policy for promoting women is based on the National Observatory for the Promotion of Women, set up by decree in 1999 and put under jurisdiction of the Ministry in charge of promotion of women. This agency makes a follow-up and evaluation of plans and programs for the promotion of women.

As shown in the JICA households survey and other surveys, children and women hold a primary role in health, hygiene, and sanitation: Water supply task, hygiene education, evacuation of solid waste, taking care of family health, participating in sanitation campaigns. The poorest is the household; the highest is the role of children and women in sanitation. According to the results of the JICA survey, children (close to 70% of households) and women (9%) have the task to dispose of the domestic refuse outside home, excepted when servant can do it. *Kouara Kano* is the example of high status housing area, where waste bin is disposed of by servants in most cases (62%), followed by children (35%). The role of the household chief in that concern is almost

non-existent. In other quarters with few households able to have a servant, this task is predominantly attributed to children (70% to 80%) and secondarily to women (up to 18% of households). The rate of community participation to improve sanitation is variable according to areas, but in all cases it is basically dedicated to women almost exclusively. The question relating to the role of housewife in family's health has shown that this role is essential, predominantly in terms of hygiene education of children (almost 60% of households) and cleaning of toilets and yard (more than 32%).

(13) Cultural Patrimony

The *Kirkissoye* archaeological site has been discovered during quarrying activities and is regarded as a significant source of knowledge about neolithic period in the Niger valley. This site is located on the right bank of the Niger River, and belongs to the border area of *Kirkissoye*. The site has been partly destroyed by quarrying which is still illegally done, since no protection measures have been taken. The archaeological area is however large enough to expect that there is still potential for future archaeological research.

The archaeological site of *Korei Gorou* has been studied for a period from 1975 to 1997. The site is also located on the right bank of the Niger River, upstream and approximately facing *Goudel*. This site has mainly provided earth poteries and statuettes of eleventh century. There is still large potential of study in this site. However, no protection measure has been taken.

Both archaeological sites are considered to be liable to listing as national patrimony. There is also a significant historical site in Niamey city on the *Corniche*, which is the governor's residence of colonial period. This residence is however becoming a ruin because no maintenance or protection measures have been taken.

(14) Urban Amenities

Potential urban amenities in Niamey are landscape scenery of the Niger valley seen from the *Corniche*, and urban vegetation, which is well disseminated through the city as street tree rows, small public places and private gardens. Several facilities, mostly restaurants and bars are lying on the left riverbank of Niger, taking advantage of the water and greenery landscape. On a whole, the greenery provides potential for improving the urban living environment of Niamey and amenities development. The Green Belt lying on the eastern side of the city is certainly the most valuable amenity for Niamey citizens.

3.7.4 Environmental Conditions

(1) Ecological Degradation of the Niger River

It is considered by the Niger government that the West Niger environmental conditions will be increasingly determined by climatic drought. These trends are shown through the data. The average flow of Niger River has dramatically decreased during the last 5 decades as shown in Table 3.7-5. This table gives the average monthly flow calculated for each of the past 5 decades based on the data of the yearly average monthly flows of the Ministry of Water Resources. The hydrological year starts in July and finishes in June. The data of monthly average of low flow in June shows very critical minima since the 70s. The lowest river flow data records have been in 1974 (0,6m3/s), 1985 (0,0), 1989 (4m3/s), and 1990 (0,2m3/s). Since 1970, the low water period has extended from 2 months (May to June) to 4 months (April to July), while the minima flow of low water has decreased.

Within this context, the Niger government has expressed some fear that the Niger river could

"disappear" in the future. This has led to the revision of the *Kadadji* dam project upstream, which main purpose is to ensure minimum flow of the Niger River against drought trends and in order to maintain water supplies and natural habitats. The High Commission of Kadadji Dam Project, directly under authority of the Prime Minister, manages the dam project.

Table 3.7-5 TRENDS OF THE AVERAGE MONTHLY FLOW OF NIGER RIVER IN NIAMEY

Decades	Average monthly flow (m3/s)	Average monthly flow in June (m3/s)
1950 - 60	1182	191
1960 - 70	1074	74.2
1970 - 80	795	19
1980 - 90	563	18
1990 - 2000	722	88.8

Source: Ministry of Water Resources

The expected consequences of such trends are already visible: Scarcity of water resources; Sanding of the rocky river bed; Degradation of aquatic ecosystems; Extinction of species unable to adapt to extreme conditions. These effects are increased due to human factors like hydraulic development of flooding plain, over-fishing, and overgrazing. An additional factor of degradation of natural conditions of the river is the severe infestation of water hyacinth. All these conditions are those that are also prevailing in the Niamey area. In addition to this background trends, the Niger River in Niamey is the final outlet of all the liquid and solid waste of the population and activities of the city. According to such pollution sources, anaerobic conditions are temporarily prominent during flooding episodes, due to the flushing of solid waste, wastewater, and sand particles.

On a whole, the river habitat has dramatically changed from natural to semi-natural conditions:

- Loss of flooding plain and flooding areas replaced with irrigated paddy fields;
- Loss of the natural vegetation of *Bourgou* grass (*Echinocloa stagnina*), also inducing the loss of breeding and spawning ground for fishes;
- Dramatic extension of water hyacinth.

An additional effect of extreme low flows of the Niger River is the potential lack of irrigation water for paddy field perimeters in future, since river water is also and in priority the water resource for municipal drinking water. The storage capacity of *Goudel* dam cannot satisfy both municipal water needs and irrigation water needs in case of very low flow in dry season.

1) Sanding

Sanding of the Niger riverbed is a major ecological problem of the Niamey area. Severe sanding action can be observed at the outlet of the *kori*, which is lying on the right bank of the Niger River at the northern tip of *Neini* Island. Sanding has caused here the obstruction of the "Small Niger river" which flows between the *Neini* Island and the Niger right bank. However
all the river bed is also affected, which reduces the depth of water and changes habitat conditions from rocky to sandy bottom.

2) Water Hyacinth

The proliferation of water hyacinth (*Eichhornia crassipes*) in the Niger River began in 1988 and is now a major source of nuisance for ecosystems and inhabitants. The programmes developed for the eradication of hyacinth in the Niamey area, based on hand eradication, have failed until now. The effects of the water hyacinth are the following:

- Loss of natural productivity and habitats of the river
- Increased development of schistosiomasis vectors (studies have estimated that malaria vector is not related to water hyacinth)
- Obstruction of irrigation canals in irrigated paddy perimeters
- Loss of the potential of flood prone riverside areas for pluvial paddy fields cultivation
- Difficulties in moving pirogues

(2) Degradation of Environmental Resources

The natural environment of Niger River in Niamey has never been studied. There are no statistics on fish catches in the Niamey area. The Regional Direction of Environment makes a daily register of the quantity of fish sold on the Niamey market, without distinction of origin nor species of fish.

It seems that fish catches have dramatically decreased during the last decade, from an estimated amount of more than 8,000 tons / year to less than 1,000 tons presently. According to the FAO study of 1987, most fish species that strongly depend on flooding plain for breeding have strongly decreased due to draughts since 1970, while fishing practices have strengthened such trends. As a result, their presence has dramatically decreased compared to other species in the fishermen catches. The Ministry of Environment considers that there are several such species that are now on extinction in the Niger River area. Especially the following species that have been also reported in the FAO report are concerned: *Tetraodon lineatus (tetraodontidae), parachna obscurata (Channidae), Barbus foureaui (Cyprinidae), Gymnarchus niloticus (Gymnarchidae), Ctenopoma petherici (Anabantidae).*

The natural herbous cover of *Bourgou* grass in the Niger valley has always been a very valuable resource for cattle owners, who consider it as the best category of fodder for feeding cattle even in the urban area. There has been however a dramatic loss of *Bourgou* because of the development of paddy irrigation areas and proliferation of the water hyacinth. The loss of this grass in the Niger River also affects and jeopardises the survival of hippopotamus living upstream or downstream.

(3) Contamination of Groundwater

Groundwater is directly exposed to the multiple sources of insalubrity described in 3.7.1. Within a context where the water sources of Niamey for drinking water supply lack reliability in conditions of accentuated drought, preventing groundwater quality should be considered as a priority and basic precaution.

The contamination of groundwater by nitrates and faecal germs (*coliforms, streptococcus*) has been studied for more than 15 years, showing chronic contamination by nitrates in few areas. They are *Gaweye, Nogaret, Gamkallé, Goudel,* and *Yantala Bas*. Contamination by faecal germs has been found to be above the WHO admitted levels for drinking water in *Goudel, Gamkalé, Lazaret, Tourakou,* and *Kafa Koira*. According to other sources, *Saga* is also strongly affected by nitrates. The JICA study team has also checked water quality in 2 wells, showing an heavy contamination by coliforms. There are no data available for heavy metals concentration.

(4) Degradation and Contamination of Soils

Soil contamination has not been surveyed but there are potential sites for soil contamination riverside in and around the industrial area, as a result of in-situ storage of industrial sludge in decanting ponds. The quantity of these wastes has not been evaluated but they represent a potential future source of soil contamination. The problem of their appropriate treatment and disposal will become urgent in the coming years. Concentration of plastic bags in arable land as a result of waste disposal practice is a source of degradation of quality of the arable land. Wind erosion and gully erosion are other important factors of degradation and loss of soil.

(5) Pollution of River Water

The JICA study team has made several sampling and analysis of river water quality, as described in 4.4.3, showing bacteriological and organic pollution. The most exposed population riverside are those of *Nogaré, Kadadji, Lamordé, Gaweye, Gnalga, Terminus, Gamkalé* and *Saga.*

(6) Environmental Diseases

Malaria and diarrhoea are the main diseases in Niamey which occurrence is strongly determined by hygienic conditions in association with water and waste. The seasonal occurrence of these diseases is shown in 3.9.2. A further description is provided below.

1) Epidemiological Approach

Health records of CSI have been compared in order to identify if some relationship could be shown between disease occurrence and environmental conditions, specially in relation with water. The following CSI have been selected: *Aéroport 1, Aéroport 2, Poudrière,* and *Talladjé* for the sample reference group (29,610 consultations); *Gamkallé, Banigoungou, Saga,* and *Saga Congregation* for the target group (20,713 consultations). The target group are quarters with riverside population particularly exposed to possible health risks from river water use, located downstream the wastewater outlets of Niamey. The sample group of reference are quarters lying on the Plateau area. Data have been compiled directly from CSI records on the yearly period from July 1999 to June 2000 only. Table 3.7-6 below shows the compared results between both groups of quarters for most significant items only, which all together represent 55.7% and 48.6% of the total medical consultations registered, for the target and sample groups, respectively. The table gives the ratio of cases found among the total number of consultations, in %. It shows that:

- Diseases likely to be induced by contaminated water (diarrhoea, dysentery) have higher occurrence in the target group. Other diseases like cholera are not significant.
- Schistosomiasis occurrence has also clearly a higher occurrence in the target group, as expected.
- Ulcer, abdominal pain and headache have also an higher occurrence in the target group. The mostly concerned CSI areas are those of *Gamkallé*, followed by *Saga Congregation* and *Banigoungou*. It must be however observed that data input in the CSI health recording sheets for this group of diseases is added to conventional disease data. This can be interpreted as a good potential for identifying anomalies in disease occurrence, or inversely as a cause of misinterpretation due to the data input method.
- Other diseases like malaria, and diseases likely to be induced by general hygiene conditions, are almost equivalent between both groups, as expected. Dermatological affections, which are predominantly caused by bacteriological and parasitic affections, are partly induced by hygiene conditions. They represent 5 to 6% of cases recorded in the analysed CSI.

2) Malaria

The number of malaria affected patients has been more than 130,000 in 1998, and is around 120,000 cases per year on average on the period 1994-98, with recrudescence in 1996 and 1998 (years with heavy rains and flooding). In 1998, the number of cases reported for Niamey represented 15% of national total. Annual average of mortality is 294 cases, with a peak in 1998 with 527 cases. The specific mortality rate in Niamey was the highest for Niger in 1998, with more than 83 cases for 100,000 inhabitants. Malaria is the first cause of mortality registered in the health districts of Niamey. According to the PRIU households survey, 85% of households are affected by malaria, and direct costs induced would amount to 15,000 FCFA per household.

The PRIU study on runoff waters has made a clear relationship between malaria recrudescence and stagnation of water during the rainy season, based on the SNIS data. The analysis has concerned 27-selected CSI distributed in 23 quarters. The recrudescence is evaluated as the ratio of three-month cases of malaria compared with the average number of cases during the drought season of 6 months. Factors of evaluation are three-months precipitation, indicators of drainage coverage rate in the urban quarter and their state of maintenance, and the flood prone character of the area.

The review of malaria data in the above mentioned 8 CSI health centres of target and reference groups has shown the extremely high prevalence of malaria cases compared with the total number of medical consultations. If such prevalence is about 30% on average (Table 3.7-6), it may be as high as 50% and more in the July / September period, as found for *Banigoungou* (50.8%), *Aéroport 1* (49.9%), and *Aéroport 2* (53.2%) in 1999.

3) Diarrhoea

The total number of diarrhoea registered is on average 35,000 cases per year in Niamey (period 94-97), with net predominance in 96-98 (about 50,000 cases per year). The total number of cases registered for Niamey in 98 was 33,000 cases, representing 10% of national total (15% in 1997). Diarrhoea is the first cause of death for the 0 to 5 years old children, with a peak in 1996-97.

The review of diarrhoea data in the above mentioned 8 CSI health centres of target and reference groups has shown the high prevalence of diarrhoea cases, as high as 12.2% in the target group (Table 3.7-6). Highest ratio are often found for the July / September period, as in *Banigoungou* (22.3%), and *Saga Congregation* (15.6%).

(7) Degradation of Living Conditions

The JICA survey has been the opportunity to check how people perceive their living conditions. More than 55% of households in the JICA survey area think that unemployment is the first problem of living conditions. In the field of health and sanitation, priorities given by the surveyed people have been as follows: Waste collection (17%), health care services (12%), and drainage of rainwater (10%). Other problems including those of wastewater are surprisingly not given such importance, as already discussed in 3.7.2. The preception of priorities is however different according to quarters. In *Kouara Kano*, unemployment is in second position behind the problem of drainage of rainwater.

To the question whether citizens are satisfied with the present system of sanitation, 31% of households answered that they were, against 51% who were not satisfied. The points of dissatisfaction are mainly the collection of waste, followed by the drainage of rain water. Satisfaction rate is however variable according to the area: Those dissatisfied with waste collection are mainly *Bandabari* (81%) and *Lamordé* (71%), and others similar to the average,

while inversely 41% of households in *Gaweye* and 84% in *Yantala* said to be satisfied with waste collection. *Kouara Kano* households find dissatisfaction for waste water (92%), which is however in apparent contradiction with the absence of positive answer for identifying

Table 3.7-6 INCIDENCE OF WATER RELATED DISEASES AMONG CSI PATIENTS IN TARGET AND REFERENCE GROUPS IN NIAMEY

Category of disease		Target group %	Reference group %
Type 1	Diarrhoea	8.7	7.0
	Diarrhoea with dehydration	0.8	0.3
	Dysentery	2.7	1.1
	Total	**12.2**	**8.4**
Type 2	Cataract	0.0	0.0
	Conjonctivitis	2.0	2.7
	Trachoma	0.1	0.0
	Trichiasis	0.0	0.0
	Eye affections	1.9	0.5
	Total	**4.1**	**3.2**
(Type 2)	Dermatological affections	**5.2**	**6.0**
Type 3	Schistosiomasis	**1.0**	**0.2**
Type 4	Malaria	**31.4**	**30.6**
Others	Ulcer, abdominal pain, headache	**1.3**	**0.0**
TOTAL		**55.7**	**48.6**

Type 1: Related to ingestion of contaminated water; Type 2: Related to poor personal hygiene; Dermatological affections partly belong to this type; Type 3: Related to parasites in water; Type 4: Insect vector related to water.

wastewater as an urban priority problem in this area. In the whole sampling area, only 6% have complained to municipality, mainly about the flooding problem and secondarily about waste collection problems. However, at the question to know why they did not complain if they had problems related to salubrity, about 70% answered that complain would be useless. Only 35% of households in *Kouara Kano* share the opinion that complaining would be useless, which certainly reflects a better relation with communal services in the field of sanitation.

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collection are mainly *Bandabari* (81%) and *Lamordé* (71%), and others similar to the average, while inversely 41% of households in *Gaweye* and 84% in *Yantala* said to be satisfied with waste collection. *Kouara Kano* households find dissatisfaction for waste water (92%), which is however in apparent contradiction with the absence of positive answer for identifying wastewater as an urban priority problem in this area. In the whole sampling area, only 6% have complained to municipality, mainly about the flooding problem and secondarily about waste collection problems. However, at the question to know why they did not complain if they had problems related to salubrity, about 70% answered that complain would be useless. Only 35% of households in *Kouara Kano* share the opinion that complaining would be useless, which certainly reflects a better relation with communal services in the field of sanitation.

Poverty has effects on the housing conditions, namely the construction materials and the sanitation facilities. The use of straw (*paillotes*) and earth (*banco*) materials for housing increases weakness against the storms of rainy season. The PRIU study has shown that traditional habitat is very vulnerable to flooding conditions. Accordingly, poor areas exposed to flooding have the highest damages and must engage expenses to restore housing conditions in the compound. With improvement of income conditions, most people shift to modern materials for housing, as this can be observed in *Lamordé* urban village, where traditional and modern types of housing coexist.

Poverty is also a factor increasing exposure to contaminated drinking water. In poor quarters where access to tap water is not easy, people prefer to use well water because they do not afford to buy it to the water vendors. In extreme cases and during the rainy season, in poor areas lying along the Niger River, surface water may be used as a source of drinking water. The JICA study team has observed a similar case in *Gamkallé - Golé*, where people consume river water when circumstances make the use of cheap tap water difficult while buying the water sold by water vendors would be too much expansive for them.

(8) Damages from Flooding and Landslide

Flooding and landslide are a regular calamity endured by the population, with more or less intensity, whether it is a disaster involving a shift of population and loss of habitat, or a repetitive and short term nuisance to the living environment, with secondary effects like stagnant pools of water. As found by the PRIU survey on households, nuisances generated by flooding are not restricted to flood prone areas: One forth of the households living outside the flood prone areas have experimented stagnation of rain water in the yard or streets, generating access problems, and also material damages.

In the JICA survey on households, 25% of households have declared damages in their house after flooding. Among the surveyed quarters, *Kouara Kano, Lamordé* and *Gaweye* are the most affected by flooding damages, with respectively 40%, 31% and 35% of households having sometimes flooding damages. However, near 70% of households on average have taken protection measures on their own, against flooding risk. In *Lacouroussou*, where flooding damages are under the average, and in *Yantala*, 100% of households did declare that they have taken such protection measures. Since block areas have done sampling in the quarter, it is not surprising that 100% of households can be concerned with flooding occurrence. The method of protection is mainly through drainage of water outside the compound (47.5% of households), and then protection by embankment (20.7%). Embankment predominates in *Kouara Kano* and *Lamordé*.

According to the PRIU study, the population exposed to flooding amounts 120,000 persons,

distributed in identified 49 flood prone areas, with exposure levels differing according to density. The survey has shown that about 1% of households have been subject to physical damages from flooding, inducing on average 14,000FCFA of expenses per household. The consequences of flooding also include public health effects like contamination and epidemic diseases among disaster victims. Flood prone areas of Niamey in 1998 have been represented in Fig. 2.1-1.

The most damaging flooding and landslide events recorded during the last decade have occurred in 1994, 1998, and 2000. Flooding in 1994 has caused the loss of 3,000 traditional houses. There is however no registration of the number of households affected and the number of victims. Data of the 1998 flooding show that more than 4,000 households have been affected in 55 quarters, with the highest share in Commune II (half the cases and 26 quarters affected). The most affected quarters have been *Lazaret, Goudel,* and *Koirategui* in Commune I, *Gamkallé,* and *Lacouroussou* in Commune II, and *Karadjé* and *Banga Bana* in Commune III. The number of persons temporarily relocated in schools in 1998 was estimated at more than 10,000 persons. Floodings in 2000 have affected about 1,700 persons (244 households) and induced a loss of 358 houses and 55 huts, as registered by the System of Early Alert and Management of Disaster (SAP). Most affected areas have been *Gamkallé, Saga Gorou* and *Kongou Gorou* in Commune II, and *Kirkissoye, Banga Bana,* and *Karadjé.* As a result of this flooding, 6 injured persons and one dead have been reported.

Commune III is particularly affected by flooding and torrential landslide, which is mixed water and sand mud discharged in the rainy season from southwestern hills. Most affected quarters are *Zarmagandey, Kirkissoye, Lamordé, Banga Bana,* and *Karadjé.*

There are no specific records for damages caused by erosion outside flooding episodes. Erosion has induced strong damages in quarters like *Madina, Couronne Nord* and *Boukoki* on the Plateau. *Gamkallé* and *Yantala* in the *Corniche* area are particularly affected by gully erosion with formation of ravines.

(9) Loss of Urban Amenities

The absence of waste collection and disposal system is the main cause of loss of urban amenities in Niamey. People of the poor peripheral quarters and illegal settlements informally use for waste and wastewater disposal and for the collection of fuel wood the Green Belt, which is considered as a major amenity resource in Niamey. More generally, the presence of "black spot" waste dumping sites throughout the city is a serious cause of loss of landscape value.

3.8 ECONOMIC, FINANCIAL AND INSTITUTIONAL SITUATION

3.8.1 Economic Situation of Niger and Niamey City

(1) Agro-Climatic Zones

Niger is landlocked. Its nearest seaport, Cotonou of Benin is 1,000 km away from Niamey, the capital city of Niger. According to climate, its land of 1.267 million sq km is divided into three agro-climatic zones:

1) Northern half, the Saharan desert zone where annual rainfall hardly reaches 200 mm;
2) Sahelian zone in the center between latitude 14º and 16º N with annual rainfall of 350 to 500 mm, where pastoral activity is a predominant way of life; and
3) One tenth of land in the south, namely Sudanese zone with annual rainfall of 500 to 850 mm, where rain fed cultivation is only possible.

Niger's economy is predominantly agricultural. Ninety (90) percent of population is engaged in agriculture. Agricultural and pastoral activities, and hence most of productive activities are distinctly characterized by these agro-climatic features. Niamey is located in the Sahelian agro-climatic zone. Goats, sheep, donkeys, poultry and cattle are raised around peri-urban area and even within the city. Seasonal rain fed cultivation of millet and sorghum is made wherever land is not occupied. In Commune III and in a part of Commune II, paddy rice is cultivated using water from Niger River.

(2) Industry

Modern industries such as slaughterhouse, tannery, and textile factory and beer brewery are located in the industrial zone in Commune III. Small-scale conventional industries and handicrafts are found at many places in the city. They are producing dry-clay bricks, fuel wood, batiks, etc. However, material supply and delivery of products of these industries are more or less limited within the domestic market and adjoining countries due to the high cost of inland transportation. The remoteness of the ocean port discourages the light industries of the low added value. As shown in Tables 3.8-1, industry sector in Niger is yet to be developed.

Table 3.8-1 INDUSTRY CONDITIONS

	1977	1987	1997	1998
Structural Economy (% of GDP)				
Agriculture	51.8	36.3	38.0	41.4
Industry	14.0	19.3	18.0	17.0
Manufacturing	5.1	6.4	6.6	6.2
Services	34.2	44.3	44.0	41.6
Trade (US$ millions)				
Total exports (fob)	197	412	271	298
Uranium	-	289	131	130
Livestock	-	43	40	49
Manufactures	-	-	-	-
Total imports (cif)	-	444	376	422
Food	-	21	27	36
Fuel and energy	-	19	28	23
Capital goods	-	99	68	87

Source: The World Bank Report

(3) Economy

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.

Table 3.8-2 GDP INDEX

	1977	1987	1997	1998
GDP (US$ billions)	1.3	2.2	1.9	2.0

GDP: average annual growth	1977-87	1988-98	1997	1998
Agriculture	0.8	2.3	0.8	18.1
Industry	3.0	1.4	4.1	2.5
Manufacturing	-	2.1	4.7	2.5
Services	-2.8	0.7	4.2	2.4

The growth of population surpasses the growth of GNP. Coupled with fall of uranium price, GNP per capita has been continuously contracted since 1970's.

Political instability in 1996 and 1999 was overcome by the peaceful general election in November 1999. Growth of Niger's economy will be steady, unless the favorable rainfall is interrupted by infrequent drought.

Table 3.8-3 GNP INDEX

GNP/Capita	1970	1980	1990	1991	1992	1993	1994	1995	1996	1997	1998
US$	554	461	310	291	290	240	210	190	200	200	190

Table 3.8-4 PER CAPITA GNP

Category	Niger	Sub-Saharan Africa	Low income
1998			
Population, mid-year (millions)	10.1	628	3,515
GNP per capita (Atlas method, US$)	190	480	520
GNP (Atlas method, US$ billions)	1.9	304	1,844
Average annual growth, 1992-98			
Population (%)	3.4	2.6	1.7
Labor force (%)	3.1	2.6	1.9

3.8.2 Institutional Setting

(1) Ministry of Equipment and Transportation

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. Directorate of Public Work Material and a road maintenance corps were privatized. General Directorate of Transportation was discontinued. Directorate of Urbanization and Habitation was separated into two directorates. Directorate of National Meteorology is also in reorganization. Nearly ten officers are not placed. These transients took place in the recent few months and are expected to occur any time soon. The Ministry's organization and approximate number of staff as of September 2000, as known to Director, Administration and Finance is shown in Figure 3.8-1.

(2) Local Government and Decentralization

Land of Niger is administratively divided into 8 departments, each of which is governed by *prefet* or chief of prefecture. In other sub-Saharan French-speaking countries, department is generally governed by governor or high commissioner, prefecture by *prefet*, district or *arrondissement*, by *sous-prefet*. Among 8 departments in Niger, Niamey city is a special capital department and governed by an only President-*Prefet* of Urban Community of Niamey. It consists of three districts namely communes. Three *administrateur delegues* (equivalent to *sous-prefets* in urban communes) are governing them. They are appointees from Ministry of Interior and assumed to represent the national government in each administrative region. While *administrateur delegues* of urban communes are sometimes called mayors, no chief of sub-national administrative tiers is elected in Niger. Thus, decentralization or devolution is nonexistent and unlikely to come soon, while many decentralization acts are under preparation and Ministry of Interior is claiming to elect chiefs of some sub-national tiers by popular vote in a few years.

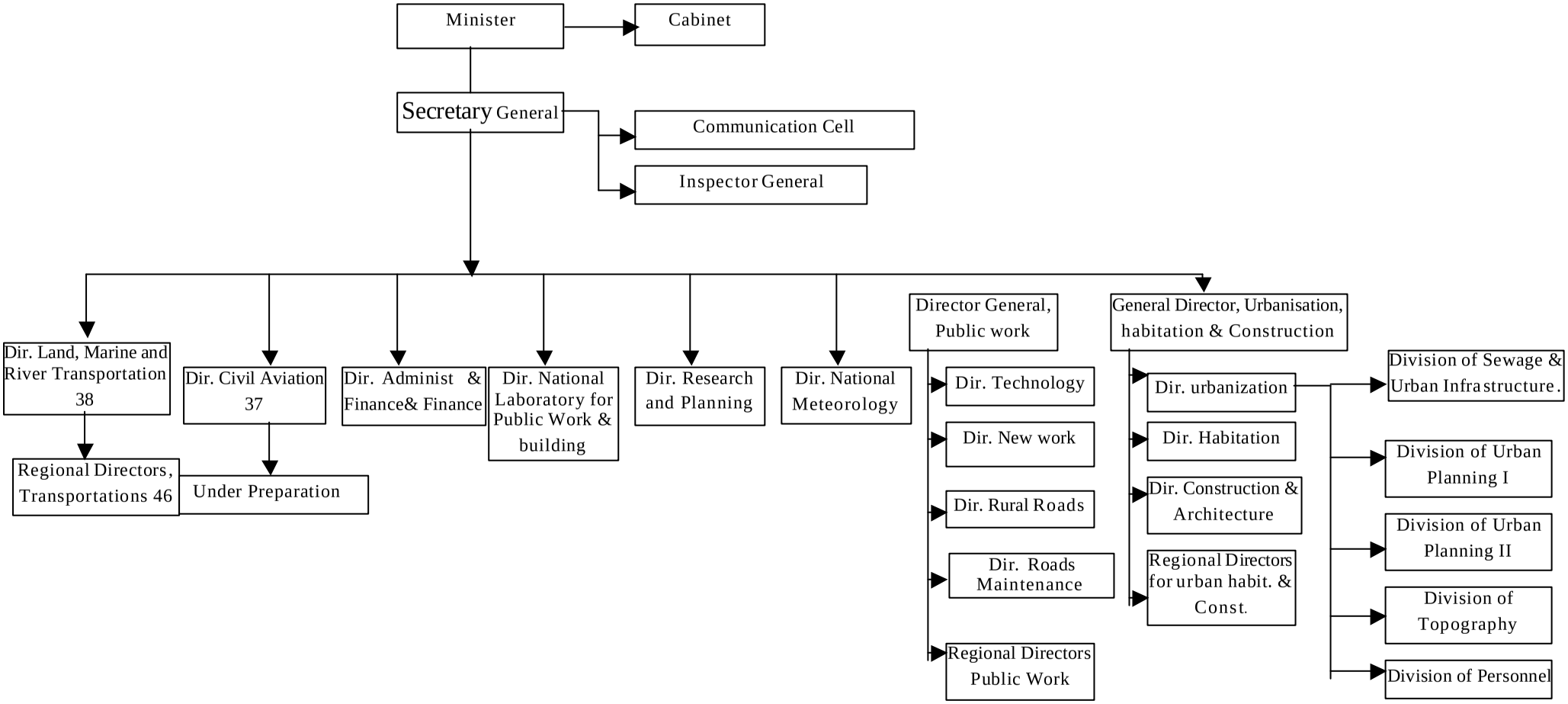


Figure 3.8-1 ORGANIZATIONS OF MINISTRY OF EQUIPMENT AND TRANSPORTS

(3) Urban Community of Niamey and Communes

Three communes that are direct subdivisions of Urban Community of Niamey (CUN) are levying 'taxes' on various services such as garbage collection, use of market, public land occupancy, advertisement in public place, operating pumps in gas station, gathering or conference, etc. that are mostly service charges. Larger part of annual revenue of CUN and communes, however, are provided as "equivalency subvention" (subsidy) by the national treasury. To learn financial capacity of CUN and communes, their actual revenues and expenses are shown in Table 3.8-5. Local governments of Niamey City maintain the total financial scale of US$ 5.5 to 7.1 million (US$ 1 = CFA F 750) for the 650,000 residents. Their organizations and number of employees are shown in Figure 3.8-2.

(4) National Development Budget and Its Achievement

Ministry of Plan (MP) is coordinating the development activities with line ministries and compiling a three-year (rolling) investment plan every year. Poverty and its eradication are focus of planning in recent years. Food shall also be sufficiently supplied through agriculture to be improved with locally available resources. Naturally rural development through income generating activities and social development consisting of water supply and sanitation, health, education, poverty alleviation, etc. are emphasized in the national investment budgets of 1997 through 2000 shown in Table 3.8-6.

It should be noted that disbursement or achievement ratio was generally poor, e.g., less than 65 percent in 1997 and 1998, and only 52 percent in 1999 when political problem arose. Sector-wise, economic infrastructure development particularly is lagging seriously. This could suggest very week executing capacity of the government institutions, particularly in sectors involving large civil engineering works. It is reported that while ample project budgets are allocated, project officers cannot afford daily operating expenses. As shown in Table 3.8-7, the national treasury could afford only 7 percent of total development budget of approximately US$ 145 million in 1998, while external donors provided the remaining 93 percent.

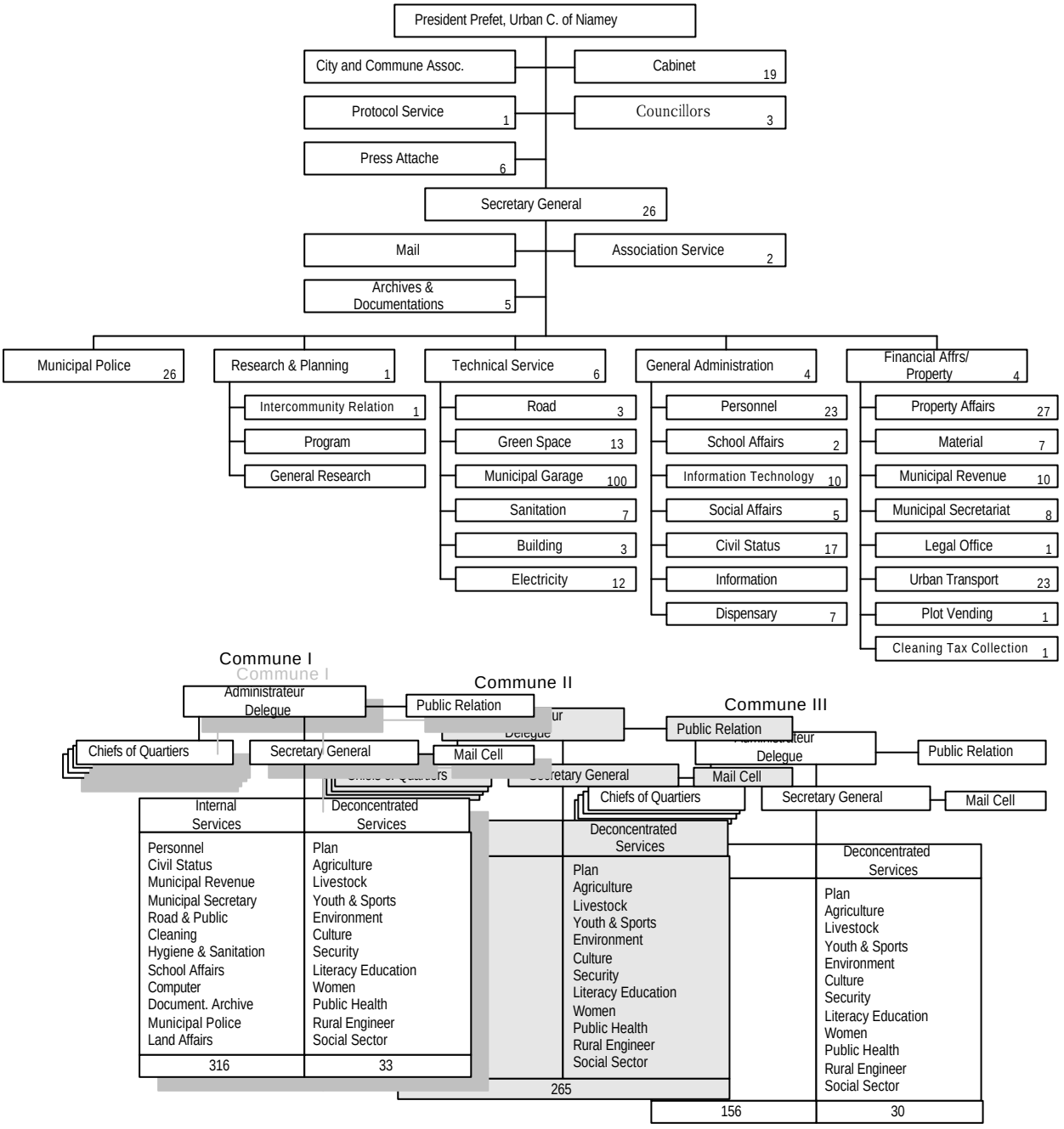
Table 3.8-5 FINANCIAL SCALE OF NIAMEY CITY

Revenue and Expense (achievement base)

Unit: Thousand CFA F

		UCN		Commune I		Commune II		Commune III		Niamey City Total	
		Revenue	Expense	Revenue	Expense	Revenue	Expense	Revenue	Expense	Revenue	Expense
1992	General	757,728	1,112,094								
	Investment										
	Total										
1993	General	854,625	1,311,752								
	Investment										
	Total										
1994	General	763,092	1,086,190								
	Investment										
	Total										
1995	General	1,015,311	1,009,119	525,090	516,580		597,162	210,816	198,991		
	Investment			122,390	122,391		94,294	21,648	21,648		
	Total			**647,480**	**638,971**		**691,456**	**232,464**	**220,639**		
1996	General	1,327,426	2,258,605	572,914	509,337	513,975	698,700	223,667	281,195	2,637,982	3,747,837
	Investment	2,314,990	907,035	138,144	215,458	101,000	129,817	91,182	91,182	2,645,316	1,343,492
	Total	**3,642,416**	**3,165,640**	**711,058**	**724,795**	**614,975**	**828,517**	**314,849**	**372,377**	**5,283,298**	**5,091,329**
1997	General	941,171	2,127,645	442,747	507,408	502,777	562,456	224,613	262,048	2,111,308	3,459,557
	Investment	1,596,252	723,290	110,233	417,981	150,151	150,131	88,732	88,732	1,945,368	1,380,134
	Total	**2,537,423**	**2,850,935**	**552,980**	**925,389**	**652,928**	**712,587**	**313,345**	**350,780**	**4,056,676**	**4,839,691**
1998	General	1,282,327	1,808,281	478,134	540,266	324,013	532,115	309,611	298,489	2,394,085	3,179,151
	Investment	1,279,436	1,026,742	218,127	236,587	94,860	94,860	108,045	108,045	1,700,468	1,466,234
	Total	**2,561,763**	**2,835,023**	**696,261**	**776,853**	**418,873**	**626,975**	**417,656**	**406,534**	**4,094,553**	**4,645,385**
1999	General			424,595	432,259	379,979	431,192	256,064	178,735		
	Investment		3,183,508	70,163	88,473	86,948	129,785	61,727	61,727		3,463,493
	Total			**494,758**	**520,732**	**466,927**	**560,977**	**317,791**	**240,462**		
2000	General			487,487		528,142					
	Investment										
	Total										

Note: General budget = Recurrent revenue/expense; Investment budget = Capital revenue/expense
Source: UCN and Communes



Remarks: Figure shows number of staff as of September 2000.

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

Figure 3.8-2

ORGANIZATION OF THE URBAN COMMUNITY OF NIAMEY AND ITS COMMUNES

Table 3.8-6 DEVELOPMENT BUDGET AND ACHIEVEMENT

Niger - 1998

Unit: Thousand CFA F

	Source of Aid/Fund	Commitment	Share	Disbursement	Share	Disbursement Ratio
Reimbursable Aid	International Development Association	21,318,583	21.0%	13,843,335	21.0%	64.9%
	African Development Bank African Development Fund	9,912,017	9.7%	5,231,340	7.9%	52.8%
	OPEC Fund	3,872,564	3.8%	119,296	0.2%	3.1%
	International Fund for Agriculture Development	3,045,800	3.0%	1,634,978	2.5%	53.7%
	Islam Development Bank	1,592,240	1.6%	388,714	0.6%	24.4%
	Kuwait Fund for Economic Development in Africa	1,431,418	1.4%	200,777	0.3%	14.0%
	Total Reimbursable Aid	**41,172,622**	**40.5%**	**21,418,440**	**32.5%**	**52.0%**
Non-reimbursable Aid	European Development Fund	21,593,954	21.2%	10,107,673	15.3%	46.8%
	Netherlands	3,470,389	3.4%	1,715,000	2.6%	49.4%
	French Development Agency	3,408,409	3.4%	1,962,087	3.0%	57.6%
	GTZ	3,387,961	3.3%	3,262,376	5.0%	96.3%
	UNICEF	3,155,500	3.1%	4,149,090	6.3%	131.5%
	UNDP	2,952,392	2.9%	1,538,817	2.3%	52.1%
	Italy	2,792,191	2.7%	2,149,987	3.3%	77.0%
	Denmark	2,687,462	2.6%	2,069,346	3.1%	77.0%
	KfW	2,573,080	2.5%	4,346,300	6.6%	168.9%
	Belgium	2,123,024	2.1%	1,647,905	2.5%	77.6%
	Switzerland	1,876,928	1.8%	2,057,036	3.1%	109.6%
	Norway	1,182,948	1.2%	584,867	0.9%	49.4%
	Luxemburg	826,373	0.8%	1,106,209	1.7%	133.9%
	French Fund for Aid and Cooperation	678,660	0.7%	1,336,847	2.0%	197.0%
	UN Population Fund	526,460	0.5%	405,374	0.6%	77.0%
	China	305,249	0.3%	235,042	0.4%	77.0%
	UN Organ Against AIDS	25,000	0.0%	19,250	0.0%	77.0%
	Total Non-reimbursable Aid	**53,565,980**	**52.7%**	**38,693,206**	**58.7%**	**72.2%**
Total Counterpart Fund (National Treasury)		**6,950,000**	**6.8%**	**5,773,966**	**8.8%**	**83.1%**
Total Development Budget		**101,688,602**	**100.0%**	**65,885,612**	**100.0%**	**64.8%**

Source: MP

Table 3.8-7 SECTORWISE DEVELOPMENT PROJECTS AND ACHIEVEMENTS

Niger 1997 - 2000

Unit: Thousand CFA F

Sector		1997		1998		1999		2000	
		Cost	Share	Cost	Share	Cost	Share	Cost	Share
Rural development	Projected	25,972,731	30.6%	36,023,206	35.4%	37,253,592	29.7%	31,867,550	25.2%
	Disbursed	19,584,607	35.8%	25,331,579	38.4%	18,129,198	27.6%		
	Disbursement ratio	75.4%		70.3%		48.7%			
Other economic programs*	Projected	3,081,580	3.6%	3,716,008	3.7%	3,608,045	2.9%	2,559,456	2.0%
	Disbursed	2,297,957	4.2%	2,853,769	4.3%	2,521,817	3.8%		
	Disbursement ratio	74.6%		76.8%		69.9%			
Social programs*	Projected	36,174,454	42.6%	38,101,008	37.5%	39,977,902	31.9%	38,453,884	30.4%
	Disbursed	20,539,977	37.6%	28,262,305	42.9%	24,658,370	37.6%		
	Disbursement ratio	56.8%		74.2%		61.7%			
Economic infrastructure*	Projected	13,497,887	15.9%	20,215,428	19.9%	34,778,136	27.8%	37,530,961	29.7%
	Disbursed	6,748,031	12.3%	5,604,303	8.5%	5,942,748	9.1%		
	Disbursement ratio	50.0%		27.7%		17.1%			
Supplemental programs*	Projected	6,219,763	7.3%	3,632,952	3.6%	9,648,594	7.7%	15,951,953	12.6%
	Disbursed	5,516,398	10.1%	3,833,656	5.8%	14,386,030	21.9%		
	Disbursement ratio	88.7%		105.5%		149.1%			
Total	Projected	84,946,415	100.0%	101,688,602	100.0%	125,266,269	100.0%	126,363,804	100.0%
	Disbursed	54,686,970	100.0%	65,885,612	100.0%	65,638,163	100.0%		
	Disbursement ratio	64.4%		64.8%		52.4%			

*Other economic programs: industries, mining, etc.

Source: MP

*Social programs: health, education, water supply & sanitation, urban, housing, human resource development, poverty alleviation

*Economic infrastructure: road, bridge, communication

*Supplemental programs: institution strengthening, studies, programming, etc.

3.9 PUBLIC EDUCATION ON SANITATION

3.9.1 Present Situation of Public Education on Health & Sanitation

(1) The Ministry of Public Health (MSP; *Ministère de la Santé Publique*)

1) Plan and Policy on Health and Sanitation

The leading official entity handles health and sanitation education in *Niger* is the Ministry of Public Health (MSP; *Ministère de la Santé Publique*). The MSP has prepared a plan and several national policies related to health and sanitation as summarized in Table 3.9-1.

Table 3.9-1 PLAN AND POLICY ON HEALTH AND SANITATION

Plan & Policy	Year	Status
Plan of Sanitation Development 1994-2000	1994	Adopted
Declaration of Health Sector Policy	Jul. 1995	Adopted by the Cabinet Administrative Board
National Policy on Health Education	Mar. 2000	Final stage of approval procedure
National Policy in the field of Hygiene and Sanitation	Jul. 2000	Under approval procedure

Source: MSP

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 the improvement of environmental sanitation. Within the concepts, the "*National Policy on Health Education*" states that health education is considered as a major strategic tool to prevent diseases. Main objectives of the education mentioned in this national policy are summarised as follows;

- Contributing to improve hygiene manners of people (knowledge, behaviour, practices)
- Contributing to reduce morbidity and mortality of communicable and parasitic diseases resulting from inappropriate hygienic practices
- Strengthening a community participation
- Strengthening cooperation with other partners in the field of health education
- Training staffs involved in health education
- Evaluating results (impacts) of the actions taken.

Accordingly, a set of strategic actions has been defined, of which the most important are;

- To support the MSP to the decentralised authorities (regions, departments, communes), which are the executing agencies of the national policy on health education
- To expect a contribution of people through a community participation
- To train the staff

The state budget allocated to health care will be 6 to 10% of the general budget, of which 2% dedicated to health education. Local authorities are expected to contribute to financing health education up to 30% of their budget allocated to health care.

2) DPH/EPS (*Direction de l'Hygiène Publique et de l'Éducation Pour la Santé*)

Under the Secretary General of the MSP, there is the Directorate of the Public Health and Health Education (DHP/EPS; *Direction de l'Hygiène Publique et de l'Éducation Pour la Santé*) as one of seven directorates. The DHP/EPS consists of the Division of Public Health (DHP: *Division de l'Hygiène Publique*) and the Division of Information and Health Education

(DIEPS; *Division de l'Information et de l'Éducation Pour la Santé*) as shown in Figure 3.9-1. The DIEPS plays the principal role as the central office that handles health and hygiene (sanitation) education in the MSP.

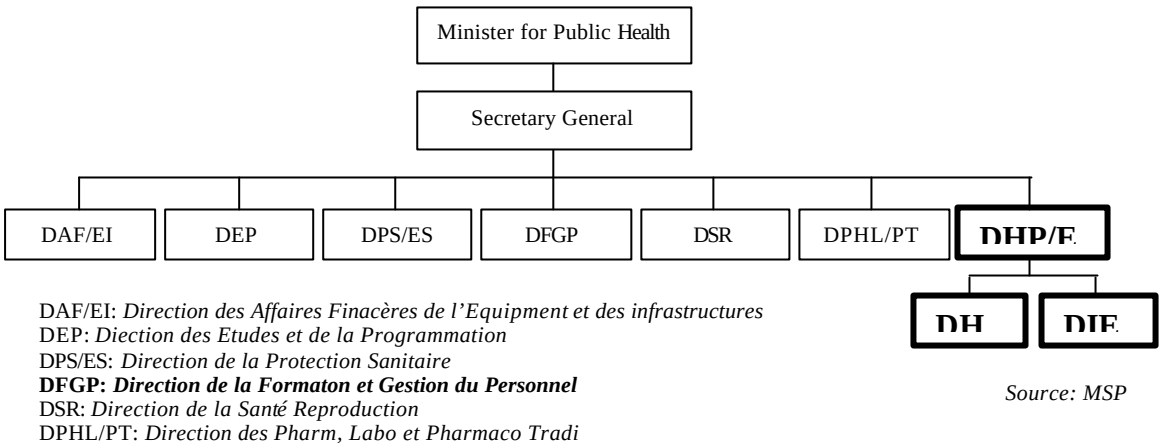


Figure 3.9-1 ORGANIZATION CHART OF MINISTRY OF PUBLIC HEALTH

Education on health and sanitation implemented by the DHP/EPS, as mentioned the above, principally focuses on human health oriented activities such as prevention of diarrhea, infectious and parasitic diseases. Consequently, the main activities on the hygiene education of the DHP/EPS are to make a national plan on related programs, to prepare educational tools, and to instruct specialized information to health experts, technicians and other officials concerned.

In 1997, the DHP/EPS published "Hygiene Manual for Schoolchildren Use (*Manuel d'Hygiene á l'usage de l'écolier*)" in cooperation with the WHO (*World Health Organization*) to instruct schoolchildren in a basic hygiene and health knowledge, a link between health and hygiene practices and so on.

3) IDA Health Project (NIR1668)

The International Development Association (IDA) of the World Bank (IBRD; *International Bank for Reconstruction and Development*) decided to start a project, "*Niger* IDA Health Project NIR 1668 (*Project Sante Niger IDA-NIR 1668*)", in 1986 as an official loan project based on provisions of a contract between the *Niger* and the IDA. The project consists of the following 10 programs, and has two phases of Phase I (1987 – 1991) and II (1992 - onward):

1. Malaria Prevention Control Program
2. Expanded Program on Immunization
3. Diarrhoea Diseases Prevention Control Program
4. Family Planning Promotion Program
5. Nutrition Improvement Program
6. Reinforcement Program for Social Affairs, and Maternal & Child Health Directorates
7. Health Education Program
8. Program on Health Education Improvement and Maintenance Engineering Services Reinforcement
9. Staff Education Program
10. Project Management

The Health Education Program among above programs can be summarized as follows:

a. Objectives of the Health Education Program

- To realize necessary actions in daily life for preserving and improving health and sanitation situation at individual levels.
- To participate in related activities for preserving and improving health and sanitation situation at community levels.

b. Specific Goal of Phase I (1987 – 1991)

- To strength services of the Health Education Program
- To strength the EPS programs

c. Specific Goal of Phase II (1992 - onward)

- To prepare the national program on information, education and communication (IEC)
- To strength capacity for management and coordination abilities at the central level
- To strength capacity for management and coordination abilities at local levels
- To execute a technical cooperation to other entities and programs active in the field of health education (including preparations for educational tools).
- To prepare annual programs.

The IDA project equipped the DIEPS with necessary audiovisual aids and devices in 1992. Table 3.9-2 shows these aids and devices and the present status of each of them as of October 2000. It is considered that these are valuable properties to prepare important tools for hygiene education and heightening public awareness on sanitation.

Table 3.9-2 LISTS OF AUDIVISUAL-AIDS AND EQUIPMENT DIEPS

No.	Equipment	Nos.	Status	No.	Equipment	Nos.	Status
1	Television Sets (Philips)	2	Good	25	Image Mixture	1	Good
2	Videotape Recorder (Philips)	2	Fair	26	Casting Table	2	Good
3	Videotape Recorder (UMATIC 9850P & 9800P)	4	Fair	27	Projector Desisti (Lamp)	1	Good
4	Color Monitor (Trinitron)	2	Fair	28	Tool Case	1	Good
5	Remote Controller (RMC 450)	1	Fair	29	16 mm Film Projector	1	Bad
6	Cassette Deck (K7 Hi8mm)	1	Fair	30	Audio Duplicator K7	1	Good
7	CCD Camera (M7)	1	Fair	31	Stencil Duplicator	1	Good
8	CCD Camera (Hi8mm)	5	Bad	32	Audio Case K7	10	Good
9	Lighting Set (Three lamps)	1	Bad	33	Microphone (Canon)	2	Good
10	Videotape Recorder (UMATIC)	1	Good	34	Directional Microphone	4	Good
11	Tripod + Dolly	1	Good	35	Foot-table Microphone	2	Good
12	Over Head Projector	2	Fair	36	Tripod for Microphone	5	Good
13	Tape Recorder K7 (Marantz)	2	Bad	37	Transformer 220V	1	Good
14	Tape Recorder K7 (Califone)	2	Bad	38	Photo Enlarger	1	Good
15	Tape Recorder D6920 (Philips)	2	Bad	39	Film Dry Box	1	Good
16	Steel Camera (Nikon 801)	1	Good	40	File Development Drum	1	Good
17	Casting Screen	2	Bad	41	Photograph Cutter	1	Good
18	Walkman	1	Good	42	Tape Recorder	2	Fair
19	Headphone	2	Bad	43	Kodak Ektagraphic Projector	5	Bad
20	Transport Case (Television + Video)	2	Good	44	Adapter 220V – 12V	1	Good
21	Transcoder (PAL – SECAM)	1	Good	45	VHS Video Camera (Panasonic)	1	Fair
22	Slide Projector	2	Good	46	16mm Film Projector (Eiki)	1	Good
23	Slid Projector (Kodak 1010)	2	Good	47	Television Set (Philips)	1	Fair
24	Monitor Controller (PAL – SECAM)	1	Good	48	Projector Cart	1	Good

Source: DIEPS, MSP

Note: - All equipment was purchased in 1992.
- The status is as of October 2000.

Up to the present, the DIEPS has prepared many educational tools in the field of health and sanitation including video programs, printed materials such as the introduction of the ORS (*Oral Rehydration Salts*), and others. Table 3.9-3 shows a list of educational video programs available in the DIEPS. Many of them were produced by the DIEPS, and others were donated by the WHO, the UNICEF (*United Nations Children's Fund*) and other international agencies. Most of them are health and disease oriented programs. Of the list, however, No. 2, No.18, No.20, No.21, No.38 and No.52 are the educational videos in the field of water and sanitation. As a matter of course, it is considered that these videos could be useful tools if hygiene education and an activity on public awareness on sanitation would be planned and conducted by a certain district or an entity with a limited budget and resources.

Table 3.9-3 VIDEO LISTS ON HEALTH AND SANITATION AVAILABLE IN DIEPS (1)

No.	Title	System
1	**Par dela les Dogmes et Prejuges* (Beyond Dogmas and Prejudices)	UMATIC
2	**L'Eau Potable* (Potable Water)	UMATIC
3	**La Sensibilisation sur (SIDA* Perception about AIDS)	UMATIC
4	**L'Allaitement Maternel* (Breast-feeding)	UMATIC
5	**La Lutte Contre la Malnutrition* (Malnutrition Control)	UMATIC
6	**Jeunesse et Stupefiants* (Youth and Drug Abuse)	UMATIC
7	**Le Ver de Guinee* (Guinea worm)	UMATIC
8	**L'Alimentation de la Femme et du Nourisson* (Diet of Women and Babies)	UMATIC
9	**Piece Theater sur la PF/CNSF* (A Drama on Family Planning / National Family Health Center)	UMATIC
10	**Fistules (FVV)* (Fistulas)	UMATIC
11	**Medicaments Essentiels* (Essential Drugs)	UMATIC
12	**La Lutte Contre le Paludisme* (Malaria Prevention)	UMATIC
13	**Medicaments Essentiels* (Essential Drugs)	UMATIC
14	**Les Denrees Alimentaires* (Foodstuffs)	UMATIC
15	**La Frequentation des CSMI* (Use of Maternal and Child Health Center)	UMATIC
16	**La Frequentation des Centres de Sante* (Use of Health Center)	UMATIC
17	**Les Vassinations* (Vaccination)	UMATIC
18	**Les Ordures Menageres* (Garbage)	UMATIC
19	**Piece Theater PF/CNSF* (A Drama on Family Planning / National Family Health Center)	UMATIC
20	**Les Ordures Menageres(Hausa)* (Garbage(*Hausa*))	UMATIC
21	**Les Ordures Menageres(Secam)* (Garbage(*Secam*))	UMATIC
22	**ONCHO* (ONCHO)	UMATIC
23	**Alimentation de la Femme et du (H et Z) Nourisson* (Diet of Women and Babies (*Hausa* and *Zarma*))	UMATIC
24	*SIDA par la Troupe "YAZI DOGO"* (AIDS by "YAZI DOGO" troupe)	VHS
25	*Eradiquer la Faim Insoupconnee* (Eradication of Unexpected Famine)	VHS
26	When You Love a Person	VHS
27	**Promotion del la Femme et la Croissance de l'Enfant* (Improvement of Women status and Child Growth)	VHS
28	*La Duperie/ Ma Fille Ne Sera Pas Excisee* (Dupery / My daughter will not suffer excision)	VHS
29	*Consequences* (Consequences)	VHS
30	Training Module on Surgical Management of Guinea Worm	VHS
31	A New Strategy for Child Survival	VHS
32	*SIDA Nigeria/ Ver de Guinee* (AIDS Nigeria/ Guinea Worm)	VHS
33	**Trois Villageois/Mariage Precoce/ Grossesse* (Three Villages/ Early Marriage/ Pregnancy)	VHS
34	*La Misadventure* (Misadventure)	VHS
35	*Evaluation de la Deshydratation D'un Enfant Diarrheique* (Assessment on Dehydration by Child Diarrhea)	VHS
36	*Les Gestes ou la Vie* (Behavior or Life)	VHS
37	*Fils D'Afrique(SIDA)* (Product of Africa (AIDS))	VHS
38	*L'Hygiene de L'Eau* (Water Hygiene)	VHS
39	*Joli Coeur* (Dear Heart)	VHS
40	*A Propos du NOMA* (Story of NOMA)	VHS
41	*Le SIDA Avec Hima Adamou* (AIDS directed by *Hima Adamou*)	VHS
42	*Par dela les Dogmes et Prejuges* (Beyond Dogmas and Prejudices)	VHS
43	*Attention SIDA/SIDA en Afrique/Soir Dimanche SIDA* (Attention AIDS/ AIDS in Africa/ Sunday Evening AIDS)	VHS
44	*Le Goiter* (Goiter)	VHS
45	*Polio + Le Reve Continue* (Polio + Dream Country)	VHS
46	*Video sur la PF* (Video on Family Planning)	VHS
47	** Fille Croix Rouge Chant SIDA* (Girls' Red Cross Song of AIDS)	VHS
48	*Eradiquer la Faim Insoupconnee* (Eradication of Unexpected Famine)	VHS
49	*L'Elimination du Tetanos Neonatal* (Elimination of Neonatal Tetanus)	VHS
50	*Le Paludisme* (Malaria)	VHS
51	*Soir Dimanche sur le SIDA, Jonathan Man* (Sunday Evening AIDS, Jonathan Man)	VHS
52	**Evacuation Orduures Menageres/Excreta/Eau* (Elimination of Solid Waste/Excreta/Water)	UMATIC
53	**Le SIDA et Migration* (AIDS and Migration)	UMATIC

Source: DIEPS, MSP,

Note 1: *; produced by DIEPS, MSP

Note 2: (Translations of video title in French into English are not authorized)

Table 3.9-3 VIDEO LISTS ON HEALTH AND SANITATION AVAILABLE IN DIEPS (2)

No.	Title	System
54	**La Maladie Honteuse* (Shameful Disease)	UMATIC
55	**Spot sur l'Accouchement* (Spot on Birth Delivery)	UMATIC
56	*Medicaments DCI (MEG)* (Pharmaceuticals DCI(MEG) 23 minutes)	VHS
57	*Joli Coeur, La Maladie Diarrheique chez les Enfants, Evaluation Désydra* (Dear Heart, Child Diarrhoeal Diseases, Dehydration Evaluation)	Unknown
58	*Pièce de Theatre sur le TRACHOME en Hausa (2) K7 (1996*Drama on Trachoma in *Hausa* (2) K7 1996)	UMATIC
59	**Sida et Migtration (Troupe Yagi Dogo)* (AIDS and Migration)	Unknown
60	*La Generation d'Orphelins* (Orphans Generation)	Unknown
61	*Examen d'un Enfanta Présentant une Toux ou des Diff. Respiratoires (IRA)* (Examination on Child Cough and Respiratory Disorder)	Unknown
62	*Le Souffle Piece de Theatre en Zarma sur la PF (Messagers du Sahel)* (The Breathing, Drama on Family Planning in *Zarma*)	Unknown
63	*Le Relais de la Vie* (Life Relay)	Unknown
64	*3000 Scenarios Contre un Virus* (3000 Scenarios against Virus)	Unknown
65	*Le Tabac (Envoyé Spécial)* (Tobacco)	Unknown
66	*Kouakou l'Impasse Samadoom* (Kouakou Impass Samadoom)	Unknown
67	*Le Trachome (En Frencais)* (Trachoma (in French))	Unknown
68	*L'Argent Facile* (Easy Money)	Unknown
69	**Spot sur le Cholera (H.F.Z)* (Spot on Cholera (*Haousa*, *Zarman*, *Fulfulde*))	Unknown
70	Freedom from Trachoma	Unknown
71	*SIDA Il est Temps que l'Ecole Reagisse* (AIDS, It is Time for School to Fight)	Unknown
72	**Allaitement Exclusif au Sein* (Lactation excluding Breast-feed)	Unknown
73	*Sida Comprendre pour Prévenir, Vidéo pour Atelier de Formation* (Instruction on AIDS Prevention, Video for Training Seminar)	Unknown
74	*Premier Forum sur l'Enseignement de la Santé de la Réproduction* (1st Forum on Reproductive Health Education)	Unknown
75	**L'Onchocercose ou (La Ceite des Rivieres) 1998* (Onchocerciasis (River Blindness) 1998)	Unknown
76	*Mal Mystérieux (Haoussa)* (Mysterious Illness(in *Haoussa*))	Unknown
77	*Mal Mystérieux (Zarma)* (Mysterious Illness(in *Zarma*))	Unknown
78	*Nos Attentes* (Our Expectation)	Unknown
79	**Caravane Anti-SIDA* (Anti AIDS Caravan)	Unknown
80	*Sketch Trachome* (Sketch on Trachoma)	Unknown
81	*Documentaire sur le Trachome en Haoussa* (Documentary Film on Trachoma in *Haoussa*)	Unknown

Source: DIEPS, MSP,

Note 1: *; produced by DIEPS, MSP

Note 2: (Translations of video titles in French into English are not authorized)

4) The *Niamey* National Hospital (*Hopital National de Niamey*)

The *Niamey* National Hospital of the MSP is the biggest one in *Niger* that has 857 patient beds. Since 1995, the hospital has been conducting a hygiene educational program to the inpatients, and to their family member(s) live on the hospital premises for taking care of each inpatient. There is a specific division of "Health, Hygiene and Sanitation Services" (*Service d'Education pour la Santé et d'Hygiène et d'Assainisssement*) handling hygiene services in the hospital. This division plans an educational program by itself without any instruction and suggestion from the MSP. Main themes of the program are prevention of communicable diseases, a suitable management of wastewater and solid waste, and a sound attitude to sanitation. The program can be summarized in Table 3.9-4.

Table 3.9-4 HYGIENE EDUCATIONS BY THE NIAMEY NATIONAL HOSPITAL

Target Group	Patients and Patient Family Member(s) live in the hospital premises		
Frequency	Three times/week, approximately 25 - 30 minutes/program		
Languages	French and Local Languages (*Haoussa* and Others)		
Main Topics	1. Communicable diseases	4. Hygiene on clothes	7. Food sanitation
	2. Parasitic diseases	5. Environmental sanitation	8. Sanitary facilities
	3. Personnel hygiene	6. Hygiene activities	9. Hospital and health conditions

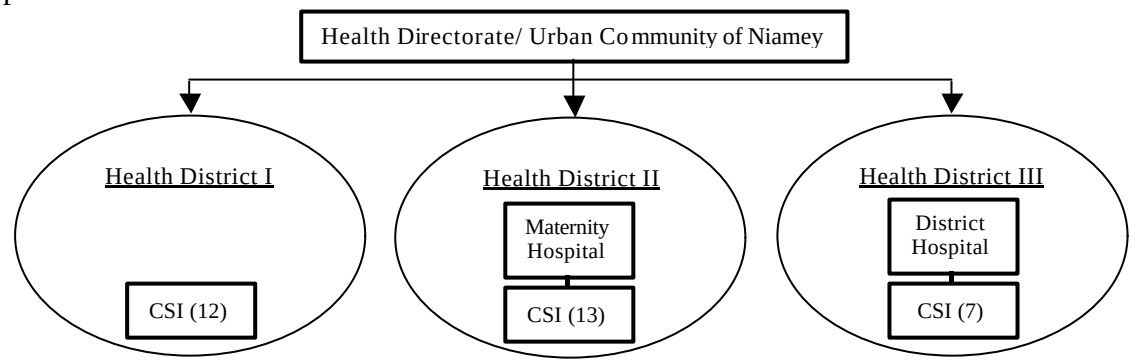
Source: Niamey National Hospital

Hygiene technicians of the hospital implement the program on the premises of each hospital ward respectively. The program is conducted by a simple oral presentation in several main local languages like *Haoussa*. Namely, specific lecture rooms and educational tools like printed materials or audio visual aids for the program are not available in the hospital at present, due to a shortage of a specific budget. The hospital perceives that these circumstances shall be improved for an effective implementation of the educational program.

5) The Health Directorate for the CUN (DS/CUN: *Direction de Santé/CUN*)

Health services at the commune levels in *Niamey*, the MSP organizes the Health Directorate for the CUN (DS/CUN: *Direction de Santé/ Communauté Urbaine de Niamey*). The DS/CUN divides *Niamey* into three health districts, namely Health District I, II and III, in accordance with the administrative divisions of the Commune I, II and III of the CUN respectively. These health districts provide primary and secondary health services, which are similar system to the Primary Health Care (PHC) discussed and defined at the *Alma-Ata* declaration by the WHO and the UNICEF in 1978. (The MSP adopted the concept of "Health for All by the year 2000" of the *Alma-Ata* declaration).

Each health district has an Integrated Health Center (CSI; *Centre de Santé Intégré*) as shown in Figure 3.9-2. Each CSI provides primary health services at the community levels including instructions of preventative health and sanitation, and health education to the population.



Note 1; CSI: Integrated Health Center

Note 2; CSI (Number): Total Number of CSI in each Health District

Figure: The JICA Study Team

Figure 3.9-2 THE DS/CUN AND HEALTH DISTRICTS

As for the education scheme in the DS/CUN, the CSI has a primary function. The activities of the health education scheme of the CSI can be summarized as follows.

- The education activities at the CSI are mainly diseases oriented.
- The DS/CUN prepares an action plan for the education at the CSI level.
- The action plan on the education is executed by each CSI.
- Health education on seasonal epidemic diseases like *malaria*, respiratory infection and so on based on each prevail season is implemented by each CSI.
- Related activities based on occasional instructions from the MSP are executed by the CSI.
- Organizing a health committee among secondary schools and executing an instruction study to the teachers. The main theme of this activity is aimed at HIV (*Human Immunodeficiency Virus*) and AIDS (*Acquired Immune Deficiency Syndrome*) issues.

(2) The Ministry of National Education (MEN; *Ministère de I'Eductaion Nationale*)

1) Education Systems

Public educational systems are formulated in the law of the educational system of *Niger* (Law No.98-12). Presently the system of primary and secondary education in *Niger* is that the primary school is for six years, the joiner high school is for four years and the high school is for three years. According to the law, the educational language to be used in the public

education is both French and the National Language. The school age at the Initiation Class (CI: *Cours d'Initiation*) of primary school usually starts at 7 years old, however, may start at 6 years old or younger depending on ability of each child. The following tables show data on the primary and secondary education in *Niamey* and of *Niger*. According to the data, it is identified that the primary schools' attendance ratio (as gross) in the CUN slightly shows a reduction trend from 1995 to 1999. However, the same ratio throughout *Niger* shows an increase trend during the five years. Including out of-school age, flunked and transfer pupils may cause the ratio showing more than 100% in Table 3.9-6.

Table 3.9-5 NUMBERS OF SCHOOL AND STUDENT (PUPIL) IN CUN

	1997		1998		1999	
	School	Student	School	Student	School	Student
Primary school	190	92,904	195	96,070	205	98,281
Joiner High school	40	28,125	40	28,912	47	27,192
High school	14	8,242	17	8,699	18	8,695

Source: DEP/MEN Service *Statistique*

Table 3.9-6 PRIMARY SCHOOL ATTENDANCE RATION IN CUN (%)

Year	1995	1996	1997	1998	1999
Male	*n/d*	*n/d*	*n/d*	102.0	99.0
Female	*n/d*	*n/d*	*n/d*	97.8	96.2
Total	*n/d*	100.7	100.1	99.9	97.6

Source: *Annuaries des Statistiques Socliares*, DEP/MEN,

Note: n/d; no data

Table 3.9-7 PRIMARY SCHOOL ATTENDANCE RATIOS IN NIGER (%)

Year	1995	1996	1997	1998	1999
Male	36.9	38.7	37.4	39.0	*n/d*
Female	22.4	22.2	23.4	25.4	*n/d*
Total	29.5	30.1	30.4	32.2	34.0

Source: Données du Document Evaluation dle l'EPT 2000, DEP/MEN,

Note:n/d; no data

2) Public Education on Sanitation

The Ministry of National Education (MEN) has not developed the national policy on public education on sanitation. The MEN has not implemented specific programs on public education on sanitation. According to the MEN, such programs on public education on sanitation would be planned and implemented by the Ministry of Public Health (MSP). The MEN, however, has executed related actions on public education on sanitation within the scope of it responsibility as follows;

- The MEN instructs schoolteachers, parents of each student (pupil) and students (pupils) in environment and health in school through another scheme of education programs.
- The MEN has developed a system of public education on school sanitation and health within the context of school curriculums of home economics, the civics and ethic. As an example, Table 3.9-8 shows authorized school programs related to sanitation in a curriculum of home economics of elementary school.
- The MEN has conducted public education on school sanitation and health within the framework of a project of the "School and Health (*Ecoles et Santé*)" in cooperation with the Ministry of Public Health (MSP) and the Ministry of Water Resources. The 3.9-9 shows the project summary.

Table 3.9-8 SCHOOL PROGRAMS ON SANITATION IN CURRICULUM OF ELEMENTARY

Subject	CI(1st grade)	CP(2nd grade)	CE1(3rd grade)	CE2(4th grade)	CM1(5th grade)	CM2(6th grade)
Cooking	(*not specified on sanitation*)	(*not specified on sanitation*)	(*not specified on sanitation*)	(*not specified on sanitation*)	Notion of Sanitation and Economy	(*not specified on sanitation*)
Home Economics	Sweep up classroom and schoolyard		Sweep up and mop classroom and schoolyard	Clean up house (inside and outside)	Discharge of wastewater and garbage. Notion of road sanitation	Extermination of harmful insects at household
Health Sanitation	- Body Sanitation : How to use toilet and wash body - Head Sanitation : How to take care of hair - Hand Sanitation : How to take care of nails - Oral Sanitation : How to take care of tooth - Other Sanitation : How to take care of ear, nose, eye and so on					

Source: *" Progremmes de l'Ensegnement du Premier degré", 1990, INDRAP, MEN*
Note :CI: *Cours d'Initiation* (Initiation Class) CP: *Cours Preparatotire* (Preparatory Class)
CE1: *Cours Elementaire 1ere Anneé*(First Elementary Class)
CE2: *Cours Elementaire 2e Anneé* (Second Elementary Class)
CM1: Cours Moyen *1ere Anneé*(First Middle Class) CM2 : Cours Moyen *2e Anneé* (Second Middle Class)

Table 3.9-9 THE SCHOOL AND HEALTH PROJECT

Project Period	15th July 1997 –31st July 2001
Project Area	1.Priority Area : *Dosso* District 2.Secondary Area: Commune in *Dosso* city
Implement Agency	*Lux-Development* (*Luxembourg* international cooperation agency)
Related Ministries	Ministry of National Education, Ministry of Public Health , Ministry of Water Resources
Objectives	1.Overall objective : to improve the education system in Niger 2.Special objective : to improve health & sanitation conditions of schoolchildren in the project area
Project Sectors	1.School infrastructure sector 3.Environmental sector 2.Sanitation/drinking water/public health sector 4.Education/enlightenment sector
Target Group	1.Priority : Schoolchildren in the project area and their family member 2.Secondary : Teachers, education advisor, education committee, *Dosso* primary education office

Source: *" NIG/008 Ecoles et Santé" , 30 Juin 1997, Lux- Development*

According to the report of the "*Ecoles et Santé*", the *Niger* government decided in the government macro economic program supported by the World Bank and the IMF, to give priority to the sector of school education and health on the ground of the following ideas.

- Improvement of labor qualities and the living environment is realized by the best education.
- Improvement of health and sanitation conditions is necessary for economic development.

(3) The Council of Environment for Sustainable Development (CNEDD: *Conseil National de l'Environnement pour un Développement Durable*)

For conservation of environment and sustainable development of *Niger*, the Government has organized the "National Council of Environment for Sustainable Development (CNEDD)" under the Cabinet of Prime Minister (*Cabinet du Premier Ministre*) as an interdepartmental function for discussing the national policy on environment. So far, the following plans have been prepared by the CNEDD.

- Prevention of desertification program
- Sustainable development for water resources management
- Biodiversity

- Sustainable development for energy
- Climate change
- Urban living environment

The Council discusses public awareness on environment as one of topics on environmental issues. Specially, specific programs or actions related to heightening public awareness on environmental sanitation field are going to be prepared in the framework of the urban living environment.

(4) The Ministry of Environment and Prevention of Desertification (MED: *Ministère de l'Envieonnement et de la Lutte Contre la Desertification*)

The Directorate of Environment (*Direction de l'Envieonnement)* of the Ministry of Environment and Prevention of Desertification (MED) is the key office for planning environmental education in *Niger*. For heightening public awareness on environmental issues, a strategy on environmental education is prepared by the Directorate through the Division of Pollution Control Services (*Service de lutte Contre les Pollutions et Nisances*), which is the office to execute the national policy for the prevention of environmental pollution and nuisances, and protection of the environment. In addition to the strategy on environmental education, there are several programs on environmental education.

An annual program on environment is prepared every year. Action plans on environmental education are going to be included in the annual program. Main target groups of the environmental education are women in rural districts and the younger generation. There are, as well, the programs targeted to the elementary school, the high school and the districts (*quartier*) respectively. As for environmental education targeted to the elementary school, the plan prepared by the MED is going to be adopted into one education program of the Ministry of National Education (MEN). Consequently, the MEN conducts the education program.

The MED, however, does not have a specific office handles environmental education. The MED plans environmental education program(s) in accordance with the strategy and so on. However, the execution of each program is going to be practically by other official entities like the Ministry of National Education (MEN), private companies and local NGOs. As a matter of fact, it can be said that principal functions of the MED are to prepare related plans and coordinate among official entities on environmental issues.

(5) The Ministry of Water Resources (MRE; *Ministère de Resources en Eau*)

The Ministry of Water Resources (MRE) prepared the Manual on Instruction of National Rural Water Supply Programs (*Guide National d'Animation des Programmes d'Hydraulique Villageoise*) in cooperation with France in 1989, which was revised in 1992. The manual is mainly for the operation and maintenance (O/M) of wells and other facilities for a rural water supply. From the viewpoint of water quality and human health, the manual refers instructions and measures on how-to prevent water contamination caused by human activities. The manual is being used as an education tool on water and sanitation to the population involved in rural water supply projects.

As a matter of fact, programs of hygiene education and public awareness on water and sanitation are generally included in each rural water supply project of the MRE, having occasionally cooperation with the Ministry of Public Health (MSP). However, such a

manual as an education tool for the urban water supply and for *Niamey*, related activities and offices has not seen in the MRE at present.

(6) The Urban Community of *Niamey* (CUN; *Communauté Urbaine de Niamey*)

There is no specific scheme on heightening public awareness on sanitation in the Urban Community of *Niamey* (CUN) at present, except past several attempts and functions of the "*Press Attaché* (PA)" of the CUN, which are summarized as follows:

1) Sanitation, Citizens Issue (*Assainissesment, l'Affaire de Tous*)

As one of emergency measures for sanitation issues of *Niamey*, a film of "Sanitation, Citizens Issue (*Assainissesment, l'Affaire de Tous*)" was produced in local languages of *Haoussa* and *Zarma*, and in French in 1987 based on the former master plan of *Niamey* sanitation improvement of 1981. The film was showed at a Juvenile Hall (*Maison des Jevnes*) of each district (*quartier*), and was broadcasted by a national TV station in the CUN. This attempt, however, terminated in a short period due to a shortage of operating budgets and, especially, financing systems.

2) Community Committee of the Living Environment Improvement of the CUN

From 1992 to 1995, the CUN had implemented activities related to the improvement of sanitation situations and public awareness on sanitation. As one of the activities, the CUN organized the Community Committee of the Living Environment Improvement (*Comité dit chargé de l'Amélioration du Cadre de vie des Populations de la Communauté Urbanie*) headed by the deputy mayor to carry out the following actions:

- To coordinate related entities active in the field of sanitation improvement
- To hold "The Sanitation Day" in the last Saturday of each month for conducting hygiene activities.
- To prepare an enlightenment program on the living environment through producing a TV program on the public awareness, which was broadcasted in a TV program of the "Life of Commune" every Wednesday by the *Sahel* TV. As well as preparing spot TV commercial for heightening awareness on sanitation infrastructures and playing a drama on the living environment.

Unfortunately, such community enlightenment and public awareness activities in the CUN have been suspended since 1996 due to the political unrest.

3) The *Press Attaché* (PA)

The main role of the *Press Attaché* (PA) is to coordinate public relations, and to control public information and the mass media in *Niamey*. Therefore, the PA occasionally conducts similar activities related to heightening public awareness on sanitation and health. These activities by the PA, however, are limited to release information concerned as follows.

- To release news of epidemiological disasters such as an outbreak of *Cholera* in *Niamey* to the mass media based on a request of the Ministry of Public Health.
- To disseminate information on preventative measures for such a disaster to the population.
- To disseminate seasonal epidemiological news, information or warning of *Malaria* and others health and sanitation issues.

In addition to the general services noted above, the office has supported the "Clean City (*Ville Propre*)" program proposed by one private radio station (*Souda* Radio) in *Niamey* since 1996.

The office provides the budget of 4,500,000F/CFA to the program every year (up to year of 2000) based on a contract between the CUN and the station. A main objective of this instructive program is to heighten public awareness on the cleanliness of *Niamey* and to disseminate the following messages from the CUN to the citizens.

- The Policy on environmental preservation by the President of the CUN
- Major topics on environmental issues and critical sites
- The necessity of community participation

The following radio stations have similar radio programs;

- The "Voice of *Sahel*" has been broadcasting a radio program of the "City and Its Issues". As one of the issues, sanitation fields are dealt with in the program. Between 1991 and 1995 the program was broadcasted in every Saturday. It, however, has been occasionally on the air since 1996.
- The "*Tambaro* FM (Voice of the Ladies) " has voluntarily started to broadcast the same theme of the "Clean City" with a different scenario since the year 2000.

According to the office, almost every household has at least one radio receiver in *Niamey* at present. The diffusion of TV set of *Niamey* was in a ratio of one TV set to two households in 1995. Therefore, it can be considered that radio is one of effective tools for heightening the public awareness activities. Table 3.9.10 shows data of the mass media in *Niamey*.

Table 3.9-10 MASS MEDIA IN NIAMEY

Media	National(Public)	Private	Broadcasting hour
Radio Station	1	5	5:30am – 11:00pm
TV Station	1	2	7:00pm – 11:00pm
News Paper	2	15	-

Source: Press Attaché, CUN

(7) Communes

1) Commune I

The office of Sanitation Engineering Services (*Technique Assainissement*) is in charge of heightening public awareness on sanitation in addition to general sanitation engineering services including sewerage, road and solid waste services of the Commune I.

Principal viewpoints of public awareness on sanitation of the Commune I can be summarized as follows:

- To implement a urban sanitation campaign for improving the environment clean
- To promote community participation
- To organize a hygiene committee in the commune

The Commune I conducted the following related activities.

- The Campaign of Commune Cleansing (*Coupe Communale de Salubrité*)
- A Hygiene Project by the JADE (a local association; *Jeunesse Action et Développment*)
- A Cleansing Project by the FABA (a local NGO; *Association pour la Salubrité*)
- The Roll Back *Malaria* Project by the UNICEF

In addition to above specific activities, cleansing of public roads and public spaces of Commune I has been carried out every week by the district (*quartier*) sanitation committee, the young men's association and other private entities.

As a matter of fact, however, activities related to public awareness on sanitation in the Commune I are occasionally implemented and limited. The Commune I perceives that the following are difficulties to implement the sound public awareness activities.

- Lack of enough budgets
- There are no specific devices like audiovisual-aids, a copying machine and a handy speaker for hygiene education.

2) Commune II

The principal viewpoint of heightening public awareness on sanitation of the Commune II can be summarized as follows:

- To improve the living environment of the population through activities on heightening public awareness on sanitation and public health in each district (*quartier*), which are for promoting collections of domestic waste, wastewater, desludging of road side gutters and hygiene situations.

The Commune II conducts the following activities:

- Officers in charge of enlightenment (*Agent d'hygiène*) usually visit every household in each district (*quartier*) for the related education and instruction.
- An Enlightenment Team (*Agent*) of the Commune II conducts hygiene education to target groups.
- The main target of hygiene education is the head of a household.
- The head consequently educates women and children of each household as the secondary target.

The cooperative relations between the Commune II and other entities;

- There is a cooperative relationship between the MSP and the Commune II in the framework of hygiene education.
- The MSP loans a technical official to the Commune II.
- Collections of plastic bags are done in cooperation with the MED.
- The CUN provides related equipment to the Commune II.
- The following NGOs, NPOs and Associations are active in sanitation and/or health issues, and hygiene education in Commune II:

    - The *Niger* Deaf Person's Association (*Association des Sourds du Niger*)
    - The SROM (a private company)
    - The SAPHTA (a local NGO; *Salubrité Propreté Hygiène Techniques Assainissements*)
    - The FABA (a local NGO; *Association pour la Salubrité*)

The Commune II perceives that the following are difficulties to implement the sound public awareness activities.

- No positive community participation in public sanitation activities

- Less positive community participation in enlightenment meetings
- No specific media to disseminate related information

3) Commune III

The Office of Hygiene and Sewerage Services (*Service hygiene / Assainissement*) is in charge of heightening public awareness on sanitation in addition to the general sanitation and sewerage services of the Commune III.

The principal viewpoint and a plan of the public awareness on sanitation of the Commune III can be summarized as follows:

- The basic policy on public awareness on sanitation is that committees on sanitation and sewerage (*Comité d'Hygiène/Assainissement*), which are organized in the Commune III, conduct related activities in all districts (*quartiers*) in the Commune.
- One committee on sanitation and sewerage has been organized in each district of *Lamorde, Karadje, Pont-Kennedy* and *Djamyowe* respectively.
- A hygiene control team has been organized to conduct hygiene education including a sound management related to solid waste, wastewater, foodstuffs, and pests and insect vector controls to each household in accordance with programs prepared by the Office of Hygiene and Sewerage Services.
- The Commune III plans a sanitation improvement campaign to improve the sanitation and hygiene situation. The campaign is to arouse a spirit of rivalry among districts, and offers a prize to a district which achieves the best sanitation conditions

The cooperative relations between the Commune III and other entities;

- The MSP loans one of executive officials of the MSP to the Commune III for promoting hygiene education.
- In cooperation with the Ministry of Environment, two teams conduct public awareness activities on air pollution and environmental pollution.
- The Commune formulates to control NGOs and NPOs (Non-Profit Organizations) activities within the administration of the Commune. The Commune III supports all public service programs conducted by NGOs and NPOs.
- The following NGOs, NPOs and Associations are active in sanitation and/or health issues, and hygiene education in Commune I:

    - The AFN (*Niger* Women's Association; *Association des Femmes du Niger*)
    - The SAPHTA (Local NGO; *Salubrité Propreté Hygiène Techniques Assainissements*)
    - The RDFN (*Niger* Women's Democratic Union; *Rassemblement Démocratique des Femmes du Niger*)
    - The ANPE (*Niger* Employment Promotion Association; *Association Nigeriènne pour Promotion de l'Empoli*)

The Commune III conducted the following related activities.

- In 1998 the UNICEF constructed low-cost latrines of the "San Plat System" in the *Saguia* and the *Kirkissoye* district as a pilot project (*Project Pilot de Latrinisation*).
- As one of activities of the pilot project, a district sanitation promotion committee (*Comité d'animation*) was organized in each district by getting supports from the UNICEF.
- The committees maintain the toilets and instruct the how-to use of the toilet to the population.

The commune III perceives that the following are difficulties to implement the sound public awareness activities.

- No specific budgets for heightening public awareness on sanitation
- No audiovisual aids and other related materials for hygiene education
- Shortage of vehicles and motorbikes for moving the hygiene control team.
- Shortage of the staffs. Only two staffs in the hygiene control team are available at present to 5,281 population in commune III (the population data is as of 1988)
- Re-education and re-training of staffs.

(8) International Organizations

International organizations that promote activities related to public awareness on sanitation within the framework of each project or program are identified in *Niamey* as summarized in Table 3.9-11.

Table 3.9-11 INTERNATIONAL ORGANIZATIONS

Organization	Activities
UNICEF	The UNICEF prepares programs on sanitation and wastewater of *Niamey* in the Sanitation Project of *Niger* (2000-2004). In the programs, hygiene education is going to be proposed. The main target groups of the education are principally women and schoolchildren.
UNDP	The main activities of the UNDP are poverty oriented.
WHO	The main activities of the WHO are health oriented. The WHO and the UNICEF have a meeting every week for coordinating health and hygiene education and other health and sanitation issues.
World Bank	The WB has been conducting the Urban Environmental Infrastructure Improvement Projects (PRI) and the Water Sector Project (PSE). In these projects, plans of hygiene and environmental education are proposed. The PSE will allocate 5% of the total project budget to the activities of public awareness on water and sanitation.

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3.9.2 Health Situation

In general, reviews of health situation are necessary for planning and preparing a suitable hygiene education plan based on infectious and parasitic diseases that are prevalent in target areas in developing countries. The attempts were made, therefore, to get a basic understanding of health situations in *Niamey*, on several limited available data and information as follows.

(1) Morbidity in the CUN

Table 3.9-12 shows the leading causes of morbidity in the CUN*. According to the data, excluding *Injury/burn* and *Cardio Vascular diseases*, such diseases of *Malaria, Respiratory infections & Cold, Diarrhoea* and *Pneumonia* are rampant in the CUN in recent years. These diseases are classified into what is called communicable diseases (including parasitic diseases). In general, health risks of these communicable diseases are influenced by the status of environmental situation. Namely, bad conditions of hygiene and environmental sanitation cause the communicable diseases.

According to the WHO, "water contaminated by human, chemical or industrial wastes can cause a variety of communicable diseases through ingestion or physical contact". The WHO summarizes these communicable diseases to four categories as shown in Table 3.9-13.

Table 3.9-12 LEADING CAUSES OF MAORBIDITY IN CUN*

(Cases)

Year		1995	1996	1997	1998	1999	Total
1	*Malaria Total*	93,622	159,760	124,778	134,475	88,873	601,508
2	*Respiratory infection & Cold*	67,663	119,161	110,340	54,576	32,284	384,024
3	*Injury/burn*	36,903	61,887	44,614	37,495	23,459	204,358
4	*Diarrhoea Total*	19,921	53,015	51,021	26,553	17,643	168,153
5	*Otorhinolaryngology ailment*	23,340	45,366	41,880	21,490	10,720	142,796
6	*Skin disease*	22,140	26,851	25,616	21,064	13,084	108,755
7	*Pneumonia Total*	6,602	17,789	24,501	31,612	16,644	97,148
8	*Conjunctivitis*	14,268	20,942	16,454	22,445	8,481	82,590
9	*Obstetrics and gynecology*	6,369	11,304	8,369	8,251	7,381	41,674
10	*Dysentery*	6,206	13,623	10,813	6,508	4,154	41,304
11	*Urinary diseases*	6,332	7,845	6,568	5,416	4,043	30,204
12	*Measles*	13,081	644	876	272	3,944	18,817
13	*Cardio Vascular*	6,797	3,041	3,187	1,818	1,507	16,350

Source: SNIS *(Systeme National d'Information Sanitaire*), MSP, (Table was arranged by the JICA Study Team)
Note: * Due to data collection system, these data are not included data from National Hospitals in Niamey.

Table 3.9-13 WHO CATEGORIES ON COMMUNICABLE DISEASES

	Categories	Causes	Typical Diseases
1	Water-Borne Diseases	Caused by the ingestion of water contaminated by human or animal faeces or urine containing pathogenic bacteria or viruses	*Cholera, Typhoid, Amoebic, Bacillary Dysentery, Other Diarrhoeal Diseases*
2	Water-Washed Diseases	Caused by poor personal hygiene and skin or eye contact with contaminated water	*Scabies, Trachoma, Flea, Lice and Tick-borne Diseases*
3	Water-Based Diseases	Caused by parasites found in intermediate organisms living in water	*Dracunculiasis, Shistosomiasis, Other helminthes*
4	Water-Related Diseases	Caused by insect vectors, which breed in water	*Dengue, Filariasis, Malaria, Onchocerciasis, Trypanosomiasis, Yellow Fever*

Source; WHO (http://www.who.int/inf-fs/en/fact112.html)

Therefore, situations of communicable diseases in *Niamey* showed in Table 3.9-12 can be roughly evaluated that Water-Related Disease (*Malaria*), Water-Borne Diseases (*Diarrhoeal, Dysentery*) and Water-Washed Diseases (*Conjunctivitis, Skin diseases*) are prevalent in accordance with the WHO categories.

(2) Precipitation and Diseases

In order to identify yearly trends of diseases of the CUN, the following principal comparison was made on between monthly (each trimester) changes of the precipitation of *Niamey* and three typical diseases of the CUN.

Table 3.9-14 shows each trimester change of the precipitation in the CUN of 1998. And Table 3.9-15 shows each trimester change in cases of *Malaria*, *Pneumonia* and *Diarrhoea* diseases in the CUN of 1998. Based on these data, approximate functional analyses were made to evaluate the sequence between the precipitation and the diseases. The results of the analyses can draw functional graphs of Figure 3.9-3, Figure 3.9-4, Figure 3.9-5 and Figure 3.9-6.

Table 3.9-14 PRECIPITATION IN CUN OF 1998 (AT NIAMEY AIRPORT)

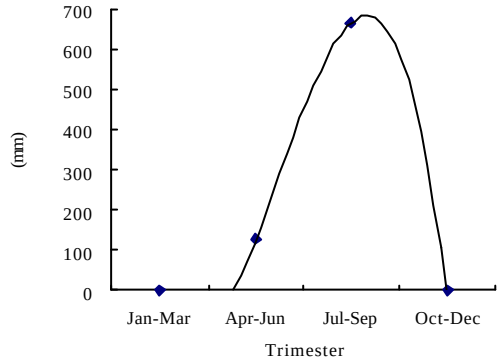
Trimester	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Total
Precipitation(mm)	0.0	126.0	665.0	1.0	792.0

Source: *Laboratoire D'Hydrologie,*

Table 3.9-15 DATA OF DISEASES IN CUN OF 1998

Trimester	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Total
Malaria (cases)	20,998	16,059	45,935	51,483	134,475
Pneumonia (cases)	8,058	4,466	3,773	15,315	31,612
Diarrhoea (cases)	6,451	7,125	6,899	6,078	26,553

Source: SNIS (*Systeme National d'Information Sanitaire*), MSP



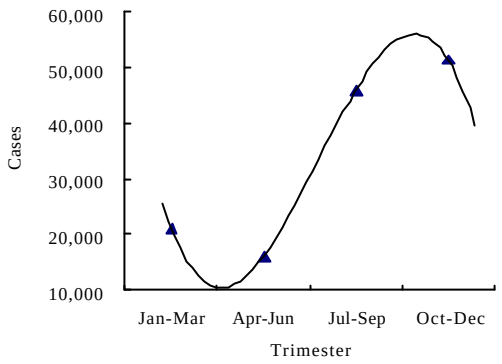
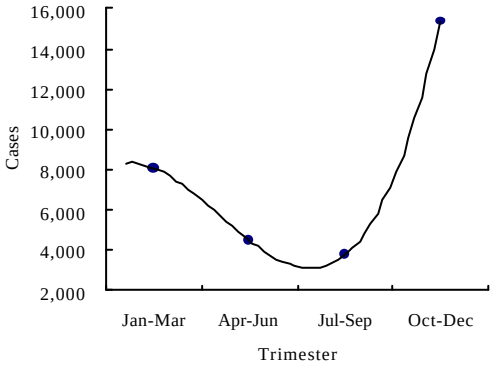


Figure 3.9-3 PRECIPITATION IN CUN (1998) **Figure 3.9-4 MALARIA IN CUN (1998)**



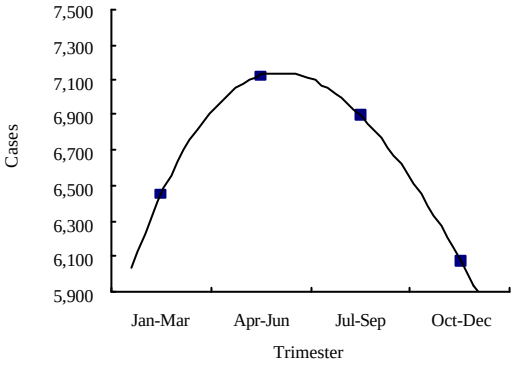


Figure 3.9-5 PNEUMONIA IN CUN (1998) **Figure 3.9-6 DIARRHIA IN CUN (1998)**

In accordance with the data analysis, the link between the precipitation and each disease can be roughly summarized as follows. These analysis and identifications may be used for preparing a plan of hygiene education.

Table 3.9-16 SEQUENCE BETWEEN PRECIPITATION AND DISEASES

	Malaria	Pneumonia	Diarrhoea
Precipitation	A similar trend with a time lag on the peak point	Almost reverse trend	A similar trend with a time lag on the peak point

The JICA Study Team

3.9.3 Present Situation of Public Awareness on Sanitation

(1) Public Awareness Survey on Sanitation

In order to identify the present situation of public awareness on sanitation in the CUN, the JICA study team conducted a public awareness survey on sanitation. The following show comprehensive aspects of practices on sanitation, public awareness, and health care (including roles of women) in *Niamey* among the results. The details and all results of the survey appear in "4.3 Public Awareness Survey" of this report.

1) Practices on Sanitation (JICA survey)

- Nearly 70% of the households answer that their children are in charge of handling a waste bin and disposing of waste.
- 98.5 % of the respondents perceive that a good collection of waste and their disposal in a good condition to improve sanitation of the city are a priority action to be taken.
- 93.8% of the respondents have not ever complained to the communes about sanitation problems.
- Nearly 70% of the respondents think that making such a complaint is a useless, and 20% think a lack of the motivation.

2) Public Awareness (JICA survey)

a. Information source

- 65.4% of the respondents perceive that their children receive information about sanitation at school.
- 19.4% of the respondents have ever received advice related to sanitation and health from the City officials.
- Among the 19.4% above, such advice received were "to maintain your compound clean including waste bins, yards and toilets (about 60%)", "to dispose correctly domestic waste at authorized sites (34.9%)", and "to adopt hygiene rules of household (7.9%)".

b. Cleanliness campaign

- Nearly half of the respondents (49.1%) has ever participated in some cleanliness campaign(s) or campaign(s) for improving public salubrity conditions of the surroundings. Approximately 82% of which answer that housewives participated in such a campaign(s).
- The purpose of such a cleanliness campaign, which has ever been heard or contributed by the respondents, was "cleansing of public places and street sweeping (about 68%)", "eradication of illegal waste dumping spots (16.4%)", "protection measures against malaria (about 8.9%), and "appropriate storage of waste in the waste bins or containers (3.7%)"
- 42.3% of the respondents receive information on such a campaign through the radio, 10.8% through a local association, 8.0% through a municipal official, and approximately 5% through the TV.
- Only 37.0% of the respondents identify that an entity responsible for implementing such a campaign.
- 99.4% of the respondents perceive that such campaigns are a useful activity and should be reinforced.

c. Collaboration

- 94.4% of the households do not belong to a volunteer group for cleaning streets regularly.
- More than 90% of the respondents who have not ever participated in any campaigns answered that they are ready to collaborate in such a cleansing campaign.
- 80.2% of the respondents are ready to pay for improving the sanitation conditions.

3) Health Aspects (JICA survey)

- 99.7% of the respondents perceive that a discharge of solid waste and wastewater in streets causes bad for human health.
- 99.7% of the respondents perceive that housewives play an important role for maintaining or improving good health in the home.
- Such roles of housewives perceived by the respondents are "a daily hygiene education for children (nearly 57%)", "the cleansing of kitchen (about 33 %)", "cares for family health (10%)", and "care for drinking and cooking water (10%)".

(2) Review of PRI Survey

The PRI project conducted a survey on household practices and awareness in the field of urban sanitation of *Niamey* from February to March in the year 2000. The objective of this study is to understand practices and behaviour of people and their expectations and willingness to improve the present sanitation conditions.

The JICA Study Team reviewed the report of the PRI survey to complement the awareness survey conducted by the Team and to understand deeply the actual situation of those practices and awareness of the population. The following shows a brief summary of the review, which is limited to household practices and awareness in the field of sanitation. The full-scale analytic summary of the PRI report appears in Appendix C.3 of this report.

1) Practices on Sanitation (PRI survey)

a. Toilets and Defecation

- The usage rate of latrines in the compounds is estimated to be around 93% of the adults and 86% of the children.
- 31% of the households throw excreta of the babies away in the surroundings, namely streets, gutters or waste deposits.
- In the compounds with traditional latrines, 81% of households did not answer the defecation place. The remaining answered such a practice do in a waste deposit site or "in the bush", namely open defecation.
- Willingness to improve the present conditions is expressed by only about 45% of the households. Less than 45% of families without a latrine and 54% of those with a traditional latrine feel the necessity to improve the conditions.
- Cleaning for traditional latrines is done at best once per week in three fourth of the households, and the housewives always do the cleaning.

b. Solid waste

- More than 90% of the households dispose of their waste outside the compound, while the others incinerate the waste inside. Only 45% of households discharge garbage in

authorised deposit sites. However in areas covered by the municipal waste collection services, the rate is more than 80%.
- Half of the households discharge their solid waste to the surroundings (and 28% of them do the same for wastewater).

c. Wastewater

- More than 45% of the households, their waste are discharged by their children, against less than 20% by the adults of the family members. However, disposing by housekeepers is less than 30%.
- 11.4% of the households discharge solid waste and wastewater into a gutter and/or a street.
- About 73% of the households discharge wastewater into a street.

2) Public Awareness (PRI survey)

a. Human excreta

- The observation survey shows that one compound of 10 has excreta around the houses, and one of 25 has excreta inside. In most of cases, there is no any latrine, or is a traditional latrine available. These conditions of excreta are felt as discomfort for 84% of the households concerned. However, at the same time, about 77% of the households have a traditional latrine are satisfied with the conditions.
- These conditions of the disposal, only 12% of the households feel them as a problem.

b. Solid waste and wastewater

- 81% of the households have litter inside the compound, and 84% of those have litter around the compound feel discomfort in such situations respectively. 19% of the households do not feel any discomfort in the situations
- In areas have public waste containers, one-third of the households is dissatisfied with the collection services of the containers.
- 65% of the households feel wastewater is a source of discomfort in the urban quarters.

c. Collaboration

- 98% of the households are ready to contribute to improve the sanitation conditions in their living areas, either by participating in hygiene heightening activities like a campaign (less than 70%), or by a financial contribution (30%).

3) Health Aspects (PRI survey)

- *Malaria* is identified by 85% of the households as a frequent disease, and eye sickness is perceived by 14% as the second disease. Other diseases identified are shistosomiasis (*bilharziasis*), diarrhoea and scabies.
- 27% of the households perceive the link between disease and human excreta, 51% perceive between it and garbage, and 76% perceive between it and rainwater. (63% between it and wastewater)
- 85% of the housewives are aware of health risks of children related to excreta in streets.
- For 56% of the households, stagnation of rainwater is regarded as a nuisance in terms of

floods and *malaria* disease.

(3) The outcome of JICA and PRI surveys

In accordance with a comparative evaluation between the JICA survey and the PRI survey, public awareness on sanitation in *Niamey* can be concluded as follows:

1) Practices on Sanitation

a. Defecation

- People practice open defecation.
- The practice by the children is higher than by the adults.

b. Solid Waste and Wastewater

- More than half of the households discharge garbage out of authorised deposit sites.
- Most of the households discharge wastewater into streets or gutters.
- The children mainly do handling of a waste bin and disposing of waste.

2) Awareness

a. Human Excreta

- Existence of human excreta in the outside is felt as discomfort by most of the people.
- However, a few people dose not feel the condition as a problem.

b. Solid Waste and Wastewater

- Most of the people feel discomfort in the situation of the discharge manner.
- Many of the people are not satisfied with present collection services of waste containers.

c. Willingness to Collaboration

- Most of the people are ready to pay for improving sanitation conditions
- Most of the people are ready to contribute to improve sanitation conditions
- Many of the people can collaborate in a cleansing campaign

3) Health

There are clearly different results between two surveys on health aspects as follows:

- The JICA survey : 99.7% of the respondents perceive the link between solid waste and disease, and between wastewater and disease (the JICA survey).
- The PRI survey : 27% the respondents perceive the link between excreta and disease, 51% perceive between it and garbage, and 76% perceive between it and rainwater. (63% between it and wastewater)

In the PRI survey, Q47 is that "Do you think that there is, generally speaking, a link between these diseases and the way of disposal (proposed items: excreta, garbage, wastewater and rainwater)?" The precedent question is Q46 about "What is the most frequent disease in

your household?" Answer to Q46 is *Malaria* in 85% cases. Accordingly, in response to Q47, wastewater is known to be a cause of *Malaria*, and 76% are aware of such a link in general. However the link between *Malaria* and excreta / garbage is mostly not recognised, while the link is possibly recognised by 25% of the households which mentioned other diseases than *Malaria*, which finally results into 51% and 27% perception. In other words, the method of questioning results into an apparent minimisation of the people's perception about the disease -sanitation link. Q47 should not be considered as a general question between disease and sanitation, at the difference of the JICA question, which is more global in scope.

- PRI survey: as for excreta and disease, 85% of housewives are aware of the link.

This is response to Q89 that "Do mothers know that excreta are dangerous for health?" This question is clear and while only 27% of households perceive the link in Q47, it increases to 85% in Q89, which is also confirmation of the fact that people reasonably do not make the link between excreta and *Malaria* in Q47, for example.

In conclusion, the JICA and the PRI survey results are concordant each other, and should be interpreted as follows:

- People are aware of disease effects of garbage and waste water (JICA)
- People are strongly aware of rain water / waste water / *Malaria* links (PRI)
- People (women) are strongly aware of excreta / disease links (PRI)

3.9.4 Identifications

Based on the evaluation and appraisal of the initial study and review on the present situation of public awareness on sanitation noted above, it could be considered that the following items would be at least important keys for preparing a plan on hygiene education, which discusses in Chapter 13.

- Policies and Plans

- Preparation of a policy and a plan on hygiene education for *Niamey*.
- A clear definition of hygiene education, health education and environmental education.

- Organizations and Systems

- A clear demarcation of roles of related Ministries in the field of hygiene education
- Creation of a multi-sectorial approach and official systems for hygiene education
- Roles of the CUN, each Commune, School, Community Association and NGO
- Community participation and participatory approaches

- Preparation and Research

- Allocation of specific national budgets for hygiene education and related activities
- Preparation of data on health including mortality, morbidity and so on
- A research for analyzing and evaluating methods on hygiene education
- A training of experts

CHAPTER 4. FIELD SURVEY

CHAPTER 4. FIELD SURVEY

4.1 TOPOGRAPHIC SURVEY

The topographic survey was subcontracted to BETLAS-GEOMESURE. The survey was carried out on 3 ha area of the proposed WWTP site as per former M/P, 1 ha area of the UASB pilot plant site constructed under this study, and 1 ha area of the Jyokaso site also constructed under this study. In addition, 10 km trunk sewer route as proposed in the former M/P, which was along the road, was also surveyed. WWTP site is 2.5 km towards airport from tail end of the trunk sewer and nearly 7.5 km from Gaweye. The topographic survey covered leveling, longitudinal profile, and plane table survey. Figure 4.1-1 and 4.1-2 show the exact location of the topographic survey sites.

4.2 SOIL INVESTIGATION

The soil investigation was subcontracted to SENAGRHY S.A. The boring was done at 3 points on the proposed WWTP site as per former M/P, at 1 point on Jyokaso site constructed under this study in Bandabari primary school II and at 1 point on UASB site constructed under this study. For each point, boring/standard penetration test (depth 30 m) and soil investigation (sampling at every 6 m until 30 m depth) were carried out. Density, granulometry, sedimentometry, limits atterberg, natural water tenor, essay protector, essay CBR, essay RIP and essay consolidation were investigated. Figure 4.2-1 and 4.2-2 show the exact location of the soil investigation sites.

4.3 PUBLIC AWARENESS SURVEY

4.3.1 Outline of the Questionnaire Surveys

The survey about households practices and awareness, undertaken by the JICA Study Team by subcontract with the FABA Association (see also 3.7.2) has focused on the perception, awareness and practices of households, industries and institutions in the field of hygiene and sanitation. Similar and recent surveys had been already performed with the same targets. These surveys are briefly described in order to better understand and justify the objectives of the JICA survey.

a) PRI and PSE Households Surveys

The state of home sanitation and sanitary uses in terms of excreta disposal, waste water disposal, night soil or solid waste disposal has 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 behaviour of people are analysed and summarised in an appendix document (Analytic summary of the report: Households Practices in the Field of Urban Sanitation and Households Survey about Behaviour and Expectations). The PRI and PSE surveys have shown that inappropriate use and deficiency of home and public sanitation are a major cause of insalubrity in Niamey.

b) PRI Survey on Industries

A PRI project survey has been done about the dangerous and insalubrious establishments with the objective of identifying the pollution generated by these units and evaluating the performance of taxation system on these establishments. The target of this survey has been defined as 14 industrial or assimilated units according to the importance of wastewater discharge. The method of survey has been a questionnaire together with sampling and analysis of wastewater quality.

c) PRI Survey on Institutions

The sanitary conditions of institutions have been the object of a specific survey within the scope of the PRI project. The objective of this survey was to carry out a statement of the sanitary equipment and its use, with aspects like the method of disposal of solid and liquid waste, the type of toilets and their maintenance. The survey method was a questionnaire at the intention of public or public receiving institutions. Surveyed institutions amounted 400 units, including schools, health centres, mosques, military establishments, prison, administrative buildings, leisure centres and hotels, and public toilets.

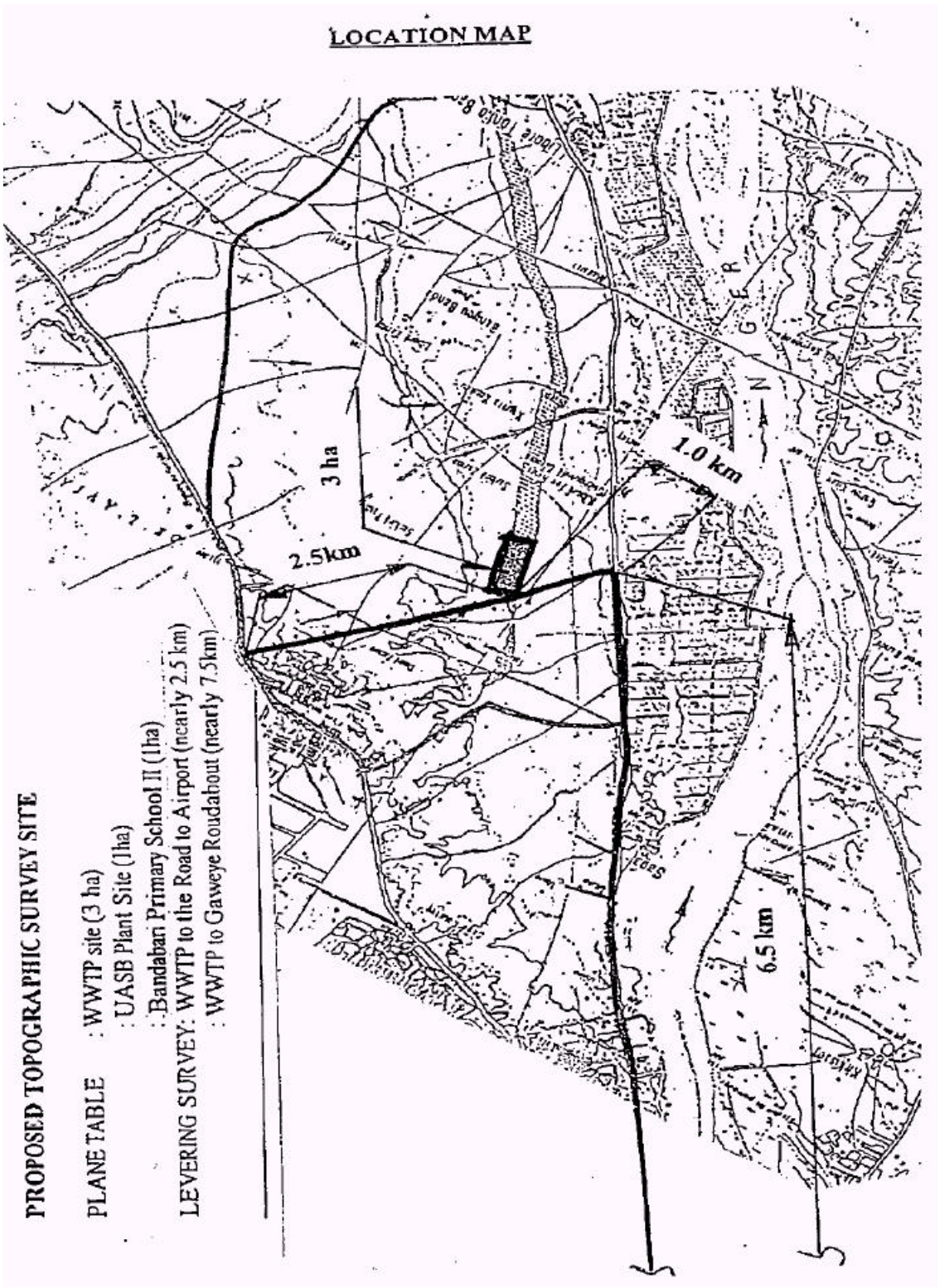
d) Specificity of the JICA Survey

Accordingly, the JICA survey tried to focus on aspects that could usefully complete the previous PSE and PRI surveys. In the case of the households survey have been included questions like those pertaining to hygiene education and public awareness, citizens perception of the role of officials in awareness heightening, participation to cleansing campaigns, role of women, young, children and men in this awareness heightening process, and perception of the priority problems of the living environment. This approach clearly gives some priority to the public awareness side of sanitation. In the case of industries and institutions, the consideration of small units together with big ones as target of the survey, including the informal sector like street catering and markets, as well as the focus on perception and practices rather than quantification, are points that make the difference with the previously done PRI surveys.

4.3.2 Households Survey

The households survey has been implemented based on a questionnaire survey on practices and perceptions of households in the field of hygiene and urban sanitation. The questionnaire has been used as a preliminary questionnaire within the JICA survey on the evaluation of waste quantity generated by households. This survey has provided data for 324 households distributed among 93 compounds. Sampling has been done to reflect the much as possible the average conditions of Niamey, in association with the waste quantity evaluation survey, based on the selection of 6 quarters: *Lacouroussou, Gaweye, Lamordé, Yantala, Kourakano,* and *Bandabari.* The basic principle for sampling was to select at least 50 households among at least 20 compounds for each quarter.

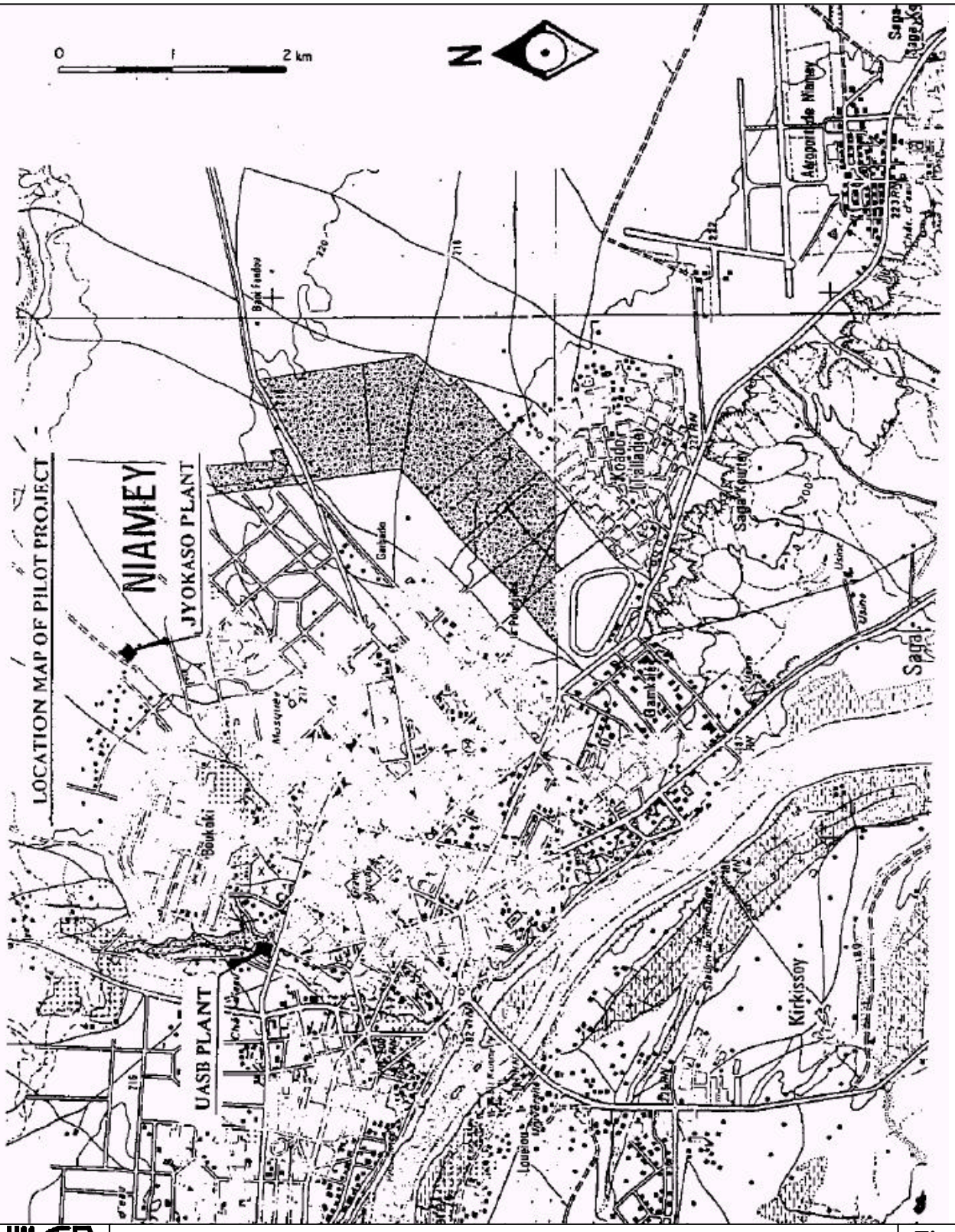
The basic items considered for the questionnaire were:
- General information
- Practices and awareness
- Health
- Education and awareness heightening
- Women's role



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

Figure 4.1-1

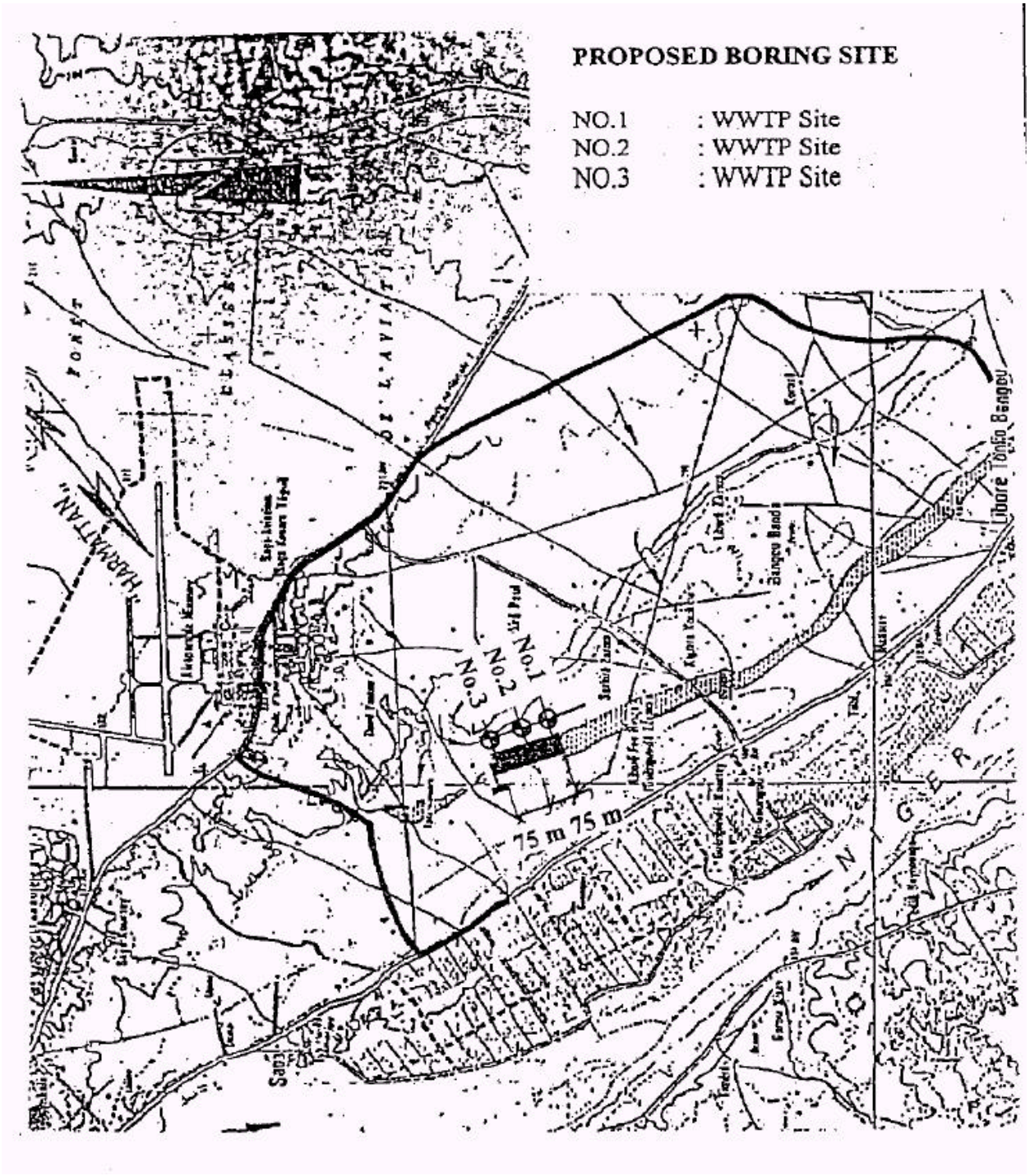
PROPOSED TOPOGRAPHIC SURVEY SITE



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

Figure 4.1-2

PROPOSED TOPOGRAPHIC SITE

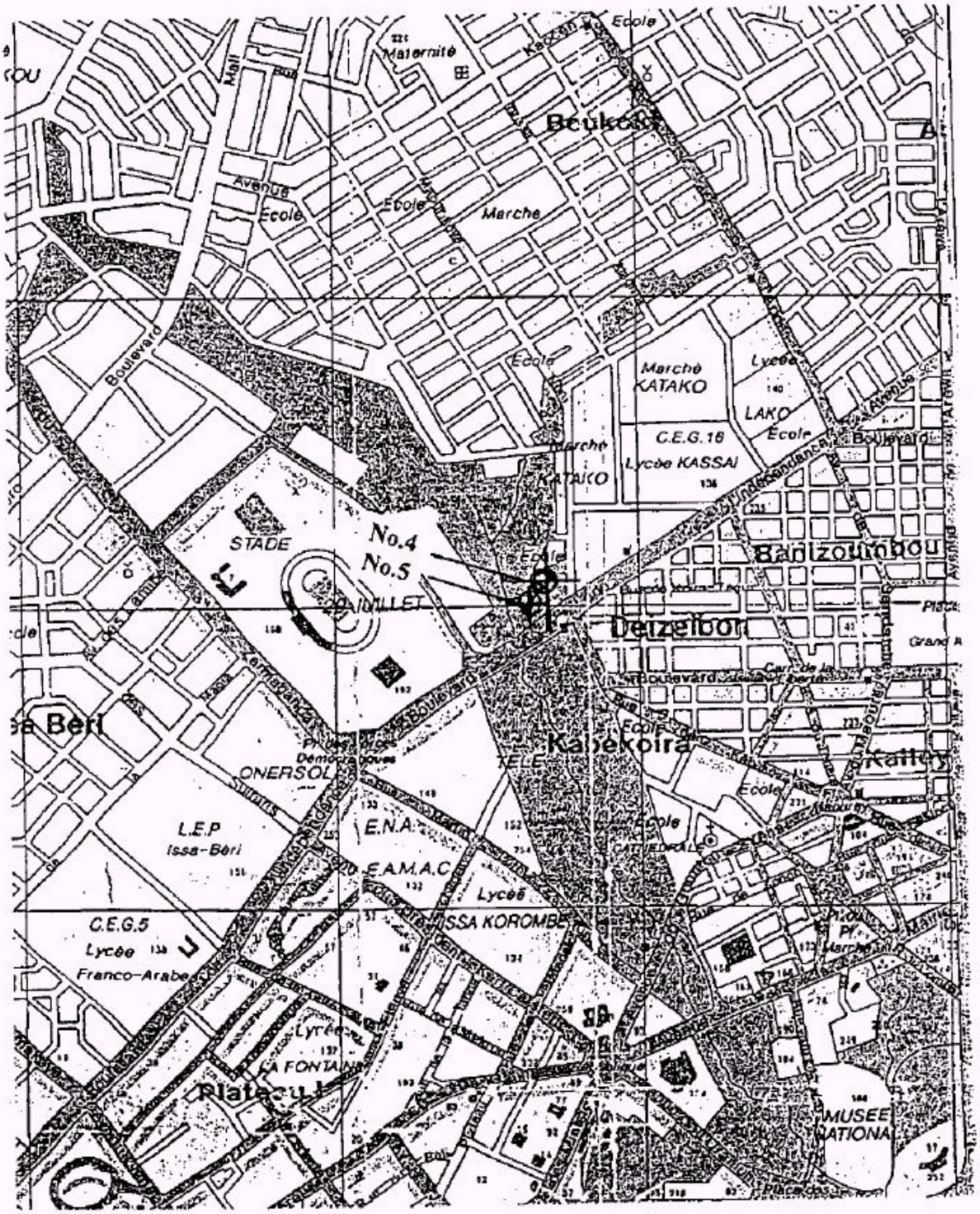


The Study on Sanitation Improvement for the Niamey City in the Republic of Niger

Figure 4.2-1

PROPOSED SOIL SURVEY SITE

NO.4 : Next to Deizenbon School
NO.5 : Next to Deizenbon School



JICA

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

Figure 4.2-2

PROPOSED SOIL SURVEY SITE

4.3.3 Industries and Institutions Survey

The industries and institutions survey has been implemented based on a questionnaire about practices and perceptions of industries and institutions in the field of urban sanitation. Included categories of activity were offices, hotels, "*maquis*" type catering, street catering, restaurants, markets, shops, handicrafts, industries, hospitals, clinics, schools, universities, and garages. This list gave some importance to the informal sector, including both day and night activities, which can be important sources of solid waste generation in the city, sometimes constituting severe "black spots" of the urban environment of Niamey.

The basic items considered for the questionnaire were:
- Category of activity
- Solid waste generated
- Liquid waste and sludge
- Perception and intention
- Salubrity and health

4.4 WATER QUALITY SURVEY

4.4.1 Wastewater

(1) Background

Niamey City doesn't have sewerage system. 25% households use improved toilets with septic tanks, 67% use traditional pit latrines and the remaining households comprise by bushes, open area, drainage, or river as per a survey result. The sludge of the septic tanks is not disposed of properly. On the other hand, the disposal of gray wastewater is done on the streets, drainage, or pits outside the compounds. The obvious consequences of these practices are exposure of ground & river water to contamination, and people to various diseases.

In our study we observed that the drainage system of Niamey discharges at eleven locations into the Gountou drainage, at one location into the pond, and directly at eight locations into the river Niger (Fig. 4.4-1). The Gountou drainage discharged into the river Niger.

In order to assess the wastewater quantity and quality of the Study Area, a survey was conducted in the month of September and October 2000. The quantity and quality survey of drainage wastewater was carried out at 8 major drainage discharge points from 6:00 h to 24 h at 2 h intervals. Typical enterprises, institutions, administrations and industries were selected for commercial and industrial wastewater survey. Details of quantity and quality survey are shown in Table 4.4-1 and Table 4.4-2.

(2) TOR

The survey was executed by subcontracting to LANSPEX, which is a semi-governmental institution, as per TOR shown in Appendix C.4.

(3) Results of Survey

Table 4.4-3 to 4.4-5 shows the quality and quantity of drainage, commercial and industrial wastewater. Additional information in the tables are taken from the World Bank Study report on Infrastructure Rehabilitation Plan for Niamey City.

1) Wastewater Quality

As shown in Table 4.4-3, wastewater contained organic, inorganic and bacteriological contaminants. The total coliform bacteria, which are pathogen indicator microorganisms were in the order of 10^6 to 10^7 MPN/100 ml. Such highly contaminated wastewater is flowing into the river Niger. Also, a part of this wastewater is 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.

In Niamey City, all the industries are located in Zone-Industriellé. Industrial effluent is discharged directly into the river or on the ground with or without any pre-treatment (Table 4.4-4). Similarly intuitions, enterprises etc discharge their wastewater untreated, except Hotel Gaweye (Table 4.4-5).

2) Wastewater Quantity

According to our survey result, average discharge of wastewater from 11 drainage discharge points (no. 1 to 11) into the Gountou drainage was 5676 m^3/d. The Gountou drainage flow into the river was measured to be 4858 m^3/day. Therefore, about 14% unaccounted for water in the Gountou drainage was due to evaporation and seepage in the ground. The direct discharge into the river from discharge points no. 13 to 20 shall be in the order of 6000 m^3/day.

The total industrial effluent was estimated to be 2,306 m^3/d in which BraNiger and ENTEX productions constituted more than 50% of the total industrial effluent. The discharge through BraNiger discharge point no. 20 is mainly from BraNiger and SPNC.

Table 4.4-6 shows water consumption by household and commercial purposes in Niamey city for the month of August 2000. Table 4.4-7 shows water consumption and wastewater collected in the Gountou drainage basin. Water consumption by households was estimated to be 40 lpcd whereas water consumed for commercial purposes was 6 lpcd equivalent. 75% of the total water consumed was collected in the drainage system.

4.4.2 Drinking Water Quality

The Study Team tested water quality at two farthest tap points of the piped water supply system of Niamey. The residual chlorine was observed at both the points. The pH was at neutral. No bacterial count was found. Thus, the water was safe for drinking.

The Study Team also conducted water quality test of two shallow drinking water wells located in highly inhabited areas. The well water was tested for physical, chemical and bacteriological parameters. The pH of both the wells water was in the range of 7.04-7.12. However, both the well water was contaminated with bacteria and organics, and thus was not suitable for drinking.

Location	TC (MPN/100 ml)	BOD_5 (mg/l)	TN (mg/l)
Banifandou I	$158 .10^2$	5	0.01
Djedda	$178 .10^2$	5	0.01

4.4.3 River Water Quality

The water quality at the downstream of Niamey (Saga bathing area) was tested for physical, chemical and bacteriological parameters. The river water pH was in the range of 7.3 to 7.5. However, 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

The river Niger is an important element in the socio-economic environment of the Republic of Niger. Therefore, the preservation of ecology and water quality of the river Niger is very important. The Republic of Niger has no water quality standards for raw water used for drinking, standards for protection of aquatic ecosystem, and standards for recreation and aesthetics values. Because of this lack of standards, water body in the country can not be classified as to their most beneficial or intended use. A rigid legal and regulatory framework and the establishment of standards and criteria are necessary to achieve the desired environmental outcomes that will affect environmental protection. WHO guidelines or standards of other countries may be tentatively adopted, like WHO and CEE guidelines adopted by SNE for tap water, for river water classification. The **P**rinciple of **P**olluter-**P**ay (PPP) should be applied to the industries, which will lead the industries to be more involved to control the industrial pollution through the establishment of their own or common effluent treatment facilities.

Table 4.4-1 DETAILS OF QUANTITY AND QUALITY SURVEY

Sectors	Frequency of sampling & flow measurement	Locations of sampling
Drainage	6.00 to 24.00 h at every two hours interval	Katako Deizeybon Boukoki III North East Onaram BraNiger Cascade Terminus Gountou
Typical Enterprises & Institutions	Spot sampling at ~10 am	Hotel Gaweye Hopital National University Soni Bank SNE office
Typical Industries	Spot sampling at ~10 am	BraNiger SPCN ENITEX Niger Lait Tannery Gamkalle

Table 4.4-2 PARAMETERS FOR WATER QUALITY ANALYSIS

Parameter	Drainage wastewater	Commercial wastewater	Industrial wastewater
Ambient Temperature	O	O	O
Water Temperature	O	O	O
pH	O	O	O
BOD_5 (mg/l)	O	O	O
COD (mg/l)	O	O	O
SS (mg/l)	O	O	O
T-N (mg/l)	O	O	x
T-P 8mg/l)	O	O	x
Oil & Grease (mg/l)	O	x	x
Normal Hexane Extract (mg/l)	x	x	O
Phenol (mg/l)	x	x	O
Total Coliform Count (MPN/100 ml)	O	x	x

Note: O = Analyzed; x = Not Analyzed / Results are shown in Table4.4-3 to Table4.4-5.

Table 4.4-3 QUALITY AND QUANTITY OF DRAINAGE WASTEWATER

Discharge points	$WW_{collect}$ (m3/d)	Effluent quality								Flow into
		pH	COD (mg/l)	BOD (mg/l)	SS (mg/l)	T-N (mg/l)	T-P (mg/l)	Oil & grease (mg/l)	TC (no./100 ml)	
1. Katako	1,821 (1,017-3,219)	8.36	215.7	90	408	21	0.6	64	275.105	
2. Deizeybon	1,301 (761-2,160)	8.26	150.7	62	242	14.2	0.1	38	325.105	
3. Boukoki III	674 (395-1,316)	8.52	254.1	94	628	31	0.5	270	261.105	
4. North-Eest	825 (734-984)	8.31	129.1	56	158	5.2	0.03	558	43.105	
5. Onaram	530 (306-786)	8.80	84	35	150	4.5	0.04	726	30.105	
6. AFD	225									Gountou
7.CEG Bagdad	Insignificant flow									
8. Recasement West										
9. Ext. Recasement										
10. Boukoki I	Discharge pt damaged									
11. Museum	300									
12. Gountou*	4328 (3846-5445)	8.24	112.3	45	414	7.2	0.01	486	31.105	River
13. Cascade Terminus	2,645 (2,012-3,063)	8.67	126	51	174	14.5	0.2	290	17.105	

14. Gamkalle	Could not be measured									
15. Gamkalle Intendance	Almost dry									
16. Kombo	348									
17. Corniche Yantala I	208									
18. Garde Republicaine	100									
19. Corniche Yantala II	Could not be measured									
20. BraNiger	636 (199- 878)	10.95	198	90	900	8.2	0.04	54	95.102	
21. Route Filinge										Pond

*Upstream of Onaram discharge point

Table 4.4-4 QUALITY AND QUANTITY OF COMMERCIAL WASTEWATER

Intuitions/ Enterprises	Treatment method	Effluent quality						
		T (oC)	pH	COD (mg/l)	BOD (mg/l)	SS (mg/l)	T-N (mg/l)	T-P (mg/l)
1. Hotel Sofitel Gaweye	Treatment	29.6	7.13	83.4	36	186	1.9	0.2
2. Hopital National de Niamey	Non-operational	-	-	-	-	-	-	-
3. University de Niamey	Non-operational	-	-	-	-	-	-	-
4. Soni Bank	Non	29.2	7.46	116.2	46	394	4.1	0.02
5. SNE office	Non	29.6	7.56	101.2	41	178	12	-

Table 4.4-5 QUALITY AND QUANTITY OF INDUSTRIAL WASTEWATER

Industries	Activities	Workers	Flow (m3/d)	Treatment level	Effluent quality					
					pH	COD (mg/l)	BOD (mg/l)	SS (mg/l)	TKN (mg/l)	Normal Hexane Extract (mg/l)
1. BraNiger	Beer brewing & soft drink bottling	165	450	Pre-treatment	10.56	88	30	172		200
2. SPCN	Soap manufacturing	155	120	Pre-treatment	7.65	58	10	229	2.7	200
3. ENITEX	Cotton weaving, printing	356	1,350	Pre-treatment	11.9	148	62	408	14	240
4. Niger Lait	Dairy products	40	20	Non	10.53	96	68.4	330		160
5. Cooperative de la Tonnerie Gamkale	Tannery	180-200	5	Non	7.34	7,800	1,200	10,409		4,380
6. ONPCC (Lanspex)	Pharmaceutical & chemical products	18	60	Non	8.0	53	33	8	11	
	TOTAL		2,005							
	OTHERS 15%		301							
	TOTAL INDUSTRIAL		**2,306**							

Table 4.4-6 WATER CONSUMPTION ZONEWISE IN NIAMECITY FOR AUGUST 2000

drain	Zone	Quartier	Pvt cons/ month	Com cons/ month	Pvt cons /day	Com cons /day	Collect /day	Population	Est. Pop /connec	Water Connections			Rmk
										Pvt	Com	Tot	
1	055	Boukoki I	2072	1395	1579.1	45	5,676	262,040			2	17	
	056	Boukoki I (Soni)	2859									255	50%
	063	Kalley ext	2474									154	
	066	Balafon	3116									188	
	069	Balafon	13855									243	
	070	Kalley Est	3062									218	
	057	Deizeybon	834										50%
	064	Banizoumbou	2051										50%
	123	Sabongari	5839									348	
	124	Kalley Est	384									13	
	125	Sabongari	12409									199	
2	027	Kabe Kouara (Deizeybon)	1063.5		309.6	182.8						151	50%
	037	Maison economique	1816.2										20%
	057	Deizeybon	1668									143	
	064	Banizoumbou	2051										50%
	065	Grande Marche		5668									
	067	Lacouroussou	2998									196	
3	053	Boukoki III	3158		295.4							257	
	054	Boukoki I	2348									245	40%
	058	Boukoki IV	3651									227	
4	056	Boukoki I (Soni)	2859		2923.4	7.0							50%
	060	Boukoki IV	5410									298	
	059	Madina	3164									176	
	062	Abidjan	4230										
	105	Bandabari	2661										
	106	Bandabari	4482										
	107	Dan Gao	2445										
	109	Dan Gao	3494										
	112	Route Fillingue (Dan Gao)	3885										
	113	Route Fillingue (Jan Gorzo)	1099.8										30%
	114	Garbado (Route Fillengue)	1239										20%
	117	Kalley Est (Sabongari)	7967										
	118	Sabongari (Zabarkarne)	47689										
		Mosque		218									
5	024	Terminus (Plateau I)	4012	6679	726.1	709					15		
	028	Kalley Amirou	1243										
	029	Kalley Amirou	1068	0									
	032	Kalley Amirou	4760	218									
	033	Terminus (Administratio n)	1401	6557									
	034	Terminus	2310	7442									
	036	Maison economique	1551	1081.5									50%
	037	Maison economique	7264.8										80%
6	026	Kabe Koira	1993		161.0								
	027	Kabe Koira (Deizeybon)	1063.5										50%
	031	Maourey	1936								4		
7-8	042	Recasement	3356		212								
	043	Recasement	3217										
9	049	Recasement	3129		100.9								
10	053	Boukoki III	1263.2		154.4								40%
	054	Boukoki I	3522										60%
11	023	Plateau I	4040	361	130	11.6					16		20%/remaining river direct
	023	Hospital only		8521									Direct to river (not accounted)

13	035	Terminus	9801				2645				5		
	036	Maison economique	3102										50%
	038	Terminus	8416										
	068	Lacouroussou	5597										
	126	Kalley sud	4396										
	127	Kalley sud (Nouveau Marche)	6206										
	128	Nouveau Marche		3890									
	129	Nouveau Marche	674								19		
14	132	G. Sabangue (Casrne GarbaH)		4320			Not measured						
	133	G. Sabangue	1331										
	134	G. Sabangue	530										
	135	G. Sabangue	2355										90%
	136	G. Golle	1394										
	138	G. Sabangue	1761										50%
	0122	Cite Faycal	7027										40%
15	135	G. Sabangue	2355				Almost dry						10%
16	018	Plateau I	36507				348				24		
	022	Plateau I	87830	2749									
17	019	Plateau I	2196	3844			208						
18	004	Yantala bas	2272	381			100						
	010	Plateau II	9794										
	012	Plateau II	32724	149									
	020	Plateau I	1110	156							4		
19	005	Yantala Haut (Yantala restructuration)	1496	14			Not measured						
20	138	G. Sabange	880.5	1102	195.9	234.6	636				9	20	50%
	139	G. Golle	5033	851							23	77	
	141	Z. Ind.	159	5203							8	15	
21	110	Dan Gao (Garba do)	4489	116			Not measured (intermitt ent flow)				2	256	
	111	Garba do (Route Fillengue)	4700									228	
	113	Route Fillengue (Jan gorzo)	3666									152	70%
	114	Garba do (Route Fillengue)	4130	2638							2	137	80%
	115	Wadata	5987	129							2	306	
	116	Route Fillengue	4429									189	
M	121	Poudriere	8595				Not measured				1	313	
	122	Cite Faycal	7027									273	60%
	131	G. Sabange	439	518							9	26	
	137	G. sabange	2932	3569								15	

M = military camp

Table 4.4-7 WATER CONSUMPTION AND WASTEWATER COLLECTION IN THE DRAIANNGE SYSTEM IN THE GOUNTOU DRAIANNGE ZONE

Water Consumption (m3/d)			WW Collected (m3/d)	% WW collected	Total population	Wat. Cons. (lpcd)		
Pvt	Com	Tot				Pvt	Com	Tot
6,591.9	955.4	7,547.3	5,676	75%	163,280	40	6	46

JICA	*The Study on Sanitation Improvement for the Niamey City in the Republic of Niger*	**Figure 4.4-1**
	LOCATIONS OF DISCHARGE POINTS	

4.5 SOLID WASTE AMOUNT SURVEY

Within the present project a survey campaign for measuring and determining of waste generation rates, waste composition as well as laboratory analysis of some parameters. The campaign consisted of 2 subjects.

The first one is an investigation by some 300 previously chosen households as well as the major industrial establishment in Niamey. The choice of the households is made in a representative manner in order to be able to use the results for the whole city of Niamey.

The second subject of the survey campaign consists of determining of waste generation rates among the 300 chosen households as well as the waste composition. Sampling for laboratory analysis will also be undertaken in order to determine the main physico-chemical parameters of waste.

Basis data on generation rates of solid waste is a very important component for the analyses of the steps to carry out in the Master Plan for solid waste management. More these data are exact better and more precise will be defined measures to be undertake for the improvement of solid waste management (exact evaluations of the necessary materials for waste collection and transport, precise design of the final landfill site etc.). The costs for investments will be therefore more precise and the financial envelope won't nor be under valued overestimated.

4.5.1 Identification of Representative Zones for the Solid Waste Survey

In order to get representative results on quantities of waste generation as well as their composition, it is indispensable to choice the zones (districts) 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 (Urban Commune of Niamey) and on the base of the 7 existing zones for different types of housing, 6 districts distributed in 4 zones have been chosen.

The 7 existing types of housing are:

Zone 1 (Modern quartiers-MDQ) : The origin of the Modern Quartiers is rooted in the Colonial era. They were first built to provide housing for the Europeans. Today, they include the extensions of these original areas, but the income is still the highest in the city, and the densities are the lowest.

Zone 2 (Traditional Quartiers-TRQ) : Traditional Quartiers are also very old, constructed around Grand Marche for the indigenous population during the Colonial era. The areas are now very crowded, and the incomes are lower.

Zone 3 (Peripheral Quartier-PQP1): There are two types of Peripheral Quartier. PRP1 are old and low-income areas, established during the 1960s.

Zone 4 (Peripheral Quartier-PQP2): There are two types of Peripheral Quartier. PRP2 are located outside PRP2 and relatively new, mostly constructed after the 1980s to absorb the rapid population growth. This group occupies the largest area on the fringe

Zone 5 (Urban Villages-UVL): Urban Villages are special areas that had existed long before the foundation of Niamey. They still keep their traditional forms of living style, which can be observed on narrow, winding streets. The population density is very high as well, and the housing materials imply lower incomes. Now they receive the large influx of immigrants into the villages as well as adjacent areas, which make up extension areas.

Zone 6 (Spontaneous quartiers-SPT): Spontaneous quartiers are not permanent settlements, and land titles are not officially established. Most housing materials used are straws, which shows a very low level of income.

Zone 7 (New Quartiers-NWQ): New Quartiers, similar to Peripheral Quartiers, are still under development and to be urbanized in near future. Most parcels have been sold, but very few residents have actually moved into the areas because of inadequate infrastructure as well as the financial shortage among landowners.

The investigations and waste collection have been carried out by 300 households in these 6 chosen districts.

The following Table 4.5-1 presents the different characteristics of the 6 districts.

Table 4.5-1 CHOZEN DISTRICT FOR THE SURVEY

DIFFÉRENT ZONES OF HOUSING	CHOSEN DISTRICTS AND THEIR CARACTERISTICS
1. Modern districts	**Kouara Kano** Residential modern district with low population density. The house construction with a good standards level are equipped (water supply, electricity, telephone). The chosen households for the survey are situated in the new district area in periphery Northwest
2. Urban Villages	**Yantala** There is existing the new and the old Yantala or high Yantala. For the survey the old Yantala was chosen which is an old district of Niamey, considered like an urban village where the traditional house construction is in Banco. The housing is collective, the population density ist very high. Serious problems of hygiene exist in spite of the recent construction of gutters. **Lamordé** Lamordé is a district situated on the right bank of the Niger stream presenting two (2) types of habitats: the old urban village and the new district. The chosen households for the survey are distributed in the two (2) zones of dwellings. The urban village is one of most traditional existing in the capital. The house construction is completely in banco. There is not electricity, nor water, dwellings have no latrines. The new district has paces of Bandaged Bari, with houses in hard or in semi-hard to the middle of dwellings in banco.
3. Traditional districts	**Lacouroussou** Lacouroussou is a traditional district, highly populated and where sanitation conditions are very poor. It seems to be similar to Yantala district but located in central area of the city. Sewage and containers are relatively available.
4. Peripheral districts	**Bandabari** Bandabari is a peripheral district located in the North of Niamey. It is characterized by a high number of dwellings made with banco. Few houses are constructed with «semi-hard» construction materials and others with «hard» construction material. We registered in Bandabari the highest number od wild transfer points. Therefore the pollution risks and non hygienic living conditions are existing in Bandabari. **Gawèye** Gawèye is also a peripheral district of the right bank of the Niger stream. The collective dwellings are in banco. The population density is also very high, the major part of houses are without latrines.

4.5.2 Procedure of Sampling, Weighing of Analysis

Before proceeding to the survey for measurement, one day of sensitization and explanation is done to each of the chosen households. In order to get their involvement and cooperation in the campaign. The procedure of waste collection and weighing is carefully presented.

The survey took place on 16 days for the 6 chosen districts. For reasons of efficiency and organization the survey is carried out in 2 phases of 8 days each. Every 3 districts have been surveyed in one phase.

1th phase: District of - Lacouroussou, Lamordé and Gawèye
2nd phase: District of - Kouara-Kano, Yantala and Bandabari

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.

(1) Procedure of collection and weigh in

Every days, investigators, equipped with all the necessary material, collect the full bags of waste. Each of bags is weighed carefully and associated to the household that produced these waste, at the time of the collection. This procedure is followed for all the 300 households having participated to the survey campaign. Results are therefore recorded compiled as shown on the Appendix 4.5-1.

Once the waste collection is finished, the vehicle transporting waste is driven toward the municipal garage where the procedure of sorting and sampling is done.

(2) Procedure of sampling

The main objective of the sampling is to bring out the fact, that from the quantity of waste collected, a small quantity of 20litres having some representative characteristics of the whole collected waste.
After having sorted out the voluminous components of waste (paper, plastic, textile, leather, wood, etc.), the remaining waste is regrouped and mixed in order to have a homogeneous mixture. From these remaining waste one extracts a quantity of 20litres. This small waste quantity will be sieved (mesh of the sieve: 5mm) and the remaining waste is sorted further out according to the different components as indicated in the following Table 4.5-2:

This sampling and sorting procedure is repeated on 6 samples (2 by each district) during the 8 days period of the survey.

After the procedure of sorting, a part of domestic waste components is wrapped separately and sent to the laboratory for the analysis. Analyses of parameters indicated in the following chapter 4.5.4 will be determined.

4.5.3 Preliminary Results of the Solid Waste Amount Survey

The survey was conducted and results of weighing sorting of domestic waste were compiled.

The following Table 4.5-2 summarizes the whole results obtained during the weighing phase in the representative areas.

Table 4.5-2 MEASURED GENERATION RATES

District	Number of households	Number of persons	Waste quantity	Generation rates
Lacouroussou	58	313	2315.5	1.05
Lamordé	52	437	2550	0.83
Gawéye	50	328	1136.7	0.49
Kouara Kano	52	349	1771	0.72
Yantala	57	353	1945.5	0.78
Total	269	1780	9718.7	0.75

The detailed results of the survey on waste weighing is shown in Appendix C.5 –1 to C.5-6.

The average value for the waste generation rate obtained for all representative areas amounts to 750g/cap. and day.

The average values as minimum and maximum waste density are:
Minimal average density: 884 kg/m^3
Maximal average density: 1030 kg/m^3

The total average value for the waste density will be 957 kg/m^3.

4.5.4 Other Components of the Survey

Within the survey other objectives were also met in order to complete the necessary basic data for the elaboration of the Master Plan.
Survey on

- Leachate quality of final disposal site and
- Soil contamination of former disposal site

(1) Leachate quality of final disposal site

As mentioned in chapter 3.6, there is no official disposal site at present. Solid waste is accumulated inside urban area. There are many places disposed of solid waste along the road and in urban area.

The following chemical parameters are analyzed:

PH, COD, SS, N-Hexane, Coliform, Phenol, Cu, Fe, Mg, Cr

(2) Soil contamination of former disposal site

On several former disposal sites settlement and agriculture activities is being registered.

Soil contamination was checked for safety and prevention of any pollution and risks. The following chemical parameters were analyzed:

Hg, Cd, Pb, Cr, CN, As, Or-P

CHAPTER 5. BASIC PLANNING CONDITIONS

CHAPTER 5. BASIC PLANNING CONDITIONS

5.1 POPULATION FORECAST

5.1.1 Overview

As discussed in Chapter 3, the population of Niamey has been rapidly increasing. This is a well-known fact, but nobody actually knows exactly how many people live in the city today. The current population is said to be 600,000 or even 800,000. Illegal settlements are constantly emerging on the fringe of Niamey. Rural-urban migrations are significant just as in other developing countries. There are also a large number of seasonal migrants who come to Niamey at the time of famine in rural areas. It is extremely difficult, therefore, to estimate the population, either current or future. In this section, the population projection will be made, using the most of the existing data sources.

5.1.2 Data Sources

The following data sources are available for forecasting the future population of Niamey.

- The 1988 Census: Actual population of Niger and Niamey in 1988.
- The Population Projections of 1994: Data available for the national population (1994-2025) as well as Niamey (1994-2000).

5.1.3 Method of Projection

The 1994 Projection has, as discussed in Chapter 3, 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 as shown in Table 5.1-1. 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.

Table 5.1-1 POPULATION COMPARISON OF NIGER AND NIAMEY

Year	1989	1994	1995	1996	1997	1998	1999	2000
Niamey	420,859	515,851	536,259	557,869	580,215	603,386	627,431	652,401
Niamey/Niger*	5.69%	6.07%	6.15%	6.23%	6.30%	6.38%	6.46%	6.54%
Growth rate	5.84%	4.51%	3.96%	4.03%	4.01%	3.99%	3.99%	3.98%
National	7,393,495	8,493,261	8,721,540	8,960,459	9,204,730	9,455,185	9,712,207	9,976,183
Growth rate	3.32%	2.77%	2.69%	2.74%	2.73%	2.72%	2.72%	2.72%

*A linear regression model is derived from these figures: y = 0.0008x + 0.0599 (y = rate, x = year as 1994 = 1)
Source: Projections Demographiques 1994-2025. Direction de la Population. November 1994.

As a result, the future population of Niamey can be forecast by using the share of Niamey in the national total (Table 5.1-2). 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 5.1-2 POPULATION PROJECTIONS ADOPTED IN THE JICA STUDY

Year	2000			2005			2010			2015		
Population of Niamey			652,401			757,192			871,346			993,724
Share (Niamey/Niger)			6.54%			6.63%			6.71%			6.79%
Growth rate			3.98%			3.21%			3.02%			2.81%
Population of Commune	I	II	III	I	II	III	I	II	III	I	II	III
	333,720	240,292	78,390	404,844	261,018	91,330	454,402	303,526	113,418	528,258	332,694	132,772
National population*			9,976,183			11,420,697			12,985,781			14,635,107
Growth rate			2.72%			2.90%			2.74%			2.54%

Compared to the population projections conducted in other studies in Niamey (Appendix G.1), the projected figures in Table 5.1-2 are justifiable, falling within the range of acceptance. Therefore, this Study adopts the projections in Table 5.1-2 as the planning framework for the Master Plan.

5.2 FUTURE DIRECTION OF URBAN DEVELOPMENT

5.2.1 Assumptions for Forecasting the Direction of Urban Development

An overall assumption determining the future direction of urban development in Niamey is that Niamey will develop, following the current trend.

In addition, it is important to set the following conditions.

- The population of Niamey will grow as projected above.
- During the 1990s, Niamey's economy was characterized as being in a state of stagnation, and its economic prospective are not so bright in 2000. The economy will probably grow but not so much because its structure is vulnerable to seasonal fluctuations, heavily relying on agriculture.
- Despite the rapid population growth, Niamey's future economy will remain relatively weak, and economic development will not bring about significant changes in the spatial structure of the city.
- No concrete master plans exist now for the future of Niamey, which makes it difficult to forecast the direction of urban development.
- Realistically speaking, unless the mining industry revives in Niger, its economy will have another hard time in the first decade of the 2000s.

5.2.2 Forecasting and Designating Areas for Residential Use

New development projects constructed or under plan after 1994 are listed in Table 5.2-1. As pointed out in Chapter 3, there are a large number of new areas emerging during the 1990s. Most areas developed by CUN are not equipped even with basic infrastructure like water, but the parcels have already been sold out. The results can be obviously seen in vast lands with very few houses. Ironically, however, it is expected that these areas will be the center of growth in ten to 15 years.

Table 5.2-1 NEW HOUSING DEVELOPMENT PROJECTS AFTER 1994

Project Name	CU	ID*	Type	Est. Year	Area (ha)	Status	Basic Infra.	Developer
Taiwan	1	43	NWQ	94-95	87.2	For sale	Yes	China
Banizoumbou II	1	36	PRP2	94	119.6	Building	No	CUN
K. Kano Nord	1	49	NWQ	94	81.9	Sold out	No	CUN
SONUCI	1	48	NWQ	95-98	60.6	Sold out	Yes	Private
Extension Talladje	2	80	NWQ	96	123.9	Sold out	No	CUN
Ext. K. Kano Nord	1	50	NWQ	96	132.8	Sold out	No	CUN
Nord Lazaret	1	42	NWQ	97	140.0	Sold out	Only plan	CUN
Nord Faisceau	1	47	NWQ	97	104.6	Sold out	No	CUN
Ext. Koira Tegui	1	51	NWQ	97	153.7	Sold out	No	CUN
Bobiel	1	44	NWQ	96	90.5	Sold out	Only plan	CUN
Ouest Faisceau 1	1	45	NWQ	97	76.6	Sold out	No	CUN
Ouest Faisceau 2	1	46	NWQ	97	156.4	Sold out	No	CUN
Sari-Koubou	2	86	PLN	2000	450.0	For sale	Planned	CUN
ZAC	1	52	PLN	Plan	400.0	Planning	-	CUN
Total					2177.8			

Note: CU = Commune. *See Appendix F.1.

Table 5.2-2 attempts to distribute the total population in Niamey projected for 2005, 2010, and

2015 to each type of residential area. It has been done, making the following assumptions.

- Most population growth will be absorbed initially in PRP1 and 2, then in NWQ, and finally PLN (Review Table 3.2-4 for description).
- All the projects in Table 5.2-1 will be, fully or partially, completed before 2015 with some infrastructure.
- Population growth will be limited in the existing dense urban areas. In particular, the density could not be increased over 300 persons per hectare without vertical development.
- It is most likely that some of the existing squatters will be officially incorporated into Niamey (e.g. Pays Bas and Koubia), but they are not included in this analysis.
- New squatters will continue emerging but are not counted as locations of population absorption.

Table 5.2-2 FORECASTING THE DISTRIBUTION OF POPULATION

Types of Quartier	Absorption Capacity	Population / Density*				Future Growth Patterns
		2000	2005	2010	2015	
1. Modern quartiers (MDQ)	Low	83,302 (58/ha)	84,390 (59/ha)	84,390 (59/ha)	84,390 (59/ha)	Keep the current status as high-income, low-density areas.
3. Traditional quartiers (TRD)	Low	74,531 (211/ha)	80,840 (229/ha)	92,448 (244/ha)	95,078 (253/ha)	Some converted into commercial. More densification should be curtailed.
4. Peripheral quartiers 1 (PRP1)	Medium	95,479 (177/ha)	107,746 (200/ha)	107,746 (200/ha)	107,746 (200/ha)	Already developed. Some room is available for additional development.
4. Peripheral quartiers 2 (PRP2)	High	215,887 (86/ha)	331,162 (124/ha)	391,157 (147/ha)	454,956 (172/ha)	Will look like PRP1 today in 2015. Growth is now underway.
5. Urban villages (UVL)	Converted	84,303 (166/ha)	88,148 (174/ha)	92,448 (182/ha)	95,078 (188/ha)	Restructuring programs are planned. Little population change expected.
6. Spontaneous quartiers (SPT)	Converted	215,887 (86/ha)	-	-	-	Will be converted into permanent settlements and become a part of PRP2.
7. New quartiers (NWQ)	High	8,847 (6/ha)	71,094 (47/ha)	105,376 (69/ha)	140,254 (92/ha)	Will have the highest population absorption capacity.
8. Planned areas (PLN)	High (later)	0	8,850 (10/ha)	28,950 (33/ha)	48,750 (55/ha)	Development takes long time. Have great potential for absorption.
Total Absorption		607,393	772,229	896,103	1,020,597	

*Should be regarded as absorption capacities. Contingencies are included, ranging from 2 to 3%.
For the distribution at the quartier level and more details on the methodology, see Appendix G.2.

Based on the distribution of the population, the forecast population densities in each quartier are derived and shown for 2005, 2010, and 2015 in Figures 5.2-1 to -3. As illustrated, the population density will continue to increase in the periphery, whereas it remains to be rather stable in the center. Even by 2015, however, the New and Planned Quartiers will not reach its full capacity of population absorption as designed. The designed population density in Sari-Koubou, for example, is 250 persons per hectare, compared to the expected density in 2015 is set to be only 60.

5.2.3 Forecasting and Designating Areas for Urban Activities

Basic assumptions for forecasting future urban activities are as follows.

- Because of the continued slow economic growth, industrial development will be limited until the target year, 2015.
- There will be an expansion of commercial activities spreading from the existing centers and along the major asphalt roads.
- Commercial and industrial activities necessary for the daily lives of the citizens will continue to take place within the residential areas.
- Future administrative activities can be contained in the existing designated areas.

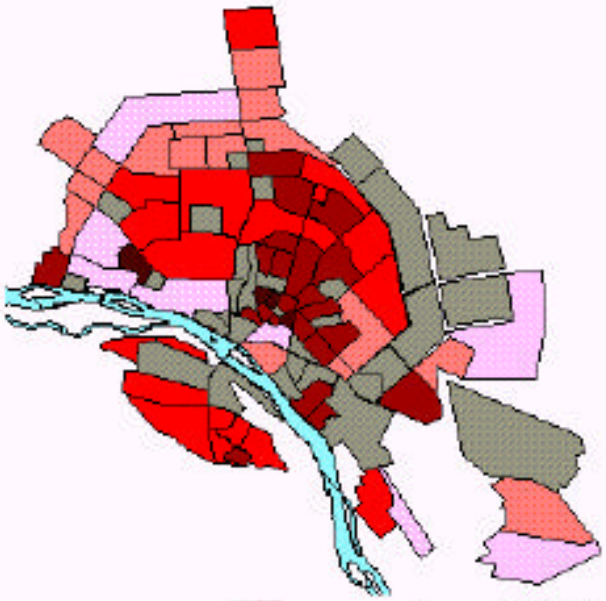


Figure 5.2-1 POPULATION DENSITY IN 2005

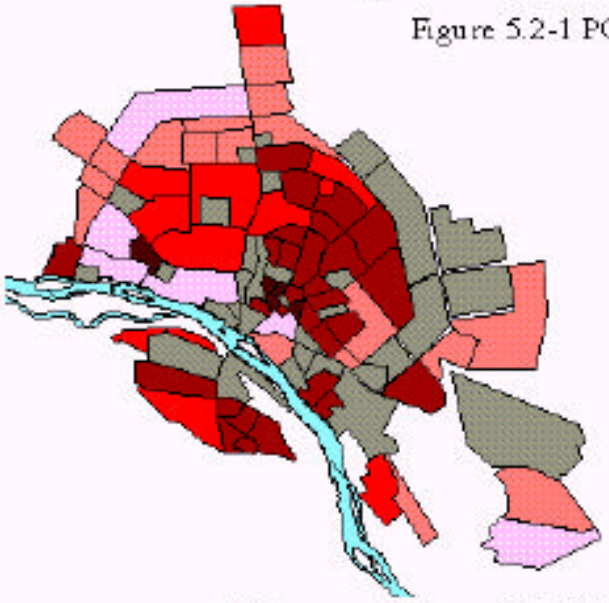


Figure 5.2-2 POPULATION DENSITY IN 2010

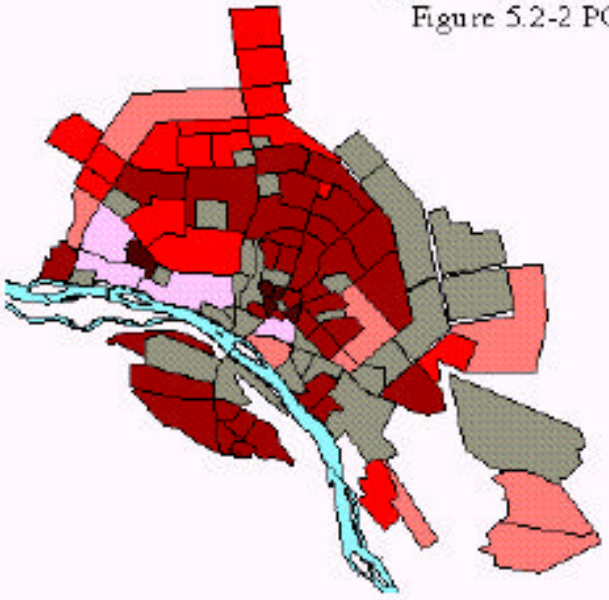


Figure 5.2-3 POPULATION DENSITY IN 2015

Notable changes, some of which have already taken place, are expected to occur during the period of 2000-2015.

1. The area around Grand Marche will be redeveloped and converted into more intensive commercial use through vertical developments. The number of houses will be reduced.
2. The second center will be created in the north of the town, ZAC.
3. Future industrial space demands can be accommodated in Industrial Zone, as vast empty space is still available.
4. Commercial development continues to take place along major roads.

5.2.4 Future Land Use Forecast

Based on the above assumptions and analyses, the area of CUN continues to expand toward 2015. The future land use forecast has been made in Table 5.2-3 and illustrated in Figure 5.2-4.

Table 5.2-3 FUTURE OUTLOOK OF NIAMEY IN 2015

	Total Area (ha)	Urbanized Area (1)	Residential Area (2)	Population (3)	Gross Densities (3)/(1)	Net Densities (3)/(2)
Commune I	8,282	4,981	4,354	528,258	106.05	121.33
Commune II	11,908	5,209	2,835	332,694	63.87	117.35
Commune III	3,726	1,021	699	132,772	130.04	189.95
Total	23,916	11,211	7,888	993,72 4	88.64	125.99

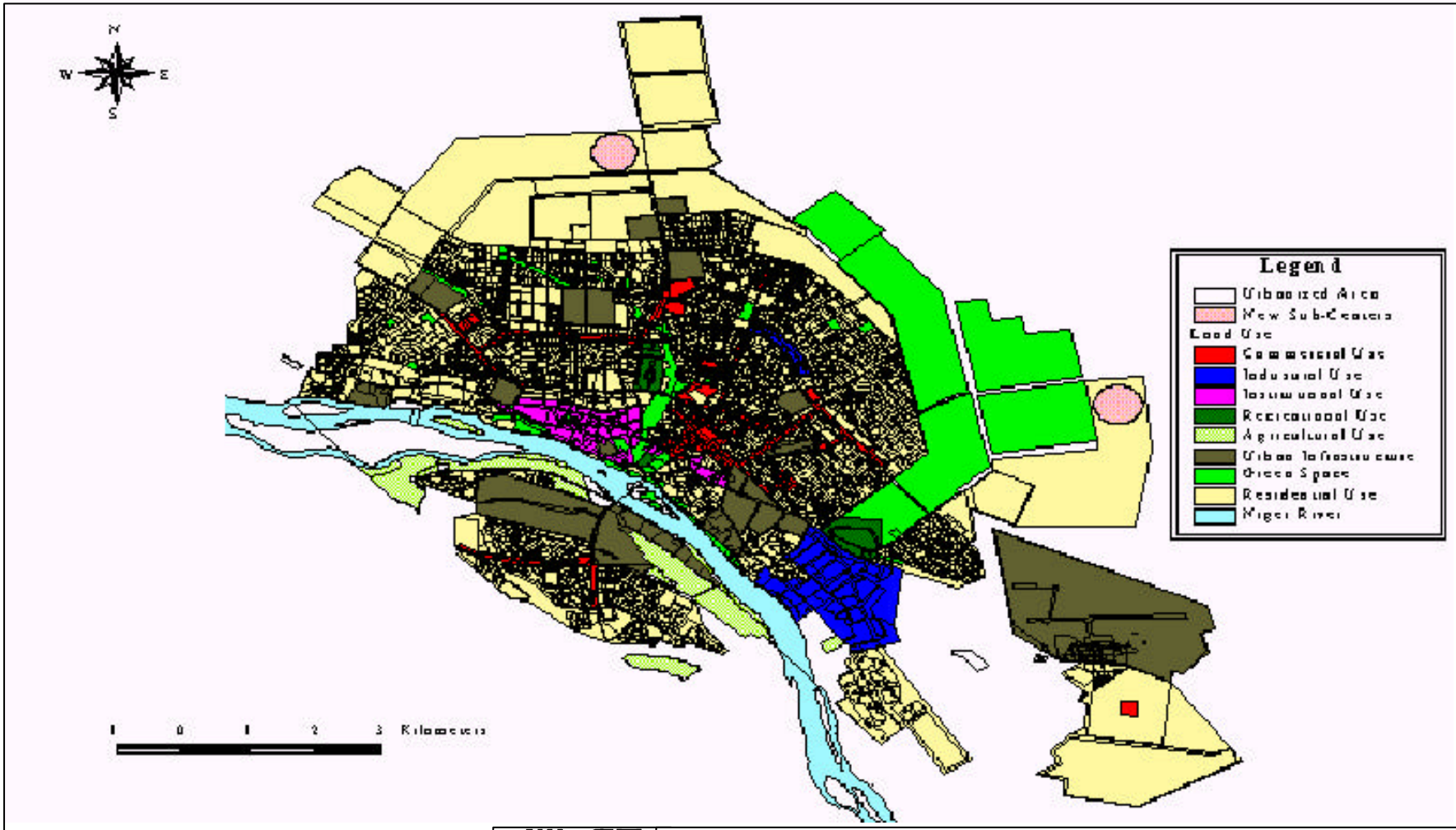
5.2.5 Implications of Future Urban Development

The future is always unpredictable with many uncertain factors. The future direction of urban development in Niamey has been forecast, but the scenario is based on precarious assumptions.

As explained in Table 5.2-2, Niamey has a sufficient capacity to absorb the future population projected for 2015 with the lands now available for residential use. In fact, there are rooms left for accommodating further growth. However, it is important to recognize that this scenario is based on rather uncertain assumptions.

First of all, the most critical is that currently underdeveloped quartiers, i.e. PRP2, NWQ, PLN, will be capable of housing new residents. In other words, CUN must provide basic infrastructure so that people can enjoy at least a minimum level of living standards. The current circumstances, however, are far from this requirement. In the majority of the new areas, as shown in Table 5.2-1, lands are simply cleared and sold without adequate infrastructure. Second, it is also imperative for the government to encourage housing constructions in these new areas. The severe shortage of financial resources among landowners is a significant constraint to future urban development in Niamey. If these two problems were ignored, few houses would actually be built, and therefore, the new areas would not have much capacity of absorbing the future population as expected.

The consequences could be detrimental to the future urban development as well as the sanitation environment in Niamey. Population will grow anyway regardless of locations. If the periphery does not provide places for additional growth, the population increase will take place in the center because it provides basic services as well as housing. Further densification in these already crowded areas would produce extremely dangerous outcomes in terms of sanitation conditions. Therefore, the implications of the assumptions made to forecast the future scenario should be seriously taken into consideration and translated into concrete measures.



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

Figure 5.2-4

FUTURE LAND USE

5.3 CONSTRAINTS OF INSTITUTIONAL SUPPORT

What has been learnt in the preliminary stage shows that the assumed executing agency is in transition and its financial capacity is yet to be known. Local governments are, also, in short of financial capacity. Capacity of human resources needs to be assessed carefully, but is reportedly limited due to deteriorated work ethics. Economic prospect will be interrupted if rainfall is not favorable.

At this tentative stage, anticipated constraints for the master plan are not fully clear. However, an approach to better access is suggested hereunder.

A Participatory Approach

In the World Bank financed Water Sector Project following the four preliminary studies, a pilot project with estimated cost of US 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*[1] and *animation*[2]. Their activities are summarized in a brief history of the water supply development projects in comparison to the governments' activities.

Until 1980's, rural water supply systems installed by ODA finance were maintained by the national government through departments responsible for rural and pastoral water supply. During the same period, NGO's also financed a number of rural water supply projects, whose maintenance was not expected by the government. After installation of wells, hand pumps and sometimes mini water supply utilities (mini *AEP*), they needed to establish an institutional structure to operate and maintain these facilities for the expected life, because they were not able to stay at these project sites, which were scattered geographically extensively. Local people, particularly, those who benefited from the project had to be organized to raise fund for costs of repair and replacement of consumables and spare parts, and also for costs of fuel/electricity in case of power-driven mechanical systems.

At first NGO's went to villages and carried out *sensiblisation*, in which people were gathered and advocated to recognize need of safe water, need of protected well or borehole to obtain safe water, and a way to construct it with conditions the NGO offered. They also carried out *animation* in which talented and experienced animators talked to and interacted with the people and let the people gradually recognize a way to voluntarily organize a water users association or cooperative to raise necessary fund and collect water charge. The animators also showed detailed procedures to operate and maintain wells and keep collected fund for repair and replacement within the association/cooperative, where selected/elected committee members should discharge given duties such as chairman, operator, cleaner, casher/bookkeeper, technician, etc. In villages, where such *sensibilisation* and *animation* were successful and hence water users

[1] *Sensibilisation* or sensitization can be interpreted to awaken or make people sensible or comprehensive to some necessity, which they do not perceive, for example, practice of hand-washing before eating and after excretion, and necessity of safe water.
[2] *Animation* may be understood to give *anima* (life), to inspire and to encourage people to do something important.

association/cooperatives were established after intervention of several months or more than on year, NGO's gave fund for construction of water facilities. They also carried out periodic visits to follow-up and give advice and training whenever necessary. This participatory approach was reportedly successful in many places. Well-organized associations could have maintained the water facilities over 10 years, while such facilities tended to corrupt in a year or two without such institution.

From end-1980's to early 90's, most of sub-Saharan economies crushed into crises and the IMF/World Bank's intervention through the structural adjustment program (SAP) became prevalent throughout these countries. Restructuring of bureaucracy was undertaken in the early stages of SAP, whereby personnel and budget in local administrative organs were minimized and governments became unable to maintain the ODA funded water supply systems. Most water supply administrations officially and nominally adopted and encouraged to organize the water user association/cooperative and gave responsibility to maintain the water systems to such entities that were not always legally incorporated. Under the NGO initiatives, however, process of *sensibilisation*, *animation* and incorporation of association/cooperative required patiencefull effort of several months or more. Governments could not pay that effort, while they decided to usurp the proven approach. It was observed that water systems tended to be deteriorated much quicker in places where the associations/cooperatives were only nominally organized and enough awakening and training activities were not undertaken. Some water administrations could afford to employ NGO to better the situation. In recent years, most ODA donors implementing rural water supply projects carry out this activity as a crucial component that often demands 15 to 30 % of total project cost.

Now, term "*social engineering*" used by the World Bank consultants here seems to mean that process of mobilizing people to organize themselves by *sensibilisation* and *animation*. In designing a public infrastructure project this participatory approach shall be suggested, if:

a. The government support (managerial, technical and financial) is lacking or insufficient;
b. Beneficiaries or the public are not necessarily aware of need and benefit of the project;

c. Public participation is crucial to maintain the project; and

d. Incentive structure in the maintenance system is not easily visible.

5.4 AVAILABLE SITE FOR SANITATION FACILITIES

5.4.1 Formulation of Pilot Study of the Facilities Construction

The Study Team has been implementing the first Stage of Master Plan for the Project. Simultaneously, the Team has been conducting the "Pilot Study of the Facilities Construction" as one of Pilot Study for urgent rehabilitation programme. The Team has proposed two kind of treatment method for domestic wastewater treatment process here in Niamey City in order to judge and evaluate weather which kind of treatment process can be acceptable for wastewater of Niamey City.

The proposed treatment process for the wastewater treatment plants are already described in Chapter 4.6.1

5.4.2 Constraint Conditions for Selection of Proposal Site

For the selection of pilot plants, the following contract conditions shall be considered to compare the each candidate site.

(1) To be able to keep constant domestic wastewater flow at the dry weather.
(2) To make sure to close the sluice gate in case of storm rainfall.
(3) To reduce the total head of submersible pumps.
(4) To proceed easily the dedicated land acquisition
(5) To install the power supply and water supply without complicated problem.
(6) To ensure to implement the undertaking from Nigerien side.
(7) To expect as early as possible to confirm the effectiveness for Hygiene Education
(8) To be able to cooperate with citizens of each communes.

5.4.3 Nomination for Candidate of the Pilot Plants

Based on the above constraint conditions, the team has considered the several sites to be nominated for the selection.
The following are the candidate of each plant.

(1) UASB Plant
- River side of Gountou Yena river at place next to national Museum.
- Next to National Palace of Gymnasium, Issa Beri Quartier.
- Next to Deizeibon primary school, Deizeibon Quartier.
- Left bank, Gountou Yena Boulevard, KabeKoira Quartier.

(2) "JYOKASO" Plant

Three story of Apartment house in front of Terminus Hotel, Terminus Quartier
- Bandabari Primary School II, bandabari Quartier
- Typical compound, Boukoki Quartier

5.4.4 Result of Selection and its Reason

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 farm field next to Deizeibon primary school and part of dumping area was selected for the Pilot Study of facilities Construction.

(2) JYOKASO Plant

JYOKASO is mainly used for community wastewater treatment. Keeping the characteristics of Jyokaso in mind and to implement the Hygiene Education, Bandabari Primary School II was chosen for the Pilot Plant.

For these two proposed sites, MET, MOE, UCN and the Study Team have arranged the coordination meeting regarding the demarcation and undertaking of Nigerien Side. (Vide Appendix A: Minute of Meeting).

CHAPTER 6. PILOT STUDY FACILITY CONSTRUCTION

CHAPTER 6. PILOT STUDY FACILITY CONSTRUCTION

6.1 OBJECTIVES OF THE PILOT STUDY

Domestic wastewater should be properly treated to prevent water-borne diseases and parasitic infections from occurring to raise public health level and to prevent water pollution. The JICA Study on Sanitation Improvement for the Niamey City in the Republic of Niger includes the construction of two pilot plants for sewage treatment, their commissioning, O&M for 6 months, evaluation for 6 months, training and technology transfer to counterpart.

(1) Short Term Objectives

1) To obtain actual data on process and O&M
2) Preparation of O&M manual, and training to operators
3) Building capacity of the counterpart in wastewater treatment and management
4) Hygiene education and awareness
5) To establish the position of the pilot plant as the landmark in Niamey city for wastewater treatment.

(2) Long Term Objectives

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).

During the operation of pilot plants, counterparts personnel are involved to manage and maintain the treatment plants. The technology transfer to the counterparts is being implemented by JICA Study Team. Such as OJT (On the Job Training) or TT (Technology Transfer) would promote capacity building efforts of the counterparts.

The first pilot plant is UASB (Upflow Anaerobic Sludge Blanket) process based on anaerobic treatment technology followed by trickling filter and eco-system ponds with a capacity of 100 m^3/day (around 2000 population equivalent according to the Niamey criteria) to treat wastewater. Eco-system ponds have been used for natural recycle of waste. The second one, named "Jyokaso" in Japan is a compact conventional mini sewage treatment plant followed by eco-system ponds with a capacity of 10 m^3/day to treat public toilet wastewater of a primary school.

From the process points of view, following objectives have been considered.

1. Confirmation of the adaptability of UASB process for domestic wastewater in Niamey
2. Confirmation of the adaptability of “Jyokaso” system for on-site treatment in Niamey
3. Conduct an experiment on Eco-system pond for natural recycle system
   - to further treat the effluent through dipped drink pack bed or gravel bed
   - to cultivate aqua plants for nutrient reduction in water
   - to breed fish
   - to recycle treated water for plantation

- to earn O&M cost by selling the sludge which is as good as fertilizer, biogas for cooking and farm products through cultivation

6.2 INTEREST OF UASB AND "JYOKASO" TREATMENT TECHNOLOGY

6.2.1 UASB Plant

The UASB process was developed at the Agriculture University in Wagenngen, the Netherlands and has already been applied for treatment of a large variety of wastewaters. Worldwide presently over 250 full-scale plants are under operation for the treatment of both domestic and industrial wastewater. In India alone there are more than 15 full scale UASB plant successfully operating for sewage treatment with capacity as large as 78,000 m^3/day.

Comparison of different treatment technology to treat sewage is shown in Table 6.2-1. Based on land availability, performance, and O&M easiness & cost, UASB followed by trickling filter was judged to be most appropriate for Niamey city. Especially, the biogas production, low energy consumption, and high loading rates are important features of this system. In order to obtain the same efficiency than a conventional aerobic plant (about 90%) UASB will be followed by trickling filter with a special bacterial support developed in Japan. This support material is readily available and is very cheap and requires no maintenance. Tentative hydraulic profile is as shown in Figure 6.2-1.

In addition to the above consideration, UASB Treatment Technology for Niamey City has following additional advantages:

(1) The efficiency of UASB increases with increase in temperature, which will give good results under Niamey climatic conditions.

(2) UASB process needs a small quantity of energy to operate, but it produces energy in the form of biogas. In the larger treatment plant, the biogas production, (400 liters per kg of COD reduction) provides energy for family cooking, electricity through cogeneration. Therefore it will be possible to save the electricity and firewood consumption.

(3) This process needs very simple operation and maintenance only for the main pump and to withdraw the excess sludge.

(4) It is very economical in construction because it requires only a small concrete tank (around 10 time smaller than those required for conventional aerobic treatment plant, for the same treatment capacity).

(5) At last, it produces very mineralised sludge which is usable as fertiliser & soil conditioner for agricultural without risk of bad smell.

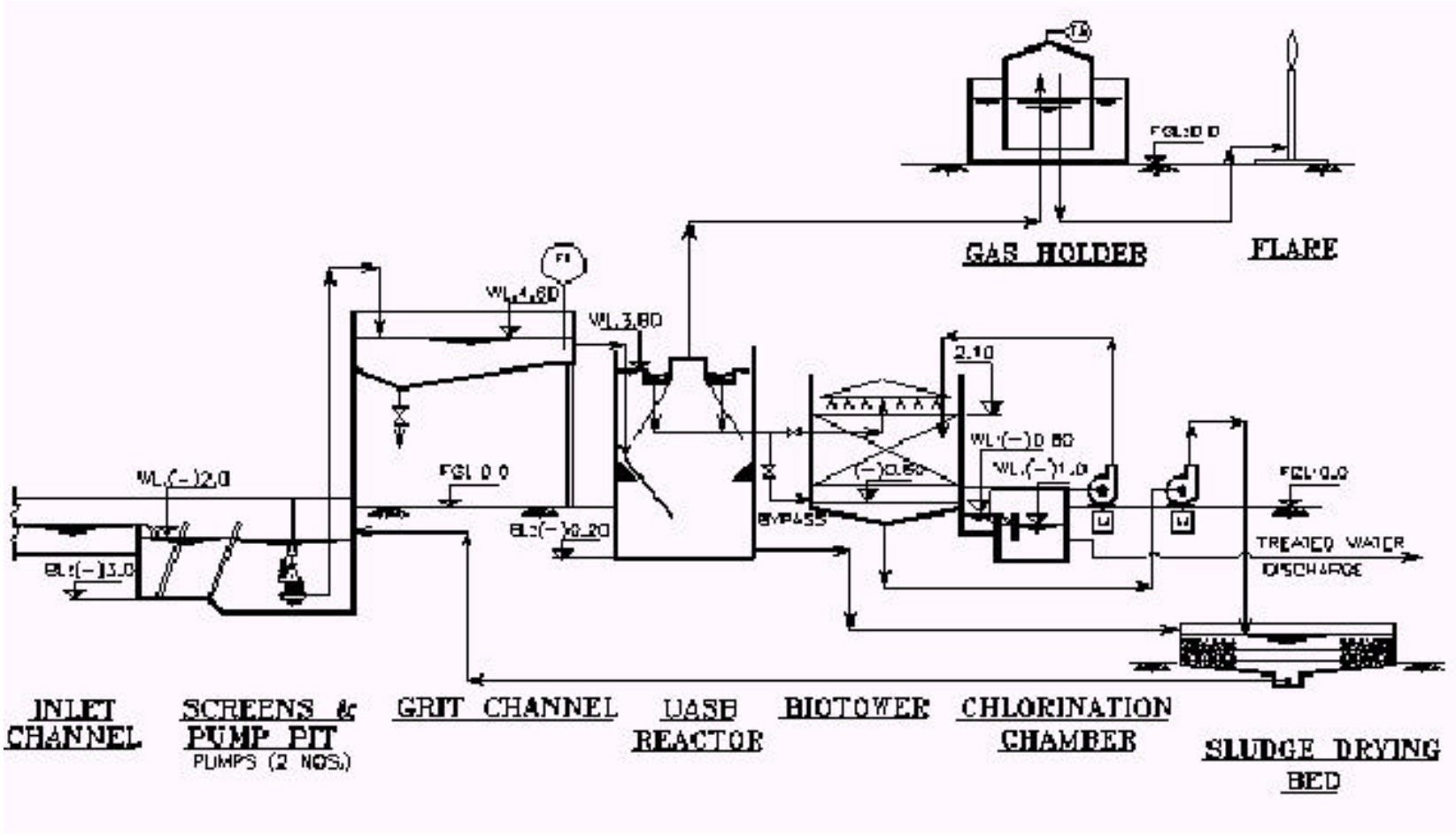
Table 6.2-1 COMPARISON OF DIFFERENT METHODS

TECHNOLOGY	MERITS	DEMERITS	MAIN PROCESS AREA	Conclusion*
OD	1. Simple operation 2. Proven design procedures 3. Many plants in world since 4. Many contractors 5. No need of primary clarifier	1. High equipment & energy cost 2. High capital & O&M costs 3. Sensitive to power failures 4. Need of treatment of excess sludge	100-200 m^2	x

		5. Need of secondary clarifier		
RBC	Low O & M cost Proven design procedures Many plants in world since Many contractors	1. Fly & odor nuisance 2. Unaesthetic appearance of effluent due to the presence of pin flocs/need sand filtration 3. Need of treatment of excess sludge 4. Need of secondary clarifier 5. Need of primary clarifier	30 m^2	△
TRICKLING FILTER	Low O&M cost Proven design procedures Many plants in world since Many contractors	1. Fly & odor nuisance 2. Several problems due to high content of SS in sewage such as clogging, deficiency in oxygen transfer etc 3. Need of treatment of excess sludge 4. Need of secondary clarifier 5. Need of primary clarifier	130 m^2	x
UASB+ TRICKLING FILTER	1. Low O&M cost 2. No need of primary clarifier 3. No need of secondary clarifier 4. No need of sludge digester as the suspended organic matter is stabilized in the reactor 5. Process can stand shocks and starvation 6. Yield biogas for power generation 7. Less excess sludge is produced (1/4 compared to conventional aerobic process) 8. Excess sludge used as fertilizer/soil conditioner 9. Effluent rich in nutrients beneficial for irrigation 10. Pathogens removal is satisfactory 11. Excellent treatment efficiency	1. Limited experiences compared to conventional. 2. Production of hydrogen sulfide can lead to problems with corrosion (need of protection against corrosion) 3. Poor removal of nutrients. In future, by recycling effluent to the UASB reactor, satisfactory nitrogen removal can be achieved.	30 m^2	O
STABILIZATION PONDS	Robust, simple to build & operate Cheapest in capital and O&M cost No skilled operational staff needed Pond green algae is rich in nutrient for irrigation	1. Land requirement is the largest 2. Occasional odor & mosquito problem if not maintained well 3. Occasional toxic algal blooms	600 m^2	x

Notes:
OD: Oxidation Ditch
RBC: Rotating Biological Contactor
UASB: Upflow Anaerobic Sludge Blanket

All these facts made obvious the interest of UASB process for Niamey city and also it is believed to be the first one to be constructed in the African continent. The Republic of Niger is getting benefit in terms of technology transfer by the JICA Study Team.



JICA	*The Study on Sanitation Improvement for the Niamey City in the Republic of Niger*	**Figure 6.2-1**
	HYDRAULIC PROFILE FOR PILOT PLANT	

6.2.2 Jyokaso Plant

The traditional way of toilet waste disposal used in Niamey city is septic tanks with soak pits or pit latrines, which exposes groundwater to contamination. In effect, septic tank is not a treatment system but just a pre-treatment.

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

6.3 SELECTION OF SITES AND CONSTRUCTION CONTRACTOR

6.3.1 Selection of Sites to Construct Pilot Plants

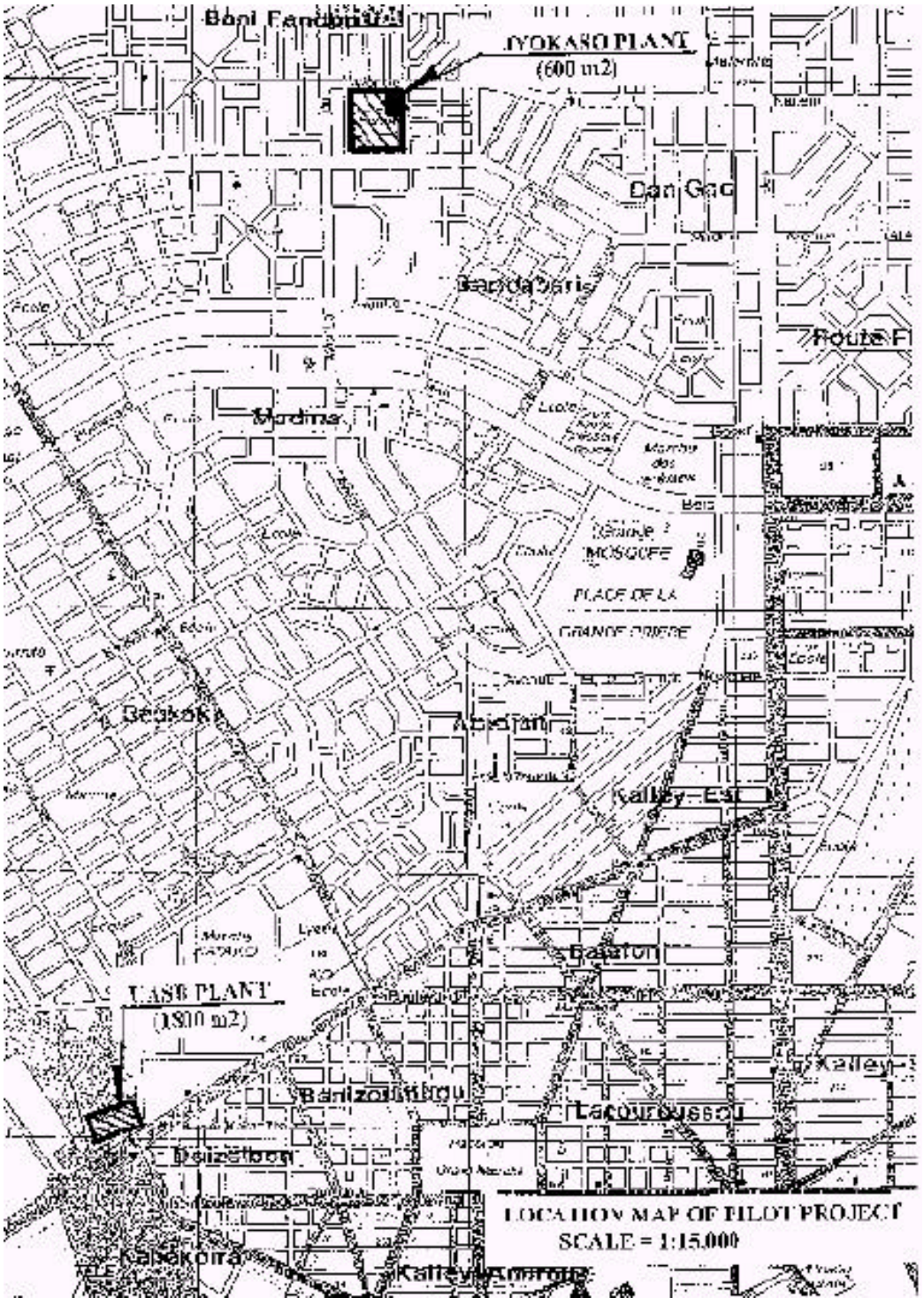
Based on our extensive survey to find appropriate sites for the two pilot plants, following two sites, as shown in Figure 6.3-1, have caught the attention of the Study Team:

We have proposed a site in the campus of primary school of Bandabari II for Jyokaso plant, thanks to the very special interest from the schoolmistress. This school's toilet system is destroyed. Under Jyokaso pilot plant, the Study Team is constructed toilets followed by Jyokaso, eco-system ponds and then soak pit for the complete treatment & natural recycle of waste. This plant is also contributed to hygiene education and awareness among teachers and students, which are important part of the society to spread their experience.

The UASB plant site, Deizeibon, is situated at the end of one of the 11 drainages flowing 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.

6.3.2 Selection of Construction Contractor

Five Nigerian companies have been contacted by the JICA Study Team to built the two pilot Plants on Full Turn Key basis. Three companies have submitted quotations for construction of two pilot plants, their commissioning, O&M for 6 months, evaluation for 6 months, training and technology transfer. A local contractor has been selected with approval from JICA. The Jyokaso plant itself was imported from Japan at the cost of JICA.



JICA	*The Study on Sanitation Improvement for the Niamey City in the Republic of Niger*	**Figure 6.3-1**

LOCATION MAP OF PILOT STUDY

6.4 INTRODUCTION OF TREATEMENT PROCESS

6.4.1 Selection of Technology for Wastewater Treatment

Selection of treatment technology for the pilot study has been done considering following points.

a) The characteristics of wastewater, temperature and climatic conditions in Niamey
b) Efficiency of the WWTP in terms of removal of the pollutant load i.e. BOD, COD, suspended solids, etc.
c) Quality of the treated effluent to match the requirements for discharging into the river/drain or application for irrigation purposes.
d) Cost effectiveness-both capital cost as well as operation & maintenance cost of WWTP.
e) The resource recovery in terms of methane gas production and its utilization, and reuse of the treated wastewater.
f) Operation and maintenance easiness.
g) Low energy consumption process.

6.4.2 UASB Treatment Process

UASB treatment process has the following advantages and disadvantages.

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

   - Low energy consumption because no aeration is required.
   - Production of biogas.
   - Low production of excess sludge with good dewatering characteristics.
   - No mechanical and rotating equipment, which result in operation and maintenance easiness.
   - Lower capital costs and 30% lower O&M costs comparing to activated sludge process.
   - Land area requirement is small comparing to the conventional aerobic treatment process.

2) The disadvantage of the UASB technology

   - BOD removal efficiency is limited to 70 – 80 %
   - Only applicable for the wastewater with higher temperature observed in tropical countries in case of domestic wastewater.
   - Initial starting up takes a little bit long time.
   - Low removal of nutrients and pathogens.
   - Need for secondary treatment facilities like polishing pond to achieve the limits set for discharging the treated effluent to water bodies.

Considering such advantages and disadvantages of the UASB technology, the UASB process has been selected as the pilot study.

6.4.3 Jyokaso Treatment Process

Jyokaso in Japan means a compact conventional mini sewage treatment plant, which purifies domestic wastewater. Jyokaso system is completely different from the septic tank, because it contains aerobic treatment process. In Japan, Jyokaso system is used in the area where public sewerage systems are not provided. Then Jyokaso system is sometimes called on-site sewerage treatment plant.

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 gray wastewater as well as wastewater from flush toilet. That is so called combined type Jyokaso system.

Various types of treatment process are available depending on the combination of primary and secondary treatment methods.

Table 6.4-1 VARIOUS TREATMENT PROCESS FOR JYOKASO

Primary treatment	Secondary treatment	Treatment process
Anaerobic filter	Contact aeration	Anaerobic filter-contact aeration process
Sedimentation/separation	Contact aeration	Sedimentation/separation-contact aeration process
Screen, equalization tank		Flow equalization-contact aeration process
	Activated sludge (extended aeration)	Extended aeration process
	Activated sludge (conventional)	Conventional activated sludge process

All these processes remove BOD, COD, SS, nitrogen, etc. to protect the water environment. The Jyokaso system is also equipped with disinfecting chamber for chlorination to kill the remaining bacteria.

6.5 PROCESS DESIGN OF PILOT PLANTS

6.5.1 UASB PLANT

(1) Outline of Design

The followings are the outline of the design.

Location :Deizeibon
Design Wastewater Flow :100 m^3/day
Land acquired :1,250 m^2
Primary Treatment Method :UASB reactor

Secondary Treatment Method :Trickling filter, Natural Eco-System Pond
Sludge Treatment Method :Sludge Drying Bed (SDB)

(2) Process Flow

Following figure shows the process flow of 100m^3/day at Deizeibon Pilot Plant. The plant consists of 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.

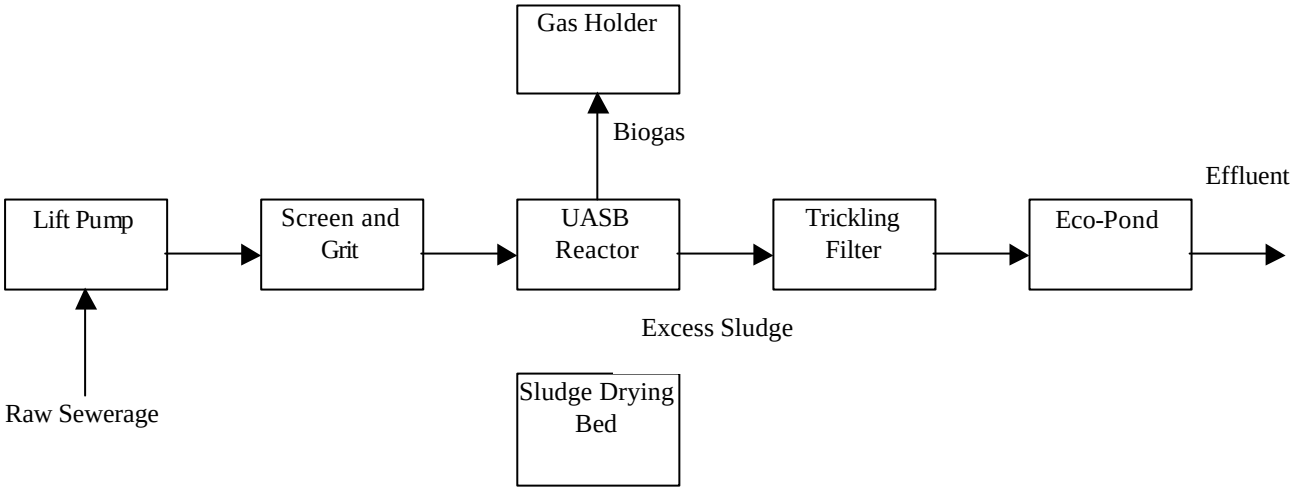


Figure 6.5-1 PROCESS FLOW OF UASB PLANT

(3) Material Balance

The material balance is shown in Figure 6.5-2.

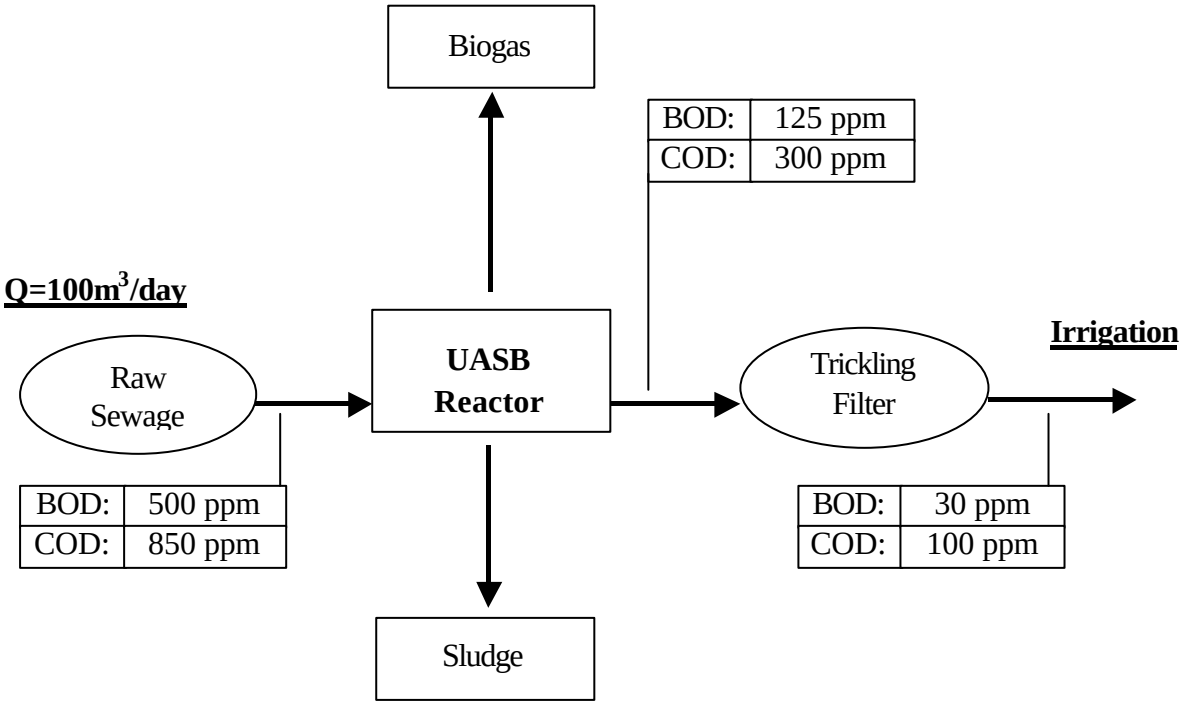


Figure 6.5-2 MATERIAL BALANCE OF UASB SYSTEM

(4) Equipment Design

1) Preliminary Treatment

Preliminary inlet work consists of screening, lifting and grit removal. Screenings are planned to remove wood or paper from the wastewater by coarse bar screens, which can be operated by manually.

2) UASB Reactor

UASB process is an anaerobic treatment process. The fundamentals of anaerobic treatment are to keep the produced methane bacteria inside the reactor and to contact it with wastewater itself. After the self-mixing, separation of gas, solid and liquid shall be carried out continuously at the top part of the reactor called separator.

The super structure of UASB reactor of Deizeibon Pilot Plant is rectangular concrete hydraulic structure which is shown in Figure 6.5-3 and 6.5-4, and reactor itself consists of inlet works for wastewater, distribution works, sludge beds, separate facilities for biogas and sludge, biogas collection apparatus and effluent gutters.

The dimension of reactor is 4.0m width x 3.0m length x 4.0m effective depth. In case of Deizeibon UASB Plant, anaerobic reactor consists of one-dome chamber.

Following is the details of reactor design.

Dimension	: Width 4.0m x length 3.0m x effective depth 4.0 m x 1 chamber
Reactor Volume	: 48 m^3
Retention Time	: 12 hours
Thickness of sludge layer	: 2.0 m
Actual upflow velocity	: 0.35 m/hours
Method of equalization for raw sewage	: Gravity flow by supply pipes

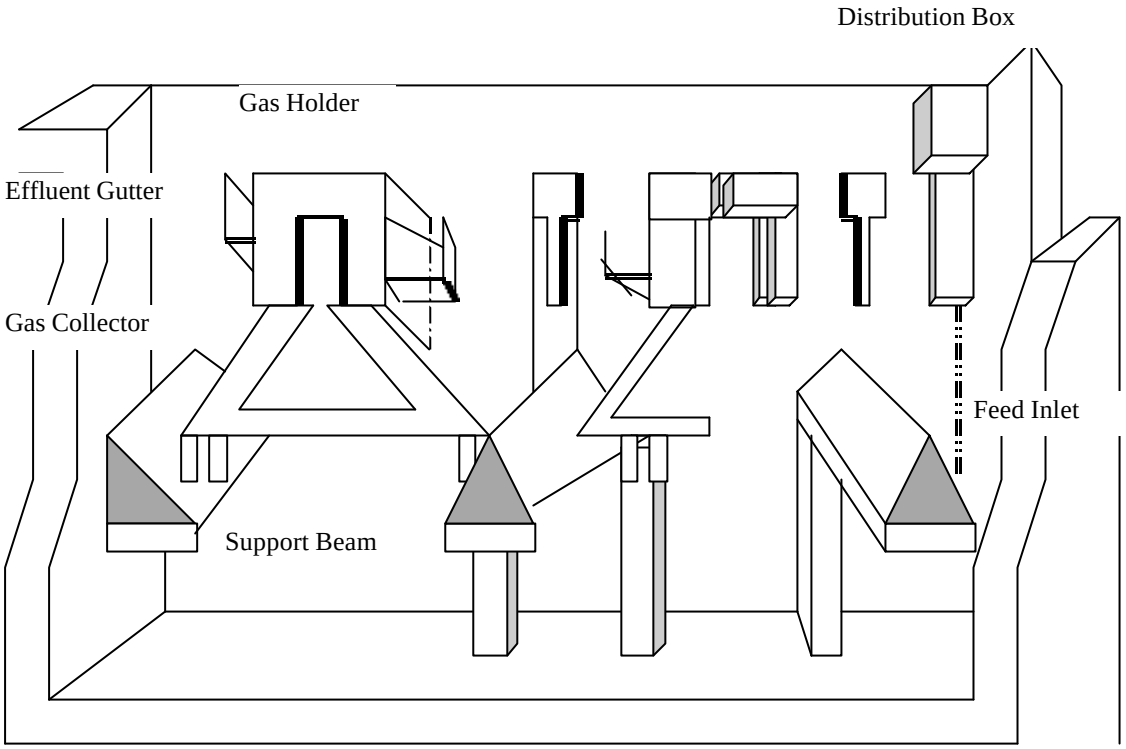


Figure 6.5-3 MODEL OF REACTOR

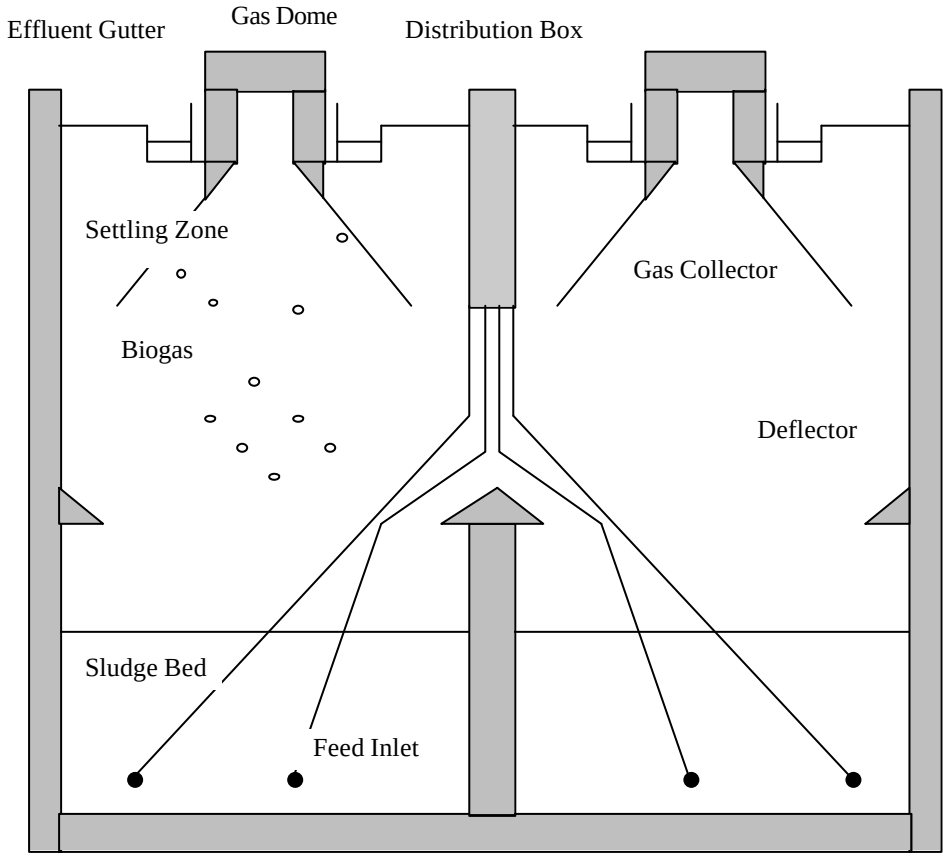


Figure 6.5-4 TYPICAL SECTION OF UASB REACTOR

3) Secondary Treatment

Trickling filter as secondary treatment to treat the effluent of the UASB reactor was installed.

Trickling filter is a circular bed of filter media. Effluent sewage is distributed over the bed and trickled down over the surface of the media.

A microbial film grows on the surface of the media and the bacteria, which constitute most of the film, oxidize the sewage as it flows down (Figure 6.5-5). As the sewage is oxidized, the microbial film grows:

$$\text{treated sewage} + \text{oxygen} \xrightarrow{\text{bacteria}} \text{oxidized effluent} + \text{new bacterial cells}$$

Some of the new cells so formed are washed away from the film by the hydraulic action of the sewage and settled at the bottom of the trickling filter which is removed periodically.

4) Sludge Drying Beds

The sludge from UASB reactor is collected on the sludge drying beds (SDB) and after drying and cake formation, it can be reused as soil conditioner on cultivated land or dumped at the disposal site. The sludge drying time varies as per the climatic condition and for design purpose 7 to 14 days is adopted.

5) Gas Holder

The produced biogas is to be utilized to generate the electricity using duel fuel engine. The electricity is used to operate pumps and to illuminate the WWTP. In this pilot plant, generated biogas shall be collected into the gas holder and then would be flared.

6) Process Control and Instrumentation

To achieve the easy and simple operation of the pilot plant, process controls and instrumentation is designed for automatic operation.

7) Equipment Dimension

- Inlet Channel & Screens : 0.5 mW x 5.0 mL
- Pump Pit : 1.5 mW x 1.5 mL
- Grit Channel : 0.5 mW x 4.0 mL
- UASB Reactor : 4.0 mW x 3.0 mL x 4.0 mH
- Trickling Filter : 3.2 mID x 2.5 m Media depth
- Final Polishing Pond : 6.0 mW x 3.0 mL x 3 sets
- Sludge Drying Bed : 5.0 mW x 5.0 mL

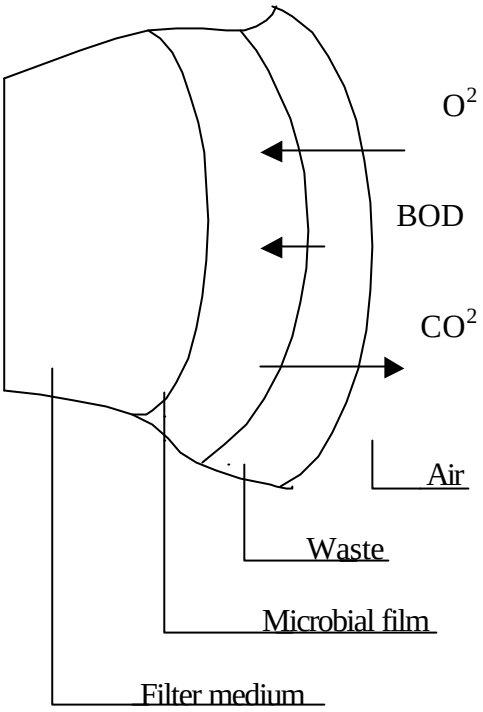


Figure 6.5-5 SCHEMATIC DIAGRAM OF BOD REMOVAL IN A TRICKLING FILTER

6.5.2 Jyokaso Plant

(1) Selection of Treatment Process

Among the various options, the "sedimentation-separation-contact aeration process" has been selected for the pilot study due to the following reasons.

- Efficient removal of pollutants is obtained.
- Structure and equipment needed are not complicated.
- Fluctuation of inflow load is absorbed.
- Construction cost is cheap.
- O&M are easy.
- Frequent desludging is not required.

As the primary treatment system, the structure of sedimentation/separation method is simple, and O&M is relatively easy. On the other hand, the anaerobic filter bed process has a complicated structure, because it requires the installation of filter media. In the meantime, screen and pump equipment are necessary for the screen/flow equalization method and the screen needs to be frequently cleaned to remove accumulated sludge.

As the secondary treatment system, the contact aeration is relatively easy for operation. In the meantime, although the treatment of activated sludge method is a simple process, it requires an advanced technology of operation to get the good quality of the activated sludge.

(2) Outline of Design

Following are the outline of the design for Jyokaso plant.

Location	: Bandabari II primary school
Design Sewerage Flow	: 10m ^{3}/day
Jyokaso Treatment Method	: Sedimentation/Separation-Contact Aeration
Secondary Treatment Method	: Eco-system Pond

The Jyokaso design is based on 50 equivalent habitants with inlet BOD 200 ppm and outlet BOD 20 ppm.

(3) Flow Chart of Jyokaso Plant

A flowchart for the sedimentation / separation – contact aeration method is shown in Figure 6.3-4. Influent flows successively through the sedimentation / separation tank (divided into two chambers), the contact aeration tank, the sedimentation tank, and the disinfection tank before discharge.

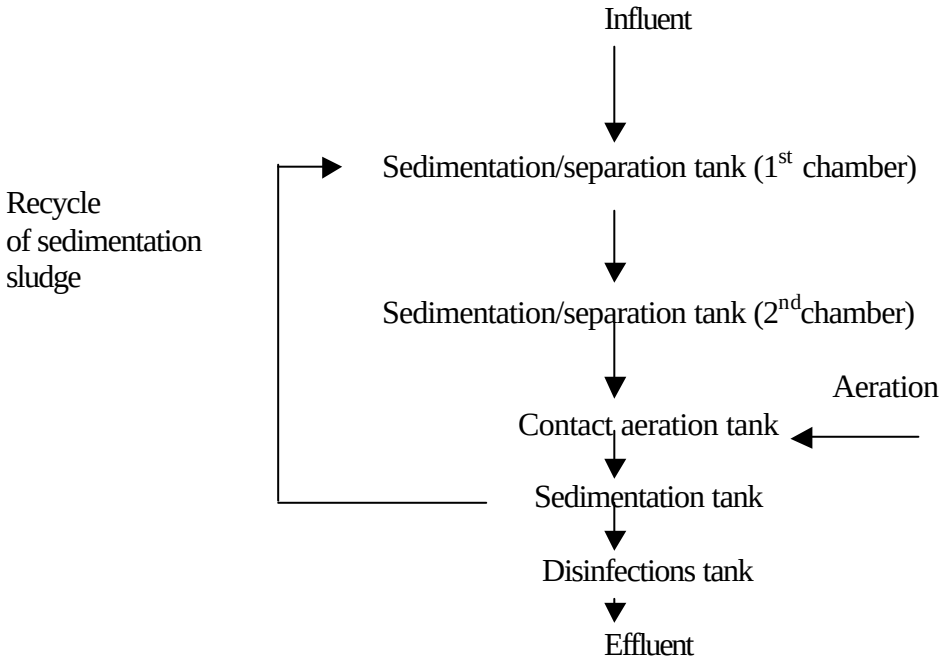


Figure 6.5-6 FLOW CHART FOR THE SEDIMENTATION/SEPARATION -CONTACT AERATION PROCESS

The functions of the respective tanks are explained below.

a. Sedimentation/separation tank : separates solid matter from the influent and stores it together with excess sludge.
b. Contact aeration tank : decomposes BOD with aerobic bacteria on the filter media.

c. Sedimentation tank : settles sludge resulted from detached bio film in the contact aeration tank.

d. Disinfections tank : mixes treated water with disinfectant to reduce bacterial contamination risks.

(4) Equipment Design

Effective volume, etc. of respective tanks for the average daily amount of water of $10m^3$/day are as follows.

- No.1 sedimentation/separation tank : 10 m^3(24 hr retention time)
- No.2 sedimentation/separation tank : 5 m^3(12 hr retention time)
- Contact aeration tank : 8.4 m^3(20 hr retention time)
- Sedimentation tank : 2.4 m^3 (5.8 hr retention time)
- Disinfections tank : 0.15 m^3(20 min retention time)
- Blower capacity : 0.4 m^3/min

The above equipment except for blower is compacted in one package made of FRP (fiber reinforced plastic) which dimension is 2.3 m diameter (1.85m effective depths) x 8.50 m Length.

In addition to Jyokaso, following equipment is arranged for the plant.

* Toilet building (8 WC)
* Eco-system Pond (10 m^2 water surface)
* Soak Pit (3.6 m inside diameter)

6.6 NIGERIEN OBLIGATION AND UNDERTAKINGS

6.6.1 Demarcation of Related Authority

The fundamental obligations have been agreed with the related Authorities on 18/09/00 at MET. More details can be explained in this section so as to meet smooth O&M toward the OJT and Technology Transform (T/T). Refer to the letter N°.JT-1120 and N°.00120 SG/MET/T/DGUH/C/DU, dated 20 th October 2000.

(1) CUN

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

(2) MET

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 after the completion of OJT&T/T.

(3) MOE

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.

6.6.2 Performance of Each Authority

In order to expedite the Pilot Study, concerned Authority is cooperating and working together with the Study Team. As mentioned in the previous section, CUN has taken action for land acquisition for Deizeibon area by issuing the Exchange Agreement. MET should supervise the Pilot Study in cooperation with CUN & MOE. MOE and Bandabari primary school have also planned the program of sanitation education campaign.

6.6.3 Progress of Soft Component for Hygiene Education

According to the outcome of the action by the residents of the district and/or quartier, the appropriate program for Hygiene Education was planned by the Team.

- Meeting with representatives of residents.
- Residents consciousness and/or awareness.
- Results of an attitude survey.
- Program of Hygiene Education.

6.6.4 Operation and Maintenance (O&M)

Nigerian side shall manage the operation and maintenance of the two Pilot Plants in association with JICA Study Team for on the job training (OJT) and Technology Transfer (T/T). The followings are outline of the O&M of the two Plants.

(1) Routine O&M of UASB Plant

Routine maintenance tasks are as follows:

a) Pumping up the raw sewage from the existing discharge channel at site.
   Since design average flow is 0.1 m^3/min, it seems to be required the uniform pumping
b) Getting rid of the sand, grit and screenings at the grit chamber by mechanical grit collector.
c) Removal of any accumulated solids in the inlets and outlets.
d) Repair if any damage of external fences and gates.
e) The maintenance requirement of ponds is very simple, but it should be carried out regularly. Otherwise, there will be serious odors, fly and mosquito nuisance.

In order to execute proper O&M tasks, UASB Plant shall be adequately staffed. Although the level of staffing depends on the type of inlet works (for example, mechanically raked screens and proprietary grit removal units require an electromechanical technician, but manually raked screens and manually cleaned grit channels do not), whether there are on-site laboratory facilities, recommended staffing levels are given in the Table 6.6-1 for UASB Plant.

Table 6.6-1 RECOMMENDED STAFFING LEVELS FOR UASB PLANT

Foreman/Supervisor	1
Mechanical engineer	1
Laboratory technician	1
Labor / Casual worker	1 *
Watchman	1 *
TOTAL	5

*Note : * Be stationed permanently.*

(2) Routine O&M of Jyokaso plant

Following points shall be checked as routine O&M. Detail is given in the Appendix.

a) Sludge/scum discharge from the sedimentation/separation tank
b) Adjustment of air flow for aeration tank, air lift and backwash
c) Adjustment of disinfectant injection rate

6.7 IMPLEMENTATION OF THE PILOT PLANTS

6.7.1 Procurement of Equipment

(1) UASB Process Equipment

Following UASB process equipment shall be imported from Mumbai, 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
- Recirculation pump
- Sludge pump
- Gas holder
- Flare and gas flow meter
- All interconnecting piping/valves, instruments such as pressure gauges, gas flow meter
- Electrical motor control panel
- Plant lighting
- Electrical cabling, earthing
- PH meter for on site testing

(2) Jyokaso Process Equipment

Jyokaso is a package type domestic wastewater treatment plant, which consists of sedimentation/separation tanks (1st & 2nd), 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

6.7.2 Construction of Pilot Plants

Facility construction for pilot study has been started from middle of November 2000 for Jyokaso plant and from beginning of January 2001 for UASB Plant, respectively. The Jyokaso plant has been commissioned from the beginning of March 2001. Commissioning of UASB plant is started from the beginning of July 2001.

(1) UASB Plant

- Process design and detail design by Paramount : Nov. – Dec., 2000
- Finalization of land acquisition : Beginning of Jan., 2001
- Site grading : Dec. – Jan., 2001
- Manufacturing of equipment : Jan., 2001
- Inspection and delivery of equipment : Feb., 2001
- Civil Construction : Feb., & Mar., 2001
- Equipment installation : Apr., 2001
- Commissioning : July 2001 -

(2) Jyokaso Plant

- Toilet construction : Dec. – Jan., 2001
- Construction for infiltration pit : Dec. – Jan., 2001
- Construction of eco-system pond : Dec. – Jan., 2001
- Digging of Jyokaso pit & basement concreting : Jan. – Feb., 2001
- Equipment installation : Feb., 2001
- Commissioning : Mar., 2001

6.7.3 Monitoring of Pilot Plants

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. Should pilot plants suddenly fail or effluents start to deteriorate, the results of such monitoring often give some insight into the cause of the problem and generally indicate what remedial action is required.

(1) Water Quality Monitoring

Following water quality monitoring shall be done.

On-site water quality test shall be done every day as follows.

Table 6.7-1 ON-SITE WATER QUALITY TEST ITEMS

	Flow	Color	Odor	Temp.	pH	Turbidity	DO	Res.Cl_2
Influent of UASB reactor	-	O	O	O	O	-	-	-
Effluent of UASB after Chlorination	O	O	O	O	O	O	O	O
Influent of Jyokaso	-	O	-	O	O	-	O	-
Effluent of Jyokaso	O	O	O	O	O	O	O	O

Water quality test shall be done twice a month as follows.

Table 6.7-2 WATER QUALITY TEST ITEMS IN THE LABORATORY

	COD	BOD	SS	T-N	NH4-N	NO3-N	NO2-N	P-PO4	Total Coliform
Influent of UASB reactor	O	O	O	O	-	-	-	-	-
Effluent of UASB before Chlorination	O	O	O	O	O	O	O	O	O
Influent of Jyokaso	O	O	O	O	-	-	-	-	-
Effluent of Jyokaso before soak pit	O	O	O	O	O	O	O	O	O

(2) Evaluation of Pilot Study

After examination for all the information of treatment efficiency and treated water quality during 6 month operation, evaluation of the Pilot Study shall be given.

CHAPTER 7. BASIC POLICY AND MASTER PLAN CONCEPT

CHAPTER 7. BASIC POLICY AND MASTER PLAN CONCEPT

7.1 BASIC POLICY AND STRATEGY OF IMPROVEMENT

7.1.1 Target Year of Master Plan

As stated in Section 1.3.2, the target year for the Study is 2015 whereas for the urgent rehabilitation work (URW) it is 2005 to bring an immediate effect for the improvement of sanitation conditions in Niamey City.

7.1.2 Problems to be Solved

Sanitation and living environment of Niamey City is deteriorating together with GDP. It is necessary to take drastic measures to improve sanitation and living environment of Niamey City by providing adequate water supply access, night soil management, sewerage, and solid waste management system. However, central and local (CUN) governments have no financial, technical and management capability to formulate and execute plan. It is also doubtful that responsible organizations have an intention to improve sanitation and living environment. On the other hand, residents of Niamey city are very poor.

Increase in population and expansion of urban area has taken place at the cost of unplanned land selling and illegal squatter. Therefore, urban area of Niamey city has high population density without basic infrastructure except water supply. As a consequence, urban area is faced with eroded pavements, several inundated areas during rainy season, full of garbage and open defecation field even in the central area.

Population increase and expansion of urban area will continue also in future. It will result in further deterioration of sanitation and living conditions. Erosion of roads will continue, inundated area will increase, and garbage dumping, and open defecation will be more in the central area. On the other hand, existing facilities and equipment will be over aged in near future. If no effort to maintain the existing facility and to renew the equipment is done, existing system will be collapse totally within few years.

Therefore, policy and strategy shall be established and executed immediately. Adequate organization shall be established as soon as possible. It is very important at this time that Niger Government expresses strong intention and actual effort to all the related international organization to obtain financial support to improve sanitation condition.

7.1.3 Master Plan Policy

Local government (CUN) as well as residents of Niamey is not financially well and sanitation condition shall be improved under this constraint. It may be necessary to obtain financial support from the international organizations. However, operation and maintenance cost shall be born by the governments as well as residents.

In order to operate and maintain facilities and equipment, government with technical and management capability and community participation is required. But the technical and management capability of Niger side is insufficient at present and shall be developed.

As mentioned above, population increase and expansion of urban area will continue in future. However, priority shall be given to the existing urban area, which condition is extremely serious. Therefore, in the Master plan only the basic strategy for sanitation improvement will be developed for future development area.

Financial constrain will be the 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.

The existing and on going process regarding the overall strategy plan for the environmental protection shall be taken into consideration, when the major items for the Master Plan will be identified.

Within the 6th Program of environmental protection defined in the National Plan of Environment for a Durable Development (PNEDD), exploration of the strategic principles has been undertaken. The preliminary results identified 5 sectarian items, which are as follows:

- Wastewater management,
- Solid waste management,
- Rain water management,
- Management of environment in the undeveloped areas,
- Environmental management in other cities of Niger.

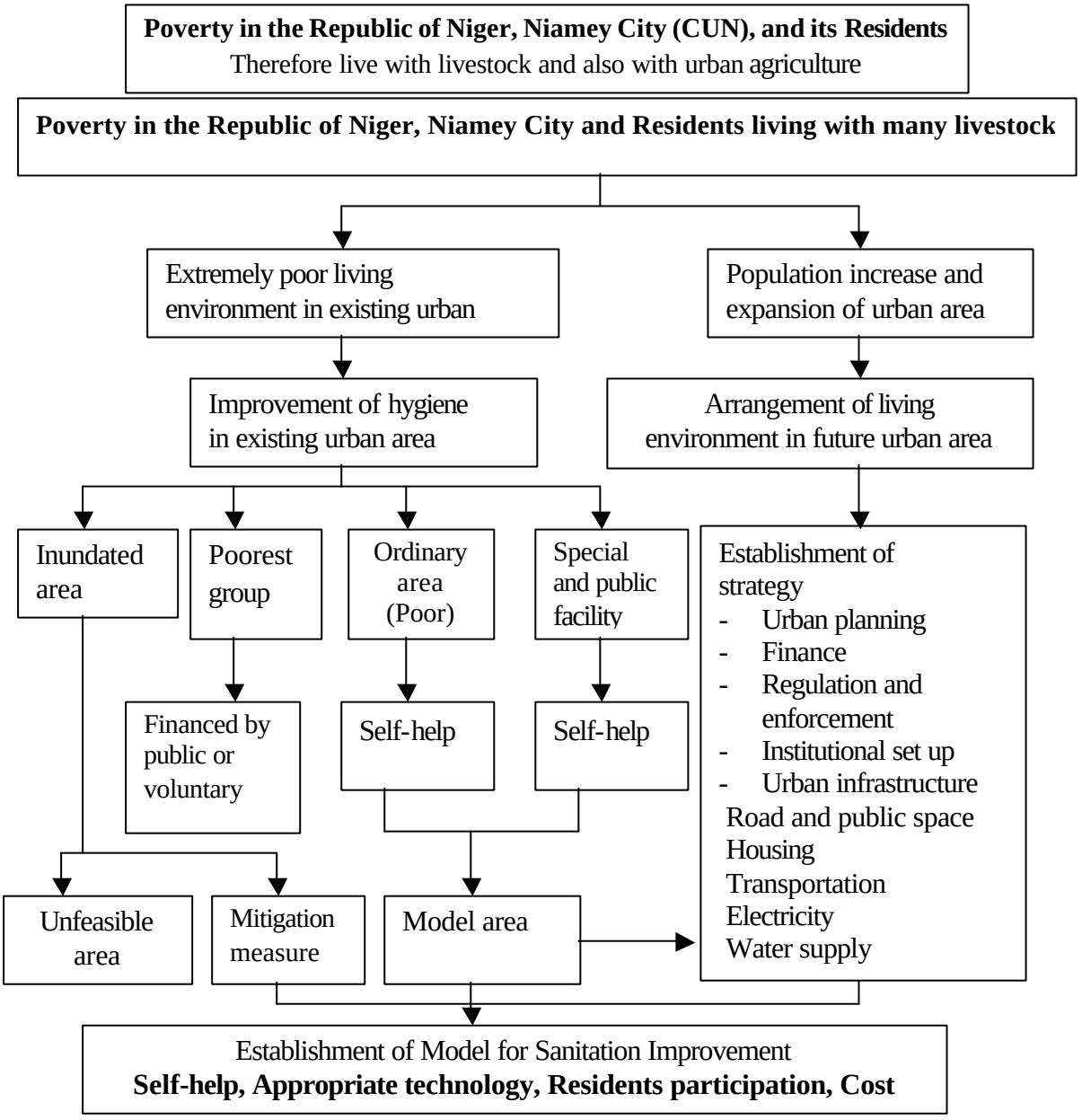


Figure 7.1-1 FRAME OF SANITATION IMPROVMENT

a) Water Supply

Although it is desirable to have water connection to each compound where water supply network is available, there is no effective measure to avoid distribution through public tap and water seller. Therefore, it should be accepted in Niamey. It is important to establish control system for water quality of well and proper guidance for usage of polluted well in Niamey.

b) Sanitation (Toilet and sludge management)

All compounds shall have toilets. De-sludge system shall be established including sludge treatment system. It is necessary to eliminate practice of field defecation. Public education shall be organized and public toilet shall be provided.

c) Drainage
Priority shall be given for mitigation measure of undated area. Proper drainage system shall be established including operation and maintenance.

d) Sewerage
Major drainage wastewater shall be treated before discharge. Sewerage system shall be provided in priority area, which has high population and financial capability for house connection.

e) Solid waste management
Solid waste collection and disposal system shall be established to avoid accumulation of solid waste in urban area. Final disposal site shall be designated and constructed.
Self-help and cost recovery are key issues to construct sustainable system of sanitation. It can be classified into 3 levels as follows.

f) Full cost recovery of construction, and operation and maintenance cost

g) Full cost recovery of operation and maintenance cost

h) Partial cost recovery of operation and maintenance cost
Target in Niamey shall be set to recover all operation and maintenance cost although it is desirable to have more capability. In this case, financial source for construction shall be found in the form of grant aid and/or loan. It is not sustainable if there is no capability to recover all operation and maintenance cost.

7.2 CONCEPT OF MASTER PLAN

7.2.1 Constraints to be Considered

Niamey sewerage Master Plan under the policy initiated by the Government of Niger was prepared in 1980 by Bank of African development (BAD) and BAD also studied wastewater treatment plan in 1989. Complying with those reports, German and Switzerland consultants cooperated to the Government of Niger and a financial proposal to BAD for the implementation of the sewerage works was submitted. However, proposal was abandoned by BAD. The responsibility for developing and expediting this project was given to the Ministry of Equipment and transports (MET). Judging that sanitation improvement project would be necessary, MET requested to the Government of Japan to carry out the Master Plan (M/P) and Feasibility Study (F/S) on sanitation improvement project in Niamey as Japan's ODA project.

7.2.2 The Concept of the Master Plan

Master plan of Sewerage/Drainage and Solid Waste Management should be prepared by proposing feasible projects in the near future. The field reconnaissance and survey including six types of sub-contract works has been carried out. Based on the out come of field survey, most appropriate plan have been selected for the target year.

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

Planning population of the Study Area.
To rectify the situation of sanitation in Niamey City.
To formulate the Master Plan for Sewerage/Drainage and Solid Waste management.
To build two Pilot Plants to campaign the Hygiene Education for Public Participation
To evaluate the most appropriate sewerage treatment process for the Republic of Niger.

The Master Plan present evidence to realize that:

* Virtually all the exiting facilities are already grossly over loaded and deteriorated.
* Short-term expediencies can no longer overcome the problem caused in city.
* General condition for Sanitary Environment is completely deplorable and deteriorating year by year.
* Hazard risk is increasing rapidly.

MET accepted the recommendations to rehabilitate the existing facilities and construct new facilities for sanitation improvement of Niamey city. MET desires to secure the funding from international agencies such as BAD and/or BADEA for implementation of the Project. The Japanese Government has agreed to carry out the formulation of M/P and Feasibility Study, through it's agency JICA. JICA Study Team has been entrusted by JICA with the Study of the Sanitation Improvement Project.

7.3 PLANNING FRAMEWORK FOR SEWERAGE SYSTEM

7.3.1 Sewerage Planning Area

Sewerage planning area shall be the urban planning area in the Urban Community of Niamey (CUN). The sewerage planning area is further classified into sewerage facility planning area and on-site treatment area.

Sewerage facility planning area is the area where wastewater is collected through sewer conduits or pipes and treated in the treatment plants. Areas that have higher population density, i.e., urban areas, are categorized in this sewerage facility planning area.

On-site treatment area is the area where wastewater is treated by individually house or community without installing ordinary sewer pipes. Areas that have lower population density, i.e. suburban areas, are categorized in this on-site treatment area.

Table 7.3-1 shows the details of sewerage planning area. Figure 7.3-1 shows the sewerage general plan.

Table 7.3-1 SEWERAGE PLANNING AREA

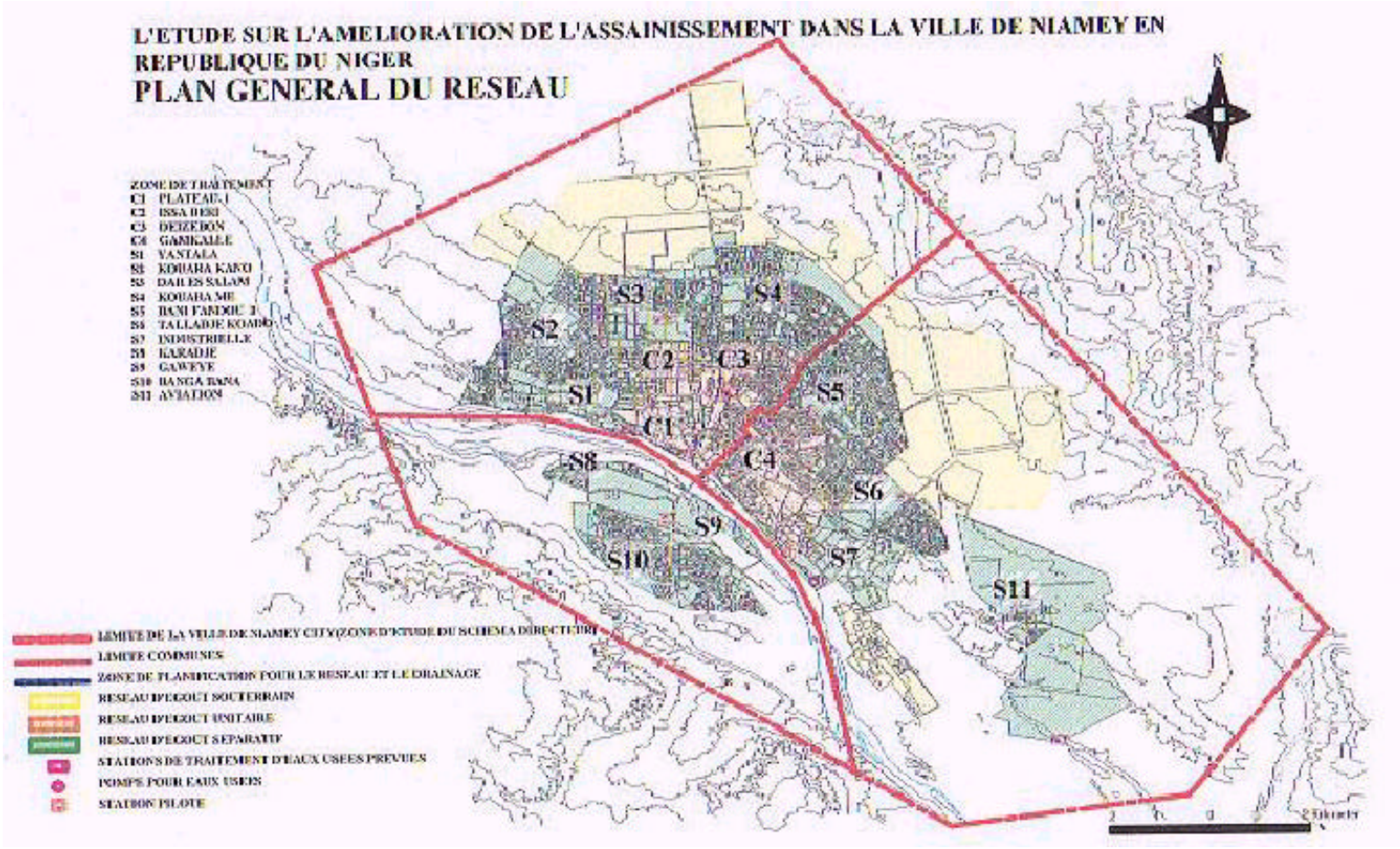
	Area Classified	Area(ha)
Commune I	Sewerage Facility Planning Area	3,340.5
	On-site Treatment Area	1,640.7
Commune II	Sewerage Facility Planning Area	3,267.1
	On-site Treatment Area	1,942.0
Commune III	Sewerage Facility Planning Area	1,021.1
	On-site Treatment Area	0
Sub-Total	Sewerage Facility Planning Area	7,628.7
	On-site Treatment Area	3,582.7
Total	Sewerage Planning Area	11,211.4

7.3.2 Sewerage Planning Population

Sewerage planning population shall be the population in the sewerage planning area, i.e., urban planning area in the Urban Community of Niamey (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 7.3-2 shows the details of sewerage planning population.

Table 7.3-2 SEWERAGE PLANNING POPULATION

		2000	2005	2010	2015
Commune I	Sewerage Facility Planning Population	292,835	333,257	355,116	389,662
	On-site Treatment Population	41,970	71,586	99,286	138,594
Commune II	Sewerage Facility Planning Population	211,778	232,180	253,576	271,263
	On-site Treatment Population	27,406	28,835	49,949	61,429
Commune III	Sewerage Facility Planning Population	78,412	91,334	113,419	132,776
	On-site Treatment Population	0	0	0	0
Sub-Total	Sewerage Facility Planning Population	583,025	656,771	722,111	793,701
	On-site Treatment Population	69,376	100,421	149,235	200,023
Total	Sewerage Planning Population	652,401	757,192	871,346	993,724



JICA	*The Study on Sanitation Improvement for the Niamey City in the Republic of Niger*	**Figure 7.3-1**
	SEWERAGE GENERAL PLAN	

7.3.3 Hypothesis of Sewerage Planning

(1) Type of Wastewater Collection System

There are two types of wastewater collection systems, one is combined sewer system and the other is separate sewer system. Combined sewer system is a system that receives and conveys both sanitary wastewater and storm water in a single conduit/pipes. On the other hand, separate sewer system is a system that receives and conveys wastewater and storm water in the independent conduit/pipes, respectively.

The main advantages and disadvantages of the two different systems are as follows.

- Construction cost of the separate sewer system is higher than that of the combined sewer system as both conduit/pipes for wastewater and storm water are required independently for the separate sewer system.
- Combined sewer system overflows polluted storm water mixed with sanitary wastewater into the receiving water bodies in the rainy season. On the other hand, separate sewer system collects storm water and wastewater in the separate conduit/pipes and storm water is not polluted by the sanitary wastewater.
- As only wastewater is flowing in the conduit/pipe in the dry season in the combined sewer system, necessary traction force may not be kept, that may cause accumulation of waste and deterioration of conduit/pipes due to corrosiveness of generated gas. To keep the traction force even in the dry season, conduits with wastewater flow section on the bottom is proposed.

(2) Return Period and Rainfall Intensity Formula

1) Criteria of Existing Plan

In the report, *Assainissement de la Ville de Niamey Schema Directeur* which is the first plan of Niamey City storm water drainage facilities prepared by GKW in 1979, the main drainage for storm water is planned based on the probable rainfall intensity with return period of two years. The branch drainage is planned based on the probable rainfall intensity with return period of one year. The rainfall intensity adopted in the report is as follows.

Rainfall with return period of 2 years: 275l/s/ha (=99mm/h) for duration of 15 minutes
Rainfall with return period of 1 year: 233l/s/ha (=84mm/h) for duration of 15 minutes
The above rainfall intensity is calculated on the basis of the data of eight years during 1965 to 1972.

According to the drainage calculation in the report, rainfall intensity within 15 minutes is adopted constant as 275l/s/ha for main drainage and 233l/s/ha for branch drainage. Higher rainfall intensity within 15 minutes is not considered for the design of drainage. Considering the nature of the rainfall in tropical zone, higher rainfall intensity within 15 minutes should be adopted based on the reasonable estimation formula.

In 1998, all of the Niamey City area suffered heavy damage from the flood. The cause of the flood and the effective countermeasures to improve the situation was investigated in the report, *Etude de base pour la maitrise des eaux pluviales, prepared by Cereve-KRB* in 2000. As for the rainfall intensity, the report suggests as follows.

Rainfall with return period of 2 years: 322l/s/ha (=116mm/h) for duration of 15 minutes
Rainfall with return period of 1 year: 267l/s/ha (=96mm/h) for duration of 15 minutes

The difference between the two reports is due to the data taken, that is, the 1979 report is based on the data of 1965 to 1972 and the 2000 report is based on the data of 1970 to 1999.

2) Criteria for this Study

(1) Rainfall Intensity Formula

The rainfall intensity formula of Niamey City given by the report of Inter-State Members Committee for Hydrological Studies (*Comite inter-Etats d'Etudes Hydrologiques*) is as follows. This formula is made under the investigation of the rainfall data during 1970 to 1999.

$I = 60a\ t^b$

a : 5.2(T=1),
6.0(T=2)
8.9(T=10)
b : -0.5
where,
T: Return period (year)
t = to + ti
t : Concentration time (min)
to : Inlet time (=5min)
ti : Flow time (min)

As the return period is longer, rainfall intensity is larger, which may cause higher investment cost if the facilities are designed based on the intensity. In this study, return period of 2 years shall be adopted taking into consideration of benefit and reasonable investment cost.

Therefore in this study, rainfall intensity is calculated based on the following formula with return period of 2 years. That is,

$I = 360\ t^{-0.5}$ (mm/hr)

The rainfall intensity versus duration is shown in Fig.7.3-2.

(2) Rational Formula

The storm water runoff is calculated according to the following rational formula.

$Q = C \cdot I \cdot A/360$

Q: Design maximum runoff storm water (m^3/s)
C: Runoff coefficient
I: Average rainfall intensity during concentration time (mm/hr)
A: Drainage area (ha)

Runoff coefficient has to be determined with considerations for future land use planning. In this master plan, runoff coefficient is classified in Table 7.4-3 based on the type of land use.

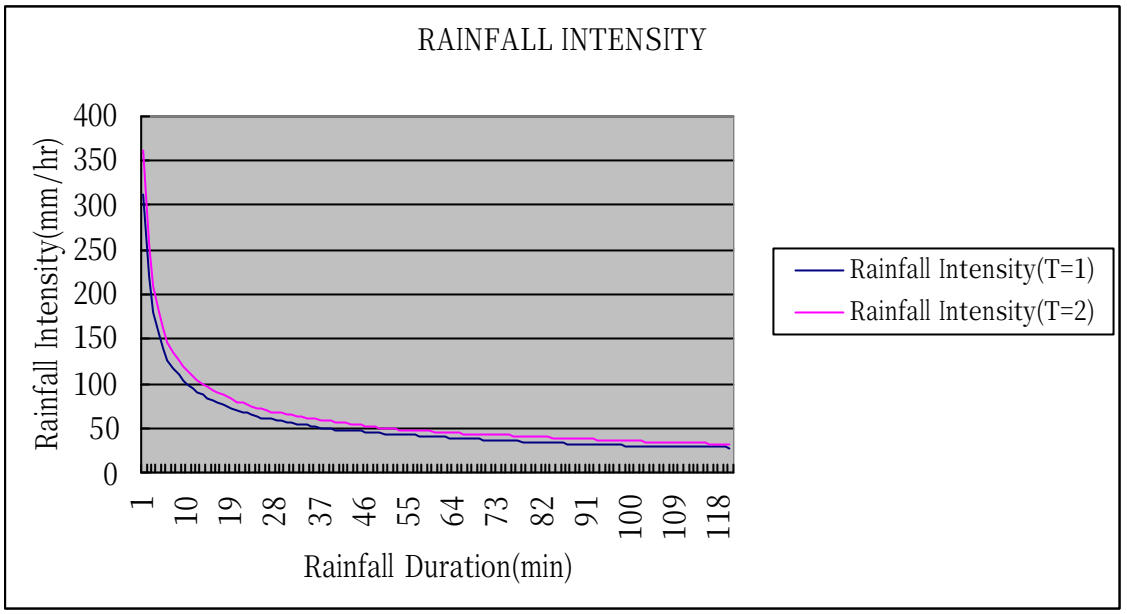


Figure 7.3-2 RAINFALL INTENSITY CURVE

Table 7.3-3 OVERALL RUNOFF COEFFICIENT FOR VARIETY OF LAND USE

Characteristics of land	Over all runoff coefficient
Business area with small vacant land Residential area with small vacant land Airport	0.80
Industrial area with small vacant land Residential area with small garden Urban infrastructure area with small vacant land Commercial Area	0.65
Housing development area Residential area with medium garden Institutional area with medium vacant land Urban infrastructure area with medium vacant land	0.50
Residential area with large garden Urban infrastructure area with large vacant land Institutional area with large vacant land Suburban area with farmland	0.35
Green space	0.20

(3) Hydraulic Calculation Formula for Drainage and Sewage Conduit/Pipe

Manning formula is applied in the case of the gravity flow type and Hazen William's formula is applied in the case of the pressurized flow type

Manning formula;

$Q = A \cdot V$

$V = (1/n) \cdot R^{2/3} \cdot I^{1/2}$

Where,

Q: Flow rate (m^3/s)

A: Section area of drainage with liquid flow (m^2)

V: velocity (m/s)

n: roughness (0.013 is applied for concrete and 0.010 for PVC.)

R: Hydraulic radius (= A/P(m))

P: Wetted perimeter (m)

I: Gradient

[Note]: It is assumed that the maximum depth of water flow is 90 % height of drainage section.

Hazen William's formula;

$Q = A \cdot V$

$V = 0.84935 \cdot C \cdot R^{0.63} \cdot I^{0.54}$

Where,

V: Average velocity (m/s)

C: Coefficient (110 is applied.)

R: Hydraulic radius (m)

I: Hydraulic gradient (h/L)

h: Friction loss for length of L (m)

(4) Maximum and Minimum Velocity for Drainage and Sewer Conduit/Pipe

Maximum velocity shall be 6 m/s considering the geological condition. Minimum velocity shall be 0.8 m/s considering self-cleaning function.

(5) Treated Effluent Quality from the Waste Water Treatment Plant

Treated effluent quality from the wastewater treatment plant shall meet the effluent standards for wastewater established by the Ministerial order n°014 of 1 November 1976, as described in Chapter 14.1. The severest standards for discharge in the natural environment close to water intake point for public water supply, bathing place or fishing area shall be applied.

Table 7.3-4 TREATED EFFLUENT QUALITY

pH	5.5 – 8.5
Suspended matter	Up to 30mg/l
BOD	Up to 40mg/l

7.3.4 Unit Design Flow and Load

(1) Unit Water Consumption

1) Domestic Use

According to the water consumption data by SNE in Table 7.3-5, unit water consumption shall be 50 lpcd (litter/capita/day) for domestic use. Domestic use includes both private tap and public tap.

Table 7.3-5 WATER CONSUMPTION DATA

	Commerce . & Ind.(m^3/d)	Domestic (m^3/d)		Total (m^3/d)	Admi. Population	Domestic lpcd
		Public	Private			
1995	9,899 (29%)	2,425 (7%)	21,838 (64%)	34,162 (100%)	475,000	51
1996	13,189 (35%)	2,912 (8%)	21,419 (57%)	37,520 (100%)	557,869	44
1997	13,962 (34%)	4,901 (12%)	22,468 (54%)	41,331 (100%)	580,215	47
1998	11,751 (30%)	5,734 (15%)	21,274 (55%)	38,759 (100%)	603,386	45
1999	12,701 (33%)	5,726 (15%)	19,753 (52%)	38,180 (100%)	627,431	41

Source: SNE

2) Commercial/Industrial Use

According to the water consumption data indicated in Table 7.3-5, commercial/industrial use is around 30% of total consumption. Therefore, commercial/industrial use shall be assumed as 30% of total consumption, that is, 43% of the domestic use as total for commercial and industrial use.

For industrial use only, monthly water consumption for Zone Industry in May 2000 was 42,269 m3/month. Assuming the operation days as 20 days in a month, daily consumption is 2,113 m3/d. Based on this consumption in 2000 and estimated annual growth rate of 1.7%/year according to the World Bank report, water consumption for industrial use is assumed as proportional to growth rate. As main industries are located in the Zone Industry, this consumption is applied for the Zone Industry.

Table 7.3-6 ESTIMATED WATER CONSUMPTION FOR INDUSTRIAL USE

Year	2000	2005	2010	2015
Industrial Use(m^3/d)	2,113	2,303	2,394	2,726

Accordingly commercial use only is that total commercial/industrial use minus industrial use.

(2) Sewage Flow

1) Collection ratio

All consumed water is usually not collected into the sewer. Some parts are evaporated; some parts are soaked into the ground. Collection ratio which is defined as (collected sewage)/(water

consumption) shall be 75% according to the field survey data as indicated in Chapter 4.4. This value is applied for domestic and commercial use.

For the industrial use, collection ratio shall be 100% based on the estimated water consumption data of 2,113 m^3/d in May 2000 and estimated wastewater flow of 2,005 m^3/d in the waste water analysis study as indicated in Chapter 4.4.

2) Daily Average 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.

3) Daily Maximum Flow

Daily maximum flow shall be 1.3 times of daily average flow based on the water production data as indicated in Table 7.3-7. The daily maximum flow shall be applied to design of water treatment plant.

Table 7.3-7 WATER PRODUCTION DATA

	Year	1995	1996	1997	1998	1999
Total Water Production (m^3/d)	Daily Ave.	44,297	45,191	47,490	48,485	52,652
	Daily Max.	53,562	61,558	59,322	61,787	67,800
Ratio	Max/Ave	1.21	1.36	1.25	1.27	1.29

Source: SNE

4) Hourly Maximum Flow

Hourly maximum flow is usually between 1.5 and 2.0 times of hourly average flow(= (daily average flow)/24) 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.

(3) Pollution Load

1) Domestic/Commercial/Industrial Waste Water

As the design parameter for the sewage and waster water treatment plant, BOD, COD and SS are the important factors. According to the water quality survey as indicated in Chapter 4.4, BOD is in the range of 30 and 100 ppm for domestic/commercial/industrial waste water except one industrial wastewater from Tannery. In the analysis data, data on the downstream point shows lower values. This is estimated due to natural treatment through the drainage. Then upstream point data seems to show actual pollution load. Here Katako data of 90 ppm is applied as typical concentration of BOD. In addition, as the actual data is analyzed at the end of receiving stream to the river, pollutant discharge load at the source that is at each house is expected higher than this considering pollutant runoff coefficient through the drainage. The pollutant runoff coefficient is generally as in Table 7.3-8. As indicated that BOD runoff coefficient for sewerage is 1.0, little self-purification for BOD is expected when the sewerage systems are installed.

Table 7.3-8 BOD RUNOFF COEFFICIENT

Pollutant Runoff Coefficient at the end of receiving stream	Suburban Area	0.0 – 0.20
	Urban Area Peripheral area Center area	 0.1 – 0.6 0.6 – 1.0
	Sewerage	1.0

Source: Guideline for comprehensive basin-wide planning of sewerage systems in Japan

Then BOD concentration at the discharge point is estimated as 150 ppm 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 ppm from the actual Katako data of 216 ppm and runoff coefficient of 0.6 same as BOD. 360 ppm is 2.4 times of BOD, that shows same tendency for other analysis data.

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

When industrial effluents are collected into the public sewerage, industrial effluents shall be pretreated in the factory so that BOD and COD shall be less than 150 ppm and 360 ppm, respectively.

2) Non Point Source Pollutant Load

As for the non point source from the urban area such as animal waste, air pollutant precipitation, etc., following load is taken into consideration based on the data from the guideline for comprehensive basin-wide planning of sewerage systems.

Table 7.3-9 NON POINT SOURCE FROM THE URBAN AREA

	Pollutant Load (kg/ha/year)	
	BOD	SS
Minimum	24	105
Maximum	605	2390
Average	128	737

Source: Guideline for comprehensive basin-wide planning of sewerage systems in Japan

Minimum pollutant load is taken into the consideration. COD is estimated as 2.4 times of BOD.

7.3.5 Alternative Study of Sewerage System

(1) Selection of Alternatives

As the alternatives to be evaluated, following three (3) alternatives are proposed for wastewater treatment system considering installation cost, operation and maintenance easiness, area available, etc.

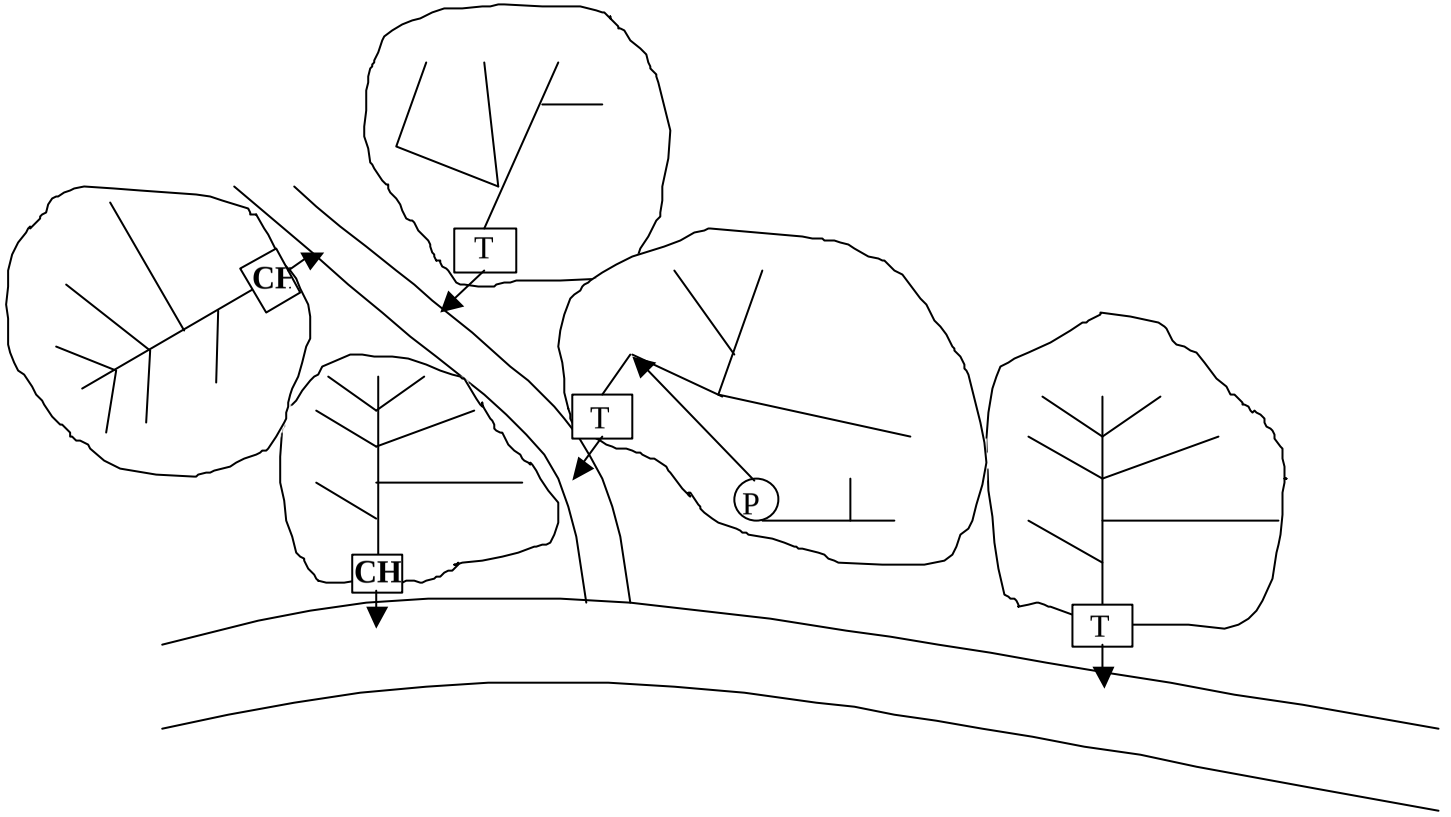
Alternative-1: Distributed UASB System
Alternative-2: Centralized Stabilization Pond System
Alternative-3: Centralized UASB System

As for the evaluation of these alternatives, basic data in Chapter 8 are used.

Alternative-1 is to locate small UASB plants in each sewage/drainage zone. As discussed in Chapter 6 for pilot project study, UASB treatment process has features such as low energy consumption, small mechanical moving parts (only feed pump), and small-required area. The nature of the design without moving parts makes the UASB process very suitable for implementation in areas with a low level of infrastructure where factors like electricity and skilled personnel for operation and maintenance are not readily available or too expensive. In addition UASB process has features for decentralization. In conventional aerobic treatment process there is a tendency to centralize sewage treatment because larger plants have scale merit. In UASB process the contribution of the mechanical equipment to the total construction cost is low. UASB treatment plants require less complicated operation and maintenance. As a result, the cost of construction and operation depends less on the size of the plant and thus the difference in cost between one large treatment plant and a number of decentralized treatment plants is small. Regarding the high cost of collection systems, decentralized treatment in UASB reactors often may be more feasible than centralized treatment. The feature of decentralization allows that sanitation improvement can be realized at low investment cost by stepwise construction of treatment plant and relevant sewer systems. Considering these process features and immediate effect to sanitation improvement, Alternative-1 is proposed. Comparing with one centralized treatment system, the trunk sewer or transfer line will be short distance and gravity flow without pumping system is expected with some exceptional cases. Schematic of this system is shown in Figure 7.3-3.

Alternative-2 proposes stabilization pond, which requires huge area, instead, lowest energy consumption. Accordingly, the treatment plant should be located approximately 10 km far from the city center to accommodate the required area. In this case, collected sewer will be pumped up two times, and huge and long pipeline is required. The sewer in the combined sewer system zone where existing drainage exists is collected towards Kennedy Bridge by the interceptor and then flows to Gamkalle by gravity. Commune III sewage (S8 & S10) is also collected here. At Gamkalle, after part of C4 sewage is joined, sewage is pumped up by elevation difference of approximately 20 m and then flows by gravity towards 2nd pumping station for approximately 7 km. Sewage from S5, S6 and S7 joins into this gravity line. At 2nd pumping station, sewage is again pumped up by elevation difference of approximately 10 m to waste water treatment plant (WTP). The schematic of this system is shown in Figure 7.3-4.

Alternative-3 is same collection and transfer system as Alternative-2 but WTP process is UASB process instead of stabilization pond system.



P : PUMP STATION

T : TREATMENT PLANT

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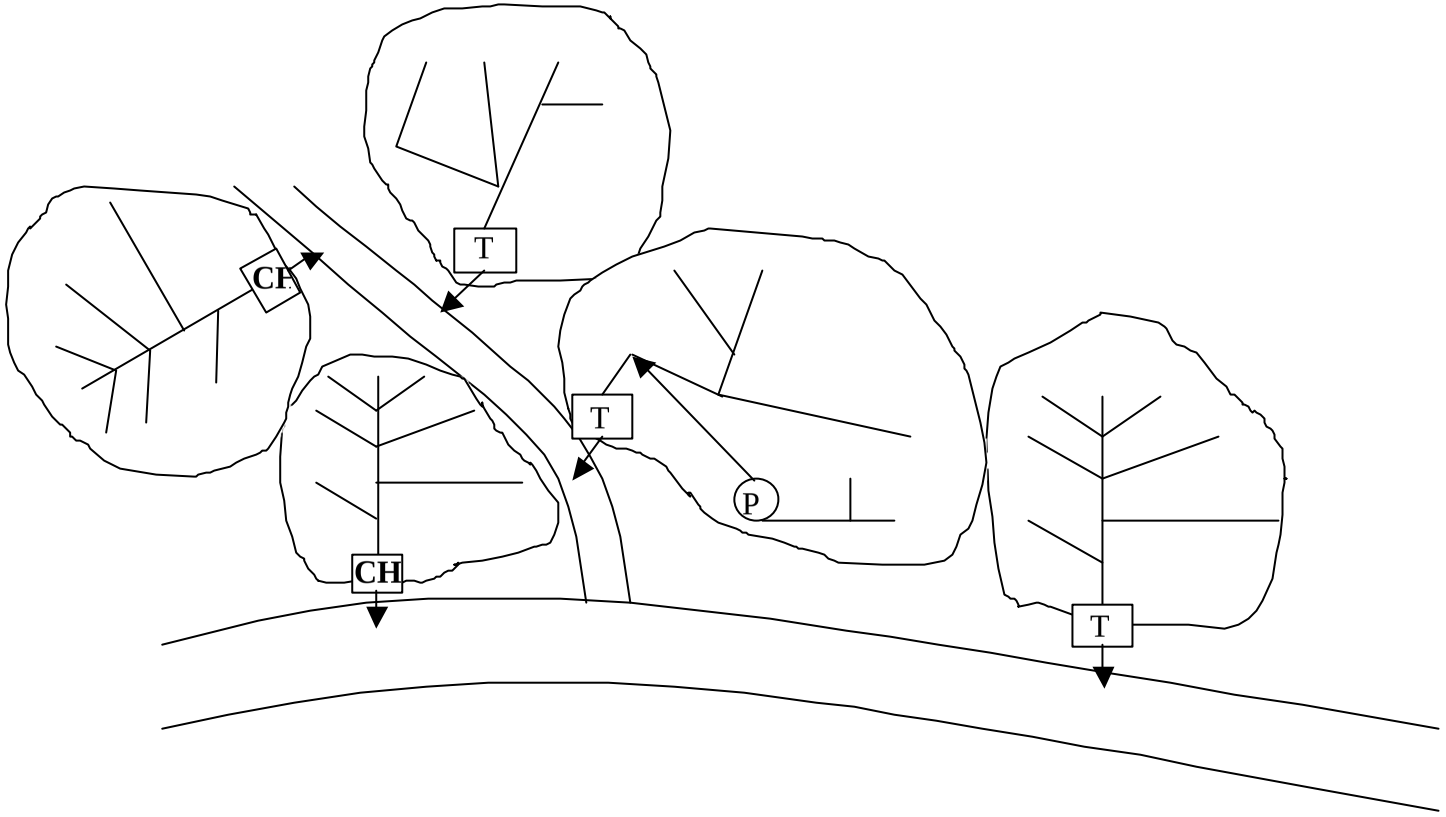
SCHEMATIC DIAGRAM FOR ALTERNATIVE-1

Figure 7.3-3



P : PUMP STATION

T : TREATMENT PLANT

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SCHEMATIC DIAGRAM FOR ALTERNATIVE-2

Figure 7.3-4

(2) Design of Alternatives

1) Design of Alternative-1

Each UASB plant consists of inlet chamber, screen chamber, feed pump, grit chamber, UASB reactor, sludge drying bed, final polishing pond and chlorination pit as illustrated in Figure 7.3-5. Collected sewer is received in the inlet chamber where overflow weir is provided to take care of flow when mechanical screen is choked and out of order. The sewage from the overflow weir enters the manual screen channel. Raw sewage may include large objects such as wood, plastics, cloths, etc. that may damage or obstruct equipment in the subsequent stages of the treatment. These objects are removed by screening. One each of manual and mechanical operated bar racks are provided in the proposed two channels respectively. The wastewater is pumped up after screening to the grit chamber to remove inorganic highly settleable solids, which may accumulate in the reactor and reduce the capacity of the reactor. Two rectangular channels are provided for grit chamber, one is in operation and the other is stand-by. This provides for degritting facility without interruption of flow. The flow from the grit chamber enters the UASB reactor through division box/distribution box. For flexibility of the operation it is recommended to construct minimally two UASB reactors at each plant site. The reactor is designed based on peak flow. BOD reduction rate in the reactor is estimated at 80% or more. Thus outlet BOD will meet the effluent standard of 40 ppm in Niger. Then trickling filter is not applied downstream of the UASB reactor in the actual plant, although it is applied for the pilot project. After the reactor, final polishing pond which has half day retention time is proposed for recycling treated wastewater for irrigation wherever possible. Chlorination is also done after final pond for sterilizing. For the sludge treatment, drying bed method will be suitable for the climatic condition in Niamey. Contrary to aerobic sludge and primary sludge, UASB sludge has high settling and thickening properties and sludge can be discharged from the reactor at concentrations between 50 and 100 kg/m^3. This sludge can be concentrated to 150 – 200 kg/m^3 by further settling or natural dewatering. The possibilities for final disposal of sludge depend on its quality, legal aspects and demands for the sludge. Comparing industrial wastewater, which may include heavy metals, domestic wastewater sludge is pure and can be utilized in agriculture. A limit may be its content of pathogenic organisms. Sun drying of sludge in open drying beds considerably reduces the pathogen content of sludge. The biogas produced by a UASB reactor operating on domestic waste water has the following average composition: CH_4: 70 – 80%; CO_2: 5 – 10%; N_2: 15 – 20%; H_2S<1%. The production of biogas from domestic wastewater is estimated at 0.15 – 0.25 m^3/kg COD removed. The produced biogas is burnt in the flare stack although it can be utilized as energy source. Figure 7.3-6 shows typical layout of the UASB plant which design capacity is 1,600 m^3/d for Plateau I.

2) Design of Alternative-2

Stabilization pond system consists of anaerobic pond, facultative pond and primary/secondary maturation pond. Raw sewage is introduced firstly into anaerobic pond, which functions BOD reduction in anaerobic condition. Dimension is decided from the volume load of 300 gBOD/m^3/d or minimum retention time of 1 day with water depth of 4 m. Expected BOD reduction rate will be 70%. Then treated wastewater enters into facultative pond, which also functions BOD reduction. Dimension is decided from the surface load of 360 kgBOD/ha/d with water depth of 1.5 m. Expected BOD reduction will be 65%. Primary and secondary maturation ponds are installed to reduce the coliform count. Retention time will be 3 – 10 days each, hereby 5 days for each pond is adopted. Based on these design criteria, required area will be approximately 60 ha. Figure 7.3-7 shows typical layout of this system, which has the design capacity of 51,000 m^3/d.

Design of the transfer pipeline from the Kennedy Bridge to the WTP will be as follows. Design capacity of the transfer pipeline should be based on peak hourly flow. From Kennedy Bridge to Gamkalle, 900 mm diameter concrete pipe with 1.5 ‰ gradient is applied which length is approximately 2.6 km. At Gamkalle, first pumping station is planned. Four (4) sets of pump including one (1) stand-by will be installed. Each pump has the capacity of 800 m3/h x 30 mH x 110 kW. Pipeline from 1st pumping station to the highest point is 700 mm diameter ductile pipe with approximately 0.4 km length. From the highest point to the 2nd pumping station for which gravity flow is applied, 1000 mm diameter concrete pipe is installed which length is approximately 7.2 km. Minimum slope of this gravity line is 1.5 ‰. Sewage from S5, S6 and S7 joins into this gravity line. Four (4) sets of pump including one (1) stand-by will be installed at the 2nd pumping station. Each pump has the capacity of 1,000 m3/h x 15 mH x 75 kW. After the 2nd pumping station, approximately 0.5 km length, 700 mm diameter ductile pipe for rising main and approximately 0.6 km length, 1000 mm diameter concrete pipe for gravity main will be applied. Figure 7.3-8 shows pipeline longitudinal profile.

3) Design of Alternative-3

UASB process is applied for the centralized water treatment plant which location is same as Alternative-2. System constitution of the UASB process is same as Alternative-1. Required area will be approximately 8 ha. Transfer pipeline and pumping system is same as Alternative-2.

(3) Comparison of Alternatives

Three alternatives are compared from the view point of installation, operation & maintenance, required area, trunk sewer and pipeline, reuse of treated water and sludge, sanitation improvement effect. Table 7.3-10 shows cost comparison for alternatives. Table 7.3-11 shows overall evaluation for alternatives.

As a conclusion, Alternative-1 is recommendable due to following reason.

- Lowest investment cost
- Lowest operation and maintenance cost
- Operation and maintenance easiness because of simplicity and small equipment
- Reuse of treated water and sludge
- Step by step and immediate sanitary improvement can be expected at low investment cost

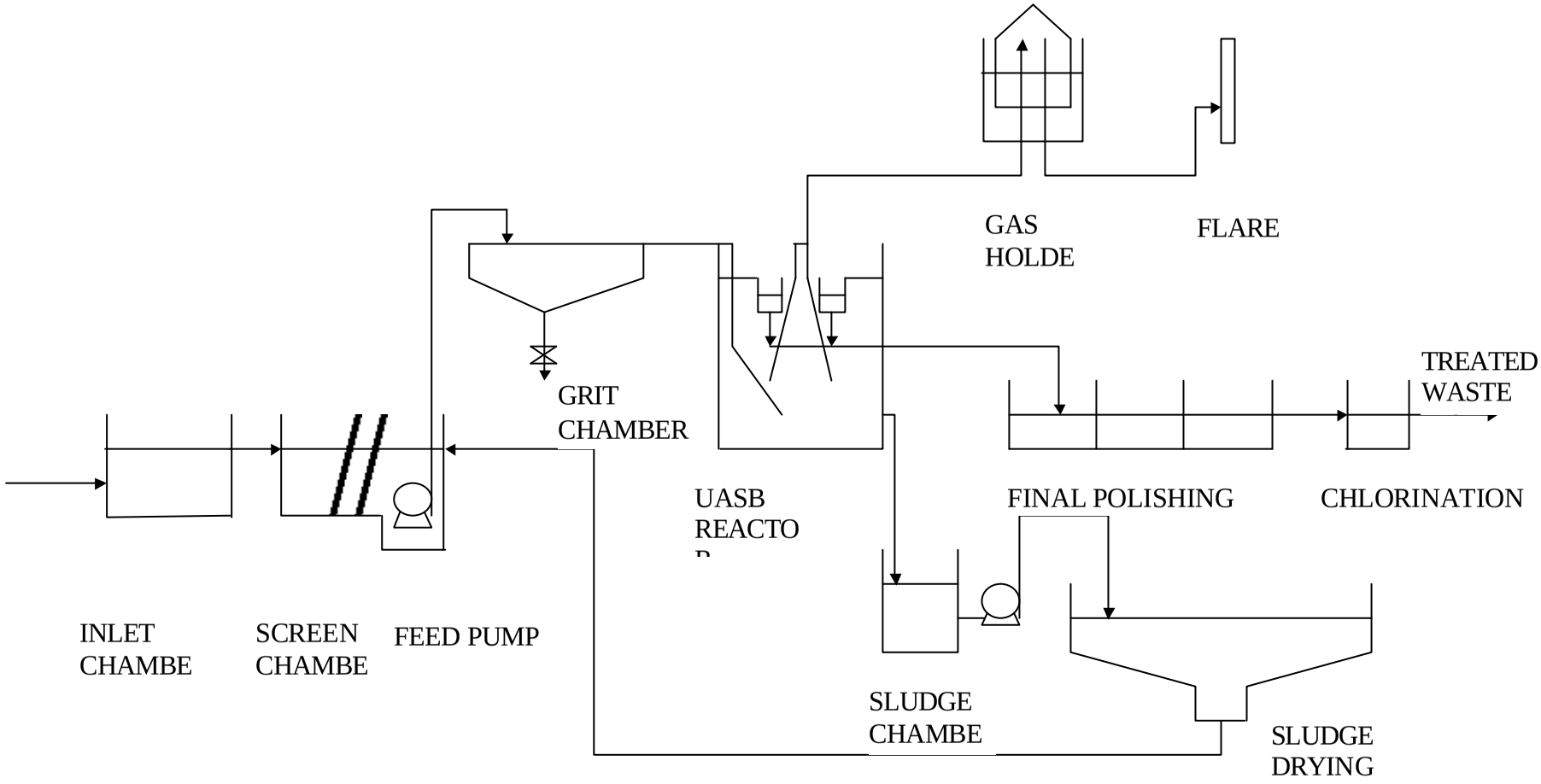
Table 7.3-10 COST COMPARISONS OF ALTERNATIVES

	Alternative-1	**Alternative-2**	**Alternative-3**
Method	Distributed UASB	Centralized Stabilization Pond	Centralized UASB
Treatment Capacity	Total 51,000 m3/d.	51,000 m3/d.	51,000 m3/d.
Required Area	Total 9 ha	70 ha	8 ha
Trunk Sewer & Pipeline	Base	Additional 900mm concrete pipe (2.6km) 1000mm concrete pipe (7.8km) 700mm ductile pipe (0.9km)	Additional 900mm concrete pipe (2.6km) 1000mm concrete pipe (7.8km) 700mm ductile pipe (0.9km)
Transfer Pump	Base	Additional 800m3/h x 30m x 90kW (4sets) 1000m3/h x15m x75kW (4sets)	Additional 800m3/h x 30m x 90kW (4sets) 1000m3/h x15m x 5kW (4sets)
Investment Cost (Million FCFA)			
Wastewater Treatment Plant	5,755	7,390	5,276
Trunk Sewer & Pipeline	Base	1,180	1,180
Pump	Base	480	480
Land Acquisition cost	854	780	108
Total (Million FCFA)	**6,609**	**9,830**	**7,044**
Operation & Maintenance Cost (Million FCFA/year)	Base	Additional 196	Additional 232

Note: Investment and O&M cost in this table is only comparison purpose and does not show the entire cost.

Table 7.3-11 OVERALL EVALUATIONS OF ALTERNATIVES

	Alternative-1	Alternative-2	Alternative-3
Method	Distributed UASB	Centralized Stabilization Pond	Centralized UASB
Area Required	Area for each system can be accommodated in each district.	Huge area is required.	Reasonable area is required.
Investment Cost	Lowest	Highest	High
Operation & Maintenance	Simple	Simple but operation & maintenance for large transfer pump may require careful attention.	Simple but operation & maintenance for large transfer pump may require careful attention.
Trunk Sewer & Pipeline	As WTP is located in each district, trunk sewer is short and no long pipeline is required.	Long and huge pipeline and transfer pump is required.	Long and huge pipeline and transfer pump is required.
Reuse of Treated Water	Treated water can be reused such as irrigation, etc. depending on the situation of each district.	Reuse is possible as irrigation purpose only for WTP area.	Reuse is possible as irrigation purpose only for WTP area.
Disposal & Reuse of Sludge	Reuse of sludge for agriculture, etc. is easy depending on the situation of each district	Organic sludge can be digested in the anaerobic pond; however, periodical removal of accumulated inorganic sludge is required.	Reuse of sludge is possible for agriculture use near WTP. If it is used in the city, transportation of sludge is required.
Sanitation Improvement Impact	As stepwise construction is possible, immediate improve-ment can be expected at low cost.	Huge initial investment is required to realize immediate improvement.	Huge initial investment is required to realize immediate improvement.
Overall Evaluation	**Recommendable**	**Not Recommendable**	**Not Recommendable**



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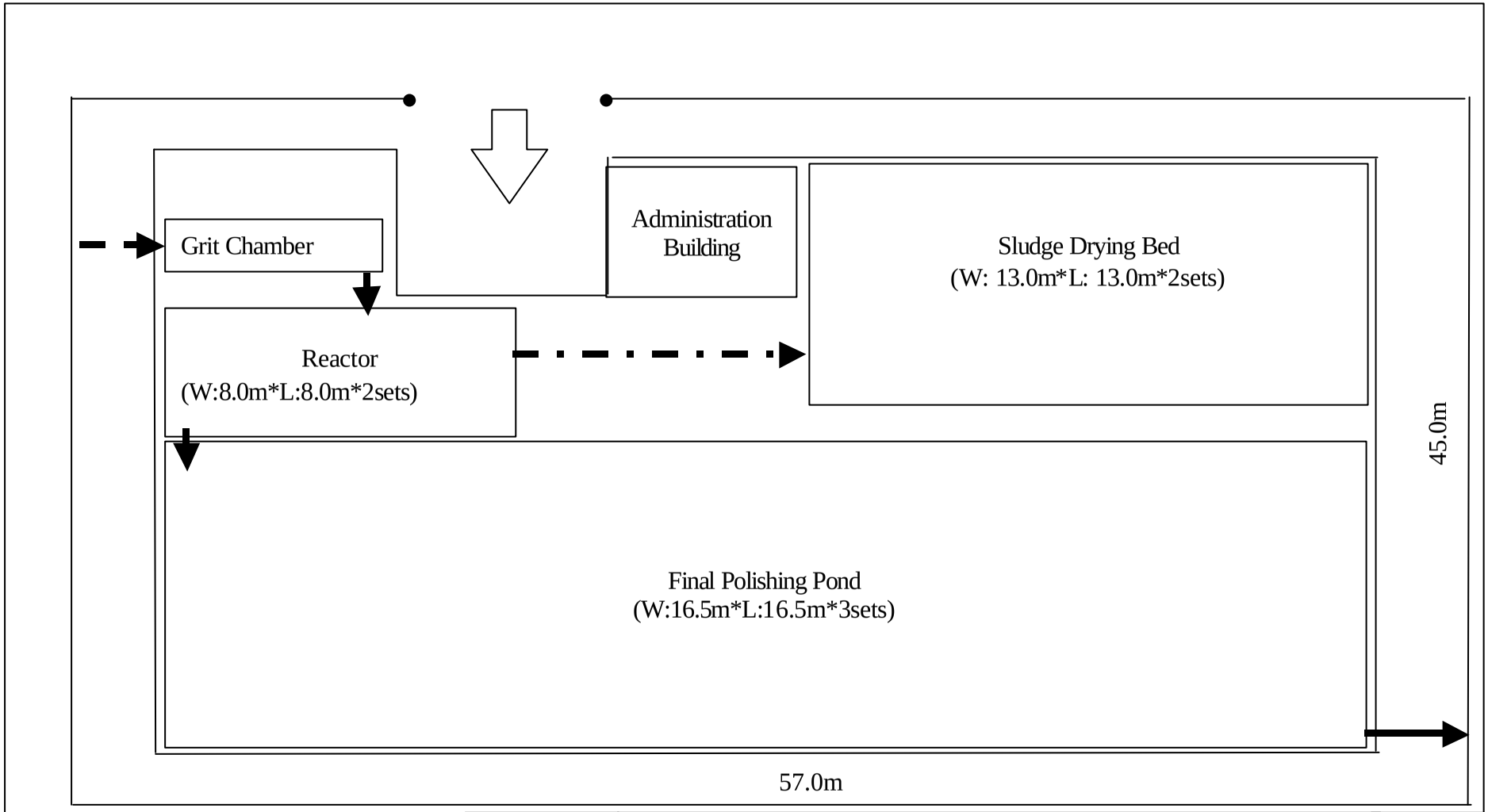
FLOW DIAGRAM FOR UASB PROCESS

Figure 7.3-5



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TYPICAL LAYOUT FOR 1,600 m^3/d UASB TREATMENT PLANT

Figure 7.3-6

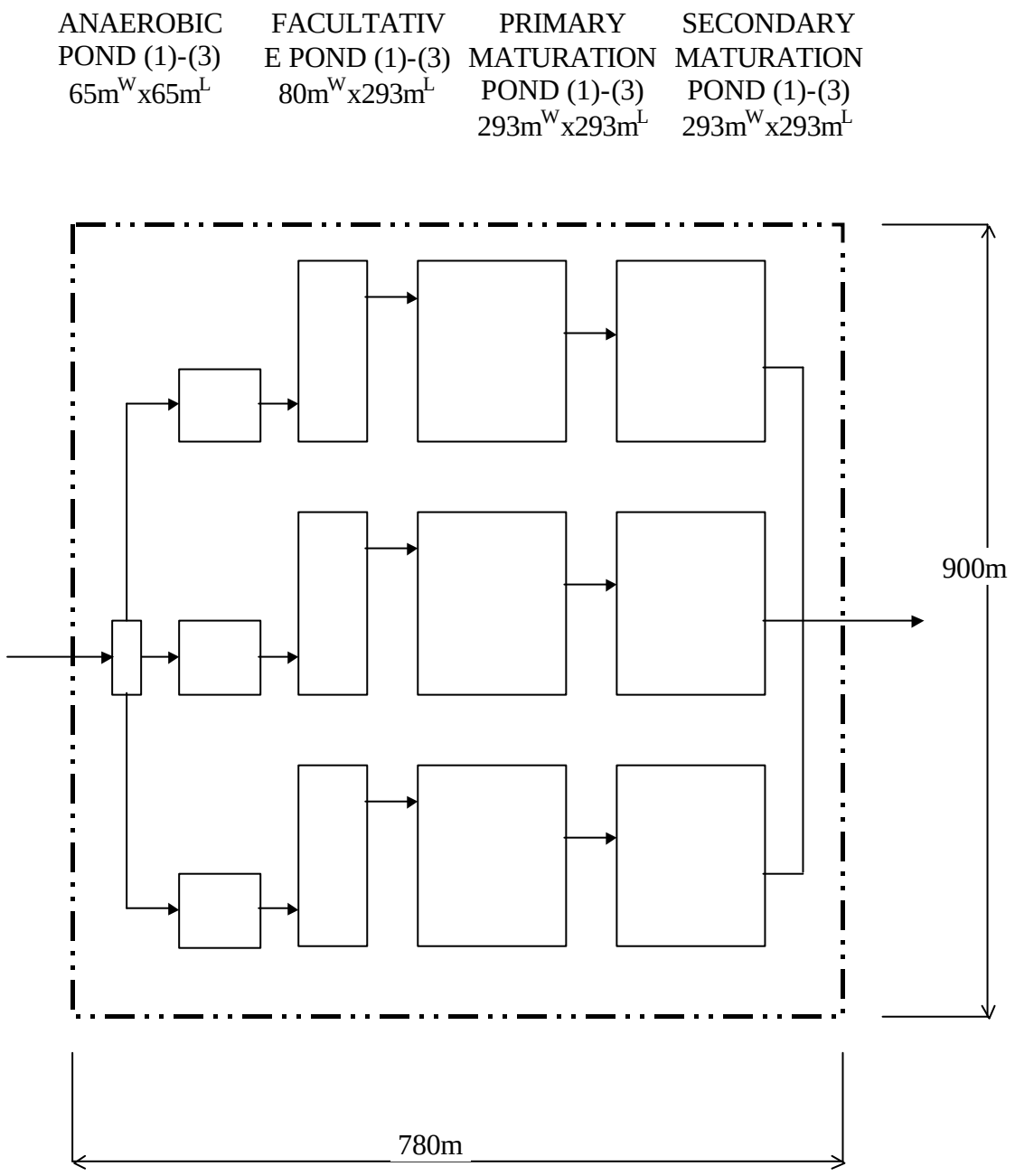

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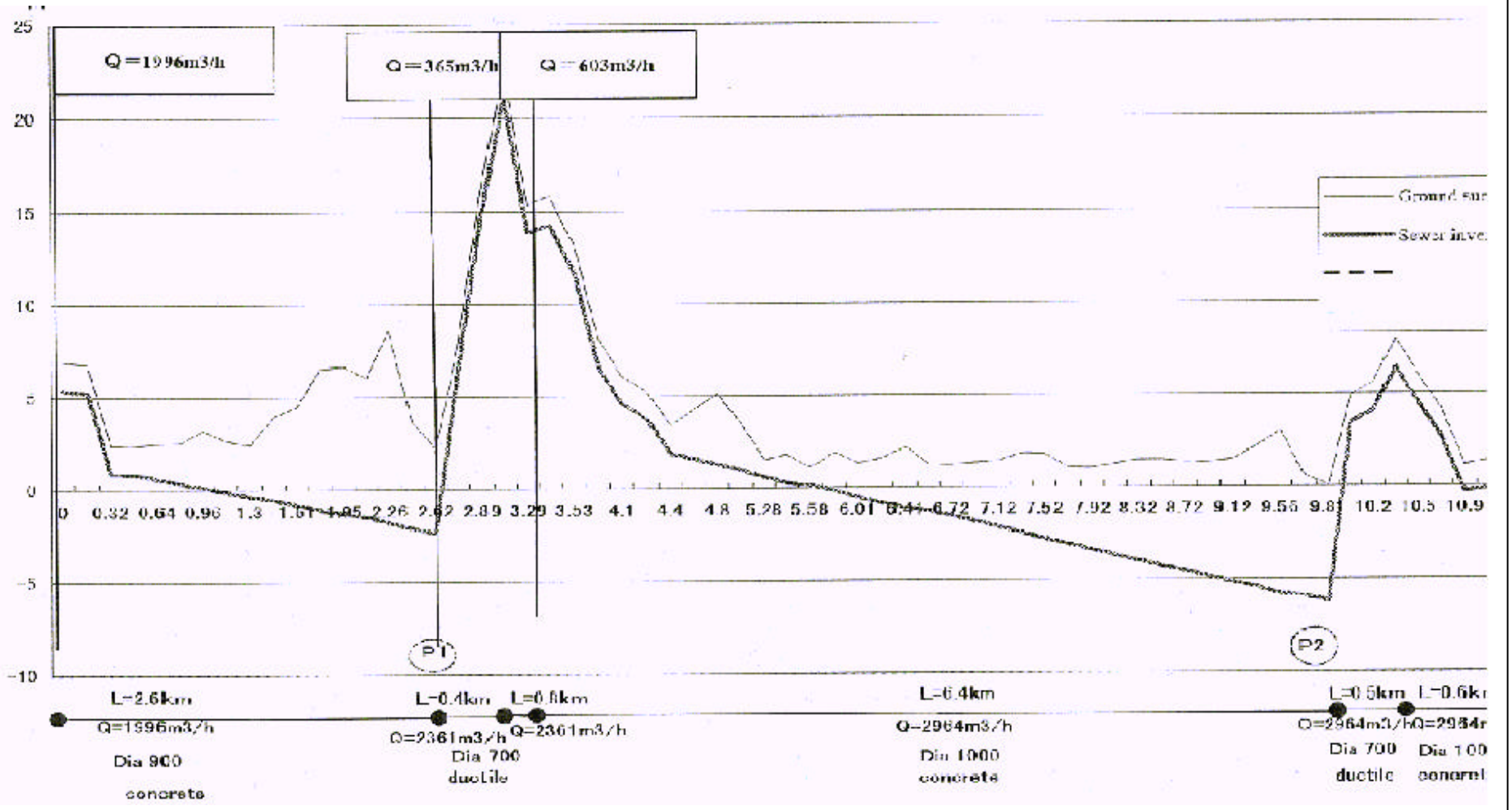
Figure 7.3-7

TYPICAL LAYOUT FOR 51,000 m^3/d STABILIZATION POND SYSTEM



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PIPELINE LONGITUDINAL PROFILE

Figure 7.3-8

7.3.6 On-site Treatment Area

On-site treatment area is where urbanization is in progress and area surrounding the sewerage planning area.

(1) Wastewater

In On-site treatment area" sewerage facilities are not feasible because housing in this area is not dense and installation cost of sewerage system will be costlier. Therefore, on-site treatment of wastewater, especially toilet wastewater, is recommended in on-site treatment area.

The characteristics of five types of toilet as described in Chapter 3.5.3. The comparison among them are mentioned in the Table 7.3-12 and briefly summarized as follows :

- From the water usage view point, A (Pit Latrine) and B (DVC Toilet) are excellent.
- From the construction cost view point, A (Pit Latrine) and C (PF Toilet) are advantageous, but not suitable to the Niamey soil which has generally low permeability.
- From the health benefit view point, D (Septic Tank) and E (Vault Toilet) are excellent. Although D shows higher construction and operating cost and E shows higher operating cost, the charge per home can be decreased by installing community facilities as combination

Based on above observation, sanitary facilities in the "On-site system area" are recommended as follows:

.

- In case of individual installation in scattered inhabitant areas, B (DVC Toilet) is recommended.
- In case of comparatively crowded housing areas, community toilet in combination of D (Septic Tank) and E (Vault Toilet) is recommended.

To install such sanitation facilities, it is mandatory to be guided by the authorities step by step considering the development in the "On-site treatment area" in the future.

(2) Drainage

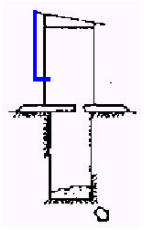
As countermeasures against rain, "Green Belt" where plenty of natural plants are utilized is to be constructed considering the natural conditions of Niamey, which has violent rainfall and laterite soil. The area, where plenty of plants consisted of native and imported are sustained, shows that these plants restrain soil erosion from rain, prevent soil deterioration, mitigate adverse climate and preserve ecological system. It is considered that these plants contribute significantly to keep good amenity in Niamey.

In addition to the preservation of plants, it is important to utilize reservoirs such as pond and natural dents. On-site impoundment at upstream ponds and dents for storm water is effective for the prevention of down stream inundation. Such impoundment also gives moderate water supply to the whole district and influences the state of plants and the climate. Rich plants are useful for water conservation.

Table 7.3-12 CHARACTERISTICS OF SANITARY FACILITIES

Facility Type	Application in Agricultural Area	Application in Urbane Area	Construction Cost	Running Cost	Difficulty of Construction	Capability of Self-help	Necessity of Water	Necessary Soil Conditions	Supplementary Off-site Facility	Capability of Reuse	Benefit on Health	Demands of system
A Pit Latrine	Proper	Proper in lower population density areas	Low	Low	Very easy except for wet soil or rock	High	Not necessary	Stable permeability	Not necessary	Low	Bad	Low
B DVC Toilet	Proper	Proper in lower population density areas	Common	Low	Very easy except for wet soil or rock	High	Not necessary	Nothing (constructive on the ground)	Not necessary	High	Good	Low
C PF Toilet	Proper	Proper in lower population density areas	Low	Low	Easy	High	Necessary, close to toilet	Stable permeability	Not necessary	Low	Very good	Low
D Septic Tank	Proper in agricultural areas	Proper in lower population density areas	High	High	Necessary for skilful workers	Low	Water supply to house and toilet	Permeability	Sludge treatment plant on off-site	Common	Very good	Low
E Vault Toilet and Cartage	Not proper	Proper	Common	High	Necessary for skilful workers	High	Necessary, close to toilet	Nothing (constructive on the ground)	Night soil treatment plant	High	Very good	Very high

Note) Pit Latrine is not presented on the table of reference papers but is applied according to Non-odor Pit Latrine with improved ventilation of that table, changing only Benefit on Health.



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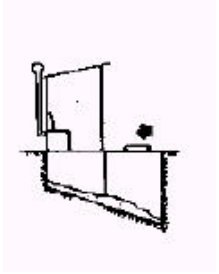

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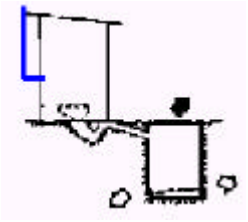

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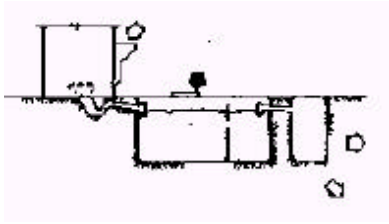

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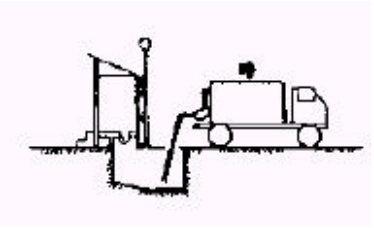

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7.4 SOLID WASTE MANAGEMENT

7.4.1 Planning Frame Work of Solid Waste Management

(1) Population and Scope of the Study

The demographic data presented in the first phase of the study (Interim Report) constitutes the basis of considerations taken into account in this chapter. The various types of considered neighborhoods are divided into 3 income brackets. A high income bracket (called High standing), an average income bracket (called Average income) and a low income bracket (called Low standing).

The High standing will include modern neighborhoods (MDQ).
The Average standing will consist of outlying neighborhoods (PRP2), the new neighborhoods (NWQ) and the planned urban development areas (Planned area PLN).
The Low standing will be made up of traditional neighborhoods (TRD) and outlying neighborhoods (PRP1).
The following Table 7.4-1 indicates the demographic development as regards the various horizons and planned income brackets:

Table 7.4-1 DEMOGRAPHIC DEVELOPMENT OF THE TOWN OF NIAMEY

Group of income	Type of settlement	Surface area (ha)	Population			
			Year 2001	Year 2005	Year 2010	Year 2015
High Standing	MDQ	1.424,14	86.021	82.747	82.058	82.167
	Sub-Total	1.424,14	86.021	82.747	82.058	82.167
Middle Standing	PRP2	2.507,02	250.060	304.935	359.226	420.309
	NWQ	1.517,70	27.398	69.707	102.465	136.561
	PLN	885,00	2.602	8.677	28.150	47.466
	Sub-Total	4.909,72	280.060	383.319	489.841	604.336
Low Standing	TRD	353,07	78.532	79.264	83.661	87.070
	PRP1	538,73	101.836	105.649	104.769	104.908
	SPT	155,18	24.535	19.780	21.125	22.664
	UVL	507,05	87.862	86.432	89.892	92.579
	OUT	0,00	14.017	0	0	0
	Sub-Total	1.554,03	306.782	291.125	299.447	307.221
TOTAL		7.887,89	672.863	757.191	871.346	993.724

The scope of the study is defined by the administrative divisions of Niamey Urban Community (CUN) made up of District Council I, II and III spreading over a surface area of roughly 7,900 ha.

(2) Generation rate and Composition of household waste

1) Generation rate of household waste

Within the framework of this study, a survey for solid waste survey (survey for assessment and sampling) 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.

The results obtained during that survey are summarized in the following table 7.4-2 :

Table 7.4-2 GENERATION RATES ASSESSED DURING THE SURVEY

Neighborhood	Number of households	Number of people	Waste quantity	Generation rate
Lacouroussou	58	313	2,315.5	1.05
Lamordé	52	437	2,550	0.83
Gawéye	50	328	1,136.7	0.49
Kouara Kano	52	349	1,771	0.72
Yantala	57	353	1,945.5	0.78
Total	269	1,780	9,718.7	0.75

Within the framework of a preceding study carried out by Socrège in February 2000, the generation rate for household waste was determinate and amounts to 0.65 kg/cap.day.

The results that are presented in the Socrége Report can not be combined with the present results in order to find an average value for the generation rate. It is not shown how and for which type of income revenue the survey has been carried out.

For the present study the generation rate for household waste of 0.75 kg/cap.day, as determinated in the survey, shall be taken as average value for the further design criteria in The Master Plan for solid waste management in Niamey.

2) Composition of household waste

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 (report separately published).

The results of the average composition obtained during the campaign are summarized in the following table 7.4-3:

Table 7.4-3 COMPOSITION OF HOUSEHOLD WASTE

	Fraction	Weight(kg)	%	Volume(l)	%	Specific weight (g/per capita/per day)
1	Paper and Cardboard	1.20	1.1%	26.5	10.2%	8
2	Plastic	3.59	3.4%	51.6	19.9%	24
3	Textiles and rags	0.57	0.5%	5.8	2.2%	4
4	Leather and rubber	0.00	0.0%	0.0	0.0%	0
5	Wood	0.79	0.7%	8.5	3.3%	5
6	Organic matter	20.49	19.1%	100.6	38.7%	137
7	Fines (< 5 mm)	76.24	71.1%	60.5	23.3%	509
8	Metal	0.63	0.6%	2.3	0.9%	4
9	Glass	0.07	0.1%	0.0	0.0%	0
10	Stones and rubber	3.67	3.4%	3.7	1.4%	25
	Total	107.25	100.0%	259.6	100.0%	745

3) Industrial waste

In order to define the quantity, origin and composition of industrial waste and within the framework of the survey on the ordinary run of things and awareness of industries in the area of sanitation, 9 industrial plants were visited. The data collected during this campaign on the nature and quantity of waste produced are summarized in the following table 7.4-4:

Table 7.4-4 VISITED INDUSTRIAL COMPANIES

Company	PRODUCTION	QUANTITY	WASTES	QUANTITY DISPOSED	DISPOSAL
Name of the company	**Manufactured products**	**Quantities of the product (t/year or unit/day or other)**	**Type of wastes (for instance: broken glass, but non usable, fragments of wood etc.)**	**Quantity of wastes (t/year or m3/day or other)**	**For instance : Dump at the level of the company or public dump or recycling, sold at …**
ENITEX	Cloth	6,000,000 m/year	Sodium hydroxide, acid, artificial coloring, cardboard and Packaging barrels	Liquide : 80 m^3/h Solid : -	Niger river Non controlled Public dump
BRANIGER	Alcoholic beverages and soft drinks, Ice	140,000 hl/year	Broken bottles old labels	Liquide : 520 m^3/a Solid : -	Niger river dump+recycling
SPCN	Soap – Cakes of soap	8,000 t/year	Sodium hydroxide, sea salt, fat acid, sludge, Soap wastes, cardboard, packaging and Food remains	Liquide : - Solide : 45 t/a	Niger river Non controlled Public dump
SOLANI	Milk-creme Butter-Yogurt	4,258,000 l/an	Plastic bags	Liquide : - Solide : 3,65 t/a	Niger river Incineration
ONPPC	Pharmaceutical products	300,000,0000 tablets 6 million bags	Plastic bags, Bottles	Liquide : - Solide : -	Niger river Incineration
ABATTOIR	Meat	158 m3/year	Animal remains + Blood	900 t/a	Public dump
NIGER-LAIT	Dairy products	3,250 t/year	Liquids (dairy industry)	1,825 t/a	Gutters Incineration
RIZ DU NIGER	"Paddy" rice "Whitened "rice	25,000 t/year	Paddy rice breakings	210 t/a	Public dump
TANNERIE	Processed skins	120,240 skins	hair, lime, natron, vegetal wastes	Liquide : - Solide : 60 m^3/a	Niger river Non controlled Public dump

4) Medical waste

Generally it is understood that medical waste is the waste that is generated in hospitals or medical establishments. Due to the fact that in hospitals not only specific hospital waste is generated but also that similar to household waste. It is essential, first of all, to define what is meant by “medical waste”. There is not even an agreed upon definition that should be used for this type of waste. Various terms are being used more or less synonymously with medical waste including infectious waste, infective waste, bio-hazardous waste, medical hazardous waste, microbiological waste, pathological waste and even “red bag” waste.

For the present study the term of medical waste is used throughout for denoting any waste generated in medical establishment and shall differentiate between:

- The first type of medical waste being specific medical waste, contains infectious waste and shall be defined as any waste that is capable to cause any infectious disease,
- The second type of waste is the household similar waste generated in the hospitals or medical establishments. It covers all types of waste that aren't infectious and shall be defined as any waste generated in the kitchen and the administration areas of the hospital or medical establishment as far as it is not mixed (collected separately) with infectious waste.

The following waste generated in hospitals is classified and should be managed as infectious waste:

- Human blood and blood products
- Culture and stocks of infectious agents
- Pathological wastes
- (Contaminated) sharps
- Contaminated laboratory wastes
- Contaminated wastes from patient care
- Discarded biological
- Contaminated animals carcasses and body parts
- Contaminated equipment
- Miscellaneous infectious wastes

On the basis of our studies experiences on medical waste together with data found in various publications[1], we can consider that 20% of waste produced are infectious waste whereas 80% are household like waste.

Within the context of the ordinary run of things and awareness campaign at the level of industries and institutions in the area of sanitation, 7 medical establishments were equally visited and a survey on medical waste production was carried out. The results of that survey are presented in the following table 7.4-5:

Table 7.4-5 TOTAL QUANTITY OF MEDICAL WASTE

Hospital	Number of beds	Occupation rate	Waste quantity m^3/per week	Specific quantity kg/bed/day
Hôpital Militaire	30	70.00%	5	8.33
CHU Lamordé	156	53.08%	10	2.43
Hôpital National	857	75.00%	33	2.06
Polyclinique Lahiya	10	70.00%	1.5	7.50
Maternité Centrale	70	90.00%	1.75	1.61
Polyclinique Pro-Santé	16	80.00%	2.5	8.93
Maternité Poudrière	64	90.00%	5.5	5.52
Total	1,203	73.73%	59.25	2.59

With these waste quantities, we can assess the volumes of infectious waste generated in medical establishments, which is given in the following table.

[1] Giroult E. (1996): Règles de gestion des déchets hospitaliers (dans les pays en voie de développement), OMS

Table 7.4-6 QUANTITY OF INFECTIOUS WASTE

Hospital	Quantity of infectious wastes kg/bed/day	Quantity of infectious wastes t/year
Hôpital Militaire	8.33	26.07
CHU Lamordé	2.43	52.14
Hôpital National	2.06	172.07
Polyclinique Lahiya	7.50	7.82
Maternité Centrale	1.61	9.13
Polyclinique Pro-Santé	8.93	13.04
Maternité Poudrière	5.52	28.68
Total	2.59	308.95

5) Future projections of waste quantities

On the basis of demographic data, various categories of neighborhoods as well as the average generation rate of household waste, can assess solid waste quantities expected in the forthcoming 15 years.

The following Table 7.4-7 summarizes population forecasts and presents the quantities of wastes in the forthcoming years on the basis of the average generation defined during the solid waste survey with a figure of 0.75 kg per capita per day :

Table 7.4-7 FORECAST ON HOUSEHOLD WASTE QUANTITIES

Group of income	Type of settlement	Surface area (ha)	Year 2001		Year 2005		Year 2010		Year 2015	
			Population	Waste quantity (t/year)	Population	Waste quantity (t/year)	Population	Waste quantity (t/year)	Population	Waste quantity (t/year)
High Standing	MDQ	1,424.14	86.021	23.548	82,747	22,652	82,058	22,463	82,167	22,493
	Sub-Total	1,424.14	86.021	23.548	82,747	22,652	82,058	22,463	82,167	22,493
Average Standing	PRP2	2,507.02	250.060	68.454	304,935	83,476	359,226	98,338	420,309	115,060
	NWQ	1,517.70	27.398	7.500	69,707	19,082	102,465	28,050	136,561	37,384
	PLN	885.00	2.602	712	8,677	2,375	28,150	7,706	47,466	12,994
	Sub-Total	4,909.72	280.060	76.666	383,319	104,934	489,841	134,094	604,336	165,437
Low Standing	TRD	353.07	78.532	21.498	79,264	21,699	83,661	22,902	87,070	23,835
	PRP1	538.73	101.836	27.878	105,649	28,921	104,769	28,681	104,908	28,719
	SPT	155.18	24.535	6.716	19,780	5,415	21,125	5,783	22,664	6,204
	UVL	507.05	87.862	24.052	86,432	23,661	89,892	24,608	92,579	25,344
	OUT	0.00	14.017	3.837	0	0	0	0	0	0
	Sub-Total	1,554.03	306.782	83.982	291,125	79,695	299,447	81,974	307,221	84,102
TOTAL		7,887.89	672.863	184.196	757,191	207,281	871,346	238,531	993,724	272 t/year

6) Future projections of industrial waste

Due to the fact that no records on industrial solid waste generation exist within the industries and the economical situation in Niger is not prospering, no basic parameter seems to be available for a realistic forecast for the industrial waste quantities that will be generated in the next 15 years. Therefore and in order to take into consideration industrial waste in the Master Plan concept, the actual situation on industrial solid waste shall be considered also for the future (see Table 7.4-4).

7) Future projections of hospital waste

The evolution of waste originating from medical establishments is considered as similar to the one of the population, given the fact that viable statistical data do not exist as concerns development in medical centers such as the number of beds and their occupation rate in future years.

Table 7.4-8 PROJECTION OF THE TOTAL QUANTITY OF MEDICAL WASTE (T/YEAR)

Hospital	Year 2001 t/year	Year 2005 t/ year	Year 2010 t/ year	Year 2015 t/ year
Hôpital Militaire	134.65	151.52	174.36	198.85
CHU Lamordé	269.29	303.04	348.73	397.70
Hôpital National	888.66	1,000.03	1,150.80	1,312.42
Polyclinique Lahiya	40.39	45.46	52.31	59.66
Maternité Centrale	47.13	53.03	61.03	69.60
Polyclinique Pro-Santé	67.32	75.76	87.18	99.43
Maternité Poudrière	148.11	166.67	191.80	218.74
Total	1,595.54	1,795.51	2,066.20	2,356.39

The following table 7.4-9 shows the evolution of the quantity of infectious waste produced in medical establishments in future years.

Table 7.4-9 PROJECTION OF THE QUANTITIES OF INFECTIOUS WASTE (T/YEAR)

Hospital	Year 2001 t/year	Year 2005 t/year	Year 2010 t/year	Year 2015 t/year
Hôpital Militaire	26.93	30.30	34.87	39.77
CHU Lamordé	53.86	60.61	69.75	79.54
Hôpital National	177.73	200.01	230.16	262.48
Polyclinique Lahiya	8.08	9.09	10.46	11.93
Maternité Centrale	9.43	10.61	12.21	13.92
Polyclinique Pro-Santé	13.46	15.15	17.44	19.89
Maternité Poudrière	29.62	33.33	38.36	43.75
Total	319.11	359.10	413.24	471.28

8) Sludge

a. Household sludge

Household sludge originates mainly from the cleaning of latrines and septic tanks in houses and administrative buildings, schools and barracks, etc.

In the case of septic tanks, it is about fecal sludge which, after emptying (at times through water pressure) has a water content of 95%. For latrines, it is about mineralized sludge up to the last layer. The sanitation department at the level of the Urban Community of Niamey, which is in charge of the emptying and removal of latrines and septic tanks sludge does not have any record on the quantities of removed sludge. The Urban Community of Niamey has 2 cesspool emptiers of a capacity of $6m^3$ and one truck tank of a capacity of $4m^3$. The number of trips of these emptying vehicles is highly variable and depends on the availability of vehicles which are at times broken down.

Within the proposed wastewater, estimation is made regarding the expected sludge quantity that will be generated at the planed Wastewater treatment plants. The following Table is summarizing the amounts of sludge:

Table 7.4-10 ESTIMATED FUTURE SLUDGE QUANTITIES (YEAR 2005)[2]

TD	Treatment Zone	Design Capa-city (m^3/d)	Treatment Process	Area Req'd (m^2)	Sludge Gene. (m^3/Mon.)	Sludge Gene. (m^3/year)
C1	Plateau I	1.600	UASB	2.500	30,5	366
C2	Issa Beri	1.000	UASB	1.600	20,3	244
C3	Deizebon	2.500	UASB	4.000	51,4	617
C4	Gamkalle	8.000	UASB	12.600	165,8	1.990
S1	Yantala	3.500	UASB	5.500	67,6	811
S2	Kouara Kano	1.600	UASB	2.500	31,9	383
S3	Dar Es Salam	6.000	UASB	9.500	120,4	1.445
S4	Kouara Me	8.000	UASB	12.600	148,8	1.786
S5	Bani Fandou II	5.000	UASB	8.000	102,6	1.231
S6	Talladje Koado	3.500	UASB	5.500	68,4	821
S7	Industrielle	3.500	UASB	5.500	62,6	751
S8	Karadje	5.000	UASB	8.000	88,5	1.062
S10	Banga Bana	5.000	UASB	8.000	88,7	1.064
S11	Airport	3.300	Stabilization Pond	38.000	NA	NA
Total		57.500		123.800	1.048	12.571

b. Sludge originating from industrial pre-processing

[2] Sludge generated is based on water content of 40% after drying bed

Presently, it does exist in Niamey six wastewater treatment plants and none of them is operational:

Waste water treatment plant of the National Hospital of Niamey:

This plant has unfortunately been out of order for several years. There are intentions to set it going again but they have not been materialized.
In case of normal operation of the plant, the amount of sludge production is estimated at 3.5 m^3 every 6 months. The water content of the sludge would be approximately 95 %.
The following wastewater treatment plants are also not in operation:

Waste water treatment plant of the university hospital of Lamordé
Waste water treatment plant of Grand Marché
Waste water treatment plant of the company Braniger and
Waste water treatment plant of the company Enitex

Due to the expected small sludge quantity from these plants and the fact that no data are available, the sludge generated in these waste treatment plants (if they are in operation) shall not be taken into consideration.

9) Design criteria

Basic criteria for a concept regarding waste management are following :

- number of inhabitants
- number of households
- population density in the various districts of the town
- specific category of waste
- quantity and quality of waste
- infrastructure of the town of Niamey
- structure of housing
- quantity and composition of special waste (for instance, those coming from hospitals, slaughtering houses, etc...)

7.4.2 Alternative study of solid waste management

(1) Household waste

1) Proposed Alternative

The system of solid waste management is generally developed through different stages as shown in Figure 7.4-1 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.

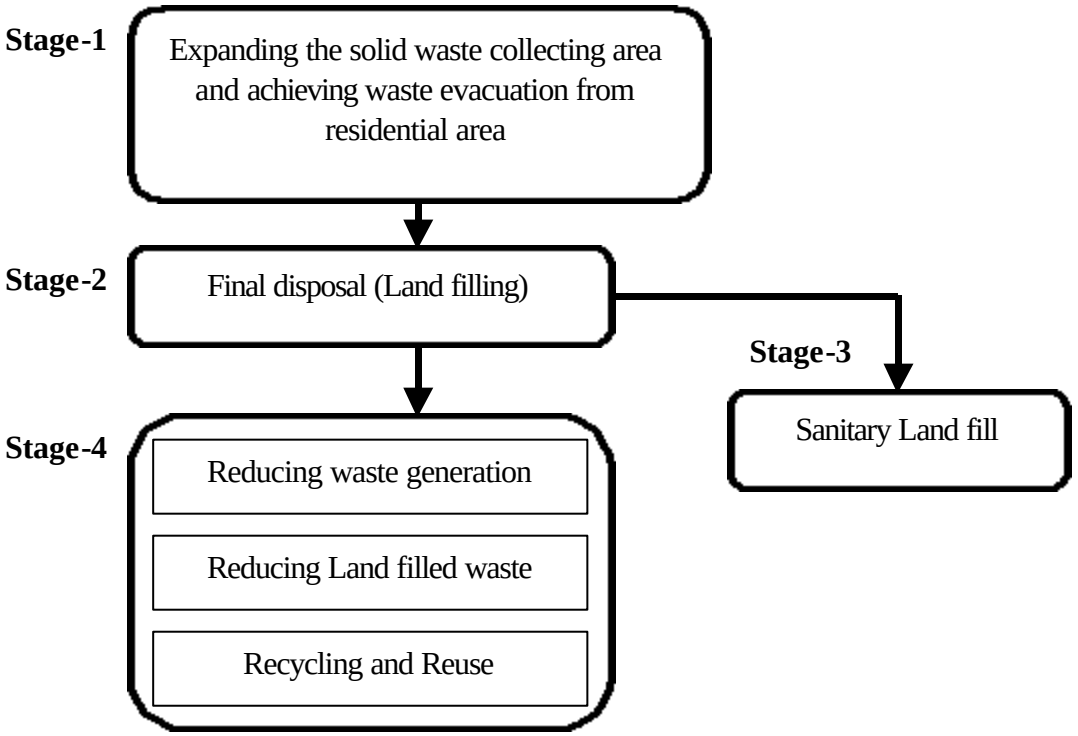


Figure 7.4-1 SOLID WASTE MANAGEMENT DEVELOPMENT STAGES

In the City of Niamey, Stage-1 and 2 have not been achieved yet, prompt waste evacuation from residential area is poorly executed and uncollected waste is scattered and accumulated in streets, wastewater channels and open areas. Furthermore no official designated disposal site is existing. Therefore the technical alternatives have been formulated to ensure regularly waste evacuation from residential area (Stage-1) and disposed properly at designated sites (Stage-2). Stage 3 is a necessary final step of waste management, for the present project basic management of the disposal site shall be carried out in order to introduce a sustainable solid waste management.

The causes of waste accumulation on street are as follows.

i. The resident discharges the waste in streets as insufficient number of containers.
ii. The resident has formed a habit of throwing the waste in streets and channels.

iii. The resident discharges the waste around container, as the containers are always full. It is caused by irregular and low frequency container collection.
iv. Some part of street has been changing to dump site since the accumulated waste calls more waste.
v. The solid waste is adopted as filling materials for holes in street and/or land reclamation.

To solve the above problems, three Alternatives have been formulated under the following policy and examined in this Study.

i. To stop the practice that the resident discharges the waste in street and channels through replacing wild transfer point with container.
ii. To introduce the pre-collection (door to door) system to avoid improper discharge by resident.
iii. To decrease the load of the waste transportation through separating sand which contains more than 70 % in weight in the generated waste.
iv. To introduce fee collection from the resident in order to cover partially the SMW cost.

The Alternatives that have been examined are as follows.

Alternative 1

The system is same as present, however all wild transfer points are replaced with containers to prevent the resident discharge in streets. The resident discharge consists of two ways,

i) direct discharge and
ii) through pre-collection for that the resident contracts directly with private pre-collection company as actual. However it is difficult for this Alternative to introduce fee collection for whole the city, as the pre-collection is only an informal system , does not obligated the resident and their financial situation is limited.

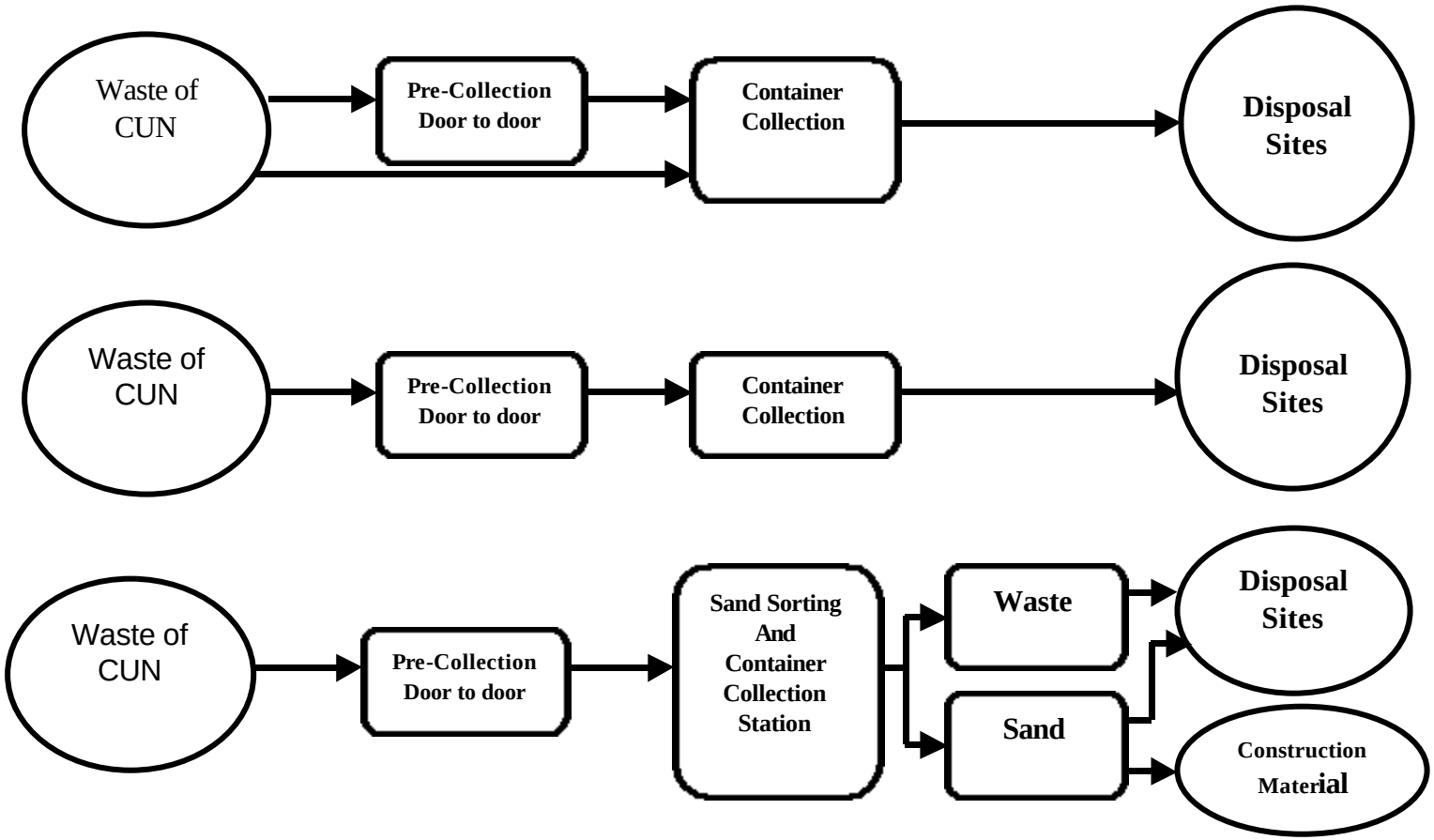
Alternative 2

It will probably continue that the resident discharges the waste in streets under the actual practice and awareness of the resident, even containers sufficiently arranged. To prevent such improper discharge, pre-collection (door to door) system is proposed to be introduced for all generated waste. The pre-collection system shall be formally introduced, obligated for the resident and start the fee collection from the resident to promote the public awareness and to keep the system sustainable. Although Alternative 1 requires heavier load for CUN and Communes who are facing to financial difficulty for SWM, Alternative 2 aim at less load for them and cost sharing among beneficiaries (the resident).

Alternative 3

Alternative 3 is a developed system of Alternative 2. The pre-collection system makes valuable material sorting possible at transfer points for containers. As first stage of recycling in Niamey, sand sorting is effective as the share of sand content in the generated waste reaches about 60% in weight. The out sorted sand will decrease the load of waste transportation and will be expected to earn through sand selling.

Basic waste flow of the three Alternatives is shown in Figure 7.4-2



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

TECHNICAL ALTERNATIVES

Figure 7.4-2

2) Alternative Study

In order to calculate the required equipment, estimate the investment and compare the three Alternatives, Alternative Study has been done for the situation of an average model quartier in 2015. All related detail calculations are presented in Appendix J-1.

a. Conditions of Alternative Design

Basic conditions of the model quartier for Alternative Study and Selection are as shown below according to the obtained figure in this study.

TABLE 7.4-11 BASIC CONDITIONS

No.	Item	Unit	Figure
1	Population in 2015	pers.	15,000
2	Population Density in 2015	pers./ha	88.64
3	Area	ha	169
4	Waste Generation Rate	kg/per.day	0.75
5	Sand content of generated waste	% in weight	60%
6	Waste content of generated waste	% in weight	40%
7	Density of waste with sand	t/m^3	0.500
8	Density of waste without sand	t/m^3	0.250
9	Density of sand	t/m^3	1.5
10	Daily Waste Generation	t/day	11
		m^3/day	19
11	Yearly Waste Generation	t/year	4,106
		m^3/year	7,080

Since the waste density is changed at stages in solid waste transportation and disposal system, the following have been applied in the study.

TABLE 7.4-12 APPLIED WASTE DENSITY TO THE STUDY (KG/M^3)

Waste type	At Generation	At Transport	At Disposal	Disposal Compacted
Waste with Sand	500	580	580	880
Waste without Sand	250	325	325	650
Sand	1,500	1,600	1,600	1,800

b. Collection Frequency

The generated solid waste is required to be removed properly within one week from its generation, otherwise, fermentation of organic content and fly growth (from hatching to imago) will occur . On the other hand and in order to keep the better working condition and equipment maintenance it is necessary to make a day off in a week.

In Alternative 1, collection frequency means transportation and disposal in a week by one container. It is important factor, as well as population and area, to set the required number of container. In alternative 2 and 3, collection frequency means the number of pre-collector's visit to one household in a week (pre-collection frequency). The pre-collected waste shall be transported to disposal site every working day.

In Alternative 1, the less frequency of container collection requires more containers but less transport capacity. However as described in "6) Collection and Transport" of this section, the necessary number of container is same among 3 collection frequency options in Alternative 1 that the containers shall be arranged at accessible location by the resident. Therefore the frequency of once a week (fq=1) that charges the lowest transportation cost is the optimum for Alternative 1.

In Alternative 2 and 3, the pre-collection frequency dose not influence the transportation quantity and capacity between the collection/recycle centers and final disposal sites. As the collection/recycle center can have some function storing a little amount of waste, the transportation capacity has to cover only for average amount divided by 6 working days. The waste stored in collection/recycle center shall be taken for disposal sites in regular, otherwise the centers would become disposal sites. The other hand, the less frequency of pre-collection, the less pre-collection capacity is required. But the less frequency requires longer period that the resident shall keep the waste in households for. And the less frequency may cause illegal discharges by the resident who can not keep it in households for a few days and/or one week. Therefore the frequency shall basically be kept at six days a week (fq=6, every day except Sunday) until resident habit improved and try in future to decrease the frequency to 2 days a week.

The collection frequency applied in Alternative study is summarized as shown in Table 7.4-13.

Table 7.4-13 COLLECTION FREQUENCY

Activity	Alternative 1	Alternative 2	Alternative 3
Resident discharge	Any time and any day.	Once a day pre-collected. **Fq=6**: Six days a week except Sunday.	Once a day pre-collected. **Fq=6**: Six days a week except Sunday.
Container collection	**Fq=1**: once a week, one-sixth containers to be collected in a working day	**Fq=6**: Containers in collection station to be collected in six days a week.	**Fq=6**: Containers in collection station to be collected in six days a week.

c. Resident Discharge

In the view of discharge way, discharging the generated domestic waste at proper collection point by the resident-self is ideal. In this case, it is necessary for CUN and Communes to provide sufficient collection points accessible by all the residents and to make a regular collection service. However the proper discharge is not completely expected when the resident awareness is low and there are traditional practices to prevent it. In Niamey, many of the people throws or discharges the waste in streets and channels. This habit is supposed to have been formed for long time and hard to change immediately.

When Alternative 1 applied, the improper discharge by the resident will decrease as sufficient number of container is provided, however it may not disappear. The CUN and Communes should pay their effort to sweep the improperly discharged waste. The other hand, it is difficult to expect that the resident is aware of SWM service costly. The resident will continue considering that SMW service is free of charge. It is difficult to follow effectively the principal of "Cost Sharing among Beneficiaries".

When Alternative 2 or 3 applied, the resident discharges the waste through pre-collection and they do not throw directly the waste into containers. Therefore this system is expected to decrease much improper discharge. Further the pre-collection makes fee collection possible. Since the pre-collector comes regularly to households moreover the resident pays for waste pre-collection, the most of improper discharge disappears. In order to have better public awareness on SWM service and its cost and to reduce the financial load of CUN and Communes, the pre-collection should be applied for whole area with some institutional arrangement and fee collection.

d. Pre-Collection

Pre-collection is applied for Alternative 2 and 3. Pre-collection shall be done by manual hand cart taking into consideration local equipment maintenance skill and capability and cost of equipment operation and investment. At the quartiers whose population density is low, applying donkey cart may be efficient. Collection/Recycle Center where the pre-collectors take the waste shall be arranged by quartier or about 100 – 200 ha in area taking into consideration the capable working area of pre-collector.

Assumed one center per 100 ha, number of required collection/recycle center shall be 2 in the model area.

Although the size of collection/recycle center depends on population, the required facilities of one center for the model area are as shown in Table 7.4-14.

Table 7.4-14 REQUIRED FACILITIES FOR COLLECTION/RECYCLE CENTER[3]

Item	Unit	Quantity	
		Alternative 2	Alternative 3
Land	m^2	400	400
Fence	m	74	74
Gate	m	6	6
Lodge	m^2	6	6
Store	m^2	-	6
Toilette	m^2	2	2
Sand Sorting Yard (in concrete:30.25m^2 x 10cm)	m^3	-	3.03
Sand Stock Yard	m^2	-	64

The required personnel for pre-collection by center as shown in Table 7.4-15

[3] Sand Sorting is described in the next section
Alternative 2 that has no sand sorting requires also the same area for truck

Table 7.4-15 REQUIRED PERSONNEL FOR PRE-COLLECTION AND SAND SORTING

Item	Unit	Quantity	
		Alternative 2	Alternative 3
Foreman for Pre-collection	Person	2	2
Clerk	Person	-	1
Pre-collector (Worker)	Person	13	13
Total	Person	15	16

And the worker shall prepare the tools as shown in Table 7.4-16. Practically one team by two workers should be formed to expect stable and effective services and the team shall not only collect the waste from the households but also pick the waste in streets up. In Alternative 3, the worker shall sort the sand out after waste collection.

Table 7.4-16 REQUIRED TOOL BY WORKER

Item	Quantity	
	Alternative 2	Alternative 3
Working uniform	0.5	0.5
Shovel	0.5	0.5
Rake	0.5	0.5
Boom/Brush	0.5	0.5
Sieve	-	0.5
Hand Cart	0.5	0.5

e. Sand Sorting

Since the generated waste in Niamey contains much sand, sand sorting has been examined for Alternative 3. Sand sorting is to be done at the final stage of pre-collection. Sorted sand can be applied not only for covering soil in final disposal sites but also for construction (filling and reclamation) material. And some income is expected through selling the sorted sand as construction material and helps to cover some portion of pre-collection cost.

The sand sorting shall be done by manual way taking into consideration local skill for equipment maintenance and cost of operation and investment.

As the share of sand is 60% in the generated waste, it is expected to obtain 163,219 t/year of sand from 272,032 t/year of generated waste and to reduce disposed waste to 108,813 t/year in Niamey as shown in Table 7.4-17.

Table 7.4-17 AMOUNT OF OBTAINED SAND THROUGH SAND SORTING

No.	Item	Unit	Amount
1	Generated (pre-collected) waste	t/year	272,032
2	Share of sand in waste	%	60%
3	Amount of sorted sand	t/year	163,219

f. Transport

Transport means the flow from containers to disposal sites for Alternative 1 and the flow from collection/recycle center to disposal sites for Alternative 2 and 3 in this report. As the type of truck should be unified, the same type of container and truck as present has been examined taking into consideration local skill and capability of equipment maintenance and operation. So the equipment component consists of 5.5m^3 waste containers and detachable container trucks (Gross Vehicle Weight: 9.3t, Payload: 4.7t) for the 5.5m^3 container. This size of container and truck is reasonable for Niamey which has numerous narrow streets and congested areas.

i) Container

Alternative 1

The capacity of container is calculated as shown in Table 7.4-18 according to 0.58 t/m^3 of the waste density with sand. Since overloading causes the waste scattered in streets during transportation to disposal sites, the capacity has to be calculated at the condition of 90% load.

Table 7.4-18 CAPACITY OF CONTAINER: ALTERNATIVE 1 AND 2

Volume	loading rate	capable volume	capable weight
m^3	%	m^3	t
5.5	90%	4.95	2.87

To store the waste generated for one week (0.75kg/person.day x 15,000persons x 7days), it is required to provide 28 containers in the model area. The other hand, the number of container has to be examined from the view of distance from each household. Since the accessible distance is about 100m between container and household, one container at least shall be arranged per 4ha. Provided one per 4ha, 43 containers are required in the view of area. The 43 of required number of containers in area wise is much larger than 28 containers required for the population. Therefore 43 is selected as the required number of container for Alternative 1.

Alternative 2

The same type of container as the above is examined.

As the collection center can have some function storing a little amount of waste, the transportation capacity has to cover only for average amount divided by 6 working days (0.75kg/person.day x 15,000persons x 7days / 6days). Therefore the required number of container is calculated as 5.

Alternative 3

The same type of container has been examined as Alternative 1 and 2. But the capacity of container in weight is naturally different from it applied for Alternative 1 and 2, since the density of waste sand sorted out is much lower than the waste before sorting. Provided 0.325 t/m^3 of the waste density without sand, the loading capacity is calculated as shown in Table 7.4-19.

Table 7.4-19 CAPACITY OF CONTAINER: ALTERNATIVE 3

Volume	Loading rate	Capable volume	Capable weight
M^3	%	m^3	t
5.5	90%	4.95	1.61

As the recycle center can have some function storing a little amount of waste, the sorting and transportation capacity has to cover only for average amount divided by 6 working days (0.75kg/person.day x 15,000persons x 40% x 7days / 6days). Therefore the required number of container is calculated as 4.

The required number of container is summarized in Table 7.4-20. In addition to the described number, one container per truck shall be prepared for keeping the waste discharge/loading stable.

Table 7.4-20 REQUIRED NUMBER OF CONTAINER

Item	Unit	Quantity		
		Alternative 1	Alternative 2	Alternative 3
5.5m^3 Waste Container	pcs	43	5	4

ii)Detachable Container Truck

According to the surveys made in this study (see the detail results in Appendix J-2), 6 containers are expected in average to be transported to final disposal sites. And the number of container to transport per day is one-sixth containers in Alternative 1 and all the containers in Alternative 2 and 3. Therefore the required number of the truck is calculated as shown in Table 7.4-21. As the trucks shall serve also for other areas than this model area, the figures of required number are shown in decimal.

Table 7.4-21 REQUIRED NUMBER OF TRUCK

Item	Unit	Quantity		
		Alternative 1	Alternative 2	Alternative 3
5.5m^3 Waste Container Truck	truck	1.3	0.8	0.7

g. Transport of Sorted Sand

In Alternative 3, the sand sorted out shall be taken out from the recycle center. The sand is not strongly required to be taken out since it is not unsanitary material, however the recycle

center would be full with the sand if any regular transportation not provided. The final destination of the sand is customers who need it for construction activities as well as final disposal sites using it as covering soil for sanitary landfill. The final disposal sites are recommended to use as stockyards of the sand. Therefore the transportation equipment of the sorted sand has been examined for the trip from the recycle center to disposal sites.

i) Case 1

In case of the same truck as 5.5m^3 container truck applied, the suitable volume of container is 2 m^3 taking into consideration the payload of truck and unexpected large density arrived. And overloading is expected when the container of waste is applied for sand,. The overload causes the damage and trouble of the truck. The capacity of 2m^3 container for sand is calculated as shown in Table 7.4-22.

Table 7.4-22 CAPACITY OF SAND CONTAINER: CASE 1

Volume	Loading rate	Capable volume	Capable weight
m^3	%	m^3	t
2.0	90%	1.8	2.88

If applied, the required number of sand container and truck is set as shown in Table 7.4-23. In addition to the described number, one container per truck shall be prepared for keeping the sand loading work stable. As the trucks shall serve also for the waste, the figure of required number is shown in decimal.

Table 7.4-23 REQUIRED NUMBER OF SAND CONTAINER AND TRUCK: CASE 1

Item	Unit	Alternative 3
2 m^3 container	Containers	3
5.5 m^3 container truck	Truck	0.5

ii) Case 2

Furthermore another way made by dump trucks and wheel loaders has been examined. Since the average amount of sorted sand in one recycle center is a little at 24 t/week, the sand collection at once a week (fq=1) is allowed for recycle center management. When a sand transportation team consisting of two of 15t dump truck and one of 2m^3 wheel loader is formed, one team can take the sand to disposal sites from 4 recycling centers in a working day, provided 4 trips/day capable.

If applied for the recycle centers, the required number of dump truck and wheel loader is set as shown in Table 7.4-24. As the dump trucks and wheel loaders shall serve also for other areas than this model area, the figures of required number are shown in decimal.

Table 7.4-24 REQUIRED NUMBER OF DUMP TRUCK AND WHEEL LOADER: CASE 2

Item	Unit	Alternative 3
15t dump truck	truck	0.2
$2m^3$ wheel loader	loader	0.1

h. Recycling

Alternative 1 and 2 are not expected to recycle the valuable material in the generated waste. However Alternative 3 makes sand recycling possible. The recycling for other materials, it should be considered when the waste collection system developed enough.

As future recycling activities, recycling for organic content, paper, plastic, iron, aluminum would be effective. To start the recycling, the development of recyclable material markets is indispensable. According to the development of the markets, the recycle center of Alternative 3 is recommended to start the other materials sorting out.

i. Intermediate Treatment Facility and Transfer Station

Since the lands of disposal sites can be obtained within about 10km from city center, transfer station that transfers the waste from collection vehicle to larger transfer vehicle is not required. As for intermediate treatment facilities, it should be considered when the waste collection system developed enough. Composting facility that makes compost from organic waste is recommendable as a future intermediate treatment facility.

j. Alternative Comparison

i) Technical Comparison

Table 7.4-25 shows the characteristics of the Alternatives.

Table 7.4-25 CHARACTERISTIC OF ALTERNATIVES

Stage	Alternative 1	Alternative 2	Alternative 3
1. Discharge	Every day (incl. Sunday) possible. Not necessary to keep the waste in resident's household. Direct discharge into container. Possible to discharge through pre-collection as present.	6 days (every day except Sunday) per week only through pre-collection.	6 days (every day except Sunday) per week only through pre-collection.
2. Pre-Collection	Seen informal pre-collection.	Formal pre-collection only.	Formal pre-collection only.
3. Recycling	Not done.	Not done.	Sand sorting after pre-collection. Sand utilized as cover soil in disposal site. Possible sand recycling as construction material.
4. Collection and Transport	Through 5.5m^3 container and container truck. One container at 4ha at least. Containers picked up once a week for disposal.	Through collection center provided at about 100ha. Transport 6 days per week from collection center to disposal sites. 5.5m^3 container between center and disposal sites.	Through collection center provided at about 100ha. Transport 6 days per week from collection center to disposal sites. 5.5m^3 container between center and disposal sites.
5. Transportation of Sand Sorted Out	N/A	N/A	<u>Case: 5.5m^3 cont. truck</u> 2m^3 container between center and disposal sites.
			<u>Case: 15t dump truck</u> 15t dump truck with 2m^3 wheel loader between center and disposal sites.

Advantages and disadvantages of the Alternatives are summarized in the following Table 7.4-26.

Table 7.4-26 TECHNICAL COMPARISON OF ALTERNATIVES

	Alternative 1	Alternative 2	Alternative 3
Advantage	1. Pre-collection not required. 2. Simple system. 3. Unnecessary to have institutional set-up.	1. Disappearance of improper discharge. 2. Possible to promote public awareness through fee collection. 3. Possible to privatize the pre-collection. 4. More chance to introduce recycling.	1. Disappearance of improper discharge. 2. Possible to promote public awareness through fee collection. 3. Possible to privatize the pre-collection and sand sorting. 4. Possible to reduce the disposed waste. 5. Possible to earn from sorted sand. 6. Unnecessary to transport and dispose the sand contained in waste.
Disadvantage	1. Improper discharge possible to be continued. 2. Countermeasures necessary against improperly discharged waste. 3. Well public education and public control necessary. 4. Poor field to promote privatization. 5. Poor chance to introduce recycling. 6. Necessary to transport and dispose the sand contained in waste.	1. Required formally introduce the pre-collection. 2. Necessary to have institutional set-up. 3. Necessary to transport and dispose the sand contained in waste.	1. Required formally introduce the pre-collection. 2. Necessary to have institutional set-up. 3. Necessary to have equipment to transport the sand.

In result, Alternative 3 that has the following advantages is the optimum from the technical view.

1) Improper discharge is expected to disappear.
2) It is unnecessary to transport and dispose the sand much contained in waste.
3) It contributes to development of recycling activity.
4) The income from sorted sand helps to cover some portion of SMW cost.

ii)Cost Comparison

Investment for Transport Equipment

The required equipment and capital cost for transport is summarized in Table 7.4-27 and 7.4-28.

Table 7.4-27 QUANTITY OF TRANSPORT EQUIPMENT

Equipment	Unit	Alternative 1	Alternative 2	Alternative 3
Container Truck GVW:9.3t	truck	1.3	0.8	0.7
5.5m^3 Container	pcs	44	6	5

Table 7.4-28 CAPITAL COST FOR TRANSPORT EQUIPMENT

Equipment	Unit	Alternative 1	Alternative 2	Alternative 3
Container Truck GVW:9.3t	CFA	48,000,000	30,000,000	24,000,000
5.5m^3 Container	CFA	132,000,000	18,000,000	15,000,000
Total		180,000,000	48,000,000	39,000,000

Investment for Sorted Sand Transport Equipment

The required equipment and investment cost for sand transport is summarized in Table 7.4-29 and Table 7.4-30.

Table 7.4-29 QUANTITY OF SORTED SAND TRANSPORT EQUIPMENT

Equipment	Unit	Alternative 3	
		Case 1	Case 2
Container Truck GVW:9.3t	truck	0.5	
2m^3 Container	pcs	4	
15t Dump Truck	truck		0.2
2m^3 Wheel Loader	loader		0.1

Table 7.4-30 INVESTMENT COST FOR SORTED SAND TRANSPORT EQUIPMENT

Equipment	Unit	Alternative 3	
		Case 1	Case 2
Container Truck GVW:9.3t	truck	18,000,000	
2m^3 Container	pcs	8,000,000	
Total		26,000,000	
15t Dump Truck	truck		8,000,000
2m^3 Wheel Loader	loader		7,500,000
Total			15,500,000

Operation and Maintenance Cost for Transport

The largest factor for setting operation and maintenance cost (O&M cost) is number of vehicles which are operated in a year. Table 7.4-31 shows the O&M cost by Alternative.

Table 7.4-31 COMPARISON OF O&M COST FOR TRANSPORT

Unit: CFA/year

No	Items	Alternative 1	Alternative 2	Alternative 3
1	Labor Cost			
1-1	Driver: 1/truck, 313 days/year	626,000	391,250	313,000
1-2	Worker: 2/truck, 313 days/year	918,133	573,833	459,067
1-3	Total	1,544,133	965,083	772,067
2	Operation			
2-1	Fuel (61.4lit/day.truck)	9,737,221	6,085,763	4,868,611
2-2	Lubricant (20% of fuel)	1,947,444	1,217,153	973,722
2-3	Total	11,684,666	7,302,916	5,842,333
3	Maintenance			
3-1	For truck (5% of purchase cost)	2,400,000	1,500,000	1,200,000
3-2	For container (2% of purchase cost)	2,640,000	360,000	300,000
3-3	Repair for accident (0.8% of pur. Cost)	384,000	240,000	192,000
3-4	Total	5,424,000	2,100,000	1,692,000
4	Administration (5% of 1,2,3)	932,640	518,400	415,320
5	**Grand Total**	19,585,439	10,886,399	8,721,719

Operation and Maintenance Cost for Sorted Sand Transport

Table 7.4-32 shows the operation and maintenance cost by Alternative.

Table 7.4-32 COMPARISON OF O&M COST FOR SORTED SAND TRANSPORT

Unit: CFA/year

No	Items	Alternative 3	
		Case 1	Case 2
1	Labor Cost		
1-1	Driver	234,750	130,417
1-2	Worker: Case 1, Operator: Case 2	344,300	70,425
1-3	Total	579,050	200,842
2	Operation		
2-1	Fuel for dunp truck	3,651,458	2,436,288
2-2	Oil for truck (20% of fuel)	730,292	487,258
2-3	Fuel for loader	0	1,094,248
2-4	Oil for loader (20% of fuel)	0	218,850
2-5	Total	4,381,750	2,923,545
3	Maintenance		
3-1	For truck (5% of purchase cost)	900,000	400,000
3-2	For container (2% of purchase cost)	160,000	0
3-3	For loader (5% of purchase cost)	0	375,000
3-4	Repair for accident (0.8% of pur. cost)	144,000	124,000
3-5	Total	1,204,000	899,000
4	Administration (5% of 1,2,3)	308,240	201,169
5	**Grand Total**	6,473,040	4,224,556

Total Equipment Cost Comparison

In case that the investment is evaluated as the cost for 10 years and divided by 10 years, the sum of yearly investment (sand transport included) and operation and maintenance costs is as shown in Table 7.4-33.

Table 7.4-33 TOTAL COST COMPARISON

CFA/year

Alternative / Sand Transp Case / Item	Alternative 1	Alternative 2	Alternative 3	
			Case 1	Case 2
Investment divided by 10 years	18,000,000	4,800,000	6,500,000	5,450,000
O&M cost per year	19,585,439	10,886,399	15,194,759	12,946,276
Total	37,585,439	15,686,399	21,694,759	18,396,276
Cost per population 2015	2,506	1,046	1,446	1,226

As a result, the total yearly cost of Alternative 2 and 3 are much lower than Alternative 1 since the Alternative 2 and 3 hold the SWM cost lower by pre-collection system. Taking into consideration this yearly cost to be born by CUN and Communes, Alternative 2 and 3 are the optimum.

As for the sand transportation equipment, case 2 whose cost is lower is the optimum.

Investment for Pre-Collection and Sand Sorting

The required investment for pre-collection and sand sorting is for construction of collection/recycle centers. The required cost of investment is as shown in Table 7.4-34.

Table 7.4-34 REQUIRED INVESTMENT FOR COLLECTION/RECYCLE CENTER

Alternative	Unit	Quantity	Unit Cost (CFA)	Amount (CFA)
Alternative 2	Center	2	4,490,000	8,980,000
Alternative 3	Center	2	5,078,900	10,157,800

In case of dividing the cost by 15 years, the yearly cost is as Table 7.4-35.

Table 7.4-35 YEARLY INVESTMENT FOR COLLECTION/RECYCLE CENTER

Alternative	Unit	Investment (CFA)	Repayment (years)	Amount (CFA)
Alternative 2	Center	8,980,000	15	598,667
Alternative 3	Center	10,157,800	15	677,187

Operation and Maintenance Cost for Pre-Collection and Sand Sorting

The operation and maintenance cost consists mainly of labor cost and tools cost. The required operation and maintenance cost is as shown in Table 7.4-36.

Table 7.4-36 REQUIRED O&M COST FOR PRE-COLLECTION AND SAND SORTING

Alternative	Unit	Quantity	Unit Cost (CFA)	Amount (CFA)
Alternative 2	Center	2	8,202,190	16,404,380
Alternative 3	Center	2	8,785,570	17,571,140

Total Pre-Collection and Sand Sorting Cost Comparison

The sum of the investment cost divided by 15 years and the operation and maintenance cost is as shown in Table 7.4-37.

Table 7.4-37 PRE-COLLECTION AND SAND SORTING COST BY POPULATION

Item	Unit	Alternative 2	Alternative 3
Investment divided by 15yrs	CFA/year	598,667	677,187
O&M Cost	CFA/year	16,404,380	17,571,140
Total Cost	CFA/year	17,003,047	18,248,327
Population	person	15,000	15,000
Cost/population	CFA/pers.year	1,134	1,217

It is normal to consider that the pre-collection cost should be born by the beneficiary (the resident). Therefore the cost does not influence the waste transportation by vehicle. And sorted sand should be sold as construction material. The sales of the sand cover partially the operation and maintenance cost for the pre-collection and sand sorting. As the yearly produced amount of sand is 2,464 t/year, it is expected to earn about 5.9 million CFA per year (price of recycled sand: 2,400 CFA/t). In result, the sand sorting contributes to the reduction of operation and maintenance cost of Alternative 3 and the cost of Alternative 3 is finally lower than Alternative 2 as shown in Table 7.4-38. Therefore Alternative 3 should be selected when the pre-collection applied.

Table 7.4-38 PRE-COLLECTION AND SAND SORTING COST BY POPULATION

(Income from the sand considered)

Item	Unit	Alternative 2	Alternative 3
Investment divided by 15yrs	CFA/year	598,667	677,187
O&M Cost	CFA/year	16,404,380	17,571,140
Income from sand	CFA/year	0	-5,913,000
Total Cost	CFA/year	17,003,047	12,335,327
Population	person	15,000	15,000
Cost/population	CFA/pers.year	1,134	822

iii) Selection of Alternative

To clean the city up and keep it clean, it is unavoidable that the total SWM cost is increased. And the cost which is newly required should be finally born by the beneficiary (the resident), as SWM is one of the public services.

As a result of the study, Alternative 3 is the optimum since the cost to be born by CUN and Communes is held lower and the pre-collection cost to be born by the resident is held also lower.

Alternative 3 having pre-collection system not only prevents the waste discharged improperly by the resident but also promotes the public awareness on sanitation and SWM cost. The other hand, Alternative 3 has a capability to recycle the valuable materials other than sand. This would contribute to creating material recycle system and other recycle businesses in the country and Niamey.

Therefore Alternative 3 shall be selected as the principal way for SWM.

3) Final Disposal Site Alternative

Developing stages of final disposal site is summarized as shown in Figure 7.4-3. Currently any disposal site has not been officially designated and the waste is disposed at wild dumping sites. The current situation is categorized in Level 0. To keep the site sanitary, introduction of Level 2 is at least required. However some countermeasure against generated leachate shall be taken in Niamey since the precipitation is much in rainy season.

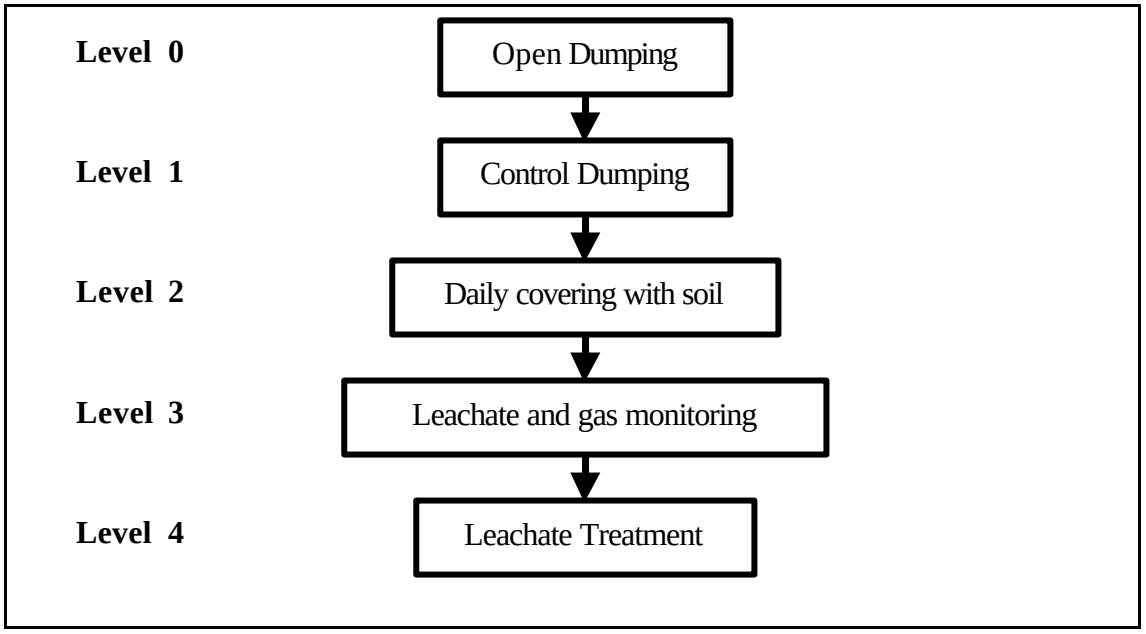


Figure 7.4-3 DEVELOPING STAGES OF FINAL DISPOSAL SITE

a. Location of Final Disposal Site

One or two final disposal sites shall be urgently designated as permanent disposal sites. The proposed location of disposal sites is described in the following chapter 7.4.2(4).

b. Control Dumping

Actually there is no system to manage the information where the container trucks dump the waste. It is the first step of the control dumping to record the truck number, name of driver, weight of incoming waste and original location of waste for all of the incoming waste into the disposal sites. This system is helpful also for management of drivers.

To keep the recording system, it is required to have one control building consisting of staff room, store and toilette at the entrance of the disposal sites. And in personnel, clerks recording the incoming truck, foremen directing the trucks to dumping location and guard men are required.

As for the required facility, a fence and a rainwater drain around the disposal sites are indispensable in addition to the above control building. The fence is capable not only to protect strangers entering into the site but also to be recognized by the citizen and truck drivers where the disposal site is. Rainwater drain is necessary for reducing leachate generation.

The required facilities and personnel are summarized as shown in Table 7.4-39.

Table 7.4-39 THE REQUIRED FACILITIES AND PERSONNEL FOR CONTROL DUMPING

Facilities	Personnel
1. Fence around the disposal site 2. Control Building (Staff room, Store, Toilette) 3. Rainwater Drain	1. Guard men 2. Truck Recording Clerks 3. Foremen of disposing location

c. Daily Covering with Soil

Daily covering with soil is the beginning of sanitary land fill. The purpose of soil covering is to protect the waste scattered, smell, self-burning and view. The soil covering shall be done at 3m of thickness of waste and the thickness of soil shall be 50cm. There are two principal methods for land fill as shown in Figure 7.4-4. For wider disposal site, the cell method is effective for daily covering taking into consideration smaller amount of disposing waste in Niamey.

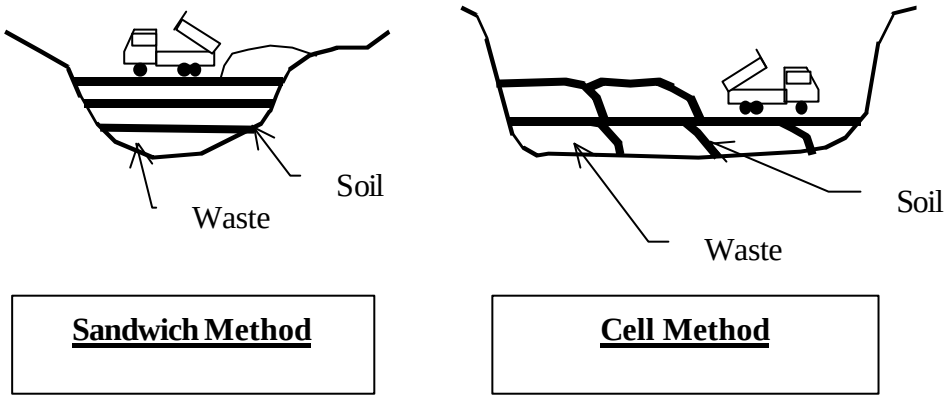


Figure 7.4-4 METHODS OF LAND FILL

For the daily soil covering, the disposal site shall be equipped with bulldozer. Required number of bulldozer is calculated by daily disposing amount.

d. Leachate Protection

In Niamey, the yearly evaporation is much larger than the precipitation. Therefore the leachate is expected to be evaporated and not required to treat and discharge.

The reachate generated in a rainy day would be evaporated while circulating in disposal site. To make the circulation, it is necessary to provide a retention pond and a reachate sending back facility to disposal site. The bottom of disposal site and the retention pond shall be protected against reachate penetration into ground by clay. The reachate shall be conducted to the retention pond by water collecting pipes. The reachate collected in the retention pond

should be sent back to disposal site by vacuum wastewater tank trucks. The vacuum wastewater tank truck system would be better than a system of pumping up and sending back with a pipeline, as the pump is unnecessary in dry season but requires the maintenance over the year. The vacuum wastewater tank trucks are reasonable since they are required in the city to take wastewater out and transport it over the year.

e. Selected Alternative

The required facilities and personnel by 2015 are summarized as shown in Table 7.4-40. The facilities shall be constructed by stage.

Table 7.4-40 THE REQUIRED FACILITIES AND PERSONNEL

Stage	Facilities/Equipment	Personnel
Level 1	1. Fence around the disposal site 2. Control Building (Staff room, Store, Toilette) 3. Rainwater Drain	1. Guard men 2. Truck Recording Clerks 3. Foremen of disposing location
Level 2 (1st Step)	1. Bulldozers	1. Bulldozers' operators
Level 2 (2nd Step)	1. Clay layer for reachate protection 2. Retention Pond 3. Reachate collecting pipes 4. Vacuum wastewater tank trucks in rainy days	1. Drivers for vacuum wastewater tank trucks in rainy days

4) Landfill site

In order to be able to control the impacts of a solid waste landfill site facility, its construction should include some essential parts which are the following:

- Preparation of areas and the base of the landfill (water tightness)
- Construction of collection and infiltration waters processing systems
- Installation of systems for the collection of the landfill body gas
- Infrastructure (including the fence, the gate, the accesses and roads, the administrative building, the house for the keeper and possibly weighing facilities)

Given the highly critical situation regarding solid waste management in the town of Niamey by and large, the nonexistence of a municipal landfill site (and even not controlled) in particular, and the financial situation of the Urban Community of Niamey, it is not contemplated to plan costly constructions for the planned landfill sites.

Within the framework of malaria control initiated by Unicef, the total planned budget for the construction of landfill sites together with repairs of containers amount roughly to FCFA 33 million, that is roughly US$ 470,000

Given this limited budget, the areas of the landfill sites are equally limited to be confined to roughly 1 ha per site. The planned constructions are equally minimized. They are limited to the fence, a small house for the keeper and the construction of an access road towards the waste dumping site surface.

a. Landfill site of Commune I

Commune I does not have any municipal landfill site. Waste, when it is collected, is carried somewhere to be tipped out. It is often tipped out in tanks created by rain waters.
Within the framework of a program initiated by Unicef to fight against malaria, it is planned to create municipal landfill sites in the administrative radius of Commune I. Two (2) sites which are old quarries have been selected.
The first site is located at Koubien on the road of Tillaberi at some 5.2 km from the head office of Commune I.
The second site is located at the level of Cité Caisse at approximately 4.5 km from the Municipality office.
The area of sites is small and is estimated at roughly 1.5 ha for each of the sites. No construction has been planned for the preparation of the landfill site base.

Delimitation works of sites (fence) are under way and houses for keepers have equally been built.

It has equally been planned to allocate at the level of the landfill site 3 workers and 1 supervisor who will be in charge to record waste carried towards the landfill site.

b. Landfill site of Commune II

Commune II does not equally have municipal landfill site. Waste management in that commune is similar to the one of Commune I.
Along the road of Filingué, we notice a pile of waste tipped out along the roadway. Apparently, it is the waste management method used in Commune II.

2 sites have equally been selected within the framework of the Unicef program for the service of municipal landfill sites regarding waste coming from Commune II.

The first site selected is located on the road of Filingué at roughly 3.9 km from the head office of Commune II. It is localized not very far from the « small forest » called the green belt of Niamey. A few houses in hatches (3 or 4 houses) are near the selected site. The site is an old quarry made up of several cavities. In one of the cavities there are traces of former waste tipped out. Like for all the other planned landfill sites within the Unicef program, solely an area of one hectare will be selected for the landfill site, whereas the field has extension potentialities. The total surface area is estimated at 15 ha.

The second site, not far from the international airport of Niamey near the District « Aviation », is at roughly 7.7 km from the head office of the Commune II. On that site, fencing works have started but not completed. On the other hand, the construction of a small house for the keeper is completed. The construction of the access is not yet made. The relatively wide field can possibly be extended beyond 5 ha.

c. Landfill site of Commune III

Commune III does not also have a municipal landfill site. The waste management in that commune is similar to the one of the other two communes.

Still within the Unicef program, a site has been selected for commune III to be the subject of a municipal landfill site for waste produced in that commune. The site is at roughly 5.6 km from the head office of Commune III.

Construction work is still under way. The fence is not yet completed and the access is not constructed; on the other hand, the keeper's house is completed.
The site is an old quarry, there are several cavities which can be used to tip out household waste in that Commune III. Not very far from the selected site with an area of roughly one hectare are located a few houses. If we take into consideration all the cavities , the area of the landfill can roughly reach 3 ha.
Commune II does not either have a municipal landfill site. Waste management is similar to the one of commune I.

Appendix J-3 shows the location of the 5 sites selected by the program on Malaria Control for the 3 Communes of Niamey as well as the designated and selected landfill sites for CU 1&2 and CU 3.

(2) Hospital waste

1) Hospital waste treatment methods

Hospital specific waste (to be distinguished from the household waste part of hospital residues), being hazardous to the environment and to people because of its composition, has to be treated before its disposal. The most important treatment methods of hospital specific waste are:

- Steam sterilization of infectious waste
- Chemical treatment and shredding
- Incineration of infectious waste

a. Steam sterilization of infectious waste

Steam sterilization requires that the infectious agents contained in the waste be exposed to a high temperature (110 – 135 °C) for sufficient long duration (2 – 30 min.). Steam is used to destroy infectious agents contained in the waste. An Autoclave is the common type of steam sterilizer (see Figure 7.4-5). The chamber has an inlet for steam and outlet for steam, air and condensation.

Waste containers are placed on racks or load carriers and loaded into the autoclave. The autoclave is closed and steam enters the chamber. Preheating of the chamber and its contents reduces the warm up period and condensation of water inside the chamber and on the waste. Once waste is sterilized, it can be transported and disposed of at the municipal landfill site.

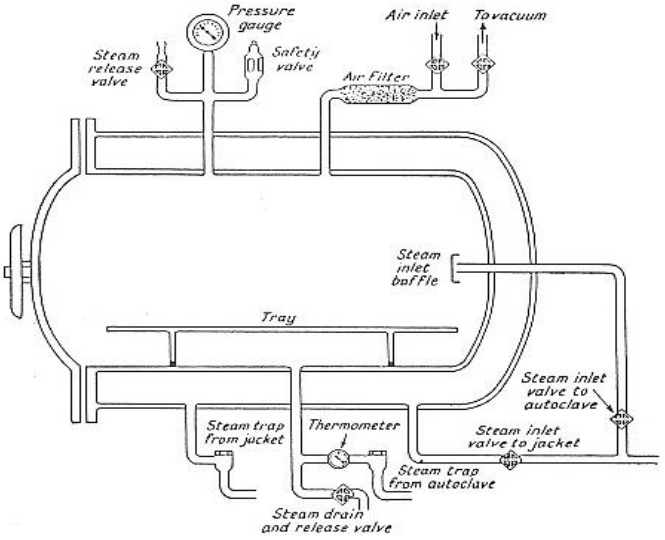


Figure 7.4-5 SCHEME OF AN AUTOCLAVE OPERATING WITH STEAM

b. Chemical treatment and shreding of infectious waste

Waste is shred, soaked in a decontaminating bath, then went through high compression before being conditioned in a waterproof packing. Shredding enables to increase the waste contact surface with a decontaminating solution and to make them unrecognizable when they come out. Processed this way, these wastes are ranked as household waste.

The loading of the equipment is manual and the process is simple. We should, however, notice that chemical and stream treatments are methods used in Japan and Europe. In developing countries, these methods can have certain disadvantages such as :

- the high investment costs for these equipment
- a strict maintenance of equipment to ensure the complete disinfection of waste

c. Incineration of infectious waste

Incineration appears, in many ways, to be the ideal solution to waste management. An incinerator has the capability of destroying hazardous components of the waste, of reducing the waste's volume by leaving only ash to dispose of.

The physical components of an incinerator include a primary combustion chamber (into which waste is fed), a secondary combustion chamber (where gases will be incinerated that have volatized from the primary chamber) and a stack to vent combustion gas (see Figure 7.4-6).

An air pollution control system can be used to remove particulate and acid gases, which consists of scrubbers. A boiler may be added after the secondary combustion chamber and before the scrubber for heat recovering.

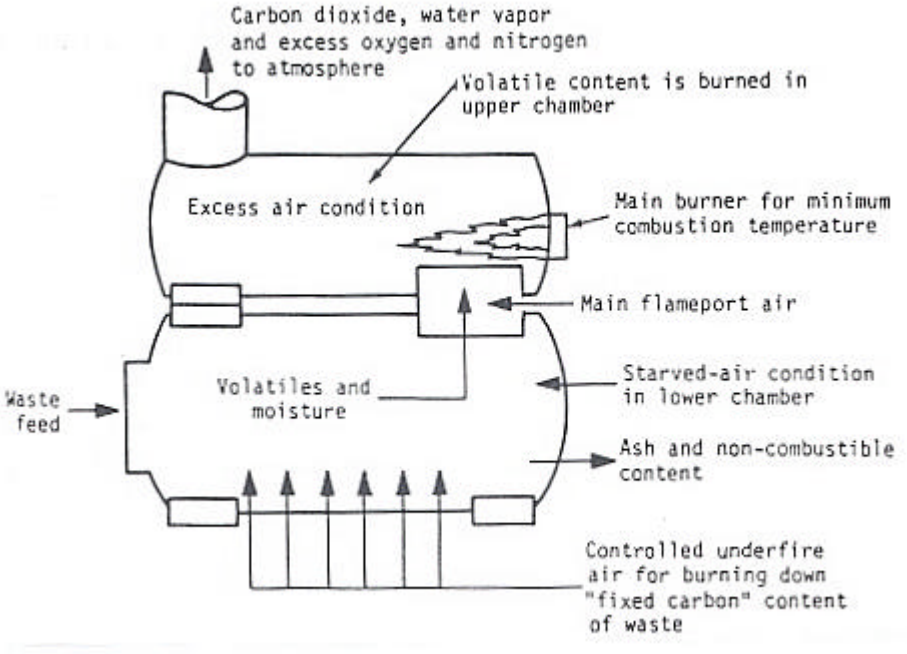


Figure 7.4-6 SCHEME OF THE FIRING SYSTEM FOR THE INCINERATION

2) Hospital Waste Management

The solid waste management at the medical establishment is not satisfactory and has basically to be improved.

A separation of infection waste should be introduced in all hospitals and clinics in order to reduce the risks of any contamination (during the collection, transport and at the landfill). Regulations should be issued and administered.

At a second stage, infectious waste should be treated and rendered harmless prior to disposal of at the municipal landfill site. The most appropriate treatment, under the existing condition in Niamey city, is the incineration.

Table 7.4-41 CAPACITY OF THE NECESSARY INCINERATOR

Quantity of infectious wastes	Year 2001	Year 2005	Year 2010	Year 2015
Quantity in (t/an)	319,11	359,10	413,24	471,28
Quantity in kg / h (8760h/an)	36,43	40,99	47,17	53,80
Quantity in kg / h (8h/day and 6 days/week)	127,50	143,48	165,11	188,30
Capacity of the incinerator	200 kg/h	200 kg/h	200 kg/h	200 kg/h

(3) Industrial waste

According to the results obtained from the survey on solid waste carried out in the first step of this project, industrial waste management is also being done in rudimentary form. In order to find out which type of treatment or recycling can be recommended, records of the quantity and quality of these industrial waste should be available. It should be noted that in Niamey no significant industry exists that generates industrial which can potentially recycled.

In the following are presented some general description of industrial waste treatment methods (non hazardous industrial waste). At present the most of them can not be applicable for the industrial waste generated in Niamey city.

Industrial waste recycling is generally the most effective means of treatment from the point of view of waste volumes reduction and more effective use of resources.

1) Industrial waste treatment methods

a. Sorting method

Sorting techniques are generally applied in combination with crushing techniques for the following purposes:

- Extraction of valuable substances (reusable)
- Separation and collection of valuable substances and organic materials immediately prior to recycling
- Separation of combustible and non-combustible materials from mixed wastes as pretreatment in land filling and incineration
- Separation and collection of valuable substances

In Niamey reusable substances from solid waste are extracted at the source of generation (informal activities of waste recycling). They are sold at the market of Katako.

b. Compression and Cutting

Compression processes for various types of industrial waste ensure reduction in waste volumes, which is one of the objectives of immediate treatment.

c. Destruction and Crushing

Destroying and crushing processes reduce industrial waste volumes and meet one of the requirements of immediate treatment. They also comprise an effective pretreatment method in the filling-up operation.

d. Dehydration and Extraction

Dehydration is mainly applied to sludge. In chemical engineering, the term “extraction" means a process of dissolving and separating soluble components contained in a solid or liquid raw material.

e. Drying and Concentration

To dry wastes is to evaporate and separate water from wet wastes and reduce the residual water content. Drying reduces their volumes and stabilizes their states.

f. Thermal Decomposition

Thermal decomposition is also called dry distillation and is applied to treatment of cellulose and plastic organic substances. It is a chemical reaction in which these substances are heated in anaerobic conditions, so that their molecules are decomposed into smaller ones.

g. Incineration

Incineration is a process of converting organic waste into a large amount of stable oxidized gases and a smaller amount of stable inorganic substances, by oxidizing them at a high temperature in a gaseous atmosphere. It also affects their volume by reducing it. In addition, the high temperature exhaust gases obtained from combustion provide thermal energy that can be collected as steam, heating water and electrical power from thermal generation by means of heat exchange. The accompanying flue gases have to be cleaned in an appropriate facility before discharging into the atmosphere.

h. Composting

Compost is a kind of fertilizer made from organic substances. Organic substances contained in wastes and other raw materials are decomposed into carbon dioxide, water and heat as microbes activate metabolism (fermentation of organic materials) under the presence of water and oxygen (aerobic conditions). The energy required for microbes to live is supplied through the biological oxidation of carbon. Phosphoric acid, nitrogen, potassium in the form of K20 and other organic salts are produced at the same time out of dead animals and vegetables as the final products of the metabolism. These products represent the fertilizing components contained in compost.

2) Industrial Waste Management

In order to initiate a proper industrial waste management, where the industry is to be responsible for collection, transport and dumping and recover the cost. Municipal services and administration should control whether industrial waste is properly managed.
Referring to the financial situation of the industry in Niamey, it will be recommend that the services for industrial waste collection and transport will be carried out by the Municipalities. The costs for theses services shall be fully covered by the industry.

One truck and 10 containers should be foreseen for industrial waste collection and transport as mentioned in the following table 7.4-42.

Table 7.4-42 CONTAINERS FOR INDUSTRIAL WASTE COLLECTION AND TRANSPORT

Company	Number of container
ENITEX	1
BRANIGER	1
SPCN	1
SOLANI	1
ONPPC	1
ABATTOIR	1
NIGER-LAIT	2
RIZ DU NIGER	1
TANNERIE	1
Total	10

7.5 RESIDENT COOPERATION

7.5.1 The Significance of Resident Cooperation

Economic growth cannot be expect with out environmental protection and vice versa. It does not seem to cover for the environmental protection without economic growth. Here in Niger, the same thing can be said of this fundamentals in terms of sanitation improvement.

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.

7.5.2 The Establishment of Project Goal

With the public consensus formulating , it shall be determine the Project goal for the Sanitation Environmental works. The undertaking body of each Sanitation Environmental works such as sewerage / drainage solid waste and sanitation works, are to be an administration organ which can be a mediator for each civil society and /or group.

According to needs for sustainable action and behavior for Nigerien side, it is really important that Nigerien side has to formulate the social System which residents are able to iron out the sanitation environment works regardless situation/occasion.

Through these social activities, residents would eventually realize that willingness to pay seem to be very significant for public services for sanitation improvement at the project goal. This precisely how and what an aid-recipient country is able to massage the sanitation improvement .

The following topics are the final goal for sanitation improvement in Niamey.

(1) Goal of effectiveness

- treat the wastewater and night soil for all Quartier.
- Carry out on enlightening hygiene education through Pilot Study.
- Bring the fare public services for residents.
- Educate resident's consciousness for the cost of public services.
- Built the low cost sanitation (LCS).
- Solve the flooding risk and hazard.

(2) Goal of Sustainability

- Carry out the allotted task force.
- Call the regular meeting and act administrative role to residents.
- Collect the cost as per agreed way.
- Keep in touch better relationship with GON vis-à-vis ONG.
- Operate and maintain the sanitation facilities.
- Infrastructure facilities are functioning

7.5.3 The Rights and Duties of Residents and Authorities

Until today, the responsibility to the residents can not be carried out by administrative Authority for especially sanitation improvement works. The sanitation improvement Authority are, thus, requested to perform their capability than showing their responsibility to the residents. To expert the immediate and satisfactory result/effective, it is precisely important activity to take iron out and talk the current issues with residents. To expect the immediate and satisfactory result/effectiveness, it is precisely important activity to take iron out and talk the current issues with residents.

All in all, the following realization shall be noted for the Authorities and residents.

a- 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.

b- 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.

c- 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.

d- Finally, only thing is that public participation and resident's cooperation is sinequanon of action and the best way to improve the sanitation conditions in the long run.

CHAPTER 8. MASTER PLAN OF SEWERAGE AND DRAINAGE

CHAPTER 8. MASTER PLAN OF SEWERAGE AND DRAINAGE

8.1 SEWERAGE / DRAINAGE ZONE

8.1.1 Fundamentals of Zoning

Sewerage facility planning area is further divided into each zone considering following conditions.

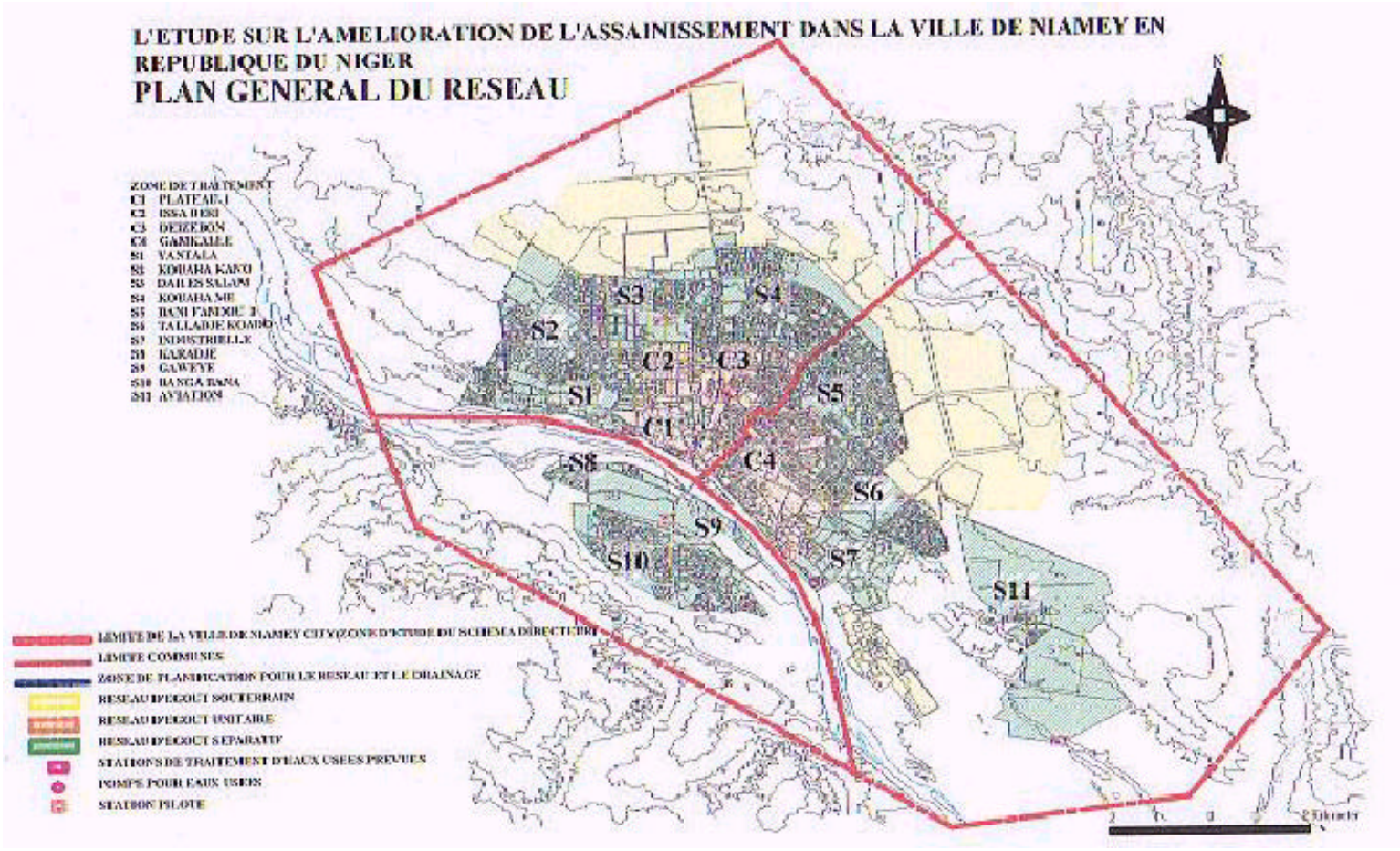
1) Geological conditions :
   Zoning shall be done considering natural divide to collect sewage by gravity as much as possible from the view point of energy saving and maintenance easiness. If the gravity flow is not feasible, pumping system shall be considered.
2) Availability of land for wastewater treatment plant
3) Commune and quartier boundary :
   Zoning shall be done considering commune and quartier boundary as much as possible as the maintenance of the sewerage systems and the collection of the sewage service charge could be done commune and quartier wise.
4) Utilization of the existing drainage systems
5) Recycle of treated wastewater as the water is valuable in Niamey for its small rain
6) Discharge point of sewage and drainage
7) Step by step construction for the immediate sanitation improvement

8.1.2 Sewerage / Drainage Zone

Based on the fundamentals in Chapter 8.1.1, sewerage facility planning area is divided into 15 sewerage/drainage zones. Zoning of wastewater and storm water is not different. Table 8.1-1 shows each treatment zone with area and quinquennial population. Figure 8.1-1 shows sewerage/drainage zone.

Table 8.1-1 SEWERAGE/DRAINAGE ZONE

No.	Zone	Area	Population			
		(ha)	2000	2005	2010	2015
C1	Plateau I	304.1	11,296	11,384	11,174	10,995
C2	Issa Beri	162.4	10,690	10,684	10,595	10,609
C3	Deizebon	254.9	40,933	43,346	42,984	43,042
C4	Gamkalle	840.4	88,213	90,348	93,657	96,529
S1	Yantala	570.4	55,503	55,016	55,607	55,107
S2	Kouara Kano	389.9	14,383	16,219	17,853	19,059
S3	Dar Es Salam	710.8	43,977	64,158	77,953	97,973
S4	Kouara Me	777.5	96,153	112,787	119,663	134,602
S5	Bani Fandou II	515.7	63,573	73,693	84,904	93,269
S6	Talladje Koado	448.7	47,465	52,457	53,134	53,947
S7	Industrielle	342.0	7,498	7,438	7,376	7,386
S8	Karadje	435.1	28,513	33,957	40,066	44,959
S9	Gaweye	135.1	0	0	0	0
S10	Banga Bana	450.9	49,899	57,377	73,353	87,817
S11	Airport	1,290.8	24,929	27,907	33,792	38,407
	Total	7,628.7	583,025	656,771	722,111	793,701



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

Figure 8.1-1

SEWERAGE/DRAINAGE ZONE

8.2 COLLECTION SYSTEM

8.2.1 Combined Sewer 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 the 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 to utilize this system.

8.1.1 Separate Sewer System

Separate sewer system which collects wastewater and storm water in the separate conduit/pipes respectively will be planned for the area where the existing drainages are not well organized and do not exist at all such as in the future residential area. Area S1 – S11 is categorized under this collection system.

8.1.2 On-site System

In the area where urbanization is in progress, sewerage facilities are not feasible since housing of this area is not dense and installation cost of sewer conduit/pipe will be higher. In this area, sewerage-like facilities such as community plant, Jyokaso plant, septic tank, etc. are recommended with minimum sewer conduit/pipe.

8.3 DESIGN SEWAGE AND RAINFALL FLOW

8.3.1 Design Sewage Flow

Based on the framework described in Chapter 7.3, design wastewater flow is estimated according to the following procedure.

1) Domestic water consumption is calculated from population and unit water consumption of 50 lpcd for each quartier where inhabited population (night-time population) exists.
2) Commercial/industrial total use is estimated as 43% of total domestic water consumption.
3) Industrial water consumption is estimated as indicated in Chapter 7.3.4.
4) Total commercial water consumption excluding industrial use is estimated as follows.
   Total commercial water consumption = (total domestic use) x 0.43 – industrial use
5) Total commercial water consumption is assigned to each commercial quartier where inhabited population does not exist as proportional to area occupied.
6) Then collected sewage flow is estimated in each quartier or each zone by multiplying collection ratio of 0.75 to water consumption data for domestic and commercial use and 1.0 to water consumption data for industrial use.
7) As for pollutant load or concentration, COD, BOD and SS is estimated based on the discharge point concentration of 360 ppm COD, 150 ppm BOD and 600 ppm SS for domestic/commercial/industrial waste water plus non point source pollutant of 58 kg/ha/year COD, 24 kg/ha/year BOD and 105 kg/ha/year SS as indicated in Chapter 7.3.4.

Table 8.3.1 shows the estimated wastewater flow and concentration in the target year of 2015.

Table 8.3-1 PLANNING CONDITION OF SEWERAGE FACILITIES

No.	Treatment Zone	Area (ha)	Population (2015)	Wastewater Daily Ave. Flow (m^3/d)	Wastewater Daily Max Flow (m^3/d)	COD (mg/l)	BOD (mg/l)	SS (mg/l)
C1	Plateau I	304.1	10,995	1,131	1,470	380	180	680
C2	Issa Beri	162.4	10,609	753	980	380	170	660
C3	Deizebon	254.9	43,042	1,904	2,480	370	160	640
C4	Gamkalle	840.4	96,529	6,152	8,000	370	160	640
S1	Yantala	570.4	55,107	2,510	3,260	380	170	670
S2	Kouara Kano	389.9	19,059	1,188	1,540	380	180	690
S3	Dar Es Salam	710.8	97,973	4,471	5,810	370	170	650
S4	Kouara Me	777.5	134,602	5,523	7,180	370	160	640
S5	Bani Fandou Ⅱ	515.7	93,269	3,810	4,950	370	160	640
S6	Talladje Koado	448.7	53,947	2,539	3,300	370	170	650
S7	Industrielle	342.0	7,386	2,322	3,020	370	160	640
S8	Karadje	435.1	44,959	3,288	4,270	370	160	640
S9	Gaweye	135.1	0	NA	NA	NA	NA	NA
S10	Banga Bana	450.9	87,817	3,293	4,280	370	160	640
S11	Airport	1,290.8	38,407	2,527	3,290	400	200	750
		7,628.7	793,701	41,411	53,830			

Note: As the sewerage system already exists in S9 Gaweye zone, S9 zone is excluded from the Master Plan.

8.3.2 Design Rainfall Flow

Rainfall flow is calculated based on the rational formula as indicated in Chapter 7.3 for evaluating the capacity of the existing drainage and planning the new drainage. Runoff coefficient in each drainage zone is summarized in Table 8.3-2.

Table 8.3-2 RUNOFF COEFFICIENT IN EACH ZONE

No.	District	Area (ha)	Runoff Coeff.	No.	District	Area (ha)	Runoff Coeff.
C1	Plateau I	304.1	0.35	S5	Bani Fandou II	515.7	0.65
C2	Issa Beri	162.4	0.50	S6	Talladje Koado	448.7	0.55
C3	Deizebon	254.9	0.66	S7	Industriell	342.0	0.65
C4	Gamkalle	840.4	0.57	S8	Karadje	435.1	0.65
S1	Yantala	570.4	0.50	S9	Gaweye	135.1	NA
S2	Kouara Kano	389.9	0.41	S10	Banga Bana	450.9	0.51
S3	Dar Es Salam	710.8	0.48	S11	Airport	1,290.8	0.58
S4	Kouara Me	777.5	0.48				

8.4 FACILITY PLANNING / PRELIMINARY DESIGN

8.4.1 Trunk Drainage Facility

Existing drainage capacity was evaluated. 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 drainage does not exist. Table 8.4-1 shows the list of additional and newly installed trunk drainage facility.

Table 8.4-1 LIST OF TRUNK DRAINAGE FACILITY

Drainage Conduit	C1	C2	C3	C4	S1	S2	S3	S4	S5	S6	S7	S8	S10	S11	Total
U type W * H (mm)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)
U600*600	600														600
U800*600					420										420
U800*800	1,170				700	320									2,190
U800*1600								850							850
U900*900	1,280		380		1,180										2,840
U1000*800						250									250
U1000*900					200										200
U1000*1000	870	1,680					1,300		330						4,180
U1000*1100					800										800
U1000*1200			410												410
U1100*1000	1,430	910			1,400			500							4,240
U1100*1100				700	720										1,420
U1200*1000	370					780					700				1,850
U1200*1200	1,150		710		1,250		1,050								4,160
U1300*1200					1,090	100	1,280		280				970		3,720
U1300*1300	250				1,420		1,980	700	280			600			5,230
U1400*1100											200				200
U1400*1300				1,100		950									2,050
U1400*1400		2,190	690				2,840		660						6,380
U1500*1000											850				850
U1500*1100											450				450
U1500*1300								1,050				1,250	1,000		3,300
U1500*1400		680		700			2,430		350						4,160
U1500*1500	820			980					1,460		620	1,000			4,880
U1500*2000								800							800
U1600*1100					280										280
U1600*1200					750	230									980
U1600*1500					1,060	3,380	940					1,100			6,480
U1600*1600			310		920		300								1,530
U1600*1800								400							400
U1700*1500											970		1,650		2,620
U1700*1600			510		900								500		1,910
U1700*1700					790										790
U1700*1800								770							770
U1800*1500					340	250									590
U1800*1700	470		410												880
U1800*1800						1,250				450					1,700
U1800*2000	200														200
U1900*1800							1,050								1,050
U2000*1100				1,200							650				1,850

U2000*1200												1,250			1,250
U2000*1300				600											600
U2000*1500										1,250					1,250
U2000*1700							730								730
U2000*1800							270	500							770
U2000*1900				750											750
U2000*2000								620							620
U2100*2000				1,400				760							2,160
U2200*1500										50					50
U2200*1800							1,180								1,180
U2200*1900									720						720
U2200*2000							400								400
U2300*1300						1,550									1,550
U2300*1500											550				550
U2300*1800							750								750
U2300*2000									150						150
U2300*2600								2,000							2,000
U2500*1300										2,480					2,480
U2500*1500											1,380			550	1,930
U2500*1800								1,750							1,750
U2500*2000							730								730
U2500*2200									430						430
U2500*2300								920							920
U2500*2700								1,480							1,480
U2600*1900									1,530						1,530
U2600*2600															0
U2700*1800								750							750
U2700*2000								550						1,350	1,900
U2800*1800										800					800
U2800*2000										1,150					1,150
U2800*2100									500						500
U2900*2700									1,350						1,350
U3000*1400										600					600
U3000*1500					1,450										1,450
U3000*1600										1,450					1,450
U3000*1700						50									50
U3000*2100									1,150						1,150
U3000*2300								720				950			1,670
U3200*3000									360			1,000			1,360
U3300*2600								820							820
U3400*2000								600							600
U3400*2500														900	900
U3400*2600															0
U3400*2700								270							270
U3500*1800											80				80
U3500*2200									3,350			400			3,750
U3500*3000									350						350
U3700*770				1,700											1,700
U3700*1100				1,050											1,050
U4000*2000										1,350					1,350
U5000*1600													3,300		3,300
U5000*1900													900		900
U5500*1600													1,000		1,000
Total	8,610	5,460	3,420	10,180	15,670	9,110	17,230	16,810	13,250	9,580	6,450	7,550	9,320	2,800	135,440

8.4.2 Trunk Sewer Pipe

For the combined sewer system zones, interceptors were planned to collect and transport wastewater from 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. Table 8.4-2 show list of trunk sewer pipe.

Table 8.4-2 LIST OF TRUNK SEWER PIPE

Sewer Pipe	C1	C2	C3	C4	S1	S2	S3	S4	S5	S6	S7	S8	S10	S11	Total
Polyvinyl Chloride Pipe Dia.(mm)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)	Length (m)
150	1,500	30			16,220	9,110	17,400	17,910	9,190	9,830	6,450	3,950	3,420	2,800	97,810
200							2,900	50	4,550			900	5,000		13,400
250			450		3,100				360	1,350	850	1,000	1,600		8,710
300				1,000											1,000
400				1,800											1,800
Total	1,500	30	450	2,800	19,320	9,110	20,300	17,960	14,100	11,180	7,300	5,850	10,020	2,800	122,720

8.4.3 Intermediate Pumping Station

Following pumping stations are required considering geological condition of sewer/drainage and treatment plant location. Pump type is submersible type without grit removal chamber.

Table 8.4-3 LIST OF PUMPING STATION

Pumping Station	Treatment Zone	Wastewater Hourly Max Flow (m^3/min)	No. of Pump	Pump Capacity (m^3/min)	Pump Head (m)	Motor kW
C4 P.S.	Gamkalle	18.4	3+1	6.2	10	18.5
S3 P.S.	Dar Es Salam	1.2	1+1	1.2	10	3.7
S5 P.S.	Bani Fandou II	3.1	1+1	3.1	10	11
S6(No.1) P.S.	Talladje Koado	1.5	1+1	1.5	10	5.5
S6(No.2) P.S.	Talladje Koado	0.5	1+1	0.5	10	2.2
S10 P.S.	Banga Bana	1.8	1+1	1.8	10	7.5

Note: 3+1 shows 3 sets of operating pump and 1 set of stand-by pump.

8.4.4 Waste Water Treatment Plant

UASB plant shall be located in each sewerage zone except for S11 according to the result of alternatives study in Chapter 7.3. For S11 zone, stabilization pond system shall be applied as the WWTP area is available near the zone and therefore longer sewer line is not required. 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 wastewater as much as possible.

Design capacity is standardized based on the daily maximum flow as in Table 8.4-4.

Table 8.4-4 LIST OF WASTE WATER TREATMENT PLANT

No.	Treatment Zone	Wastewater Daily Max Flow (m^3/d)	Design Capacity (m3/d)	Treatment Process
C1	Plateau I	1,470	1,600	UASB
C2	Issa Beri	980	1,000	UASB
C3	Deizebon	2,480	2,500	UASB
C4	Gamkalle	8,000	8,000	UASB
S1	Yantala	3,260	3,500	UASB
S2	Kouara Kano	1,540	1,600	UASB
S3	Dar Es Salam	5,810	6,000	UASB
S4	Kouara Me	7,180	8,000	UASB
S5	Bani Fandou II	4,950	5,000	UASB
S6	Talladje Koado	3,300	3,500	UASB
S7	Industrielle	3,020	3,500	UASB
S8	Karadje	4,270	5,000	UASB
S10	Banga Bana	4,280	5,000	UASB
S11	Airport	3,290	3,300	Stabilization Pond

Note: As the sewerage systems already exist in S9 Gaweye zone, S9 zone is excluded from the Master Plan.

Storm water flow introduced into WWTP through the interceptors in the combined sewer system zones will be bypassed to the final polishing pond if the flow is beyond the design capacity of the UASB reactor.

(1) Design Parameter for the UASB Process

Design parameter of each component of the UASB process is as follows.

1) Inlet Chamber

- Retention time shall be 10 seconds.

2) Screen Chamber

- No. of channels: 2 including one stand-by, each channel is equipped with manual bar racks

3) Pump Pit
- Retention time shall be 10 minutes.

4) Feed Pump
- No. of pumps: 3 including one set stand-by
- Total pumping capacity shall be based on the peak hourly flow rate.

5) Grit Chamber

- No. of channels: 2 including one stand-by
- Max. Channel velocity shall be 0.3 m/s.
- Grit settling velocity shall be 0.017 m/s.

6) Division Box
- Retention time shall be 10 seconds.

7) Distribution Box
- Retention time shall be 10 seconds.

8) UASB Reactor
- Average liquid upflow velocity: 0.5 m/h
- Maximum liquid upflow velocity: 0.8 m/h
- Peak liquid upflow velocity: 1.5 m/h
- SRT (Sludge Retention Time): This depends on temperature, hereby 31 days are taken at $24^{o}C$
- Height of reactor is set at 4 m and height of gas collector is set at 1.4 m.
- To satisfy the peak upflow velocity of 1.5 m/h, reactor surface area is decided.
- Two reactors are planned from the view point of operation flexibility.
- HRT (Hydraulic Retention Time) will be 6 – 10 hours.

9) Sludge Drying Bed
- Sludge drying bed is designed considering climate in Niamey.
- Sludge concentration: 80 kg-TSS/m^3
- Water content in the dried solids: 40 %
- Sludge bed load: 2 kg-TSS/m^2/d

10) Final Polishing Pond
- Total retention time: 0.5 days
- To be split into 3 compartments, first one for floating microphytes, second for rooted microphytes and third for fish culture.

11) Chlorination
- Chlorine injection rate: 5 ppm

12) Biogas Production
- Production ratio: 0.2 m^3/kg COD removed as 75% methane gas
- Expected COD reduction: 60 -70 %

(2) Design Parameter for Stabilization Pond System

1) Anaerobic Pond
- Volume load: 300 gBOD/m^3/d or minimum 1 day retention time
- Water depth: 4 m
- Expected BOD reduction: 70 %

2) Facultative Pond
- Surface load: 360 kgBOD/ha/d
- Water depth: 1.5 m
- Expected BOD reduction: 65 %

3) Primary/Secondary Maturation Pond
- Retention time for each pond: 5 days
- Water depth: 1.0 m

(3) Design Results of the Waste Water Treatment Plant

As the design results of the wastewater treatment plant, required area, expected sludge generation and expected gas generation are summarized in Table 8.4-4.

Table 8.4-5 SUMMARY OF DESIGN FOR WASTE WATER TREATMENT PLANT

No.	Treatment Zone	WW Daily Max Flow (m^3/d)	Design Capacity (m^3/d)	Treatment Process	Area Req'd (m^2)	Sludge Gene. (m^3/Mon.)	Biogas Gene. (m^3/day)
C1	Plateau I	1,470	1,600	UASB	2,500	30.5	71.2
C2	Issa Beri	980	1,000	UASB	1,600	20.3	47.5
C3	Deizebon	2,480	2,500	UASB	4,000	51.4	120.2
C4	Gamkalle	8,000	8,000	UASB	12,600	165.8	387.7
S1	Yantala	3,260	3,500	UASB	5,500	67.6	158.0
S2	Kouara Kano	1,540	1,600	UASB	2,500	31.9	74.6
S3	Dar Es Salam	5,810	6,000	UASB	9,500	120.4	281.6
S4	Kouara Me	7,180	8,000	UASB	12,600	148.8	348.0
S5	Bani Fandou II	4,950	5,000	UASB	8,000	102.6	239.9
S6	Talladje Koado	3,300	3,500	UASB	5,500	68.4	159.9
S7	Industrielle	3,020	3,500	UASB	5,500	62.6	146.4
S8	Karadje	4,270	5,000	UASB	8,000	88.5	207.0
S10	Banga Bana	4,280	5,000	UASB	8,000	88.7	207.4
S11	Airport	3,290	3,300	Stabilization Pond	38,000	NA	NA

Note: 1) Sludge generated is based on water content of 40% after sludge drying bed.
2) Composition of gas generated is 75 vol% CH_4 with inert of balance.

CHAPTER 9. SOLID WASTE MANAGEMENT MASTER PLAN

CHAPTER 9. SOLID WASTE MANAGEMENT MASTER PLAN

9.1 CONCEPT FOR THE SOLID WASTE MANAGEMENT MASTER PLAN

From the study that has been made, the problem on solid waste management has been summarized as follows:

- Existing capacity to collect and transport the household waste is only for 21% of generated waste. Even if CUN keeps this capacity of 21%, uncollected waste amount will increase according to the population growth as shown in Figure 9.1-1.
- If the current situation is left as it is, this low capacity rate will lead to more deterioration of sanitary environment in Niamey since the existing equipment has reached approximately at their working life limit.
- Industrial waste is not collected. It is burnt or disposed in the surrounding area.
- No separation of infectious waste is being done at the hospitals. Hazardous waste is thrown and dumped with domestic waste. No disposal site is being designated for such purposes.

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

- The proposed collection system that is analyzed in Alternative Study, Chapter 7.4, is showing lower costs. It shall be introduced for household waste. The proposed system shall consist of 2 components, one is privatized pre-collection with sand recycle, and other is transport of container by CUN and Communes.
- To help the proposed system, the present system shall keep the capacity at 21% of generated waste. Where the proposed collection system will be introduced, it will replace the existing collection system. Therefore the area/population covered by the present system will decrease. CUN and Communes shall increase the service to lower income area where it is probably difficult to introduce the privatized pre-collection. Finally total amount of waste collection is planned as shown in Figure 9.1-2.
- Container shall be provided and industrial solid waste collection service shall be introduced.
- Infectious waste shall be collected separately from household similar waste. Infectious waste has to be incinerated, Ash from the incineration shall be transported as well as household similar waste from the hospital to landfill site.

The planned waste flow in 2015 is as shown in Figure 9.1-3 and 9.1-4. The detail plan is shown in the following sub-chapters and sections.

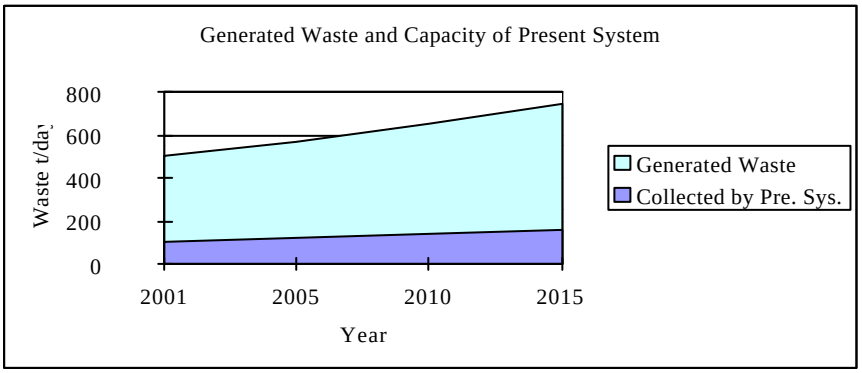


Figure 9.1-1 GENERATED WASTE FORECAST AND PLANNED COLLECTED WASTE BY PRESENT SYSTEM

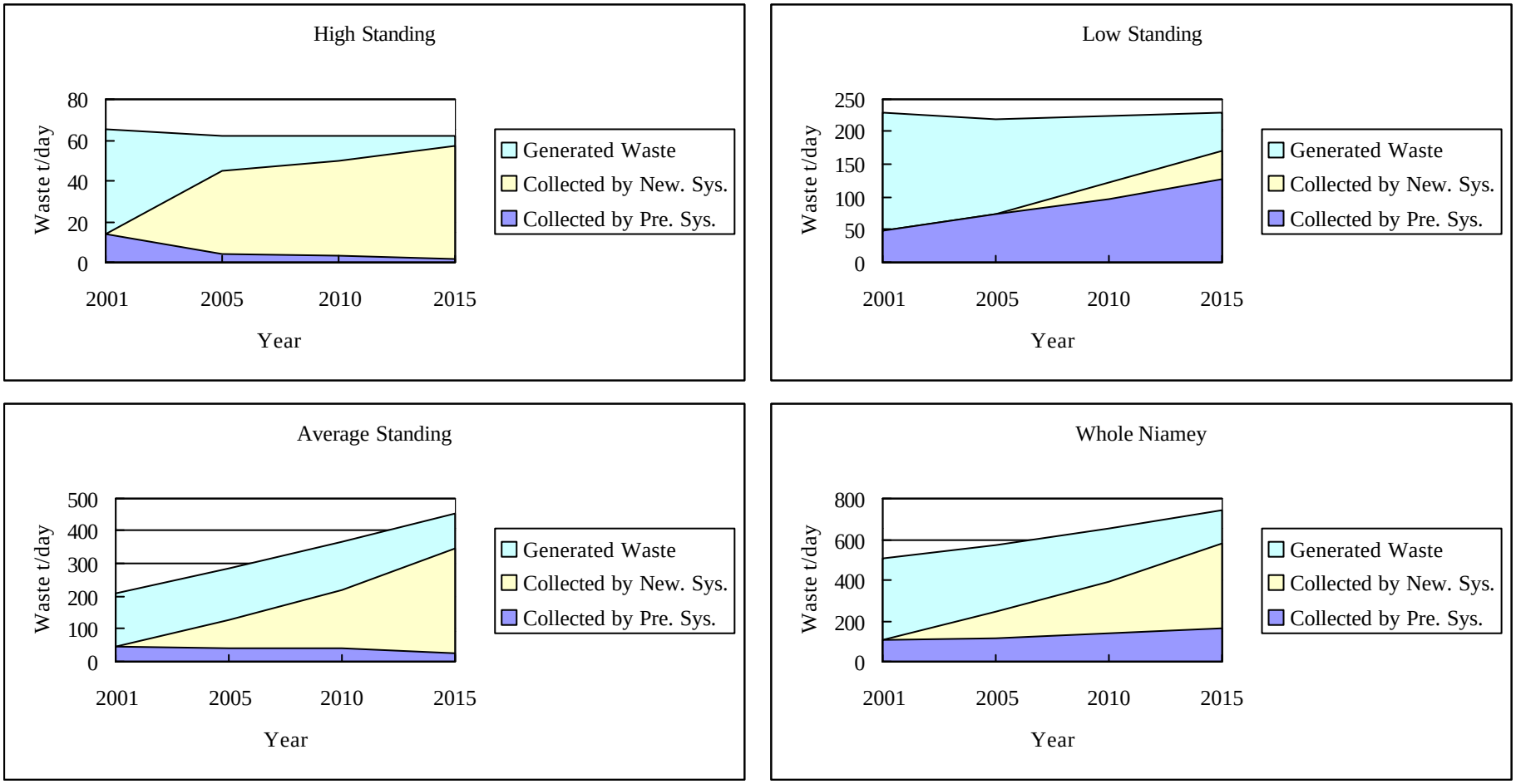
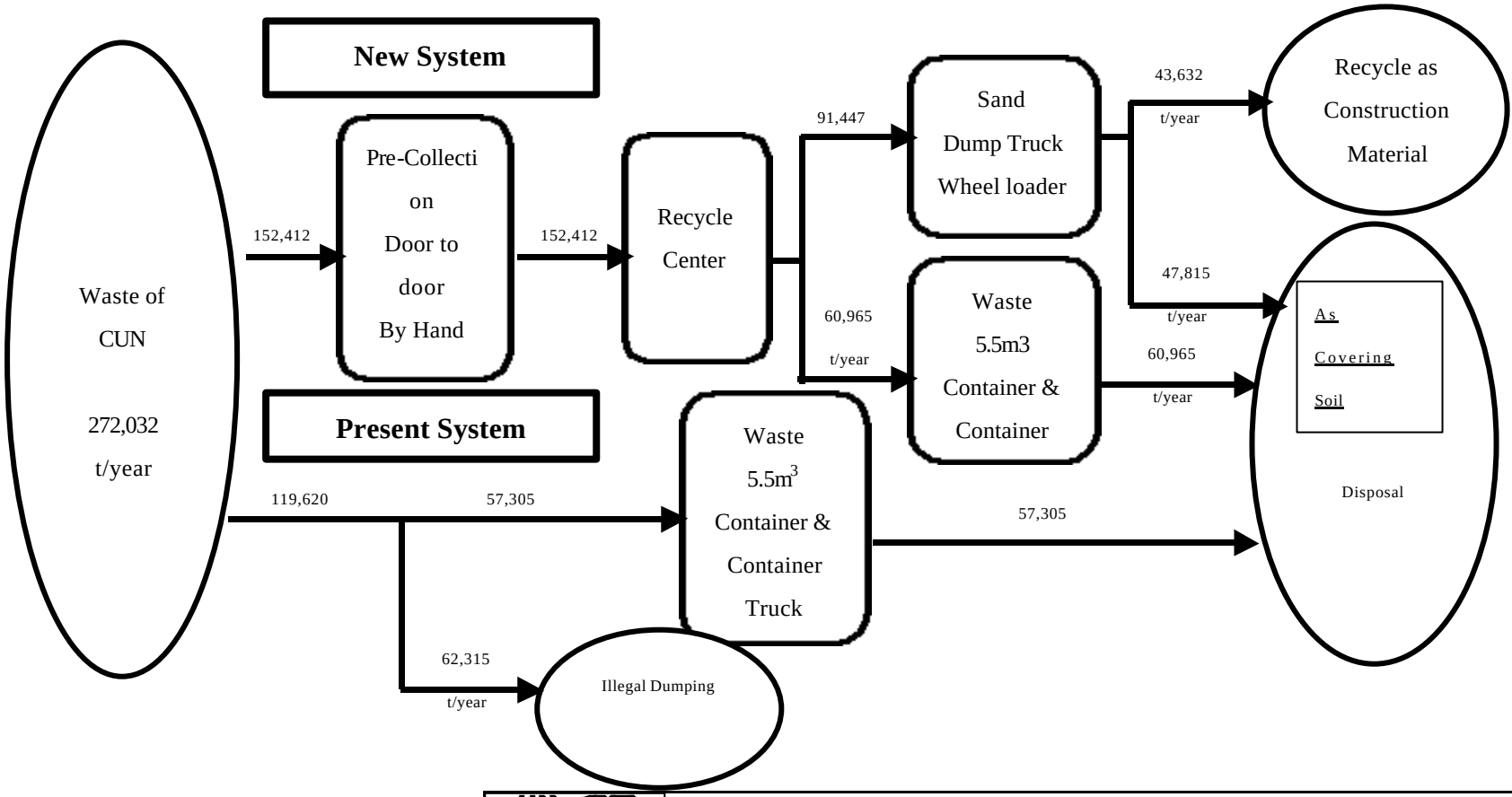


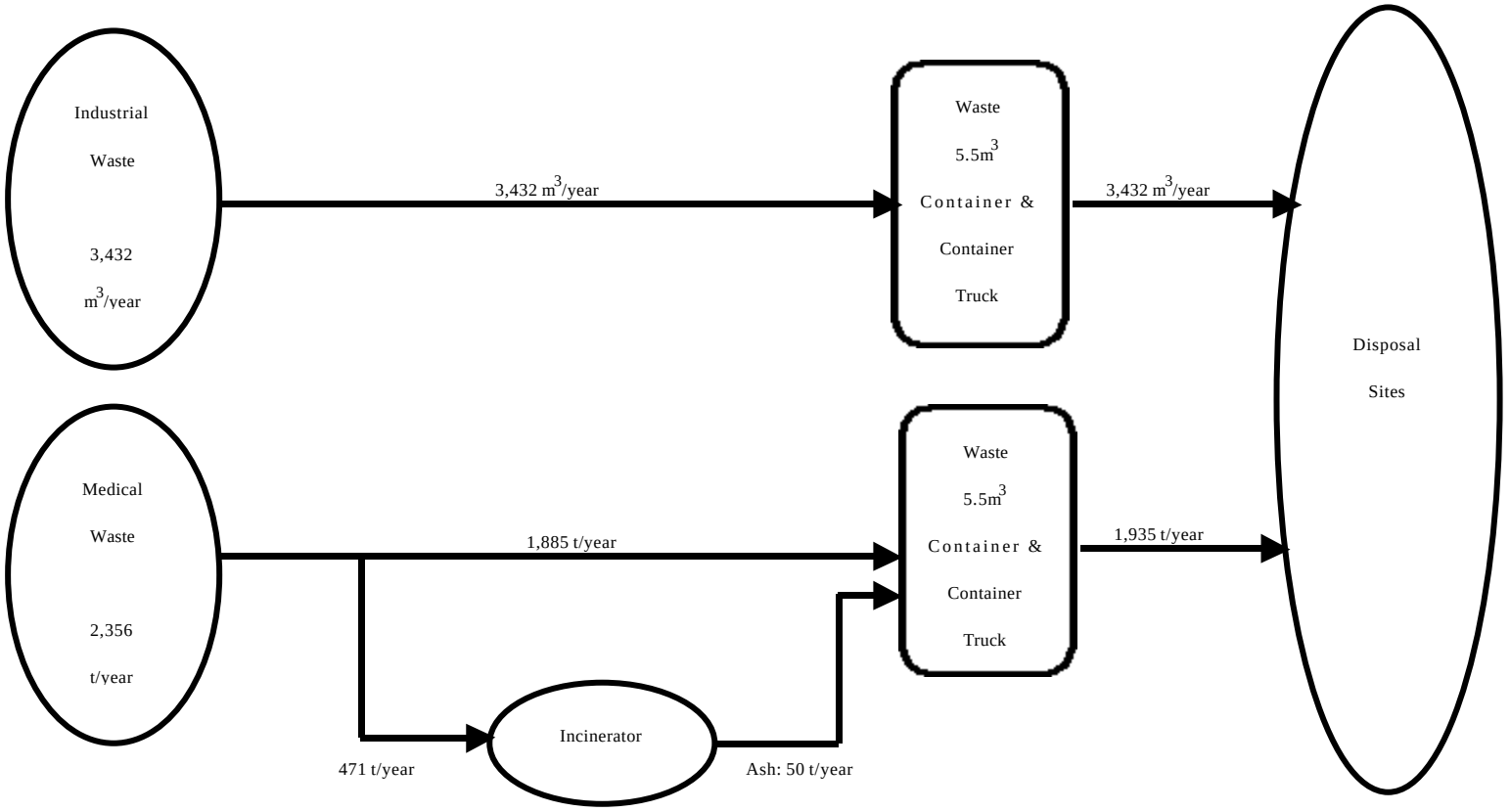
Figure 9.1-2 GENERATED WASTE FORECAST, PLANNED COLLECTED WASTE BY NEW SYSTEM AND PRESENT SYSTEM



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

HOUSEHOLD WASTE FLOW IN 2015

Figure 9.1-3



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

INDUSTRIAL AND MEDICAL WASTE FLOW IN 2015

Figure 9.1-4

9.2 DOMESTIC WASTE

9.2.1 Target Collection Rate

Following the conclusions of the survey, sampling and weighing operations made within the framework of this study, roughly 21% of waste produced in the town of Niamey are removed (see Appendix Q: separate report on the quantity and composition of household waste generated in the town of Niamey). Within the framework of this study, will consider that the proportions of removed waste will increase in coming years. Given the fact that the present waste management is different from one district to the other, the following proportions will be the base of our study:

Table 9.2-1 RATIO OF COLLECTED AND REMOVED WASTE QUANTITIES

Income bracket	Type of housing	Year 2001		Year 2005		Year 2010		Year 2015	
		Quantity of waste (t/year)	Propor-tion removed	Quantity of waste (t/year)	Propor-tion removed	Quantity of waste (t/year)	Propor-tion removed	Quantity of waste (t/year)	Proportion removed
High Standing	MDQ	23,548	21 %	22,652	70 %	22,463	80 %	22,493	90 %
	Sub-Total	23,548		22,652		22,463		22,493	
Middle Standing	PRP2	68,454	21 %	83,476	45 %	98,338	60 %	115,060	75 %
	NWQ	7,500	21 %	19,082	45 %	28,050	60 %	37,384	75 %
	PLN	712	21 %	2,375	45 %	7,706	60 %	12,994	75 %
	Sub-Total	76,666		104,934		134,094		165,437	
Low Standing	TRD	21,498	21 %	21,699	40 %	22,902	55 %	23,835	75 %
	PRP1	27,878	21 %	28,921	40 %	28,681	55 %	28,719	75 %
	SPT	6,716	21 %	5,415	40 %	5,783	55 %	6,204	75 %
	UVL	24,052	21 %	23,661	40 %	24,608	55 %	25,344	75 %
	OUT	3,837	21 %	0	-	0	-	0	-
	Sub-Total	83,982		79,695		81,974		84,102	
TOTAL		184,196		207,281		238,531		272,032	

On the basis of projections made on the population together with the quantities of waste produced in coming years (see chapter 7.4), we can assess the quantities of waste which will be removed in the years 2005, 2010 and 2015. Table 9.2-2 presents these waste quantities:

Table 9.2-2 ESTIMATION OF COLLECTED AND REMOVED WASTE QUANTITIES

Income bracket	Type of housing	Year 2001		Year 2005		Year 2010		Year 2015	
		Removal rate	Quantity removed (t/year)	Removal rate	Quantity removed (t/year)	Removal rate	Quantity removed (t/year)	Removal rate	Quantity removed (t/year)
High Standing	MDQ	21%	4,945	70%	15,856	80%	17,971	90%	20,244
	Sub-Total		4,945		15,856		17,971		20,244
Middle Standing	PRP2	21%	14,375	45%	37,564	60%	59,003	75%	86,295
	NWQ	21%	1,575	45%	8,587	60%	16,830	75%	28,038
	PLN	21%	150	45%	1,069	60%	4,624	75%	9,745
	Sub-Total		16,100		47,220		80,456		124,078
Low Standing	TRD	21%	4,515	40%	8,679	55%	12,596	75%	17,877
	PRP1	21%	5,854	40%	11,569	55%	15,774	75%	21,539
	SPT	21%	1,410	40%	2,166	55%	3,181	75%	4.653
	UVL	21%	5,051	40%	9,464	55%	13,534	75%	19,008
	OUT	21%	806	-	0	-	0	-	0
	Sub-Total		17,636		31,878		45,085		63,076
TOTAL		21%	38,681	46%	94,955	60%	143,513	76%	207,398

In taking into account the composition of waste, which presents a high component of sand (see table above), 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 charge to transport the remaining waste to the municipal dumping site. The recycled sand can be used by municipal services as backfilling material. This will enable to put an end to the present method of waste removal which consists of using waste as filling materials.

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

Thus obtain a reduction of the remaining waste which will be removed and tipped out at the level of the municipal landfill site.

Table 9.2-3 WASTE QUANTITIES AND COMPOSITION

	Component	%	Quantity t/a		
			2005	2010	2015
1	Paper et Cardboard	1.12%	2,329	2,680	3,056
2	Plastic	3.35%	6,944	7,991	9,114
3	Textiles & rag	0.53%	1,103	1,269	1,447
4	Leather & rubber	0.00%	0	0	0
5	Wood	0.73%	1,518	1,747	1,992
6	Organic	19.10%	39,599	45,569	51,969
7	Fines (<5mm)	71.09%	147,347	169,561	193,375
8	Metal	0.58%	1,209	1,391	1,587
9	Glass	0.06%	132	151	173
10	Stones	3.43%	7,101	8,172	9,319
	Total	100.00%	207,281	238,531	272,032

9.2.2 Discharge and Pre-Collection

The Pre-Collection System described in chapter 7.4.2 as Alternative 3 shall be introduced in step by step in order to improve the SMW system. Since the pre-collection system (hereinafter referred as "new system") requires the payment of pre-collection fee to the beneficiary, it is difficult to introduce it for whole Niamey at the same time. Therefore the introduction should be started from high and middle income classes areas. And for the area not to be introduced the new system, actual collection system (hereinafter referred as "present system") should be continued by CUN and Communes. Furthermore it is expected that some part of the resident who does not join the new system by reasons of finance and/or habit having been formed for long time. The present collection system shall be kept in these population groups. In conclusion two collection ways will exist in Niamey. It is unavoidable until the system completed.

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 proposed system. The collection rate will increase and will be covered by proposed system whose cost is lower for CUN and Communes. The improvement of waste collection according to the introduction of proposed system will be as shown in Figure 9.2-1 when this Master Plan is executed.

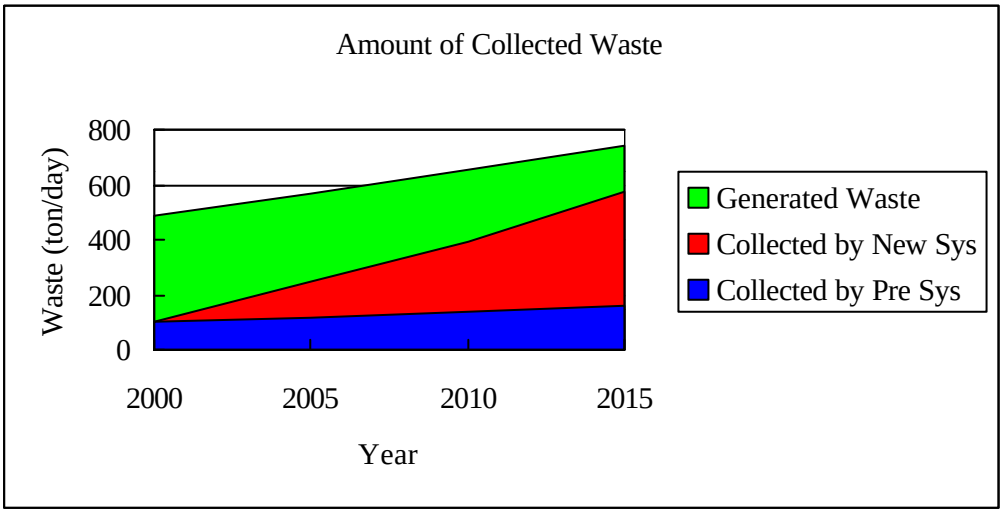


Figure 9.2-1 INCREASE OF WASTE COLLECTED AMOUNT

(1) Introduction Plan of New System

Taking into consideration the above situation and the target collection rate in this Master Plan mentioned in 9.2.1, the proposed system introduction have been planned according to the planning policies as follows and as shown in Figure 9.2-2 and Figure 9.2-3. The planned quartiers are

shown in Figure 9.2-4. In Appendix J-4 are listed in detail the planed quartiers where the proposed system shall be introduced.

- Although the proposed system starts for high and middle income classes areas in 2005, for low income class area in 2010 since the low income class area which seems difficult to collect the fee had better be introduced after the system penetrated into the citizen of Niamey.
- Even for high and middle income classes areas, it is better to introduce the new system step by step to divide the capital cost into several years. The approximate target introduction rate population wise is set as shown bellow.

High income class area:	80% (2005)	90% (2010)	100% (2015)
Middle income class area:	70% (2005)	80% (2010)	95% (2015)
Low income class area:	0% (2005)	30% (2010)	40% (2015)

- The rate (Join Rate) of resident who does not join the proposed system is estimated as follows. Those are the target figures to make the pre-collection contract between resident and pre-collector in the introduced area.

High income class area:	80% (2005)	85% (2010)	90% (2015)
Middle income class area:	45% (2005)	60% (2010)	75% (2015)
Low income class area:	0% (2005)	40% (2010)	50% (2015)

- Step by step introduction is done according to priority. For high and middle income classes areas, quartiers having larger population density are introduced earlier since the living environment impact from the scattered waste is larger in congested areas. However the quartiers of Kouara Kano and its extension are introduced earlier (in 2005) since they are served by the pre-collection and pay the collection fee. They are expected to introduce the proposed system easily.
- For low income class area, the quartiers located in city central area, where not only the population are congested but also the public and business activities are more, are prior.

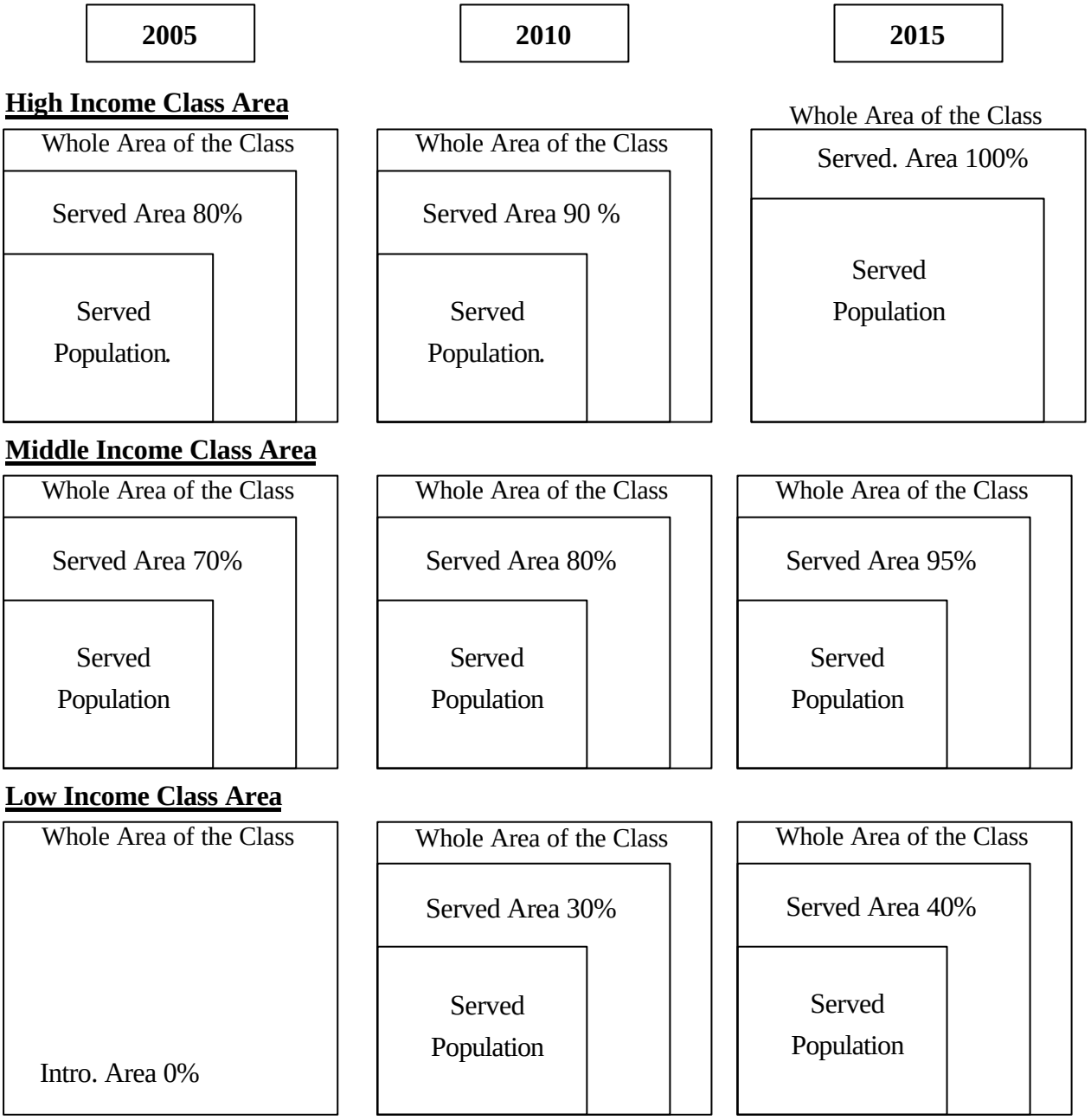
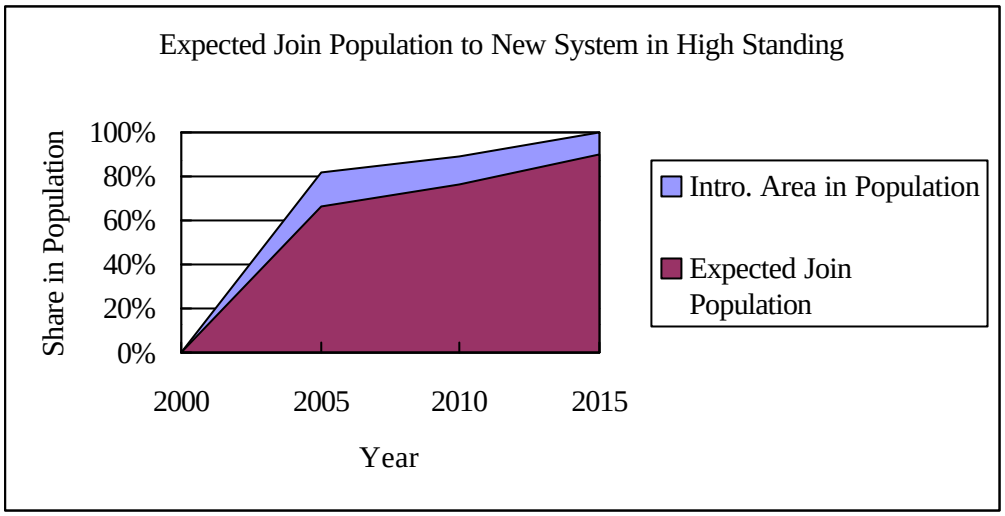
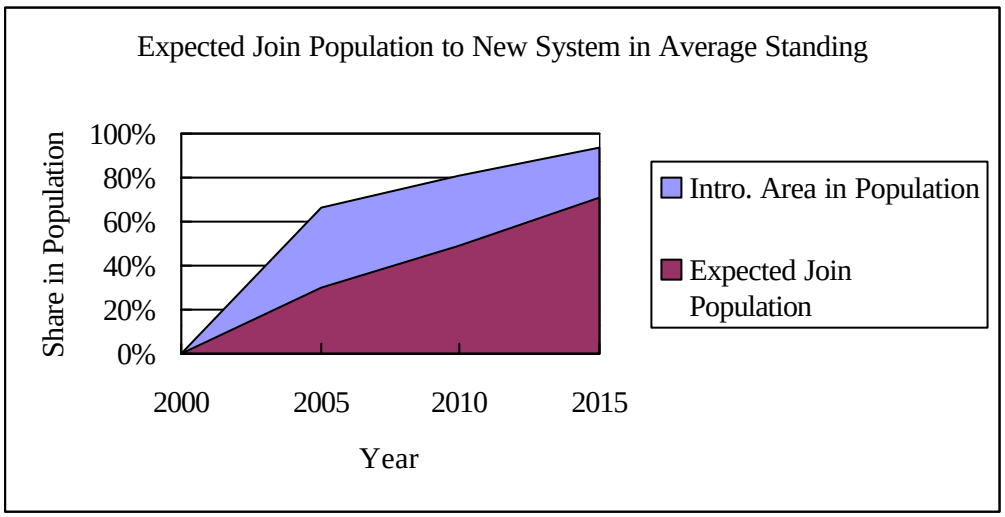


Figure 9.2-2 SCHEDULE FOR NEW SYSTEM INTRODUCTION





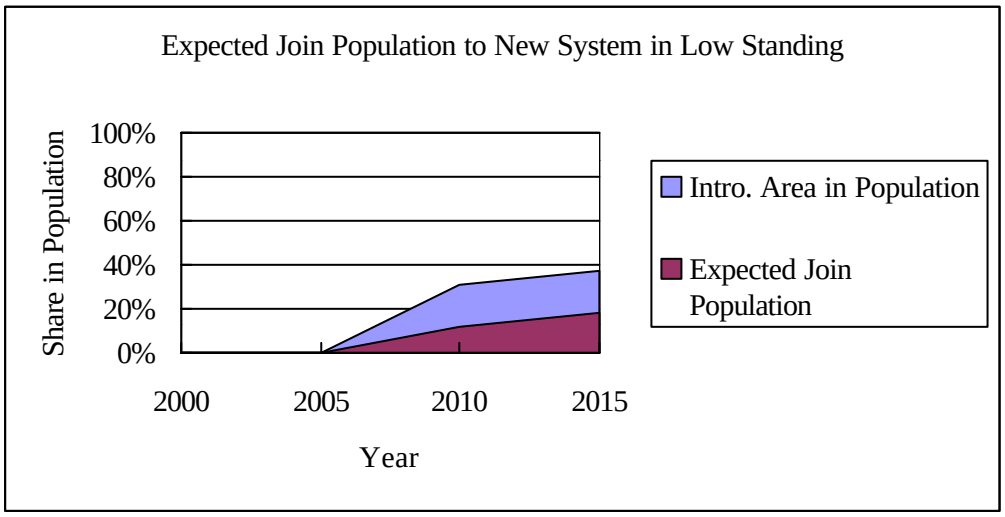


Figure 9.2-3 SHARE OF NEW SYSTEM INTRODUCED POPULATION PER INCOME CLASS

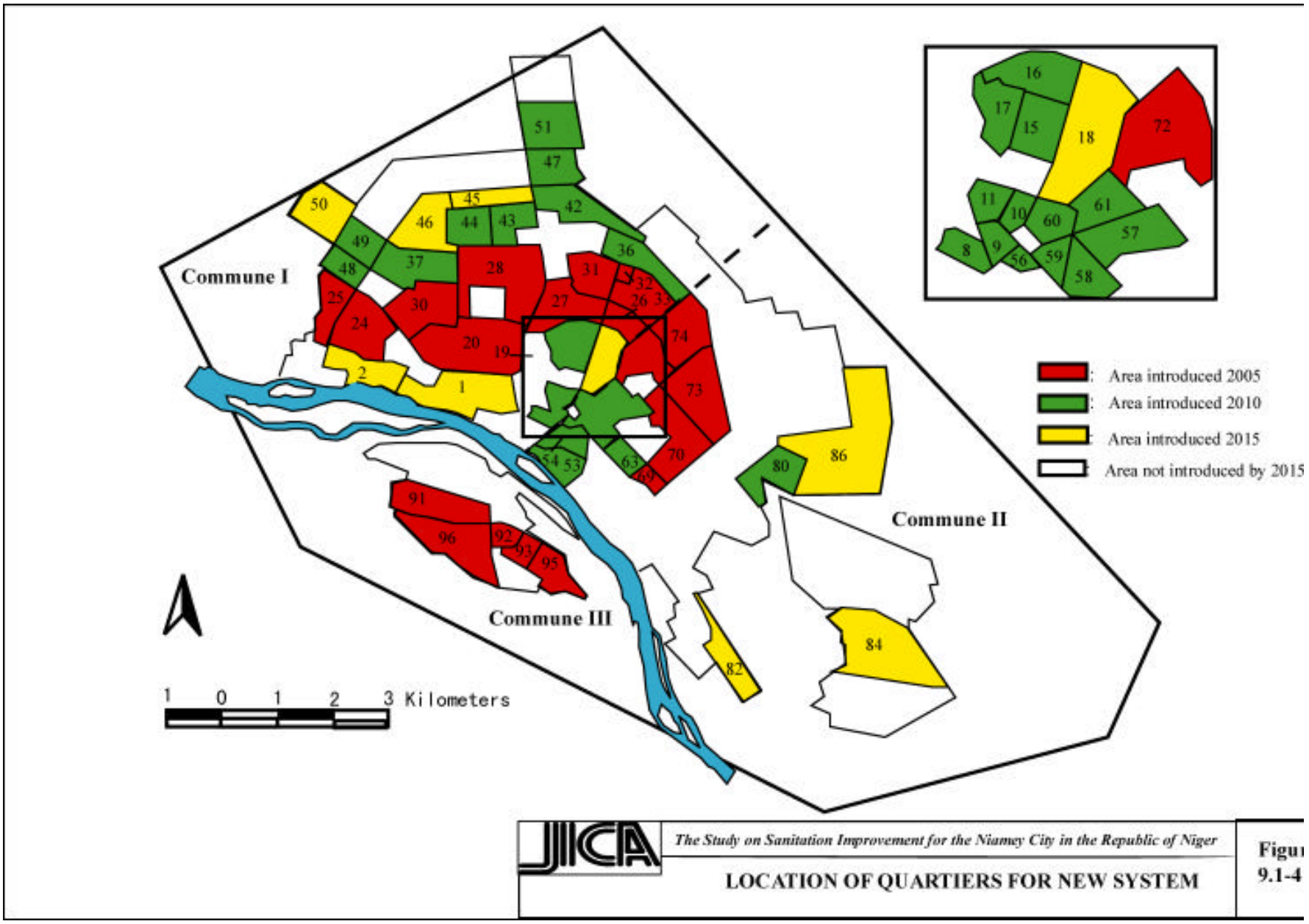


Figure 9.2-4 LOCATION OF THE QUARTIERS CONSIDERED FOR THE NEW SYSTEM

Table 9.2-4 TOTAL POPULATION TO BE SERVED BY THE NEW SYSTEM

Item In whole Niamey	2005 Population served	2010 Population served	2015 Population served
Total population served	322,204	562,775	763,732
Ground Total Population	757,191	871,346	993,724
Collection Rate for served population	43%	65%	77%

As described before, a part of the resident is expected not to be served by the proposed system. The actual target population to design necessary equipment and facilities shall be estimated according to the collection rate mentioned in the planning policies of proposed system. The planned actual target population is shown in detail in Appendix J-5 as population to be served by the proposed system.

(2) Planed Population to be Collected by Present System

For areas where the proposed system will not be introduced the current (present) collection shall be maintained and improved so that higher collection rates would be achieved. The planned population for the present collection system is shown in Appendix J-6.

(3) Present and New Collection System

The collection system in Niamey shall consider two systems of waste collection and discharge as described in the above chapters. The share of each discharge way in whole population in Niamey is summarized in Table 9.2-5.

Table 9.2-5 SERVED POPULATION BY NEW AND PRESENT SYSTEMS

Year	Total Popu.	New system for waste collection (Pre-collection)					Present System for waste collection (Direct Discharge)		
		Consideration rate	Considered population	Collection rate	Served population	Share within the total population	Considered population	Served population	Share within the total population
Year 2005	757,191	43%	322,204	52%	168,771	22%	588,420	588,420	78%
Year 2010	871,346	65%	562,775	60%	337,545	39%	533,801	533,801	61%
Year 2015	993,724	77%	763,732	73%	556,755	56%	436,969	436,969	44%
Breakdown									
Year 2005									
High Income Class	82,747	82%	67,941	80%	54,353	66%	28,394	28,394	34%
Middle Income Class	383,319	66%	254,263	45%	114,418	30%	268,901	268,901	70%
Low Income Class	291,125	0%	0	0%	0	0%	291,125	291,125	100%
Year 2010									
High Income Class	82,058	89%	72,983	85%	62,036	76%	20,022	20,022	24%
Middle Income Class	489,841	81%	397,961	60%	238,777	49%	251,064	251,064	51%
Low Income Class	299,447	31%	91,831	40%	36,732	12%	262,715	262,715	88%
Year 2015									
High Income Class	82,167	100%	82,167	90%	73,950	90%	8,217	8,217	10%
Middle Income Class	604,336	94%	568,089	75%	426,067	71%	178,269	178,269	29%
Low Income Class	307,221	37%	113,476	50%	56,738	18%	250,483	250,483	82%

(4) Pre-Collection Plan

1) Pre-Collection Method

The pre-collection shall be managed for every recycling center as explained in the following chapter 9.2.2(5). Pre-collecting workers (pre-collectors) visit households which are served by the new system at the frequency of 6 days a week (fq=6) except Sunday to collect the generated waste. The collected waste shall be taken to the recycling center where sand will be out sorted by pre-collectors. All the works shall be done manually as shown in Figure 9.2-5.

The required personnel for one pre-collection area is presented in Table 9.2-6. The number of pre-collector which shall be fixed by target population is shown in the table the model number required for average pre-collection area (population: 7,500, area: approx. 100ha). Considering a productivity of pre-collector as about 500 kg/worker.day, one pre-collector shall be associated to approximately 670 persons of resident. The clerk shown in the table shall be based at recycling center to record incoming waste amount and to monitor the stored waste and sand in the center.

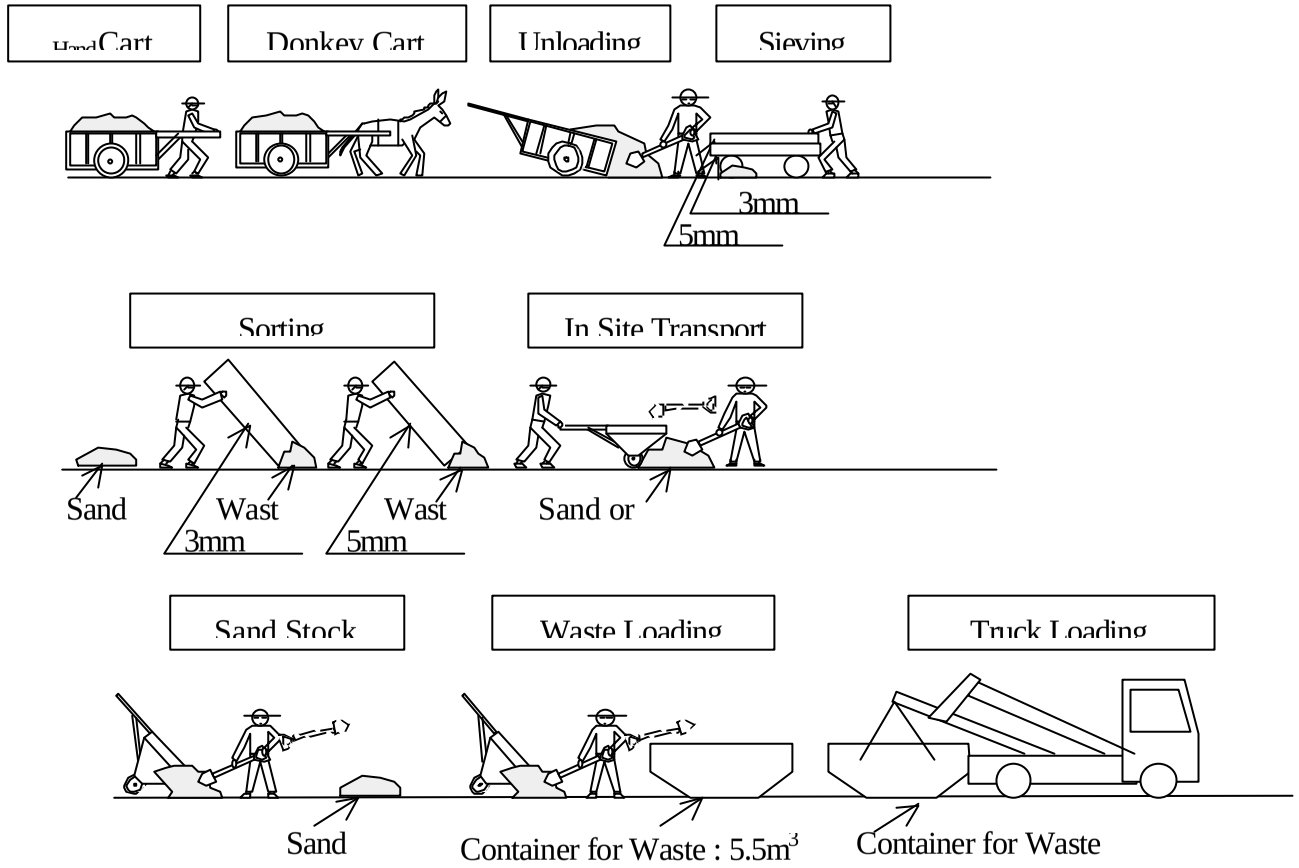
Table 9.2-6 REQUIRED PERSONNEL FOR PRE-COLLECTION AND SAND SORTING

Item	Unit	Quantity
Foreman for Pre-collection	Person	2
Clerk	Person	1
Pre-collector (Worker)	Person	13
Total	Person	16

Workers shall be equipped with tools as shown in Table 9.2-7. Practically one team by two workers should be formed to expect stable and effective services and the team shall not only collect the waste from the households but also pick the waste in streets up. Sieve in the table is applied for manual sand sorting. To sort sand out effectively, 3mm and 5mm sieves shall be prepared.

Table 9.2-7 REQUIRED TOOL BY ONE WORKER

Item	Unit	Quantity
Working uniform	LS	0.5
Shovel	pcs	0.5
Rake	pcs	0.5
Boom/Brush	pcs	0.5
Sieve	pcs	0.5
Hand Cart	pcs	0.5



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

CONCEPT DRAWING OF PRE-COLLECTION AND SAND SORTONG

Figure 9.2-5

2) Grouping Plan of Pre-Collection Area

Although the pre-collection areas will better be determined per unit of quartiers. When the quartiers are too small and close to each other, they shall be combined. When they are too large, they shall be divided into several pre-collection areas since the size of quartier where the new system will be introduced differs.

Grouping of pre-collection area has been planned under the following considerations.

- The area with smaller population should be combined with next quartier in order to reduce the specific construction and operation cost for the recycling center.
- The area having larger area shall be divided into several areas since it is difficult to collect and transport the waste manually in large area.
- The area having larger population size shall be divided into several areas since larger size of recycle center and its land is required.
- The size of area where a pre-collector can move and work on foot is approximately 1km x 1km. Therefore the area size of a pre-collection area shall be approximately 100-200ha.
- The grouping should be done in the same income class to make easy management of fee collection and control of the new system join rate.

The grouping plan is as shown in Appendix J-7. One recycling center is presented and described in the next section and shall be representative for all pre-collection group.

(5) Recycling Center Plan

As described before, one recycling center shall be provided in one pre-collection area. The purpose of the recycling center is to collect the waste in the area, to sort out the sand, to prepare remaining waste in container that will be transported to designate landfill sites. The containers shall be provided by CUN and Communes. Sand shall be stocked and managed by the pre-collectors.

1) Facilities Plan

The required land and facilities have been planned in two different sizes. The first type (Type 1) is for the pre-collection area where the required number of waste container is 3 or less. And the second type (Type 2) is for the pre-collection area where the required number of waste container is 4 or more (but less than 8). There is no area which requires containers more than 7 until 2015. The

required facilities are as shown in Table 9.2-8.

Table 9.2-8 REQUIRED FACILITIES FOR RECYCLE CENTER

No.	Item	Unit	Quantity	
			Type 1	Type 2
1	Land	m^2	400	600
2	Fence	m	74	94
3	Gate	m	6	6
4	Lodge	m^2	6	6
5	Store	m^2	6	6
6	Toilette	m^2	2	2
7	Concrete Floor (Type 1: 30.25m^2 x 10cm) (Type 2: 70.00m^2 x 10cm)	m^3	3.03	7.00

Basic layout of the recycle center is shown in Appendix J-8 and Appendix J-9.

2) Personnel Plan

The personnel plan is the preceding section 9.2.2(4).

(6) Handling of Sorted Sand

Sand shall be sorted out from the pre-collected waste and certain amount of sand will be produced as recycled sand. Handling plan of the sand is described bellow.

1) Amount of Sorted Sand

Due to the high portion of sand included in waste (see also chapter 9.1.1), it is expected that the amount of sand will be about 60 % of the collected waste. The Quantity of sand that is potentially recyclable in the next years is estimated and shown in the Table 9.2-9.

Table 9.2-9 FORECAST OF AMOUNT OF SAND

Commune	2005			2010			2015		
	Join popu.	Sorted sand t/day	Sorted sand t/year	Join popu.	Sorted sand t/day	Sorted sand t/year	Join popu.	Sorted sand t/day	Sorted sand t/year
Commune 1	91,245	41	14,987	187,930	85	30,868	306,855	138	50,401
Commune 2	43,358	20	7,122	91,755	41	15,071	164,367	74	26,997
Commune 3	34,169	15	5,612	57,859	26	9,503	85,533	38	14,049
Total	168,771	76	27,721	337,545	152	55,442	556,755	251	91,447

2) Reuse of Sorted Sand

There are generally two ways to reuse the sorted sand. One is to utilize it in disposal sites as covering soil and the other is to utilize it as construction material (filling and reclamation material). Assuming that the waste is collected and sorted sand as described in this master plan, the required sand in disposal sites as covering soil for domestic waste is forecasted as shown in Table 9.2-10. In the Master Plan, the soil covering is not planned to start until 2010. Therefore the sand shall be reused as construction material until 2010. From 2010, the sand quantity of about 60 t/day in 2010 and 120 t/day in 2015, which corresponding to about 18,500 t/year respectively 37,000 t/year, can be utilized as construction material.

For the case that sand is needed for soil covering at the disposal sites from 2005, the following Table shows the required amounts of sand:

Table 9.2-10 SAND TO BE UTILIZED IN DISPOSAL SITES

Item	Unit	2005	2010	2015
Total required sand	t/day	64	93	131

One of the purposes of sand recycling is to cover some portion of pre-collection operation cost and finally it is expected to reduce the fee to be collected from the beneficiaries. Therefore the sand shall be sold for construction activities even to CUN for soil covering at the disposal sites.

The amount of generated sand is forecasted large. The recycle centers cannot have enough space to stock the sand for long time. Therefore permanent stockyards of sand shall be considered. To stock the sand, final disposal sites are appropriate since the sites need the sand daily and have a large area.

(7) Transport Plan

Transport Plan has been made in three different categories. One is for the present system, another is for the waste of new system and the other is for the sand of new system. Each plan is described bellow.

1) Plan for Present System

The CUN and Communes have actually a capacity to transport 21% of the waste generated in whole Niamey. Even the new system is applied from 2005, this present system shall be continued

as long as the new system is not totally completed. The collection rate of the new system will increase to 56% in year 2015, it is required to hold the capacity of 21% (of the existing system) of whole generated waste of Niamey. Otherwise the solid waste management in the areas where the new system is not introduced becomes worst. CUN and Communes shall keep the capacity of the 21% to whole generated waste in Niamey, the total collection rate will increase according to the specified targets.

The planned equipment shall be adapted to the existing equipment, 5.5 m^3 containers and detachable container truck for 5.5 m^3 container are therefore planned. The plan for present system is described bellow.

Target Capacity to Prepare

The target capacity of 21% for whole generated waste in Niamey by using the present collection system is calculated as shown in Table 9.2-11. It increases according to the population growth.

Table 9.2-11 TARGET CAPACITY BY USING THE PRESENT COLLECTION SYSTEM

No	Year and Commune	Population	Unit Gene. Rate	Generated Waste Amount	Target Collection Rate	Capacity to Have
		Pers.	kg/per.day	t/day	%	t/day
1.	**Year 2000**					
	Commune I	333,720	0.75	250	21%	53
	Commune II	240,292	0.75	180	21%	38
	Commune III	78,390	0.75	59	21%	12
	Total	652,402		489		103
2.	**Year 2005**					
	Commune I	404,843	0.75	304	21%	64
	Commune II	261,015	0.75	196	21%	41
	Commune III	91,333	0.75	68	21%	14
	Total	757,191		568		119
3.	**Year 2010**					
	Commune I	454,402	0.75	341	21%	72
	Commune II	303,525	0.75	228	21%	48
	Commune III	113,419	0.75	85	21%	18
	Total	871,346		654		137
4.	**Year 2015**					
	Commune I	528,256	0.75	396	21%	83
	Commune II	332,692	0.75	250	21%	52
	Commune III	132,776	0.75	100	21%	21
	Total	993,724		745		157

Evaluation of Existing Equipment

At present, CUN and Communes have 21 detachable container trucks for 5.5 m^3 containers. Those are very old at 15 years and operative rate is very low. Average total daily number of trip is only 37.8. The existing equipment is arranged as shown in Table 9.2-12.

Table 9.2-12 PRESENT CONDITION OF EXISTING TRUCK

Item	Com I	Com II	Com III	CUN	Total
Present Number					
Container Truck	6	5	2	8	21
Arranged Number					
Container Truck	11	7	3		21
Operative Rate	60%	60%	60%		
Operative Number	6.6	4.2	1.8		12.6
No of trips /truck	3	3	3		
Operative No of trip	19.8	12.6	5.4		37.8

Those equipment should be replaced with new one, however it is unavoidable to use them more in view of the fact that the municipalities have very limited financial support. Assuming the operative rate in 2005 at 30% and in 2010 at 0%, the total number of trip made by the existing truck is expected 25.2 trip/day in 2005 and 0 trip/day in 2010. Therefore it is required to strengthen the truck fleet in 2005 and the system will be operated by new trucks from 2010.

Required Number of Truck for Present System

Based on the consideration that the new trucks shall be operated 6 trips/day and the existing (even when limited) capacity of the old trucks, it will be necessary that additional 3new trucks by 2005, 5 by 2010 and 1 by 2015 shall be provided. Finally 8 new trucks are operated in 2010 and 9 in 2015. The calculation summary is shown in Table 9.2-13.

Table 9.2-13 REQUIRED NUMBER OF NEW TRUCK FOR PRESENT SYSTEM

No	Year and Commune	Required No of trip	No of Trip by present truck	No of Trip by additional truck	No of Trip by one new truck	Required No of New Truck	No of Truck to add
		trips/day	trips/day	trips/day	trips/day	truck	truck
1.	**Year 2005**						
	Commune I	22.2	13.2	9.0	6	2	2
	Commune II	14.3	8.4	5.9	6	1	1
	Commune III	5.0	3.6	1.4	6	0	0
	Total	42	25.2	16.4		3	3
2.	**Year 2010**						
	Commune I	24.9	0.0	24.9	6	4	2
	Commune II	16.7	0.0	16.7	6	3	2
	Commune III	6.2	0.0	6.2	6	1	1
	Total	48	0.0	47.8		8	5
3.	**Year 2015**						
	Commune I	29.0	0.0	29.0	6	5	1
	Commune II	18.3	0.0	18.3	6	3	0
	Commune III	7.3	0.0	7.3	6	1	0
	Total	55	0.0	54.5		9	1

Required Number of Additional Container

The required number of container has been calculated from the view of capable number of trips made by truck. Actually 254 containers are distributed in Niamey. Taking into consideration that the containers are collected once a week (fq=1), total required number of container is identical as total number of trip made by truck in one week. Therefore required additional containers have been planned to provide for differences between the total number of truck and the number of existing container. The additional number of container is as shown in Table 9.2-14.

Table 9.2-14 REQUIRED NUMBER OF CONTAINER FOR PRESENT SYSTEM

No	Year and Commune	No of Trip made by truck	No of Trip made by truck	No of existing container	Required No of new container	No of new container to add
		trip/day	trip/week	pcs	pcs	pcs
1.	**Year 2005**					
	Commune I	22.2	155.5	173	0	0
	Commune II	14.3	100.3	61	39	39
	Commune III	5.0	35.1	20	15	15
	Total	41.6	290.9	254	54	54
2.	**Year 2010**					
	Commune I	24.9	174.6	173	2	2
	Commune II	16.7	116.6	61	56	17
	Commune III	6.2	43.6	20	24	9
	Total	47.8	334.7	254	82	28
3.	**Year 2015**					
	Commune I	29.0	202.9	173	30	28
	Commune II	18.3	127.8	61	67	11
	Commune III	7.3	51.0	20	31	7
	Total	54.5	381.7	254	128	46

2) Plan for New System: Waste

Transport plan for the new system has been made for every Commune. Although the waste is collected for each pre-collection unit area, the container trucks shall transport the containers from the different areas since most of pre-collection areas requires that daily one or two containers has (have) to be collected. Therefore Communes that control the SWM system over pre-collection areas shall make available containers and trucks. The container collection shall be made 6 days a week (fq=6), otherwise the recycling centers become temporally dump sites. For the transport detachable container trucks and container ($5.5m^3$) shall be applied.

Required Number of Container

Based on the served population in pre-collection area the required number of container are determinate. 4,600 persons of served population approximately require one container ($5.5\ m^3$). The required number of container by pre-collection area and Communes is shown in Appendix J-10. In order to keep the collection and transportation works uninterrupted, additional containers as reserve shall be considered. The number of these additional containers is identical to the number of trucks. These figures are shown in the table as spare containers.

Required Number of Truck for New System

The required number of truck is determinate on the base the number of container for the new system. As the container collection frequency is 6 days a week (fq=6), the number of truck is calculated from the number of container divided by 6 trips/day. The required number of truck is shown in Table 9.2-15, which shall be provided by Communes.

Table 9.2-15 REQUIRED NUMBER OF TRUCK FOR NEW SYSTEM

Commune	2005		2010		2015	
	Required No of container	Required No of truck	Required No of container	Required No of truck	Required No of container	Required No of truck
	pcs	truck	pcs	truck	pcs	truck
Required Number						
Commune I	24	4	48	8	76	13
Commune II	11	2	24	4	41	7
Commune III	9	2	13	3	20	4
Total	44	8	85	15	137	24
Required Number to add						
Commune I		4		4		5
Commune II		2		2		3
Commune III		2		1		1
Total		8		7		9

3) Plan for New System: Sorted Sand

The sorted sand in the recycling centers shall be taken to disposal sites by dump trucks (15t) and wheel loaders ($2m^3$). It is necessary to form a team consisting of two dump trucks and one wheel loader since the most of pre-collection areas requires two trips of dump truck per week. The required quantity of dump truck and wheel loader is quite small and it is not effective to keep and manage it per Commune. Therefore the management and operation of these equipment shall be done by CUN for whole Niamey. Based on the consideration that one dump truck can provide 4 trips/day, the required number of equipment is calculated and shown in Table 9.2-16.

Table 9.2-16 REQUIRED NUMBER OF EQUIPMENT FOR SAND TRANSPORT

Commune	2005				2010				2015			
	Sand Sorted	Req No of Dump Trips	Req No of Dump Truck	Req No of loader	Sand Sorted	Req No of Dump Trips	Req No of Dump Truck	Req No of loader	Sand Sorted	Req No of Dump Trips	Req No of Dump Truck	Req No of loader
	t/week	trip	truck	loader	t/week	trip	truck	loader	t/week	trip	truck	loader
Required Number												
Commune I	287.4	19.16			592.0	39.47			966.6	64.44		
Commune II	136.6	9.11			289.0	19.27			517.8	34.52		
Commune III	107.6	7.18			182.3	12.15			269.4	17.96		
Total	531.6	35.44	2	1	1,063.3	70.88	3	2	1,753.8	116.92	5	3
Required Number to add			2	1			1	1			2	1

9.2.3 Disposal Site

(1) Construction of Disposal Sites

The construction shall be divided into 3 phases. The 1st phase aims to complete the facilities by 2005 for starting the control dumping and disposing the waste until 2010. The construction of 1st phase consists mainly of construction of fence around whole site, control house, access road from main street, internal road and rainwater drain around planed location for waste disposal until 2010. The 2nd phase aims at preparation to dispose waste from 2010 until 2015 and its construction consisting of extension of internal road and rainwater drain shall be completed by 2010. The 3rd phase aims at starting leachate protection and collection and completion of preparation for waste disposal after 2015 and its construction shall be completed by 2015.

The required construction for the sites of Communes 1 and 2 (CU1&2) and of Commune 3 (CU3) is shown in Table 9.2-17. The general layout plans for the designated landfill are shown in Appendix J-11 for CU 1&2 and Appendix J-12 for CU 3.

Table 9.2-17 MAIN TECHNAICAL CHARACTERISTCS OF THE DISPOSAL SITES

Item	Unit	Quantity					
		Site CU1&2			Site CU3		
		2005	2010	2015	2005	2010	2015
Fence	m	2,614			1,034		
Gate	m	6			6		
Control House							
Lodge	m^2	12			12		
Store	m^2	12			12		
Toilette	m^2	2			2		
Access Road form main street (compacted gravel 3.5m x 20cm)	m	100			100		
Internal Road (compacted gravel 3.5m x 20cm)	m	990		800	330	160	310
Rainwater Drain (1m x 1m)	m	540	693	1,203	240	260	303
Leachate Protection Layer (cray t=50cm)	m^2			153,200			21,000
Leachate Collection Pipes	m			8,221			1,258
Protection of cray layer (with sand t=50cm)	m^2			153,200			21,000

(2) Equipment for Landfill site

The disposal sites shall be equipped with bulldozer which push and compact the waste and covering soil. Although the site CU1&2 requires one bulldozer (165HP class) at approx. 4 hours work per day in 2010 and 6 hours work per day in 2015, the site CU3 requires less than 1 hour work even smaller bulldozer (135HP class) is being applied. Therefore the site CU3 shall not be equipped with bulldozer until 2015. Until 2015, the site CU3 shall use the bulldozer of site CU 1&2 once a week. As the amount of site CU3 is a little, the required work of pushing and compacting is expected to complete. On the other hand, the site CU1&2 can complete the weekly waste management for 5 days as the site requires 4 to 6 hours per day. Therefore equipment purchase schedule is as following table:

Table 9.2-18 REQUIRED EQUIPMENT FOR DISPOSAL SITE

Equipment	Quantity		
	By 2005	By 2010	By 2015
Bulldozer 165HP	1		
Bulldozer 135HP			1

The detail calculation is shown in Appendix J-13.

(3) Personnel

The required personnel is as shown in Table 9.2-19. As this personnel is required for control dumping, it shall be prepared by 2005.

Table 9.2-19 THE REQUIRED PERSONNEL FOR DISPOSAL SITE

Item	Site CU1&2	Site CU 3
Guard man	6 (2 x 3 shifts)	3 (1 x 3 shifts)
Clerk	2	1
Foremen	4	1

(4) Operation

The operation of disposal sites shall be managed and operated by CUN as the covering area of sites is over the Commune's boundaries. CUN shall manage the environment condition of the sites and amount of waste.

1) Truck Recording

All incoming truck shall be recorded by clerks. Items to record are Truck No., driver's name, time, original location of waste and observed amount. This is a beginning of control dumping and shall start by 2005.

2) Daily Covering with Soil

Daily covering with soil is the beginning of sanitary landfill. This shall be started after bulldozer provided and recyclable sand obtained by new system, therefore by 2010 at least. The soil covering shall be done at 3m of thickness of waste and the thickness of soil shall be 50cm. The cell method shall be applied for daily covering as described in Alternative Study, Chapter 7.

3) Leachate Protection

Until 2015, leachate amount shall be minimized by construction of rainwater drain to protect the incoming rainwater to the site. Therefore the drain shall be inspected daily (during the rainy season) and repaired if necessary.

After 2015, the leachate protection layer by clay is to be constructed at the bottom of disposal area reserved for landfilling after 2015. Leachate will be transported by collection pipes to the leachate

pond. The retained leachate shall be taken by vacuum wastewater tank truck and sprayed on the disposal site. In/after rainy day, CUN shall rent vacuum wastewater tank trucks.

9.3 INDUSTRIAL WASTE

Each industrial establishment shall be responsible for treatment and transport of their generated waste. In view of the fact that presently industrial solid waste is not recorded nor removed properly. The first step that is to be introduced is to provide every industrial establishment container in order that their industrial waste can be properly collected. In order to keep unified transport system container with capacity of 5.5 m^3 shall be used.
Furthermore waste quantity shall be recorded at the generation source as well as the characteristics of the industrial waste that is generated. In a second stage it will be necessary to establish a recording and documentation system for industrial waste.
Due to the fact that no data on waste generation is available the total waste amount is estimated on the observation done during the solid waste survey as described in Chapter 7.4.2. The quantity of industrial waste amounts to 3,432 m^3/year. As described in Chapter 10.2, 12 containers are required for industrial waste management. The truck for removing the containers shall be used as well as for industrial waste as for hospital waste.

It is recommended that the services for solid waste management shall be carried out by the CUN. These services are:

- making container available (rent system),
- 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.

9.4 HOSPITAL WASTE

As mentioned in Section 7.4, individual treatment system for infectious waste is essential for proper and low cost treatment. Separation of infectious waste at the generation source should be introduced in all hospitals and clinics to reduce the risk of contamination during collection, transport and disposal. It also will reduced the amount that should be treated and therefore the investment and operation costs for infectious waste treatment.

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

Non infectious waste that is collected separately shall be managed as household waste by using containers. Because of the small quantity of hospital waste (ash and non infectious waste) as well as industrial waste, One truck is considered for transporting both types of waste to the landfill sites.

9.5 PROJECT LIST

As result of the detailed analyze for the required works to carry out the master plan, the following Table 9.5-1 presents the total equipment needed for the solid waste management in Niamey.

Table 9.5-1 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[1]	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[1]	0.66			0.66
6.2	Purchase of 5.5m^3 Container	11			11
6.3	Construction of Incinerator (200kg/h)	1			1

Appendix J-14 presents detail project list required for the Solid Waste Master Plan.

[1] One Container shall be used as well as industrial waste as for hospital waste

CHAPTER 10. PROJECT COST AND IMPLEMENTATION SCHEDULE

CHAPTER 10. PROJECT COST AND IMPLEMENTATION SCHEDULE

10.1 SEWERAGE SYSTEM

10.1.1 Project Cost

(1) Basis of Cost Estimate

1) Unit Price of Labor, Material and Equipment

Unit price of each element such as labor, major material and major equipment is determined on the basis of the data collected through the field investigation in January 2001 in Niamey city. The social and market conditions of Niamey city are to be taken into account to determine the unit cost of each construction work.

2) Procurement of Sewer Pipes

The procurement of PVC pipe is assumed to be from Europe. Unit price of PVC pipe is based on the market price of FOB at France port and is adjusted considering customs, insurance and freight cost and inland transportation cost.

3) Procurement of Pump Equipment

The procurement of pump equipment is assumed to be from Europe. Unit cost of pump equipment includes costs of material, design, manufacturing in factory in France, workshop test, spare parts, and seaworthy packing based on the FOB France prices and is to be adjusted considering customs, insurance and freight.

4) Procurement of Wastewater Treatment Plant Equipment

The procurement of wastewater treatment plant equipment is assumed to be from Europe. Unit cost of equipment includes costs of material, design, manufacturing in factory in France, work shop test, spare parts and seaworthy packing based on the FOB France prices and is to be adjusted considering customs, insurance and freight.

5).Basic Cost of the Construction Works

The basic cost of the construction works is obtained by accumulating labor cost, material cost, equipment cost for the assumed typical and preliminary design. The construction methods, equipment and labors, proceeding speed of the works shall be in accordance with standards for public works in Niamey city.

(2) Total Investment Cost

The total investment cost of the proposed facilities for the Master Plan is summarized as shown in Table 10.1-1. The total investment cost comprises of the following items.

- Direct construction cost estimated for the preliminary design of the facilities
- Engineering fee of consulting services for the stages of design and construction
- Physical contingency for the construction works
- Land acquisition cost

1) Direct Construction Cost

The details of the work categories and the direct costs estimated for each category are described in Table 10.1-1.

2) Engineering Fee

Engineering fee is estimated taking into account the provision of the following scope of services.

- Investigation of subsoil condition required in the stages of basic design and detail design,
- Detail design of all facilities and equipment,
- Construction supervisory services.

3) Contingencies

A physical contingency is required for the construction works and is estimated empirically as 15% of the summation of direct construction cost and engineering fee.

4) Land Acquisition Cost

Land acquisition cost for water treatment plant is calculated based on the unit cost of 5,000 to 10,000 CFAF/m^2 depending on the location and the required area.

(3) Operation and Maintenance Cost

Operation and maintenance cost is shown in Table 10.1-2 according to the implementation schedule. Operation and maintenance cost includes following.

1) WWTP utilities and chemical cost
2) WWTP personnel cost including engineer, operator, worker, secretary, etc.
3) Headquarter operation and personnel cost

10.1.2 Priority for Implementation

Cost per beneficiary is calculated and shown in Table 10.1-1. 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 view point 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.

10.1.3 Implementation Schedule

The implementation schedule is shown in Table 10.1-3. Main assumptions in 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.
3) The third stage is to implement the projects for the separated sewer system zones of S1 to S11 by year 2015.

The yearly expenditure of investment costs is also shown in Table.10.1-3 in accordance with the planned construction schedule.

Table 10.1-1 PROJECT COST (Unit: 1,000 CFAF)

Description	C1	C2	C3	C4	S1	S2	S3	S4	S5	S6	S7	S8	S10	S11	Total
Piping Works(Sewage)	23,700	237	4,050	33,400	156,038	71,969	161,820	141,489	114,061	89,807	58,605	47,765	83,418	22,120	1,008,899
Piping Works(Drainage)	1,439,001	990,158	673,655	2,395,090	3,031,787	1,931,668	3,693,545	4,759,027	4,003,742	2,686,444	1,388,901	1,953,673	2,882,743	889,553	32,718,988
Water Treatment Works	92,353	61,569	155,806	502,600	204,810	96,751	365,013	451,084	310,984	207,323	189,732	268,263	268,891	288,000	3,463,176
Pumping Station Works	0	0	0	7,530	0	0	10,040	0	10,040	15,060	0	0	7,530	0	50,200
Total Construction Cost	1,555,054	1,051,963	833,511	2,938,620	3,392,634	2,100,388	4,230,418	5,352,019	4,438,826	2,998,634	1,637,238	2,269,701	3,242,582	1,199,673	37,241,263
Engineering Cost	155,505	105,196	83,351	293,862	339,263	210,039	423,042	535,202	443,883	299,863	163,724	226,970	324,258	119,967	3,724,126
Sub-Total	1,710,559	1,157,160	916,863	3,232,482	3,731,898	2,310,427	4,653,460	5,887,221	4,882,709	3,298,497	1,800,961	2,496,671	3,566,840	1,319,641	40,965,389
Contingencies	256,584	173,574	137,529	484,872	559,785	346,564	698,019	883,083	732,406	494,775	270,144	374,501	535,026	197,946	6,144,808
Land Acquisition	25,000	16,000	40,000	126,000	55,000	17,500	66,500	63,000	40,000	27,500	55,000	56,000	40,000	190,000	817,500
Total	1,992,143	1,346,734	1,094,392	3,843,355	4,346,683	2,674,491	5,417,979	6,833,304	5,655,115	3,820,772	2,126,106	2,927,172	4,141,866	1,707,587	47,927,698
Population(habitant)	10,995	10,609	43,042	96,529	55,107	19,059	97,973	134,602	93,269	53,947	7,386	44,959	87,817	38,407	793,701
Cost/Pop(*1000 CFAF)	181	127	25	40	79	140	55	51	61	71	288	65	47	44	60

Table 10.1-2 OPERATION AND MAINTENANCE COST (Unit: 1000 CFAF/year)

Year		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Plants	# of operating plants	0	1	3	4	6	8	9	10	11	12	13	14
	Utilities & Chemicals	0	4,178	38,875	40,526	48,612	77,021	91,885	110,494	115,582	122,775	136,510	136,510
	Personnel cost	0	16,224	48,672	64,896	97,344	129,792	146,016	162,240	178,464	194,688	210,912	227,136
	Plant Operating Cost Subtotal	0	20,402	87,547	105,422	145,956	206,813	237,901	272,734	294,046	317,463	347,442	363,646
Head-quarters	% established	0%	25%	25%	25%	30%	55%	65%	75%	80%	85%	95%	100%
	Personnel cost	0	22,230	22,230	22,230	26,676	48,906	57,798	66,690	71,136	75,582	84,474	88,920
	Operating cost	0	36,538	36,538	36,538	43,845	80,383	94,998	109,613	116,920	124,228	138,843	146,150
	Headquarter cost Subtotal	0	58,768	58,768	58,768	70,521	129,289	152,796	176,303	188,056	199,810	223,317	235,070
Total operating cost 1,000 CFAF/year		0	79,170	146,315	164,190	216,477	336,102	390,697	449,037	482,102	517,273	570,739	598,716

Table 10.1-3 IMPLEMENTATION SCHEDULE

		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
C1	Whole Project														
C2	Whole Project														
C3	Engineering														
	Land Acquisition														
	Pipe (Sewage)														
	Pipe (Drainage)														
	Treatment Plant														
	Pumping Station														
C4	Whole Project														
S1	Whole Project														
S2	Whole Project														
S3	Whole Project														
S4	Whole Project														
S5	Whole Project														
S6	Whole Project														
S7	Whole Project														
S8	Whole Project														
S10	Whole Project														
S11	Whole Project														
Total (1,000 CFAF)		220,881	1,415,374	1,821,351	2,916,537	6,461,495	6,469,838	7,541,335	6,556,483	3,744,956	3,220,544	2,904,197	2,282,509	1,776,621	595,577
G.Total (1,000CFAF)															47,927,698

10.2 SOLID WASTE MANAGEMENT

10.2.1 Project Cost

(1) Household Waste

1) Capital Cost

The estimated capital cost that is required to carry out the master plan for household waste management is as shown in Table 10.2-1.

Table 10.2-1 PROJECT COST FOR HOUSEHOLD WASTE MANAGEMENT

No	Project	Capital Cost (in 1,000 CFAF)			
		2005	2010	2015	Total
1.	Equipment Purchase for Present System				
1-1	Commune I	91,080	98,670	151,800	341,550
1-2	Commune II	193,545	155,595	41,745	390,885
1-3	Commune III	56,925	79,695	26,565	163,185
	Sub Total	341,550	333,960	220,110	895,620
2.	Equipment Purchase for New System				
2-1	Commune I	288,420	288,420	352,935	929,775
2-2	Commune II	140,415	148,005	212,520	500,940
2-3	Commune III	132,825	64,515	75,900	273,240
2-4	CUN	235,290	174,570	235,290	645,150
	Sub Total	796,950	675,510	876,645	2,349,105
3.	Construction of Recycle Center				
3-1.	Commune I	69,241	52,075	30,473	151,789
3-2	Commune II	27,323	20,315	30,473	78,111
3-3	Commune III	22,244			22,244
	Sub Total	118,808	72,390	60,946	252,144
4.	Disposal Site				
4-1	Construction of Disposal Site CU1&2	117,847	1,753	986,680	1,106,280
4-2	Construction of Disposal Site CU3	49,588	4,908	143,899	198,395
4-3	Equipment Purchase for Disposal	189,750		113,850	303,600
	Sub Total	357,185	6,661	1,244,429	1,608,275
Grand Total		1,614,493	1,088,521	2,402,130	5,105,144

Note: The capital cost estimated here above do not include the cost for land acquisition and the earth excavation costs for the preparation of the base of the disposal site. If the costs for these elements are taken into account, the capital cost for the construction of the disposal sites will be:
Koubia site: 2,244 million FCA F in 2005, 2,428 million CFA F in 2010 and 5,207 million CFA F in 2015
Bengale Torombi site: 387 million CFA F in 2005, 427 million CFA F in 2010 and 722 million CFA F in 2015. The total cost for the execution of the two disposal sites will then be: 4,078 million CFA F in 2005, 3,936 million CFAFF in 2010 and 7,200 FCA F in 2015.

2) Operation and Maintenance Cost

The required operation and maintenance cost is estimated for the year 2005, 2010 and 2015 as shown in Table 10.2-2. Depreciation costs are not included in the table. The estimated operation cost for the existing equipment is included in "A. Present System".

Table 10.2-2 OPERATION AND MAINTENANCE COST

No	Project	O&M Cost (in 1,000 CFAF)		
		2005	2010	2015
A.	Present System			
	Commune I	78,898	78,003	95,023
	Commune II	45,179	56,258	57,990
	Commune III	12,721	19,540	20,643
	Total for Present System	136,798	153,801	173,656
B.	New System			
1.	Transport Equipment			
	Commune I	54,850	109,701	177,949
	Commune II	27,268	54,850	95,831
	Commune III	26,953	40,350	54,220
	CUN	67,240	112,316	179,556
	Total for Transport Equipment	176,310	317,217	507,555
2.	Pre-Collection and Recycling			
	Commune I	99,074	194,178	294,671
	Commune II	43,998	89,080	156,444
	Commune III	34,829	51,720	71,452
	Total for Pre-Collection and Recycling	177,901	334,978	522,567
	Total for New System	354,211	652,196	1,030,122
C.	Disposal Site			
1	Disposal Site CU1&2	35,205	107,037	140,745
2	Disposal Site CU3	8,350	18,862	35,857
	Total for Disposal Site	43,555	125,899	176,602
Grand Total		534,564	931,895	1,380,380

(2) Industrial Waste

1) Capital Cost

The estimated capital cost which is required to carry out the master plan for industrial waste management is CFAF 53,564 thousand. This cost shall be born by the factories.

2) Operation and Maintenance Cost

In the master plan, 10 containers are planned to arrange in 9 factories and to transport to the

disposal sites. However 1 container out of 10 is planned to transport 3 times a week and others once a week. Therefore 12 containers in total shall be transported in a week. This number of transported container will have continued until 2015. The required operation and maintenance cost is CFAF 5,898 thousand / year and it is required until 2015. This cost is also to be born by factories.

When the capital cost is divided into 10 years, the sum of yearly capital cost and operation cost is required CFAF 11,255 thousand. And the cost to transport one container is calculated CFAF 18,037 since the total transporting number of container is 624 (12 x 52 weeks) as shown in Table 10.2-3.

Table 10.2-3 YEARLY COST FOR INDUSTRIAL WASTE MANAGEMENT

Item	CFAF	2005 CFAF/ transp cont	2010 CFAF/ transp cont	2015 CFAF/ transp cont
Capital by 10 years	5,356,371	8,584	8,584	8,584
Yearly O&M cost	5,898,456	9,453	9,453	9,453
Total	11,254,827	18,037	18,037	18,037

(3) Medical Waste

1) Capital Cost

The capital costs for hospital waste management are to be considered for both types of waste generated within the hospital establishments, namely infectious waste and household similar waste.
The estimated capital cost which is required to carry out the master plan for the non infectious medical waste management is CFAF 71,671 thousand.
The capital costs for the incineration of infectious waste are estimated to 99,000,000 CFAF. These costs shall be born by the hospitals.

2) Operation and Maintenance Cost

The total transporting number of container for transporting non infectious waste is expected to increase slightly from 2005 to 2015, however number of provided container and truck is constant through the years. Therefore the operation and maintenance cost can be assumed as approximately constant through the master plan period. The required costs are CFAF 10,019 thousand / year and that also are to be born by hospital.

When the capital cost is divided into 10 years, the sum of yearly capital cost and operation cost is required CFAF 17,186 thousand. The cost to transport one container is decreasing according to increase of yearly total transporting number of container as shown in Table 10.2-4.

Table 10.2-4 YEARLY COST FOR NON INFECTIOUS WASTE MANAGEMENT

Item	CFAF	2005 CFAF/ transp cont	2010 CFAF/ transp cont	2015 CFAF/ transp cont
Capital cots for truck & container (10 years)	7,167,129	7,254	6,265	5,993
Yearly O&M cost for truck & container	10,019,123	10,141	8,758	8,377
Total	17,186,252	17,395	15,023	14,370

The incineration of infectious waste will also generate operation and maintenance costs. The economical life of the incinerator is assumed to be 15 years. Due to the increasing of infectious waste generation through the years, the operation and maintenance costs shall increase accordingly. The following Table 10.2-5 summarizes the figures of these costs.

Table 10.2-5 YEARLY COST FOR INFECTIOUS WASTE INCINERATION

Item	CFAF	2005 CFAF/ Incineration	2010 CFAF/ Incineration	2015 CFAF/ Incineration
Capital cost for incinerator (15 years)	6,600,000	6,600,000	6,600,000	6,600,000
Yearly O&M cost for incinerator		9,690,000	10,950,000	12,720,000
Total		16,290,000	17,550,000	19,320,000

(4) Applied Unit Cost

Major unit costs applied for the cost estimation are shown in Table 10.2-6

Table 10.2-6 APPLIED UNIT COST TO ESTIMATION

No.	Item	Unit Cost (CFAF)
1.	**Salary**	
1-1	Common Worker	1,100 /day
1-2	Foreman	3,000 /day
1-3	Clerk	1,600 /day
1-4	Light Truck Driver	1,500 /day
1-5	Heavy Truck Driver	2,500 /day
1-6	Heavy Construction Equipment Operator	2,700 /day
2.	**Equipment**	
2-1	5.5m^3 Detachable Container Truck	36,000,000
2-2	5.5m^3 Container	3,000,000
2-3	15t Dump Truck	48,000,000
2-4	2m^3 Wheel Loader	90,000,000
2-5	165HP Class Bulldozer	150,000,000
2-6	130HP Class Bulldozer	90,000,000

10.2.2 Priority for Implementation

As for the projects for households waste, project priority is studied as follows.

(1) Project Priority in Solid Waste Management

The Projects are categorized into three large packages,

i) Equipment purchase for Present System,
ii) Equipment Purchase for New System and Construction of Recycle centers and
iii) Construction and Equipment Purchase for Disposal Sites.

The solid waste must be collected, transported and disposed at designated site and three functions of collection, transportation and disposal form a chain. When one function is insufficient or lack, the chain is not formed effectively. The category i) is indispensable to collect and transport the waste from the people who is not served by new system and can not capable to pay for new system. The category ii) is necessary to expand to increase the waste collection rate and keep the city clean. Both categories have a valuable function to collect and transport the waste. And the category iii) is to construct the disposal sites and to arrange necessary equipment for disposal in Niamey which has no designated disposal site. When disposal sites are not provided, the collected waste have no proper destination to be disposed. From this point of view, these categories are unsuitable to be ranked by priority. All categories shall be dealt with as the first priority.

Although the priority ranking is not done among the three categories, cost by beneficiary has been calculated as reference indexes for the projects that require new investment. It is shown in Table 10.2-7. The cost for disposal site that serves to large population with a little amount of cost has better figure. The figures of 1-1 is better than 1-2, since the present system is not considered well the accessible distance for container by the resident. When the accessible distance considered, the cost/beneficiary jump up as described in Alternative Study in Chapter 7. The figure of "Cost to be born by beneficiary" is showing the average fee to be collected by pre-collectors.

Table 10.2-7 COST/BENEFICIARY OF THE PROJECTS

No	Project	No. of Net Beneficiary 2015	Capital Cost until 2015 Total (CFAF)	Capital/ Benef. 2015	O&M Cost (CFAF/year)	O&M/ Benef. 2015	Total Cost / Beneficiary (CFAF/Y)
1.	Cost to be born by CUN & Communes						
1-1	Equipment Purchase for Present System	208,682	895,620,000	4,292	133,650,711	640	1,070
1-2	Equipment Purchase for New System	556,755	2,349,105,000	4,219	507,555,351	912	1,334
1-3	Disposal Site	993,724	1,608,276,286	1,618	176,601,582	178	286
	Total to be born by CUN & Communes	993,724	4,853,001,286	4,884	817,807,644	823	1,268
2.	Cost to be born by Beneficiary						
2-1	Recycle Center and Pre-Collection for New System	556,755	252,147,500	453	522,566,991	939	969
	Total to be born by Beneficiary	556,755	252,147,500	453	522,566,991	939	969

Note: For total cost calculation, capital for equipment and construction divided by 10 years and 15 years respectively.

(2) Priority Ranking by Quartier for New System

The master plan, Chapter 9, 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).

The evaluation has been taken a scoring method. Scoring policies are as follows and summarized in Table 10.2-8 and the result is shown in Table 10.2-9.

(3) Scoring Policies

- The standard cost/beneficiary (C/B) in high, middle and low income class are set as 2,000 CAF/person.year, 1,000 CAF/person.year and 800 CAF/person.year respectively. And the pre-collection areas whose C/B is not more than 2,000/1,000/800 score "5".
- In the calculation of C/B, the expected income from recycle sand is not included. The amount of produced recycle sand is expected to reach at 91,447 t/year in 2015 and its sales is expected 219,472,841 CFA. This amount of expected sales is can cover more than 30% of total required cost (capital cost divided into 15 years and O&M cost in 2015). Therefore even C/B exceeds the above standard C/B, the pre-collection areas whose C/B is not more than 110% and 120% of the standard B/C score "4" and "3" respectively. Other areas score "2".
- The existence of current pre-collection activity is valuable index to expect the successful new system introduction. The areas where some pre-collection activity organized by NGO/Company are much easier to be introduced. Therefore the areas where some organized pre-collection activity is seen score "5" and others score "0".
- The ranking of area is done according to the total score. The areas totally score not less than "10","8" and "5" are ranked priority "First", "Second" and "Third" respectively. And the areas score less than "5" are ranked priority "Forth".

Table 10.2-8 SCORING POLICY FOR NEW SYSTEM INTRODUCED AREA

C/B Score		Current Pre-Collection Score		Priority Ranking	
C/B	**Score**	**Activity**	**Score**	**Total Score**	**Priority**
High Income		Yes	5	Score>=10	First
C/B<=2,000	5	No	0	Score>=8	Second
C/B<=2,200	4			Score>=5	Third
C/B<=2,400	3			Score<5	Firth
C/B>2,400	2				
Mid Income					
C/B<=1,000	5				
C/B<=1,100	4				
C/B<=1,200	3				
C/B>1,200	2				
Low Income					
C/B<=800	5				
C/B<=880	4				
C/B<=960	3				
C/B>960	2				

Table 10.2-9 PRIORITY OF QUARTIER TO INTRODUCE NEW SYSTEM (1/2)

No			Project	No. of Beneficiary 2015	Cost/ Benef. (CFA/y)	Income Class	Current Pre-cole. Activity	Score C/B	Score Pre-cole. Activity	Score Total	Priority
CU	Group	ID	Quartier								
1	**Commune I**										
	1-1	1	Plateau I-A: (60%)	3,494	2,209	H	Y	5	5	10	1
	1-2	1,2	Plateau I-A: (40%) + Ambassades	3,602	2,164	H	Y	5	5	10	1
	1-3	20	Plateau II-A: (33%)	7,957	1,370	H	Y	5	5	10	1
	1-4	20	Plateau II-B: (33%)	7,957	1,370	H	Y	5	5	10	1
	1-5	20	Plateau II-B: (33%)	7,957	1,370	H	Y	5	5	10	1
	1-6	24	Kouara Kano	2,935	2,494	H	Y	5	5	10	1
	1-7	25	Ext. Kouara Kano	3,906	2,051	H	Y	5	5	10	1
	1-8	30	Yantala Haut	18,617	996	H	Y	5	5	10	1
	1-9	26	Courronne Nord	8,523	1,326	M		4		4	4
	1-10	27	Kouara Me	19,345	985	M		5		5	3
	1-11	28	Dar Es Salam-A: (50%)	18,794	993	M	Y	5	5	10	1
	1-12	28	Dar Es Salam-B: (50%)	18,794	993	M	Y	5	5	10	1
	1-13	31	Bani Fandou I	15,248	1,059	M	Y	5	5	10	1
	1-14	32,33	Cite CNSS + Bani Fandou II-A: (40%)	9,105	1,287	M	Y	4	5	9	2
	1-15	33	Bani Fandou II-B: (60%)	10,619	1,205	M		5		5	3
	1-16	36	Banizoumbou II	15,716	1,048	M		5		5	3
	1-17	37	Baghdad	21,555	958	M	Y	5	5	10	1
	1-18	42	Nord Lazaret	12,267	1,139	M		5		5	3
	1-19	43	Taiwan	6,369	1,534	M	Y	3	5	8	2
	1-20	44	Bobiel	7,273	1,432	M		3		3	4
	1-21	45	Ouest Faisceau 1	6,150	1,563	M		3		3	4
	1-22	46	Ouest Faisceau 2	11,420	1,171	M		5		5	3
	1-23	47	Nord Faisceau	7,638	1,397	M		4		4	4
	1-24	48,49	SONUCI+Koura Kano Nord	11,008	1,188	M		5		5	3
	1-25	50	Ext. Kouara Kano Nord	8,726	1,312	M		4		4	4
	1-26	51	Ext. Kouara Tegui	11,222	1,179	M		5		5	3
	1-27	8,9,10,11	Zongo,Maourey,Gandacthe, Deizebon	9,138	1,285	L		2		2	4
	1-28	15,16,17	Boukoki I, II, III	11,887	1,153	L		2		2	4
	1-29	18	Boukoki IV	9,635	1,256	L		2		2	4

Note: In the column of Current Pre-Colle Activity, "Y" means "the activity exists" no indication means "the activity does not exist".

TABLE 10.2-10 PRIORITY OF QUARTIER TO INTRODUCE NEW SYSTEM (2/2)

No			Project	No. of Beneficiary 2015	Cost/ Benef. (CFA/y)	Income Class	Current Pre-cole. Activity	Score C/B	Score Pre-cole. Activity	Score Total	Priority
CU	Group	ID	Quartier								
2	**Commune II**										
	2-1	53,54	Terminus+Niamey Bas	4,583	1,854	H	Y	5	5	10	1
	2-2	69,70	Cite Faycal+Poudriere-A: (40%)	6,110	1,569	H	Y	5	5	10	1
	2-3	70	Poudriere-B: (60%)	6,834	1,478	H	Y	5	5	10	1
	2-4	72	Madina	16,124	1,040	M		5		5	3
	2-5	73	Route de Filingue	30,212	887	M	Y	5	5	10	1
	2-6	74	Ext. Route de Flingue	23,615	936	M	Y	5	5	10	1
	2-7	80	Ext. Talladje	9,046	1,291	M		4		4	4
	2-8	82	Ext. Saga	4,544	1,863	M		2		2	4
	2-9	84	Aviation 1-A: (50%)	8,751	1,310	M		4		4	4
	2-10	84	Aviation 1-B: (50%)	8,751	1,310	M		4		4	4
	2-11	86	Sari-Koubou-A: (33%)	6,572	1,508	M		3		3	4
	2-12	86	Sari-Koubou-B: (33%)	6,572	1,508	M		3		3	4
	2-13	86	Sari-Koubou-C: (33%)	6,572	1,508	M		3		3	4
	2-14	56,58, 59,63	Kalley Centre, Sud + Lacouroussou + Nouveau Marche	12,869	1,119	L	Y	3	5	8	2
	2-15	57,60 ,61	Kalley Est, Banizoumbou I, Abidjan	13,211	1,109	L	Y	3	5	8	2
3	**Commune III**										
	3-1	91	Karadje	23,420	938	M		5		5	3
	3-2	92,93	Pont Kennedy + Gawaye	11,944	1,151	M		5		5	3
	3-3	95	Ext. Kirkissoye	19,762	980	M		5		5	3
	3-4	96	Banga Bana	30,408	886	M		5		5	3

Note: In the column of Current Pre-Colle Activity, "Y" means "the activity exists" no indication means "the activity does not exist".

In result of this priority ranking, the area priorities are summarized in Table 10.2-10.

Table 10.2-11 AREA PRIORITY RANKING TO INTRODUCE NEW SYSTEM PER INTRODUCTION STAGE

CU	Group	ID	Quartier	Priority
Stage 1 New System Introduced by 2005				
1	1-3	20	Plateau II-A: (33%)	1
1	1-4	20	Plateau II-B: (33%)	1
1	1-5	20	Plateau II-B: (33%)	1
1	1-6	24	Kouara Kano	1
1	1-7	25	Ext. Kouara Kano	1
1	1-8	30	Yantala Haut	1
1	1-11	28	Dar Es Salam-A: (50%)	1
1	1-12	28	Dar Es Salam-B: (50%)	1
1	1-13	31	Bani Fandou I	1
2	2-2	69,70	Cite Faycal+Poudriere-A: (40%)	1
2	2-3	70	Poudriere-B: (60%)	1
2	2-5	73	Route de Filingue	1
2	2-6	74	Ext. Route de Flingue	1
1	1-14	32,33	Cite CNSS + Bani Fandou II-A: (40%)	2
1	1-10	27	Kouara Me	3
2	2-4	72	Madina	3
3	3-1	91	Karadje	3
3	3-3	95	Ext. Kirkissoye	3
3	3-4	96	Banga Bana	3
3	3-2	92,93	Pont Kennedy + Gawaye	3
1	1-15	33	Bani Fandou II-B: (60%)	3
1	1-9	26	Courronne Nord	4

CU	Group	ID	Quartier	Priority
Stage 2 New System Introduced by 2010				
1	1-17	37	Baghdad	1
2	2-1	53,54	Terminus+Niamey Bas	1
1	1-19	43	Taiwan	2
2	2-14	56,58, 59,63	Kalley Centre, Sud + Lacouroussou + Nouveau Marche	2
2	2-15	57,60, 61	Kalley Est, Banizoumbou I, Abidjan	2
1	1-16	36	Banizoumbou II	3
1	1-18	42	Nord Lazaret	3
1	1-24	48,49	SONUCI+Koura Kano Nord	3
1	1-26	51	Ext. Kouara Tegui	3
1	1-20	44	Bobiel	4
1	1-23	47	Nord Faisceau	4
1	1-27	8,9,10 ,11	Zongo,Maourey,Gandacthe,Deizebon	4
1	1-28	15,16, 17	Boukoki I, II, III	4
2	2-7	80	Ext. Talladje	4
Stage 3 New System Introduced by 2015				
1	1-1	1	Plateau I-A: (60%)	1
1	1-2	1,2	Plateau I-A: (40%) + Ambassades	1
1	1-22	46	Ouest Faisceau 2	3
1	1-21	45	Ouest Faisceau 1	4
1	1-25	50	Ext. Kouara Kano Nord	4
1	1-29	18	Boukoki IV	4
2	2-8	82	Ext. Saga	4
2	2-9	84	Aviation 1-A: (50%)	4
2	2-10	84	Aviation 1-B: (50%)	4
2	2-11	86	Sari-Koubou-A: (33%)	4
2	2-12	86	Sari-Koubou-B: (33%)	4
2	2-13	86	Sari-Koubou-C: (33%)	4

10.2.3 Implementation Schedule

The implementation schedule of master plan project is summarized as shown in Table 10.2-11.

Table 10.2-12 IMPLEMENTATION SCHEDULE FOR SOLID WASTE MANAGEMENT

No.	Project	Year													
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1.	Equipment Purchase														
1-1	Equipment for Present Sys.														
1-2	Equipment for New Sys.														
1-3	Equipment for Disposal Sites														
2.	Construction and Preparation of Recycle Center														
(1)	Explanation for the resident & pre-collector														
(2)	Design, preparation and construction by Pre-collectors														
(3)	Commencement														
3.	Construction of Final Disposal Sites														
3-1	Construction Site CU1&2														
3-2	Construction Site CU3														

: First Phase Project
: Second Phase Project
: Third Phase Project

CHAPTER 11. INSTITUTIONAL AND ORGANIZATIONAL ARRANGEMENTS

CHAPTER 11. INSTITUTIONAL SET-UP

11.1 INSTITUTIONAL REQUIREMENTS

Assuming that the Master Plan for the Sanitation Improvement shall be implemented, the project facility shall be operated and maintained by suitable organization. In the solid waste management sector, the Municipality is expected to reinforce the present collection and dumping operation from roadside containers to the newly specified disposal sites, while the private *pre*-collectors are encouraged to collect solid wastes from houses and sort sand from wastes. Thus the solid waste operation will be maintained through the two-tiered mechanism: the primary tier by private pre-collectors, and the upper tier by the municipality. The former will require institutional support, whereby pre-collectors are allowed to pursue reasonable incentives, while the latter may require improvement of financial situation and uplifting of work ethics.

In the drainage and wastewater sector, newly constructed drains and sewage treatment plants are expected to be operated 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. It will be necessary to institute a new organization to control the workforces and deliver resources required. Since Niger as a country has no experience in that it has operated an urban sewerage system, it should be emphasized that Niger is launching an urban sewerage utility service for the first time. The municipality at the present time does not have enough human and financial resources to properly maintain even the roadside drains alone. It will not be an easy task for the municipality to establish a new entity, which shall provide an urban drainage and sewerage service. In the master plan stage, however, institutional requirements to launch the drainage and sewerage service will be identified. A basic organization structure and its development will then be envisaged to satisfy such requirements, and legal requirements to support the new sanitation services will finally be enumerated.

11.1.1 Concepts of Institution and Organization

Institutional setup, in its broad sense, includes cultural, socioeconomic and legal frameworks, organizations and their operational, financial and human resources. This chapter will cover these issues of the study and will be intended to present a comprehensive guidance to pursue a sustainable undertaking of the project.

In the course of the master plan study, construction plans for the drainage and sewerage facilities and the solid waste management program will be conceived and proposed. Once the proposed facilities are defined, a technical operation and maintenance program will be defined, and scale and qualifications of personnel to keep facilities running will be assessed. Costs for capital construction and ongoing operation will also be estimated.

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, which act and behave under them.

Institutional arrangements, therefore, have to include the public consensus on the necessity of the project and to what extent its costs shall be recovered from the beneficiaries, a legislative means to support the private waste collectors and to institute an organization for drainage and sewerage services, an enforceable tariff system, obligation of connection to sewers, prohibition from discharging certain substance or chemicals into sewers, etc. Organizational arrangements will comprise at least design of the organization's structure, placement of required personnel, i.e., engineers, technicians, workers, accountants, business handlers, etc., to the suitable seats or roles, clear descriptions of key roles and measures to keep staff in a desirable work ethics, which may include training programs to upgrade technology and skills and a well defined promotion scheme.

11.1.2 Requirements to the Drainage and Sewerage Service Provider

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:

Single management - One integrated and responsible entity shall operate and maintain all the drainage and sewerage facilities, and provide the services to the citizens. There shall be a single central organization to manage and operate the drainage and sewerage services for the whole city.

Efficient operation / Least cost - The service of acceptable quality should be provided with expense of the least operation cost. The provider needs to render the services very efficiently.

Transparent cost - To ensure the least cost operation, detailed cost components that are verified by the audited financial reports shall be made available to the public and the beneficiaries.

Financial autonomy - Facilities are constructed and owned by the national government. The service provider is responsible to operate and maintain the facilities and thereby to provide the services. Such operational costs are desired to be recovered by means of the service charge or tariff. The Government or the Municipality cannot afford to subsidize the operational costs.

These principles are bases and targets in instituting any modern public utility service, which is natural monopoly in the service area. Layout of organization for the service provider and implementing legal framework should follow the line to conform these principles.

11.1.3 Tariff Setting and Collection

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.

11.1.4 Accountability to the Taxpayers and the Customers

The drainage and sewerage facilities are constructed by the National Government through its project budget. The services are operated on fees comprising the connection charge and the service charge. The budget is originated from taxpayers and granted by sanctions of representatives at the national and city levels. The fees are originated from customers who pay for the service. Both taxpayers and customers expect that their money is utilized very efficiently and no unnecessary expense is allowed in the service operation. The service provider is therefore accountable to both of them. It should make all of its activities publicly monitorable and its financial status properly audited and reported.

Costs of the service should be grasped in sufficient details and controlled by a single management so that they can be enumerated in one financial statement. This practice would be possible in an independent entity that operates the services in a way similar to those of commercial or business operations.

11.1.5 Control of Tariff

The drainage and sewerage service is a natural monopoly and, therefore, does not face any market competition. Where price is not determined in the market, it should be determined by the public interest. Rate of tariff or amendment thereof shall be approved by the suitable authority.

11.1.6 Required Functions of the Service Provider

Divisional and unit functions given below are those of the minimum requirement to a modern drainage and sewerage service provider. These can be followed in this Project in a smaller scale. Any single function, however, should not be omitted.

a. Technical operation (Technical operation, maintenance and repair, procurement and storehouse, laboratory, design and construction management)

   Sewerage engineers and technicians are required to operate the facilities with the minimum expense. Shift work routine shall be organized where the facilities are to be operated 24-hour a day. There should be an Operation Unit. Daily, weekly, monthly and yearly routines to check specific equipment and facilities have to be established. Periodical replacements are necessary as to the consumable parts. For the unexpected malfunction of the system, urgent repair has to be made by the in-house personnel. A Maintenance and Repair Unit should carry out both corrective and preventive maintenance. Consumable chemicals and spare parts are to be procured and stored in the specified quantities. There should be a Procurement and Storehouse Unit.

To ensure the water quality standards and function of each facility within the sewage treatment plant, water quality at each unit process should be kept monitored at the in-house laboratory. Daily, weekly, monthly and yearly checklists shall be developed and organized as a routine program of a Laboratory Unit.

Function of design and construction management should be established to supply plans and designs for construction work necessary to develop or maintain the sector services. There will be a Design and Construction Management Unit.

b. Planning Function (planning)

Planning function should be assumed, at first, to be a monitoring center of progress of projects under the master plan. If difficulty to the progress is encountered, a planning unit shall analyze the problem and prepare measures to solve it. This unit function begins with analysis of the problem and its solution by comparing the present service with the targets set according to social, economic, environmental and regulatory policies within which the sector service must function.

Using this frame of reference, the unit should aim at effective accomplishment of the objectives of the service in the long, medium and short term. The planning function must make sure all parts of the service provider work efficiently to meet targets so that it may deliver the services required by the community.

c. Administration Support (public and customer relations, human resources administration and development, payroll, supply and asset administration, legal office)

The public and customers as essential for their health and environment shall recognize the drainage and sewerage service. The customers need to know that the tariff they pay is utilized in the most appropriate way. Decision-makers and politicians also need to be aware of the importance of the financial support to the drainage and sewerage service. The provider shall supply thus required information through a Public and Customer Relations Unit. In areas where on-site sanitation system is adopted, the provider should organize sensitization activity for the sanitation improvement through this Unit.

The provider needs to recruit the required personnel and train them for the demanded expertise, as its service area and capacity develop in line with the master plan. To ensure stable supply of required expertise, a plan of human resources demand and supply should be drawn up, and a Unit of Human Resources Administration and Development should develop external and in-house training programs.

A Supply and Asset Administration Unit should be organized to control the provider's procurement of supplies and holding of asset. Within this unit, a sub-unit for transport administration may be attached as responsible for the management, operation and maintenance of vehicles used by the provider.

A General Administration Unit will be assigned for tasks that are not assigned to other units. Legal function can be combined with this unit.

d. Financial Control (accounting, financial administration and cost control)

A Financial Administration and Cost Control Unit should be responsible for managerial accounting as well as cost control and compilation of annual budget, while an Accounting Unit should be responsible for financial accounting and cash handling. These two units in collaboration should compile financial reports for audit by the professional authority designated by the National and Municipal Governments. They should then publish thus audited financial reports annually for the general circulation. The most important function of the Financial Administration and Cost Control Unit is to grasp and control actual cost of the sewerage service.

e. Commercial System (billing and collection, customer registration, marketing)

The provider's major source of revenue will be the drainage and sewerage charge and the new connection charge. A Customer Registration Unit should register a new connection and arrange the work thereof. A Billing and Collection Unit shall establish a database for all the connected customers by the time the sewerage service will be started. This will be easily made, if the customer database of the water supply company is available. Otherwise, the provider's management needs to mobilize a taskforce to create a connection/customer database by canvassing all the buildings and houses within the service area.

These unit functions are basic and represent a minimum requirement. Neither of the functions should be omitted while physical units can have combined functions. It should be emphasized that functions of financial and commercial nature are of important role in order to control costs to the minimum level while retaining revenue sources from customers and government subsidy. Objectives and targets of these unit functions should be similar to those of private commercial / business entities.

11.2 REQUIREMENTS TO THE PROJECT IMPLEMENTING AGENCY

After the planning stage, the Project will be implemented in accordance with the construction schedule. An implementing agency shall be instituted and suitably staffed to undertake implementation activities. The implementing activities comprise stage of selection and employment of consultants, detailed design stage, bidding stage and procurement and construction stage. Another important activity, however, will be acquisition and preparation of lands, which may involve relocation of inhabitants.

The first job of the agency is to employ a consultant in accordance with the guidelines of the lender. The consultant's main duties are the professional advice to the executing and implementing agencies, detailed design, preparation of tender documents and supervision of construction. 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:

- Listing of the potential consultants (preparation of the long list)
- Preparation of Letter of Invitation for Proposal including Terms of Reference
- Preliminary selection of the most relevant consultants (short list)
- Invitation for Proposal
- Evaluation of the submitted proposals
- Obtaining the consent of the lender on results of the evaluation

- Negotiation with the selected consultant on terms of the service agreement
- Signing of the agreement and approval by the lender

In the detailed design stage, the consultant shall prepare detailed design and tender documents in close collaboration with the implementing agency, to which the consultant is actually an advising organ. Here, the agency shall sign to approve design drawings on behalf of the executing agency. In most of countries, the tender and contracting procedures shall be taken in accordance with the laws and regulations relevant to the public procurement and construction works. In the case of projects funded by the bi- or multi-lateral loan agency, however, these procedures are required also to follow guidelines of such agency, which will be stipulated in the Loan Agreement. While the consultant is preparing the tender documents, the agency is expected to supply information on legal restrictions, if any, of procurements and contracts of the public works. Such information will be incorporated into terms of tender and contract of the tender documents, while the terms of the Loan Agreement between the executing agency and the lender are more influential. The tender documents thus prepared shall be submitted to the lender for its approval prior to the bidding stage.

At the bidding stage, the consultant shall assist the implementing agency in evaluating the tenders submitted, negotiating contracts with the successful bidders and finalizing the contracts. The executing agency and the lender before approving contract shall approve all of these procedures.

In the procurement and construction stage, the consultant shall supervise the construction work, check quality and quantity of material procured, and measure progress of the work. More importantly, the consultant shall advise the contractor in organizing technology transfer and training on operation and maintenance of the constructed facilities and the installed equipment. By that time, the implementing agency shall have the personnel to be trained. That personnel shall be transferred to the drainage and sewerage service provider after the handing-over the completed project facilities.

Acquisition and preparation of lands for the wastewater treatment plants and pump stations will have to be completed by the time construction work shall begin.

11.3 PROPOSED ORGANIZATION AND ITS DEVELOPMENT

Requirements for the operation and maintenance organization were identified. The organization should be defined as a public service provider. Its unit functions should need to work collectively to provide the services suitable to the public interest. To make a combination of unit functions work effectively, guiding conditions and principles will be presented, and then design of basic organization and its establishing guidelines will also be indicated.

11.3.1 International Best Practice as a Guide

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:

- Autonomy in all aspects of managing the enterprise and operation of drainage and wastewater systems, including the planning, financing and implementation of investments;

- A clearly defined regulatory framework by Government, which hold the companies to high standards of efficiency, while insulating professional management from undue political interference;

- Financial self-sufficiency from the collection of tariffs sufficient to meet all financial needs - operational, maintenance, investment, and debt service;

- A strong sense of public service and consumer orientation to render service of best quality for minimal cost;

- Access to credit for financing investments; and

- Reliance on a strong, competitive private sector to provide quality support service.

These principles hold true for the most economically advantaged countries in Western Europe and North America, as well as for the poorer countries in the world.

Accepting these principles and creating viable working conditions for them in Niamey can lead to an efficient drainage and wastewater sector that provides adequate services at a reasonable cost. To adopt these principles of international experience and best practices, deep adjustments to current policies and attitudes among all participants in the sector at all levels are needed. It requires a paradigm shift to make the customer a central actor by requiring the customer to pay the full cost of service in exchange for a voice in the sector. The price for services should be related to consumption to provide an equitable sharing of the costs and foster responsible use of limited public resources. The drainage and wastewater utilities providing services would recognize their responsibility to spend resources efficiently to provide a fair return on the financial resources entrusted to them. Responsible resource usage would be carried out by the utility, and by governments at the municipal, regional and national levels.

11.3.2 Basic Organization of Urban Drainage and Sewerage Service

To provide the drainage and sewerage services at the least cost, the provider's organizational structure should be that of the minimum required. Presented hereunder is such a basic organization. Function of each unit is outlined in the following.

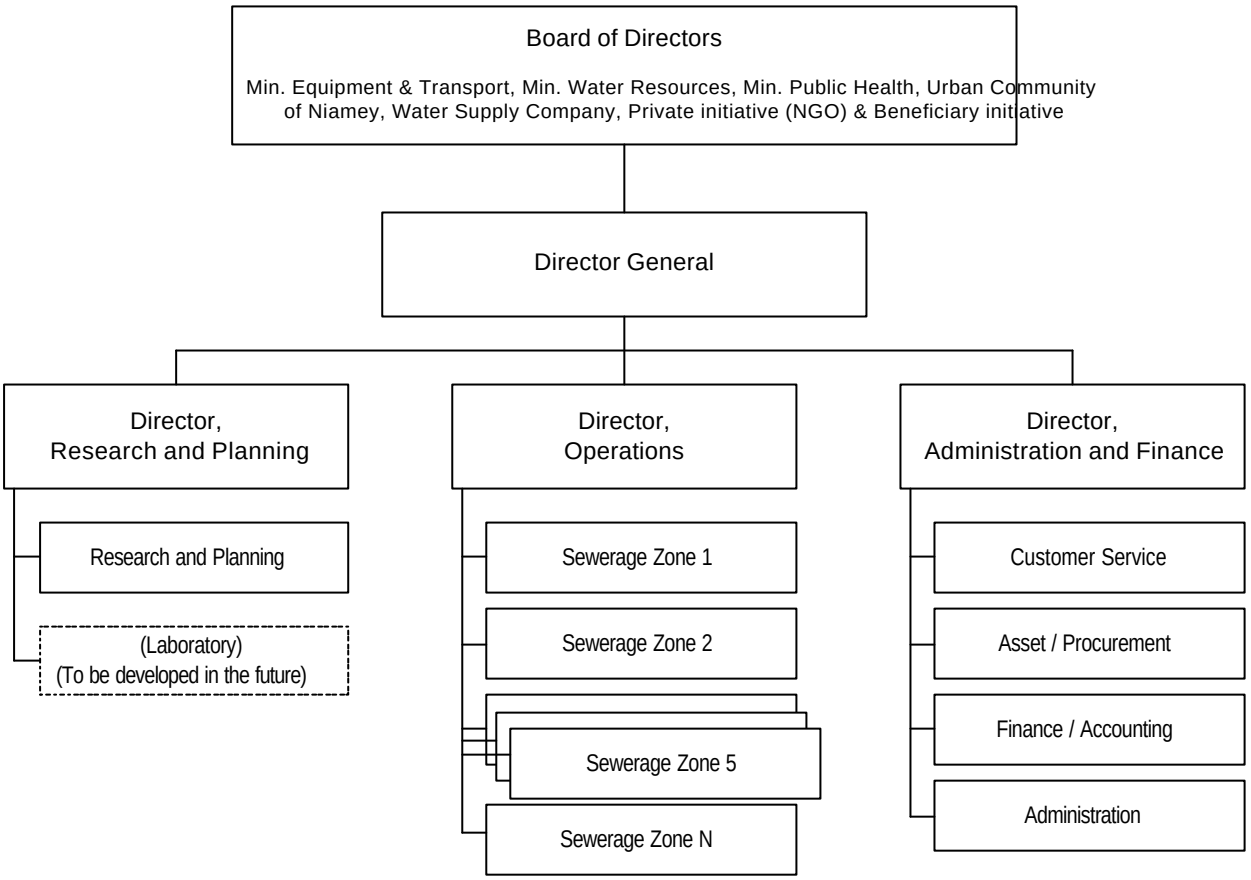


Figure 11.3-1 ORGANIZATION OF THE URBAN DRAINAGE AND SEWERAGE SOCIETY

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.

In this basic organization, the unit functions paraphrased in the previous section will fit into each division and unit in the following way.

Division	Unit	Unit function
Research and Planning	Research & planning	Planning, design & construction management
	Laboratory	Laboratory (to be developed in the future)
Operations	Sewerage zone offices	Technical operation, maintenance and repair
Administration and Finance	Customer service	Public & customer relations, billing & collection, customer registration, marketing
	Asset/procurement	Procurement & storehouse, supply& asset
	Finance/accounting	Accounting, financial administration & cost control
	Administration	Human resource, payroll, legal office

11.3.3 Personnel Required and Their Training

Training programs in country and abroad particularly for wastewater engineering will have to be prepared and implemented. It would be a good idea to train key engineers in the countries where sewerage system is extensively developed. Key staff for financial and cost control shall be recruited from among the graduates of the reputed accountant school. Further training on the international accounting principles and reasonable calculation of service costs shall be undertaken if such is available in the adjoining countries. Training program for the commercial staff in the customer service needs to be prepared carefully with guidance by the experienced staff from the water supply company. Besides these strategic training for the key management staff, general training for the computer literacy and handling of the management information system should be extensively undertaken to all the staff.

11.3.4 Technology Transfer on Operation and Maintenance of Facilities

Manufacturer's instructors shall implement technology transfer programs during the initial operation period after installation of facilities and equipment. This obligation shall be included in the conditions of contract. By the timing of the initial operation, key personnel for operation and maintenance should have been appointed.

11.3.5 Definition of Costs for the Service

Apart from the financial accounting, the managerial accounting shall be maintained to grape actual costs of services in details. For this purpose, techniques should be developed to define individual cost items and journalizing of the common cost items. Introduction of the computerized management information system and cost control system would help develop these costs calculations.

11.3.6 Clear Definition of Job Scopes for Key Personnel

Job descriptions for key personnel such as Director General, directors of divisions, important unit chiefs, etc., shall be defined, and their objectives/targets to be achieved have to be clarified.

11.3.7 Placement, Development and Promotion of Human Resources

In the framework of the Master Plan, drainage and sewerage facilities are expected to expand year by year, and operation and maintenance personnel will need to be increased. A series of programs for personnel placement and human resource development or career development will need to be developed in the long and medium term. A well considered promotion scheme should also be defined to motivate those who achieve objectives of each position.

11.4 LEGAL ARRANGEMENTS FOR THE DRAINAGE AND SEWERAGE SERVICE AND THE SOLID WASTE MANAGEMENT

11.4.1 Obligation of Connection to Sewer

Every house in areas where sewer network is developed must be connected. Disposal of sewage and wastewater to open channels other than sewers is prohibited. This obligation should be legalized.

11.4.2 Enforceable Service Charge

While direct beneficiaries of urban drainage facilities are difficult to be specified, those of water supply and sewerage services can be specified, and their volume of use can be defined by metering. Therefore, cost recovery from the direct users of water supply and sewerage is theoretically possible. While recovery of one hundred percent of cost will be ultimate target, a practical tariff system must be applied in view of affordability to pay from household expenses. In the case of the sewerage services, costs for operation and maintenance, for the time being, shall be recovered through service charge from beneficiaries. Laws or decrees to this effect shall be enacted.

11.4.3 Urban Development Plan and Integrated Flood Control

Formal and informal housing development in the peripheral Niamey is observed rapid. Pattern of stormwater concentration will be diversely changed, as the urbanization and housing development progress without any control or global urban planning. It is very important to control the urban development taking into account the micro-topography such as natural drains. In order to enable effective control, the urban development master plan should be formulated. On the other hand, flood control measures may be integrated with non-structural ones such as catchment area development plan and land use plan, where developer's obligation to provide retention pond, utilization of low-laying land as natural flood plain, etc. should be defined. Legal arrangement and organizational setup to enable such urban development plan including non-structural measures shall be sought for.

11.4.4 Sewerage Law and Sewerage Facilities Law

Legal concept and definition of drainage and sewerage facilities shall be established. A basic law including ideal, objectives, definition, provider and provider's responsibility of the drainage and sewerage service will need to be enacted. A law to establish the service provider will also be needed.

11.4.5 Control of Groundwater Exploitation

There is no enforceable control over the groundwater wells. Mechanisms for effective control of groundwater exploitation may be instituted. Should the exploited volume be significant, measures to quantify the groundwater yield and hence wastewater generation should be sought for.

11.4.6 Legal Status of Private Pre-Collectors

There will be the two-tiered solid waste control mechanism. Private pre-collector is a new concept in many parts of the world. Its roles need to be defined and enabling legal framework to encourage its incentives should be ensured.

Main problems in Niamey's solid waste control are limited operational, financial and human resources on the part of Municipality. Roadside garbage containers are not conveniently located and their number is not sufficient. Thereby people are discouraged to bring their wastes to the suitable containers. Moreover, containers are not necessarily regularly emptied due to shortage of transportation means and financial deficiency. It is not easy to improve the capacity of the Municipality's taskforce.

Private pre-collectors are expected to collect wastes from the source of generation such as offices, shops, restaurants, households, etc., reduce volume of wastes by sorting sand, - and other recyclable or tradable contents eventually, and load thus reduced wastes to the containers to be provided by the Municipality. These are the roles of the pre-collectors.

At the end of the pre-collectors' task, the Municipality's role shall start. The remaining waste at the sorting centers should be removed regularly to the designated landfill site. It is one of the important links in the chain of solid waste management that the remaining waste will be removed and disposed of properly. Municipal services shall consider the transport of containers from the sorting centers to the municipal landfill site as one of their duties. The operation of the landfill sites shall be managed by the municipal services that have to be trained for such purposes.

In this two-tiered mechanism, private pre-collectors are assumed to undertake their activities on the basis of individual contracts with the waste generators (offices, shops, households, etc.). It will be necessary for the Municipality to encourage and propagate such private entrepreneurship in this sector.

The Municipality, therefore, needs to license their activity of pre-collection without any levies, charges or taxes. It should also encourage the waste generators to engage, by contracting with, the private pre-collectors. At the same time, it should ensure the pre-collection activities to be a reasonably profitable business. It should allow the pre-collectors to freely sell sand and other by-products, while excessive collection charge should be controlled. Laws or regulations to this effect, if necessary, shall be enacted.

11.5 COMMUNITY PARTICIPATION

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

- Participation of residents – assumed beneficiaries
- Participation of women – main actors of sanitary behavior
- Participation of Non-Government Organizations (NGO) – some already active
- Participation of schoolchildren through hygiene education

The National Government and the Municipality are hereby encouraged to formulate a workable mechanism to involve these important participants. They are not only important in the awareness raising but also in generating a public consensus on the necessity and importance of the proposed projects in the present Master Plan. They would act leading roles in upgrading the sanitation environment as a whole.

To help this mechanism building, exercise of the Pilot Projects and succeeding hygiene education would bring about visible examples. They should be properly utilized by letting more people eye watch them and their benefits become recognized. It would be a key issue to utilize impacts of the Pilot Projects properly.

CHAPTER 12. FINANCIAL ANALYSIS

CHAPTER 12. FINANCIAL ANALYSIS

12.1 PROPOSED SCALE AND SCHEDULE OF INVESTMENT

The Master Plan proposes sanitation improvement projects in two sectors: drainage and sewerage sector, and solid waste management sector. Capital investment cost, and annual operation and maintenance cost for the drainage and sewerage projects may be summarized in Table 12.2-1.

Table 12.1-1 PROJECT COST FOR DRAINAGE AND SEWERAGE VS. DIRECT BENEFICIARY

In thousand CFA F

Year	Capital cost	O&M cost	Total	Beneficiary
2002	220,881		220,881	(person)
2003	1,415,374		1,415,374	
2004	1,821,351		1,821,351	
2005	2,916,537	0	2,916,537	
2006	6,461,495	79,170	6,540,665	43,346
2007	6,469,838	146,315	6,616,153	43,273
2008	7,541,335	164,190	7,705,525	43,201
2009	6,556,483	216,477	6,772,960	54,386
2010	3,744,956	336,102	4,081,058	64,885
2011	3,220,544	390,697	3,611,241	158,410
2012	2,904,197	449,037	3,353,234	158,956
2013	2,282,509	482,102	2,764,611	159,505
2014	1,776,621	517,273	2,293,894	233,932
2015	595,577	570,739	1,166,316	459,700
2016		598,716	598,716	793,701
Thereafter		598,716	598,716	
Total	47,927,698			

In the solid waste management projects, costs are shown in Table 12.1-2.

Table 12.1-2 PROJECT COST FOR SOLID WASTE MANAGEMENT VS. DIRECT BENEFICIARY

In thousand CFA F

Year	Capital cost	O&M cost	Total	# of Beneficiary*
2005	1,614,493	534,564	2,149,057	757,191
2010	1,088,521	931,895	2,020,416	871,346
2015	2,402,130	1,380,380	3,782,510	993,724
Thereafter		1,380,380	1,380,380	
Total	5,105,144			

* Total population of Niamey city is the assumed beneficiary.

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 be recovered from the contracted service-users or beneficiaries.

Table 12.1-2 (a) MUNICIPALITY PORTION

In thousand CFA F

Year	Capital cost	O&M cost	Total	# of Beneficiary
2005	1,495,685	180,353	1,676,038	757,191
2010	1,016,131	279,699	1,295,830	871,346
2015	2,341,184	350,258	2,691,442	993,724
Thereafter		350,258	350,258	
Total	4,853,000			

Table 12.1-2 (b) PRIVATE PRE-COLLECTOR PORTION

In thousand CFA F

Year	Capital cost	O&M cost	Total	# of Beneficiary
2005	118,808	177,901	296,709	168,771
2010	72,390	334,978	407,368	337,545
2015	60,946	522,567	583,513	556,755
Thereafter		522,567	522,567	
Total	252,144			

The total investment cost, therefore, is 53 billion CFA 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.

Table 12.1-3 CAPITAL EXPENDITURE - NIGER

In billion CFA F

	1997	1998	1999	2000
Capital expenditure	54.7	68.8	69.3	66.4
Domestic finance	5.7	8.9	17.1	11.9
External finance	49.0	60.0	52.2	54.5

Source: The World Bank / IMF / MP

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

Scale of the investment under the present project implies the need for external financial source. This will be discussed later in this chapter.

12.2 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. Annual operation cost of the service provider is shown in Table 12.2-1.

Table 12.2-1 OPERATION AND MAINTENANCE COST SHARED BY BENEFICIARY AND PER TREATED VOLUME

Cost: CFA F

Year		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Plants	# of operating Plants	0	1	3	4	6	8	9	10	11	12	13	14
	Plant operating cost	0	4,178,000	38,875,000	40,526,000	48,612,000	77,021,000	91,885,000	110,494,000	115,582,000	122,775,000	136,510,000	136,510,000
	Personnel cost	0	16,224,000	48,672,000	64,896,000	97,344,000	129,792,000	146,016,000	162,240,000	178,464,000	194,688,000	210,912,000	227,136,000
	Plant cost	0	20,402,000	87,547,000	105,422,000	145,956,000	206,813,000	237,901,000	272,734,000	294,046,000	317,463,000	347,422,000	363,646,000
Headquarters	% established	0%	25%	25%	25%	30%	55%	65%	75%	80%	85%	95%	100%
	Personnel cost	0	22,230,000	22,230,000	22,230,000	26,676,000	48,906,000	57,798,000	66,690,000	71,136,000	75,582,000	84,474,000	88,920,000
	Operating cost	0	36,537,500	36,537,500	36,537,500	43,845,000	80,382,500	94,997,500	109,612,500	116,920,000	124,227,500	138,842,500	146,150,000
	Headquarter cost	0	58,767,500	58,767,500	58,767,500	70,521,000	129,288,500	152,795,500	176,302,500	188,056,000	199,809,500	223,316,500	235,070,000
Total operating cost		0	79,169,500	146,314,500	164,189,500	216,477,000	336,101,500	390,696,500	449,036,500	482,102,000	517,272,500	570,738,500	598,716,000
Population served (beginning of year)		0	43,346	145,615	156,806	229,886	424,102	514,390	576,472	593,077	645,523	741,047	793,701
Operating cost per beneficiary	Constant price	0	1,826	1,005	1,047	942	793	760	779	813	801	770	754
	Inflation by 3 percent	0	2,117	1,200	1,288	1,193	1,034	1,021	1,078	1,159	1,177	1,165	1,175
	Inflation by 5 percent	0	2,331	1,347	1,473	1,391	1,229	1,237	1,332	1,460	1,511	1,525	1,568
Daily treated flow (in cu m)		0	1,908	9,193	9,947	13,640	23,632	27,440	29,978	32,301	35,586	38,878	41,409
Operating cost per 1 cum	Constant price	0	114	44	45	43	39	39	41	41	40	40	40
	Inflation by 3 percent	0	132	52	56	55	51	52	57	58	58	61	62
	Inflation by 5 percent	0	145	58	64	64	60	64	70	73	75	80	82

In the Master Plan, recovery of operation and maintenance cost alone is expected. Per Capita 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 (US$ 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.

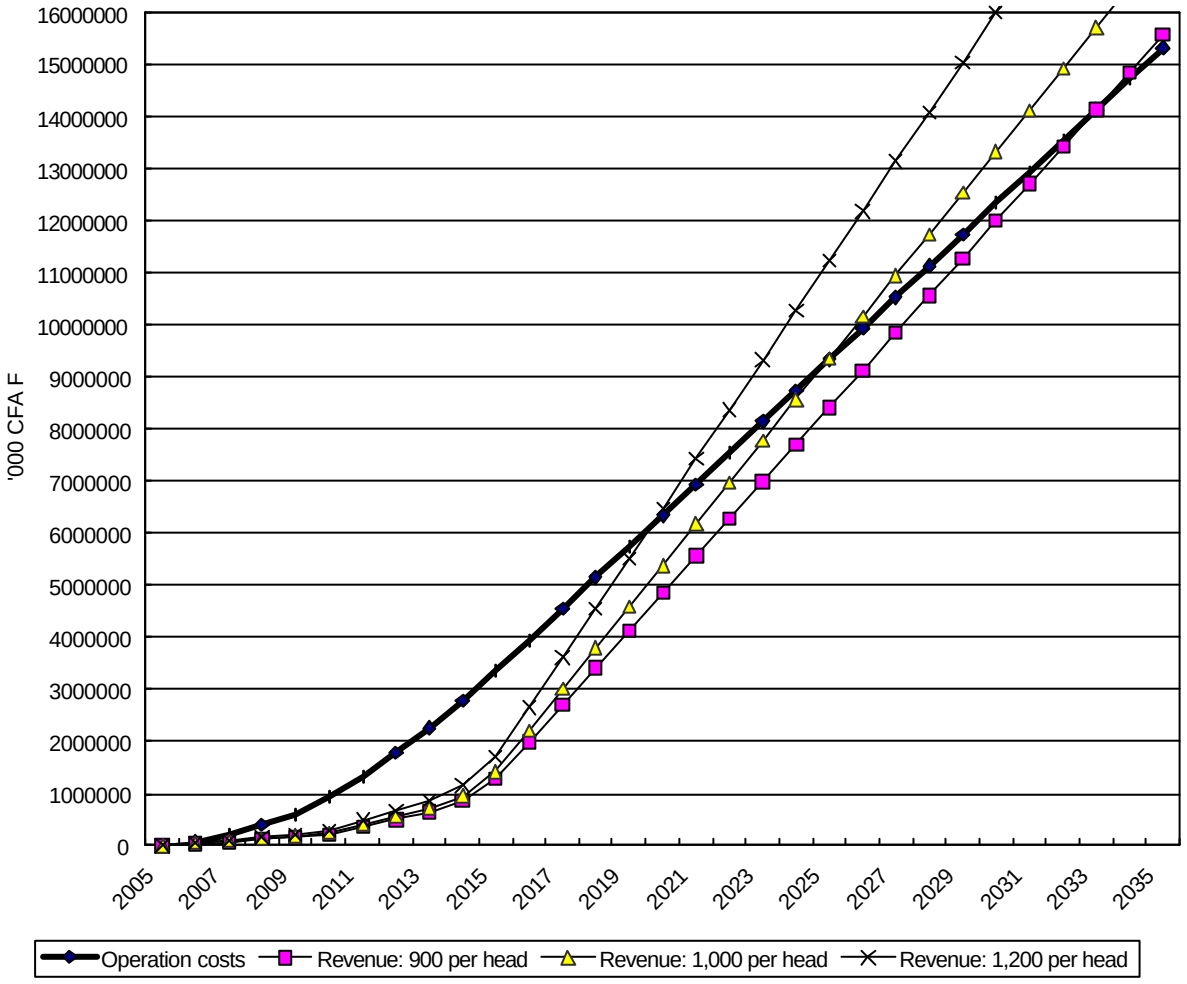


Figure 12.2-1 BALANCE OF REVENUE AND OPERATION COSTS

In the case of 900 CFA F per capita per year, balance will be attained only in year 2033. If it is 1,000 then in 2025, and if 1,200 then in 2017 (for detail, see Table 12.2-2) will be stained respectively. This will be much delayed in the actuality where factors of price escalation, value added tax, loan and its repayment have to be taken into account. It should be also noted that this calculation is intended to show scale of tariff only, and it is not suggesting a way to set the tariff.

Table 12.2-2 BALANCE OF TARIFF REVENUE AND OPERATION COSTS

(Unit: thousand CFA F unless otherwise specified.)

Year	Operation cost	Accumulated operation cost	Population served	Tariff revenue	Annual balance	Accumulate revenue	Accumulated balance
					If per-head tariff is	900	CFA F.
2005	0		0		0	0	0
2006	79,170	79,170	43,346	39,011	-40,158	39,011	-40,158
2007	146,315	225,484	43,273	38,946	-107,368	77,957	-147,527
2008	164,190	389,674	43,201	38,881	-125,309	116,838	-272,835
2009	216,477	606,151	54,386	48,947	-167,530	165,786	-440,365
2010	336,102	942,252	64,885	58,396	-277,705	224,182	-718,070
2011	390,697	1,332,949	158,410	142,569	-248,128	366,751	-966,198
2012	449,037	1,781,985	158,956	143,060	-305,976	509,811	-1,272,174
2013	482,102	2,264,087	159,505	143,555	-338,547	653,366	-1,610,721
2014	517,273	2,781,360	233,932	210,539	-306,734	863,904	-1,917,455
2015	570,739	3,352,098	459,700	413,730	-157,009	1,277,634	-2,074,464
2016	598,716	3,950,814	793,701	714,331	115,615	1,991,965	-1,958,849
2017	598,716	4,549,530	793,701	714,331	115,615	2,706,296	-1,843,234
2018	598,716	5,148,246	793,701	714,331	115,615	3,420,627	-1,727,619
2019	598,716	5,746,962	793,701	714,331	115,615	4,134,958	-1,612,004
2020	598,716	6,345,678	793,701	714,331	115,615	4,849,288	-1,496,390
2021	598,716	6,944,394	793,701	714,331	115,615	5,563,619	-1,380,775
2022	598,716	7,543,110	793,701	714,331	115,615	6,277,950	-1,265,160
2023	598,716	8,141,826	793,701	714,331	115,615	6,992,281	-1,149,545
2024	598,716	8,740,542	793,701	714,331	115,615	7,706,612	-1,033,930
2025	598,716	9,339,258	793,701	714,331	115,615	8,420,943	-918,315
2026	598,716	9,937,974	793,701	714,331	115,615	9,135,274	-802,700
2027	598,716	10,536,690	793,701	714,331	115,615	9,849,605	-687,085
2028	598,716	11,135,406	793,701	714,331	115,615	10,563,936	-571,470
2029	598,716	11,734,122	793,701	714,331	115,615	11,278,267	-455,855
2030	598,716	12,332,838	793,701	714,331	115,615	11,992,597	-340,241
2031	598,716	12,931,554	793,701	714,331	115,615	12,706,928	-224,626
2032	598,716	13,530,270	793,701	714,331	115,615	13,421,259	-109,011
2033	598,716	14,128,986	793,701	714,331	115,615	14,135,590	6,604
2034	598,716	14,727,702	793,701	714,331	115,615	14,849,921	122,219
2035	598,716	15,326,418	793,701	714,331	115,615	15,564,252	237,834

Year	Operation cost	Accumulated operation cost	Population served	Tariff revenue	Annual balance	Accumulate revenue	Accumulated balance
					If per-head tariff is	1000	CFA F.
2005	0		0		0	0	0
2006	79,170	79,170	43,346	43,346	-35,824	43,346	-35,824
2007	146,315	225,484	43,273	43,273	-103,041	86,619	-138,865
2008	164,190	389,674	43,201	43,201	-120,989	129,820	-259,853
2009	216,477	606,151	54,386	54,386	-162,091	184,206	-421,944
2010	336,102	942,252	64,885	64,885	-271,217	249,091	-693,161
2011	390,697	1,332,949	158,410	158,410	-232,287	407,501	-925,448
2012	449,037	1,781,985	158,956	158,956	-290,081	566,457	-1,215,528
2013	482,102	2,264,087	159,505	159,505	-322,597	725,962	-1,538,125
2014	517,273	2,781,360	233,932	233,932	-283,341	959,894	-1,821,466
2015	570,739	3,352,098	459,700	459,700	-111,039	1,419,593	-1,932,505
2016	598,716	3,950,814	793,701	793,701	194,985	2,213,294	-1,737,520
2017	598,716	4,549,530	793,701	793,701	194,985	3,006,995	-1,542,535
2018	598,716	5,148,246	793,701	793,701	194,985	3,800,696	-1,347,550
2019	598,716	5,746,962	793,701	793,701	194,985	4,594,397	-1,152,565
2020	598,716	6,345,678	793,701	793,701	194,985	5,388,098	-957,580
2021	598,716	6,944,394	793,701	793,701	194,985	6,181,799	-762,595
2022	598,716	7,543,110	793,701	793,701	194,985	6,975,500	-567,610
2023	598,716	8,141,826	793,701	793,701	194,985	7,769,201	-372,625
2024	598,716	8,740,542	793,701	793,701	194,985	8,562,902	-177,640
2025	598,716	9,339,258	793,701	793,701	194,985	9,356,603	17,345
2026	598,716	9,937,974	793,701	793,701	194,985	10,150,304	212,330
2027	598,716	10,536,690	793,701	793,701	194,985	10,944,005	407,315
2028	598,716	11,135,406	793,701	793,701	194,985	11,737,706	602,300
2029	598,716	11,734,122	793,701	793,701	194,985	12,531,407	797,285
2030	598,716	12,332,838	793,701	793,701	194,985	13,325,108	992,270
2031	598,716	12,931,554	793,701	793,701	194,985	14,118,809	1,187,255
2032	598,716	13,530,270	793,701	793,701	194,985	14,912,510	1,382,240
2033	598,716	14,128,986	793,701	793,701	194,985	15,706,211	1,577,225
2034	598,716	14,727,702	793,701	793,701	194,985	16,499,912	1,772,210
2035	598,716	15,326,418	793,701	793,701	194,985	17,293,613	1,967,195

Table 12.2-2 CONTINUED BALANCE OF TARIFF REVENUE AND OPERATION COSTS

(Unit: thousand CFA F unless otherwise specified.)

Year	Operation cost	Accumulated operation cost	Population served	Tariff revenue	Annual balance	Accumulate revenue	Accumulated balance
					If per-head tariff is	1200	CFA F.
2005	0		0		0	0	0
2006	79,170	79,170	43,346	52,015	-27,154	52,015	-27,154
2007	146,315	225,484	43,273	51,928	-94,386	103,943	-121,541
2008	164,190	389,674	43,201	51,841	-112,348	155,784	-233,889
2009	216,477	606,151	54,386	65,263	-151,214	221,047	-385,103
2010	336,102	942,252	64,885	77,862	-258,240	298,909	-643,343
2011	390,697	1,332,949	158,410	190,092	-200,605	489,001	-843,948
2012	449,037	1,781,985	158,956	190,747	-258,289	679,748	-1,102,237
2013	482,102	2,264,087	159,505	191,406	-290,696	871,154	-1,392,933
2014	517,273	2,781,360	233,932	280,718	-236,554	1,151,872	-1,629,487
2015	570,739	3,352,098	459,700	551,640	-19,099	1,703,512	-1,648,586
2016	598,716	3,950,814	793,701	952,441	353,725	2,655,953	-1,294,861
2017	598,716	4,549,530	793,701	952,441	353,725	3,608,394	-941,136
2018	598,716	5,148,246	793,701	952,441	353,725	4,560,836	-587,410
2019	598,716	5,746,962	793,701	952,441	353,725	5,513,277	-233,685
2020	598,716	6,345,678	793,701	952,441	353,725	6,465,718	120,040
2021	598,716	6,944,394	793,701	952,441	353,725	7,418,159	473,765
2022	598,716	7,543,110	793,701	952,441	353,725	8,370,600	827,490
2023	598,716	8,141,826	793,701	952,441	353,725	9,323,042	1,181,216
2024	598,716	8,740,542	793,701	952,441	353,725	10,275,483	1,534,941
2025	598,716	9,339,258	793,701	952,441	353,725	11,227,924	1,888,666
2026	598,716	9,937,974	793,701	952,441	353,725	12,180,365	2,242,391
2027	598,716	10,536,690	793,701	952,441	353,725	13,132,806	2,596,116
2028	598,716	11,135,406	793,701	952,441	353,725	14,085,248	2,949,842
2029	598,716	11,734,122	793,701	952,441	353,725	15,037,689	3,303,567
2030	598,716	12,332,838	793,701	952,441	353,725	15,990,130	3,657,292
2031	598,716	12,931,554	793,701	952,441	353,725	16,942,571	4,011,017
2032	598,716	13,530,270	793,701	952,441	353,725	17,895,012	4,364,742
2033	598,716	14,128,986	793,701	952,441	353,725	18,847,454	4,718,468
2034	598,716	14,727,702	793,701	952,441	353,725	19,799,895	5,072,193
2035	598,716	15,326,418	793,701	952,441	353,725	20,752,336	5,425,918

12.3 TARIFF SETTING AND COLLECTION

The Master Plan suggests that the drainage and sewerage tariff shall be collected as a surcharge in the water bill. Simplest way is to add a certain percentage in 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 is assumed as 6,000 million in 2016, then 18.2 percent would be added to the water bill.

The water tariff table for Niamey city (see Table 12.3-1) incorporates the cross-subsidy among categories of customers and stepped tariff for domestic customers, in that the well off helps the poorer parts of population. The sewerage surcharge that is a specific percentage applicable to all the customers would be simple and easily acceptable, as it will bring about the social equitability as well.

Table 12.3-1 OPERATION OF WATER SUPPLY COMPANY, SOCIETE NATIONAL DES EAUX (SNE)

Operation in Niger

SNE is supplying drinking water to Niamey and other 51 towns and villages.	
Total production in 2000:	21million cu m
Total consumption:	16million cu m
Annual revenue:	5,000 to 6,000 million CFA F
Production per day:	45,000 to 55,000 cu m
Bad debt	2,700 million CFA F
Bad receivable	3,700 million CFA F

Operation in Niamey

Number of customers	
Public tap:	882 working among 950
Domestic customer:	23,000
Administrations:	544
Office, business and industries:	653

SNE Water Tariff Table for Niamey (Decree No. 99-539, February 1, 2000)	
For public tap:	115 FCFA / cu m
For domestic users:	
Up to 15 cu m/month:	115 FCFA / cu m
More than 15 to40 cu m/month:	207
More than 40 to 75:	312
More than 75:	349
For administrations:	283
For office, business and industries:	289
Fixed rental charge for water meter:	
Dia. 15 mm:	500 / month
Dia. 20 mm:	700
Dia. 30 mm:	1,000
VAT of 19% is applicable after first 50 cu m for domestic users.	

Privatization

SNE will be divided into two: an asset holding and planning entity, Societe de Patrimoins des Eaux de Niger, and a production and distribution company, Societe d'Exploitation des Eaux du Niger, of which 51 % share will be held by Vivandi, a French water supply operator. Other shareholders of the company are private Nigeriens (34 %), the Government (5 %) and staff of the company (10 %). The contract will be signed in March 2001.

12.4 SOURCE OF FUND AND REPAYMENT

The present master plan encompasses global improvement of the basic sanitation infrastructures for Niamey city. Social and environmental benefits will be diverse. 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 finance, which should be in the form of grant aid or a credit with concessive 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

Credit repayment schedule or amortization schedule is prepared with the assumption that the credit would be disbursed 3 times in three of the 5-year stages. Table 12.4-1 shows such disbursement assumption and amount of credit, in that included are all the capital costs of drainage and sewerage services and the municipality portion of solid waste management services, as well as the initial financial imbalance of the drainage and sewerage service provider, for example, for the case of the per-head tariff of 1,200 CFA francs, since the last O&M gap is not insignificant.

Table 12.4-1 DISBURSEMENT ASSUMPTION

In million CFA F

Year	Drainage & sewerage		Solid waste	Assumed disbursement
	Capital	O&M gap	Capital	
2002	221			
2003	1,415			
2004	1,821		1,496	7,870
2005	2,917			
2006	6,461	27		
2007	6,470	94		
2008	7,541	112	1,016	32,434
2009	6,556	151		
2010	3,745	258		
2011	3,221	201		
2012	2,904	258		
2013	2,283	291	2,341	14,126
2014	1,777	237		
2015	596	19		
Total	47,928	1,649	4,853	54,429

Table 12.4-2 AMORTIZATION SCHEDULE

In million CFA F

Year	Principal of credit	Disburse-ment #	Grace period (repayment of charges)			Repayment of principal and charges			Total repayment
			Disb. 1	Disb. 2	Disb. 3	Disb. 1	Disb. 2	Disb. 3	
2002									0
2003									0
2004	7,870	1							0
2005			-98						-98
2006			-98						-98
2007			-98						-98
2008	32,434	2	-98						-98
2009			-98	-405					-504
2010			-98	-405					-504
2011			-98	-405					-504
2012			-98	-405					-504
2013	14,126	3	-98	-405					-504
2014			-98	-405	-177				-680
2015				-405	-177	-251			-833
2016				-405	-177	-251			-833
2017				-405	-177	-251			-833
2018				-405	-177	-251			-833
2019					-177	-251	-1,035		-1,463
2020					-177	-251	-1,035		-1,463
2021					-177	-251	-1,035		-1,463
2022					-177	-251	-1,035		-1,463
2023					-177	-251	-1,035		-1,463
2024						-251	-1,035	-451	-1,737
2025						-251	-1,035	-451	-1,737
2026						-251	-1,035	-451	-1,737
2027						-251	-1,035	-451	-1,737
2028						-251	-1,035	-451	-1,737
2029						-251	-1,035	-451	-1,737
2030						-251	-1,035	-451	-1,737
2031						-251	-1,035	-451	-1,737
2032						-251	-1,035	-451	-1,737
2033						-251	-1,035	-451	-1,737
2034						-251	-1,035	-451	-1,737
2035						-251	-1,035	-451	-1,737
2036						-251	-1,035	-451	-1,737
2037						-251	-1,035	-451	-1,737
2038						-251	-1,035	-451	-1,737
2039						-251	-1,035	-451	-1,737
2040						-251	-1,035	-451	-1,737
2041						-251	-1,035	-451	-1,737
2042						-251	-1,035	-451	-1,737
2043						-251	-1,035	-451	-1,737
2044						-251	-1,035	-451	-1,737
2045						-251	-1,035	-451	-1,737
2046						-251	-1,035	-451	-1,737
2047						-251	-1,035	-451	-1,737
2048						-251	-1,035	-451	-1,737
2049						-251	-1,035	-451	-1,737
2050						-251	-1,035	-451	-1,737
2051						-251	-1,035	-451	-1,737
2052						-251	-1,035	-451	-1,737
2053						-251	-1,035	-451	-1,737
2054						-251	-1,035	-451	-1,737
2055							-1,035	-451	-1,486
2056							-1,035	-451	-1,486
2057							-1,035	-451	-1,486
2058							-1,035	-451	-1,486
2059								-451	-451
2060								-451	-451
2061								-451	-451
2062								-451	-451
2063								-451	-451
2064									0
2065									0

12.5 FINANCIAL INTERNAL RATE OF RETURN

12.5.1 Urban Drainage and Sewerage Society

Drainage and sewerage components of the project shall be constructed by the National Government and its operation and maintenance shall be undertaken by the proposed service provider, i.e., the Urban Drainage and Sewerage Society. 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. Other assumptions used in Table 12.5-1 are:

- Ten (10) percent of replacement cost also shall be taken, wherein civil engineering work shall be replaced after 50 years, and mechanical and electric equipments after 20 years.
- Tariff revenue alone comprises revenue of the Society.
- As a sensitivity analysis, 3 levels of tariff are compared:
    - Per-capita tariff of 800 CFA francs per year, representing the year 2001 constant price,
    - Per-capita tariff of 1,200, assuming 3 percent annual inflation, and
    - Per-capita tariff of 1,600, assuming 5 percent annual inflation.

12.5.2 Private Pre-Collectors Engaged in the Solid Waste Management

The solid waste management projects consist of component operated by the municipality and component operated by the private pre-collectors as shown in Table 12.1-2. Cost of the municipality component is expected to finance by the national and municipal budgets. Its revenue is virtually nil, 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.

On the other hand, costs, particularly capital cost of the pre-collector component is to be financed by the private entrepreneurships with their own risk. It will have flow of tariff revenue as well. Therefore, costs that consist of investment and operation can be compared with the revenue. Table 12.5-2 shows the financial internal rate of return of this component, where the following assumptions are used:

- Eighty (80) percent of investment (capital) costs are repeated in 20-year cycle for replacement of recycle center structures,
- Three (3) sets of revenue: 1,000, 1,200 and 1,500 CFA francs per head are compared.
- Revenue on sale of sand and other eventual byproducts are not calculated. If such is established, internal balance will be improved.
- The interest rate on locally available loans, which varies from 12 to 17 percent/annum, is considered.

Table 12.5-1 FINANCIAL INTERNAL RATE OF RETURN
SEWERAGE AND DRAINAGE

In million CFA F

Year	Capital cost	O&M cost	Total cost	Case of 800			Case of 1,200			Case of 1,600		
				Revenue @800	Balance	IRR	Revenue @1,200	Balance	IRR	Revenue @1,600	Balance	IRR
2002	22		22		-22			-22			-22	
2003	142		142		-142			-142			-142	
2004	182		182		-182			-182			-182	
2005	292	0	292	0	-292		0	-292		0	-292	
2006	646	79	725	35	-691		52	-673		69	-656	
2007	647	146	793	116	-677		175	-619		233	-560	
2008	754	164	918	125	-793		188	-730		251	-667	
2009	656	216	872	184	-688		276	-596		368	-504	
2010	374	336	711	339	-371		509	-202		679	-32	
2011	322	391	713	412	-301		617	-95		823	110	
2012	290	449	739	461	-278		692	-48		922	183	
2013	228	482	710	474	-236		712	1		949	239	
2014	178	517	695	516	-179		775	80		1,033	338	
2015	60	571	630	593	-37		889	259		1,186	555	
2016		599	599	635	36		952	354		1,270	671	
2017		599	599	635	36		952	354		1,270	671	
2018		599	599	635	36		952	354		1,270	671	
2019		599	599	635	36		952	354		1,270	671	
2020		599	599	635	36		952	354		1,270	671	
2021		599	599	635	36		952	354		1,270	671	
2022	0	599	599	635	36		952	353		1,270	671	
2023	2	599	601	635	34		952	351		1,270	669	
2024	3	599	602	635	33		952	351		1,270	668	
2025	5	599	603	635	32		952	349		1,270	667	
2026	10	599	609	635	26		952	343		1,270	661	
2027	10	599	609	635	26		952	343		1,270	661	
2028	12	599	611	635	24		952	342		1,270	659	
2029	10	599	609	635	26		952	343		1,270	661	
2030	6	599	605	635	30		952	348		1,270	665	
2031	5	599	604	635	31		952	349		1,270	666	
2032	5	599	603	635	32		952	349		1,270	667	
2033	4	599	602	635	33		952	350		1,270	668	
2034	3	599	602	635	33		952	351		1,270	668	
2035	1	599	600	635	35		952	353		1,270	670	
2036		599	599	635	36		952	354		1,270	671	
2037		599	599	635	36		952	354		1,270	671	
2038		599	599	635	36		952	354		1,270	671	
2039		599	599	635	36		952	354		1,270	671	
2040		599	599	635	36		952	354		1,270	671	
2041		599	599	635	36		952	354		1,270	671	
2042	0	599	599	635	36		952	353		1,270	671	
2043	2	599	601	635	34		952	351		1,270	669	
2044	3	599	602	635	33		952	351		1,270	668	
2045	5	599	603	635	32		952	349		1,270	667	
2046	10	599	609	635	26		952	343		1,270	661	
2047	10	599	609	635	26		952	343		1,270	661	
2048	12	599	611	635	24		952	342		1,270	659	
2049	10	599	609	635	26		952	343		1,270	661	
2050	6	599	605	635	30		952	348		1,270	665	
2051	5	599	604	635	31		952	349		1,270	666	
2052	18	599	617	635	18		952	336		1,270	653	
2053	89	599	687	635	-52		952	265		1,270	583	
2054	112	599	711	635	-76		952	242		1,270	559	
2055	176	599	775	635	-140		952	178		1,270	495	
2056	388	599	986	635	-351		952	-34		1,270	284	
2057	388	599	987	635	-352		952	-34		1,270	283	
2058	452	599	1,051	635	-416		952	-99		1,270	219	
2059	393	599	992	635	-357		952	-40		1,270	278	
2060	225	599	823	635	-188		952	129		1,270	447	
2061	193	599	792	635	-157		952	160		1,270	478	
2062	175	599	773	635	-138		952	179		1,270	497	
2063	139	599	738	635	-103		952	215		1,270	532	
2064	110	599	708	635	-73		952	244		1,270	562	
2065	40	599	639	635	-4		952	313		1,270	631	
2066	10	599	609	635	26		952	343		1,270	661	
2067	10	599	609	635	26		952	343		1,270	661	
2068	12	599	611	635	24		952	342		1,270	659	
2069	10	599	609	635	26		952	343		1,270	661	
2070	6	599	605	635	30		952	348		1,270	665	
2071	5	599	604	635	31		952	349		1,270	666	
2072	5	599	603	635	32		952	349		1,270	667	
2073	4	599	602	635	33		952	350		1,270	668	
2074	3	599	602	635	33		952	351		1,270	668	
2075	1	599	600	635	35	-15.12%	952	353	6.05%	1,270	670	11.32%

Table 12.5-2 FINANCIAL INTERNAL RATE OF RETURN
SOLID WASTE MANAGEMENT

In million CFA F

Year	Capital cost	O&M cost	Total cost	Case of 1,000			Case of 1,200			Case of 1,500		
				Revenue @1,000	Balance	IRR	Revenue @1,200	Balance	IRR	Revenue @1,500	Balance	IRR
2002	40	0	40		-40			-40			-40	
2003	26	59	86	56	-29		68	-18		84	-1	
2004	26	103	129	97	-32		117	-12		146	17	
2005	26	178	204	169	-36		203	-2		253	49	
2006	14	202	216	194	-23		233	16		291	74	
2007	14	229	244	223	-21		267	24		334	90	
2008	14	260	275	256	-19		307	32		384	109	
2009	14	295	310	294	-16		353	43		441	131	
2010	14	335	349	338	-12		405	56		506	157	
2011	12	366	378	373	-5		448	69		560	181	
2012	12	400	412	412	-0		495	82		619	206	
2013	12	437	450	456	6		547	97		684	234	
2014	12	478	490	504	13		604	114		756	265	
2015	12	523	535	557	22		668	133		835	300	
2016		523	523	557	34		668	146		835	313	
2017		523	523	557	34		668	146		835	313	
2018		523	523	557	34		668	146		835	313	
2019		523	523	557	34		668	146		835	313	
2020		523	523	557	34		668	146		835	313	
2021		523	523	557	34		668	146		835	313	
2022	32	523	554	557	3		668	114		835	281	
2023	21	523	544	557	13		668	124		835	291	
2024	21	523	544	557	13		668	124		835	291	
2025	21	523	544	557	13		668	124		835	291	
2026	12	523	534	557	23		668	134		835	301	
2027	12	523	534	557	23		668	134		835	301	
2028	12	523	534	557	23		668	134		835	301	
2029	12	523	534	557	23		668	134		835	301	
2030	12	523	534	557	23		668	134		835	301	
2031	10	523	532	557	24		668	136		835	303	
2032	10	523	532	557	24		668	136		835	303	
2033	10	523	532	557	24		668	136		835	303	
2034	10	523	532	557	24		668	136		835	303	
2035	10	523	532	557	24		668	136		835	303	
2036		523	523	557	34		668	146		835	313	
2037		523	523	557	34		668	146		835	313	
2038		523	523	557	34		668	146		835	313	
2039		523	523	557	34		668	146		835	313	
2040		523	523	557	34		668	146		835	313	
2041		523	523	557	34		668	146		835	313	
2042	32	523	554	557	3		668	114		835	281	
2043	21	523	544	557	13		668	124		835	291	
2044	21	523	544	557	13		668	124		835	291	
2045	21	523	544	557	13		668	124		835	291	
2046	12	523	534	557	23		668	134		835	301	
2047	12	523	534	557	23		668	134		835	301	
2048	12	523	534	557	23		668	134		835	301	
2049	12	523	534	557	23		668	134		835	301	
2050	12	523	534	557	23		668	134		835	301	
2051	10	523	532	557	24		668	136		835	303	
2052	10	523	532	557	24		668	136		835	303	
2053	10	523	532	557	24		668	136		835	303	
2054	10	523	532	557	24		668	136		835	303	
2055	10	523	532	557	24		668	136		835	303	
2056		523	523	557	34		668	146		835	313	
2057		523	523	557	34		668	146		835	313	
2058		523	523	557	34		668	146		835	313	
2059		523	523	557	34		668	146		835	313	
2060		523	523	557	34		668	146		835	313	
2061		523	523	557	34		668	146		835	313	
2062	32	523	554	557	3		668	114		835	281	
2063	21	523	544	557	13		668	124		835	291	
2064	21	523	544	557	13		668	124		835	291	
2065	21	523	544	557	13		668	124		835	291	
2066	12	523	534	557	23		668	134		835	301	
2067	12	523	534	557	23		668	134		835	301	
2068	12	523	534	557	23		668	134		835	301	
2069	12	523	534	557	23		668	134		835	301	
2070	12	523	534	557	23		668	134		835	301	
2071	10	523	532	557	24		668	136		835	303	
2072	10	523	532	557	24		668	136		835	303	
2073	10	523	532	557	24		668	136		835	303	
2074	10	523	532	557	24		668	136		835	303	
2075	10	523	532	557	24	6.41%	668	136	32.80%	835	303	74.28%

CHAPTER 13. HYGIENE EDUCATION

CHAPTER 13. HYGIENE EDUCATION

13.1 GENERAL

Based on the present level of public awareness and education and hygiene and sanitation of Niamey as reviewed in CHAPTER 3.9, it is pointed out that following critical issues should be overcome for preparing the effective plans and necessary actions on hygiene education for the Niamey city.

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

In this section, these critical issues shall be examined which are important for considering a basic concept and a plan of hygiene education in Niamey.

13.1.1 Policy and Plan

(1) Rural Issue and Urban Issue

The Ministry of Public Health (MSP) has prepared plans and policies on health and sanitation, and health education as shown in Table 3.9.1. These plans and policies, however, are not specifically dealing with a hygiene education for Niamey. This is because the MSP is handling health and sanitation issues at the national level.

At the national level, there are diverse problems and issues on health and sanitation such as malnutrition, leishmaniasis, endemic diseases and so on. These problems and issues naturally vary from region to region in Niger. Particularly, there are differences in the problems and issues between rural area and urban area due to mutually different backgrounds of social, cultural custom, natural environment and others. Namely, rural issues and urban issues should be dealt with separately. Consequently, it is essential to distinguish between policies and plans of hygiene education for a large city like Niamey and those for rural areas in Niger.

As to morbidity in CUN, for example, communicable (infectious and parasitic) diseases such as *Malaria*, *Pneumonia*, *Dysentery* and others are prevailing as shown in Table 3.9-12. Besides these diseases, *Cardio Vascular* diseases are reported as one of the leading causes of morbidity in CUN as well. Given that these *Cardio Vascular* diseases are chronic diseases, it can be said that the health situation in Niamey is facing the so-called "*double burden*" which has been seen often in many urban cities of developing countries in recent years. That is to say, two types of health issues of communicable diseases seen in developing countries and chronic diseases seen in developed countries are existing in Niamey at the same time. This situation of Niamey can be characterized as one of urban issues on health.

(2) Human Health and Urban Environment

The primary consideration in preparing a policy and plan on hygiene education for Niamey should be the selection of issues on health and sanitation for an urban city. From the viewpoint of the sanitation improvement of the city, generally, it can be stated that hygiene education for

Niamey has both aspects of human health and urban environment. In fact, communicable diseases are prevailing in Niamey, so that the first thing to consider in these two aspects is human health. Therefore, it is reasonable to assume that the human health has priority over urban environment in preparation order of a hygiene education plan for Niamey.

(3) Definition of Hygiene Education

In Niamey, there are lots of publications including reports, documents and printing materials in the field of health, sanitation and environment. The term of "hygiene education" has been seen often in such publications. Depending on the situation and occasion, however, "hygiene education" implies different meanings. For example, medical doctor may think "hygiene education" is a measure for preventing communicable diseases among population. On the other hand, civil engineer may suppose "hygiene education" is a means for changing wastewater discharge manner of public. This is because "hygiene education" covers considerably extensive fields from hand wash practice to eliminating of endemic diseases.

In addition to "hygiene education", there are similar terms related to education on health, sanitation and environment as follows.

- Health Education
- Environmental Education

As well, an environmental expert may deal with an instruction on wastewater discharge manner to population as "environmental education".

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 13.1-1.

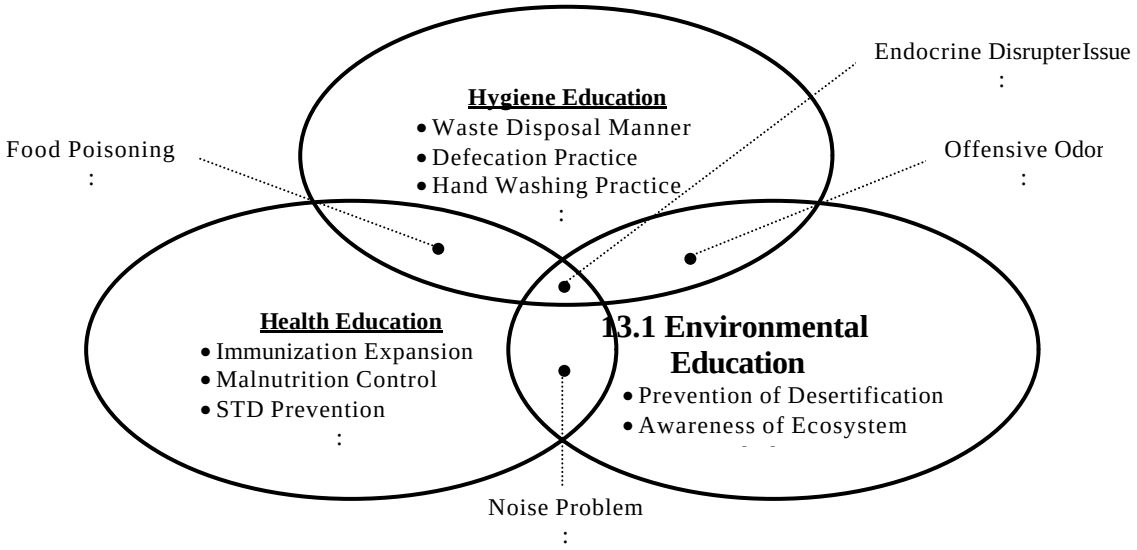


Figure 13.1-1 EDUCATION ON HYGIENE AND HEALTH

In this JICA study, the purpose and framework of the study and the present situation of Niamey are taken into consideration to identify the definition of "hygiene education" handled by this study, as follows:

- Actions to heighten public awareness on notion of health and sanitation
- Actions to heighten mutual understanding between community and concerned authority
- Actions to heighten public awareness on urban environment protection

13.1.2 Organizations and Approaches

(4) Actors

Except for the Ministry of Public Health (MSP), there are no specific section or function handling hygiene education in both public and private sectors. As discussed above, hygiene education covers extensive fields and definition of the education for Niamey has been given. Therefore, leading actors to be involved in the hygiene education and their possible involvement in the education can be summarized in Table 13.1-1. In this table, private sector includes community, civil society and individual.

Table 13.1-1 LEADING ACTORS AND INVOLVEMENT

	Leading Actors	Health & Sanitation	Mutual Understanding	Urban Environment
Public Sector	Ministry of Public Health (MSP)	●	◎	○
	• Health District/CUN (DS/CUN)	●	●	○
	• Integrated Health Center (CSI)	●	●	○
	Ministry of National Education (MEN)	○	●	○
	• Elementary and Secondary School	○	●	○
	Ministry of Environment and Prevention of Desertification (MED)	○	◎	●
	Ministry of Equipment and Transportation (MET)	○	◎	●
	Ministry of Water Resources (MRE)	◎	◎	○
	Urban Community of Niamey (CUN)	◎	●	◎
	• Commune I, II, III	◎	●	◎
	Public Mass Media	○	○	○
Private Sector	Local NGO/NPO	◎	●	◎
	Local Association/Union (Women, Youth and so on)	○	●	◎
	Commercial Association/Union	○	●	○
	Representative of District (*Cultier*)	○	●	○
	PTA/Board of Education	○	◎	○
	Religious Group	○	○	○
	Private Mass Media	○	○	○

Note; ●: Most Important Involvement ◎: Important Involvement ○: General Involvement

(5) Multi-Sectorial Cooperation

As for hygiene education, MSP, MEN, CUN and Communes and others have executed many attempts to heighten public awareness on sanitation. Especially, before the year of 1996, there were lots of activities and programs related to hygiene education for Niamey. Some of attempts were executed in cooperation with two or three actors, but each actor implemented most of them respectively.

In order to make the attempts efficacious measures, as a matter of course, it is necessary to make the best use of competence, expertise and ability of each actor. Therefore, more

aggressive multi-sectorial cooperation systems for the education are required to introduce among actors listed in Table 13.1-1. For effective and flexible implementation of the multi-sectorial cooperation, following coordination is necessary at least.

- To create specific function or office for handling hygiene education in each sector, specially in the public sector
- To coordinate lateral communication among actors
- To open related information each other

(6) Approaches

1) Top-down Approach

There have been various attempts on public awareness on hygiene and sanitation in Niamey as pointed out above. Most of which were conducted by the so-called "top-down approach" such as one-way instruction on related issue and measures from an authority to a target population through mass media or printing materials, and so on. This approach, however, is essentially required for certain relationship of mutual trust between an authority and a target group such as community or population. If there is no such a relationship, then the approach is going to be nothing but disposal of information.

For example, through a radio program an authority can easily say "do not throw your garbage on the road". But if there are no waste bins and no regular public collection services available, then apparently nobody follows such an instruction.

As to the situation in Niamey, the survey on the public awareness shows:

- More than half of respondents (51.2%) are not satisfied with present sanitation system by the CUN.
- Almost all the respondents (93.8%) have never complained to the commune about their sanitation problems.
- Most of them perceive (69.7%) that to say such a complaint to the commune is "useless".

In accordance with these survey results, it can be said that the relationship of mutual trust is not formed between CUN and the population yet. To improve this situation, followings are critical points to recognize each other at least.

- Each authority concerned shall identify what kind of public cleansing services and activities do not satisfy communities and population.
- Each community and population shall understand the present situation and constraints of public cleansing services.

Therefore, in principle, the "top-down" approach should be introduced to actions of public awareness on sanitation and hygiene education if these critical points are sufficiently satisfied.

2) Participatory Approach

In general, it is expected for community and population as generating source of garbage and wastewater to positively participate in cooperating authorized cleansing services by reducing total amount of the generation at the source and so on. To build up the cooperative relationship,

as a matter of course, following conditions are necessary to consider among actors in the first place.

- Sound relationship of mutual trust between public sector and private sector including individual.
- Good interactive communication among the actors involved.
- Active private sector involvement in every stage from planning to implementation of cleansing services.

In order to attain each condition above, following activities and coordination are required to be implemented by each actor as the next step.

- To recognize the critical points mentioned in the previous section.
- To create communication channels among the actors including preparation of specific office and function in Each Ministry involved, DS/CUN, CUN and Communes.
- To hold regular meeting and dialogue among actors, and related campaign to discuss and to make information exchange how they can improve present conditions of sanitation and cleansing services in Niamey and so on at each stage from planning to implementation.

Therefore, positive private sector including community, civil society and individual participation in the activities is very much important. This participatory approach is called as "Community Participation". For this approach, intervenes of the CUN and each Commune are required. Because these local authorities are located between the Ministries involved as central government and private sector including individual so as to be able to work as an intermediate actor for connecting and communicating between them as shown in Figure 13-1.2. As well, local functions of each Ministry such as DS/CUN, CSI and elementary and secondary schools are expected to work as the intermediate actors.

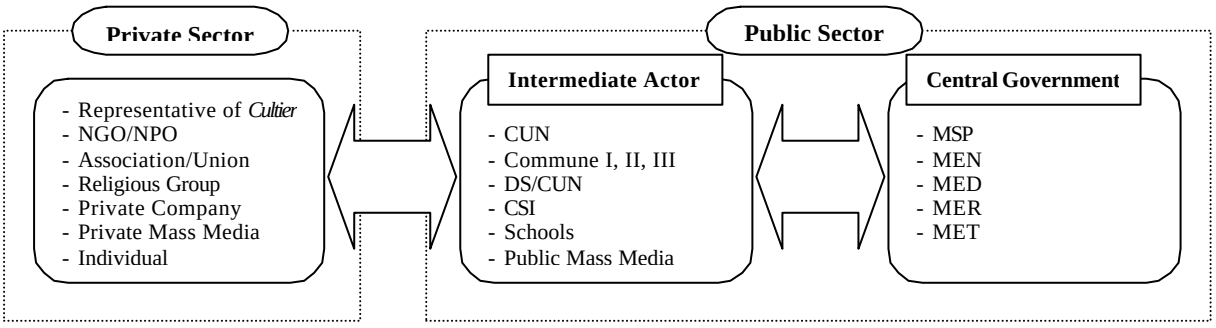


Figure 13.1-2 RELATIONS AMONG ACTORS

In addition to above, willingness to participate by community, civil society and individual are extremely required to implement the sound community participation. As opinion among population of Niamey in this matter, the surveys on public awareness show:

- 80.2% of the respondents are ready to pay for improving sanitation condition. (JICA)
- 98% of households are ready to contribute to improve sanitation condition in their living area, either by participating in hygiene heightening activities like campaign (less than 70%), or by financial contribution (30%). (PRI)

Accordingly, active cooperation from population and community is expected to implement the community participation approach.

13.1.3 Preparation and Evaluation

(7) Preparation

1) Resources

Lots of resources including budget, expert, tools and data are required to implement the activities of public awareness on sanitation and the hygiene education. Table 13.1-2 shows summary of the necessary resources and the present conditions.

Table 13.1-2 NECESSARY RESOURCES AND PRESENT SITUATION

Resources	Present Situation
Budget	- The "National Policy on Health Education" (Final Draft) noted the necessity of specific budget allocation for the hygiene education as mentioned in the Chapter 3.9.1. However, no such a specific budget has been allocated for the activities of the DIEPS (Division of Information and Health Education) of the MSP excluding the staff salary in recent years. Therefore, their activities for the hygiene education as central government are limited. - Specific budgets may be allocated within a water supply and related project. But it would be very limited amount. - Each Commune may occasionally allocate such a budget. But it is very limited.
Expert	- Experts on hygiene education are a few in the MSP. - Such an expert there is not available in other entities including the MEN and the CUN.
Education Tool	- Lot of education tools like video films and printing materials are available in the MSP as shown in Table 3.9-1 and 3.9-2. - Several video films in the field of sanitation improvement are available in the CUN.
Information & Data	- There are data on morbidity and mortality of CUN in SINIS of the MSP. - The data are available in each trimester and not included data of National Hospitals in Niamey.

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2) Constraint Factors

Based on the summary of Table 13.1-2, it can be said that there are few specific budget, expert and detailed data on human health in the public sector at present. As for the education tools, lots of devices were equipped with, and related video films and printing materials were produced by the MSP. However, due to shortage of the budget, the MSP cannot replace such devices with new ones, and cannot produce new version of the education tools. It can be identified that these circumstances are "Constraint Factor" to implement the hygiene education.

Within the constraint factors, all actors have to consider the future actions on the public awareness on the sanitation and the hygiene education. Of course, public sector shall call for necessary resources through present official procedures. However, in general, the order of priority in this field of hygiene education is not high in many developing countries. Because that there are lots of other high priority and emergent issues in such counties and city including Niamey.

How can the actors overcome the constraint factors? In accordance with the discussion so far, it can be considered that following series of concepts is the useful solutions as one of the future actions.

- The best use of competence, expertise and ability of each actor
- Multi-sectorial cooperation
- The full utilization of available equipment and tools at present
- Community participation

Within these constraints and concepts, the JICA study team tries to consider how to implement a hygiene education campaign in the chapter of 13.4 below.

(8) Evaluation

It goes without saying that evaluation of all activities on public awareness on sanitation and hygiene education is necessary for enhancing further actions to be taken. However, it is not so easy to quantitatively analyze effects of these activities. Therefore, certain analytical methodology shall be studied and developed to evaluate such activities by related entities such as MSP and others. To develop the methodology, key points and steps can be summarized as follow.

- ***Survey***: the actors shall conduct an interview survey and/or a questionnaire survey to the participants in such activities.
- ***Analysis***: based on the survey results, quantitative and qualitative analysis shall be done by the actors.
- ***Evaluation***: all actors involved shall make evaluation on the analysis.
- ***Report***: survey methods, analysis results and evaluation shall be compiled as printing report.
- ***Feedback***: such report shall be made use of as feedback and instruction tools for improving the methodology, training the related experts and instructing next related activities and so on.

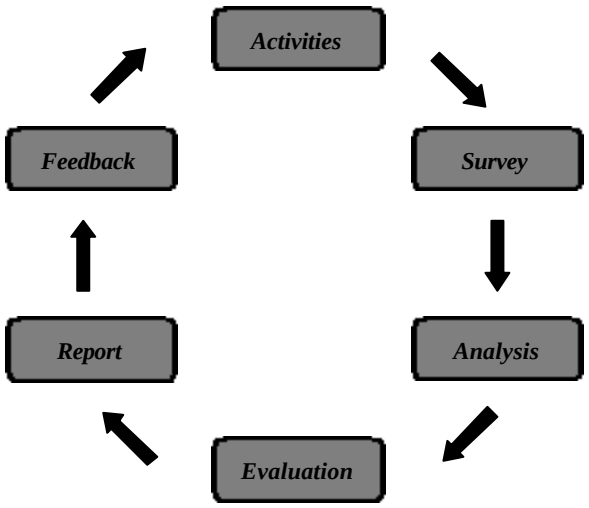

Figure 13.1-3 KEY POINTS, EVALUATION AND FEED BACK CYCLE

13.2 BASIC CONCEPT OF HYGIENE EDUCATION

Taking into account the discussion in above sections and the framework of the JICA study as target year of 2015 into consideration, it is reasonable to consider that step-by-step

improvement and heightening plan shall be introduced as basic concept of hygiene education. From year of 2000 to 2015, following three terms can be proposed in the stepwise plan on hygiene education for Niamey. And awareness level at each term can be illustrated in Figure 13.2-1.

- Short term : to heighten health and sanitation notion (health oriented)
- Middle term: to heighten mutual understanding (community participation & willingness to pay)
- Long term : to heighten awareness on urban environment protection (re-cycling city)

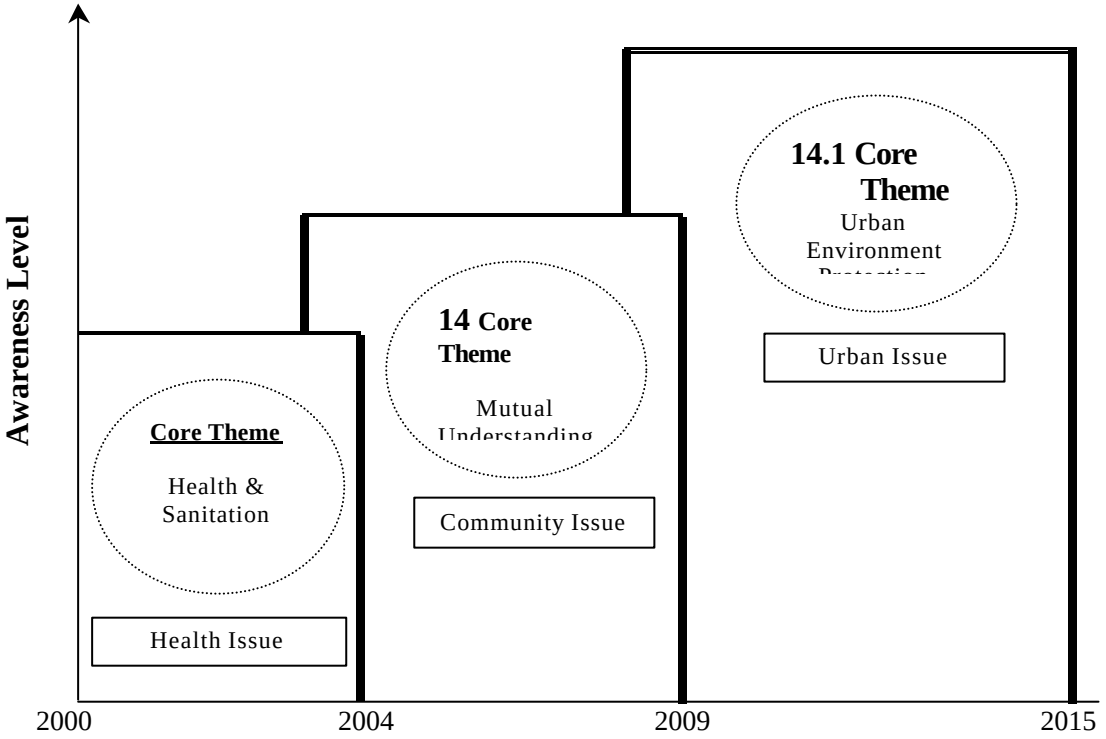

Figure 13.2-1 AWARENESS LEVEL OF POPULATION

(1) First Step (Short Term Target)

The first step shall be initiation stage to heighten health and sanitation notion. Namely in the short term, population in Niamey shall identify more specifically relation 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 individual effort, but also cooperation among actors involved can attain improvement of the sanitation as community issues. Namely in this term, the followings are expected to be attained:

- To set up relationship of mutual trust between authority as official sanitation service side and community side including individual as wastes resource side
- To identify proper responsibilities of both sides on the cleansing activities including finical

contribution (willingness to pay) and waste separation at source of community side.

(3) Third Step (Long Term Target)

The third step shall be 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.

13.3 HYGIENE EDUCATION PLAN

13.3.1 Consideration of Plans

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

13.3.2 Effort Level and Specific Actions

To attain each target in the stepwise plan of hygiene education, effort level to be attained by all actors can be illustrated in the Figure 13.3-1. In the effort level, following two actions shall be implemented at suitable timings.

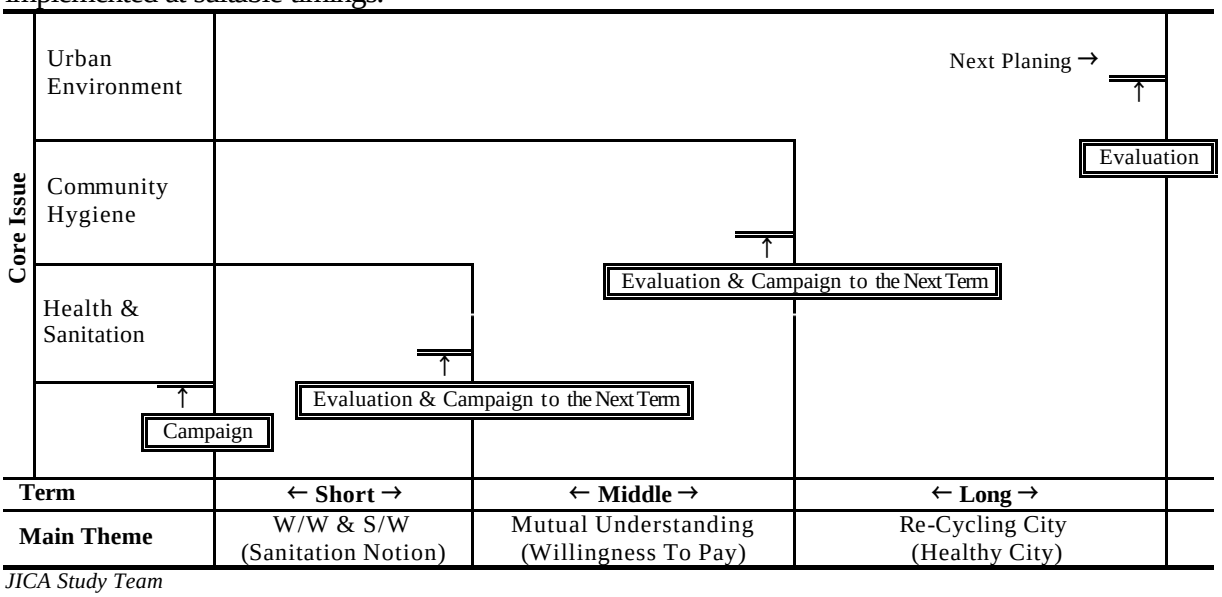

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Figure 13.3-1 EFFORT LEVEL AND SPECIFIC ACTIONS

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

Therefore, three times of hygiene campaign and evaluation activities shall be carried out at least as shown in Figure 13.3-1.

13.3.3 General Actions

In addition to the specific actions, periodic activities are necessary for heightening public awareness on sanitation continually as general action.
For example, it can be considered to set up a national holiday of "National Clean Day" or "Week of Clean Niamey" and so on. As a matter of fact, such a day or week has not been seen in Niamey as shown in the Table 13.3-1 and 13.3-2.

Table 13.3-1 LIST OF NATIONAL HOLIDAY

Month	Day	Name of Holiday	Note
January	1st	New Years' day	
February		-	
March		-	
April	*	Easter Monday	Next Monday of Easter Sunday
	24th	*Con Corde* day	Commemoration of peace agreement with *Touareg* rebellion
May	1st	May day	Labor's festival
June		-	
July		-	
August	3rd	Day of Tree	Independence declaration anniversary day
September	25th	Peace day	Incineration day of guns collected from rebels
October		-	
November		-	
December	18th	National Feast day	Republic declaration anniversary day
	25th	Christmas	Christmas

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Table 13.3-2 LIST OF DAY & WEEK OF COMMEMORATION AND CULTURAL EVENTS

Month	Day & Week	Name of Day or Week	Ministry Concerned
January	29th	World Leprosy Day	MFE
February	-	-	-
March	8th	International Day of Women	MFE
	22nd	World Water Day	MHE
	22nd-29th	National Water Week	MHE
April	7th	Wold Health Day	MSP
	Last Saturday	National Arts and Crafts Day	MJSC
May	13th	National Day of Women	MFE
	25th	International Celebration of Museum	MJSC
	31st	No Smoking Day	MSP
June	5th	World Environmental Day	MED
	16th	African Nation Day	MFE
	17th	International Day of Desertification	MED
	21st	Music Feast	MJSC
	22nd	Wold Day of Tuberculosis Prevention	MSP
July	11th	World Population Day	MFE
	31st	National Day of Disabled Persons	MFE
August	3rd	National Cerebration Day of Tree	MED
September	8th	International Day of Literacy	MEN
	16th	International Day of Ozone Layer Protection	MED
	27th	World Tourism Day	MTA
October	1st	Day of Aged	MFE
	First Monday	World Housing Day	MET
	5th	International Day of Teaching	MEN
	10th	World Day of Mental Health	MSP
	17th	International Day of Poverty Elimination	MFE
November	10th	International Festival for African Fashion (FIMA)	MJSC
	14th	Wold Day of Diabetes Prevention	MSP
December	1st	Wold AIDS Day	MSP

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13.4 HYGIENE CAMPAIGN

13.4.1 Purpose

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

- To instruct how-to use of toilet to the schoolchildren at pilot project sites
- To present know how of hygiene education to all actors
- To present know how of community participation approach to all actors
- To make good relationship between public sector and private sector

13.4.2 Campaign Sites

Campaign sites shall be selected at the pilot project sites;

- Pilot Project 1: UASB and Trickling Filter Construction Site
- Pilot Project 2: *Jyokaso* Construction Site

13.4.3 Campaign Plan (Tentative)

The campaign was held in July 2001 at each of the pilot project. Taking account of the constraint factors discussed at 13.1.3, tentative plan of the campaign of the campaign is proposed as follows.

(9) Commune I (UASB + TF) site

1) Target Group

1. Primary Target Group: Schoolchildren *Deizeibon* Primary School

   - How-to use toilet
   - Health & Sanitation

2. Secondary Target Group: Teacher and Family Member

   - Health & Sanitation

3. Special Target Group: *Deizeibon* District, (Bus terminal, shop Associations and the population)

   - Community Participation

2) Demonstration Campaign : At the Project site (*Deizeibon* Primary School)

- Exhibition
- Video Show
- Variation of popular song
- Others

3) Community participation

- Initiation of community toilet construction (to organize a committee)
- Competition of Drawings and Slogan
- Others

4) Actors to be involved :

- Official: *Dizelbon* Primary School, MET, MSP, MEN, CUN, Commune I, CSI (Health Center)
- Associations: Community, Women's, Youth, Business
- NGOs: Local NGO
- Mass media (Radio, TV & News Paper)

(10) Commune II (*Jhyokaso* System) site (*Bandabari* II School)

1) Target Group

1. Primary Target Group: Schoolchildren

- How-to use toilet
- Health & Sanitation

2. Secondary Target Group: Teacher and Family Member

- Health & Sanitation

2) Exhibition Campaign: *Bandabari* II Elementary School

- Exhibition
- Video Show
- Variation of popular song
- Others

3) Community Participation:

- Inviting slogans on sanitation
- Competition of Drawings and Slogan
- Others

4) Actors involved:

- Official: MET, MSP, MEN, CUN, Commune II , CSI (Health Center), School
- Associations: Community, Women's, Youth, Business, PTA
- NGOs: Local NGO
- Mass media (Radio, TV & News Paper)

(11) Evaluation for Campaign

- Questionnaire Survey

- Participation Rate Survey
- Opinion Survey
- Reporting

13.4.4 Community Explanatory Meeting on Hygiene Campaign

To explain the general plan on hygiene education and hygiene campaign mentioned above from the JICA Study team to the representatives of each actors, Community Explanatory Meeting on Hygiene Campaign was hold at the CUN on 23rd Number 2000 as fist step of the community participation approach.

1) Date : 23rd November 2000
2) Time : 9:00 a.m. – 11:30 a.m.
3) Place : CUN Conference room
4) Participants: total approximately 30 participants

- MET, MSP, MEN, CUN, Commune I, II, III
- Director and Teachers of Elementary school at each pilot project
- Representatives of each district of the pilot project
- Representatives of local association of each district of the pilot project
- Private Company
- NGO
- JICA Study Team
- Others

CHAPTER 14. INITIAL ENVIRONMENTAL EXAMINATION

CHAPTER 14. INITIAL ENVIRONMENTAL EXAMINATION

14.1 ENVIRONMENTAL PROTECTION

14.1.1 Institutions and Jurisdictions

(1) Environmental Agencies

1) Ministry of Environment and Prevention of Desertification

The Direction of Environment and the Direction of Fauna, Fishing and Fish Farming, which both belong to the Ministry of Environment and Prevention of Desertification, are the main central agencies for the protection of the environment in Niger. They include 4 jurisdictional units which are:

- Service of Prevention of Pollution and Nuisances (*Service de lutte contre les pollutions et nuisances*);
- Brigade of Protection of Nature (*Brigade territoriale de protection de la nature*);
- Service of Development, Fauna and Apiculture;
- Service of Fishing and Fish Farming.

All these agencies are awaiting for their new attributions as application of Decree n° 2000-200 of 10 July 2000 on organisation of the Ministry of Environment and Prevention of Desertification. According to Order n°064 of 3 September 1992, the Service of Prevention of Pollution and Nuisances plays a key role in the control of dangerous industrial establishments, solid and liquid waste management and waste disposal sites.

2) National Council of Environment for a Sustainable Development

The National Council of Environment for a Sustainable Development (CNEDD) (*Conseil national de l'environnement pour un développement durable*) has been set up in 1996 under direct authority of the Prime Minister in order to carry out, follow-up and evaluate the National Environmental Plan for Sustainable Development. At local level, the agency is represented by the Regional Council of Environment for a Sustainable Development (*Conseil départemental de l'environnement pour un développement durable*). The executive secretary of the CNEDD makes coordination between the concerned agencies to prepare and submit plans and projects which have been defined within the scope of the national plan. The Decree n°2000-272 of 4.08.00 modifying and completing the decree on attributions of the CNEDD designates the CNEDD as the coordinator of all activities induced by the Rio Conference of 1992 and the *focus point* for all conventions and protocols in the field of environment and sustainable development. For the time being, only conventions induced by the Rio conference process are managed by the CNEDD.

The lack of a sufficiently clear partition of duties between the CNEDD and the Ministry of Environment, especially in the field of coordinating and executing tasks, is often stressed by environmental officials. They perceive some confusion of roles between these 2 national institutions for the management of environment, which results into frustration and loss of efficiency.

3) Regional Direction of Environment

At CUN and municipalities levels, environment management tasks are classically those dealing with urban vegetation, municipal solid waste and waste water. There is however no overall environment management agency, and this task is finally relayed to the Regional Direction of Environment, which is the representative office of the National Direction of Environment.

The Regional Direction of Environment (DDE/CUN) is organised into several services, which are:

- Administrative and Financial Service,
- Service of Programming and Statistics,
- Service of Forestry Development and Reforestation,
- Service of Environmental Protection,
- Service of Fauna, Fishing and Fish Farming,
- Communal Services.

Such organisation shows the existing gap between attributions inherited from an older system of protection of nature and the necessity of dealing with regional urban environmental issues, which are new issues raised by the urbanisation of population in Niamey area. The organisation and attributions of the Regional Direction of Environment have been specified in Decree n°77 of 4 October 1988. This decree shows a backward of environment management at regional level compared with national level which started to integrate urban and industrial environment objectives. The Regional Direction of Environment operates in the field of controlling natural resources like wood and forests, fishing products, and hunting products. A decree defining the new attributions of the Regional Direction of Environment as application of Decree n° 2000-200 of 10 July 2000 on organisation of the Ministry of Environment and Prevention of Desertification is expected soon.

4) Bureau of Environmental Evaluation and Impact Studies

The Bureau of Environmental Evaluation and Impact Studies (BEEEI, *Bureau d'évaluation environnementale et des études d'impact)* is presently the basic institution having potential for protecting the environment in an integrated manner through the EIA system. This office was instituted by decree in 1997 and started operation in 2000. Its objectives are to follow-up the authorisation procedure and to supervise the conformity of EIA and the effective application of countermeasures taken by the promoter of the project. Among the attributions of the BEEEI are those directly related to the EIA procedure like:

- Managing and coordinating the EIA studies;
- Analysing and checking the conformity of the EIA study with TOR;
- Preparing the notification of conformity;
- Preparing the permit of activity;
- Following up and evaluating the plan of evaluation, attenuation and compensation measures.

The staff of BEEEI will be composed of the permanent staff in BEEEI office and semi-permanent staff in sector offices, constituted of key persons belonging to line ministries, and identified as the *focal points* of BEEEI. The non permanent staff will be designated by the

concerned line ministries. The BEEEI will be represented at regional, departmental and communal levels by appointing staff in charge of environmental evaluation.

(1) Other Agencies Strongly Involved in Environment Management

Several central agencies have environment oriented tasks but only those having strong implication in the management side are considered.

5) Ministry of Public Health

The Office of Environmental Hygiene, and the Office of Protection against Diseases Vectors, both belonging to the Division of Public Hygiene under the Direction of Public Hygiene and Education for Health (*Direction de l'hygiène publique et de l'éducation pour la santé*) of Ministry of Public Health, are major managing agencies for dealing with the urban environmental issues of Niamey. The Office of Environmental Hygiene is involved in the setting and application of emission standards for waste water, excreta, and disposal of waste. The office is also in charge of housing and living environment hygiene. At local level, the agency is represented by the Regional Service of Public Hygiene and Education for Health (*Service régional de l'hygiène publique et de l'éducation pour la santé*).

6) Ministry of Mines and Energy

The Service of Mines, within the Regional Direction of Mines and Energy, under central authority of the Ministry of Mines and Energy, is the authority in charge of receiving and examining the demands of authorisation for classified establishments (EDII, see 14.1.3). The main duties of the Service of Mines are to study the demands for operating mines and quarries and for operating EDII, to make administrative control of these units after authorisation, and to control the security conditions of industrial installations.

7) Ministry of Water Resources

The Ministry of Water Resources is under reorganisation and will have environmental tasks to perform through its Division of Water Quality and Pollution, within the Direction of Water Resources. According to the draft order of November 2000 for achieving such organisation, the Division will have to follow up the application of regulations and conventions in the field of drinking water quality.

8) Ministry of Youth, Sports and Culture and Ministry of Higher Education, Research and Technology

The Direction of Patrimony and Museums, within the Ministry of Youth, Sports and Culture is in charge of establishing the national inventory of goods, monuments and sites of cultural value. In the case of an archaeological site being registered in the national inventory and declared as a classified site, the managing authority is the Research Institute in Human Sciences (IRSH), under authority of the Ministry of Higher Education, Research and Technology. Besides the classification procedure, an archaeological site can be registered as a reserved area for future excavations, according to a joined order of both ministries.

(2) Outline of Jurisdictions and Competencies

Beside the decentralised local responsibilities in the field of waste management, environmental management is basically the competence of state representative agencies, which are considered in this review of jurisdictions and competencies.

1) Industrial Environment

In the field of industrial environment, the Service of Protection against Pollution and Nuisances has a duty to control polluting establishments, in coordination with other concerned agencies, since it overlaps with the Service of Mines in the task of controlling nuisances and pollution sources. Furthermore, the Direction of Hygiene through its office of environmental hygiene is also involved in the supervision of waste water discharge. The BEEEI is also a major piece of the control of pollution and nuisances in its task of supervising the adoption of measures in conformity with environmental plan proposed in the EIA.

Actually, jurisdictions in the field of industrial environment are overlapping, which contrasts with the obvious absence of proper management in this field. Overlapping results into the risk of inefficient actions, conflicting relations instead of coordinating, and loss of reliability on the side of polluters into the capacity of authorities to manage.

Presently, the supervision work is sporadically done by the Service of Mines, almost never done by the Service of Prevention of Pollution and Nuisances (excepted within the scope of a study), and never done by the Division of Hygiene since 1987. The absence of effective supervision is justified by the lack of sampling and analysis equipment, the lack of clear cut duties between agencies, and the lack of environmental standards and law enforcement tools.

Inspectors of classified establishments (EDII) of the Service of Mines are in charge of controlling the application of conditions set in the authorisation. The last inventory of the Service of Mines has identified about 800 classified establishments, almost constituted by small units. Among them, only about 10% have been registered, the others being informal. Each establishment is in principle controlled 2 times a year. However, the effective rate of visits is no more than 20 units per year in Niamey, because of the very limited capacities: Only 1 inspector, who is also responsible for receiving and transmitting the authorisation procedure documents. The object of controls includes various inspections like those for noise, electric installations, nuisances, waste and substances, etc. There is no enforcement procedure to oblige the industrials to take measures in case of infractions, and only instructions are delivered to the polluters at the issue of controls.

The staffs of inspectors of mines operate without the material capacity needed to perform such inspection. The Service of Mines in charge of inspection of EDII has only 1 vehicle for 1 inspector, neither computer nor laboratory. Registers are not computerised. Sampling and sampling equipment are at the technical charge of the university laboratory.

2) Living Urban Environment

In the field of quality of the living urban environment, the main agencies responsible are the Ministry of Public Health for hygiene and sanitation and the Ministry in charge of Environment for amenities, specially greenery.

The sanitary police have been instituted by the Public Hygiene Code (Order n°93-13 of 2 March 1993) in order to control the application of rules provided in this law. This police is not yet operational. The order defining its organisation and attributions is under preparation. The sanitary police will be organised into national, regional, departmental and communal levels. The inspection tasks of the sanitary police will in principle include basic controls like sanitation in public places and in houses, hygienic conditions of food stuff and drinking water, and noise conditions. Also are included the hygiene of industrial and commercial establishments and the hygiene of natural environment, which means classic hygienic conditions of work but also sanitary conditions of surroundings, control of conformity of waste disposal method, check of effluents emissions indicators, and the like.

3) Natural Resources

Natural resources relevant in Niamey are mainly water and fishery. In the field of natural resources, surface and ground water resources and their quality as drinking water are managed by the Ministry of Water Resources. The protection of ambient surface water quality involves the Ministry of Environment for nature protection purpose, and the Ministry of Health for hygiene and sanitation purpose.

Monitoring of surface water and groundwater is not performed in Niamey area. Groundwater monitoring belongs to the attributions of the Ministry of Water Resources. Surface water monitoring will in principle be shared by the Ministry of Environment and Prevention of Desertification, the Ministry of Public Health, and the Ministry of Water Resources. As provided in the Frame Law for Management of Environment, the conditions of control, sampling and analysis of waste water effluents will be set on a case-by-case basis according to a joint order of the Minister in charge of public health and the Minister in charge of industry.

The elaboration of ambient and emission standards involves all the agencies mentioned above together with the CNEDD. However, the preparation and follow-up of standards for the conditions of disposal of industrial and municipal waste are basically an attribution of the Service of Prevention of Pollution and Nuisances.

The environmental brigade under the Regional Direction of Environment of Niamey has a staff of about 30 persons, including fixed and mobile units, and is mainly in charge of inspecting the activities related to forest and fuel wood collection, hunting and fishing. The material means of the Niamey brigade are limited to one working and 2 breakdown cars, and 15 bikes.

4) Natural Habitats and Species

Conservation of natural habitats and species is made through management of natural resources by the Ministry in charge of Environment. There is however no institution specifically dealing with the protection and conservation of nature, excepted the Direction of Fauna, Fishing and Fish Farming, which manages the national parks and rules of the international conventions for the protection of nature signed or ratified by Niger.

The EIA procedure is the main tool available for preventing negative effects on natural environment, under supervision of BEEEI. Presently, the BEEEI employs only 2 engineers and 1 jurist, assisted by 8 persons, of which 3 engineers under national service. The planned organisation into 3 technical services is not yet operational. The material means are still

limited to 1 car and 2 computers. The extension of equipment is however a basic condition for achievement of the objectives.

5) Information System

There is no regular collection of environmental data in Niamey, if we except health data and drinking water quality data. Natural habitats and living species of the Niger river are neither monitored nor studied. Groundwater and surface water quality are known through isolated studies only. The Frame Law for Management of Environment has however required for the preparation of annual statement of environmental quality. The CNEDD has the duty to submit each year to the government an annual state of environment and sustainable development, which first publication is planned for 2001.

The Service of Prevention of Pollution and Nuisances has already carried out an evaluation of the industrial environment in 1998, which largely deals with the Niamey area. However this study is descriptive and does not refer to sampling and analysis of effluents.

14.1.2 Legislative and Regulatory Framework

The Constitution of 1999 and the Frame Law of Environmental Management of 1998 provide that everybody has a right to live in a healthy environment.

(1) Living Environment

The Frame Law of Environmental Management of 1998, which largely refers to the Water Code for water related matters and to the Public Hygiene Code for public health concerns, stipulates that discharge and disposal of liquid and solid waste by individuals or industries are forbidden. The Water Code (Order n°93-014 of 2 March 1993) and Public Hygiene Code (Order n°93-13 of 2 March 1993) explicitly provide that waste deposits in public places as well as throwing away domestic waste and other waste like gravel and stones in public places, streets, rivers, or ponds are forbidden. The Public Hygiene Code has an article forbidding urinating and defecating in public places. Table 14.1-2 below is a summary of the main stipulations according to environmental issues. The CUN order n°41 of 1 November 1996 about Regulation of the Disposal of Used Materials in CUN is the application document for Niamey.

Application decrees of the sanitation and environment management related laws are almost not yet published excepted those relating to a modernised institutional organisation, which is actually in its starting stage:

- Decree of 1 November 1999 instituting the Sanitary Police;
- Decree of 10 July 2000 instituting the Ministry of Environment and Prevention of Desertification;
- Decree of 10 January 1997 establishing the EIA;
- Decree of 9 January 1996 instituting the CNEDD.

Application decrees on regulatory aspects like emission and quality standards are still lacking. The Decree n°76-129 of 31 July 1976, which is application of Law n°66-033 of 24 May 1966 on Dangerous, Insalubrious and Inconvenient Establishments, establishes the procedure of requirement of authorisation for an activity classified as dangerous, insalubrious and inconvenient establishment. These establishments are classified according to 3 classes, with

their nomenclature provided in appendix of the decree. These laws and regulations notify the conditions of waste discharge and accompanying measures, before approval of activity by the Ministry of Mining. The criteria applied for the management of the establishments of third class in conformity with the law are provided in the ministerial order n°014 of 1 November 1976.

(2) Natural Environment

The legislation for protection of fauna species is constituted by the Law n°98-07 of 29 April 1998 on Setting the Hunting and Fauna Protection System, and its application decree n°98-295 also dated 29 April 1998. These laws establish hunting rules, classification procedure and rules for conservation of natural areas, and provide a list of mammals, reptiles and birds species under 3 classes of protection: The first class of protection is integral protection and includes 32 species in total (19 mammals, 3 reptiles, 10 birds species). The second class of protection is partial protection. The third class is defined as species subject to national regulation within the limits of Niger competencies when cooperation with other countries is necessary in order to limit or prevent their exploitation. This class includes species that often already belong to the first and second classes, but are additionally regulated under international rules. According to the Direction of Fauna, Fishing and Fish Farming, the later mainly refers to the CITES convention, although there is no actualisation of the list.

None of the bird species observed in Niamey (see 3.7.3) belong to the IUCN Red List of threatened animals. Table 14.1-1 below is a summary of the status of inventoried species as regards to current protection rules relevant for Niger. List A of the Algiers Convention designates total protection, while list B is protection with special authorisation for hunting. As shown in the table, there is no complete integration of the species defined in the Algiers Convention into national law. This table shows the weakness of the protection status of birds.

The Law n°98-042 of 7 December 1998 about fishing provides articles on the protection of fishes, molluscs, shellfish and algae. In this concern, the following are forbidden: Destruction of aquatic fauna habitats and fish breeding zones. Existing application decree for fishing comes back to 1974 according to the fishing law of 1971, and a new application decree is under preparation. There are no fish species under any protection status in Niger.

The Law n°74-7 of 4 March 1974 on Forestry stipulates management rules of state forest according to 2 categories of management, which are classified forests and protected forests. From the point of view of environmental quality, the following stipulations are important:

- Wood and brushwood clearing is not allowed along river banks 10m width without special authorisation.
- There are 15 tree species which are protected against felling without special authorisation: *Acacia senegalensis, Butyrospernum parkii, Borassus flabellifer, Khaya senegalensis, Bombax buenopozens, Pterocarpus erinaceus, Acacia albida, Tamarindus indica, Parkia biglobosa, Hyphaene thebaïca, Acacia scorphioïdes, Andansonia digitata, Poupartia birria, Balanites aegytiaca, Parinari macrophylla.*
- Bare lands in sensitive conditions like unstable river banks and lands subject to erosion and ravines are considered as forest restoration areas.

Table 14.1-1 CHECKING OF THE PROTECTION STATUS OF BIRD SPECIES INOVENTORIED IN THE NIAMEY AREA

Species	Hunting Law	Algiers Convention	Bonn Convention (Appendix 2)
Squacco Heron		List A	
Cattle Egret		List A	
Great White Heron	Liste 2	List A	
Little Egret	Liste 2	List A	
Grey Heron		List A	
Black Headed Heron		List A	
Purple Heron		List A	x
Abdim's Stork	Liste 3	List A	
Sacred Ibis		List A	x
Glossy Ibis		List A	x
White-faced Whistling Duck			x
Garganey			x
Spar Winged Lapwing			x
Little Ringed Plover			x
Common Ringed Plover			x
Black Tailed Godwit			x
Marsh Sandpiper			x
Little Stint			x
Common Sand Piper			x
Green Sand Piper			x
Ruff			x
Black-winged Stilt			x
Western Marsh Harrier		List B	x

In practice, these laws provide the protection status of species, but there is currently no program to set conditions for effective protection of valuable species like for example *Hippopotamus*, outside the nature conservation areas system. Furthermore, these laws are more oriented to regulating hunting, fishing and forestry activities than to protecting natural environment. More nature conservation focused regulations are planned to be set on as application of the Frame Law for Management of Environment.

Protection of groundwater is made through general stipulations of the environmental law presented above, and focuses on the protection of potable water resources. Then basically, protection of groundwater is limited to the areas where groundwater constitutes the water resource of living population.

(3) Landscape and Cultural Patrimony

The preservation of cultural patrimony is managed under the Law n°97-022 of 30 June 1997 on Protection, Conservation and Development of National Cultural Patrimony, and its application Decree n°97-407 of 10 November 1997 on Protection, Conservation and Development of National Cultural Patrimony. On the other hand, the Frame Law for Management of Environment provides that an application document will be launched in order to preserve historical, archaeological and scientific sites, as well as specific sites with landscape value. According to the law, the Minister in charge of culture must establish the national inventory of goods, monuments and sites of cultural value. Presently, the agency in charge is the Ministry of Youth, Sports and Culture.

(4) Natural and Technological Risks

The management of natural and technological risks, specially the risks related to flooding, landslide, drought and fires, is the duty of the System of Early Alert and Management of Disaster (SAP/GC), directly under jurisdiction of Prime Minister. This agency is basically in charge of preventing and managing crisis situations of socio-economic nature related to food supply, sanitary conditions, disease epidemics and others. There is no measure taken as regards to the risk of industrial disasters. The National Plan for Managing Disasters is under preparation.

(5) Community Participation

The Frame Law for Management of Environment has dedicated one chapter to community participation in the management of environment, in terms of access to information, consultation of population, presence of communities representatives in advisory committees and awareness heightening. The Decree n°2000-397 of 20.10.00 on the Administrative Procedure for Evaluation and Examination of Environmental Impacts, Contents of Environmental Impact Studies, and Action of Advertisement provides similar conditions for the EIA procedure: Information of population about the project, consultation of concerned persons and general public for the final EIA report, access of population to the report, and information to and dialogue with population about the EIA report contents. However, there is no directive about the procedures necessary for such participation of communities.

14.1.3 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 in Chapter 2. This project will provide in 2002 the National Plan for Management of Urban Environment.

(1) Local Environmental Plans

There is no local environmental plan. The CUN has launched a program of environmental protection in 1998, with the objectives of protecting ecosystems and living conditions of people. However actions have been limited to specific aspects like preservation of green belt, eradication of water hyacinth, rehabilitation of soils and vegetal cover in peripheral rural housing areas, awareness heightening and training of fishermen, fish vendors and haulage contractors, and finally reforestation of Commune III with useful tree species for food consumption or energy supply.

The CUN has also carried out in 1997 a Diagnostic of Environmental Issues and Identification of Priority Programs for Sustainable Development, within the scope of preparation of the PNEDD. The actions proposed are largely focusing on agricultural development projects while environmental protection is not considered, except plastic waste issue.

Table 14.1-2 RELEVANT STIPULATIONS COMPILED FROM MAIN ENVIRONMENTAL LAWS

Items	Stipulations
Solid waste	**Frame Law for Management of Environment** - Solid waste must be eliminated or recycled in accordance with the stipulations of the Public Hygiene Code and coming application decrees. - Criteria relating to waste discharge in the natural environment will be set up by the Ministry of Health through decree. - Disposal of domestic and industrial waste in water courses and ponds is not allowed. - Anatomic and infectious waste generated by hospitals and public or private sanitary institutions must be treated by chemical method, incineration, or land filling after disinfection. **Public Hygiene Code** - Any industrial or commercial unit must have a waste disposal system. Waste disposal must be executed in accordance with the regulations specific to each industry. - Mixing industrial waste or toxic or dangerous substances with domestic waste is not allowed. - Communes and other local authorities are responsible for the proper and regular elimination of domestic solid and liquid waste. - Any siting for waste disposal site must be done in conformity with regulations. - Mixing excreta with solid waste is forbidden.
Water	**Frame Law for Management of Environment** - Any use of water or hydraulic installation must be considered within the limits of the hydrologic hydro-geologic water basin. - Discharge of garbage, industrial waste, gravels, stones, and wood in the public riverbed or riverside areas, lakes, ponds and canals , is forbidden. **Public Hygiene Code** - Protection perimeters of potable water resources are established. The perimeters are delimited by the technical services of Ministry of Water Resources, Public Health, Environment, Equipment. - Bathing in rivers, lakes, ponds is not allowed in polluted areas **Water Code** - A laboratory nominated by the Ministry of Health will make controls of water quality.
Soil, Groundwater, Air	**Frame Law for Management of Environment** - Any discharge of liquid or solid waste or substance that could affect groundwater quality is forbidden - Measures for the protection of soil against contamination by chemical products, pesticides and fertilisers will be set up through application decree. - Emitting polluting substances over the standards (to be set) and harmful smell is prohibited.
Waste water and liquid waste	**Frame Law for Management of Environment** - Discharge of wastewater in public water courses, lakes, ponds or canals is forbidden. - Discharge of wastewater generated by industries and sanitary or scientific institutions is authorisations of Ministry of Water, Ministry of Environment, Ministry of Mines, and Ministry of Health. This wastewater must be treated before discharge. - Discharging industrial waste water without treatment is not allowed. Effluents must fit with discharge criteria in accordance with the relevant regulations. **Public Hygiene Code** - Discharge of wastewater in nature without treatment is forbidden. - Each industrial or commercial unit has obligation to install a wastewater treatment plant, and the effluents must be in conformity with the regulations?? - Discharge of oil waste in nature is not allowed. - The construction of wastewater pits, septic tanks, and other sanitation equipments is not allowed outside the property, excepted in case of special authorisation. - Urinating and defecating in public places are forbidden **Ministerial order n°014 of 1 November 1976 on Dangerous, Insalubrious and Inconvenient Establishments of 3rd class**

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	- Discharge of infected or harmful water in public water is prohibited. Establishments of concern must take disposition to avoid water pollution. **Fishing Law** - Discharge of industrial effluents in areas frequented by fishes, mo lluscs and shellfishes is basically forbidden and subject to authorisation of the Ministers in charge of fishing, water resources, and environment.
Nature and landscape	**Frame Law for Management of Environment** - Any activity that can induce negative effects on animal and vegetal species or natural environment is subject to authorisation. - The list of species for special preservation and the protection rules will be set up by application decree. **Law Setting the Hunting and Fauna Protection System** - Wild animal species in Niger are classified according to 3 protection categories list

(2) National Plan of Environment for Sustainable Development (PNEDD 1999-2001, *Plan National de l'Environnement pour un Développement Durable)*

This plan has been prepared and is executed under supervision of CNEDD. It was adopted in 1998. The PNEDD is defined in the Decree n°2000-272 about attributions and composition of the CNEDD as an instrument for reinforcing capacities against desertification and poverty, and for promoting sustainable development. The national plan covers 6 major programs in the field of natural environment, urban environment, energy and water resources, each of them being presented as national strategy and action plan. The National Strategy and Action Plan in the field of Biological Diversity has been finalised in 1998 and provides the orientations and measures for the management of water and aquatic resources. The National Action Plan for Combating Desertification has been finalised in November 2000. The national strategy and action plan for management of the urban environment are under preparation within the scope of the PRIU project (described in Chapter 2). The basic objectives of the PNEDD are:

- Prevention and eradication of poverty
- Rational management of natural resources
- Integration of environmental consideration in sector development plans and programs
- Management of balance between population and environment
- Making population aware of its responsibilities in natural resources management and protection of living environment
- Developing partnership between actors involved in environment and sustainable development
- Execution and follow-up of all conventions in the field of environment and sustainable development

(3) National Frame Program of Prevention and Eradication of Poverty (PNLCP, 1999-2001, *Programme Cadre National de Lutte contre la Pauvreté*)

This program consists in reducing and eradicating poverty at long term through economic and sector policies. There are 3 components:

- Promoting sustainable conditions of life for poor people and supplying work and income;
- Improving the quality and access to social services;
- Developing capacities of communities to organise themselves.

Execution is focusing on 4 rural areas, and on women and women groups. The executive agency is the Ministry of Plan, with support of PNUD. Basic principles of the plan are:

- Participatory approach of planning, execution and evaluation
- Reinforcement of institutional capacities at local level
- Synergy and complementarities of actions
- Technology using high intensity labour
- Integrating environmental aspects in the actions
- Sustainability of actions through full participation of people

One of the major components of the plan is to improve and develop the social sector, namely primary health care, access to potable water, hygiene, sanitation, and demographic control as well as socio-economic promotion of women.

(4) Health and Sanitation Related Frame Plans

1) National Plan of Sanitation Development (*Plan de Développement Sanitaire*, 1994-2000)

This plan has been elaborated and executed by the Ministry of Public Health. Objectives of the plan include health targeted objectives and various management objectives of which the promotion of environmental hygiene. The strategy of primary health care development was based on the establishment of sanitary districts, and communities participation through setting of health committees for the management and control. One major orientation of the plan was the development of preventive medicine, focusing on hygiene and disease prevention.

2) The Action plan 2000-2002 of the Health-Cities Program (*Programme Villes-Santé, Plan d'action triennal* - 2000-2002)

The Action plan 2000-2002 of the Health-Cities Program has been jointly prepared by the Direction of Public Hygiene and Education for Health and CUN, and adopted in partnership with several concerned ministerial agencies. The plan proposes a list of 9 projects, 4 of them being dedicated to sanitation improvement, and 1 to water supply.

3) Initiative Africa 2000, Water Supply and Sanitation for All (Initiative Afrique 2000 Approvisionnement en Eau et Assainissement pour Tous)

Initiative Africa 2000 is an international program for improving water supply and sanitation conditions in Africa, adopted in 1993 by the WHO Regional Committee for Africa. This program is intended to take benefit from the past experience, namely the International Decade for Drinking Water and Sanitation (1981-1990), in order to initiate a change in the sectorial approach and to improve coordination between sectors. Key issues to be resolved for implementation have been defined as planning, community participation, education, and coordination. Increasing sanitation facilities in the low income communities, and satisfying the sanitation needs of people in shanty towns and new urban peripheral quarters are among the main objectives of this program.

4) National Plan for Eradication of Malaria 1994-2000 (Programme national de lutte contre le paludisme)

The National Plan for Eradication of Malaria 1994-2000 was aiming at reducing malaria in Niger, with special focus on pregnant women and children, and with the following 2 major objectives:

- Reducing by 30% the mortality rate of malaria among children under 5;
- Reducing by 50% the morbidity rate of malaria among general population.

The strategic tools are preventive (chemoprophylaxis, protection against and elimination of vectors, and information / education activities) and curative (full medical care of patients). No evaluation of the achievements of this program has been made, apart from 3 districts evaluations selected within the scope of the Initiative Roll Back Malaria (Declaration of Abuja of April 2000). Based on this Initiative, the member states have to carry out action plans. The Niger government is going to carry out the Plan 2001-2005 Against Malaria. Presently, an Action Plan 2001 has been set up based on the local evaluations and is under improvement through taking into account the results of the UNICEF project Malaria 2000 in Niamey. The main objectives of the Initiative Roll Back Malaria are:

- Reducing to 50% the rate of mortality due to malaria in Africa by 2010
- Initiating local actions for the implementation, follow-up and management of the Initiative
- Taking measures for the sustainable reinforcement of health care systems by year 2005, for persons affected by or exposed to malaria.

14.1.4 Environmental Conventions and Criteria

(1) International 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. They are:

- Convention for Combating Desertification (ratified in 1996)
- Convention on Biological Diversity (ratified in 1995)
- Convention on Climate Change (ratified in 1995)

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.

Environmental conventions signed or ratified before 1992 are directly managed in Niger by sector agencies, mostly the Ministry of Environment and Prevention of Desertification. They are particularly:
- Algiers Convention (ratified in 1971);
- RAMSAR Convention (ratified in 1987);
- CITES Convention (ratified in 1975);
- Bonn Convention (ratified in 1980).

The Algiers Convention (African Convention on Conservation of Nature and Natural Resources) has been adopted by the Organisation of African Unity and signed by member states in 1968. This convention was requiring the adoption of measures for the conservation

and use of natural resources, including conservation measures for those animal and plant species that are listed in appendices of the convention.

Other important environmental conventions signed or ratified by the Niger government are the Wien convention (ratified in 1992), the Montreal protocol (ratified in 1992), and the Bâle convention. The later will be ratified after ratification of the Bamako convention about the interdiction of importation and control of transfrontier movements of dangerous waste.

(2) Environmental Standards

There are no ambient quality standards for environment in Niger. Emission standards are only those for waste water, 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. A project of law about water quality standards is presently studied by the Ministry of Environment and Prevention of Desertification.

Table 14.1-3 below shows the basic emission standards with distinction of 4 cases:

- Case 1: Waste water discharged in a public sewerage system with treatment plant.
- Case 2: Waste water discharged directly or through public sewerage in the natural environment without treatment plant.
- Case 3: Discharge in the natural environment close to water withdrawal point for public water supply, bathing place or fishing area.
- Case 4: Discharge in an artificial absorption well.
- There is a fifth case for spreading on cultivated or pasture area for natural purification, which is not considered in the table.

In all cases, it is required that pH must be between 5.5 and 8.5, temperature must be up to 40°C, and substances generating abnormal odours, taste or colour in natural water as well as halogenic compounds are prohibited in case of human water consumption.

Table 14.1-3 WASTEWATER EMISSION STANDARDS FOR 3rd CLASS EDII

	1	2	3	4
Suspended matter	Up to 1000mg/l	Up to 100mg/l	Up to 30mg/l	Up to 50mg/l
BOD	-	Up to 200mg/l	Up to 40mg/l	Up to 100mg/l
Total nitrogen	Up to 150mg/l (elementary nitrogen) or 200mg/l (ion ammonia)	Up to 60mg/l (elementary nitrogen) or 80mg/l (ion ammonia)	Up to 10mg/l (elementary nitrogen) or 15mg/l (ion ammonia)	Up to 30mg/l (elementary nitrogen) or 40mg/l (ion ammonia)

14.1.5 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. There are 2 laws that are directly concerned here:

- Order n°97-001 of 10 January 1997 on Institutionalisation of Environmental Impact;
- Law n°66-03 of 24 May 1966 on the Insalubrious, Dangerous and Inconvenient Establishments (EDII).

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 (nuisances and pollution) 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.

(1) Insalubrious, Dangerous and Inconvenient Establishments (EDII)

Law n°66-03 of 24 May 1966 on the Insalubrious, Dangerous and Inconvenient Establishments (EDII), and more specifically the Decree 76-129 of 31 July 1976 provide the authorisation procedure for controlling security and salubrity conditions, nuisances to the neighbourhoods, and health effects of industrial and commercial establishments which are submitted to such authorisation. The categories of establishments subject to such procedure are defined in a nomenclature in appendix of the decree. The demand of authorisation is made by the Communal Direction of Mines for classes 2 and 3, and by the Ministry of concern, generally the Ministry of Industry, for class 1 establishments. At the end, after examination by the Service of Mines for small units, all the requirements are centralised at the level of the Division of Classified Establishments, within the Ministry of Mines and Energy, for delivery of the authorisation. The submitting establishment must provide a description of the activity, and waste treatment and disposal methods.

The classification of the EDII has been made according to the ranking of dangers or nuisances:

- Class 1: Establishments requiring some distance (buffer zone) from dwellings
- Class 2: Such buffer zone is not required, but operation is subject to application of measures against dangers and nuisances
- Class 3: Only general prescriptions of public health concern, since the corresponding establishments do not generate much inconvenience

According to the nomenclature of Insalubrious, Dangerous and Inconvenient Establishments, the solid waste related activities have been ranged as shown in Table 14.1-4 below. Wastewater treatment plants are not included in the nomenclature.

Specific prescriptions have been enacted by legal orders for selected activities of the nomenclature. The activities related to waste handling have not been the object of specific prescriptions.

Table 14.1-4 CLASSIFICATION OF WASTE RELATED ACTIVITIES IN THE EDII SYSTEM

	Category	Code	Comments
Treatment of domestic waste when it is up to 150t/day and if operated without separation of materials and within 24 hours after reception of waste materials	2	O01	
Treatment of domestic waste in all other cases	1	0O1	
Deposit of sludge and refuse, waste	1	D05	
Deposits of domestic waste in controlled landfill	1 and 2	D02	The concept of controlled landfill is not explicit in the nomenclature. The nomenclature provides both classes 1 and 2 for this activity

General prescriptions have been enacted for establishments belonging to class 3 of the nomenclature, in Order n°014 of 01.11.76. They provide a general idea of the nature of the nuisances considered and the necessary countermeasures:

- In case of noise nuisance, these establishments must be located at a minimum distance of 200m from hospitals and schools.
- In case of activity by night, this requirement does apply also for dwellings.
- Establishments generating nuisances like bad smells, dust, or smoke must be located outside the built up area, unless countermeasures have been undertaken, like closed area and ventilation system.
- In addition to such prescriptions, the same order provides quality standards for effluents (Table 14.1-3).

In conclusion, the interpretation of the EDII requirements for waste and wastewater related activities are not easy. Wastewater treatment sites are not found in the nomenclature of EDII but the Service of Mines would apparently consider them as establishments submitted to authorisation, according to discussion with the JICA study team. Whatever the case, there is no prescription for solid waste or wastewater related activities. It is then reasonable to consider the prescriptions enacted for class 3 establishments as being pertinent and minimum requirements for environmental purpose. Accordingly, water quality standards as presented above have been considered for the wastewater treatment plants of the project.

(2) EIA Procedure

The Frame Law of Environmental Management requires activities to follow the environmental authorisation procedure of approval of the EIA study before starting activity. The Order 97-001 of 10 January 1997 sets the environmental authorisation procedure for activities, projects and programs that have potential effects on the environment. The core of the procedure is the EIA requirement. EIA is the main instrument for preservation of the social and natural environment, including cultural patrimony. The order has also established the authority in charge of examination of EIA, namely the BEEEI. Application decrees are:

- Decree n°200-397 of 20.10.00 on the Administrative Procedure for Evaluation and Examination of Environmental Impacts, Contents of Environmental Impact Studies, and Action of Advertisement;

- Decree n°2000-398 of 20.10.00 on List of Activities, Works and Planning Documents that are Subject to Environmental Impact Studies;
- Decree n°2000-369 of 12.10.00 on Attributions, Organisation, and Operation of the Office of Environmental Evaluation and Impact Studies.

There are no sector guidelines for EIA and the present approach is based on the establishment of TOR of the EIA study on case by case basis, in accordance with the existing guidelines of aid agencies. In principle, TOR of the EIA study is prepared by the concerned agencies between the promoter and the impact assessment unit, to be submitted to the BEEEI for approval or observations. Based on the approved TOR, the EIA study is performed by an independent expert for the project promoter, before its in-house examination by the impact assessment unit, called the *focus point*, which is the unit belonging to the supervising agency of the project in charge of coordinating actions with BEEEI. Final draft of EIA is submitted to the BEEEI, which checks the validity of the study (respect of TOR, pertinence of the evaluation) in cooperation with a committee composed of all the parties concerned by the project and the association of experts in environmental evaluation. If corrections are necessary, they are notified to the promoter. After finalisation and submission of the EIA study, the BEEEI will notify its approval to the minister within 21 days after submission. The Minister in charge of environment has ability to deliver the environmental autorisation within 7 days after reception of BEEEI notification. The EIA report must be submitted to BEEEI in 6 copies.

The presentation of the EIA report is regulated by decree and should be as follows:

- Summary of the study
- Introduction with outline of the report
- Description of project
- Analysis of the initial state of environment
- Legal framework of EIA
- Evaluation of expected positive and negative effects
- Description of project alternatives
- Identification of measures
- Plan of supervision and follow-up of environment
- General conclusion
- Appendices

14.2 EXAMINATION OF ENVIRONMENTAL EFFECTS

14.2.1 Scope of Environmental Evaluation

(1) EIA Requirement

The environmental law and the decree establishing an EIA both require an EIA for activities, projects and programs of development. These requirements are discussed below in order to better define the expected scope and pertinence of an EIA for the sanitation improvement master plan. According to the decree defining the types of activities subject to an EIA, there are 2 or 3 categories of projects that require special attention:

- Construction or extension of sewerage system over 1 km length and wastewater treatment plant designed for the treatment of more than 200m^3/day of wastewater flow. In the master plan, the smallest treatment plant is designed for 1000m^3/day.
- Siting, construction and extension of collection and disposal systems of dangerous waste, including medical waste. There is no specific legal definition of dangerous waste in Niger.
- There is finally the third case of little explicit but relevant case of any installation or program set up in the public and fluvial domain.

Accordingly, if wastewater treatment plants are subject to EIA, this is not the case for domestic solid waste disposal systems. However, it is reasonable to consider that EIA should be performed in this case too, because international rules, including those of JICA do require such EIA for municipal waste disposal sites. Moreover, medical waste and possibly some dangerous waste do enter the system of municipal waste collection in Niamey.

The EIA legal requirement as established in Niger concerns activities, projects and programs all together. This means that the master plan itself should in principle be the object of an EIA, besides the projects which are proposed within the scope of the master plan. However, this last requirement is very subject to interpretation because:

- The list of activities, projects and plans subject to an EIA as defined in the decree clearly focuses on projects only.
- There is no any specification about the study process in case of plans and programs.

It is then reasonable to consider that the EIA is firstly required for identifying the impacts of the planned projects but must as well take into account the general evaluation of the cumulated and synergetic effects of the master plan. Within the scope of the master plan, such approach is fully recommended.

Finally, the decree specifies that BEEEI will have ability to decide if a project is subject to EIA or not. The preparation of TOR of EIA in coordination with the BEEEI is a prerequisite for getting consensus on the scope of the EIA study.

In conclusion, the following scope of evaluation seems reasonable in order to meet with the Niger requirements and the international standards:

- EIA of priority projects as part of feasibility study
- EIA of all waste, waste water and runoff water management projects
- Consideration and global evaluation of the effects at the level of the whole master plan

The EIA procedure in Niger requires that positive and negative impacts are both considered and explicitly mentioned in the study. The objectives of the master plan, which are drainage of water runoff, collection and treatment of waste water, and collection, transportation and treatment of waste, are all positive environmental objectives. The role of an EIA in such project is then to:

- Make sure that the project objectives are not realised through pollution and nuisances transfer from urban area to natural area, or from one community to the other, but through the full integration of environmental requirements and priorities.
- Make sure that objectives are realised according to sustainability and acceptability concepts.

- Prepare an environmental plan with measures able to increase the positive effects and measures able to reduce or eliminate the non desirable effects.

(2) Purpose of IEE

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.

14.2.2 Project Components and Sources of Impacts

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. Siting, 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 collection of wastewater and storm water, and the treatment of wastewater are based on 3 types of systems and geographical areas (see Chapter 8): 4 combined sewer system areas; 11 separate sewer system areas; and the peripheral urban on-site treatment system area. The collection, transportation and treatment of municipal waste are based on a plan of pre-collection of waste, 48 waste recycling centres for sorting out the 4 zones de système unitaire de collecte des eaux usées; sand material, and 2 controlled landfill sites.

Within the sewerage facilities planning area, the planned 14 wastewater discharge points can be classified according to the category of receiving environment.
- 4 outlets directly discharging on the left bank of Niger river
- 2 outlets on the right bank of Niger river
- 4 outlets along the Gounti Yéna river
- 4 outlets on the plateau

The main characteristics of these groups of outlets can be summarised as in Table 14.2-1 below. The estimates take into account the 25% volume of domestic wastewater which are generated as non-point sources.

Table 14.2-1 FUTURE PATTERN OF DISTRIBUTION OF WASTE WATER DISCHARGE OUTLETS IN THE ENVIRONMENT

	Niger river left bank	Niger river right bank	Gounti Yéna river	Plateau
Planned number of outlets	4	2	4	4
Max daily flow 2015	15,750	10,060	16,450	13,080
% of daily flow from separate sewer system	40%	100%	79%	100%
Present number of outlets	8		11	
Present daily flow (observed outlets)	6000m3/day	-	About 5700m3/day	-
Demographic increase 2000/2015	4.6%	69%	49%	29%

The main components of the implementation of the master plan and the corresponding impact sources are overviewed in Table 14.2-2 below. The main potential sources of impacts can be summarised here:

- Failure in the treatment process and lack of maintenance
- Conditions of installation and maintenance of facilities in the on-site treatment area
- Generation of solid waste, sludge, and night soil
- Stagnant water of polishing ponds and stabilisation pond
- Sewer overflows in the combined sewer system area
- Siting of facilities and wastewater outflows
- Construction works
- Others (pollution and nuisances)

On a whole, it is expected that a large part of potentially positive or negative effects of the project will be related to the capacity of authorities to manage and maintain facilities on the one hand, and to manage and implement the set of environmental measures made necessary, on the other hand.

14.2.3 Screening of Potential Effects

The analysis of the present conditions of environment in Niamey, which has been presented in 3.7, has shown that there are critical issues both in terms of urban and natural environment. The sanitary conditions of Niamey have important impacts on the health of people, their quality of life, the potential of useful resources like groundwater, and the quality of the natural environment, specially water courses and the Niger river. These negative effects are intensified by factors like poverty, drought and desertification trends, past agricultural development of Niger flood plain, and local climatic conditions. A summary of the environmental conditions in Niamey area is presented in Table 14.2-3 and Table 14.2-4.

The screening of the possible effects of the sanitation projects on environment is done in Table 14.2-5. The screening checklist has been fulfilled according to the JICA guidelines applying to waste and wastewater management sectors. The relevance of each item is considered according to the following ranks, regardless of the positive or negative character of these effects:

- A- possibly important effect expected;
- B- possible effect expected;
- C- unknown;
- D- no effect or no relevance.

Table 14.2-2 CHECKLIST OF POTENTIAL SOURCES OF IMPACTS OF PROJECT COMPONENTS

Project components	Potential sources of environmental impacts	Conditions of Implementation & management	Factors (strengthening the effects or reducing them)
Waste Water Treatment Plants			
UASB treatment plants	Siting and construction in 14 locations 4 units on left bank of Niger river 4 units along Gounti Yéna 6 units in urban area	Target 2005 and 2010 Largest plot: 1.26ha Smallest plot: 0.16ha Average plot: 0.66ha Total area: 8.58ha 4 plants in the combined sewer system, 10 plants in the separate sewer system	Legal requirements of the Ministry of Mines and others (Forestry code) Conditions of natural and land resources dependence of local communities, conditions of land use rights and settlements, etc.
	Operation / maintenance failure	Final selection of the treatment technology 8 plants in separate sewer area, and 4 plants in combined sewer area	Institutional / technical capacity for long term maintenance, motivation of employed staff
	Generation of sludge from sludge drying bed	Total quantity generated: 15,710m3/year Quantity of sludge generated at the industrial zone plant: about 750m3/year Biggest unit will generate about 60,500m3/year. (assumption of 40% water content)	Disposal, and possibility of reuse of domestic waste sludge for agriculture
	Generation of methane gas	Quantity expected is about 894,000m^3/year in total; Biggest unit will generate about 141,000m^3/year. (75% vol. CH_4)	reuse as energy source
Wastewater discharge points	4 outlets on the left bank and 2 outlets on the right bank of Niger river; 4 outlets along the Gounti Yéna; 4 outlets on plateau	Time horizon 2015. In total, 14 outlets, 55,000m^3/day. Niger river: Left bank, 4 outlets, max. 15,750m^3/day, instead of 8 outlets / about 6000m^3, actually. Right bank, 2 outlets, max. 10,000m3/day, instead of no outlets actually. Gounti Yéna: 4 outlets, max. 16,450m^3/day instead of 11 outlets / about 5600m^3, actually	Application of effluent quality standards; Overflow in the combined sewer system area; Niger river outlets: 40% of max. daily flow as separate sewer system, on left bank; 100% as separate system on right bank; Gounti Yéna: 79% of max. daily flow as separate sewer system;
	One plant receiving pre-treated industrial waste water (industrial area) mixed with domestic used water	Discharge in Niger river of about 3000m3/day max. as separate sewer system (data included in 4 outlets of Niger river above).	Implementation of industrial pre-treatment program
Water ponds	Irrigation water ponds at the 4 outlets located on the Plateau	Waste water discharged: about 15,000m3/day max. all as separate sewer system.	Reuse for irrigation
	Polishing ponds at each UASB site, being potential sites for breeding of disease vectors, specially mosquitoes	Secondary treatment in association with fish farming	Know how for good maintenance Income generated by fish farming
Stabilisation pond treatment	Stagnant water	1 unit at airport area, with plot area of 3.8ha	

Pumping stations

6 stations	Siting, and construction on 6 sites	Operating + stand-by pumps - Total hourly maximum flow is 335m3 in Dar Es Salam	Capacity of maintenance is essential for the whole system
	Generation of solid waste	No grit removal chamber; solid waste screens located upstream the pumping stations.	

On-site treatment facilities

Septic tanks	Generation of night soil	Total estimate of night soil produced: 4000m3/day (assumption: 20 litres per day capita) Total estimate of night soil to be collected (latrines): 50,000m3/year, in 2015 (assumption: 1.5m3 / family / year, and 6 persons / family)	Control measures of proper construction and use. People awareness /behaviour. Management plan for collection and disposal of night soil.

Sewerage and storm drainage

Sewerage network	Sewers	Construction of trunk sewerage pipes (15 to 25 cm): 105km.	
	Storm drainage (main trunks)	Existing trunks: about 85km Construction of new trunks: 128km	Set dimension of storm drains is based on a 2 years probability rain of 100mm/hour
	Failure in maintenance would increase the potential sites for breeding of disease vectors		People behaviour Capacity of maintenance
	Discharge of storm water in Niger river (separate sewer system and on-site system)		

Solid waste management facilities

Controlled landfill sites	Siting	Siting of 2 sites in old quarries: Landfilled quantity in 2015: 1 million m3 (*Route de Filingué* site); 140,000m3 (Commune III site)	
	Plan for improving landfilling operations	Waste disposal, access road, fencing, and levelling in 2005 Daily earth cover, truck scale in 2010	Management plan of hospital
	Transportation of waste	No transportation plan	
Recycling centers	Siting	Location of 48 facilities in the urban quarters: Sorting out of sand material	Neighbourhoods
	Conditions of operation	Manual separation of waste materials	Security of working conditions and occupational health check

This checklist shows that the projects could have major effects on the environment, in principle positively oriented, and several side effects that need consideration for the good integration of environmental requirements in the implementation of the master plan. All the relevant items are reviewed and discussed in Table 14.2-6.

Table 14.2-6 shows that the scope of possible effects to consider in the EIA study is quite large. However, there are 5 major global issues needing priority evaluation. They are:

- Improvement of the Niger river environment (and other watercourses)

- Natural conditions, livelihood and living environment conditions of communities in projects sites
- Generation of solid waste and exposure to health risks related to the waste handling activities
- Outbreak of malaria
- Protection of groundwater

The Table also shows that the conditions of operation and maintenance of facilities are the main factors of environmental sustainability of the projects and determine the nature and importance of the potential effects. Institutional capacity to manage and follow up environmental measures is also a critical factor of good integration of environment in the project and master plan. Finally, the awareness heightening of residents for their waste disposal behaviour and for the good acceptance of sanitation facilities should be given much attention because of its close links with maintenance conditions of facilities, directly through ecological behaviour, and indirectly through sanitation policy legitimisation.

Table 14.2-3 SUMMARY OF THE INITIAL STATE OF SOCIAL ENVIRONMENT IN NIAMEY

Items	State of environment and sensitive issues	Current protection status and environmental quality objectives
Rurality	Livelihood being strongly dependent on the "empty" plot areas of the city, as well as Niger riverside areas: fuel wood, fodder, fishing products, gardening and cropping. 6 camps fishermen.	Control of fuel wood collection and fishing activity (permits).
Marginality	Several marginal pocket areas: Spontaneous settlements, old settlements outside basic infrastructure areas like *Neini* island and along Niger river, isolated villages around the city.	National Plan of Sanitation Development
Public health	Good health care system with local insufficiencies Dramatic incidence levels of malaria and diarrhoea, with strongest effects on children. Riverside population and laundry workers and fishermen are affected by schistosomiasis and possibly water contaminants.	National Plan for Eradication of Malaria. Roll back Malaria project Initiative Africa 2000 Health Cities Program
Women, children, young	67% of Niamey population under 25 years old. Primary role of women and children in health, hygiene, sanitation	Declaration of Women Promotion Policy
Poverty	Worsening the effects of exposure to contaminated water and the social effects of flooding. Few pocket areas with tempora ry but severe exposure to contaminated water: Well water and river water consumers. Unemployment perceived as the first cause of degradation of living conditions and poverty	National Frame Program of Prevention and Eradication of Poverty
Cultural patrimony	*Kirkissoye* archaeological site *Korei Gorou* archaeological site Governor's residence	Legal framework of protection exists but not yet effective
Natural disasters	Chronic incidence of flooding and landslide in rainy season, with degradation and loss of human settlements (houses, fields, roads).	National Plan of Disasters Management, under preparation

Table 14.2-4 SUMMARY OF THE INITIAL STATE OF NATURAL ENVIRONMENT IN NIAMEY

Items	State of environment and sensitive issues	Current protection status and environmental quality objectives
Desertification and drought	Context of desertification, with trends toward rarefaction of water resources. Decreasing average flow of the Niger river and increasing occurrence of severe shortages.	*Kadadji* dam project to maintain the minimum stream flow of Niger river. National Plan of Environment for Sustainable Development / National Action Plan for Combating Desertification.
Natural habitats	Niger river is the most valuable natural area of Niamey, with aquatic habitats and waterfowl. This environmental resource is however strongly degraded by urban / industrial effluents, sanding, proliferation of water hyacinth, and past agricultural development and use of agricultural inputs.	Isolated programs for eradication of water hyacinth, without success. 10m width riverbanks protected under Forestry Law.
Water resources	Surface water sources like river and water pools are largely used for irrigation of gardens, cattle herds, and laundry, the Niger river being the main one. Waste water flowing in *koris* are sometimes used for gardening during the drought season.	*Kadadji* dam project
Flooding and erosion	Ecological effects of flooding and erosion are sanding of riverbed, degradation of water courses and river banks.	Bare lands must be dedicated to restoration of forest (Forestry law)
Biodiversity	There is no recent investigation but biodiversity is dominated by 21 fish species found in fish catches (in principle a total of 68 existing species, of which several have disappeared). Minimum 30 species of birds observed. Natural vegetation: Almost isolated tree species.	23 species of birds in Niamey area have some protection status. 15 tree species protected under Forestry Law.
River water	No follow-up of river water quality, but JICA survey has shown bacteriologic and organic pollution. All water courses in Niamey are used as sewers.	Effluents quality standards of the Service of Mines No classification of rivers according to quality objectives
Groundwater	Very sensitive to surface pollution and strongly contaminated by infiltration of urban waste water. Groundwater consumed by 8 to 15% of population. But less than 3% households supplied with well water, with however big geographical disparities.	No protection rule in the case of Niamey, but recognised as potential water resource

Table 14.2-5 CHECKLIST OF POSSIBLE EFFECTS OF PROJECTS

	Solid waste	Waste water	Storm drainage
Social environment			
Resettlement of population	C	C	C
Change in life style, behaviour	B+	B+	D
Economic activity	B+	B+	B+
Loss of the resource base (livelihood)	C	B	C
Degradation of living environment	B	B	C
Minorities, ethnies	C	C	C
Social conflicts	C	C	D
Transport / infrastructure	B	D	B+
Regional disparity	D	D	D
Historical heritage	C	C	C
Land rights	C	C	D
Water rights	D	D	D
Health / sanitation	A+	A+	A+
Waste	A+	B	B
Disaster	D	D	A+
Natural Environment			
Morphology, erosion	D	C	A+
Groundwater	B	A+	B+
Rivers	A+	A+	D
Fauna and flora	B+	B+	C
Climate	B	B	D
Landscape	C	B	B+
Pollution			
Air pollution	B	B	D
Water quality	B+	B+	B+
Soil contamination	B	D	D
Noise, vibrations	B	D	D
Land subsidence	D	D	D
Bad smells	B	B	D

A- possibly important effect expected; B- possible effect expected; C- unknown;
D- no effect or no relevance.
+ means that the effects are basically and prominently positive in good management figure;
no indication means that the effects if any are positive or negative or both.

Table 14.2-6 REVIEW AND DESCRIPTION OF POTENTIAL EFFECTS / SOCIAL ENVIRONMENT (a)

Items	Rank	Specific issues and observations
		Social life
Resettlement of population	+	Possibility of involuntary resettlement must be considered with the construction of waste water treatment plants or pumping stations, within limited scale.
Loss of the resource base / livelihood	++	Siting of treatment plants has strong potential to severely affect the resource base of local communities. Need to understand land use patterns and land use rights, as well as contribution to households income or activities of sensitive members of the households (women, children). Siting of landfill sites could impair secondary uses like extraction of materials for *banco* and use of water pools by local communities.
Degradation of the living environment	++	Siting and construction of treatment plants and landfill sites, and operation of waste sorting out centers have potential to contribute to the degradation of the living environment of local communities.
Change in life style	_	Change will be necessary to increase citizens responsibility about waste handling and cooperation with communes (role of environmental awareness)
Social conflicts	+	Small scale conflicts liable to occur in the scope of land rights if not properly managed when expropriation is made for siting of facilities
Indigenes, minorities, ethnies	_	Not known
Change in economic activity, unemployment	_	The project increases the potential of water resources of Niger river for agricultural use, and also improves the quality of small cultivation systems riverside and along water courses. It also increases employment opportunities, specially for the sorting out the waste materials and management of waste disposal site
Sensitive social groups, women, children	+	Population of spontaneous settlements, marginal groups, women and children have special sensitivity to the effects of the project
Geographical distribution of benefits, social disparity	+	Existing disparities in social environment conditions (poverty, infrastructure, exposure to contaminated water) are factors to consider in the possible inadequate distribution of benefits as regards to the priorities and urgencies of communities (sanitation and flooding).
Occurrence of flooding	_	The prevention of flooding is one major objective of the project.
		Health
Outbreak of endemic disease, communicable disease	++	The extension of the sewage system and the adoption of ponds for final treatment in UASB sites may directly favor conditions of breeding for mosquitoes depending on conditions of maintenance of facilities. In the worst case, it could generate a major public health problem through spreading of malaria vectors in dwelling areas.
Toxic substances in food chain	+	The possible reuse of waste water and sludge for irrigation and enrichment of crop fields should not raise significant risks excepted for pathogens. Irrigation water users along watercourses will be direct beneficiaries of improved quality of water. Possible reuse or discharge of sludge and waste water from the industrial zone treatment plant provides potential risk of food chain contamination.
		Cultural patrimony
Destruction of remains and assets	_	Archaeological sites located in Commune III are not concerned by the planed location of waste water treatment plants nor by sewerage network, but it should be confirmed during advancement of the study.
Loss of valuable landscape, amenities, aesthetic values	+	The project has potential to contribute to a better quality and attraction of the Green Belt, but inverse trends are also to be considered (illegal waste deposits, traffic generated by transportation to landfill site). There are potential landscape effects due to location of facilities, including landfill sites. But the general benefit of the project is obvious for increasing urban amenities, through eradication of waste deposits and litter in public places.

++ Primary issues for negative effects, needing special attention; + Secondary issues for negative effects, needing consideration; - Other issues for negative effects, that are not relevant, or unknown, or improbable, or negligible.

Table 14.2-6 REVIEW AND DESCRIPTION OF POTENTIAL EFFECTS / NATURAL ENVIRONMENT (b)

Items	Rank	Specific issues and observations
		Ecological issues
Aquatic habitats, fauna and flora species,	++	Flora and fauna seem to be severely degraded in the present natural conditions of the Niger river. Then, waste water treatment will strongly decrease chronic pollution and have positive effects for aquatic life. Siting of the waste water outlets with the possible presence of sensitive river habitat must be investigated. There are possible time limited effects on water quality that have to be considered, as described below, and which could affect natural aquatic habitats at local level.
Degradation of riverside areas, waterfowl	++	Basically related to the siting of waste water treatment plants. Project is not in principal a factor of degradation of the natural vegetation, but possible impact on valuable tree species must be considered. The possible effects on birds habitats (only one tree may be important for migratory species) should be considered in the siting of facilities, specially the waste water treatment plants.
		Soil and groundwater
Contamination of soil and groundwater	++	On-site treatment in the peripheral area will be a potential source of contamination of groundwater because of the dramatic population increase expected in this area. The management pattern of sludge generated by waste water treatment plants, specially for the industrial area, is also a factor to take into consideration.
Soil erosion and sanding	_	Not known because closely related to local conditions. The global effect expected is however decreased erosion through a better control of the rain water runoff.
Deterioration of soil fertility	_	Waste management should contribute to the eradication of plastics in cropping soils and then improve soil quality; The use of sludge and waste water may also be a factor of increased fertility.
Loss of land / desertification	_	Loss of land will be limited to sporadic places for facilities and is not significant, while landfill disposal site will take benefit of use of old quarries. The project will be positive in the water balance and water resource potential.
		Pollution / nuisances
Surface water pollution	++	On a whole, the collection system will geographically concentrate more waste water quantity in few discharge points, which is a factor of water pollution risk in case of critical conditions like failure of operation, overflow and drought. Low flow and drought of the Niger river would be conditions increasing pollution load of the river; Sewerage overflow may lead to "shock pollution". The risk of failure in operation and maintenance increases when technology involves regular supplies (electricity, water) and qualified human resources. The residents perception of relatively lower priority of waste water management compared with other sanitation objectives is a factor of weakness that increases the risk of failure in operation and maintenance unless it is supported by a strong political will and accompanied with public awareness heightening.
Air pollution	+	From facilities and in relation to the possible increase of traffic jam between city and landfill site. Specially to consider during construction of facilities.
Traffic	+	Transportation of waste to the landfill sites is a factor of increased traffic, with all the potential nuisances that can be induced (air pollution, traffic jam, noise, accidents).
Waste	++	Activities for sorting out waste and handling waste present potential health risk to workers who are exposed in permanence. Generation of sludge in treatment plants and solid waste at waste water screening sites. Extension of trunk sewers / storm drains gives potential additional sites for waste littering by people, and increases solid waste quantities washed out toward the Niger river in rainy season. Generation of inert waste during the engineering construction works.
Noise	+	In relationship with transportation of waste and around landfill site. Also pumping stations. Sensitive issue during engineering works for construction of facilities.
Proliferation of harmful species (pest)	+	Increased proliferation of birds, rodents, insects and other pest is to be expected in and around landfill sites, recycling centres, and treatment plants (sludge storage), locations for screening of solid waste before pumping.
Unpleasant smell	+	Potential sources of unpleasant smells are pumping stations, landfill site, waste sorting out centres, and airport stabilisation pond. Sludge disposal operation should also be considered. Operation failure of UASB treatment plants and pumping stations must be considered.

14.2.4 Terms of Reference of EIA

(1) Purpose of the EIA Study

The master plan for sanitation improvement of Niamey will permit to achieve better public health performances and to upgrade the quality of the living environment through urban sanitation. Citizens will be the direct beneficiaries of this plan. The full achievement of such objectives is however related to the proper selection of sites for sanitation facilities, their technical design and their good operation and maintenance.

The purpose of the environmental impact assessment study (EIA) 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. From the environmental point of view, the project must achieve objectives like the following:

- Social environment: Improvement of living conditions and health; fair distribution of the benefits of the project; participation of public and women; creation of durable / productive employment; development of amenity potentials.
- Natural environment: Restoration of natural habitats; preservation of water resources; protection of the natural resources base and livelihood; protection of valuable natural assets.
- Institutional side: Capacity to manage the impacts through measures to be undertaken, and capacity to follow-up environmental conditions during implementation of the project.

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.

(2) Study Areas and Projects

The assessment of the environmental impacts will be done within the scope of the feasibility study and cover the study area of the master plan. The frame of the assessment is then triple:

- Priority projects defined for the feasibility study as priority projects (short term projects)
- All the projects planned within the Master plan and considered on a case by case basis for the assessment of impacts (mean and long terms)
- Synergetic and cumulated effects at the Master plan level

The projects defined within the scope of the master plan are the following:

- 2 municipal waste disposal sites
- 48 waste recycling centres
- 14 waste water treatment plants of UASB type with polishing ponds
- 1 waste water treatment plant of stabilisation pond type
- 10 waste water discharge outlets of which 4 lying on left bank of Niger river
- 6 pumping stations
- Sewerage and storm drainage

- On-site waste water treatment alternatives

The projects defined within the scope of the feasibility study of priority project are the following:

- 2 municipal waste disposal sites
- 4 to 6 waste recycling centres
- 1 waste water treatment plants of UASB type, already in construction at *Dezeibon*.
- 1 waste water discharge outlets in the *Gounti Yéna*

(3) Scope and Objectives of the EIA

It is assumed that the scope of this EIA is basically determined by the global figure of the master plan more than the individual projects induced by the master plan, which will be subject to alternative choices. Then, it is also assumed that future technical studies to design each of the facilities will be accompanied with individual full EIA studies.

Within the scope of the feasibility study, neither the UASB waste water treatment plant of *Dezeibon* nor the waste recycling centres and the municipal waste disposal sites are legally subject to an EIA. The UASB plant is already under construction. Accordingly, it is assumed that within the scope of the feasibility study, environmental assessment will almost be limited to the municipal waste disposal sites, and some attention given to the possible nuisances generated by the recycling centres.

The evaluation of the positive and negative impacts expected from the projects within the scope of the master plan constitutes the core of the study. It will be based on a good knowledge of the present conditions in the project areas and the impact sources of planned facilities. Environmental assessment will be based on analysis of each project site with the objective of providing an overview of the impacts at the level of the master plan. The proposition of the environment management plan will be the major conclusion of the EIA study.

The EIA investigation report will provide a clear presentation of the expected effects of the projects taken individually and the master plan taken on a whole. Special attention will be given to the presentation of environmental impacts, as to cover all the following interfaces for full interpretation of results:

- Short / long term impacts
- Direct / indirect impacts
- Individual projects / master plan impacts
- Construction phase / operation phase impacts
- Social / natural impacts
- Impacts according to alternatives and according to project deadlines

In addition, effects will be characterised and evaluated as much as possible taking into account their importance and acceptability levels through the following approaches:

- Ranking of importance
- Acceptability levels (global environment, local regional environment, local communities)
- Effects with / without environmental measures

- Effects within a scenario of operation / management failure of facilities
- Weighting overall negative / positive effects of the master plan.

(4) Major Potential Sources of Impacts and Main Issues of Study

The major potential sources of impacts of the projects have been identified in 14.2.2 and are summarised again:

- Failure in the treatment process and lack of maintenance
- Conditions of installation and maintenance of facilities in the on-site treatment area
- Generation of solid waste, sludge and night soil
- Stagnant water of polishing ponds and stabilisation pond
- Sewer overflows in the combined sewer system area
- Siting of facilities and waste water outflows
- Construction works
- Others (pollution and nuisances)

Results of the IEE have stressed the need to consider 5 broad priority issues in the evaluation of the possible environmental negative impacts, within the EIA. The assessment should however not be limited to these 5 issues, since screening of effects has identified several other isolated issues needing attention, and possibly intertwining with the broader ones. The 5 priority evaluation issues are recalled here:

- Improvement of the Niger river environment (and other watercourses)
- Natural conditions, livelihood and living environment conditions of communities in projects sites
- Generation of solid waste and exposure to health risks related to the waste handling activities
- Outbreak of malaria
- Protection of groundwater

Isolated issues are those which environmental incidences are not known or seem to be more limited than the precedent in their extent, if they do occur. It is however possible to find out that some are important on local scale, based on the results of investigations of the EIA. These effects have been given in Table 14.2.6 and are summarised here:

- Resettlement of population
- Land rights related conflicts
- Sensitive social groups (women, children, marginal population)
- Strengthening marginality of isolated communities
- Toxic substances in food chain
- Loss of landscape, amenities, aesthetic values
- Air pollution, traffic nuisances, noise, unpleasant smells and proliferation of harmful species

(5) Field Surveys

The environmental assessment will be based on a set of investigations and field surveys, which will be conducted by the local consultant in coordination with JICA study team and

BEEEI, and based on the TOR. TOR is prepared by the JICA study team in coordination with BEEEI for finalisation.

1) Ecological Survey

The questions raised by the impact of the project on the Niger river environment are:

- Does the treatment system proposed achieve the water quality objectives retained for the project and the intended uses objectives of the Niger river?
- What are the expected benefits in terms of environmental quality, natural resources savings, public health and amenities? The evaluation should be based on the 2005, 2010 and 2015 figures of achieving wastewater treatment and solid wastewater treatment.

The ecological survey of the Niger river will provide data for a better evaluation of the effects of wastewater discharge and for future follow-up of environmental improvement with implementation of the master plan. There is no classification of rivers according to their intended use but safe bathing and swimming and preservation of ecosystems are the basic objectives to be considered.

The survey should focus on the aquatic habitats existing at the location of the planned wastewater outlets and more largely in the Niger river within the CUN area. Data will deal with main aquatic species (plants, fishes), with description of their ecological characteristics, their quantitative / qualitative importance, and the environmental and resource values.

2) Environmental Surveys

Physical natural conditions of the planned waste landfill sites will be surveyed, focusing on groundwater and soil conditions. In the case of the other planned facilities, the check of natural conditions will be normally limited to field observation.

3) Social Surveys

The social questions raised by the project sites issue are:

- To which extent does the implantation of facilities impair the livelihood resource base of local communities and their living environment?
- To which extent do these facilities after implantation and during construction works induce nuisances to the neighbourhood residents?
- Does the project directly and indirectly fit with the social objectives of current policies (poverty, employment, public health) and how is it accepted by local communities?
- Are the project sites free of valuable natural assets or environmentally valuable assets?

As regards to the social aspects, there are several questions which are particularly relevant at the level of the master plan itself:

- Does the project improve livelihood and public health for all, and does it fit with existing plans against poverty?
- Is there confirmation that population already spoiled by environmental degradation (loss of resources, exposure to health risks) will at least take benefit of the sanitation project?

- Are there communities where benefits of the project in sanitation improvement will be however impaired by other factors (lack of safe water supply, exposure to contaminants and disease vectors)?

The social surveys of facilities implantation areas will provide all the necessary data for a better understanding of possible effects on the human communities. All the areas with planned location of facilities are concerned with social surveys. The surveys will cover several key tasks that need to be identified after observation of sites on case by case basis. Basically, they could include aspects like:

- Land property and land use rights
- Land use patterns (livelihood)
- Settlements and social groups
- Sanitation and health conditions
- Social and economic conditions
- Landscape and amenity values

(6) Analytic studies

Investigations will be based on the analysis of existing data and on field observation, as well as from discussion with experts as possible. These investigations deal with 2 categories of objectives:

- Evaluating the possible importance of expected impacts for specific issues, according to the projects design and management conditions.
- Evaluating the measures to be undertaken as regards to all the identified impacts of the project on the environment.

Specific issues are:

- Risk and extent of outbreak of malaria
- Risk and extent of groundwater contamination in the on-site treatment area
- Risk of food chain contamination
- Importance of pollution and nuisances during construction works

(7) Reporting

The full EIA report will include all the chapters required by the decree on environmental impact studies in Niger, based on the environment related chapters included in the feasibility study and the final report of the JICA study. The relevant chapters distributed in the JICA study will fit with those of the EIA report required by the Niger side as shown in Table 14.2-7 below. All the reports constituting the EIA study will be edited in a special separate volume (6 copies) at the intention of the BEEEI, without significant modification of contents. This report will be entitled in agreement with the BEEEI.

Table 14.2-7 DISTRIBUTION AND CONNECTION OF CHAPTERTS IN THE EIA

Study outline required by decree	Environmental evaluation in the JICA study
Summary of the study	Chapter on EIA in the feasibility report
Introduction with outline of the report	Chapter on EIA in the feasibility report
Description of project	Master plan area level: Chapter 14 of this report Individual projects level: Chapter on EIA in the feasibility report
Analysis of the initial state of environment	Master plan area level: Chapter 3.7 of this report Individual projects level: Chapter on EIA in the feasibility report
Legal framework of EIA	Chapter 14 of this report
Evaluation of expected positive and negative effects	Chapter 14 of this report for screening Chapter on EIA in the feasibility report for analysis and conclusions
Description of project alternatives	Chapter on EIA in the feasibility report
Identification of measures Plan of supervision and follow-up of environment	Environmental management plan: Chapter on EIA in the feasibility report
General conclusion	Chapter on EIA in the feasibility report
Appendices	Appendix of the feasibility report: Documentation consisting in: a) Appendices C3, M, N, and O of this report (attachment to 3.7) b) New appendices constituted by the reports of surveys made by the contracting local consultant within the scope of EIA study.

CHAPTER 15. PROJECT EVALUATION

CHAPTER 15. PROJECT EVALUATION

15.1 TECHNICAL EVALUATION

The success of the Master Plan (M/P) for the Niamey City is dependent upon combination of several schemes for the Sanitation Improvement Projects.

15.1.1 Sewerage/Drainage Projects

1) Former Niamey Sewerage Master Plan

Former Master Plan was not envisaged during the examination and investigation of BAD due to financial conditions and performance of Nigerian side.

2) Implementation Schedule

Implementation of the Urgent Rehabilitation Works (URW) shall be set till 2005.

3) The Monitoring of Pilot Study

The sustainable monitoring shall be continued till the year 2005 so that concrete performance of the proposed technology could be established.

4) Reuse of Effluent from WWTPs

Reuse of effluent from WWTPs has to be well considered for the irrigation purpose. The quality of the wastewater (effluent) that will be treated at the proposed WWTPs shall meet the standards for irrigation water.

15.1.2 Solid Waste Management Projects

Based on the results obtained from the subcontracted works and the preliminary analysis of the solid waste management in the city of Niamey, several schemes are elaborated for improvement of solid waste collection, transport and disposal. The most appropriate alternative is recommended.

Because of the viability of the selected projects, Quartiers have been grouped in different categories for revenue. Further more 2 landfill sites have been identified and are proposed for construction.

15.1.3 Urban Sanitation Projects

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 designated sites for both the pilot plants have been acquired and proper maintenance staffs have been deployed for both the pilot plants. The OJT&T/T can be carried out to expedite self-sustainability and capacity of MET/CUN Authorities.

15.2 FINANCIAL EVALUATION

15.2.1 Drainage and Sewerage Project

To operate and maintain the project, Urban Drainage and Sewerage Society shall be organized as a financially autonomous service provider. It will collect the service charge or tariff from the beneficiaries of the project. The tariff is set, as proposed, to recover the operation costs alone. This implies that the national government shall provide the capital construction cost. If the government is able to receive a credit with the concessional terms from an international / bilateral financial agency, the credit of 54 billion CFA francs (including imbalance of initial operation and the municipality component of solid waste projects) shall be repaid over 50 years with the highest annual installment of 1.7 billion that will last over 30 years.

The society's financial position will be firm, even if it shall pay 10 percent of the capital and replacement costs. If the per-capita 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.

15.2.2 Solid Waste Management

The municipality components of the solid waste management are not financially balanced, as the revenue on the services is virtually nil. Generation of the capital costs needs to depend on the aforementioned credit, which shall be subsidized by the national government. The annual operation cost 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.

The private entrepreneurship component, the pre-collection and recycling services can generate revenue on the service from the contracted service users. If 1,200 CFA francs per person per year could be earned as the average service charge, this service will not be only financially sustainable part of the waste management but also a very profitable business. It can generate such profit, even if it equip and construct the recycle center on a loan with 17 percent interest that is locally available. Its revenue can be enhanced through sale of recyclable byproducts.

15.3 SOCIO-ECONOMIC EVALUATION

The master plan is intended to generally uplift sanitation level of Niamey city until the target year of 2015. Virtually, most of the built-up urban area will be serviced by:

- Combined sewerage network in the central area,
- Separate drainage and sewerage networks in the recently developed area,
- Treatment of all the sewage thus collected, and
- Integrated solid waste management service by the municipality and private enterprises.

These services at present are virtually nil or quite inefficient in Niamey, the capital city of Niger where some 7 percent of some 10 million national population resides. Malaria, diarrhea and other waterborne diseases are endemic there, because some people have no access to safe water, and poorer people cannot afford to buy water from vendors. Moreover, sanitation facilities and hygiene practices are at very low level. Introduction of the new sanitation services, coupled with the hygiene education that could be helped by demonstration of the pilot study facilities, would induce diverse effects on improvement of sanitation.

Direct effects are:

- Removal of storm water in most expeditious way,
- Removal of sewage and solid waste from houses and urban area, and
- Outfall of treated wastewater ultimately into Niger River.

Stormwater will be directed through gutters, roadside drains and channels to the River. Risks of flooding, impounding, clogging and other water concentration in the urban area will be minimized. Chances and length of inundation in the flood prone areas will be substantially reduced. Significant environmental and economic losses are to be redeemed. Absence of clogged water will prohibit mosquito larvae from germination; thereby significant reduction in malaria cases is expected. This will eventually bring about more people's dynamic participation in the productive activities.

Flies and other bacterial vectors tend to grow in soaked garbage, pit latrines and cesspools that are inappropriately structured. Periodic removal of garbage will terminate their growing process, while the sewerage services will provide people with chances to replace old toilet with the sanitary one, with that no flies will grow in houses, and in urbanized areas. Coupled with raised awareness on proper hand washing and food preserving, extinction of flies and other vectors will reduce the orally transmitted infections that are also major causes of fatal diseases in Niamey.

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.

15.4 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 targeted year is 2010.

15.4.1 Sewerage / Drainage

(1) Indices of Evaluation
Complying with following evaluation factors, priority projects shall be determined towards the Feasibility Study (F/S) for the next phase II.

- Project costs.
- Decrease in environmental load or increase in the degree of improvement for sanitation condition.
- Contribution to the public health
- Decrease in the hazard risk by flooding
- Effectiveness of investment of the project.

(2) Evaluation of Priority Projects
According to each indices of evaluation, following verdict/evaluation are given in Table 15.4 -1.

Table 15.4-1 EVALUATION OF PROJECT

Factors / Zone / Area	Project Costs & Unit Cost	Degree of Improvement	Contribution to the Public Health	Decreasing of Hazard Risk	Effective of Investment	Necessity of LCS	Total Point	Order of Priority
C1	3	5	4	3	4	3	22	**3**
C2	3	5	4	3	4	3	22	**3**
C3	5	5	5	4	5	5	29	**1**
C4	4	5	3	4	4	5	25	**2**
S1	3	4	3	5	4	2	21	**5**
S2	1	4	3	5	4	2	19	
S3	5	4	3	3	3	2	20	**7**
S4	3	4	3	2	2	3	17	
S5	3	4	3	4	4	3	21	**5**
S6	3	4	3	2	2	2	16	
S7	3	4	3	2	2	2	16	
S8	5	3	3	4	4	2	20	**7**
S9	2	3	2	2	2	2	13	
S10	3	3	2	4	4	2	18	
S11	3	3	2	3	3	2	16	
O.S.A.(*)	1	2	1	1	1	1	7	

*Note *: O.S.A. is On-site System Area.*

To sum up the score for evaluation, C3 sewerage zone is precisely selected for the most priority area for Sewerage / Drainage Project. C4 sewerage zone is the second priority followed by C1 and C2 zones.

(3) Selection of Priority Project

Based on evaluation result in the table 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 for feasibility study.

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

1) Sewerage/drainage system in the C3 sewerage zone

   A comprehensive combined drainage and sewerage system shall be installed in the C3 sewerage zone. Such system shall include:

   - Rehabilitation and improvement of existing drainage
   - Installation of the trunk main drainage
   - Installation of wastewater treatment plant adopting UASB process

2) Rehabilitation of the existing wastewater treatment plant at the National Hospital

   The structure of the plant is fairly well, but is not in operation 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. By enhancing the capacity of this drainage will reduce flood risks in wide area.

15.4.2 Solid Waste Management

(1) Priority Ranking by Quartier for New System

The master plan, Chapter 9, shows and presents the schedule for the introduction of the new collection system 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).

The evaluation has been taken a scoring method. Scoring policies are as follows and summarized in Table 15.2-2 and the result is shown in Table 15.2-3.

Scoring Policies

- The standard cost/beneficiary (C/B) in high, middle and low-income class is set as 2,000 CAF/person.year, 1,000 CAF/person.year and 800 CAF/person.year respectively. And the pre-collection areas whose C/B is not more than 2,000/1,000/800 score "5".
- In the calculation of C/B, the expected income from recycle sand is not included. The amount of produced recycle sand is expected to reach at 91,447 t/year in 2015 and its sales is expected 219,472,841 CFA. This amount of expected sales is can cover more than 30% of total required cost (capital cost divided into 15 years and O&M cost in 2015). Therefore even C/B exceeds the above standard C/B, the pre-collection areas whose C/B is not more than 110% and 120% of the standard B/C score "4" and "3" respectively. Other areas score "2".
- The existence of current pre-collection activity is valuable index to expect the successful new system introduction. The areas where some pre-collection activity organized by NGO/Company are much easier to be introduced. Therefore the areas where some organized pre-collection activity is seen score "5" and others score "0".
- The ranking of area is done according to the total score. The areas totally score not less than "10","8" and "5" are ranked priority "First", "Second" and "Third" respectively. And the areas score less than "5" are ranked priority "Forth".

Table 15.4-2 SCORING POLICY FOR NEW SYSTEM INTRODUCED AREA

C/B Score		Current Pre-Collection Score		Priority Ranking	
C/B	Score	Activity	Score	Total Score	Priority
High Income		Yes	5	Score>=10	First
C/B<=2,000	5	No	0	Score>=8	Second
C/B<=2,200	4			Score>=5	Third
C/B<=2,400	3			Score<5	Firth
C/B>2,400	2				
Mid Income					
C/B<=1,000	5				
C/B<=1,100	4				
C/B<=1,200	3				
C/B>1,200	2				
Low Income					
C/B<=800	5				
C/B<=880	4				
C/B<=960	3				
C/B>960	2				

(2) Selection of Priority Project

Based on the results of scoring, following ranking has been established for priority project areas for introducing the new collection system.

Table 15.4-3 PRIORITY PROJECT FOR NEW COLLECTION SYSTEM

CU	Group	ID	Quartier	Priority	CU	Group	ID	Quartier	Priority
Stage 1 New System Introduced by 2005					**Stage 2 New System Introduced by 2010**				
1	1-3	20	Plateau II-A: (33%)	1	1	1-17	37	Baghdad	1
1	1-4	20	Plateau II-B: (33%)	1	2	2-1	53,54	Terminus+Niamey Bas	1
1	1-5	20	Plateau II-B: (33%)	1	1	1-19	43	Taiwan	2
1	1-6	24	Kouara Kano	1	2	2-14	56,58, 59,63	Kalley Centre, Sud + Lacouroussou + Nouveau Marche	2
1	1-7	25	Ext. Kouara Kano	1	2	2-15	57,60, 61	Kalley Est, Banizoumbou I, Abidjan	2
1	1-8	30	Yantala Haut	1	1	1-16	36	Banizoumbou II	3
1	1-11	28	Dar Es Salam-A: (50%)	1	1	1-18	42	Nord Lazaret	3
1	1-12	28	Dar Es Salam-B: (50%)	1	1	1-24	48,49	SONUCI+Koura Kano Nord	3
1	1-13	31	Bani Fandou I	1	1	1-26	51	Ext. Kouara Tegui	3
2	2-2	69,70	Cite Faycal+Poudriere-A: (40%)	1	1	1-20	44	Bobiel	4
2	2-3	70	Poudriere-B: (60%)	1	1	1-23	47	Nord Faisceau	4
2	2-5	73	Route de Filingue	1	1	1-27	8,9,10 ,11	Zongo,Maourey,Gandacthe,Deizebon	4
2	2-6	74	Ext. Route de Flingue	1	1	1-28	15,16, 17	Boukoki I, II, III	4
1	1-14	32,33	Cite CNSS + Bani Fandou II-A: (40%)	2	2	2-7	80	Ext. Talladje	4
1	1-10	27	Kouara Me	3	**Stage 3 New System Introduced by 2015**				
2	2-4	72	Madina	3	1	1-1	1	Plateau I-A: (60%)	1
3	3-1	91	Karadje	3	1	1-2	1,2	Plateau I-A: (40%) + Ambassades	1
3	3-3	95	Ext. Kirkissoye	3	1	1-22	46	Ouest Faisceau 2	3
3	3-4	96	Banga Bana	3	1	1-21	45	Ouest Faisceau 1	4
3	3-2	92,93	Pont Kennedy + Gawaye	3	1	1-25	50	Ext. Kouara Kano Nord	4
1	1-15	33	Bani Fandou II-B: (60%)	3	1	1-29	18	Boukoki IV	4
1	1-9	26	Courronne Nord	4	2	2-8	82	Ext. Saga	4
					2	2-9	84	Aviation 1-A: (50%)	4
					2	2-10	84	Aviation 1-B: (50%)	4
					2	2-11	86	Sari-Koubou-A: (33%)	4
					2	2-12	86	Sari-Koubou-B: (33%)	4
					2	2-13	86	Sari-Koubou-C: (33%)	4

15.4.3 Urban Sanitation

Combined with Sewerage / Drainage and Solid Waste Management, scheme of Urban Sanitation is rather simple for this supplemental work in order to complement the Urban Sanitation Projects. This project is also called " Low Cost Sanitation" (LCS) which is to be the construction of public toilets. Moreover public sanitation campaign is also significant as a part of soft component of Urban Sanitation Project.

CHAPTER 16. RECOMMENDATIONS

CHAPTER 16. RECOMMENDATIONS

Identifying areas and issues requiring most urgent attention was elaborated in the Master Plan study on sanitation improvement for the Niamey City. As a consequence of the comprehensive study including review of other existing and ongoing projects, the following recommendations are hereby made to the related officials and people of Niger.

16.1 URBAN PLANNING AND DEVELOPMENT

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

From these projection and scenario, the design population was determined as follows:

Design population in 2005:	757,192
2010:	871,346
2015:	993,724

Based on the land use forecast shown in Table 5.2-3 and Figure 5.2-4, extent of city area and population in the target year, 2015 were set as follows:

Future City Area:	23,916 ha
Administrative Population:	993,724

It is expected that review of these planning factors should be undertaken and any adjustment thereof should be made in intermediate years of 2005 and 2010.

16.2 SEWERAGE/DRAINAGE

According to urban development scenario and land use forecast which were concluded in the previous section, planned population for the sewerage facility is estimated to be 583,025 in the year 2005, and 793,701 in the year 2015. The following recommendations are formulated for planning framework:

(1) 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, where fairly developed drainage systems are already in existence.

(2) For intermediate term, the separate system is recommended in the recently urbanized areas, where drainage systems are only sporadically developed.

(3) A smaller scale wastewater treatment plant is installed in each sewerage zones that represent drainage basins.

(4) In the Master Plan, Up flow Anaerobic Sludge Blanket (UASB) treatment method is adapted for most of the treatment sites.

(5) Communal latrines are proposed in poorer quarters where households have no proper facilities.

(6) Combination of communal latrines, dispersed sewerage system as a package in each sewerage zone and solid waste management therein shall be developed step by step in Niamey City. Implementation of combination of these three components as a package in smaller areas would be most efficiently undertaken. This implementing arrangement can be a model to other urban centers in Niger.

16.3 SOLID WASTE MANAGEMENT

The M/P has been prepared for the target year of 2015. The generation of solid waste was forecast annually by type. The flow of generated waste has been estimated based on the results obtained from the solid waste survey and the demographic growth for the next years (see Chapter 7.4.1.

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.

16.3.1 Domestic Waste

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 16.3-1 is summarizing the target population that is expected to serve by the new system:

Table 16.3-1 EXPECTED POPULATION TO BE SERVED BY THE NEW SYSTEM

Commune	2005		2010		2015	
	Served population	%	Served population	%	Served population	%
Commune 1	91,245	22,5	187,930	41,4	306,855	58,1
Commune 2	43,358	16,6	91,755	30,2	164,367	49,4
Commune 3	34,169	37,4	57,859	51,0	85,533	64,4
Total	168,771	22,3	337,545	38,7	556,755	56,0

Sand shall be sorted out in the recycling center that will be operated by the private pre collection companies. Remaining waste, which represents approximately 40% of the collected waste, shall be transport to the designated and constructed landfill sites.

In order to increase waste collection overall in the City of Niamey the present collection system shall be maintained and support the new collection system. Both collection systems will remove
in 2005: 46 %
in 2010: 60 %
and in 2015: 76 %

of the generated domestic waste in Niamey.

Furthermore 2 landfill sites have been selected. One landfill site located at Koubien on the road of Tillaberi at some 5.2 km from the head office of Commune I, shall be constructed and used for waste generated as well as in Commune I as Commune II.

For Commune III, the designated landfill site located in the east side at roughly 5.6 km from the head office of Commune III shall be constructed and waste generated in Commune III shall be disposed properly.

For the implementation of the pilot study in the following project phase, necessary preparatory works is carrying out. Meetings with NGOs and representatives of CUN and Communes are being hold for the final selection of the quartiers and preparations of the fieldwork during the Feasibility phase started and are going on.

16.3.2 Industrial Waste

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 are fully recovered by the industry.

16.3.3 Medical Waste

A separation of infection waste shall be introduced in all hospitals and clinics in order to reduce the risks of any contamination (during the collection, transport and at the landfill). Household similar waste shall be removed by using 11 containers.

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

16.4 INSTITUTIONAL SET-UP

In the drainage and sewerage sector, a new public utility shall be created. It shall provide the drainage and sewerage services to the city of Niamey and collect sewer fee from the beneficiaries.

Representatives from the Ministry of Equipment and Transport, Ministry of Water Resources, Ministry of Public Health, Urban Community of Niamey, water supply company, Non-governmental organizations (NGOs) and the beneficiary initiative (residents) should be convened, and should work together to define everyone's role in the creation of the service provider. Requirements for this service provider are basically given in this report. However, since the drainage and sewerage service is the fourth public utility in Niger, following the electric power supply, drinking water supply and 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.

Roles of private pre-collectors in the waste management sector shall be well defined and appreciated by the Municipality, since they are to complement the shortcomings of the municipal services. The Municipality should encourage private entrepreneurship to launch the pre-collection services by licensing and providing garbage containers, and also enacting legal supports, whenever desired.

16.5 HYGIENE EDUCATION

The analysis of hygiene education activities has shown that there are active agencies at the national level to upgrade awareness levels in the field of health education. Several deficiencies have been however identified and have permitted to define basic principles of hygiene education development in Niamey. These principles are:

- Clarifying the definition and concept of hygiene education and upgrading awareness according to such concepts
- Involving all the potential actors and developing the synergetic effects of multi-sectarian coordination
- Shifting from the Top-Down approach to the Participatory approach (community participation), together with getting a mutual understanding between CUN and communes and the residents.
- Making full use of the available resources, which are expertise, multi-sectarian coordination, equipment and educative materials.

The plan of hygiene education aims at the smooth implementation of the objectives of the Master Plan through understanding and acceptance of the projects by local communities. The objective of the plan is to progressively shift from awareness in the field of health and hygiene to community participation mind and dynamics, which means the achievement of mutual understanding with local authorities and the social and financial participation of communities to sanitation improvement services. The final stage of the plan is to reach the level of the "recycling city", where people are aware of the urban environmental issues and contribute to improve it.

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 Jokaso 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:

(1) Hygiene Education consists of three categories/fields, which have been described like in Figure 13.1-1, Chapter 13.

(2) The role of each Authority is also recommended in Table 13.1-1. The following Authorities have basic responsibility to develop in the field of hygiene awareness heightening: Mutual understanding between people and authorities for CUN, communes and NGOs/NPOs, Health & Sanitation for MSP, hygiene education and environmental education for MEN and Ministry in charge of environment, and operation and maintenance through contracting with NGOs/NPOs.

(3) As regards to the involvement of local communities, the following public awareness has been observed by the study/survey.

- 80.2% of the respondents are ready to pay for improving sanitation condition. (JICA)
- 98% of households are ready to contribute to improve sanitation condition in their living area, either by participating in hygiene heightening activities like campaign (less than 70%), or by financial contribution (3%). (PRIU)

(4) Based on the concept of Hygiene Education, the concrete education plan shall be implemented by participants together with "Hygiene Campaign" which is planned in Section 13.4.3 at the proposed project sites.

16.6 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.

The assessment of the environmental impacts will be done within the scope of the feasibility study and cover the study area of the Master Plan. The frame of the assessment is then triple:

- Projects defined for the feasibility study (short term projects)
- All the projects planned within the Master plan and considered on a case by case basis for the assessment
- Synergetic and cumulated effects at the Master plan level

The EIA study should be based on field surveys and investigations to be done by contracting with local consultant. The TOR of the study has been presented in 14.2.4 and must receive agreement of the BEEEI before carrying out the study work. The major issues that need priority investigations are as follows:

- Improvement of the Niger river environment (and other watercourses)
- Natural conditions and livelihood of communities in projects sites
- Generation of solid waste and exposure to waste handling activities
- Outbreak of malaria
- Protection of groundwater

Several field surveys will be required to collect the necessary data, but there are 2 major field surveys which will constitute the core of the investigations, and which are:

- Field survey on the ecology of the Niger river
- Field survey on the physical and social conditions of facilities implantation areas.

16.7 FINANCIAL IMPLICATION OF THE 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, and
- 4.9 billion to help the municipality in realigning its waste management.

It is anticipated that this amount accounts for approximately 4 percent of total capital investment of the national government. In the case that the entire amount would be financed by an external credit with the special concessive terms, the government shall set aside 1.7

billion every year over the 30 year period and the lesser amount for more than 50 years of repayment of the credit (for details, see Table 12.4-1 and 2). In view of the significant scale of the project cost, the executing agency shall make every effort to pursue consensus in the government and among the public.

Operating costs of the drainage and sewerage services will be recoverable from the beneficiaries or service users. The sewerage tariff of 1,200 CFA francs per capita per year in average may be collected as approximately 19 percent surcharge in the water bill.

In the waste management sector, for preliminary collection and recycling services private enterprises are proposed. These services will be sustainable or even reasonably profitable, if the average tariffs of 1,200 CFA francs per capita 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.

16.8 CAPACITY BUILDING

Capacity building includes, in institutional terms, building of organizational, financial and human capacity. Most needed in the scope of the Master Plan study is development of human resources.

Human resources to be mobilized directly under the Master Plan include new employees of the Urban Drainage and Sewerage Society (UDSS) and those of the private pre-collectors in waste management. Capacity building of these people is a primarily concern in the study. However, it shall be emphasized that the beneficiaries or residents of the City also need to participate in the capacity building through awareness raising activities.

In the UDSS, the administration division is expected to prepare and implement various training programs with assistance by the research and planning division. These programs should be aimed to upgrade skills, techniques and work ethics of the personnel from top to bottom, and should cover technical, managerial and financial disciplines. In preparing such training programs, therefore, it is necessary to consult with the external advanced educational institutions whenever necessary.

Most important, however, is to give incentives to everyone to improve his capacity. If the achievement / performance based promotion system is clearly established, then everyone will be encouraged to improve his ability to perform the given duties very efficiently. This cannot be achieved by efforts of the administration division alone. Members of the board of directors, who should be responsible for the UDSS organizational structure, should pay every effort to implant a very fair promotion system that is a basic principle in the modern public utility services. The capacity building in UDSS will be brought about by such an organizational strategy of the board and by the well-prepared training programs in every discipline.

In the waste management sector, a few private bodies including NGO's are already working under contract with the municipality and with the households. They are supposed to be gathering techniques and know-how's in their services. These should be learned by the private entrepreneurships, which are planning to launch the waste pre-collection service. They will, however, be giving the services in the free market where balance of demand and supply

presides. They will naturally learn ways to improve quality of services through daily operation.

The public sector including related ministries and the municipality seems to need improvement of capacity of personnel. The sanitation unit of the municipality, most directly, would require up-lift of disciplines to run the solid waste collection and disposal services. Other authorities would also need to improve disciplines to plan, implement and evaluate the official duties including development projects or even maintenance of the present sanitation standards. As the government bureaucracy, they have potentials within themselves to strengthen capacities. Under the present study, pilot project facilities were installed. Those who are concerned are able to utilize their experience with such facilities.

The pilot project facilities shall be operated and maintained by the respective authorities after handing-over by the Study Team. In-service training and technology transfer are being made even in the construction stage involving related officers and residents. Those who are being trained shall play major roles in the operation after the handing-over. There should be a strongly organized effort to operate the facilities, which the Nigerian people and government shall consecrate as their self-help efforts. Those who will be at the operation of the pilot project facilities would be able to serve, with their accumulated knowledge and experience, as core of the UDSS personnel. The capacity building for the coming sewerage service has been already launched, in that Niger's serious need for sanitation improvement shall be proven. Capacity building in other disciplines shall be pursued in projects assisted by United Nations group and other multinational and bilateral donors.

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.

CHAPTER 17. SEWERAGE/DRAINAGE SYSTEM

CHAPTER 17. SEWERAGE/DRAINAGE SYSTEM

17.1 PLANNING PRINCIPLE

The Master Plan proposed 15 sewerage/drainage zones in the sewerage facility planning area of the Niamey City. The M/P is based on the assumption that the Republic of Niger and Niamey City will achieve economic development that will warrant reticulated sewerage system, as one of the basic human needs, both financially and socially in 2015.

However, by the year 2005 (proposed completion year of the Feasibility Study), it is unlikely that the above optimistic assumption will be achieved. Then the most important is to select the projects for the Feasible Study that is exactly to be achieved.

The Feasibility Study area is shown in Figure 17.1-1, which covers the already developed and highly urbanized zones of Boukoki I to Boukoki IV and Lycée Kassai quartiers named C3 treatment district in the Master Plan.

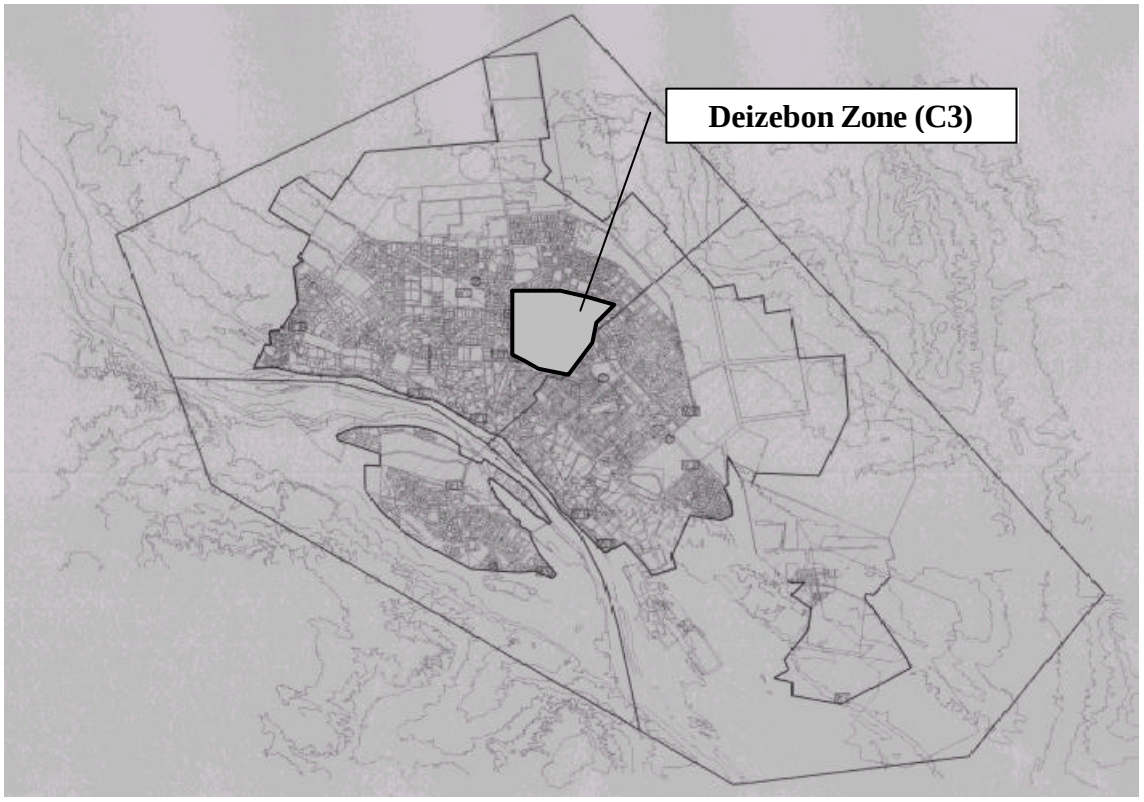

Figure 17.1-1 LOCATIONS OF FEASIBILITY STUDY AREA

The existing drainage facilities have been utilized as "combined sewer system". However these facilities neither cover all of the area nor some of them have enough capacity to drain all of the collected storm water. In addition, there is no wastewater

treatment plant except the pilot UASB plant, which was constructed under the programs of this Study.

The goal of the project is to improve sanitation condition of the Feasibility Study area as well as water quality of the Niger River, which is being polluted from wastewater via Gountou Yena storm water drainage. Appropriate sewerage/drainage facilities shall be constructed to achieve the goal.

The principles of the sewerage/drainage facilities in the Feasible Study area are as follows.

(1) To utilize the existing drainage open channel and box culvert

The schematic diagrams of the existing drainage facilities are as shown in Figure 17.1-2. The existing facilities, which have been constructed since 1984, are of semi-separation type. At the bottom of this facility, there is a small gutter for wastewater drainage and the upper space is for storm water drainage. The proposed drainage facilities should be also of the semi-separation type.

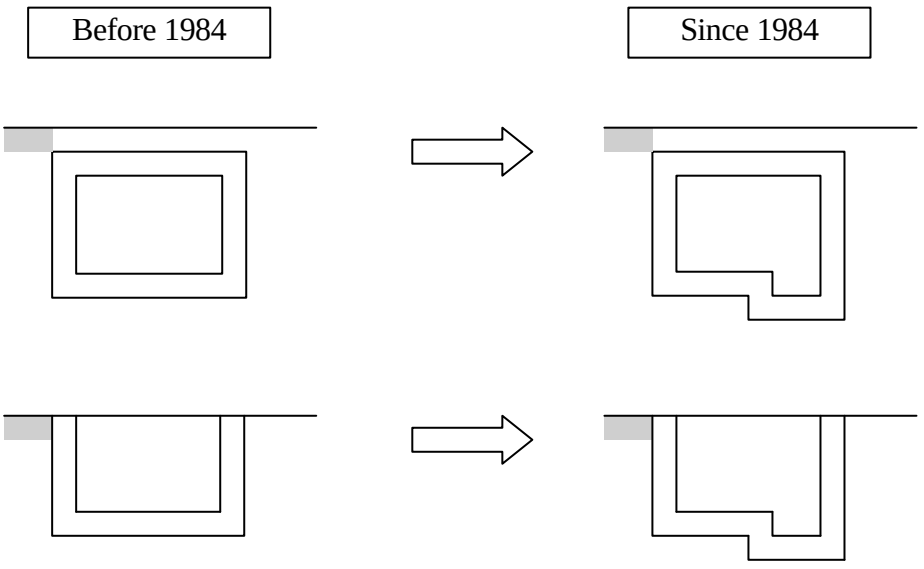

Figure 17.1-2 EXISTING SEWERAGE/DRINAGE FACILITIES

(2) To continue utilizing combined sewer system

From the point of water quality preservation, it is clear that the separate system is more advantageous than the combined system. On the other hand, from the point of cost performance, it is clear that the latter system is more advantageous than the former system.

Especially for the existing urban areas it is important to keep the sequence of construction program, it is reasonable to adopt combined sewer system for the existing urban areas like this Feasible Study area.

(3) To utilize UASB method for the wastewater treatment

In the Master Plan, UASB method has been proposed as the most adaptable method to treat the wastewater of the Study Area. For wastewater treatment plant in the Feasibility Study area, UASB method will be adopted.

(4) To use the same criteria as proposed in the Master Plan

The frameworks of the Feasibility Study (population, wastewater quantities, rainfall intensity, etc.) are shown in Table 17.1-1. The design criteria as proposed in the Master Plan will be appropriate for the Feasibility Study.

Table 17.1-1 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		

17.2 SEWER LAYOUT

The Feasibility Study area is situated within the urbanized area. From minimal disturbance point of view in the urban activities, existing drainage facilities would be utilized. 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 planning for improvement works in the existing facilities is shown in Figure 17.2-1. The proposed sewer network is shown in Figure17.2-2 and Table 17.2-1. The general philosophy used in designing the sewer layout is as follows.

(1) To select the wastewater treatment plant at the lowest point of the collection area
(2) To collect wastewater by gravity depending on the topography and economic

viability

(3) From maintenance convenience point of view the dimensions of facilities should be more than 600 mm except U type ditch.

(5) To divide the Feasibility Study area into three drainage areas, the North-Boukoki Trunk Line area, the Mid-Boukoki Trunk Line area and the South-Boukoki Trunk Line area.

(6) To take measure for the first flush pollutant of storm water, a pond in the riverbed of Gountou Yena with capacity of three times of the hourly maximum wastewater flow for fifteen minutes.

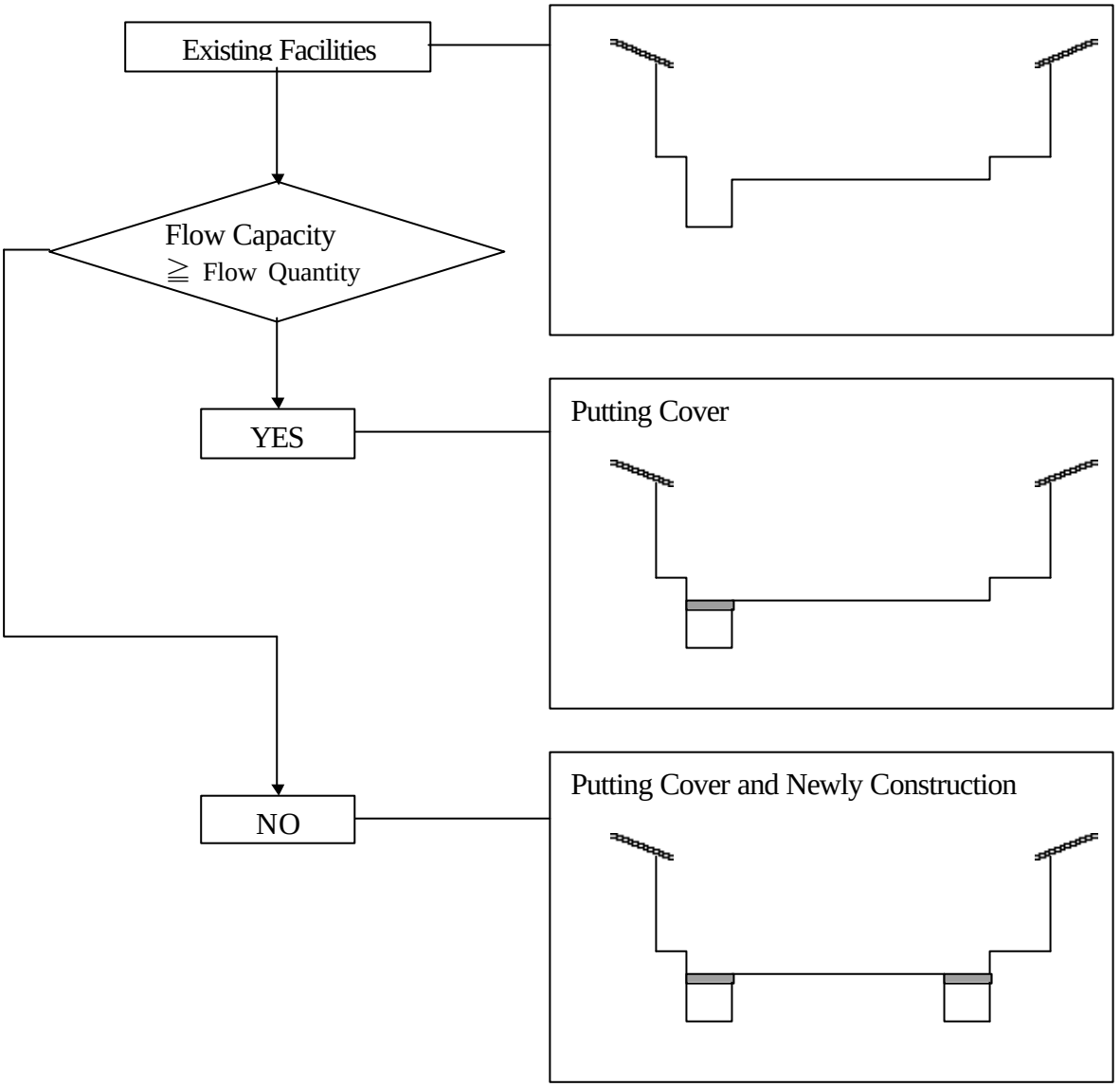

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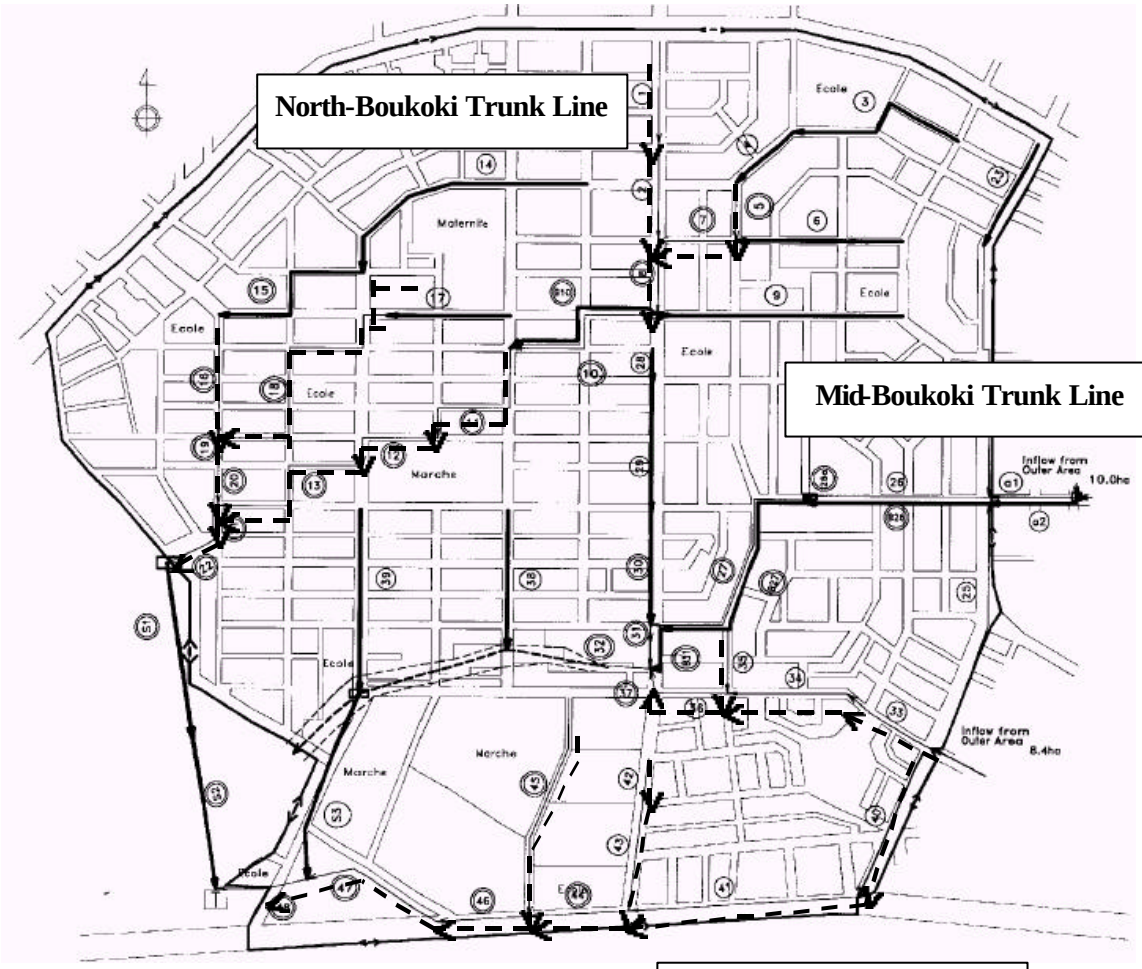
Figure 17.2-1

PLAN FOR IMPROVEMENT IN THE EXISTING FACILITIES



Existing Open Channel

Existing Open Channel + Newly Construct Open Channel

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Figure 17.2-2

SEWER NETWORK LAYOUT

Table 17.2-1 LIST OF SEWER NETWORK

Line		Length (m)	Dimension (mm)	Remarks
1		200	D 600	Existing
2		190	D 800	Existing
5		110	□ 1500 × 1000	Existing
7	5	150	□ 1500 × 1000	Existing
8	2	150	□ 1500 × 1000	Existing
10	8	360	□ 1500 × 1000	Existing
11		320	□ 1500 × 1500	Existing
12		210	□ 1500 × 1500	Existing
13		360	□ 1500 × 1500	Existing
16		240	□ 1500 × 1500	Existing
18		570	□ 1500 × 1500	Existing
19	16	50	□ 1500 × 1500	Existing
20		80	□ 1500 × 1500	Existing
21	13	60	□ 2200 × 1800	Existing
22		100	□ 2200 × 1800	Existing
24		500	U 1000 × 800	Existing
25		340	U 1000 × 800	Existing
26	a1, 24	360	U 1000 × 1000	Existing
27	26	490	□ 800 × 800	Existing
31	27	70	U 2000 × 1500	Existing
32		80	U 2000 × 1500	Existing
33	b	190	□ 2500 × 2200	Existing
34		230	□ 2500 × 1700	Existing
35		120	□ 800 × 800	Existing
36	34	140	□ 2500 × 1800	Existing
37	B31.32	180	□ 5000 × 2000	Existing
41		450	□ 1500 × 1600	Existing
42		90	D 800	Existing
43		210	D 1000	Existing
44	41	180	□ 1500 × 1600	Existing
45		460	□ 1200 × 1200	Existing
46	44	170	□ 1500 × 1600	Existing
47		300	□ 2150 × 2150	Existing
48		100	□ 2150 × 2150	Existing
Total Length of Existing Open Channel = 7,810m				

Line		Length (m)	Dimension (mm)	Remarks
3		340	U 1000 × 1000	Newly Construct
4		150	U 1000 × 1000	Newly Construct
6		320	U 1000 × 1000	Newly Construct
9		470	U 1200 × 1000	Newly Construct
B10		360	U 1500 × 1000	Newly Construct
14		540	U 1500 × 1400	Newly Construct
15		360	U 1500 × 1400	Newly Construct
17		240	U 1500 × 1200	Newly Construct
S1		380	ö 600	Newly Construct
S2		400	ö 600	Newly Construct
23		220	U 600 × 500	Newly Construct
B26	a2, 25	360	U 1100 × 1100	Newly Construct
26a	26	5	□ 800 × 800	Newly Construct
B27	B26	490	□ 1800 × 1800	Newly Construct
28		70	U 600 × 600	Newly Construct
29		260	U 1000 × 1000	Newly Construct
30		210	U 1100 × 1100	Newly Construct
B31	B27	150	□ 1800 × 1800	Newly Construct
38		270	□ 1000 × 1000	Newly Construct
39		350	□ 800 × 800	Newly Construct
40		300	U 500 × 400	Newly Construct
S3		380	ö 600	Newly Construct
Total Length of Newly Construct Open Channel = 6,625m				

17.3 SEWAGE COLLECTION FACILITIES

The wastewater collection facilities are composed of open channels and lids, inlet chambers, manholes, and diversion weir manholes etc. The schematic diagram of the sewer collection network facilities and diversion weir manholes are shown in Figure 17.3-1 and Figure17.3-2 respectively.

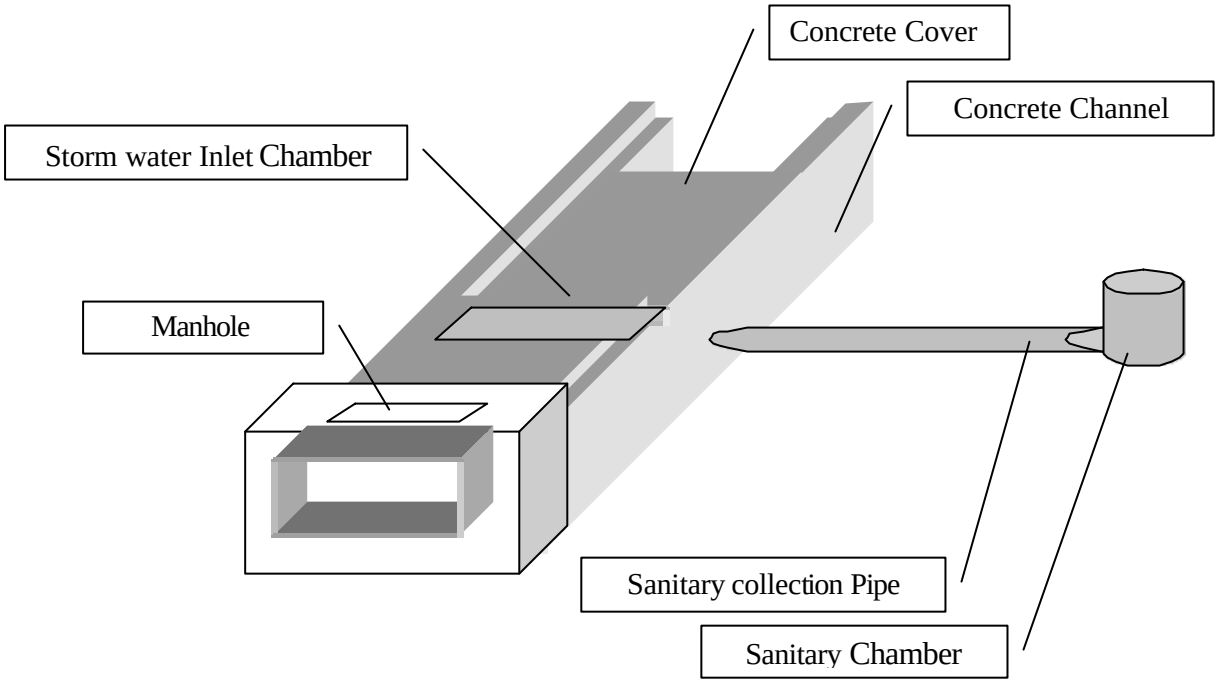

Figure 17.3-1 SCHEMATIC OF SEWAGE COLLECTION FACILITIES

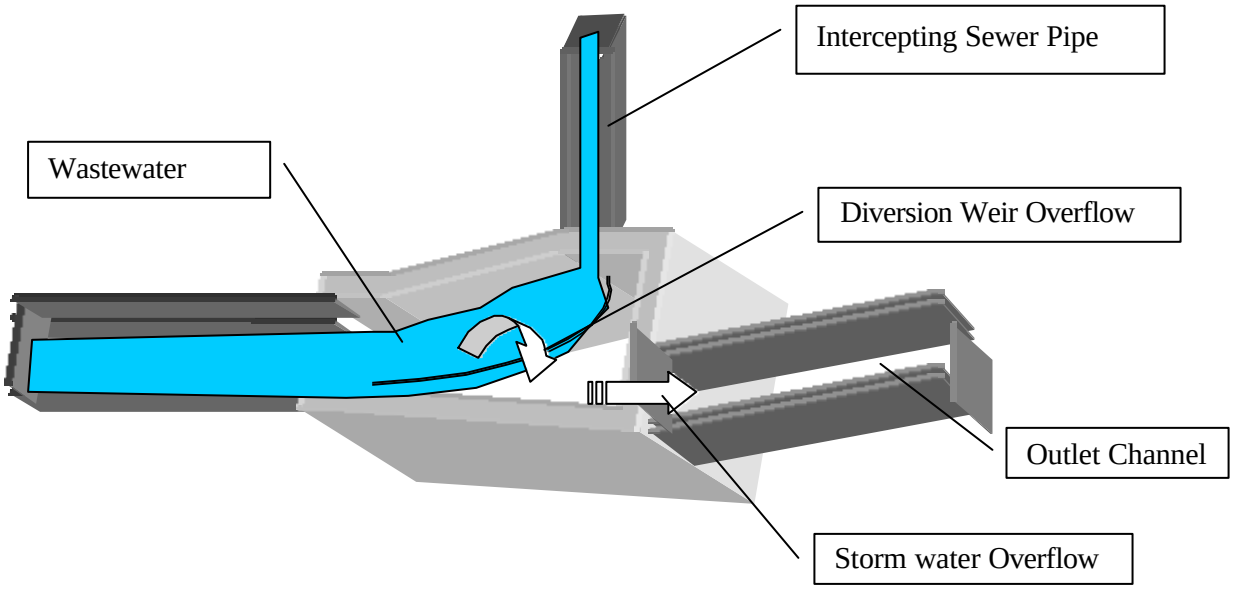

Figure 17.3-2 SCHEMATIC OF DIVERSION WEIR MANHOLE

17.4 WASTEWATER TREATMENT PLANT

The site of the proposed wastewater treatment plant is located northward of the UASB pilot plant in the Deizebon quarter. The site is at the near end of the drainage flowing into the Gountou Yena. The proposed wastewater treatment plant is as an extension of the existing UASB pilot plant.

The existing inlet chamber of the pilot plant will be used with some modification. The capacity of the UASB pilot plant is 100 m^3/day and the proposed plant would be of the capacity of 2,400 m^3/day. Consequently, the total capacity would become 2,500 m^3/day, which is the estimated flow of the wastewater in the Feasible Study area not only in the target year of the Feasibility Study (year 2005), but also in 2015 which is the target year of the Master Plan.

The main equipment list of the proposed plant is shown in the Table 17.4-1.

Table 17.4-1 EQUIPMENT SPECIFICATIONS

Facility	Number	Specification	Material
Inlet Chamber	1	Use existing inlet chamber	Concrete
Screen Chamber	1	With double bar screen	Concrete
Pump pit	1	4.0 m-W x 3.0 m-L x 2 m-H	Concrete
Grit Chamber	2(1)	0.3 m-W x 8.0 m-L x 0.7 m-H	Concrete
UASB Reactor	2	12.25 m-W x 8.0 -L x 4 m-H	Concrete
Sludge Drying Bed	2	20.0 m-W x 13 x 1.0 m-H	Concrete
Final Polishing Pond	1^{ST}	20.4 x 20.4 x 1 m-H	Concrete
	2^{ND}	20.4 x 20.4 x 1 m-H	Concrete
	3^{RD}	20.4 x 20.4 x 1 m-H	Concrete
Chlorine Tank	1	200 liter	FRP
Transfer pump	3(1)	72 m^3/hr x 20.0 m-H x 5.2 kw	CI

Note: (N) means standby

The topographic feature of the proposed site is shown in Figure 17.4-1. The ground height of site varies from 199 to 202 m with about three meters elevation and the lands itself are used mainly for agriculture. *Boulevard de l'Independance* runs the southern boundary of the site and it is the only access to the plant.

Consequently taking topographic condition and accessibility into consideration the general plan of the wastewater treatment plant is proposed as shown in Figure 17.4-2.

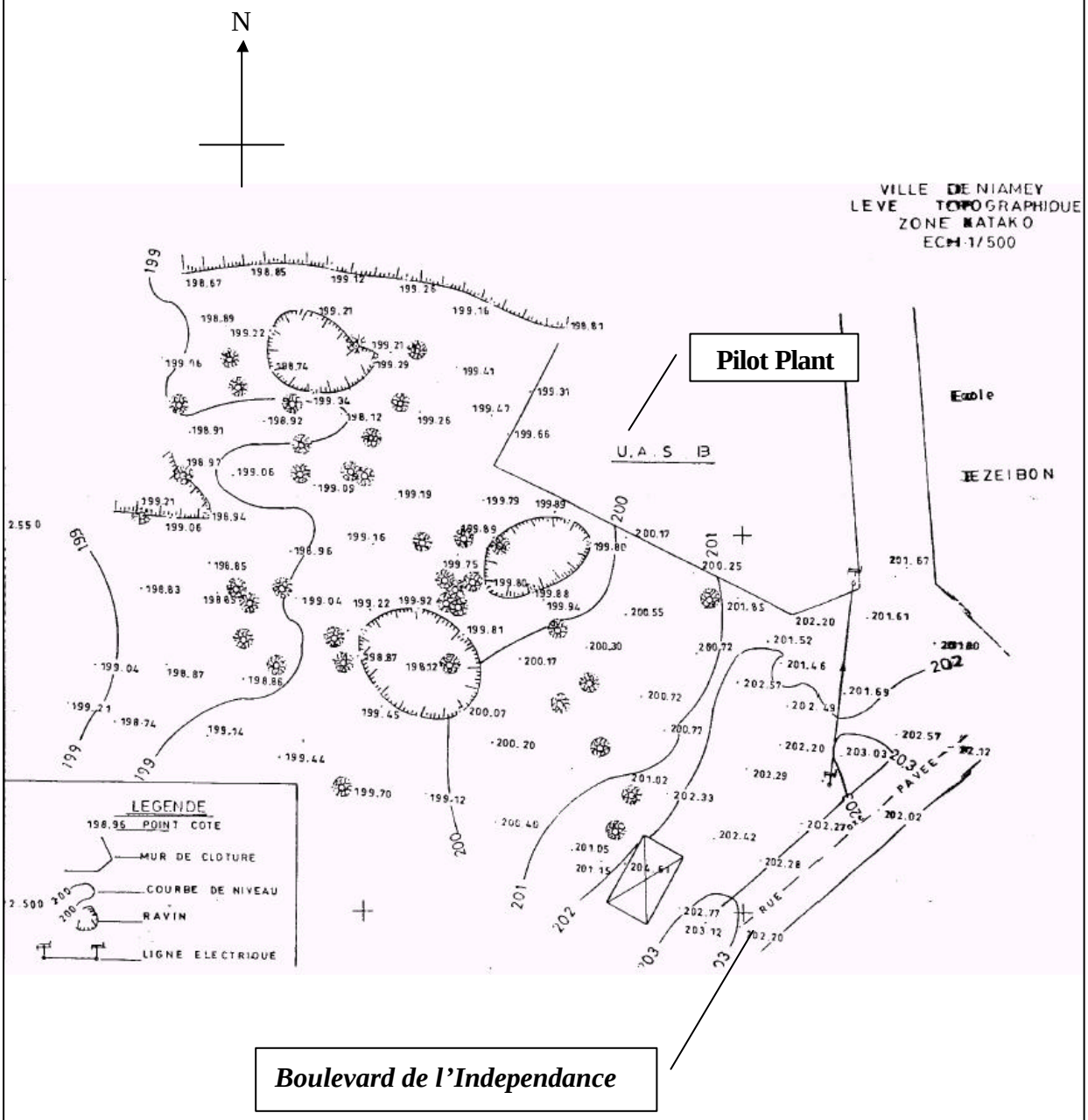

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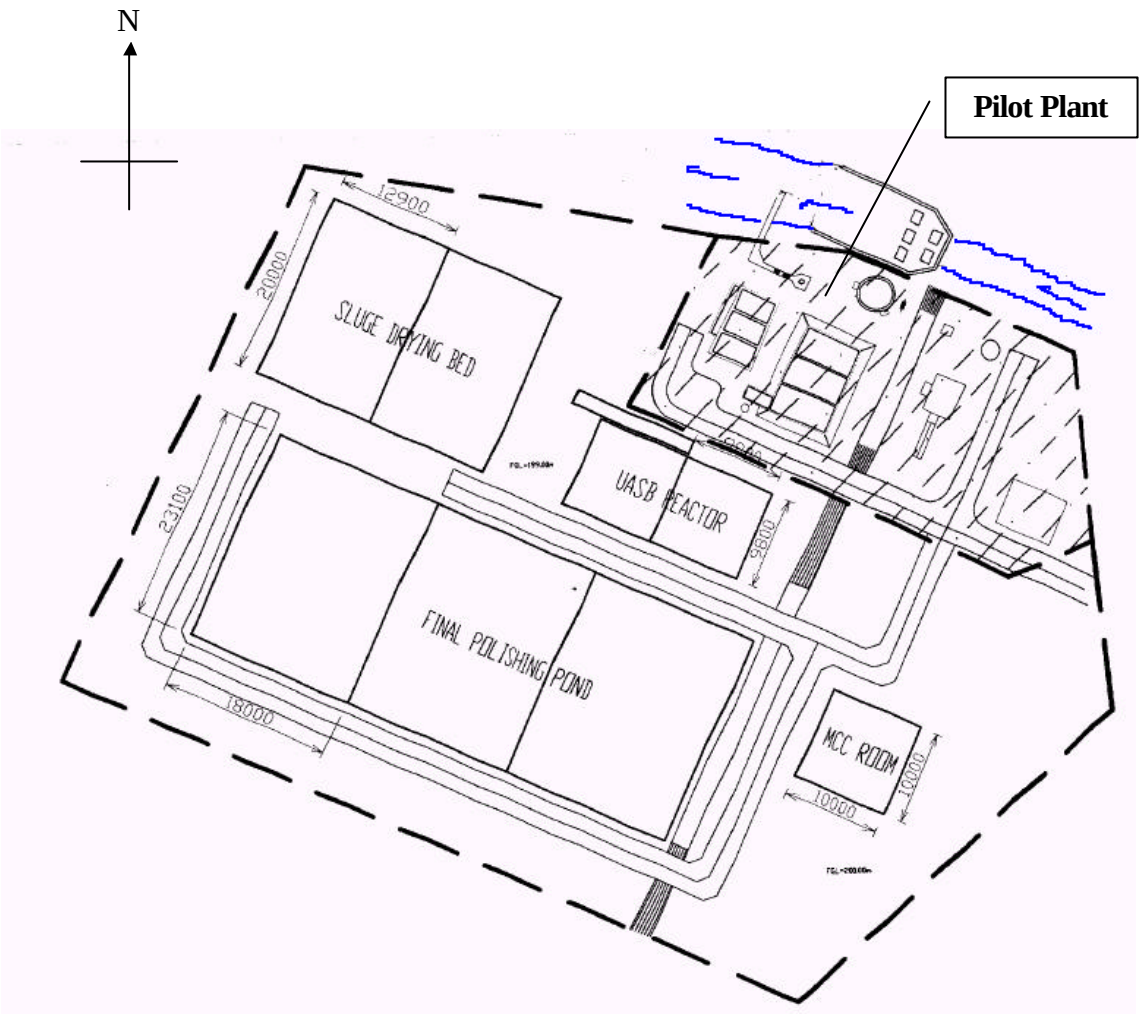
Figure 17.4-1

TOPOGRAPHY PLAN OF THE PLANT SITE



	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 17.4-2

GENERAL PLAN OF UASB WASTEWATER TREATMENT PLANT

CHAPTER 18. SOLID WASTE MANAGEMENT

CHAPTER 18. SOLID WASTE MANAGEMENT

18.1 INTRODUCTION

Within the present study phase, Feasibility stage, the recommended alternative for solid waste management, shall be analyzed in detail. It consists of:

- 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. The recycling centers shall also have a function of transfer center for remaining solid waste. After sand sorting, remaining waste shall be transported to the landfill site, where it will be properly discharged;

- Planning of 2 municipal dumping sites. One dumping site shall be used for solid waste generated in Commune 3 and one shall serve Commune 1 and 2.

18.2 BASIC DATA

18.2.1 Demographic Data and Evolution of Solid Waste Generation

The demographic data that are presented in previous chapters 3.2 and 9.2 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 is summarized in the Tables of the sub chapter 18.3

18.2.2 Climatic Data

Niger is belonging to the hottest regions of the world. The specific characteristic of the climate of Niger is the drought. Precipitation and their intensities are some important climatic data regarding design and operation of landfill site.

The progression of the humid season in the spring takes 2 times more of time than the withdrawal in autumn. The rain intensity is relatively moderate even though their stormy character. The average rain intensity registered in the last years amounts to 1.6mm.
The following Table 18.2-1 summarizes temperatures, precipitation and middle evaporations recorded during the last ten years:

TABLE 18.2-1 AVERAGED CLIMATE DATA IN NIAMEY

Item		Jan.	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug	Sep.	Oct.	Nov.	Dec.	Ave.
Temp. (deg.)	Max	32.0	34.9	38.5	41.3	40.0	37.6	34.4	32.9	35.0	38.0	36.6	33.4	36.2
	Min	16.8	19.3	23.5	27.1	28.4	26.4	24.5	23.7	24.5	25.7	20.4	17.5	23.1
Precipitation (mm)		0.0	0.0	0.2	12.7	29.1	82.7	141.5	199.6	92.8	12.6	0.0	0.0	47.6
Evaporation (mm)		347.8	365.5	451.8	431.1	389.0	303.0	233.3	179.6	205.5	295.3	322.4	323.6	320.7

Source: Laboratoire d'Hydrologie (Niamey Aéroport, 1989-1998), data was summarized by JICA.

18.3 NEW COLLECTION SYSTEM FOR HOUSEHOLD WASTE

As analyzed in the Master Plan Phase, 9 zones have been selected for introduction of new pre collection of household waste. Operation and Management of the pre-collection and the recycling center shall be entrusted to private sector. The Municipality shall operate and manage directly the waste transport from the recycling center to disposal sites.

The demographic evolution of the sixteen chosen Quartiers for the detailed analyze in the feasibility is summarized in the following Table18.3-1:

TABLE 18.3-1 DEMOGRAPHIC EVOLUTION OF THE SELECTED QUARTIERS

CU	Zone No	ID	Quartier	Type	Area(ha)	Population considered		
						2005	2010	2015
High Income Class								
2	(1)	53	Terminus	MDQ	75		3,301	3,500
		54	Niamey Bas	MDQ	62			1,083
			Total Zone (1)		137		3,301	4,583
2	(2)	69	Cite Faycal	MDQ	30		1,465	1,553
		70	Poudriere South	MDQ	74	4,078	4,297	4,556
			Total zone (2)		104	4,078	5,762	6,109
2	(3)	70	Poudriere North	MDQ	112	6,118	6,446	6,834
Area (1)			High Income Total			10,196	15,509	17,526
Middle Income Class								
1	(4)	28	Dar Es Salam East	PRP2	143	7,571	11,679	18,794
1	(5)	28	Dar Es Salam West	PRP2	143	7,571	11,679	18,794
1	(6)	31	Bani Fandou I	PRP2	104	9,213	12,182	15,248
Area (2)			Middle Income Total			24,355	35,540	52,836
Low Income Class								
1	(7)	8	Zongo	TRD	20		1,782	2,424
		9	Maourey	TRD	15		1,535	1,996
		10	Gandacthe	TRD	13		1,802	1,934
		11	Deizebon	TRD	19		2,596	2,785
			Total Zone (7)		67	0	7,715	9,139
1	(8)	15	Boukoki I	PRP1	41		3,182	3,983
		16	Boukoki II	PRP1	47		3,629	4,543
		17	Boukoki III	PRP1	35		2,686	3,362
			Total Zone (8)		123	0	9,497	11,888
1	(9)	18	Boukoki IV	PRP1	99			9,635
Area (3)			Low Income Total			0	17,212	30,662
Grand Total						34,551	68,261	101,024

With regard to the estimation made on the population growth for the target years and based on the measured generation rate for solid waste (see Chapter 7.4), one can also estimate the waste generation that has to be removed in the years 2005, 2010 and 2015. The following 18.3-2 is presenting the figures of these waste quantities :

TABLE 18.3-2 GENERATION OF SOLID WASTE IN THE SELECTED QUARTIERS

CU	Zone No	ID	Quartier	Type	Area(ha)	Household waste (t/year)		
						2005	2010	2015
High Income Class								
2	(1)	53	Terminus	MDQ	75		904	958
		54	Niamey Bas	MDQ	62		0	296
			Total Zone (1)		137		904	1,255
2	(2)	69	Cite Faycal	MDQ	30		401	425
		70	Poudriere South	MDQ	74	1,116	1,176	1,247
			Total zone (2)		104	1,116	1,577	1,672
2	(3)	70	Poudriere North	MDQ	112	1,675	1,765	1,871
Area (1)			High Income Total		290	2,791	4,246	4,798
Middle Income Class								
1	(4)	28	Dar Es Salam East	PRP2	143	2,073	3,197	5,145
1	(5)	28	Dar Es Salam West	PRP2	143	2,073	3,197	5,145
1	(6)	31	Bani Fandou I	PRP2	104	2,522	3,335	4,174
Area (2)			Middle Income Total			6,667	9,729	14,464
Low Income Class								
1	(7)	8	Zongo	TRD	20		488	664
		9	Maourey	TRD	15		420	546
		10	Gandacthe	TRD	13		493	529
		11	Deizebon	TRD	19		711	762
			Total Zone (7)		67	0	2,112	2,502
1	(8)	15	Boukoki I	PRP1	41		871	1,090
		16	Boukoki II	PRP1	47		993	1,244
		17	Boukoki III	PRP1	35		735	920
			Total Zone (8)		123	0	2,600	3,254
1	(9)	18	Boukoki IV	PRP1	99		0	2,638
Area (3)			Low Income Total		479	0	4,712	8,394
Grand Total					1,159	9,458	18,686	27,655

Taking account that the waste composition is showing a high portion of sand (see Table 7.4-3 in Chapter 7.4), it planned that sand will be sorted out. The following Table18.3-3 is presenting the sand quantities that will be reused and remaining waste quantities:

TABLE 18.3-3 EVOLUTION OF SAND QUANTITY IN THE SELECTED QUARTIERS

CU	Zone No	ID	Quartier	Type	Area(ha)	Recycling sand (t/year)		
						2005	2010	2015
High Income Class								
2	(1)	53	Terminus	MDQ	75		542	575
		54	Niamey Bas	MDQ	62			178
			Total Zone (1)		137		542	753
2	(2)	69	Cite Faycal	MDQ	30		241	255
		70	Poudriere South	MDQ	74	670	706	748
			Total zone (2)		104	670	946	1,003
2	(3)	70	Poudriere North	MDQ	112	1,005	1,059	1.122
Area (1)			High Income Total		290	1,675	2,547	2,879
Middle Income Class								
1	(4)	28	Dar Es Salam East	PRP2	143	1,244	1,918	3,087
1	(5)	28	Dar Es Salam West	PRP2	143	1,244	1,918	3,087
1	(6)	31	Bani Fandou I	PRP2	104	1,513	2,001	2,504
Area (2)			Middle Income Total			4,000	5,837	8,678
Low Income Class								
1	(7)	8	Zongo	TRD	20		293	398
		9	Maourey	TRD	15		252	328
		10	Gandacthe	TRD	13		296	318
		11	Deizebon	TRD	19		426	457
			Total Zone (7)		67	0	1,267	1,501
1	(8)	15	Boukoki I	PRP1	41		523	654
		16	Boukoki II	PRP1	47		596	746
		17	Boukoki III	PRP1	35		441	552
			Total Zone (8)		123	0	1,560	1,953
1	(9)	18	Boukoki IV	PRP1	99			1,583
Area (3)			Low Income Total		479	0	2,827	5,036
Grand Total					1,159	5,675	11,212	16,593

18.3.1 Pre-Collection of Household Waste

The 9 selected zones consist of several quartiers as shown in Table 18.3-1. The private pre collectors shall collect waste door to door using pushcarts (mainly two wheeled dollies). It is also possible to use animals (horse, mule or camel) for pulling the carts. The pre collection shall be done regularly and at usual fixed time.

18.3.2 Sorting and Recycling Center

The location of the recycling center is chosen so that no mechanized vehicles are necessary for transporting pre collected household waste to the center. The human powered pushcarts can easily reach the recycling center from the area where waste is collected. The site locations for the 9 recycling centers are shown in detail in Appendix U-1

The recycling center shall have a second function, it may be used as a transfer point. After sand sorting, remaining waste shall be transported to the dumping site.
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. Based on the first results regarding the market for recycling sand, it is expected that high interest does exist for the use of recycling sand by construction enterprises. The detail result and analysis are attached in Appendix S-4.

18.3.3 Transport of Solid Waste

The municipal services should make containers available at the recycling centers as well be responsible for their transport to the disposal site. The pre collection of waste, made by private organization, shall lead to concentrate waste at the recycling centers and the number of dispatched containers will be reduced in the areas where recycling centers are operated.

Costs of solid waste transport from the recycling center to the disposal site must be met by the municipal services. Recycling sand be sold and as alternative used for recovering expenditures for waste transport to disposal site.

18.4 CONSTRUCTION OF THE MUNICIPAL LANDFILL SITES

18.4.1 Introduction

The construction and the operation of disposal site is indispensable step for proper solid waste management and environmental protection .

Within the present study, 2 sites have selected for design and realization of two municipal disposal sites. The site at Koubia shall be for landfilling 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.

18.4.2 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. Topographic survey results, that served for the data basis for the detailed survey are included in the Appendix Report (Appendix S.2) as well as the results of soil investigations (see Appendix S.3).

(1) Topographical and geological conditions of the landfill site at Koubia

The site of Koubia is an abandoned quarry of several cavities with different sizes. 4 cavities are selected for the construction of the disposal site that are merged to 2 zones. The first zone has a surface of about 3 ha and the second about 7.2 has (see Figure 18.5-3)

The soil characteristic shows some layers of clay, colored clay and latérite at different levels as shown in detail in Appendix S.3. Standard penetration test could confirm that ground soil is very compacted. Ground water has not been reached. It should be deeper than 11.7m at the first bore hole and deeper than 10.25m at the second bore hole.

(2) Topographical and geological conditions of the landfill site at Bengale Torombi

The site of Bengal Torombi is also an abandoned quarry of several cavities with different sizes. 3 cavities are selected for the construction of the new landfill site. The first cavity has a surface of about 0.45 ha (quarry 1)and the second (quarry 11 and 12) of about 1.56 ha (see Figure 18.5-5).

The soil characteristic shows very important layer of clay of about 8m depth that is suitable for dumping site. Standard penetration test also confirmed that clay layer is compacted with an approximate resistance of about 140 bar. Ground water has been found at 9.50m depth for the first bore hole and 14.20 m at the second bore hole. Details of the soil investigation are included in Appendix S.3.

18.4.3 Municipal Landfill Site

(1) Infrastructure

In all directions, the dumping site shall be demarcated by a fence and an access road shall connect the site to the public road network. The trucks that are delivering waste shall use the constructed access road and stop at the entrance where they shall be inspected and instructed. It shall be possible to dump waste only during opening time of the landfill. Waste can not be dumped at the landfill site without permission of the disposal site personnel.

After having passed the control at the entrance where waste has been recorded and inspected visually, the small vehicles transporting waste shall follow the main road inside the landfill to the area where waste is being discharged. The large collection trucks shall be attended by the operation personnel and waste shall be properly landfilled. A track shall allow walking around the area where waste is discharged. It also will facilitate the control and inspection of all the disposal area and particularly and later the control pits, the leachate pound and other zones inside the landfill site.

The entrance zone consists of the following:

- Guardian and registration lodge
- Access
- Administration building and social service
- Hangar for bulldozer and other
- Area of visual control

Beyond the zone of entrance will be

- The surface of waste disposal that is distributed in 2 phases of planning
- The basin retaining infiltration water (reserved for the second stag of construction)

(2) Preparation of the ground soil

As already introduced in the previous phase, the preparation of the ground soil at the disposal area, in order to make it watertight, constitutes one of the main conditions in order to avoid leachate infiltration in the underground waters. Additionally an natural layer of low permeability in the ground soil contributes to reduce more the risk of contamination of ground water. These conditions have already been considered during the selection of landfill sites.

The results of the undertaken soil investigations could confirm that the selected sites are presenting suitable characteristics for a disposal site. For both sites the substratum is building a real geological barrier against any pollution of the ground water.

(3) Infiltration water

The conception of the controlled disposal site implies a suitable watertight basement and equipment of a system for catchment of the infiltration water. These devices aim to reduce any risk for infiltration of water that might be contaminated in to underground and may pollute underground water.

It is expected that the construction of the disposal site shall be step by step. 2 construction stages are scheduled. Only at the second realization stage, a pond for temporarily leachate storage, will be construted. In order to avoid the use of any pump devices leachte and infiltration water shall flow principally by gravity.

(4) Gas handling

In the begin of the operation of the landfill site, generated gas is not very important due to the small and freshly dumped waste quantity. Furthermore the waste composition presents low proportion of organic (about 19%), water content is also reduced (less than 20%). On the other hand sand is the largest proportion in solid waste (around 70%). If waste quantity is reduced to half by sand sorting and recycling, the organic proportion will increase to about 38%. It is recommended to monitor gas generation at the disposal site 5 years after commissioning of the site, in order to determine the exact gas generation.

After the landfilling of waste and reaching a high level of 4 to 5m, the installation of drainage system for produced gas is to be foreseen. It is not recommended to install the gas drainage device from a lower level, one risks to import the air of the outside of the waste body.

(5) Operation of the disposal site

At the entrance area a visual control and registration of waste that is delivered shall be undertaken. In order to reduce the investment budget for the construction of the disposal site and considering the small waste quantity generated in Commune 3, the landfill site will not be equipped with a weigh bridge. Waste registration shall be done on estimation base (truck load, container capacity and visual estimation). Recorded should be, not only the estimated waste quantity, but also date and time of delivery, waste type (industry, household, etc.), form of waste (solid liquid or pasty), generator/supplier of waste and any particularity observed during the registration process.
All recorded data, even on an estimation basis, can serve for any ulterior planning or actualization of waste management plan.
It is possible, later when the financial situation does permit, to equip the disposal site with a weigh bridge, in order to record exactly the landfilled waste quantity. The registration can also be upgraded to an electronic registration system by using PC.

In order to collect separately toxic waste such as old oil, batteries, accumulators etc., some reserved containers should be made available at the entrance zone and controlled by the personnel of the landfill.

It will be expected that the density of dumped waste at the lower layers will be about 1 ton/m^3. This occurs from the compaction activities during landfilling and the pressure that is exerted on the lower waste layers.

The landfill site are old quarries, that shall be filled progressively with solid waste. According to the construction phases, different cavities shall be filled. For the 1st construction stage zone1 is foreseen with a surface of about 3 ha and at site Koubia and 0.45 ha at site Bengale Torombi. For the second construction stage zone 2 is reserved with a surface of about 7.2 ha at site Koubia and 1.56 ha at site Bengale Torombi.

(6) Post operation phase and closure of the disposal site

After expected operation phase of the disposal site, for zone 1 in year 2006, a layer of about 0.5m earth shall cover the waste body in order to minimize the water infiltration. From the top of the cavity the height of waste body shall reach about 4.5 to 5m.

The definitive cover layer should not be before biologic decomposition nearly be completed and when waste compression will nearly be finished. During exploitation phase on the waste body's side a cover layer shall be applied, in order, on hand to avoid dispersion of light waste fraction such as plastic and paper and on the other hand not to attract any pest. Trees have to be planted in order to hide the disposal site and protect it against wind.

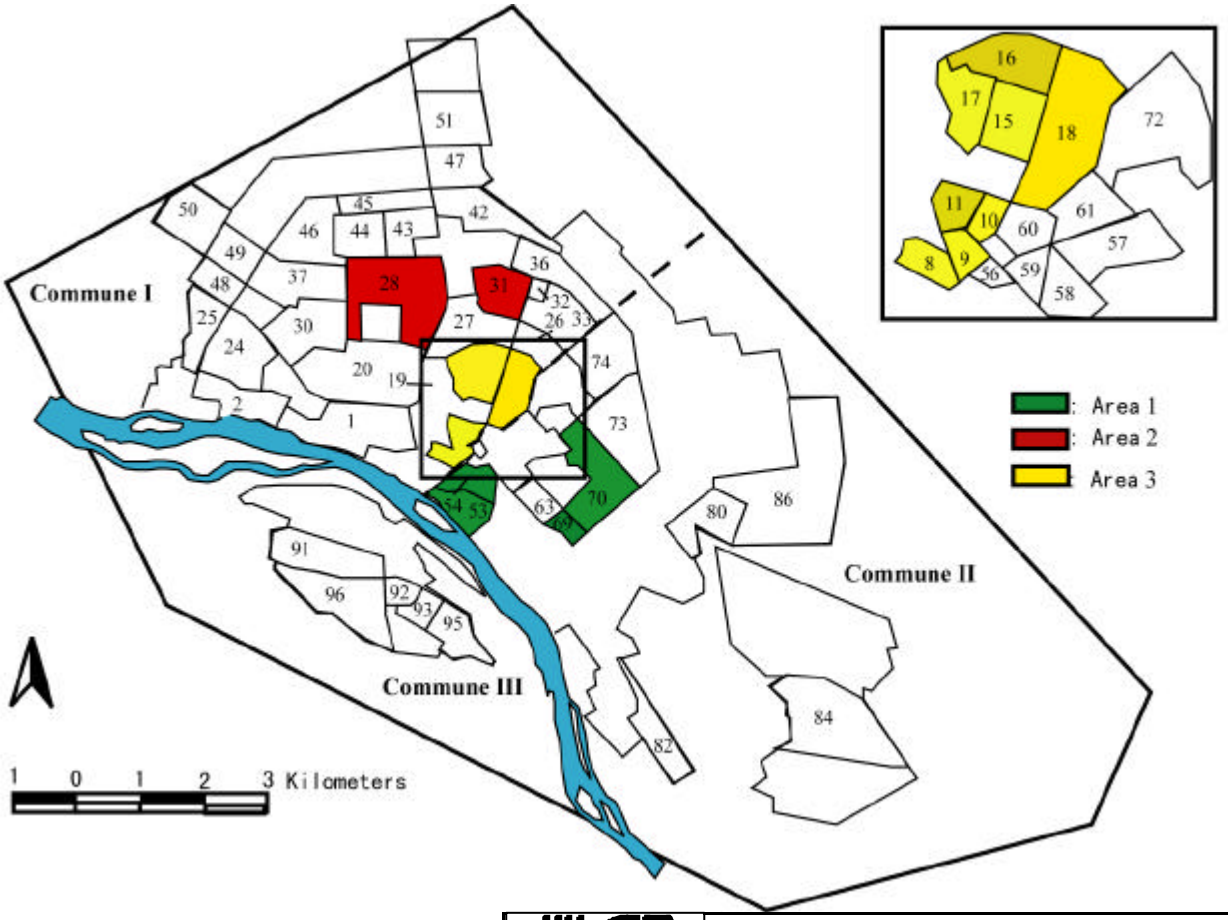
18.5 DESIGN OF THE FACILITIES

18.5.1 Pre-Collection and Transport of Solid Waste in the Priority Project Area

(1) Design Condition

1) Target Area

The target area consists of 3 areas as shown in the following Figure 18.5-1. Each area consists of several quartiers (as presented in Table 18.3-1). Area 1, 2 and 3 are considered as high, middle and low standings respectively.



Area 1

53: Terminus

54: Niamey Bas

69: Cite Faysal

70: Poudriere

Area 2

28: Dar Es Salam

31: Bani Fandou I

Area 3

8: Zongo

9: Maourey

10: Gandacthe

11: Deizeibon

15: Boukoki I

16: Boukoki II

17: Boukoki III

18: Boukoki IV

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LOCATION OF NEW SYSTEM TARGET QUARTIERS

Figure 18.5-1

2) Population to be considered for New System

The new system should be introduced in step by step. According to the master plan, the considered population for new system is summarized as Table 18.3-1. The calculation is shown in Appendix U-2. The design was carried out based on this population.

(2) Pre-Collection

The pre-collection as well as recycling centers described in the next section has been designed to be operated by private pre-collection companies.

The pre-collection work requires hand carts, dust bins, blooms and so on. As those tools are considered as consumable, the tools are counted as operation cost.

(3) Recycling Center

The function of recycling center is not only sorting out sand but also storing the collected waste and controlling the pre-collection activities in the zone. Taking into account the pre-collection activity that should be done in manual and on foot, one recycling center shall be established by zone.

The recycling center shall be equipped with the following facilities.

- Fence and Gate (see Drawing B-101 and 103)
- Sand Sorting Yard (see Drawing B-101 and 103)
- Sand Stock Yard (see Drawing B-101)
- Control House (see Drawing B-102)

a. Required Land Area

The containers, which transport the waste to the disposal site, shall be put in the recycling center. Therefore the recycling center shall have an enough space for containers. The required land area depends on required number of container for the zone. (see Table 18.5-1) Taking into account the required area of the facilities and space that is required for the truck, the standard required land area was set as follows.

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

b. Fence and Gate

The recycling center is generally located in residential area, so that the protection from strangers' entry and waste scattered out shall be considered. Therefore a fence, which is made in concrete blocks (height: 2m), and the gate, which is made in steel (width: 6m, sliding type), were designed. (see Drawing B-103)

c. Sand Sorting Yard

Sand sorting yard was designed to be made in concrete to separate the sand and waste. The plan is shown in Drawing B-103. Standard area of the sand sorting yard was set as follows.

- $30m^2$ for zones require at maximum 3 containers in 2015.
- $70m^2$ for zones require more than 4 containers in 2015.

d. Sand Stock Yard

Sand stock yard is not required to be paved. Standard area of the sand stock yard was set as follows.

- $42m^2$ for zones require at maximum 3 containers in 2015.
- $100m^2$ for zones require more than 4 containers in 2015.

e. Control House

The control house was designed for 2 foremen and 1 clerk. It consists of staff room, store and toilette. The plan is shown in Drawing B-102. The planned structure and material are as follows.

- Structure: Reinforced concrete (columns and beams)
- Wall: Concrete blocks
- Floor: Concrete
- Roof: Galvanized steel panel

f. Location

Locations of the recycling centers were selected as shown in Appendix U-1.

g. Layout of Recycling Center

The recycling centers shall be constructed in each zone. 9 centers in total are required. Typical Layout of recycling center is shown in Drawing B-101.

(4) Transport

In the recycling center, the pre-collected waste is separated into waste and sand. Both waste and sand shall be regularly transported out of the center. (see Appendix U-3 for amount of waste and sand). As the transport work requires a lot of investment and the equipment is capable to serve for other quartiers, the transport equipment have been considered as the Municipality's duty.

1) Transport of Waste

Waste shall be transported through container and detachable container truck as shown in Appendix U-4.

a. Container

The volume of container should be $5.5m^3$ as present and it should be made in steel and to be adapted to the present type container truck. The required number of container, which shall be

made available at the recycling center, is as shown in Table 18.5-1. Therefore the container shall be purchased as the schedule shown in Table 18.5-2.

TABLE 18.5-1 REQUIRED NUMBER OF CONTAINER

Area	Zone No.	Required Number of Container 2005	Required Number of Container 2010	Required Number of Container 2015
Area 1	Zone 1	0	1	1
	Zone 2	1	2	2
	Zone 3	2	2	2
	Total	**3**	**5**	**5**
Area 2	Zone 4	2	3	4
	Zone 5	2	3	4
	Zone 6	2	3	4
	Total	**6**	**9**	**12**
Area 3	Zone 7	0	2	2
	Zone 8	0	2	3
	Zone 9	0	0	2
	Total	**0**	**4**	**7**
	Grand Total	**9**	**18**	**24**

Source: Master Plan Sub-Chapter 9.2.2 and Appendix J-10

Note: Capacity of container is 1.61ton for the waste not containing sand

TABLE 18.5-2 CONTAINER PURCHASE SCHEDULE

Items	By 2005	2006-2010	2011-2015
Container shown in Table 18.5-1	9	9	6
Spare container described in next section b.	2	1	1
Total to be purchased	**11**	**10**	**7**

b. Container Truck

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. Therefore the truck shall be purchased as the schedule shown in Table 18.5-3. Furthermore one container per truck shall be purchased as reserve together with truck in order to keep the waste storage in container continuously.

TABLE 18.5-3 TRUCK PURCHASE SCHEDULE

Items	By 2005	2006-2010	2011-2015
5.5m3 container truck	2	1	1

2) Transport of Sand

The amount of sand sorted out will reach approximately 100, 200 and 300ton/week in 2005, 2010 and 2015 respectively (see Appendix U-3). Those amount can be removed out and transported by one dump truck (15ton) and using one wheel loader ($2m^3$) for 6 days. Although the dump truck and wheel loader would have some amount of useless time especially in 2005 and 2010, the equipment could be effectively used for other solid waste management activities such as cleaning up wild disposal sites. Therefore one dump truck (15ton) and one wheel loader ($2m^3$) should be purchased by 2005.

18.5.2 Facilities at the Disposal Site Koubia

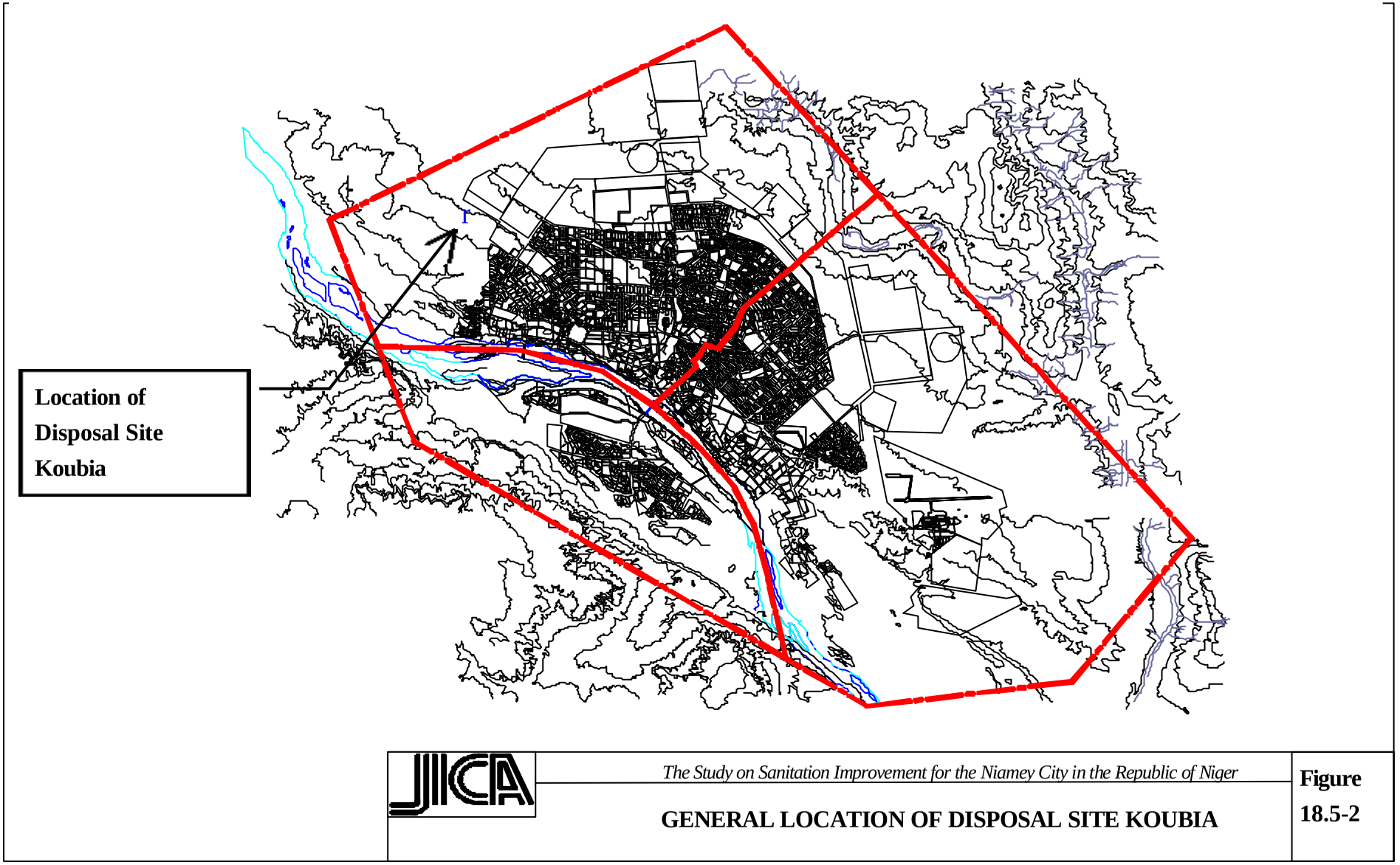
(1) Connection and Access Road

The disposal site Koubia will serve for Commune 1 and 2. The site is located along Route de Tilaberi and the distance is approximately 6.6km from National Hospital in Niamey. The location of the site is shown in Figure 18.5-2 and 18.5-3. Route de Tilaberi is paved and has enough capacity for the waste transport. However an access road should be constructed to keep the traffic and operation in the rain between Route de Tilaberi and the site as there is only unpaved road. Its distance is approx. 320m. A gravel road, therefore, is designed as the access road. The width of the access road is 4m and thickness is 50cm with compacted gravel. The plan is shown Drawing B-202 and 204.

Since there are some quarries behind the site and the actual unpaved road is an access for the quarries, some part of the access road should be opened in public.

(2) Water and Electricity Supply

There is actually no water and electricity supply. The water and electricity are necessary to manage the landfill operation and keep the minimum working conditions for the operation staff, so that the water and electricity should be fed to the site. As the residential area has been expanding to the direction of the site from the city center, the water and electricity feeding should be completed sooner in association with the companies of water and electricity.



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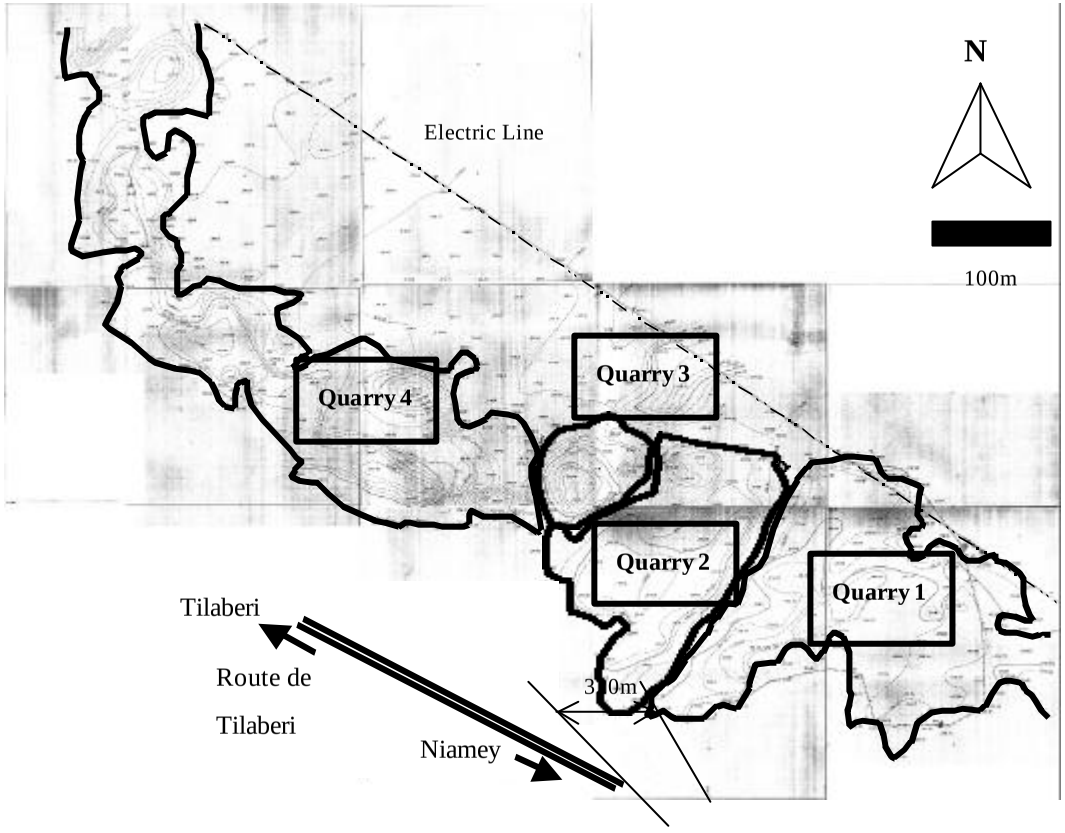
GENERAL LOCATION OF DISPOSAL SITE KOUBIA

Figure 18.5-2



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

LOCATION OF DISPOSAL SITE KOUBIA

Figure 18.5-3

(3) Civil Work

1) Infrastructure

Besides the access road and water and electricity supply described in the above sections, the followings shall be constructed as basic infrastructure for the landfill site.

- Fence and Gate
- Operation Road
- Control House
- Shade of Bulldozer

a. Fence and Gate

The fence and gate are generally required to protect the site from strangers' entry. However simple fence and gate should be appropriate, for the time being, to minimize the construction cost, as the planned sites are located far from residential area. Even the fence and gate are simple, it is enough to have the general public be aware of the area of landfill site. The designed fence is in concrete piles and steel wires with thorns and the designed gate is in steel. The designed fence and gate are shown in Drawing B-202 and B-210. Total required length of fence is approx. 2,530m.

b. Operation Road

The vehicle traffic shall be kept in operation even in the rain in landfill site. Therefore the operation road shall be constructed for land-filling work in landfill zones prior to the landfill operation. In order to minimize the construction cost, gravel road was designed for the operation roads. The width of the road is 3m and thickness is 30cm with compacted gravel. The length of operation road to be constructed is 850m as shown in Drawing B-202 and B-204.

c. Control House

A guard-men house has been constructed in the planned landfill site. Therefore only control house, which is for clerks, foremen and store, is required. The control house was designed as shown in Drawing B-207. The house was planned for 1 chief foreman, 3 foremen and 2 clerks. In order to record the incoming truck number, amount and origin of waste, drivers' names and so on, a reception window shall be provided at the staff room. As for the toilette, 2 toilette rooms shall be provided to keep the 2 accesses, one is from staff room and the other is from outside of the house. The planned basic structure and materials are as follows.

Structure:	Reinforced Concrete (columns and beams)
Wall:	Concrete blocks
Floor:	Concrete
Roof:	Galvanized steel panel

d. Shade of Bulldozer

As described in chapter 18.7 "Equipment of disposal site", a bulldozer is planned to be arranged in the landfill site. To avoid leaving the equipment under the strong sunshine and rain during non-operated time, a shade should be constructed. Steel columns and beams and a galvanized

steel roof were planned as the materials of shade. The planned shape of shade is shown in Drawing B-208.

2) Landfill Construction

The area of planned site is over 10ha. This area is enough for about 10 years operation. In order to utilize the land efficiently, zoning was designed. The followings describe the landfill zones construction.

a. Zoning

The required landfill capacity, which was set in the master plan, is as shown in Table 18.5-4.
In this study, the zones 1 and 2 have been designed. According to required capacity, the location of the 2 zones was set as shown in Drawing B-201 and B-202.

TABLE 18.5-4 REQUIRED CAPACITY OF LANDFILL SITE KOUBIA

No. of Zone	Years	Waste to be land-filled (m3)	Covering Soil (m3)	Total (m3) (Required Capacity)
Zone 1	2002-2005	189,416	0	189,416
Zone 2	2006-2010	519,005	86,501	605,506
Zone 3	2011-2015	1,004,197	167,366	1,171,563
Zone 4	2016-2020	1,662,151	277,025	1,939,176
Total		3,374,769	530,892	3,905,661

The area of zones is as shown in Table 18.5-5.

TABLE 18.5-5 AREA OF LANDFILL ZONE: DISPOSAL SITE KOUBIA

	Zone 1	Zone 2
Area	30,000m^2	72,000m^2

b. Earth Work

Although the planned site was a quarry and it is in cavity, some excavation work is required under the following reasons. The required volume of excavation is as shown in Table 18.5-6.

- To grade and level the bottom of cavity in order to keep the truck traffic.
- To grade and level the bottom of cavity in order to keep the slope and passes for leachate.

TABLE 18.5-6 REQUIRED VOLUME OF EXCAVATION: DISPOSAL SITE KOUBIA

	Zone 1	Zone 2
Excavation Volume	17,000m^3	131,400m^3

On the other hand, the banking work (construction of dike) is also required in order to make properly the filled waste layers and to keep the landfill area boundary. The height of dike was basically designed at the top level of first planned waste layer which is about 4.00m (see also Appendix U8). The required volume of banking work is as shown in Table 18.5-7.

TABLE 18.5-7 REQUIRED BANKING VOLUME: DISPOSAL SITE KOUBIA

	Zone 1	Zone 2
Banking Volume	9,500m^3	29,000m^3

The earth work plan is shown in Drawing B-203.

c. Leachate Protection

As described in Sub-Chapter 18.2, the quantity of evaporation is much larger than precipitation in the yearly basis. All the rainwater should be evaporated. However it is possible that the monthly precipitation exceed the evaporation in rainy season. Therefore some leachate is possible to be generated for a while until evaporated and some countermeasures should be taken.

Since zone 1 is required to start its operation urgently, countermeasure (such as additional clay layer at the bottom) is not foreseen. However zone 2 (for later operation stage) should have additional clay layer at the bottom, as shown in Appendix U8 .

As the low permeability layer is deep at the site (see Appendix S3), the leachate protection is not expected through natural soil layers. Therefore clay lining, which is put on the ground at the bottom of excavated cavity, was designed as the countermeasures. The clay lining should be as shown in Table 18.5-8 and Appendix U8. The clay lining is expected to protect much the ground from leachate filtration.

TABLE 18.5-8 REQUIRED CLAY LINING: DISPOSAL SITE KOUBIA

Item	Description	Remark
Clay lining area	72,000m^2	Only for Zone 2
Thickness of the lining	50cm	Well compacted
Permeability of clay	Not more than 10^{-6}cm/sec.	

d. Leachate Collection

The principal of leachate management is to let be evaporated due to the climate conditions in Niamey. In order to promote the leachate evaporation, the leachate drain was designed for the zone 2. Through collecting the leachate from the bottom of landfill zone and spraying it on the filled waste, the leachate evaporation should be well promoted. The followings describe the leachate collection facilities.

Leachate Collection Pipe

The drainpipe that has holes on the surface should be laid on the clay lining. The pipe network

consists of main and brunch lines. The diameter and slope should be designed in detail in the detail design stage, however the diameter shown in Table 18.5-9 and Drawing B-206 is considered as appropriate in this feasibility study. The brunch line should be laid at 20m interval.

TABLE 18.5-9 DIAMETER OF LEACHATE COLLECTION PIPE: DISPOSAL SITE KOUBIA

Item	Diameter	Total Length	Remark
Main Line	300mm	900m	Plastic pipe
Brunch Line	150mm	2,100m	Plastic pipe

Leachate Pond

The collected leachate should be conducted to leachate pond. The purpose of the leachate pond is to observe the amount of collected leachate and to vacuum the leachate up (see Sub-Chapter 18.7). The leachate pond shall be also put the clay lining and the planned location is shown in Drawing B-206. The planned capacity of the pond is 2,200m^3 (see Appendix U-5).

3) Rain Water Drainage

In order to minimize the leachate generation, it is required to construct rainwater drains, which have the rainwater not enter into landfill zones. The size of the drain varies depending on catchment area. The plan is shown in Drawing B-205 (refer Appendix U-6). The collected rainwater shall be discharged out from the sites.

The required quantity of rainwater drain is as Table 18.5-10.

TABLE 18.5-10 REQUIRED QUANTITY OF RAINWATER DRAIN: DISPOSAL SITE KOUBIA

Required Section	Quantity (m)	
	Zone 1	Zone 2
H=300mm, W=300mm	-	110
H=400mm, W=400mm	165	-
H=500mm, W=500mm	180	450
H=600mm, W=600mm	-	480
H=700mm, W=700mm	-	-
H=800mm, W=800mm	550	-

4) Gas Handling

In the anaerobic biodegradation process of the filled organic contents, varied gas such as methane and hydrogen sulfide is generated. It is necessary to take such gas out from the filled area. Taking into account that the anaerobic biodegradation is slowly proceeded under the dry condition of Niamey, simple gas exhaust facility, whose cost is low, should be applied. Therefore the gas exhaust facility in gravel were designed. Although it is difficult to estimate the quantity of the generated gas, the quantity seems less because of the dry condition. Vertical gas exhaust (diameter: 1m) planned to be constructed at 50m interval (one exhaust per 2,500m^2).

The plan is shown in Drawing B-209.

The construction of gas exhaust facility was planned for Zone 2. The zone 1, which is urged to be started land-filling operation, was not planned it. The required quantity of gas exhaust facility is as Table 18.5-11.

TABLE 18.5-11 REQUIRED QUANTITY OF GAS EXHAUST: DISPOSAL SITE KOUBIA

Zone and Item	Quantity	
	No. of set	Length of Exhaust (m)
Gas Exhaust (5.4m/set)	29	156

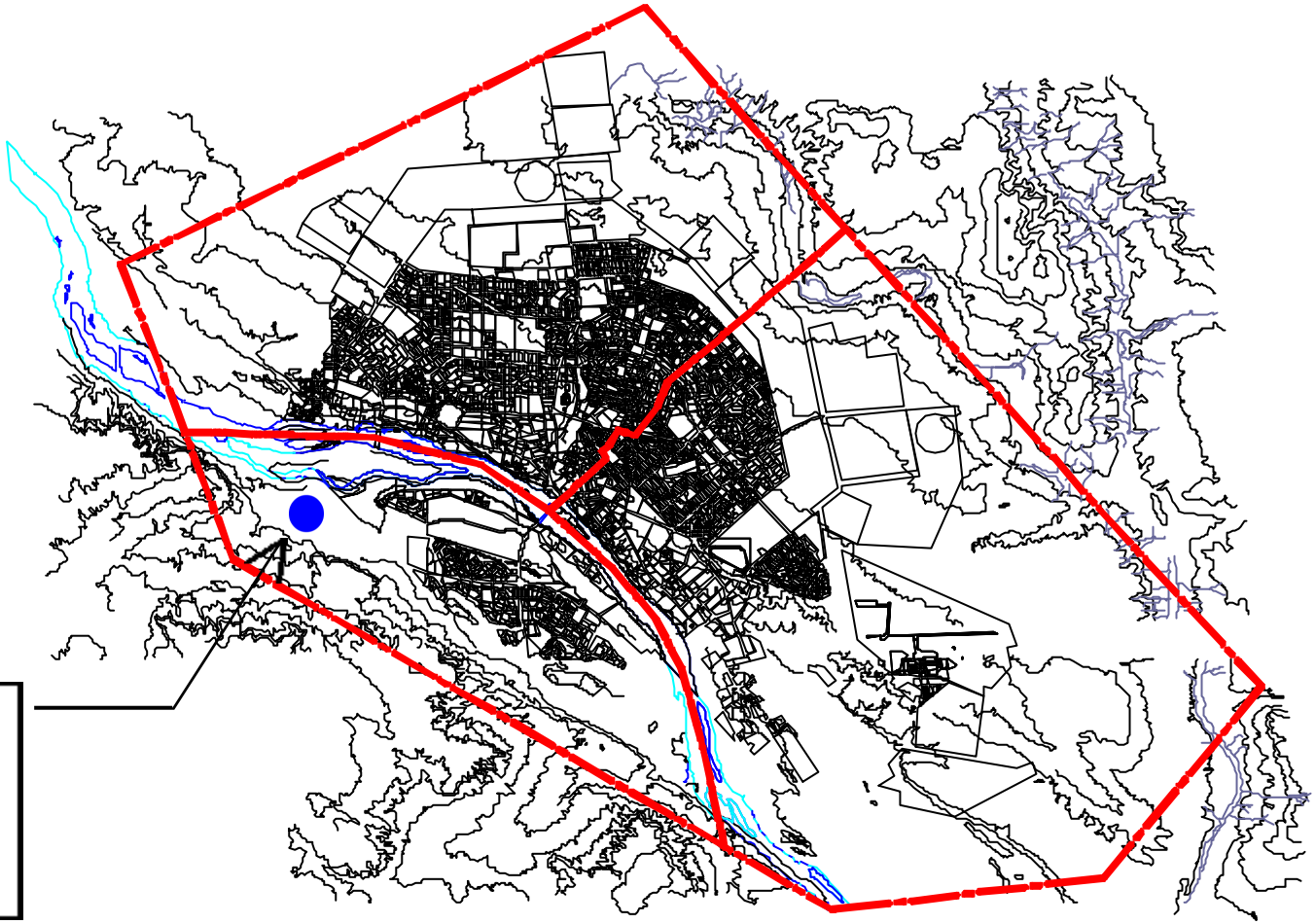
18.5.3 Facilities at the Disposal Site Bengale Torombi

(1) Connection and Access Road

The disposal site Bengale Torombi will serve for Commune 3. The site is located along Route de Torodi and the distance is approximately 6.2km from the Office of Commune 3. The location of the site is shown in Figure 18.5-4 and 18.5-5. Route de Torodi is paved and has enough capacity for the waste transport. However an access road should be constructed to keep the traffic and operation in the rain between Route de Torodi and the site as there is only unpaved road. Its distance is approx. 80m. A gravel road, therefore, is designed as the access road. The width of the access road is 4m and thickness is 50cm with compacted gravel. The plan is shown Drawing B-302 and 304.

(2) Water and Electricity Supply

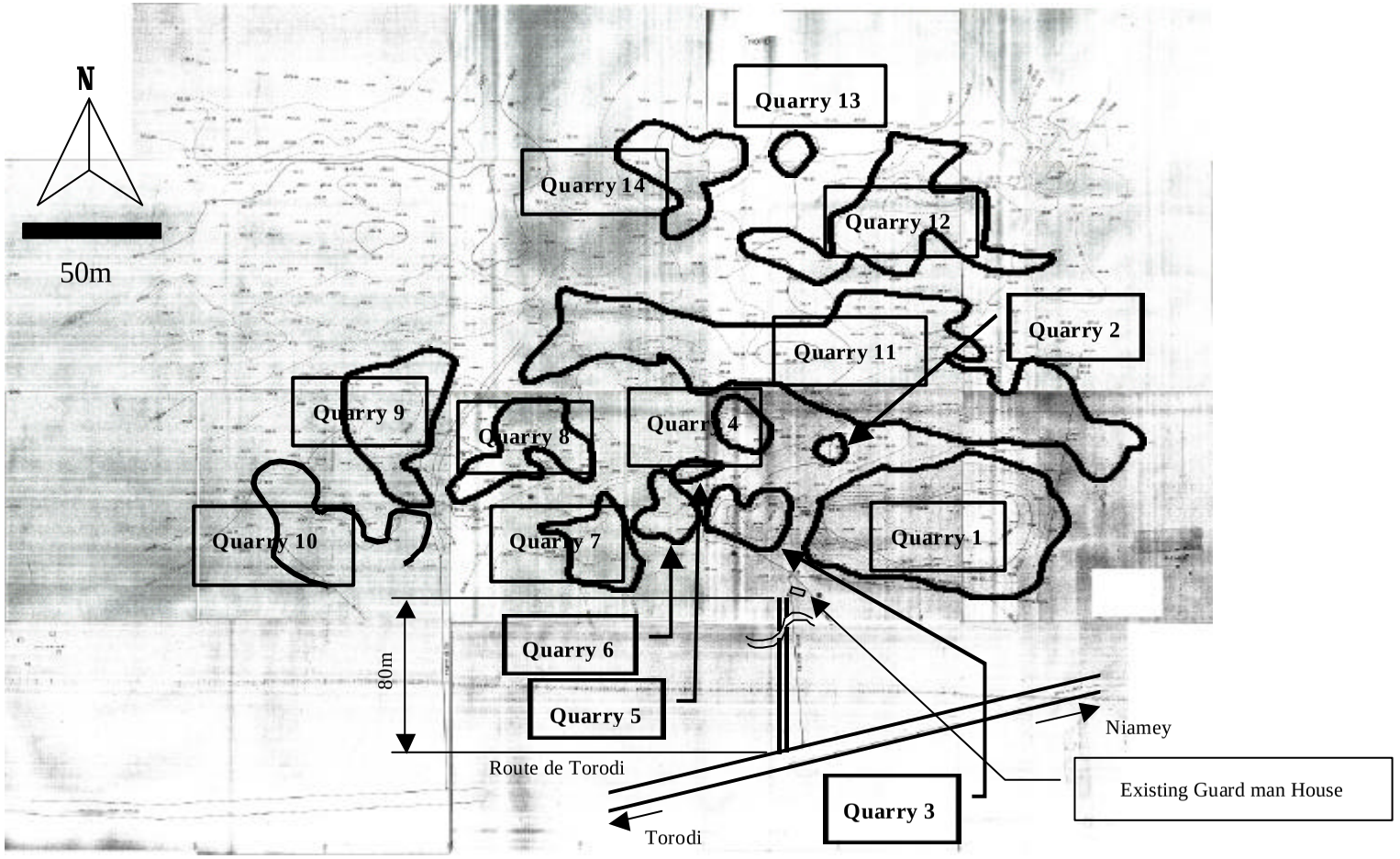
There is actually no water and electricity supply. The water and electricity are necessary to manage the landfill operation and keep the minimum working conditions for the operation staff, so that the water and electricity should be fed to the site. As the residential area has been expanding to the direction of the site from the city center, the water and electricity feeding should be completed sooner in association with the companies of water and electricity.



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

GENERAL LOCATION OF DISPOSAL SITE BENGALE TOROMBI

Figure 18.5-4



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

LOCATION OF DISPOSAL SITE BENGALE TOROMBI

Figure 18.5-5

(3) Civil Work

1) Infrastructure

Besides the access road and water and electricity supply described in the above sections, the followings shall be constructed as basic infrastructure for the landfill site.

- Fence and Gate
- Operation Road
- Control House

a. Fence and Gate

The fence and gate were designed as well as them at Disposal Site Koubia. The designed fence and gate are shown in Drawing B-302 and B-309. Total required length of fence is approx. 1,030m. the gate shall be 6m wide.

b. Operation Road

The operation road was designed as well as it at Disposal Site Koubia. The length of operation road to be constructed is 370m as shown in Drawing B-302 and B304.

c. Control House

A guard-men house has been constructed in the planned landfill site. Therefore only control house, which is for clerk, foreman and store, is required as well as in Disposal Site Koubia. The control house was designed as shown in Drawing B-307. The house was planned for 1 foreman and 1 clerk.

2) Landfill Construction

The area of planned site is over 7ha. This area is enough for over 10 years operation. In order to utilize the land efficiently, zoning was designed. The followings describe the landfill zones construction.

a. Zoning

The required landfill capacity, which was set in the master plan, is as shown in Table 18.5-12.
In this study, the zones 1 and 2 have been designed. According to required capacity, the location of the 2 zones was set as shown in Drawing B-301 and B302.

TABLE 18.5-12 REQUIRED CAPACITY OF LANDFILL SITE BENGALE TOROMBI

No. of Zone	Years	Waste to be land-filled (m3)	Covering Soil (m3)	Total (m3) (Required Capacity)
Zone 1	2002-2005	23,113	0	23,113
Zone 2	2006-2010	67,786	11,298	79,084
Zone 3	2011-2015	139,650	23,275	162,925
Zone 4	2016-2020	239,220	39,870	279,090
Total		469,769	74,443	544,212

The area of zones is as shown in Table 18.5-13.

TABLE 18.5-13 AREA OF LANDFILL ZONE: DISPOSAL SITE BENGALE TOROMBI

	Zone 1	Zone 2
Area	4,500m^2	15,600m^2

b. Earth Work

As well as Disposal Site Koubia, some excavation work and banking work are required. The required volume of excavation and banking works is as shown in Table 18.5-14 and 18.5-15 respectively. The earth work plan is shown in Drawing B-303.

TABLE 18.5-14 REQUIRED VOLUME OF EXCAVATION: DISPOSAL SITE BENGALE TOROMBI

	Zone 1	Zone 2
Excavation Volume	4,600m^3	68,400m^3

TABLE 18.5-15 REQUIRED BANKING VOLUME: DISPOSAL SITE BENGALE TOROMBI

	Zone 1	Zone 2
Banking Volume	200m^3	3,200m^3

c. Leachate Protection

As well as Disposal Site Koubia, the leachate protection was considered in the site. As the low permeability clay layer is existing under a few meter in deep from the existing cavity bottom, this layer is expected the leachate protection. Therefore all the cavity bottom should be graded until the clay layer for both the zone 1 and zone 2. As for the zone 2, the clay lining should be put at the cavity slope. The clay lining should be as shown in Table 18.5-16.

TABLE 18.5-16 REQUIRED CLAY LINING: DISPOSAL SITE BENGALE TOROMBI

Item	Description	Remark
Clay lining area	500m^2	Only for slope of Zone 2
Thickness of the lining	50cm	Well compacted
Permeability of clay	Not more than 10^{-6}cm/sec.	

d. Leachate Collection

As well as Disposal Site Koubia, the leachate drain was designed for the zone 2. The followings describe the leachate collection facilities. The planned leachate collection pipe is as shown in Table 18.5-17 and Drawing B-306.

TABLE 18.5-17 DIAMETER OF LEACHATE COLLECTION PIPE: DISPOSAL SITE BENGALE TOROMBI

Item	Diameter	Total Length	Remark
Main Line	300mm	900m	Plastic pipe
Brunch Line	150mm	2,100m	Plastic pipe

The leachate pond is as shown in Drawing B-306. The planned capacity of the pond is 450m^3 (see Appendix U-5).

3) Drainage

As well as Disposal Site Koubia, the rainwater drain was designed. The plan is shown in Drawing B-305 (refer Appendix U-6). The collected rainwater shall be discharged out from the sites.

The required quantity of rainwater drain is as Table 18.5-18.

TABLE 18.5-18 REQUIRED QUANTITY OF RAINWATER DRAIN: DISPOSAL SITE BENGALE TOROMBI

Required Section	Quantity (m)	
	Zone 1	Zone 2
H=300mm, W=300mm	147	511
H=400mm, W=400mm	-	225
H=500mm, W=500mm	-	-
H=600mm, W=600mm	-	-
H=700mm, W=700mm	135	-
H=800mm, W=800mm	250	-

4) Gas Handling

As well as Disposal Site Koubia, the gas exhaust facility was designed. The plan is shown in

Drawing B-308. The required quantity of gas exhaust facility is as Table 18.5-19.

TABLE 18.5-19 REQUIRED QUANTITY OF GAS EXHAUST: DISPOSAL SITE BENGALE TOROMBI

Zone and Item	Quantity	
	No. of set	Length of Exhaust (m)
Gas Exhaust (2.1m/set)	6	13

18.6 MANAGEMENT OF NEW WASTE COLLECTION SYSTEM

18.6.1 Operation of New Waste Collection System

The planned flow of waste in the new waste collection system is as shown Figure 18.6-1. The private sector shall be involved in the activities of solid waste management recycling center. From where waste shall be transported and managed by Municipality.

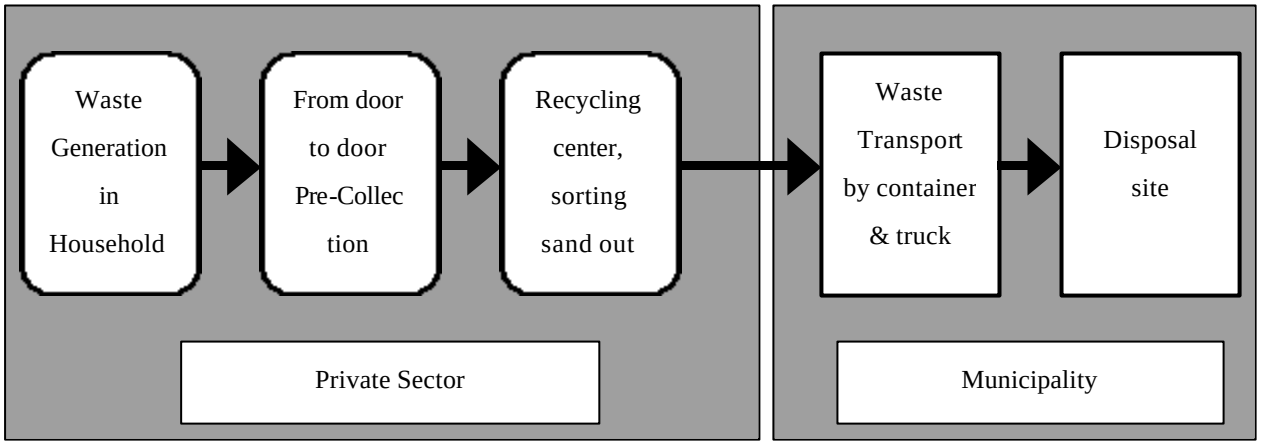


FIGURE 18.6-1 WASTE FLOW IN NEW COLLECTION SYSTEM

(1) Pre-Collection and Recycling Center

The planned pre-collection and recycling is a developed system of current pre-collection activity, which is done by several numbers of NGO. Therefore it has been planned to be arranged and managed by private sector. In principal, the private sector collects the waste collection fee from contracted residents and cover the required investment and operation and maintenance cost by the collected fee.

1) Equipment for recycling center

The pre-collection is planned to be carried out through manual way as current pre-collection activity. The pre-collector shall visit every day, except Sunday, each contracted household and collect the waste. The collected waste shall be transport to the recycling center by hand cart and sorted out sand. The work of sorting out sand shall also be curried out at manual way with hand sieve by pre-collectors. The required tools for pre-collector are as shown in Table 18.6-1.

TABLE 18.6-1 REQUIRED TOOLS FOR PRE-COLLECTORS

Item	Unit	Quantity
Working uniform	LS	1
Shovel	pcs	1
Rake	pcs	1
Boom/Brush	pcs	1
Sieve	pcs	1
Hand Cart	pcs	1

Note: As the tools are considered as consumable, its cost is counted in Operation & Maintenance Cost at the rate of 0.5 unit per year.

2) Personnel

As the productivity of pre-collector is considered as 500 kg/worker/day and the waste generation rate is 0.75 kg/person/day, one pre-collector is required per 670 persons of resident. The required number of pre-collector by zone is shown in Appendix U-7 (Table U7-1).

In order to manage and direct the pre-collector, foremen shall be provided. The required number is planned under the following policy and the number by zone is shown in Appendix U-7 (Table U7-2).

- 1 foreman for the zone whose number of pre-collector is no more than 10.
- 2 foremen for the zone whose number of pre-collector is more than 10.

Furthermore 1 clerk shall be provided in each recycling center in order to assist the foremen and record the amount of waste and recycled sand.

3) Store of Waste and Sand

The collected waste and sand sorted out shall be stored temporally in the recycle center by the private pre-collection company until taken out by municipal truck. The waste shall be kept in the container provided by CUN and for the sand at the sand stock yard in the recycling center.

(2) Transport

Both the waste and sand sorted out shall be collected at the recycling center and transported to the disposal sites by CUN as a public sector keeping the city clean. The waste is disposed and the sand is stored in the disposal sites.

The waste shall be collected and transported every day, except Sunday, however the sand should be once or twice a week. In order to keep the periodical collection and transport, the private companies and CUN shall keep the touch with each other. CUN shall not loose any planned collection to keep the waste removal from the residential area otherwise the recycling center would become a disposal site.

(3) Management of Recycled Sand

The sand sorted out shall be dealt as recycled sand by the private companies. As the number of private companies would be several, the companies should have a coordination committee and deal the sand in cooperated.

The sand is effective as covering soil mixture for landfilled waste or filling material for construction. The buyer, therefore, would be mainly CUN, public construction sector or construction companies.

The benefit from selling sand shall be utilized for reducing the waste collection fee to be collected from the resident.

18.6.2 Awareness Campaign

Public awareness of introduction of new system for waste management is a very important aspect. The success of the new system depends directly on the degree of information and awareness of the population on hygiene and sanitation problems.

Within the realization of future projects proposed in the Master Plan, particularly the waste water treatment plants, it is recommendable to program awareness campaigns. Women associations and other different association structure of important users should be integrated in the campaigns. Hygiene education programs that are proposed in chapter 24 should particularly contain the solid waste management subject.

18.6.3 Training Program

In order to be able to establish training program, it is necessary to have an adequate personnel to form. In the preceding chapter the presented staff is necessary for services of waste collection and operation of recycling center as well as the disposal site.

(1) Personnel

In order to assure proper services of solid waste management, personnel that is proposed to be trained, should be available for training and fulfill the requirements for training course (see also previous chapter 18.6.1).

1) Solid Waste Collection

Pre collectors belonging to private organization are mainly worker for pushing handcars and collecting waste door to door. Some controller are also to be expected for quality control of waste collection services.

2) Solid Waste Transport

Drivers of the CUN shall be in charge for waste transport to the landfill sites. They will be accompanied by workers for replacement of containers and their transport toward the disposal sites.

3) Operation of Recycling Center

- A chief of the recycling center shall be responsible for the general service of the plant and its administration. He is in charge of the manning schedule and activities management.

- Workers shall sort sand manually using sieve and shovels. They shall load remaining waste in containers as well as recycled sand. They also are responsible for keeping clean the center in order to avoid any nuisances to the neighbors (particularly odor nuisances).

- Guardians are responsible for controlling in and outgoing person not belonging to the recycling center and vehicles. They shall guard the equipment and the center.

For training course the target groups are therefore summarized in the following Table 18.6-1:

TABLE 18.6-2 TARGET GROUPS FOR TRAINING COURSE

Category	Waste Collection	Recycling Center
Director	-	X
Drivers	-	-
Controller	X	-
Workers	X	X
Guardiens	X	X

The program for the training must, preferably foresee training in several phases.

Training Course

At first a general introduction of the objectives of the training shall be given to the participants within the training course. Furthermore the description and presentation of the following items are to be considered for the different activities of solid waste management. Training courses for waste collection, operation of recycling center should be hold separately.

Solid waste pre collection

- Quantities and types of waste produced in the different pre collection zones,
- Tours of waste collection in the quartiers,
- Respect of the regularity of the services
- Behavior towards the households while waste collection,
- Optimized path for waste transport to the recycling center,
- Organization and management of pre collection services
- System of control.

Recycling center

- Quantities and types of waste produced in the different pre collection zones,
- Internal organization and program for recycling center activities,
- Technique and progress of sorting activities,
- Quality of recycled product and quality assurance
- Sweeping activities within the recycling center and reduction of nuisances,
- Relationship and behavior towards neighbors,
- System of control.

The training course units shall give basic understanding for achieving good services for waste collection, their recycling, transport and landfilling. A first training course shall take place.

With regard to the level and intensity of training, the units shall be adapted to the different target groups. The training for high skilled operation personnel and technicians should be deeper than engine operators or workers. For them, other main points shall be focussed; they have to be more aware about the style how to operate and use carefully equipment and material in order to avoid unnecessary maintenance.

On The Job Training

During the on-the-job-training, the personnel shall be accompanied and advised by experts and experienced instructors. The new experiences and the present problems shall immediately be discussed with instructors.

18.7 EQUIPMENT OF THE DISPOSAL SITES

18.7.1 Equipment of the Disposal Site Koubia

(1) Bulldozer

One bulldozer (165HP Class) shall be provided by 2005 (see Sub-Chapter 9.2.3) for spreading, pushing and compacting waste and covering soil. As described in Sub-Chapter 18.6.2, this bulldozer shall work one day a week at the Disposal Site Bengale Torombi until 2015. Therefore the bulldozer shall work 5 days a week at the site.

The bulldozer shall be low ground pressure and heavy duty type and equipped with trash rack and air conditioner.

(2) Equipment for Covering Soil Transport

In addition to the bulldozer, one wheel loader ($2m^3$) and two dump truck (15t) should be provided for in site transportation of covering soil (see Sub-Chapter 18.7 for covering soil). This equipment should also work one day a week at the Disposal Site Bengale Torombi.

18.7.2 Equipment of the Disposal Site Bengale Torombi

(1) Bulldozer

Any bulldozer is not planned to be purchased before 2015 for the site, since the daily working volume is quite a little (see Sub-Chapter 9.2.3). As the bulldozer to be provided at the site Koubia should have enough capacity to cover the work for the site Bengale Torombi, the spreading, pushing and compacting the waste and covering soil shall be done one day a week by the bulldozer of site Koubia until 2015.

(2) Bulldozer Transfer Vehicle

To transfer the bulldozer between the 2 sites, one transfer vehicle will be necessary. As the frequency of transfer is just one day per week, the vehicle is not required to be purchased. Therefore the vehicle shall be rent and the cost shall be counted as operation cost.

(3) Wheel Loader and Dump Truck

For in site transportation of covering soil, the site Bengale Torombi should be also equipped with the wheel loader and dump truck. However the wheel loader and dump truck of the site Koubia shall be used for this site as the equipment works always together with the bulldozer.

18.8 OPERATION OF THE DISPOSAL SITE

18.8.1 Method of Landfilling and Operation

(1) Method to be Applied

1) Zone 1

The cell method described in the following section is not possible to be applied as any bulldozer is not planned to stay. The waste will be openly dumped by container trucks. It is recommended to hire a Bulldozer regularly in order to compact waste, otherwise landfill capacity becomes smaller in case that the waste is left as dumped. The frequency of bulldozer operation is estimated once a month. The waste should be pushed up until the height shown in Table 18.8-1 and the waste should be covered with soil (thickness: 50cm) when the landfill finished. (see Appendix U.8)

TABLE 18.8-1 HEIGHT OF FILLED WASTE: ZONE 1

Item	Koubia	Bengale Torombi
Landfill Area	30,000m^2	4,500m^2
Waste	189,416m^3	23,113m^3
Waste Height	6.3m	5.1m
Soil Cover	0.5m	0.5m
Final Height	6.8m	5.6m

2) Zone 2

a. Landfill Method

The disposal sites were designed based on cell method. This is to make one cell with the daily waste and the cell is considered as one landfill unit. The waste shall be dumped at the bottom of landfill zone and the waste shall be pushed up by bulldozer to make the cell. Pushing up is easier than pushing down to control the thickness and to compact well (see Figure 18.8-1). The conceptual drawing is shown in Appendix U-8. The height of one cell is planned at 3m. The width of cell depends on the waste amount of the day.

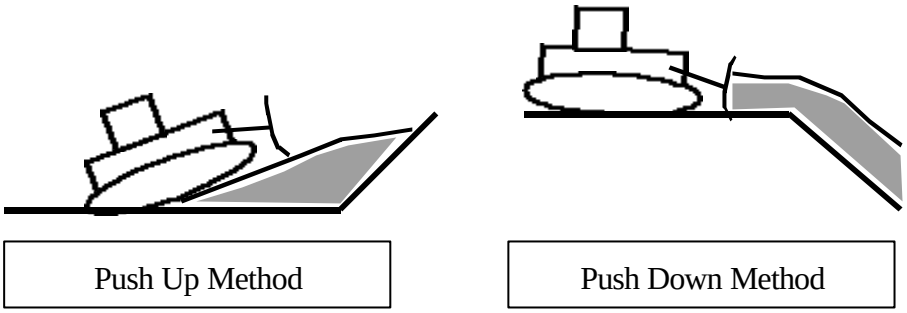


FIGURE 18.8-1 SPREADING AND COMPACTING METHOD

Note: In Disposal Site Bengale Torombi, whose bulldozer operation is once a week, the work as well as soil covering described in the next section would be weekly.

b. Soil Cover

The waste shall be daily covered by soil. The thickness of soil cover shall be 50cm. When the soil cover is finished, the cell of the day is completed. (see Figure 18.8-2)

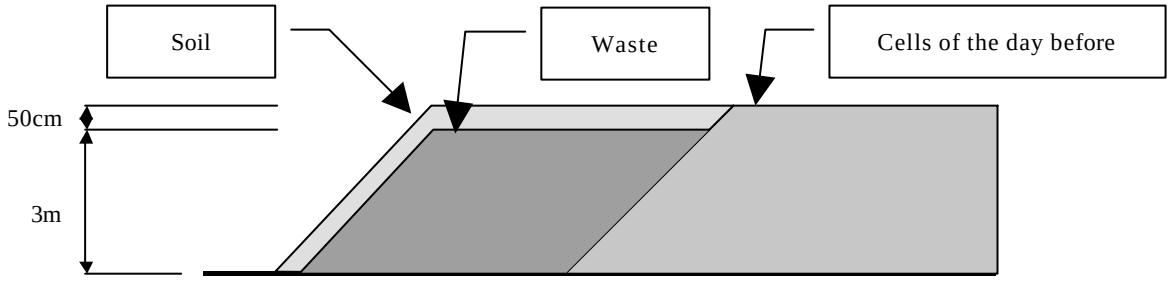


FIGURE 18.8-2 CONCEPTION OF SOIL COVER

c. Height of Filled Waste

The height of filled waste is planned as shown in Table 18.8-2. (see Appendix U-8)

TABLE 18.8-2 HEIGHT OF FILLED WASTE: ZONE 2

Item	Koubia	Bengale Torombi
Landfill Area	72,000m2	15,600m2
Volume (Waste + Soil)	605,506m3	79,084m3
1st layer	3.5m	3.5m
2nd layer	3.5m	1.6m
3rd layer	1.4m	
Final Height	8.4m	5.1m

(2) Covering Soil

The required volume of soil to cover the filled waste is as shown in Table 18.8-3. In the construction stage, a lot of excavated soil is produced. When the soil necessary for banking is subtracted from the excavated volume, the required soil to cover can be obtained in the construction stage. For the zone 1 of Disposal Site Koubia, the obtained soil will be short at the construction stage, however the excavated soil for the zone 2 can be applied to cover the zone 1.

TABLE 18.8-3 REQUIRED VOLUME OF COVERING SOIL

Item	Koubia		Bengale Torombi	
	Zone 1	Zone 2	Zone 1	Zone 2
Required Soil to cover (m^3)	15,000	86,501	2,250	11,298
Surplus (excavated – banking) soil (m^3)	7,500	102,400	4,400	65,200

(3) Operation

1) Measuring the Incoming Waste

No weigh-bridge is planned to be installed in the sites. The waste that is transported to the sites shall be measured from the number of trucks and observed volume. All numbers of truck and observed volume shall be recorded as well as driver's name, origin of waste. As a reception window was designed at the control house, the drivers should inform the required information to the clerks and the clerks record it.

2) Guide to Landfill Zone

The foremen shall guide the truck to the landfill zone and dumping point of the day. The foremen shall also assist the bulldozer to make cell.

3) Management of Rainwater Drain, Access Road and Operation Road

The rainwater drain, access road and operation road shall be cared for and taken necessary repair during the operation.

4) Landfill in Zone 1 for the Years 2003 – 2005

No bulldozer is planned for the zone 1 that is for the year 2003 – 2005. In order to keep the landfill capacity and access of truck, the periodical compacting work by bulldozer shall be required. The frequency should be determined from observation, however it shall be once a month at least.

5) Landfill in Zone 2 for the Years 2006 – 2010

a. Making Cell

The waste is planned to be transported to the sites for 6 days, except Sunday, in week. However

the bulldozer is planned to work for 5 days in site Koubia and for 1 day in site Bengale Torombi. In site Koubia, the waste of the 6 days shall be filled in cell during the 5 days. In each of the 5 days, one cell shall be completed (including soil cover). Therefore 5 cells will be made in a week. In site Bengale Torombi, the waste of the 6 days shall be filled in cell on 1 day. In this 1 day, all the waste of 1 week shall be filled and covered with soil as one cell.

b. Soil Cover

The last step of forming the cell is soil covering. The forming cell should be completed with soil covering, whose thickness is 50 cm. The soil shall be used the surplus soil in the construction stage..

c. Gas Exhaust Facility

Gas exhaust facility shall be installed in the operation stage, even the cost is counted in construction cost. The first installation is planned at the completion of the 1st waste layer and then the facility should be extended according to landfill progress. The concept of the installation and extension is as shown in Figure 18.8-3.

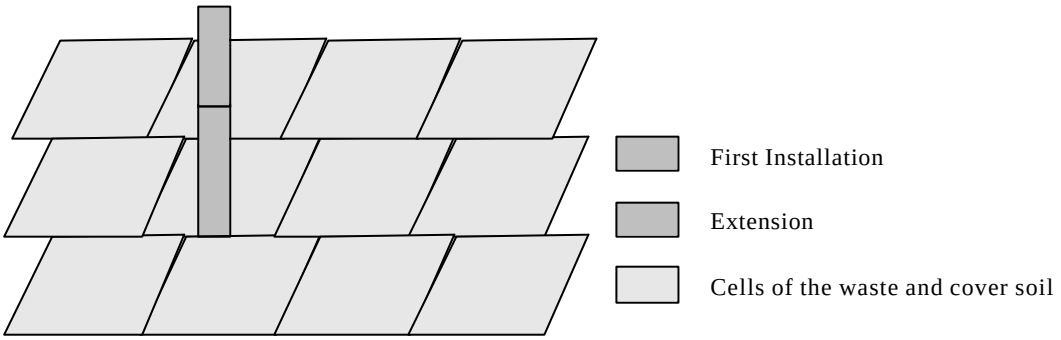


FIGURE 18.8-3 CONCEPT OF GAS EXHAUST EXTENSION

(4) Personnel

The required personnel are as shown in Table 18.8-4. This personnel is required to be prepared by the commencement of landfill.

TABLE 18.8-4 THE REQUIRED PERSONNEL FOR DISPOSAL SITES

Item	Koubia	Bengale Torombi
Guard man	6 (2 x 3 shifts)	3 (1 x 3 shifts)
Clerk	2	1
Foremen	4	1

18.8.2 Public Awareness

As indicated in the previous sub-chapter 18.6.2 the introduction of a new system of solid waste collection can succeed only if the population participates actively. It therefore necessitates to conduct public awareness campaign in order to inform the population and let them participate. In the case of the operation of the municipal disposal site, the neighbor population is more concerned.

Within the realization of future projects proposed in the Master Plan, particularly the waste water treatment plants, it is recommendable to program awareness campaigns. Women associations and other different association structure of important users should be integrated in the campaigns. Hygiene education programs that are proposed in chapter 24 should particularly contain the solid waste management subject.

18.8.3 Training Program

In order to be able to establish training program, it is necessary to have an adequate personnel to form. In the preceding chapter the presented staff is necessary for services of waste collection and operation of recycling center as well as the disposal site.

(1) Personnel

In order to assure proper services of solid waste management, personnel that is proposed to be trained, should be available for training and fulfill the requirements for training course (see also previous chapter 18.8.1).

- The chief of the disposal site shall be responsible for the general service of the plant and its administration. He is in charge of the manning schedule and all activities management for the disposal site,

- The drivers, responsible of the handling of vehicles and the equipment for the systematic landfilling of waste, of the transport of earth for waste covering, waste spreading and compacting as well as the execution of maintenance easy works,

- Guards, responsible of the control of vehicles that arrives to the disposal site, take care of the waste quantity estimation, of the taxation, of the control of waste brought to the landfill,

- Workers that guide collection vehicles to discharge area and also in charge of divers works at the site (such as clearing, excavation etc.)

For training course the target groups are therefore summarized in the following Table 18.8-5:

TABLE 18.8-5 TARGET GROUPS FOR TRAINING COURSE

Category	Disposal site
Director	X
Drivers	X
Inspectors	-
Workers	X
Guardians	X

The program for the training must, preferably foresee training in several phases.

Training Course

At first a general introduction of the objectives of the training shall be given to the participants within the training course. Furthermore the description and presentation of the following items are to be considered for the different activities at the landfill site.

Disposal site
- Quantities and types of waste produced in the different pre collection zones,
- Technique of construction and landfilling,
- Progress and organization of the operation,
- Control of the disposal site.

The training course units shall give basic understanding for achieving good services for waste collection, their recycling, transport and landfilling. A first training course shall take place.

With regard to the level and intensity of training, the units shall be adapted to the different target groups. The training for high skilled operation personnel and technicians should be deeper than engine operators or workers. For them, other main points shall be focussed; they have to be more aware about the style how to operate and use carefully equipment and material in order to avoid unnecessary maintenance.

On The Job Training

During the on-the-job-training, the personnel shall be accompanied and advised by experts and experienced instructors. The new experiences and the present problems shall immediately be discussed with instructors.

CHAPTER 19. PROJECT COST AND CONSTRUCTION PROGRAMME

CHAPTER 19 PROJECT COST AND CONSTRUCTION PROGRAM

19.1 PROJECT COST AND CONSTRUCTION PROGRAM FOR SEWERAGE/DRAINAGE WORKS

19.1.1 Basis for Cost Estimation

The project cost components and the estimation basis are as follows;

1) Direct Construction Cost: Based on the preliminary design of each facility
2) Land Acquisition Cost: Land area and unit land price (10,000 CFAF/m^2)
3) Engineering Cost: l0% of direct construction cost
4) Physical Contingency: 15% of sum of the direct construction cost and engineering cost

19.1.2 Project Cost

The total cost of the project is 1,679 million CFAF which breakdown is as shown in Table 19.1-1. Out 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 19.1-1 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 Services	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

19.1.3 Operation and Maintenance Cost

The annual operation and maintenance cost of the proposed sewerage facilities in the Feasibility Study area after implementation is estimated at 50 million CFAF.

19.1.4 Implementation Priority for Sewerage/Drainage

The project for the trunk and sub-trunk sewer network and wastewater treatment plant should be implemented synchronously. To improve the existing drainage facilities for the storm water and wastewater discharge, Mid-Boukoki Trunk sewer Line should be implemented first. The construction work for this trunk sewer will commence from the downstream which is located near the UASB pilot plant, following gradually to upstream. The construction work will be completed by 2004. Thereafter, North-Boukoki and South-Boukoki Trunk Line will be implemented and completed in 2005.

19.1.5 Implementation Schedule for Sewerage/Drainage

(1) Trunk Sewer Construction

The schematic diagram of the trunk sewer network implementation schedule is shown in Figure 19.1-1.

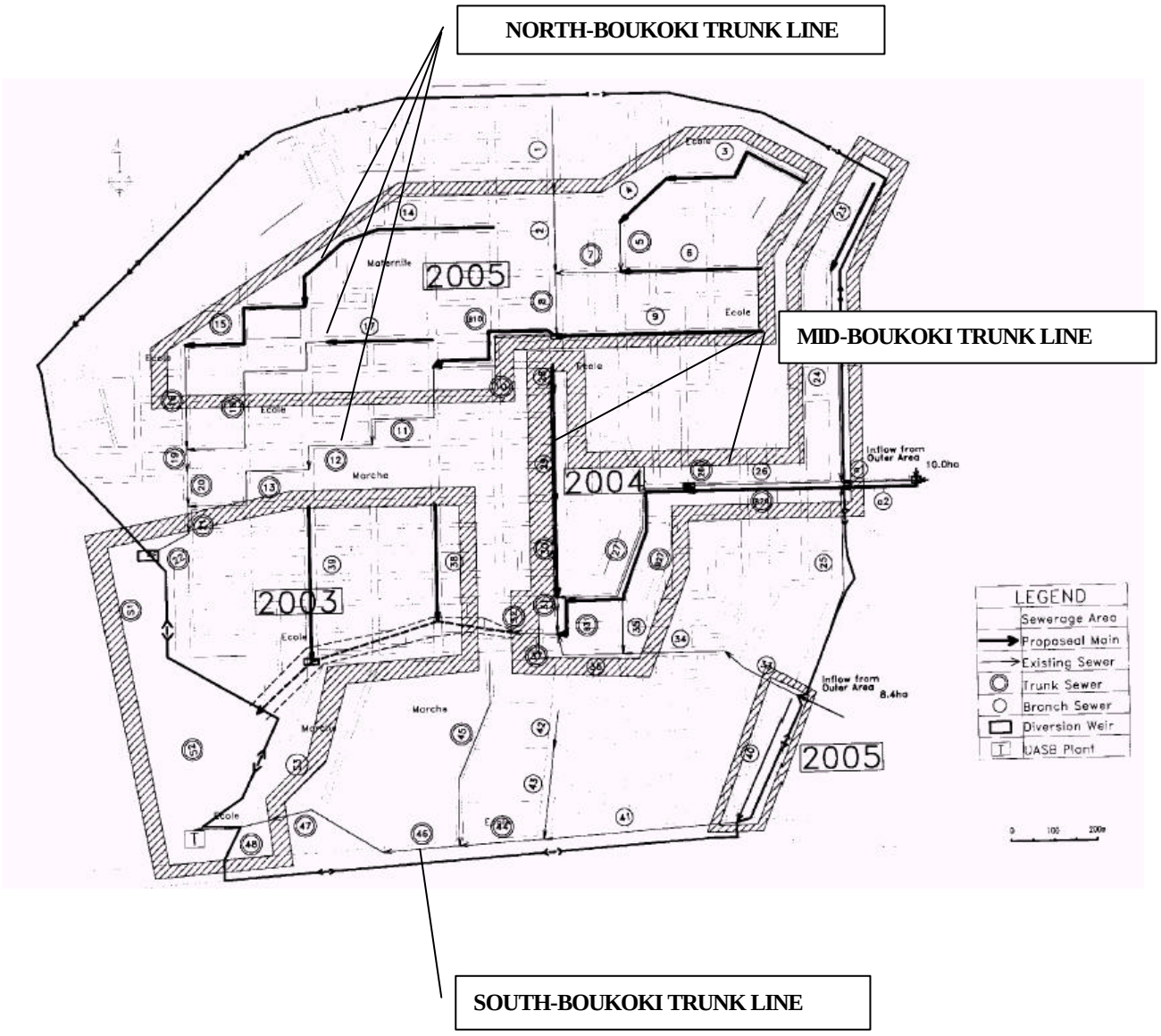
The project will start in 2002 with the detailed design. In the following year, in 2003, construction of trunk sewer of the North-Boukoki will begin. In 2004 construction of this line will be completed, and in the following year, in 2005, the construction of the North-Boukoki Trunk Line and the South-Boukoki Trunk Line will be started. Finally, the end of 2005 will complete construction of all the trunk sewers.

The construction works of the trunk sewers includes rehabilitation of the existing drainage facilities, wastewater collection facilities, and interceptor.

(2) Wastewater Treatment Plant Construction

The project of Wastewater Treatment Plant will start in 2002 with the detailed design and land acquisition. The land development and civil works will start in the following year, in 2003 followed by mechanical and electric installation works.

Operation of the plant will start immediately after the completion at the end of 2005.



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

Figure 19.1-1

TRUNK SEWER NETWORK CONSTRUCTION IMPLEMENTATION SCHEDULE

19.1.6 Disbursement Schedule

From sustainability point of view, the project should be implemented in steps based on priority and financial plan. The proposed disbursement schedule is shown in Table 19.1-2.

Table 19.1-2 DISBURSEMENT SCHEDULE

Project Item	Cost Item	Total	2002	2003	2004	2005
Trunk Sewer Construction	Local Currency	911,549	0	115,746	303,714	492,089
	Foreign Currency	119,049	0	25,860	35,047	58,142
	Total	1,030,598	0	141,606	338,761	550,231
Wastewater Treatment Plant	Local Currency	128,355	0	10,700	114,855	2,800
	Foreign Currency	105,322	0	0	6,045	99,277
	Total	233,677	0	10,700	120,900	102,077
Construction Cost	Local Currency	1,039,904	0	126,446	418,569	494,889
	Foreign Currency	224,371	0	25,860	41,092	157,419
	Total	1,264,275	0	152,306	459,661	652,308
Engineering Service	Designing	43,980	43,980	0	0	0
	Supervising	105,815	0	12,398	39,191	54,226
	Total	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 Project Cost	Local Currency	1,455,310	104,077	163,550	532,588	655,095
	Foreign Currency	224,371	0	25,860	41,092	157,419
	Total	1,679,681	104,077	189,410	573,680	812,514

Operation and Maintenance Cost (After 2006)

Personnel Expenses	29,640
Office& Vehicle	10,500
Electricity, etc	10,000
Total O/M cost	50,140

19.1.7 Implementation Schedule

The proposed implementation schedule of the sewerage/drainage project of the Feasibility Study is shown in Table-19.1-3

Table 19.1-3 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

19.2 FACILITIES AND SYSTEM OF SOLID WASTE MANAGEMENT

The capital and operation cost and implementation schedule of the priority projects for the solid waste management has been explained in the following paragraphs. The reference documents such as cost breakdown are as in Appendix U-21.

19.2.1 Introduction of New Waste Collection System

The cost is divided into 2 portions, in which one is for private sector and other for municipality.

(1) Capital Cost

1) Cost for Private Sector Contracted Work

The capital cost for the private sector by target area is shown in Table 19.2-1. The estimation has been done on the following basis.

- Direct cost is counted only for the construction cost of recycling centers.
- Land acquisition cost is not included as it is accounted in operation cost.
- Engineering cost is not included as the planned facilities are not complicated.
- Physical contingency is accounted at 15% of the direct cost.

Table 19.2-1 CAPITAL COST OF PRIVATE SECTOR FOR THE NEW SYSTEM INTRODUCTION

(Unit: 1000CFAF)

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**

2) Cost for Municipality Direct Work

The cost to be born by CUN is as shown in Table 19.2-2. The estimation has been done on the following basis.

- Direct cost is counted only for the transport equipment purchase cost.
- Engineering cost is estimated at 10% of the direct cost.

- Physical contingency is accounted at 15% of the sum of the direct cost and engineering cost.

Table 19.2-2 CAPITAL COST OF CUN FOR NEW SYSTEM INTRODUCTION

(Unit: 1000CFAF)

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

1) Cost for Private Sector Contracted Work

The operation and maintenance cost (O&M cost) to be born by the private sector is as shown in Table 19.2-3. The estimation has been done on the following basis.

- Introduction schedule is planned in accordance with the Master Plan.
- The counted costs are for the personnel, tools, land and management.
- The cost of land is counted 400 CFAF/m^2/year as lease cost.
- The management cost is counted for company management and benefit at 20% of the sum of the personnel and tools costs.

Table 19.2-3 O&M COST OF PRIVATE SECTOR FOR NEW SYSTEM INTRODUCTION

(Unit: 1000CFAF)

Area	Year										
	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**

2) Cost for Municipality Direct Work

O&M cost to be born by CUN is as shown in Table 19.2-4. The estimation has been done on the following basis.

- The counted costs are for the personnel, fuel and oil, maintenance and management.
- The maintenance cost per year is counted at 5% and 0.8% of purchase cost for periodical maintenance and repair respectively.
- The management cost is counted at 5% of the sum of the personnel, fuel and oil and maintenance costs.

Table 19.2-4 O&M COST OF CUN FOR NEW SYSTEM

(Unit: 1000CFAF)

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

19.2.2 Construction of Disposal Site

(1) Capital Cost

The capital cost for the disposal sites is shown in Table 19.2-5. The cost is divided into 2 portions, in which one is for construction and other for equipment purchase. All the cost shall be born by CUN. The estimation for construction has been done on the following basis.

- Direct cost is counted only for the construction cost of the disposal sites.
- Land acquisition cost is counted as an item of capital cost at 2,500 CFAF/m^2.
- Engineering cost is counted at 10% of the direct cost.
- Physical contingency is counted at 15% of the sum of the direct, land acquisition and engineering costs.

The estimation for equipment purchase has been done on the following basis.

- Direct cost is counted only for the equipment purchase cost.
- Engineering cost is estimated at 10% of the direct cost.
- Physical contingency is counted at 15% of the sum of the direct cost and engineering cost.

Table 19.2-5 CAPITAL COST FOR CONSTRUCTION DISPOSAL

(Unit: 1000CFAF)

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

O&M cost is as shown in Table 19.2-6. The cost shall be born by CUN. The estimation has been done on the following basis.

- The counted costs are for the personnel, equipment operation and maintenance and management.
- The management cost is counted at 10% of the personnel cost.

Table 19.2-6 O&M COST FOR CONSTRUCTION OF DISPOSAL

(Unit: 1000CFAF)

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**

19.2.3 Implementation Priority

(1) Introduction of New Waste Collection System

The introduction priority for new waste collection system shall be in accordance with Master Plan. Even in the priority project areas, the new system should be introduced step by step.

(2) Construction of Disposal Site

The construction is planned at two different sites. One shall serve for Commune 1 and 2 and the other will serve for Commune 3. There is no priority rank between the 2 sites. Therefore both 2 sites have been planned to commence in 2002. However the construction of zone 1 shall be commenced earlier than zone 2 for both 2 sites. The purchase of equipment such as bulldozer shall be done by the operation start of zone 2.

19.2.4 Implementation Schedule

The followings describe the schedule of facility construction and equipment purchase.

(1) Introduction of New Waste Collection System

The new waste collection system is planned to introduce in 3 steps, which are in 2005, 2010 and 2015. The construction of recycling center and all arrangement for pre-collection should be done by private sector (private pre-collector) before each operation start year, the facilities shall be constructed in 2004, 2009 and 2014 in short. The construction and disbursement schedule, which are to be done and managed by private sector, are as shown Table 19.2-7.

Regarding purchase of transport equipment, the schedule shall correspond with the above system introduction schedule. Therefore the equipment shall be purchased in 2004, 2009 and 2014. As the purchase cost is to be born by CUN, the schedule is shown in Table 19.2-8 as integrated schedule for CUN.

(2) Construction of Disposal Site

In both 2 sites, the construction of zone 1 shall be started and completed in 2002, as the disposal site is urgently required to be provided in Niamey. After the completion of zone 1, the construction of zone 2 is planned to commence and completed by 2005 in order to keep the operation start in 2006. The equipment purchase is planned be done in 2005.

Table 19.2-7 IMPLEMENTATION SCHEDULE OF NEW 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														
Disbursement Schedule															
Area 1	Local Currency			15,606					7,803						
	Foreign Currency			1,472					736						
	Total			**17,078**					**8,539**						
Area 2	Local Currency			29,342											
	Foreign Currency			2,208											
	Total			**31,550**											
Area 3	Local Currency								15,606					7,803	
	Foreign Currency								1,472					736	
	Total								**17,078**					**8,539**	
Disbursement Total				**48,628**					**25,617**					**8,539**	

(Currency unit: 1000CFAF)

Table 19.2-8 IMPLEMENTATION SCHEDULE OF NEW SYSTEM INTRODUCTION AND CONSTRUCTION OF DISPOSAL SITE: MUNICIPALITY

Area	Item	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
New System Introduction															
Equipment Purchase															
Construct Disposal Site Koubia															
Zone 1															
Zone 2															
Equipment Purchase															
Construct Disposal Site Bengale Torombi															
Zone 1															
Zone 2															
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**	**1,098,840**										
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**	**181,840**										
Dispo. Equip. Purchase	Local Currency														
	Foreign Currency				425,040										
	Total				**425,040**										
Disbursement Total		**604,316**	**1,221,457**	**1,594,704**	**1,705,720**				**83,490**					**72,105**	

(Currency unit: 1000CFAF)

CHAPTER 20. ORGANIZATION AND OPERATIONS

CHAPTER 20. ORGANIZATION AND OPERATIONS

20.1 ORGANIZATION AND OPERATION FOR SEWERAGE SYSTEM

It is necessary to constitute a new organization that is appropriate for works that should be executed for sewerage/drainage works. On the other hand, for the solid waste management the present organizational structure seems to be appropriate. However, this structure should be slightly restructured and strengthen in order to cope with the additional tasks and bigger work volume.

The Study Team proposed the construction of new wastewater treatment plant, and sewer and drainage trunks extensions in the Feasibility Study area, which will not only protect the residents' life from storm water damages, but also improve the sanitation environment and the water quality of the water bodies.

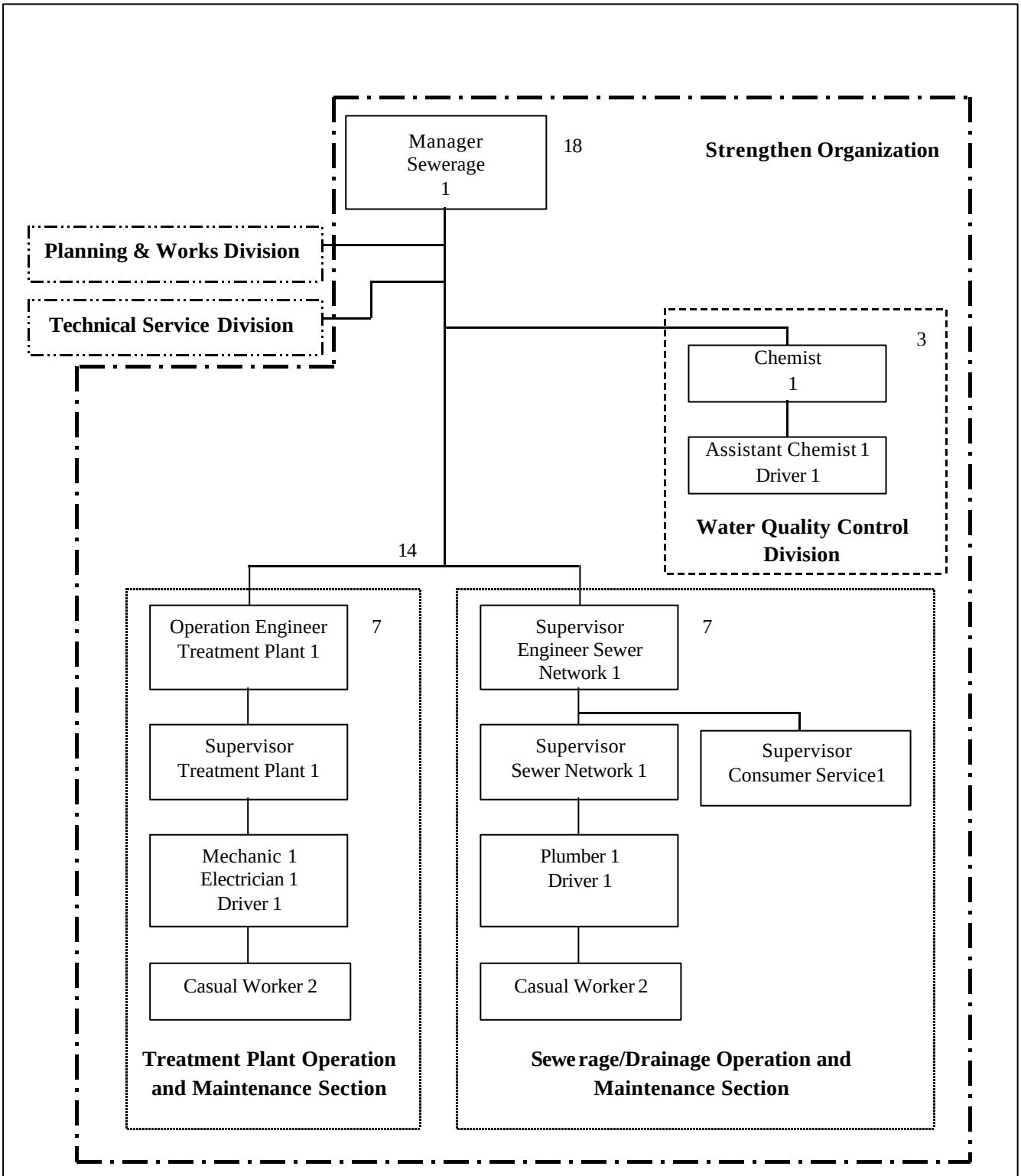
20.1.1 Organizational Structure for Sewerage

At the beginning of new institution its staffs, who will be engaged in the management, operation and maintenance works, will be consisted of officers, engineers and casual workers from MET and CUN. The tasks of the sewerage and drainage management should be carried in collaboration of the existing national and local governmental organizations.

And after the new organization starts to work along the right direction, the structure should be strengthened for full sufficiency to manage all works itself. Shifting the new organization into a public service corporation, which is proposed in the Master Plan, should be discussed after the institution set-ups have been achieved steadiness.

The proposed organizational structure of the Sewerage Operations after the completion of the Feasibility Study project is shown in Figure 20.1-1.

The tasks of the sewerage and drainage management will be done by the strengthen organization staffs who still will belong to the existing national and local governmental organizations just after the completion of the Feasibility Study project and start of the operation and maintenance.



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

Figure 20.1-1

ORGANIZATION CHART OF THE SEWERAGE/DRAINAGE OPERATION

20.1.2 Sewerage/Drainage Operation and Maintenance Section

This Section is responsible for the two major operations that are sewer maintenance and consumer services. The sewer maintenance section is responsible for all the sewer maintenance works, while the large-scale maintenance work such as new trunk sewer installations is to be contracted to the private sector. The consumer services group is to manage the installation of sanitary chambers and sewer connections, while the house connections up to the sanitary chambers are to be carried out by the clients themselves.

This section is responsible for works mentioned below.

- Daily inspection of sewer and drainage trunk/sub-trunks.
- Frequent investigations of unexpected water influx into sewers and taking measures to prevent it.
- Fixing of pipes and superannuated pipes.
- Frequent investigations of severely polluted water discharged into sewers, and preparation of reports on preventive measures.
- Weekly inspection on the conditions of sewer and drainage trunk/sub-trunks and sewage effluent facilities.
- Monthly cleaning of sewer and drainage trunk/sub-trunks and manholes, and as necessary.
- Installation of new sewer pipes and replacement of old/damaged sewer and drainage trunk/sub-trunks with new ones (to be contracted out, when necessary).
- Installation of service connections: Sanitary chambers and sewer connections. (House connections upto sanitary chambers are to be installed by the clients).
- Daily record of operation and maintenance activities.

The maintenance members will be formed one staff-working group and it will be sufficient at the beginning step of the new management of sewerage and drainage works, however, for an effective and efficient execution of responsibilities it is recommended that maintenance two staff-working groups will be formed in the target year of the Master Plan.

20.1.3 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.

The works listed below are to be carried out by the staffs of this section such as small scale and daily work for operation and maintenance. The works that require special knowledge and skills are to be contracted out to private engineering companies.

- Daily inspection of the wastewater treatment plant' s condition.
- Daily recording of influent wastewater volume for each treatment step.
- Weekly removal and scrubbing of sludge from the plant.
- Weekly accumulation of sludge and leveling of sludge drying bed.
- Weekly delivery of dry sludge from the treatment plant site to farm land.

- Small-scale maintenance of machines at stations, when necessary.
- Large-scale maintenance of machinery is to be contracted out to engineering companies, when necessary.
- Regular maintenance of wastewater treatment plants, such as mowing of the plant site, etc.

20.1.4 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 water bodies.

This division is to control and examine the water quality of the treated wastewater from the treatment plants.

The following are the major works to be carried out by this division:

- Weekly inspection and examination of the quality of influent/effluent of the wastewater treatment plant.
- Weekly water quality examination of effluent discharge into the water bodies
- Weekly observation of commercial wastewater discharge into sewer trunk/sub-trunks.
- Examination of the quality of commercial wastewater discharges on regular basis
- Detection of pollutants and harmful materials and finding its origin on regular basis
- Annual plan for the expansion of the treatment capacity.
- Recording of water quality inspection, observation and examination results.

20.1.5 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. These sections will support sewerage and drainage management but their positions and staffs are belonging to the existing governmental organization.

Drafting of plans for the sewerage and drainage system, and supervising facility developments and construction by developers and private constructors are the main responsibility of the Planning and Project Division. These two main work areas should be achieved in accordance with the urban development plan, such that this division will carry out its activities in close coordination with the planning governmental section. At the beginning step of sewerage and drainage management, the existing urban planning sections will carry out these works.

The following are the duties to be carried out by this division.

- Maintaining official and legal documents concerning to the sewerage and drainage management.

- Regular discussion with developers and contractors regarding new projects and developments' connection of service into the existing system, making sure that plans and workmanship follows the standards.
- Developing the annual plan for sewerage and drainage system construction and renovation for the proceeding year.
- Preparation of basic design and cost estimation of sewer and drainage construction, rehabilitation, etc., in accordance with the annual construction and renovation plan.
- Supervision of works contracted out.

20.1.6 Technical Service Division

This division is responsible for the procurement, safekeeping and stores of materials; tools and machinery required for sewerage and drainage management. At the beginning step of sewerage and drainage management, the existing urban infrastructures maintenance sections will carry out these works.

The following are the main duties of this division.

- Procurement of materials, machines, equipment, tools, etc., necessary for operation and maintenance.
- Administrative support when contracting out jobs.
- Daily inspection of the condition of incoming stock materials, machines, equipment, tools, vehicles, etc.
- Organize for the repair of machines, equipment, tool, vehicles, etc., when necessary.
- Daily control of stock material, machines, equipment, tools, vehicles, etc.

20.1.7 Considerations for Operation and Maintenance

(1) Keeping Records
It is difficult to study how much construction work has been contracted out and how often emergency cleaning has been carried out. Nevertheless, works contracted out to the private sectors can be accounted for by counting individual order forms and invoices.

Maintaining work records will help strengthen control over all works accomplished. It is also useful for review purposes and in identifying past problems and solutions, serving as reference should similar situations occur in the future. It is useful to file important information for future reference. Important records to be kept include the following:

- Sewer and drainage, manhole inspection and maintenance records including sewer replacement works.
- House-connection.
- Treatment plant inspection, operation and maintenance.
- Water quality inspection and examination.
- Stock in-out records. In addition to the semi-annual stock records, annual inventory should also be taken.
- Maintenance records of vehicles, machines, equipment, tools, etc.

(2) Job Procedure Manual

With operating the two pilot plants, MET and CUN are in the process of developing the job procedure manual that is useful for not only the present workforce but would also be helpful to new recruits and internal transferees of the new organization. The job manuals should contain work schedules, procedures/steps on how to execute jobs, teamwork, etc. The job procedure manual to be developed includes the following:

- House-connection.
- Sewer and drainage maintenance.
- Pump station operation and maintenance.
- Treatment plant operation and maintenance.
- Wastewater-quality monitoring.
- Procurement and inventory control.

(3) Training

The workforce of MET, CUN and new organization should have basic knowledge on the job assigned to them. To their capability and knowledge building, training courses and orientation seminar should be given periodically. To implement the training programs the following are to be considered:

- Basic knowledge on sewerage system.
- Basic and practical knowledge on sewerage facility planning and designing.
- Construction quality control and supervision.
- Operation and maintenance of sewer.
- Wastewater quality monitoring.

The current workforce, new recruits and internal transferees should undergo periodic training in order to achieve proficiency. It is also essential to get the services of trainers and lectures having sufficient background in their respective fields.

20.2 ORGANIZATION AND OPERATION FOR SOLID WASTE MANAGEMENT

It is not required to change fundamentally the existing organization or to create new agencies in order to commence and carry out the priority projects. However the personnel reinforcement is required in the Municipality and the relation shall be promoted among CUN, private companies that deal with pre-collection and recycling and the resident of Niamey. In the following sections, necessary role and formation of the Municipality and the private companies have been described.

20.2.1 Management Structure of Priority Project

The proposed management structure is as shown in Figure 20.2-1 for the priority projects. It is a developed structure based on the existing one.

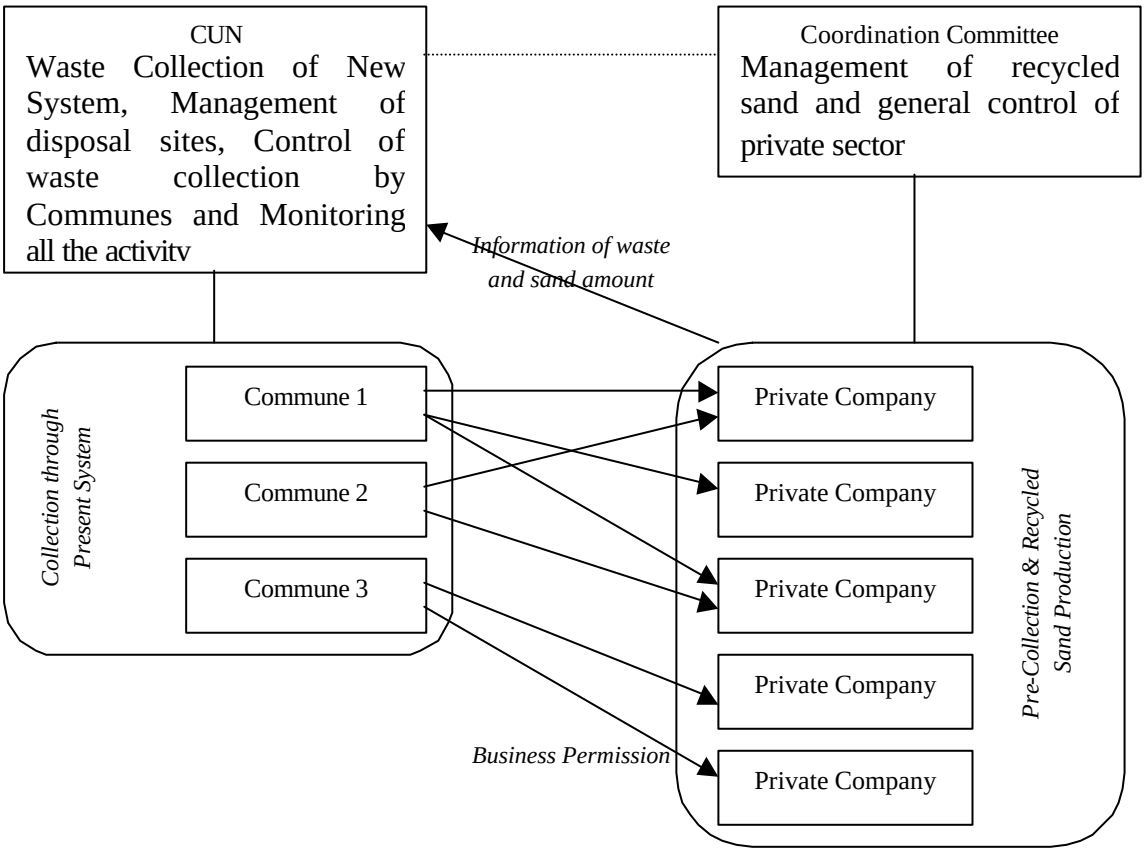


Figure 20.2-1 PROPOSED MANAGEMENT STRUCTURE

20.2.2 Role of Municipality and Improvement

To carry out the priority project, the role of CUN is important. The required role of CUN is summarized as follows for the solid waste management.

(1) To monitor and direct all the activity of waste collection and disposal in Niamey.
(2) To control/direct the waste collection team/equipment belonging to CUN.

(3) To collect the waste and sand to be pre-collected through the new system.
(4) To construct and manage the disposal sites.
(5) To entrust the pre-collection and sand recycling to the private companies and supervise their activities.

Among the above roles, (3), (4) and (5) actually do not exist in CUN. Therefore the staff shall be reinforced. And the reinforcement is also required for monitoring and controlling/directing the waste collection team although the role of waste collection exists. CUN shall collect the waste and sand at the recycle centers periodically and/or at demand of the private companies that manage the centers. Especially, CUN shall complete all the arrangement for new waste collection by zone prior to the introduction of recycling center.

The proposed reinforcement is as follows.

- To foresee a director only for solid waste management.
- To foresee two assistant of the above director.
- To foresee two truck fleet manager for waste collection
- To foresee the disposal site management staff as described in Sub-Chapter 18.8.

In addition to the above roles, the directors to be put for solid waste management shall promote the pre-collection activity in whole city and the utilization of recycled sand.

Communes are directly concerned with solid waste management. The system of licensing by commune to the private companies for pre-collection exists and the current pre-collection companies are operating under the system. At the opposite, the role Commune is less important than CUN for the realization of the priority projects.

20.2.3 Role of Private Sector and Improvement

Actually the private companies contribute, in some portion, to keep the city clean through waste pre-collecting activity. They are now expanding the pre-collection area. Their activity shall be linked to the introduction of new waste collection system. The continuous expansion of customers, who are contracted residents of pre-collection are, is indispensable.

Furthermore the private companies shall create the management system of recycled sand. As the number of concerned companies would be several, the system, which manages and sells the sand in cooperation, should be created. Creating a coordination committee is proposed. The committee shall consist of representatives of each concerned company and CUN. The benefit shall be utilized to develop and maintain the solid waste management and to reduce the cost of pre-collection to expand the pre-collection customers.

CHAPTER 21. FINANCIAL AND ECONOMIC EVALUATION

Chapter 21. FINANCIAL AND ECONOMIC EVALUATION

The feasibility study covers the priority projects of Sewerage/Drainage and Solid Waste Management as envisaged in the Master Plan. The year 2005 is the target year for the completion of these priority projects.

The investment cost for the Feasibility Study projects is based on the same assumptions as in the Master Plan for parameters such as population, wastewater flow forecasting etc.

21.1 FINANCIAL FORECAST AND EVALUATION OF THE PRIORITY PROJECTS

21.1.1 Drainage and Sewerage Scheme

(1) Investment Plan

The investment plan as shown in Table 21.1-1 is exactly same as the first four years investment plan of the Master Plan; however, detail estimations yield the tolerance of the investment amount. The total investment of 1,679 million CFAF is planned for the completion of construction works for sewerage drainage trunk/sub-trunk facilities and wastewater treatment plant by year 2005.

The annual operation and maintenance cost was assumed as 50,140,000 CFAF as described in Chapter 19.

Table 21.1-1 INVESTMENT PLAN

Unit: 1,000CFAF

Cost	Total	2,002	2,003	2,004	2,005	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	50,140	-	-	-	-	50,140

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

Water consumption and tariff in the sewerage zone C3 is shown in the Table 21.1-2.

Table 21.1-2 ANNUAL WATER CONSUMPTION BY VOLUME AND TARI FF

Boukoki Area - Niamey, Niger
August 2000 - July 2001

In CFA F

Distribution zone		Public taps	Households	Administrations	Offices industries	Total	Share*	Corrected*
52	CFA F	4,519,500	15,610,250	3,993,413	899,657	25,022,820		25,022,820
	cu m	39,300	91,825	14,111	3,113	148,349	100%	148,349
53	CFA F	54,637,650	9,150,420	816,738	0	64,604,808		45,223,366
	cu m	475,110	53,826	2,886	0	531,822	70%	372,275
54	CFA F	3,298,775	10,179,430	1,370,286	5,456,031	20,304,522		20,304,522
	cu m	28,685	59,879	4,842	18,879	112,285	100%	112,285
55	CFA F	1,654,390	451,520	2,419,367	6,754,219	11,279,496		11,279,496
	cu m	14,386	2,656	8,549	23,371	48,962	100%	48,962
56	CFA F	612,260	11,773,180	93,673	1,367,548	13,846,661		13,846,661
	cu m	5,324	69,254	331	4,732	79,641	100%	79,641
58	CFA F	2,390,275	9,397,600	208,571	5,491	12,001,937		12,001,937
	cu m	20,785	55,280	737	19	76,821	100%	76,821
59	CFA F	1,357,230	7,722,590	0	10,982	9,090,802		4,545,401
	cu m	11,802	45,427	0	38	57,267	50%	28,634
60	CFA F	3,864,230	13,902,090	367,900	7,514	18,141,734		18,141,734
	cu m	33,602	81,777	1,300	26	116,705	100%	116,705
62	CFA F	800,285	9,397,940	2,198,627	7,514	12,404,366		3,721,310
	cu m	6,959	55,282	7,769	26	70,036	30%	21,011
Total	CFA F	73,134,595	87,585,020	11,468,575	14,508,956	186,697,146		154,087,246
	cu m	635,953	515,206	40,525	50,204	1,241,888		1,004,683

Source: DAF/SC/DCP, SEEN

* Distribution zones 53, 59 and 62 include some area out of Boukoki boundary. Therefore the study team made some adjustments.

As a result of the privatization of the water supply utility, average tariff is expected to raise by 10 percent in 2002, 5 percent in 2004, 8.5 percent in 2005 and 8.5 percent in 2006, resulting in the eventual raise by 25.3 percent in early 2006 and 35.9 percent after the end of 2006. If water consumption remains on the same level, the total water tariff in the project area will be 193.1 million CFA F by early 2006, when the sewerage service of the priority project will launch.

Since the new water supply company had agreed to collect sewerage tariff as surcharge onto the water tariff, the sewerage tariff may be calculated by percentage to the water tariff. Here, cases of 25, 30 and 35 percent to the water tariff are compared.

Table 21.1-3 WATER AND SEWERAGE TARIFF IN 2006 AND ONWARD

In CFAF

		Annual tariff	Per capita	Percent to GNP/capita*	Per month/ household**
Water tariff	In 2001	154,087,246	3,580	2.54%	1,790
	Early 2006	193,098,285	4,486	3.19%	2,243
	After 2006	209,511,639	4,868	3.46%	2,434
Sewerage tariff	Early 2006	48,274,571	1,122	0.80%	561
If @ 25%	After 2006	52,377,910	1,217	0.86%	608
Sewerage tariff	Early 2006	57,929,486	1,346	0.96%	673
If @30%	After 2006	62,853,492	1,460	1.04%	730
Sewerage tariff	Early 2006	67,584,400	1,570	1.12%	785
If @35%	After 2006	73,329,074	1,704	1.21%	852
Water & sewerage	Early 2006	241,372,856	5,608	3.98%	2,804
If @25%	After 2006	261,889,549	6,085	4.32%	3,042
Water & sewerage	Early 2006	251,027,771	5,832	4.14%	2,916
If @30%	After 2006	272,365,131	6,328	4.50%	3,164
Water & sewerage	Early 2006	260,682,685	6,056	4.30%	3,028
If @35%	After 2006	282,840,713	6,571	4.67%	3,286

Note*: GNP per capita at 1999: US$ 190 = 140,741 CFA F is assumed.
**: 6 member households

Surcharge by 25 to 35 percent to water tariff signifies the total spending for water supply and sewerage of 4.3 to 4.7 percent of GNP per capita at 1999. It is well known that the income level of the residents in Niamey is well above the national average. These levels of water and sewerage tariffs are considered applicable and affordable in the City.

(3) Financial Internal Rate of Return

To evaluate financial viability of the project, financial rate of return (FRR) is calculated with the following assumptions:

- The project life is 50 years from year 2005.
- Mechanical parts of the treatment facility shall be replaced every 20 years.
- Three cases of financial revenue, considering sewerage tariffs of 25, 30 and 35 percent to the water tariff, are calculated.

In the case of 25 percent sewerage surcharge, FRR was –10 percent. It was -4.74 percent in the case of 30 percent and –2.06 percent in the case of 35 percent surcharge (see details in the Table 21.1-4). To obtain positive FRR such as 1.7 percent, surcharge onto water tariff should be 50 percent or more. It is considered that 50 percent surcharge is not affordable.

Table 21.1-4 FINANCIAL INTERNAL RATE OF RETURN –DRAINAGE AND SEWERAGE

In thousand CFAF

Year	Capital cost	O&M cost	Total cost	Case of 25%			Case of 30%			Case of 35%		
				Revenue	Balance	IRR	Revenue	Balance	IRR	Revenue	Balance	IRR
2002	104.007		104.007		-104.007			-104.007			-104.007	
2003	189.410		189.410		-189.410			-189.410			-189.410	
2004	573.680		573.680		-573.680			-573.680			-573.680	
2005	812.514		812.514		-812.514			-812.514			-812.514	
2006		50.140	50.140	48.275	-1.865		57.929	7.789		67.584	17.444	
2007		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2008		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2009		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2010		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2011		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2012		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2013		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2014		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2015		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2016		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2017		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2018		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2019		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2020		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2021		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2022		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2023		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2024		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2025	99.277	50.140	149.417	52.378	-97.039		62.853	-86.564		73.329	-76.088	
2026		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2027		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2028		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2029		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2030		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2031		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2032		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2033		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2034		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2035		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2036		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2037		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2038		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2039		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2040		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2041		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2042		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2043		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2044		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2045		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2046		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2047		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2048		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2049		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2050	99.277	50.140	149.417	52.378	-97.039		62.853	-86.564		73.329	-76.088	
2051		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2052		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2053		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2054		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2055		50.140	50.140	52.378	2.238	#DIV/0!	62.853	12.713	-4.74%	73.329	23.189	-2.06%

Many projects in Niger, particularly related to the basic human needs, environmental conservation, poverty alleviation, etc., are carried out with the free donation or grant-aid. In this project, the Niger Government intends to provide local counterpart fund that is approximately 10 percent of the total project cost. Therefore, a new set of assumptions are made as follows:

- Local parties (the government and the beneficiaries) are responsible for only 10 percent of capital investment costs and replacement costs.
- The external donor donates the other 90 percent of such costs.
- The beneficiaries provide full operation and maintenance costs. It will be again the 25, 30 and 35 percent surcharge onto water tariff.

Under these assumptions, the following FRRs are calculated (see details in table 21.1-5):

Percentage of surcharge	FRR
25 %	-2.23 %
30 %	6.60 %
35 %	12.15 %

Table 21.1-5 FINANCIAL INTERNAL RATE OF RETURN-10 PERCENT CAPITAL

In thousand CFAF

Year	Capital cost	O&M cost	Total cost	Case of 25%			Case o f 30%			Case of 35%		
				Revenue	Balance	IRR	Revenue	Balance	IRR	Revenue	Balance	IRR
2002	10.408		10.408		-10.408			-10.408			-10.408	
2003	18.941		18.941		-18.941			-18.941			-18.941	
2004	57.368		57.368		-57.368			-57.368			-57.368	
2005	81.251		81.251		-81.251			-81.251			-81.251	
2006		50.140	50.140	48.275	-1.865		57.929	7.789		67.584	17.444	
2007		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2008		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2009		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2010		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2011		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2012		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2013		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2014		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2015		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2016		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2017		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2018		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2019		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2020		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2021		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2022		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2023		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2024		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2025	9.928	50.140	60.068	52.378	-7.690		62.853	2.785		73.329	13.261	
2026		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2027		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2028		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2029		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2030		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2031		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2032		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2033		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2034		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2035		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2036		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2037		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2038		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2039		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2040		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2041		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2042		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2043		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2044		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2045		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2046		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2047		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2048		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2049		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2050	9.928	50.140	60.068	52.378	-7.690		62.853	2.785		73.329	13.261	
2051		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2052		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2053		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2054		50.140	50.140	52.378	2.238		62.853	12.713		73.329	23.189	
2055		50.140	50.140	52.378	2.238	-2.23%	62.853	12.713	6.60%	73.329	23.189	12.15

It is concluded that the beneficiaries are able to pay the operation and maintenance costs and 10 percent of capital and replacement costs, if 90 percent of capital and replacement costs are donated. To operate the project properly, the beneficiaries have to pay 27 or 28 percent of water tariff additionally as surcharge.

21.1.2 Solid Waste Management

(1) Investment Plan

Based on the implementation schedule described in Chapter 19, the new solid waste collection system is planned in three steps, which are in 2005, 2010 and 2015. The construction of recycling center and all arrangements for pre-collection should be done by private sector in three target-areas respectively.

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 estimated to be 4,737 million CFAF for the municipality project and 82 million CFAF for the private sector project respectively, as shown in Table 21.2-1.

As a result of topographic survey, soil investigation and further consideration for environmental protection, which were done in the feasibility study stage, the construction cost of the disposal sites is calculated to be much higher than the estimated value in the Master Plan.

Table 21.1-6 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) Operation and Maintenance Costs

Operation and maintenance costs for the municipal collection project and the private pre-collection project are shown in Table 21.1-.7.

Table 21.1-7 OPERATION AND MAINTENANCE COSTS FOR MUNICIPAL COLLECTION AND PRIVATE PRE-COLLECTION

In Thousand CFAF

Year	Municipal Collection			Private Pre-Collection				Grand Total
	Material	Unskilled Labor	Total	Material	Skilled Labor	Unskilled Labor	Total	
2004								
2005	64,831	7,203	72,034	7,473	7,721	19,854	35,048	107,082
2006	64,831	7,203	72,034	7,820	8,107	20,846	36,773	108,807
2007	64,831	7,203	72,034	8,081	8,396	21,589	38,066	110,100
2008	64,831	7,203	72,034	8,790	8,237	23,753	40,780	112,814
2009	64,831	7,203	72,034	9,051	8,526	24,497	42,074	114,108
2010	77,602	8,622	86,224	13,810	14,636	37,635	66,081	152,305
2011	77,602	8,622	86,224	14,331	15,214	39,123	68,668	154,892
2012	77,602	8,622	86,224	15,026	15,985	41,106	72,117	158,341
2013	77,602	8,622	86,224	15,635	16,660	42,841	75,136	161,360
2014	77,602	8,622	86,224	16,329	17,432	44,824	78,585	164,809
2015	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2016	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2017	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2018	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2019	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2020	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2021	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2022	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2023	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2024	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2025	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2026	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2027	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2028	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2029	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2030	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2031	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2032	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2033	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764
2034	89,946	9,994	99,940	18,803	20,166	51,855	90,824	190,764

(3) Financial Revenue of the Private Sector Project

Among the priority projects, pre-collection, which is sorting for recycling of the solid waste from the contracted beneficiaries, and secondary collation, which is collection of solid from recycling, centers and conveying and dumping them to landfill site will generate revenues.
Therefore, financial evaluation is applicable to the re-collection and secondary collection project.

Willingness to pay for the pre-collection service was surveyed during the feasibility phase of the study and the result of it shoes the average of it is 116 CFAF per month per person. Therefore the tariff for the analysis should be set 110 CFAF per month per person.

These amounts of willingness to pay are assumed revenue of the pre-collection and secondary collection services.

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

To evaluate financial viability of the project, financial rate of return (FRR) is calculated with the following assumptions:

- The project life is 25 years from the completion of the recycling centers.
- Full costs for capital investment and operation and maintenance is included without replacement in 25 years.
- Amount of willingness to pay is assumed revenue.
- The benefit yielded by selling the recycled sand is assumed revenue.

As shown in Table 21.1-8, FRR is 7.13 percent.
The pre-collection and secondary collection services are sound and prospective.

Table 21.1-8 FINANCIAL INTERNAL RATE OF RETURN – SOLID WASTE MANAGEMENT

Tariff = 110CFAF/Month
Sand = 1,000CFAF/Mm^3

In Thousand CFAF

Year	Cost			Benefit			FIRR
	Capital	O&M	Total	Sand	Revenue	Balance	
2004	48,628	0	48,628		0	-48,628	
2005	0	58,186	58,186	5,675	43,207	-14,979	
2006	0	65,587	65,587	5,675	49,177	-16,410	
2007	0	66,880	66,880	5,675	55,147	-11,733	
2008	0	70,594	70,594	5,675	61,119	-9,475	
2009	25,617	71,888	97,505	5,675	67,089	-30,416	
2010	0	100,571	100,571	11,212	101,317	746	
2011	0	103,158	103,158	11,212	109,965	6,807	
2012	0	106,608	106,608	11,212	118,615	12,007	
2013	0	109,626	109,626	11,212	127,265	17,639	
2014	8,539	113,075	121,614	11,212	135,915	14,301	
2015	0	130,799	130,799	16,593	149,945	19,146	
2016	0	130,799	130,799	16,593	149,945	19,146	
2017	0	130,799	130,799	16,593	149,945	19,146	
2018	0	130,799	130,799	16,593	149,945	19,146	
2019	0	130,799	130,799	16,593	149,945	19,146	
2020	0	130,799	130,799	16,593	149,945	19,146	
2021	0	130,799	130,799	16,593	149,945	19,146	
2022	0	130,799	130,799	16,593	149,945	19,146	
2023	0	130,799	130,799	16,593	149,945	19,146	
2024	0	130,799	130,799	16,593	149,945	19,146	
2025	0	130,799	130,799	16,593	149,945	19,146	
2026	0	130,799	130,799	16,593	149,945	19,146	
2027	0	130,799	130,799	16,593	149,945	19,146	
2028	0	130,799	130,799	16,593	149,945	19,146	
2029	0	130,799	130,799	16,593	149,945	19,146	7.13%

21.2 ECONOMIC EVALUATION OF THE PRIORITY PROJECTS

21.2.1 Assumptions for the Economic Evaluation

Economic evaluation shall be 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, 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.

  Discount rates applied are:

Local material	93%
Unskilled labor	50%
Skilled labor	93%
Engineering	93%
Contingency	50%
Land	50%
Foreign currency	100%

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

21.2.2 Drainage and Sewerage Scheme

The proposed project aims at improving efficiency of the storm water removal, removal of contaminants from disposed wastewater and thereby improving living conditions of approximately 43,000 residents and commuters to Katako and other markets in the most densely populated part of the Niamey city. Reduced pollutant load through the open outfall and flowing into Niger River is another benefit that is not quantifiable.

(1) Economic Costs and Benefits

Tables 21.2-1 and 21.2-2 shows the assumed costs and benefits calculated into economic (shadow) prices.

Table 21.2-1 COST CALCULATION

Finanacial Cost	Cost Item	Totaql	2002	2003	2004	2005
	Local Currency	1,039,904		126,446	418,569	494,889
Construction Cost	Foreign Currency	224,371		25,860	41,092	157,419
	Total	1,264,275		152,306	459,661	652,308
	Designing	43,980	43,980			
Engineering Service	Supervising	105,815		12,398	39,191	54,226
	Total	149,795	43,980	12,398	39,191	54,226
Sub-total		1,414,070	43,980	164,704	498,852	706,534
Contingency		212,111	6,597	24,706	74,828	105,980
Land Acquisition		53,500	53,500			
	Local Currency	1,455,310	148,057	163,550	532,588	655,095
Total Project Cost	Foreign Currency	224,371		25,860	41,092	157,419
	Total	1,679,681		189,410	573,680	812,514

Components of local currency: Material 30%, Unskilled labor 50%, Skilled labor 20%

Local Material	93%
Unskilled labor	50%
Skilled labor	93%
Engineering	93%
Contingency	50%
Land	50%
Foreign currency	100%

Economic Costs	Cost Item	Totaql	2002	2003	2004	2005
Construction Cost		967,902		116,269	340,369	511,265
Engineering Service		139,309	40,901	11,530	36,448	50,430
Contingency		106,056	3,299	12,353	37,414	52,990
Land Axquisition		26,750	26,750			
	Local currency cost	1,240,017	70,950	140,152	414,230	614,685
	Foreign currency cost	224,371		25,860	41,092	157,419
	Total	1,464,388	70,950	166,012	455,322	772,104
Operatin & Maintenance		50,140				
Discounted O&M Costs(93%)		46,630				

Table 21.2-2 BENEFIT CALCULATION

Finanacial Benefit	Unit	Benefit	Population	Benefit per year
Reduced medical costs (30% of 1,200 cfa f per person)	per person	360	43,042 (note 1)	15,495,120
Reduced medical costs, which is shared by the public sector (Health care center, etc.) (30% of 1,200 cfa f per person) x 3		1,080	43,042	46,485,360
Reduced absence from work (3 day / 260 working days, 60,000 cfa f /month)	per person	8,308 9,748	15,065 (note 2)	125,152,892
Recycling of dried sludge for agricultural use ($12m^3$/week x 1,000cfaf x 52weeks)				624,000
Land proce increase (0.2% of land, 1,000cfaf/sq.m)		20	2,550,000	51,000,000
Total benefits				238,757,372
Economic Benefits (x 0.93)				222,044,356

Note 1: Population of the priority project area (Drainage Zone C3) will be 43,042.
2: Working population = Total population x 1/2 (labor force) x 7/10 (actual workers)
3: Extent of the project area = 255 ha

(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 (see details in Table 21.2-3). 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, etc., significance of the priority project will be clear. It is concluded that the project is feasible in economic terms, and will bring the unprecedented 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, which 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, learned is that economic rate of return will be more than 8 percent, even if costs are increased by 10 percent and benefits are reduced by the same rate. Viability of the priority project is encouraging. For the details, see Tables 21.2-4, -5 and -6.

Table 21.2-3 ECONOMIC INTERNAL RATE OF RETURN – DRAINAGE AND SEWERAGE

In thousand CFAF

Year	Capital cost	O&M cost	Total cost	Benefit as calculated	Balance	IRR
2002	70,950		70,950		-70,950	
2003	166,012		166,012		-166,012	
2004	455,322		455,322		-455,322	
2005	772,104		772,104		-772,104	
2006		46,630	46,630	222,044	175,414	
2007		46,630	46,630	222,044	175,414	
2008		46,630	46,630	222,044	175,414	
2009		46,630	46,630	222,044	175,414	
2010		46,630	46,630	222,044	175,414	
2011		46,630	46,630	222,044	175,414	
2012		46,630	46,630	222,044	175,414	
2013		46,630	46,630	222,044	175,414	
2014		46,630	46,630	222,044	175,414	
2015		46,630	46,630	222,044	175,414	
2016		46,630	46,630	222,044	175,414	
2017		46,630	46,630	222,044	175,414	
2018		46,630	46,630	222,044	175,414	
2019		46,630	46,630	222,044	175,414	
2020		46,630	46,630	222,044	175,414	
2021		46,630	46,630	222,044	175,414	
2022		46,630	46,630	222,044	175,414	
2023		46,630	46,630	222,044	175,414	
2024		46,630	46,630	222,044	175,414	
2025	99,277	46,630	145,907	222,044	76,137	
2026		46,630	46,630	222,044	175,414	
2027		46,630	46,630	222,044	175,414	
2028		46,630	46,630	222,044	175,414	
2029		46,630	46,630	222,044	175,414	
2030		46,630	46,630	222,044	175,414	
2031		46,630	46,630	222,044	175,414	
2032		46,630	46,630	222,044	175,414	
2033		46,630	46,630	222,044	175,414	
2034		46,630	46,630	222,044	175,414	
2035		46,630	46,630	222,044	175,414	
2036		46,630	46,630	222,044	175,414	
2037		46,630	46,630	222,044	175,414	
2038		46,630	46,630	222,044	175,414	
2039		46,630	46,630	222,044	175,414	
2040		46,630	46,630	222,044	175,414	
2041		46,630	46,630	222,044	175,414	
2042		46,630	46,630	222,044	175,414	
2043		46,630	46,630	222,044	175,414	
2044		46,630	46,630	222,044	175,414	
2045	99,277	46,630	145,907	222,044	76,137	
2046		46,630	46,630	222,044	175,414	
2047		46,630	46,630	222,044	175,414	
2048		46,630	46,630	222,044	175,414	
2049		46,630	46,630	222,044	175,414	
2050		46,630	46,630	222,044	175,414	
2051		46,630	46,630	222,044	175,414	
2052		46,630	46,630	222,044	175,414	
2053		46,630	46,630	222,044	175,414	
2054		46,630	46,630	222,044	175,414	
2055		46,630	46,630	222,044	175,414	10.95%

Table 21.2-4 ECONOMIC INTERNAL RATE OF RETUR–DRAINAGE AND SEWERAGE SENSITIVITY ANALYSIS WITH –10% AND +10% BENEFITS

In thousand CFAF

Year	Cost as calculated	Benefit less 10 %	Balance	IRR	Benefit as calculated	Balance	IRR	Benefit more 10 %	Balance	IRR
2002	70,950		-70,950			-70,950			-70,950	
2003	166.012		-166.012			-166.012			-166.012	
2004	455.322		-455.322			-455.322			-455.322	
2005	772.104		-772.104			-772.104			-772.104	
2006	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2007	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2008	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2009	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2010	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2011	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2012	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2013	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2014	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2015	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2016	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2017	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2018	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2019	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2020	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2021	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2022	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2023	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2024	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2025	145.907	199.840	53.933		222.044	76.137		244.249	98.342	
2026	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2027	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2028	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2029	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2030	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2031	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2032	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2033	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2034	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2035	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2036	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2037	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2038	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2039	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2040	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2041	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2042	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2043	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2044	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2045	145.907	199.840	53.933		222.044	76.137		244.249	98.342	
2046	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2047	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2048	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2049	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2050	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2051	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2052	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2053	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2054	46.630	199.840	153.210		222.044	175.414		244.249	197.619	
2055	46.630	199.840	153.210	9.58%	222.044	175.414	10.95%	244.249	197.619	12.28%

Table 21.2-5 ECONOMIC INTERNAL RATE OF RETUR–DRAINAGE AND SEWERAGE SENSITIVITY ANALYSIS WITH –10% COST AND VARIED BENEFIT

In thousand CFAF

Year	Cost as calculated	Benefit less 10 %	Balance	IRR	Benefit as calculated	Balance	IRR	Benefit more 10 %	Balance	IRR
2002	63,855		-63,855			-63,855			-63,855	
2003	149.411		-149.411			-149.411			-149.411	
2004	409.790		-409.790			-409.790			-409.790	
2005	694.893		-694.893			-694.893			-694.893	
2006	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2007	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2008	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2009	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2010	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2011	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2012	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2013	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2014	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2015	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2016	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2017	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2018	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2019	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2020	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2021	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2022	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2023	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2024	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2025	131.316	199.840	68.523		222.044	90.728		244.249	112.932	
2026	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2027	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2028	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2029	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2030	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2031	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2032	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2033	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2034	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2035	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2036	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2037	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2038	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2039	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2040	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2041	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2042	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2043	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2044	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2045	131.316	199.840	68.523		222.044	90.728		244.249	112.932	
2046	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2047	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2048	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2049	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2050	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2051	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2052	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2053	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2054	41.967	199.840	157.873		222.044	180.077		244.249	202.282	
2055	41.967	199.840	157.873	10.95%	222.044	180.077	12.43%	244.249	202.282	13.87%

Table 21.2-6 ECONOMIC INTERNAL RATE OF RETUR–DRAINAGE AND SEWERAGE SENSITIVITY ANALYSIS WITH +10% COST AND VARIED BENEFIT

In thousand CFAF

Year	Cost as calculated	Benefit less 10 %	Balance	IRR	Benefit as calculated	Balance	IRR	Benefit more 10 %	Balance	IRR
2002	78,045		-78,045			-78,045			-78,045	
2003	182.613		-182.613			-182.613			-182.613	
2004	500.855		-500.855			-500.855			-500.855	
2005	849.314		-849.314			-849.314			-849.314	
2006	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2007	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2008	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2009	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2010	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2011	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2012	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2013	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2014	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2015	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2016	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2017	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2018	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2019	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2020	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2021	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2022	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2023	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2024	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2025	160.498	199.840	39.342		222.044	61.546		244.249	83.751	
2026	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2027	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2028	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2029	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2030	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2031	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2032	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2033	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2034	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2035	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2036	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2037	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2038	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2039	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2040	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2041	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2042	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2043	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2044	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2045	160.498	199.840	39.342		222.044	61.546		244.249	83.751	
2046	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2047	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2048	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2049	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2050	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2051	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2052	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2053	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2054	51.293	199.840	148.547		222.044	170.751		244.249	192.956	
2055	51.293	199.840	148.547	8.42%	222.044	170.751	9.71%	244.249	192.956	10.95%

21.2.3 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 collectively 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.

Economic benefits are calculated with the following assumptions:

- Benefits attributable to person are reduced medical costs and reduced absence from work. Reduced medical costs are assumed 15 percent of the medical cost paid by average person (1,200 CFA F) and 3 times of that provided by the public sector through the health care center, hospital, etc. Reduced absence from work was assumed a day a year, whereby average monthly salary of 60,000 CFA F, and 260 working day/year are assumed, and actual workers are 70 percent of workforce, that is a half of the population in the project area. Calculated benefits are 1,689 CFA F per beneficiary in financial price, and 1,571 CFA F in economic price.

- Benefits that are not attributable to person are assumed and expressed as the increase of the land price, that is 0.02 percent of the average land price (10,000 CFA F/sq m). This will be 2 CFA F per square meter of benefited land in financial price, and 1.86 CFA F in economic price.

The calculated economic benefits are shown in Table 21.2-7 and -8.

(2) Economic Internal Rate of Return

Economic rate of return is 14.17 percent as shown in Table 21.2-9. 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%
		0.79%	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. Also, it showed that economic rate of return will be plus even if costs are increased by 10 percent and benefits are reduced by the same rate. Viability of the priority project is encouraging. For the details, see Tables 21.2-10, 21.2-11 and 21.2-12.

Table 21.2-7 BENEFITS PER BENEFICIARY

Benefit=1,571 CFAF/Year — In Thousand CFAF

Year	Population				Beneficiary			Total
	Area 1	Area 2	Area 3	Total	Area 1	Area 2	Area 3	
2004				2,004				
2005	4,078	24355		30,438	6,407	38,262		44,669
2006	6,364	26592		34,962	9,998	41,776		51,774
2007	8,650	28829		39,486	13,589	45,290		58,879
2008	10,937	31066		44,011	17,182	48,805		65,987
2009	13,223	33303		48,535	20,773	52,319		73,092
2010	15,509	35540	17,212	70,271	24,365	55,833	27,040	107,238
2011	15,912	38999	19,902	76,824	24,998	61,267	31,266	117,531
2012	16,316	42458	22,592	83,378	25,632	66,702	35,492	127,826
2013	16,719	45918	25,282	89,932	26,266	72,137	39,718	138,121
2014	17,123	49377	27,972	96,486	26,900	77,571	43,944	148,415
2015	17,526	52836	30,662	103,039	27,533	83,005	48,170	158,708
2016	17,526	52836	30,662	103,040	27,533	83,005	48,170	158,708
2017	17,526	52836	30,662	103,041	27,533	83,005	48,170	158,708
2018	17,526	52836	30,662	103,042	27,533	83,005	48,170	158,708
2019	17,526	52836	30,662	103,043	27,533	83,005	48,170	158,708
2020	17,526	52836	30,662	103,044	27,533	83,005	48,170	158,708
2021	17,526	52836	30,662	103,045	27,533	83,005	48,170	158,708
2022	17,526	52836	30,662	103,046	27,533	83,005	48,170	158,708
2023	17,526	52836	30,662	103,047	27,533	83,005	48,170	158,708
2024	17,526	52836	30,662	103,048	27,533	83,005	48,170	158,708
2025	17,526	52836	30,662	103,049	27,533	83,005	48,170	158,708
2026	17,526	52836	30,662	103,050	27,533	83,005	48,170	158,708
2027	17,526	52836	30,662	103,051	27,533	83,005	48,170	158,708
2028	17,526	52836	30,662	103,052	27,533	83,005	48,170	158,708
2029	17,526	52836	30,662	103,053	27,533	83,005	48,170	158,708

Table 21.2-8 BENEFITS ATTRIBUTABLE TO LAND

Benefit=1.86 CFAF/Year — In Thousand CFAF

Year	Area				Benefit			
	Area 1	Area 2	Area 3	Total	Area 1	Area 2	Area 3	Total
2004								
2005	241	390		631	4,483	7,254		11,737
2006	241	390		631	4,483	7,254		11,737
2007	241	390		631	4,483	7,254		11,737
2008	241	390		631	4,483	7,254		11,737
2009	241	390		631	4,483	7,254		11,737
2010	353	390	190	933	6,566	7,254	3,534	17,354
2011	353	390	190	933	6,566	7,254	3,534	17,354
2012	353	390	190	933	6,566	7,254	3,534	17,354
2013	353	390	190	933	6,566	7,254	3,534	17,354
2014	353	390	190	933	6,566	7,254	3,534	17,354
2015	353	390	289	1,032	6,566	7,254	5,375	19,195
2016	353	390	289	1,032	6,566	7,254	5,375	19,195
2017	353	390	289	1,032	6,566	7,254	5,375	19,195
2018	353	390	289	1,032	6,566	7,254	5,375	19,195
2019	353	390	289	1,032	6,566	7,254	5,375	19,195
2020	353	390	289	1,032	6,566	7,254	5,375	19,195
2021	353	390	289	1,032	6,566	7,254	5,375	19,195
2022	353	390	289	1,032	6,566	7,254	5,375	19,195
2023	353	390	289	1,032	6,566	7,254	5,375	19,195
2024	353	390	289	1,032	6,566	7,254	5,375	19,195
2025	353	390	289	1,032	6,566	7,254	5,375	19,195
2026	353	390	289	1,032	6,566	7,254	5,375	19,195
2027	353	390	289	1,032	6,566	7,254	5,375	19,195
2028	353	390	289	1,032	6,566	7,254	5,375	19,195
2029	353	390	289	1,032	6,566	7,254	5,375	19,195

Table 21.2-9 ECONOMIC INTERNAL RATE OF RETURN-SOLID WASTE MANAGEMENT

In Thousand CFAF

Year	Capital Cost	O&M Cost	Total	Benefit Calculated	Balance	EIRR
2004	32,138		32,138		-32,138	
2005	0	75,366	75,366	56,406	-18,960	
2006	0	89,130	89,130	63,511	-25,619	
2007	0	90,012	90,012	70,616	-19,396	
2008	0	92,536	92,536	77,724	-14,812	
2009	16,737	93,419	110,156	84,829	-25,327	
2010	0	121,753	121,753	124,592	2,839	
2011	0	123,520	123,520	134,885	11,365	
2012	0	125,874	125,874	145,180	19,306	
2013	0	127,936	127,936	155,475	27,539	
2014	5,579	130,291	135,870	165,769	29,899	
2015	0	150,816	150,816	177,903	27,087	
2016	0	150,816	150,816	177,903	27,087	
2017	0	150,816	150,816	177,903	27,087	
2018	0	150,816	150,816	177,903	27,087	
2019	0	150,816	150,816	177,903	27,087	
2020	0	150,816	150,816	177,903	27,087	
2021	0	150,816	150,816	177,903	27,087	
2022	0	150,816	150,816	177,903	27,087	
2023	0	150,816	150,816	177,903	27,087	
2024	0	150,816	150,816	177,903	27,087	
2025	0	150,816	150,816	177,903	27,087	
2026	0	150,816	150,816	177,903	27,087	
2027	0	150,816	150,816	177,903	27,087	
2028	0	150,816	150,816	177,903	27,087	
2029	0	150,816	150,816	177,903	27,087	10.67%

Table 21.2-10 ECONOMIC INTERNAL RATE OF RETURN-SOLID WASTE MANAGEMENT SENSITIVITY ANALYSIS WITH-10% COST AND VARIED BENEFIT

In Thousand CFAF

Year	Total Cost	10b % Less Benefit			Benefit as calculated			10 % More Benefit		
		Benefit	Balance	IRR	Benefit	Balance	IRR	Benefit	Balance	IRR
2004	28.924		-28.924			-28.924			-28.924	
2005	67,829	50,765	-17,064		56,406	-11,423		62,047	-5,783	
2006	80,217	57,160	-23,057		63,511	-16,706		69,862	-10,355	
2007	81,011	63,554	-17,456		70,616	-10,395		77,678	-3,333	
2008	83,282	69,952	-13,331		77,724	-5,558		85,496	2,214	
2009	99,140	76,346	-22,794		84,829	-14,311		93,312	-5,829	
2010	109,578	112,133	2,555		124,592	15,014		137,051	27,474	
2011	111,168	121,397	10,229		134,885	23,717		148,374	37,206	
2012	113,287	130,662	17,375		145,180	31,893		159,698	46,411	
2013	115,142	139,928	24,785		155,475	40,333		171,023	55,880	
2014	122,283	149,192	26,909		165,769	43,486		182,346	60,063	
2015	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2016	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2017	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2018	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2019	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2020	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2021	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2022	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2023	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2024	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2025	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2026	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2027	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2028	135,734	160,113	24,378		177,903	42,169		195,693	59,959	
2029	135,734	160,113	24,378	10.67%	177,903	42,169	20.23%	195,693	59,959	29.78%

Table 21.2-11 ECONOMIC INTERNAL RATE OF RETURN-SOLID WASTE MANAGEMENT SENSITIVE ANALYSIS WITH –10% AND +10% BENEFITS

In Thousand CFAF

Year	Total cost	10 % Less Benefit			Benefit as calculated			10 % More Benefit		
		Benefit	Balance	IRR	Benefit	Balance	IRR	Benefit	Balance	IRR
2004	32,138		-32,138			-32,138			-32,138	
2005	75,366	50,765	-24,601		56,406	-18,960		62,047	-13,319	
2006	89,130	57,160	-31,970		63,511	-25,619		69,862	-19,268	
2007	90,012	63,554	-26,458		70,616	-19,396		77,678	-12,334	
2008	92,536	69,952	-22,584		77,724	-14,812		85,496	-7,040	
2009	110,156	76,346	-33,810		84,829	-25,327		93,312	-16,844	
2010	121,753	112,133	-9,620		124,592	2,839		137,051	15,298	
2011	123,520	121,397	-2,124		134,885	11,365		148,374	24,854	
2012	125,874	130,662	4,788		145,180	19,306		159,698	33,824	
2013	127,936	139,928	11,992		155,475	27,539		171,023	43,087	
2014	135,870	149,192	13,322		165,769	29,899		182,346	46,476	
2015	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2016	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2017	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2018	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2019	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2020	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2021	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2022	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2023	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2024	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2025	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2026	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2027	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2028	150,816	160,113	9,297		177,903	27,087		195,693	44,877	
2029	150,816	160,113	9,297	2.01%	177,903	27,087	10.67%	195,693	44,877	19.30%

Table 21.2-12 ECONOMIC INTERNAL RATE OF RETURN-SOLID WASTE MANAGEMENT SENSITIVITY ANALYSIS WITH-10% COST AND VARIED BENEFIT

In Thousand CFAF

Year	Total Cost	10% Less Benefit			Benefit as calculated			10% More Benefit		
		Benefit	Balance	IRR	Benefit	Balance	IRR	Benefit	Balance	IRR
2004	35.352		-35.352			-35.352			-35.352	
2005	82,903	50,765	-32,137		56,406	-26,497		62,047	-20,856	
2006	98,043	57,160	-40,883		63,511	-34,532		69,862	-28,181	
2007	99,013	63,554	-35,459		70,616	-28,397		77,678	-21,336	
2008	101,790	69,952	-31,838		77,724	-24,066		85,496	-16,293	
2009	121,172	76,346	-44,826		84,829	-36,343		93,312	-27,860	
2010	133,928	112,133	-21,796		124,592	-9,336		137,051	3,123	
2011	135,872	121,397	-14,476		134,885	-987		148,374	12,502	
2012	138,461	130,662	-7,799		145,180	6,719		159,698	21,237	
2013	140,730	139,928	-802		155,475	14,745		171,023	30,293	
2014	149,457	149,192	-265		165,769	16,312		182,346	32,889	
2015	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2016	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2017	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2018	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2019	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2020	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2021	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2022	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2023	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2024	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2025	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2026	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2027	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2028	165,898	160,113	-5,785		177,903	12,005		195,693	29,796	
2029	165,898	160,113	-5,785	3.82%	177,903	12,005	0.79%	195,693	29,796	10.67%

CHAPTER 22. ENVIRONMENTAL IMPACT ASSESSMENT

CHAPTER 22. ENVIRONMENTAL IMPACT ASSESSMENT

22.1 DESCRIPTION OF PRIORITY PROJECT

22.1.1 Combined Sewerage Network of Boukoki

(1) General Description

The project of concern is the sewerage network of C3 area as designated in the Master Plan, which is geographically overlapping the urban quarters of Boukoki and Lycée Kasai. The network is a combined sewer system covering a drainage area of more than 250ha. Wastewater of the C3 network will be collected and conveyed to the treatment plant of Deizebon as described in 22.1.2.

The average sewage flow generated by this area is about 1,740m^3/day in 2000 for a population close to 41,000 residents. The flow measured at the sewer outlet is presently 1,300m^3/day on average, which would increase to about 1,740m^3/day in 2000 and about 1,900m^3/day in 2015 within the adopted scenario of 100% collection of C3 waste water.

The existing sewer system is almost constituted of covered underground conduits. Its total length is 7,810m. Within the scope of the priority project, the existing sewer system will be maintained without modification.

(2) Sewerage Network to Be Built

The combined sewer network to be built will upgrade the system of collecting wastewater and rainwater. The total length of the main trunks to build will reach 6,805m. Within this total is included the 180m section that belongs to the C4 area. This section is however integrated in C3 for the environmental assessment study. The sewer facilities will be built with cover.

The size of sewer trunks will generally turn around 1 to 2 metres of section according to facilities.

22.1.2 Waste Water Treatment Plant of Deizebon

(1) Presentation

The project site is the same as the one of pilot plant (UASB treatment process) which has been already built in 2001 within the framework tasks of the JICA study team. The required area for the new plant will be of 6,420m^2 instead of 1,070m^2 actually. Operation of the pilot plant will be maintained.

The treatment process is the anaerobic UASB process, completed with the treatment of polishing ponds. This treatment alternative has been retained after analysis of 3 alternatives. The trickling filter facility present in the pilot plant for secondary treatment will not be installed. Details of the UASB treatment process can be found in Chapter 6.

It is planned that the wastewater treatment plant will employ 7 persons in total.

(2) Facilities

The priority project consists in increasing the treatment capacity of the pilot plant from its present 100m^3/day to 2,500m^3/day in 2005. The plant will be closed by a wall which height will be similar to the one existing at the pilot plant site (about 2m high). Main facilities of the plant are:

- A double UASB reactor structure made of concrete will be about 12m width, 16m length, and 4m height. Like in the pilot plant, the top of the reactor will be installed with several open compartments containing wastewater.
- A set of 3 polishing ponds which total dimension will be about 61m x 20m, for a water depth of 1m (1,220m^2 area).
- A set of 2 sludge drying beds which total dimension will be about 26m x 20m (520m^2 area).
- A gas holder to collect biogas produced by the treatment process, and a flare stack to burn it.

Polishing ponds will contribute to eliminate the nitrogen and phosphate pollution charge. In this objective, the best alternative under study in the pilot project is to filter wastewater through a water jacynth bed and other rooted aquatic plants. Retention time in the polishing ponds will last for 0.5 day. Feeding fishes will be done in the last pond in order to take benefit of rich nutrients water.

Sludge drying beds will dehydrate the sludge after 7 to 14 days of retention drying period.

(3) Cut in Pollution Load

The treatment plant will have a capacity of 2,500m^3/day and will treat on average a sewer flow of 1,923m^3/day, including the existing capacity of the pilot plant (100m^3/day). The assumption is that inlet wastewater pollution load is 160ppm for BOD, 370ppm for COD, and 640ppm for suspended matter. The entire process should eliminate 75% of BOD, 65% of COD, and 95% of suspended matter, which gives an outlet effluent charged with 40ppm for BOD, 130ppm for COD, and 30ppm for suspended matter.

Wastewater will be chlorinated in a chlorination pit just before final discharge. This water has potential reuse value for the purpose of irrigating market gardening fields in the surroundings.

(4) Waste Generated by the Treatment Plant

The treatment process will generate about 1,100kg sludge per day, which gives in the final stage about 50m^3/month of dried sludge at 40% humidity. This sludge can be used as fertilisers for cultivation fields.

The quantity of biogas stemming from the treatment is estimated to be about 120m^3/day. Its composition is about 70% in volume of methane gas, 10% of carbon dioxide, 19% of nitrogen, 1% of oxygen, and traces of sulphide hydrogen (less than 10ppm). The simplest alternative retained for the project is burning of gas in the flare stack.

Screening of wastewater will generate a quantity of solid waste which is not actually estimated. In a similar way, the alternative use of water jacynth in the polishing ponds would induce the generation of organic waste.

22.1.3 Municipal Waste Disposal Sites

(1) Presentation

The waste management plan is based on a strategy of minimising waste quantity to be disposed of, reusing and recycling materials and more specifically the sand content of waste, and sanitary disposal of the remaining waste. Management facilities are recycling centres, which are not the object of an EIA but are subject to authorisation by the Ministry of mines, and the 2 waste disposal sites of Koubia and Bengale-Torombi, which are the object of this EIA study. Priority recycling centres will be established in each of the 9 defined pre-collection areas, which include the urban quarter of Boukoki, also concerned by the extension project of combined sewer in C3 area. The 2 sites proposed for waste disposal have been selected among 4 potential sites on the basis of practical management criteria.

It is planned that the staff employed on both sites will be as follows:
- 9 guards
- 3 workmen
- 5 supervisors

(2) Planning and Operation of Waste Landfill Sites

Planning of sites will consist in a progressive shift from the controlled to sanitary landfills. The 2 main planning stages up to 2005 have been defined as follows:

- An urgent stage of planning and operating a landfill zone from now to 2005, after minimal planning conditions like excavation and levelling, drainage of rain water around the site, closure of the site, access road and control of entering waste. For the operation phase, the method of compacting waste with monthly instead of daily soil cover will be adopted.
- A second stage of planning a more extensive landfill zone up to 2005, for operation between 2005 and 2010. Planning will include the already mentioned facilities of the first stage with completion by drains to collect leachate. For the operation phase, the landfilling of waste with daily cover with earth or sand will be adopted.

Rainwater collected during the rainy season will be discharged outside and near the site. Leachate will be collected and stored in a small pond during the rainy season, before re-injection in the landfill site during the dried season.

Data about areas and capacities required for the land fill sites are summarised in the following Table 22.1-1.

Table 22.1-1 AREA AND CAPACITY REQUIRED FOR THE LANDFILL SITES

	Koubia		Bengale Torombi	
Operation phase	until 2005	from 2005 to 2010	until 2005	from 2005 to 2010
Area (m2)	30,000	72,000	4500	15,600
Quantity (tons of waste)	189,400	519,000	23,100	67,800

(3) Construction Works

Main construction works will consist in:

- Excavation and levelling
- Building the drainage of rain water
- Building the access road

On the Koubia site and for both the 2 planning stages, excavation will be done on a depth of about 2 to 3m under surface, to reach the topographic level 204m as floor of the disposal facility. There will not be artificial waterproof lining of the excavated site during the first phase of operation. However, floor and edge of the excavation will be made waterproof through deposit of a clay layer during the second phase.

On the Bengale-Torombi site and for both the 2 planning stages, excavation will be done on a depth of about 4 to 5m under surface, to reach the topographic level 199m as floor of the disposal facility. There will be no artificial waterproof lining of the excavated site since the disposal facility is designed to take benefit of the existing natural waterproof layer of clay. However, the edge of the excavation will be made waterproof through deposit of a clay layer during the second phase.

(4) Waste Transportation Toward Landfill Sites

It can be estimated that about 20% of waste which are generated by households are actually collected and transported by the Urban Community, which is about 38,700 tons a year (quantity generated in 2001 was estimated to about 184,000 tons). Also should be included hospital waste and industrial waste collected by municipal services, but their quantity is not known. As for the trucks traffic induced by the transportation of waste, it represents about ten trips per day for the 3 municipalities all together, without any specific disposal site at end. This traffic is diluted in the city area without possible way to localise it.

Waste collected in Communes 1 and 2 on the left bank of the Niger river will be transported to the Koubia waste disposal site, while those of Commune III on the right bank will be transported to the Bengale-Torombi site. In 2005, the number of trips induced by the transportation of waste to the landfill sites is estimated to be as in Table 22.1-2.

Table 22.1-2 ESTIMATED NUMBER OF TRIPS

	Koubia	Bengale Torombi
Commune I	46	x
Commune II	25	x
Commune III	x	14

Such estimates do not take into account the possible transportation of sand recovered at recycling centres and stored or used in the waste landfill sites. This alternative might be a possible solution according to the results of the sorting out of waste materials and recovery of sand up to 2010.

22.2 STATE OF ENVIRONMENT OF PROJECT SITES

22.2.1 General Presentation

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 environment data are the result of field investigation made by the local consultant during 2 weeks in August 2001. The role of the consultant during this investigation was also to heighten public awareness of the target population about sanitation and implementation of the project.

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.

The detailed description of the state of environment of project sites can be referred to in Appendix S.5. Only the most important aspects for understanding the environmental sensitivities of the sites have been considered and summarised below.

22.2.2 Boukoki Project Site

(1) General Presentation

The project of Boukoki covers the residential quarters of Boukoki I, II, III, and IV. This quarter has been classified as a peripheral quarter of class 1 in the analysis of Chapter 3, which means a high population density (180 to 200 / ha) and households income belonging to the average of Niamey. A PSE study has estimated that about 45% of households in Boukoki are suffering lack of privacy conditions.

The project site area can be divided into 3 geographic zones, which are:

- Zone I, which is located on the northern side of the project area. This area covers mainly Boukoki II, and also overlaps on Boukoki III and IV. Zone I is a traditional type housing area with low level of sanitation and overpopulation in compounds. The survey conducted for this study has shown an average of 8 persons per household, which is more than the Niamey average, while the area of living is restricted.
- Zone II, which is on the western side of the project area. This is a residential area established outside main accesses and belonging to Boukoki III. Zone II is characterised by very poor social conditions. According to a study of PSE project, one fifth of the compounds in this area have no latrine, 70% of them have no electricity and more than 80% no tap water supply.
- Zone III, which is located in central and east side of the project site and belongs to Boukoki IV. Zone III is a mixed habitat with an important ratio of houses built in hard materials. There are modern aspects in the life style of residents, due to infrastructure,

shops and services available. One of the streets concerned by the project, the Ader Avenue, is also an important access road for Niamey.

(2) Living Environment

In Zone I and II, the public space of streets is used by inhabitants as an extension of the yard of their compounds. The overpopulation conditions in these compounds are such that street space becomes an essential part of daily life space. Community life is critically dependant on streets: Weddings, baptisms and funerals take place in streets, as well as various events and community meetings, and praying. Leisure and playing of children as well as small shopkeepers hold by women are also taking place in streets. The private use of streets brings a series of amenities which are lacking inside the compounds and improve the conditions of life.

Zone I is a flood prone area where flooding and erosion are causing damages to houses. During the rainy season, water remains stagnant for few days in compounds yards and streets. People complain about the proliferation of mosquitoes, which is a direct consequence of bad sanitation conditions.

Zone II lies along the Gounti Yéna and its tributary kori water course coming from the east, which causes a strong geographic isolation of the area because of almost no access to the west and south excepted by walk. The urban environment in this zone is then strongly influenced by the presence of these watercourses (kori) and by dramatic erosion damages caused to the housing area along the kori. This area is also known for social insecurity.

Zone III is already equipped with wastewater and rainwater collection sewers but they lack good performance to prevent flooding. Flooding here is not a cause of physical and socio-economic damages to the residents like in Zone I, because of a better infrastructure.

(3) Women

The role of women in the local economy of Zone I and II is important. Women prepare some cooking products that are sold in front of the living compounds or in a favourable place close to the domicile.

Pocket money earned by women from these small activities is used for themselves and most generally for improving education and health conditions of children. It is also used for financially contributing to the organisation of ceremonies and events by families of the neighbourhood. The various social implications of women activities should not be underestimated.

22.2.3 Deizebon Project Site

(1) General Presentation

The project site lies in the up-stream area of the Gounti Yéna valley at about 1.5km from the confluence with the Niger River down-stream. The project site lies at a frontier between a built area and a market gardening area riverside. There is no residential area around the site. The project implantation site is limited by road on east and south and by the Gounti Yéna on west.

(2) Natural Environment

In natural conditions, the Gounti Yéna presents a series of water ponds connected with the Niger River during the rainy season. These ponds have certainly constituted important natural habitats before the effects of urbanisation.

Natural conditions of Gounti Yéna are now limited to the riverbanks where has developed adapted agro-ecosystems. There is no natural habitat able to support a significant aquatic or waterfowl fauna. The Gounti Yéna valley has however a big potential for the upgrading of the quality of the urban environment in Niamey. The major urban amenities of Niamey, like the National museum, the zoo, and the sports stadium are all settled along this greenery flow.

The vegetation cover of the project site is made of a trees strata of useful species and market gardening species strata. Most of the tree species are protected species under the Forest Law. They are Tamarindus Indica (4 trees), Andansonia digitata (Baobabs, in great number but all of small size), Borassus flabellifer (Rônier, 2 trees), Hyphaene thebaïca (Doum palm tree, 2 trees). Apart from these protected species, there are a large number of Date palm trees, which predominate in the landscape.

(3) Market Gardening

The Gounti Yéna represents 12% (40ha) of the total market gardening area of Niamey. Vegetables are generally planted in association with fruit trees, but gardening in river bed during the dry season has become more important down-stream.

The water resource for irrigating gardens is the riverbed aquifer. During the rainy season, pits and wells provide water for upper terrace cultivation. All the remaining time, especially from October to May, gardens in the riverbed are irrigated from small holes where groundwater rises to the surface. Direct use of surface sewer water for irrigation is prohibited and most farmers are aware of sanitary risks incurred.

The whole implantation area between the street and the Gounti Yéna presently occupies 11 gardeners at full time. The reclamation area for construction of the projet occupies 5 gardeners at full time, of whom a woman. There would be between 400 and 500 gardening plots which would be destroyed by the implantation of the project. Gardeners working within the limits of the reclamation area will loss all the plots, with only insignificant remains on the east and south borders near the road. It seems that the remaining 6 gardeners riverside are not touched by the project.

22.2.4 Koubia Project Site

(1) General Presentation

The project site is composed of an urban planning area and a rural area. The urban planning area has been allocated to newcomers. The rural area outside the urban planning operation is the land strip lying between the project site and the Tillabéry road. This area is occupied by only 2 families of the Peul ethnic group, who settled here 50 years ago. They cultivate land under traditional lending. Besides this group, landowners and farmers of the site are presently living in the villages of Koubia or Goudel, and Kouara Kano quarter. Land is cultivated under farming lease or traditional lending.

Households living around the project site get an income from the use of local resources, namely land cultivation, cattle breeding, and extraction of quarry materials, but their livelihood is not determined by such activities. These activities are mostly a heritage of rural customs subsisting in the modern way of life.

(2) Natural Environment

The altitude of the plateau is between 216 and 217m. During the rainy season, rain water is stored in the quarry cavities or drained out toward south-east on the plateau. It is not sure if the site belongs to the hydrographic system of Gounti Yéna. Vegetation is very poor.

The JICA geographical study has provided the identification of a series of clay, laterite, sand and limestone geological layers on more than 10m depth in the project site. The drilling made for the study could not reach the groundwater table at this depth. Clay layers found at the altitude level 204m are very compacted and with low permeability. The floor of the project excavation site will be at 214m level, which is 9m above this natural protection layer. The aquifer is still lower at a non-identified depth. Sand layers coming between the project waste disposal site and the natural protection layer are located between levels 209 and 205m. These 4m thick sand materials are then exposed to leachate infiltration. The coalface of the project excavation will be about 2 to 3m high.

22.2.5 Bengale-Torombi Project Site

(1) Natural Environment

The project site lies at the foot of a gentle hill. Around the hill, the area is a large stretch of sand cut by several kori oriented from south to north or north-east. The project site is just located at the interfluve area of 2 major watercourses (kori), before their confluence with the Niger River at about 1.5 km north.

The altitude of the plain is around 206m but morphology shows that the site is located on an elevation. The final outlet of rainwater is Niger River on north, together with infiltration in sand along the kori.

The JICA geographical study has provided the identification of a series of clay layers on about 20m depth, with water table found at the 195m level, which is at about 10m depth in the centre part of the site, and less on the western and eastern sides. The aquifer table is protected by waterproof clay at 199m level. The floor of the project excavation will be planned just above this natural protection layer. Geological layers cut by the project excavation are also clays.

Vegetation cover is dominated by the Doum palm tree, but there other species of the dry forest and riparian forest at level of woods. The herbaceus level has been replaced by rain cultivation fields and market gardens, but useful plants are present. This vegetation can constitute a natural habitat for waterfowl.

(2) Village Community

There are 8 households living all around the project site. The eastern border is more intensively inhabited than the west border. People have established their housing in their cultivation fields. There are 25 housing settlements in total, of which 20 are straw huts, 3 are banco houses, and 2 are modern houses, the later being the most recent ones. There are 3 settlements which are located at 10 to 30m from borders of the quarry. On the north and western borders, more distance is kept between settlements and the quarry, and the hill itself makes a kind of screen.

The Peul ethnic group represents 7 households and totalize about 88 residents. The remaining household is of Germa ethnic group and totalize 12 members. This population is young for 68% of the total (under 30 years old), and the ratio of children (0 to 10 years old) represents 30% of the local population. Women population represents 56% of total against 44% for men. The average size of household is then 12.5 which is double the Niamey average.

All the community is organised around the Torombi hill, which has partly developed to become a quarry. All traditional settlements are located upland around the hill, leaving lowlands area to cultivation purpose. Small enclosures for cattle are made close to the habitations. The hill area with the quarry is a kind of core space geographically located in the centre of the village community. This space has essential functions like pathways connecting inhabitants between them and giving access to the Torodi road or others, as well as pathways for cattle herds which are not allowed to go through the cultivation fields. It also provides recreational (bathing) or useful (body hygiene, washing) amenities.

22.3 IMPACTS OF THE PROJECT ON ENVIRONMENT

22.3.1 Presentation of Results

(1) Method of Identification

The identification of impacts is made from crossing data of the state of environment with key issues of environmental evaluation. Issues of the checklist presented in Table 22.3-1 had been previously defined for the major part in the initial environmental examination (Chapter 14.2).

The range of possible impacts of the project on environment is large because of the diversity of projects, variety of issues, and various intensities of impacts. Then, only the important impacts as they emerged from the screening through the checklist of Table 22.3-1 have been retained and presented in this study.

The presentation of main impacts which is proposed here includes impacts that may be both positive or negative according to the case. These impacts are however classified into 2 categories:

- Potential impacts
- Expected impacts

(2) Definition of Main 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 case, the environmental receptor is sensitive but can be preserved to maintain initial conditions.

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 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 instead of conservation of the environment. 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 impacts are summarised in the Table 22.3-1 below, according to projects.

Table 22.3-1 CHECKLIST OF EVALUATION OF IMPACT

Grouping	**Items** (each number refers to section number below)
1. Social life and living environment	(2) Livelihood (3) Quality of the living environment (4) Life style and social behaviour (5) Community life and social conflicts (6) Change of economic activity and employment (7) Protection of sensitive groups and promotion of women (8) Damages caused by urban flooding and erosion (9) Poverty and social disparity
2. Public health	(10) Endemic disease (11) Communicable disease (12) Occupational health
3. Pollution and nuisances	(13) Surface water quality (14) Air quality and unpleasant smells (15) Urban nuisances and risks (traffic, accidents, noise, pests) (16) Waste
4. Natural patrimony	(17) Habitats, fauna and flora species (18) Conservation of river banks and prevention of sanding (19) Conservation of soil (20) Conservation of groundwater (21) Climate Change
5. Cultural patrimony	(22) Landscape, amenities, aesthetic values

(3) Impacts on the Natural Environment

The study has shown that there are potential impacts of Koubia and Bengale-Torombi projects on groundwater and expected impacts of Deizebon project on river bank and vegetation of the site. On a whole, the project has few impacts on the natural environment. Improvement of the aquatic ecosystems of Niger River downstream of Deizebon should be notable thanks to the

improvement of surface water quality. This improvement is induced first by the absence of carriage of solid waste by torrential waters in the rainy season, thanks to the implementation of the two waste disposal sites. It is secondly induced although in a more limited way by the better quality of wastewater discharged in the river thanks to the implementation of the wastewater treatment plant of Deizebon.

Table 22.3-2 RELEVANCE OF MAIN IMPACTS ACCORDING TO PROJECT

Items	BOUKOKI	DEIZEBON	KOUBIA	BENGALE TOROMBI
Main Potential Impacts				
Contamination of groundwater			x	x
Worsening of the living environment	x			
Worsening of endemic malaria		x		
Main Expected Impacts				
Improvement of sanitation and health	x	x	x	x
Exposure to pollution and nuisance			x	x
Threatening of women welfare	(a)			x
Loss of environmental asset		x		
Improvement of surface water quality		x		
Loss of livelihood		x		(b)

(a) is already included in the living environment item as potential impact; (b) is a possible alternative

(4) Impacts on the Social Environment

Table 22.3-2 provides a ranking of the main social issues raised by the review of the impacts induced by the project. Items retained for this table are of both types:

- Social indicators of sensitivity, which are simply the size of population and its roots in the place of living.
- Main expected negative impacts which have been raised as a result of study within the field of the social environment. Main potential impacts have not been considered in this table in order to focus on most critical aspects.

Ranking of issues in the table is made according to 3 classes of intensity, which means importance of the sensitivity in one case, and importance of the impact in other case. The most optimistic alternative has been retained for scoring. The total scoring provides an estimate of the global importance of impacts of the project on the site, according to 3 qualifications: Critical, severe, moderate, and negligible. The table shows that Bengale-Torombi is in a critical position, and Deizebon is in a severe position.

(5) General Conclusion

The global impact of the project on environment is basically positive for the welfare and quality of life of people in Niamey. The question of negative impacts of the project is raised for the local communities living in the project sites.

Impacts have been found to be critical for the local community of Bengale-Torombi. This community will be exposed to pollution and nuisances. Women will be seriously affected through the loss of amenities like pathways and easy accesses through the site.

The Deizebon site raises a social problem of unemployment of 5 gardeners presently working on the reclamation land. This project has also some effects on the natural environment, through the loss of few valuable trees, and by contributing to the urbanisation of the Gounti Yéna river bank and degradation of the riverside landscape potential.

Since the environmental benefit of the project for salubrity and public health of Niamey population is not questionable, few measures to solve the problems identified have been proposed. These measures, which are mainly prevention, mitigation and remediation measures, aim at making the impacts acceptable for the local community and respectful of the right of each citizen to enjoy a healthy environment.

Table 22.3-2 STATEMENT OF SOCIAL IMPACTS IN PROJECT SITES

	BOUKOKI	DEIZEBON	KOUBIA	BENGALE TOROMBI
Indicators of sensitivity				
Size of population directly exposed to impacts	3	1	1	2
Cultural roots with the place of living	2	1	1	3
Scoring A	5	2	2	5
Main expected negative impacts				
Exposure to pollution and nuisance	0	1	2	3
Worsening of standard of living of women	0	2	0	3
Loss of livelihood	0	3	0	0
Scoring B	0	6	2	6
Total scoring AxB	0	12	4	30
QUALIFICATION RATE	NEGLIGIBLE	SEVERE	MODERATE	CRITICAL

Ranking order in most optimistic alternative: 0 negligible; 1 moderate; 2 important; 3 very important;

22.3.2 Main Potential Impacts

(1) Contamination of Groundwater

Sensitivity of groundwater by leachate infiltration from the waste disposal sites seems limited thanks to favourable geological conditions. The shallow groundwater of Bengale-Torombi is protected by a water proof clay layer. This layer will be maintained at the bottom of the waste disposal site for isolation. For comparison, this geological barrier does not fit with the EU minimum thickness requirements (Council directive on the landfill of waste).

The deep groundwater of Koubia is protected by a clay layer of low permeability. If compared with the EU criteria of permeability requirements for non hazardous waste deposit sites, the permeability level at Koubia site is still insufficient. The geological strata above the low permeability level are exposed to leachate infiltration and could contaminate gravel and sand.

However, there are also conditions limiting the risk of contamination:

- Low permeability layers are thick compacted clay.
- Groundwater table is deep.
- Evaporation conditions in Niamey mostly eliminates the infiltration of leachate excepted during the rainy season.

The knowledge about the possible patterns of contamination is limited, and it is a basic precaution to consider that during the long life of the waste disposal site, there is enough potential for contamination.

Any contamination of groundwater must be prevented since groundwater is a potential water resource for the future in a context of increasing scarcity. The Bengale-Torombi groundwater already supplies the local community through wells.

The potential of groundwater contamination can be minimised to the best levels by reinforcing isolation of sites (drainage of rain water, collection of leachate, barrier made of waterproof clay layer), which has been taken into account in the design of this project. During the first phase of operation of waste disposal at Koubia, sensitivity to groundwater contamination will be higher, but still limited by the following factors:

- Installation of a rainwater collection drain around the site.
- Natural isolation of deep groundwater by compacted clays.
- Small size of the landfill during this phase.
- Infiltration limited to the 3 months of the rainy season each year.

(2) Worsening of the Living Environment

The installation of the sewerage network at Boukoki has both positive and negative impacts on the living environment. Positive impacts are the improvement of sanitation conditions. Negative impacts however offset the positive ones in the alternative of open sewers. Such alternative would lead to a critical disruption of the important social functions of streets in Boukoki for men, women, and children. Security of children would be threatened by the risk of falling down in sewers. Loss of community space for residents living in overcrowded compounds would threaten the quality of life. Welfare of women who send products in front of compounds would be directly and indirectly affected. Moreover, the risk of generating unsanitary conditions compared to present is high, since wastewater and solid waste could accumulate in sewers, with unpleasant smells and proliferation of flies and pests.

On the other hand, the alternative of closed sewers would induce a definitively positive impact on the living environment. This alternative has been retained for the project during the planning study process. Then, the potential negative impact of open sewers is mentioned to insist on the importance of a simple measure like closing sewers to eliminate negative effects.

The choice of the good alternative will have the following positive impacts if maintenance of sewers is properly done:

- Elimination of habitats favourable to the malaria vector and pests.
- Containment of unpleasant smells.
- Clean and sanitary environment of living.
- Facilitating accesses especially during the rainy season.

(3) Worsening of Endemic Malaria

Worsening of endemic malaria means that there are new conditions favourable to the reproduction of malaria vector during the dry season. While reproduction and infestation of

malaria vector is general in Niamey during the rainy season, it remains limited to specific geographic sectors like riverside areas along the Niger River during the dry season.

Worsening of endemic malaria can be regarded as a potential impact of the polishing water ponds of the wastewater treatment plant project of Deizebon. These ponds will not be emptied during operation and it can be expected that Anophele larvae can survive in water of one or more of these ponds. Since the Deizebon area is not recognised as having conditions of worsening endemic malaria, as shown in the state of environment, then the impact could be a serious one. The presence of a sensitive population of school children in front of the plant site, who will be directly exposed to this new risk, is a decisive factor of worsening.

22.3.3 Main Expected Impacts

(1) Improvement of Sanitation and Public Health

The primary impact of the project is determined by its objective, which is the improvement of salubrity and sanitary conditions of the Niamey area. In that concern, the waste landfill projects will stop the present practices of unsanitary waste disposal in Niamey city and make the city clean. The collection of wastewater in the Boukoki area and its treatment in Deizebon will help to improve the sanitary conditions of Boukoki. On a whole, exposure of people and more particularly children who play in streets to communicable diseases pathogens will be strongly reduced and public health will improve.

At the level of local communities around project sites, there will be mainly improving trends in comparison with present. Population living around the waste landfill project sites is already seriously exposed to unsanitary conditions like solid waste accumulated in cultivation fields, and solid waste and medical waste disposed of in the quarries. The Deizebon site itself is an area showing strong trends toward the creation of urban insalubrity pockets, because of its location riverside. The implementation of waste landfill sites should help to eliminate all these sources of pollution and nuisance.

Waste disposal sites however generate pollution and nuisance on their own, and local communities can be affected in a new way. This question is considered below.

(2) Exposure to Pollution and Nuisance

The village community of Bengale-Torombi of about 100 persons is living at few metres only around the site and will be directly exposed to pollution and nuisances that can be expected from a waste disposal site. Settlements lie in an area which will become unsanitary with implementation of the project and which is in principle prohibited for housing. For example, the World Bank standards require that housing settlements are not permitted around a municipal solid waste disposal site on a radius of 500m. From this point of view, the whole area occupied and cultivated by the Bengale-Torombi community belongs to such uninhabitable zone.

There are a series of conditions that make the situation particularly critical here, and it is useful to come back on these conditions:

- Livelihood of the community is based on the cultivation fields around the project site.
- The community has its roots in this land around Torombi hill where lies the quarry.

- The area of living of this community is an interfluve area shut in by watercourses, and then it seems impossible to find appropriate substitute housing zone.

In the case of Koubia, population potentially exposed to pollution and nuisance of the project includes:

- Residents already living in the north-east border of the site at about 200m distance. They will be exposed to smells and dust during the rainy season (winds from south-west).
- Potential residents who have purchased land plots between the later mentioned residential area and the site, with 2 categories of people: Those located to a certain distance of the quarry and presently authorised to settle here, and those located just in front of the site, where plots have been allocated but have not been an object of expropriation procedure.
- Traditional households settled between the road and the site. One of them is located just at the entrance of the present access road to the site.

Then, the impact of the project on the population of Koubia will depend on the decision given to the distance required for a buffer zone around the site. The capacity of disposal at Koubia will be 8 times the capacity of Bengale-Torombi, and a consequent buffer zone will be necessary to protect the border which is becoming a residential area.

The traditional household located near the access road to the site would severely exposed to the traffic of trucks and associated nuisances (noise, dust, high risk of accident, insalubrity) if the present access road was maintained for the project.

(3) Worsening of Standard of Living of Women

The possible worsening of standard of living of women is one of the most serious negative impacts of the project. This impact can be important for 2 reasons:

- Both Boukoki and Bengale-Torombi are concerned.
- Promotion of women on the one hand, and struggle against poverty on the other hand have been designated as important objectives of the development policy of Niger.

In the case of the Boukoki project, this impact is raised as a potential one and can be then easily solved not to say improved through technical design. In the kori area, the project will not affect women.

In the case of the Bengale-Torombi site, the welfare and way of life of women is directly and critically threatened by implementation of the project. Village women will loss welfare components like water ponds and pathways and accesses in the quarry. It is always possible for them to adapt to new conditions and to find substitutes to these village amenities lost with implementation of the project, but this will not be possible without increased physical efforts to only maintain a same level of quality of life. The women are especially sensitive to such impact because they are more clearly concerned than men. Women go to public places to send few market garden produces, and go to health centres when children are sick, among other possible needs. In the final, such additional efforts can affect money earnings of women and their health, without speaking of secondary effects for children.

This impact is important at Bengale-Torombi because it deals with a population where women clearly predominate in number (56%).

(4) Loss of Environmental Asset

The implantation of the Deizebon wastewater treatment plant project will cause the loss of valuable trees (see 22.2.2) and contribute to the degradation of the valuable potential of riverside landscape.

The project also contributes to the urbanisation trends of a river bank area, which increases weakening of river banks which are threatened at short or long term by erosion. However, it seems that the requirement of leaving a 10m width strip of land along water courses is respected by the localisation of the project, although it might be at the limit.

Land use change also contributes to increasing the trends toward torrential water runoff.

(5) Improvement of Surface Water Quality

Improvement of surface water quality will be a synergic effect of better management of wastewater and solid waste all together.

An important and indirect benefit for water quality comes from the elimination of solid waste as sources of organic pollution of surface water, especially by effects of water flushing when torrential floods of the rainy season carry away this entire pollution load to the Niger River

The improvement of wastewater quality of Boukoki after discharge in the Gounti Yéna is a direct factor of improvement of surface water quality. The wastewater quality objective has been set at the best level using the standards applied for dangerous, insalubrious and inconvenient establishments. The quality objective is set according to the intended use of river water (Niger River) for drinking, bathing and fishing (see 14.1.4). Then, achievement of these objectives by the UASB plant will contribute to reduce organic pollution of Niger River. The role of the UASB plant in improving river water quality is explained in Chapter 23.

The contribution of the Deizebon wastewater treatment plant project to improve Niger River water quality must be considered within the scope of Gounti Yéna sewerage plan:

- The total volume of waste water discharged in the Gounti Yéna will be 3 times more important in 2015 than present, while its share in total waste water finally discharged in the Niger river in Niamey will amount 30%. With implementation of the Master plan, the daily average waste water volume collected by the Deizebon sewer will represent about 15% of the total sewer water discharged in the Gounti Yéna.
- The sewerage network of Boukoki is a combined system, which means the discharge of wastewater together with storm water without treatment during storms, as it was initially the case before implantation of the plant. The maximum flow of wastewater discharged by the combined system in the Gouti Yéna (C2 and C3) will represent about 20% of total maximum flow of wastewater collected in the Gounti Yéna watershed in 2015. Then, the risk of shock pollution generated by the combined system of Gounti Yéna network during storm in the Niger River should be quite limited.

(6) Loss of Livelihood

Loss of livelihood, namely market gardening, is a serious impact in the case of the Deizebon project, and could be a significant one in the case of Bengale-Torombi project according to the type of environmental plan which will be retained.

At Deizebon, the project induces the complete loss of livelihood of 5 gardeners. This impact induces the other one, which is the potential loss of income and welfare for the women in charge of the distribution of market garden produces.

At Bengale-Torombi, the loss of cultivation fields will be limited to the borders of the quarry, where space will be required for fencing and for draining rainwater. This impact should remain of secondary order, but could be amplified by the alternative of relocating people in response to the pollution and nuisance problem.

22.4 ENVIRONMENT MANAGEMENT PLAN

22.4.1 Boukoki Project

Only few measures are needed for improving the environmental performance of the Boukoki project. The main one consists in closing the sewers. Without such measure, the project would impair the living environment and quality of life of people. This measure has been integrated in the planning of the project. The second set of measures is related to the construction phase. The contract bid documents should be required to include a plan of environmental measures. Measures are:

- Regular and proper evacuation of earth during excavation works and prevention of dust.
- Works during the dry season only to avoid the effects of water runoff during rainy season (erosion, plugging, landslip, physical degradation of water).
- Control of speed of vehicles and regulation of traffic.
- Employment of local people for works, and good hygiene conditions of work.

22.4.2 Deizebon Project

Main measures are summarised in Table 22.4-1 according to 3 types of measures.

(1) Plan of Environmental Measures During Construction

This plan of measures is of same type as for Boukoki.

(2) Prevention of Urban Insalubrity Pockets

Preventing the formation of urban insalubrity pockets is possible at the stage of planning of the project. It is recommended to re-evaluate the land reclamation area in order to find more efficiency in the use of land. The riverside area should be considered as the most valuable side and then restricted as much as possible. However the 2 street sides of the project site have no environmental value and it would be fruitful to extend the reclamation area of the project by putting its limits on these both sides, instead of leaving a free space along the streets. On the one hand, such revision of the project planning area will help to avoid the constitution of

strips of land favourable to the constitution of unsanitary pockets in the city. On the other hand, this extension in the gardens area toward street sides of the project site do not intensify in any way the social problems as they are raised by the project.

Table 22.4-1 PLAN OF MEASURES FOR DEIZEBON PROJECT

	Social life and living environment	Public health	Pollution, nuisances	Natural environment	Landscape, amenities
Prevention measures					
Plan of measures during construction	x		x		
Prevention of urban insalubrity pockets		x	x		x
Security of the biogas installation			x		
Environmental monitoring			x		
Mitigation and remediation measures					
Settling a greenery buffer zone	x		x		
Plan of social reinsertion	x				
Plan against proliferation of malaria vector		x			
Management of solid waste		x	x		
Sustainability measures					
Sanitary use of sludge		x			
Reuse of waste water for irrigation		x			
Management of biogas			x	x	

(3) Security of the Biogas Installation

The biogas treatment installation of the Deizebon project does not represent a major risk of accident, but its localisation in the urban area and proximity of the Deizebon School makes this place highly sensitive to any potential nuisance or danger.

The biogas installation will need authorisation from the Ministry of Mines. There are minimum requirements to be achieved in order to ensure the security of the site against fire risks caused by biogas. They are:

- Keeping distance between the gas installation and the school.
- Keeping equipment ready-to-use against fire.
- Maintaining the installation and checking regularly the working conditions.

(4) Environmental Monitoring

Environmental monitoring of wastewater quality discharged in the water body must be done as explained in Chapter 23.

(5) Settling a Greenery Buffer Zone

Settling a greenery buffer zone with planted trees is an easy task, especially with the availability of water resource in the plant (waste water reuse), once the several advantages for environmental purpose have been understood. Planting area should be in priority in front of the plant, and then the inside borders of the plant.

- Compensation for the loss of valuable tree species.
- Creating a buffer zone between the plant and the city.

- Maintaining some continuity of greenery landscape along Gounti Yéna.
- Retention capacity for rainwater.
- Preventing dispersion of aerosols and unpleasant smells.
- Compensating the greenhouse effect that could occur from accidental release of methane gas.

(6) Plan of Social Reinsertion

A plan of social reinsertion should be established by the project unit with CUN in order to provide a minimum attention and assistance to the gardeners concerned by the loss of their work with implementation of the project. The objectives of such plan are dictated by the national policy of struggle against poverty. Possibilities of reinsertion are:

- Giving a priority to gardeners for job opportunities induced by the construction works.
- In case of opportunity of work for the operation phase, affected gardeners should receive priority.
- The case of the woman gardener needs specific attention, because she will face more difficulties than men to find a substitute activity.
- Since these gardeners are young, few of them should be able to find other gardening job, since there are plans for extension of market gardening in Niamey; they need to receive some support to this end.
- Providing to the gardeners some information about the possibilities to find a new job and about existing structures that could help, like associations or social services.

(7) Plan Against Proliferation of Malaria Vector

The prevention of mosquitoes larvae in the polishing ponds is important. The most promising method should be the use of larvae feeding fishes, which are commonly called the "guppies" or Poecillia reticulata. This fish is already largely used against extension of malaria. It shows some tolerance to water pollution. Since the feeding of such fishes could help to fight against malaria vector in natural environment, there would be here a good opportunity to valorise the wastewater of the polishing ponds.

The prevention approach is already experimented through the use of plants recommended by the university of Niamey to send away mosquitoes, and planted all around the polishing ponds of the pilot plant.

(8) Management of Solid Waste

Management of solid waste will be an important task for good maintenance of the project installation. Its purpose is to avoid accumulation or bad evacuation of the waste that are generated by screening of waste water and by polishing ponds in case of use of the water Jacynth.

Integration of solid waste management with wastewater treatment operation is an essential task to prevent nuisances. The workers in charge of maintenance of the plant must know exactly how to dispose of the waste, and coordination with the commune will be necessary for regular transportation to the landfill site.

(9) Sanitary Use of Sludge

Viral contamination of sludge is higher when drying process is insufficient or made in bad conditions, which mainly depends on the time of retention in drying beds. It is not sure that drying conditions during the rainy season are satisfying for the efficient elimination of the viral load.

A sludge reuse management plan should be prepared to make sure that reuse is made in the best possible sanitary conditions. Inside the plant, the basic requirement is to make sure that sludge has been sufficiently dried before use for agriculture. When not suitable for use, the sludge should be managed as a solid waste.

(10) Reuse of Waste Water for Irrigation

The potential of reuse of wastewater for irrigation at Deizebon will be very limited after implantation of the project. This potential is however high for the Gounti Yéna valley downstream. A plan of reuse of wastewater of the Gounti Yéna watershed for irrigation of the market gardens should be set up.

Although the reuse of wastewater for irrigation is able to improve the sanitary quality of market garden produces of Gounti Yéna gardens, a minimum level of care and measures are needed. It may be for example to avoiding irrigation just before harvest of produces. Chlorinating wastewater before discharge and use for irrigation cannot provide full eradication of bacteria and more particularly gastro-enteritis viruses. The suspended matter load in water is still about 30mg/l at the outlet of the treatment plant, which reduces consequently the action of chlorine. The time of retention in polishing water ponds is 0.5 day, which is short to expect full elimination of the virus load in water. It is however possible that this load is lower in a UASB process compared with others.

(11) Management of Biogas

With implementation of the Master plan and in a configuration of 14 treatment plants similar to the one of Deizebon project, the annual fire wood equivalent production of biogas could amount 1171 tons in 2005 and 1398 tons in 2015 in total, which covers the needs of more than 1000 households, and represents 1% of the present annual consumption of fire wood in Niamey and 0.7% for 2015.

This is a low potential but needs evaluation in a context of a national policy to struggle against desertification. At Deizebon, since methane gas is a powerful greenhouse gas, biogas must be burned in flare.

22.4.3 Koubia Project

Main measures are summarised in Table 22.4-2 according to 2 types of measures.

(1) Plan of Environmental Measures During Construction

Measures during construction aim at limiting nuisances generated by excavation and levelling on the natural environment. The plan of transportation of excavated materials should insist on aspects like prevention of worsening traffic conditions and proper disposal.

(2) Establishment of a Buffer Protection Zone

The establishment of a buffer protection zone is a preliminary measure. A buffer zone has been determined by the CUN in relationship with authorisation of the quarrying activity. The buffer zone of the waste disposal site should be set at minimum at the existing distance, and possibly extended, without impairment on the already existing housing area. Expropriation procedure should follow.

Table 22.4-2 PLAN OF MEASURES FOR KOUBIA PROJECT

Basic measures	Social life and living environment	Public health	Pollution, nuisances	Natural environment	Landscape, amenities
Prevention measures					
Plan of measures during construction	x		x		
Establishment of a buffer protection zone		x	x		
Protection of groundwater by lining				x	
Localisation of the access road			x		
Control of waste			x		x
Environmental monitoring			x	x	
Campaigns of information of public	x				
Mitigation and remediation measures					
Greenery of borders (buffer zone)	x		x	x	x
After closure plan of waste disposal site		x	x		x

(3) Protection of Groundwater

Protection of groundwater is performed through technical measures like lining with clay layer, collection of rainwater and leachate. These measures have been taken into account in the planning of the project.

(4) Localisation of the Access Road

The localisation of the access road should be different with the existing access road, in order to avoid heavy nuisances and risks of accidents for residents and for people coming to the mosque.

(5) Control of Waste

Control of waste at entrance of the site is planned as a component of waste disposal site operation. However, the conditions of transportation of waste should also be checked and arranged to avoid the loss of litter during transportation and the development of waste deposits along the road or at proximity of the landfill site.

(6) Environmental Monitoring

A monitoring plan of groundwater quality should be set up.

(7) Campaigns of Information of Public

Campaigns of information of public will be performed before and during construction of the landfill site, for the people living around the site.

(8) Greenery of Borders (buffer zone)

Greenery of borders within the limits of the protection buffer zone is strongly recommended for the following advantages:

- Protection of residents against dust, air pollutants and plastic bags.
- Minimising noise nuisance.
- Landscape beautification.
- Struggle against desertification.

This action will be considered within the larger scope of actions that CUN will have to take against the increasing degradation of the green belt of Niamey.

(9) After Closure Plan of Waste Disposal Site

The after closure plan should be done for the 1st phase of operation of landfill site as a first step. The objectives are:

- To protect the site.
- To monitor for a period of time the pollution generated by the site.
- To restore / improve morphology and landscape.
- To define the final land use of the site; best alternative is to return land to agriculture.

22.4.4 Bengale-Torombi Project

The question raised by the Bengale-Torombi project is how to mitigate or make acceptable the pollution and nuisance effects of the project on the local small community. There are 3 basic alternatives:

- Alternative 1: A large buffer zone is established around the site and inhabitants must be resettled outside the area.
- Alternative 2: No buffer zone or a buffer zone of very limited extension is applied and inhabitants can stay in the site area.
- Alternative 3: The site is considered as inappropriate for waste disposal because of the social implications.

Alternative 1 means the loss of livelihood, loss of the traditional and family land, as well as cultural and ancestral roots, and certainly the necessity to shift to an urban life style. These effects seem unacceptable.

Alternative 2 presents the big advantage of keeping the initial conditions around the site. This solution seems acceptable because the social advantage which will be got largely offsets the pollution and nuisances to which the population will be exposed. Then, measures will have to minimise such effects. Moreover, it is the first phase of operation of waste disposal which is the most problematic one because of the proximity of few settlements. At the project level,

the waste disposal activity will however be limited to 14 trips per day equivalent waste quantity, which restrains the importance of possible nuisances.

Alternative 3 should also be considered if alternative 2 is not appropriate.

Then, measures are considered according to the Alternative 2. Main measures are summarised in Table 22.4-3, according to 2 types of measures and issues.

Table 22.4-3 PLAN OF MEASURES FOR BENGALE-TORONBI PROJECT

Basic measures	Social life and living environment	Public health	Pollution, nuisances	Natural environment	Landscape, amenities
Prevention measures					
Plan of measures during construction	x		x		
Establishment of a protection buffer zone		x	x		
Protection of groundwater by lining				x	
Control of waste			x		
Environmental monitoring			x	x	
Mitigation and remediation measures					
Community participation	x				
Water supply improvement plan	x	x			
Waste disposal site after closure plan	x	x	x		x

(1) Plan of Environmental Measures During Construction

Measures during construction aim at limiting nuisances generated by excavation and levelling on the natural environment and on the local community.

Measures for protection of the natural environment include the proper disposal of excavation materials.

Measures for protection of the human environment consist in minimising nuisances like noise, dust and others. The plan of transportation of materials should insist on aspects like prevention of worsening traffic conditions. Employment of local people for construction works is strongly recommended.

(2) Establishment of a Protection Buffer Zone

The protection of the site will be done by a fence. The need to establish a protection buffer zone should be discussed with the local population in order to find consensus about the nature of this zone, in terms of purpose, distance, land use, and access. This zone could be limited to the strict minimum.

(3) Protection of Groundwater by Lining

Protection of groundwater is performed through technical measures like lining with clay layer, collection of rainwater and leachate. These measures have been taken into account in the planning of the project.

(4) Control of Waste

Control of waste at entrance of the site is planned as a component of waste disposal site operation. However, the conditions of transportation of waste should also be checked and arranged to avoid the loss of litter and the formation of waste deposits along the road.

(5) Environmental Monitoring

A monitoring plan of groundwater quality should be set up, with sampling in water wells around the site.

(6) Community Participation

Community participation will be necessary in view to solve the critical issues raised by the project. Participation to the decision making process of the project must be promoted by the commune. The commune will identify NGOs of concern that could support and play a role of intermediate with the village community. A women association would be appropriate. Participation of the population will be done through representation in working committees of the project planning process and through direct discussion and meetings organised on the field. The purpose will be to find a way to conciliate development objective of the site with preservation of the resources and way of life of inhabitants around the site.

(7) Water Supply Improvement Plan

Village people around the site are supplied by well water. These wells lack convenient system of water withdrawal and are sometimes at some distance from the settlements. The purpose of improving water supply is to make easier the access to water, and to increase availability of water for washing and bathing uses. Developing an easy access to water supply appears as a good solution in view to compensate the negative effects of the project on women. The main effect is an increased effort required to the village women in order to sustain their level and way of life, as a result of the loss of pathways and accesses with implementation of the project. An easier access to water resources would have the inverse effect of decreasing the effort required for the equivalent level or way of life, and possibly improving conditions. This measure should at the same time compensate for the loss of water related village amenities like the washing and bathing ponds of the quarry. Easier access to water will also improve sanitary conditions at the level of settlements. The water supply improvement plan must be established in consensus with the population.

(8) After Closure Plan of Waste Disposal Site

The after closure plan should be done during the 1st phase of operation of landfill site. Local community should be involved in planning. The objectives are:

- To protect the site.
- To monitor for a period of time the pollution generated by the site.
- To restore / improve morphology and landscape.
- To define the final land use of the site; best alternative is to return land to agriculture.
- To define the possibility of return of land to the benefit of the local community.

22.4.5 Conditions of Implementation of Measures

The institutional capacity to manage environment is a key issue for implementation of measures and environment management plan within the scope of the project. This management capacity is now under building in Niger. The role of the BEEEI in finalising the environmental measures of the project and controlling their application on the field is essential. The lack of material means makes however difficult the good achievement this task, and the development of this capacity of control of the BEEEI could constitute a first condition for the application of measures given by the environment management plan of the project. The work of the BEEEI should be coordinated with the work of the sanitary police in evaluating the conditions of application of measures in project sites and the effects on the population of concern.

Moreover, the acceptability of the impacts through application of measures is not only a matter of institutional capacity to manage the environment. It is also a matter of public participation and public awareness, which still remains a weakening point in Niamey in the field of environmental protection. Public participation needs to be promoted and supported for the environmental plan of the Bengale-Torombi project. Public participation is more generally required for the good maintenance of sanitation infrastructure and for contributing to a cleaner city. Public awareness campaigns are the basic tool toward communities' participation to planning and decision-making.

CHAPTER 23. EVALUATION OF PILOT STUDY

CHAPTER 23. EVALUATION OF PILOT STUDY

23.1 BACKGROUND

In Niamey, domestic wastewater from household is a major source of pollution of water bodies namely river and groundwater. Major pollutants are organic matter from toilets, kitchens, bathrooms, urinals etc. in the form of dissolved, colloidal and suspended solids. These pollutants reduce dissolved oxygen in river, increase nitrogen and phosphorous components and increase bacterial counts. Not only river becomes unfit for bathing, drinking but affects the aquatic flora and fauna like plankton, benthic macro-invertebrates, fishes etc.

Deterioration in water and sanitation environment is because neither sewerage system, which includes wastewater treatment and sewer network nor onsite wastewater treatment system was constructed in Niamey. There is also no existing organization to develop and provide sewerage service in Niamey.

Therefore, JICA decided to implement the pilot study with the aim of capacity building in the form of transfer of technology for selection, designing and construction, O&M training for appropriate wastewater treatment systems to its Counterparts.

Under this study, two pilot studies were implemented, one for on-site and other for off site wastewater treatment. 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 design capacity of the Jyokaso is 10 m^3/day, which is 200 population equivalent (PE) based on the JICA Study in Niamey.

Other pilot study is based on UASB (Upflow Anaerobic Sludge Blanket) technology followed by modified trickling filter, which was developed in Japan, and NRS. UASB was constructed at Deizebon near outfall of the drainage system. The design capacity of the UASB is 100 m^3/day, which is 2,000 PE.

NRS have been used not only for polishing effluent but also for natural recycle of wastewater.

23.2 OBJECTIVES

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

23.2.1 Effectiveness

According to the Nigerian effluent discharge standard for effluent into the water bodies, the effluent shall not have BOD more than 40 mg/l and SS 30 mg/l.

Jyokaso pilot study, which consisted of Jyokaso itself followed by NRS and soak pit was commissioned in March 2001 and achieved an effluent quality of BOD of 20 mg/l and SS less than 10 mg/l for which it was designed (APPENDIX S.6) keeping in mind the effluent discharge standard of Niger as well as to prevent ground water contamination.

To achieve the maximum efficiency, Jyokaso consisted of several compartments and each compartment has its own important function. First and second compartments were to remove most of the solids of toilet waste just like septic tank. Aerobic attached growth process was adopted for the third and fourth compartment. Because of bacteria growth on the packing material, there is no requirement of concentrated MLSS like in activated sludge process in these compartments. 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. Moreover, there is piping and valve arrangement to transfer sludge from the settling tank to the first tank using air through blower and thus manually sludge withdrawal is not required. The sludge removal is required only from the first and second compartment at every two years.

UASB pilot study, 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 the countries, which has temperature more than 20^{o}C. The additional advantage for Niamey is that temperature range in Niamey is around 25^{o}C –30^{o}C and the UASB efficiency is highest in this temperatures range.

Further more, with operation time of UASB, activity, settleability, and concentration of sludge in the blanket zone of UASB will increase and as a result the effluent quality will improve further. Trickling filter further improves the effluent quality of UASB by removing residual soluble and suspended solids, and by increasing dissolved oxygen upto the satisfactory level for aquatic flora and fauna like plankton, benthic macro-invertebrates, fishes etc. to live.

NRS, which consisted of water hyacinths, Lettuce and fishing ponds, recycle the residual waste through natural recycle system.

23.2.2 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 from selling the dried sludge as fertilizer and generating electricity from bio-gas.

On the other hand, effluent quality complied the effluent discharge standard of Niger. The effluent of UASB is rich in nutrients, therefore, it can be used for raising food, fibre & fodder crops as well as food grains.

Minimal green house gas emission is expected from UASB when compared to the activated sludge process (ASP) or waste stabilization pond (WSP), since all the bio-gas is used for power generation, which otherwise would have used fossil fuel for combustion with associated CO_2, H-C, NO_x and SO_2 emissions for the power output.

In the case of UASB pilot plant, bio-gas is flared as generation of electricity is not cost effective because of the scale of the pilot plant. Although there is possibility to collect the bio-gas in cylinders for selling purpose on demonstration scale if initiatives for small investment is taken by the counterparts in the future. Farmers have been encouraged to use the effluent for irrigation purpose. Also, possibility of selling dried sludge is being investigated, first on experimental basis to grow plants at the pilot plant site itself.

Since land need is minimum, the UASB can be located in different locations in a decentralized manner, thereby reducing the impact on land use pattern and social acceptability for location in green belt areas etc.

UASB plant requires regular maintenance and excess of salts; SO_4 and heavy metal concentration should be avoided for prolonged period by strict enforcement of industrial pollution control. 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 ASP, WSP etc. But as per WHO guidelines, the UASB + polishing pond effluent is suitable for application on land for raising food, fibre & fodder forestry and food grains like wheat & rice using controlled irrigation method.

Odor generation is minimum because any H_2S in UASB reactor is in the molecular form and it is mostly trapped under the gas dome and removed in caustic solution scrubber before sending for electricity generation. The recovery of sulphur in full-scale plant is cost effective.

On the whole, the UASB process has very high positive impacts on water environment, sanitation improvement, and economy of Niamey and ecology in the micro-habitat of its location in comparison to above negligible or no negative impacts on Niamey.

Jyokaso can be varied in size and used for treatment of wastewater from community and individual toilets, hotels, restaurants, and apartments. As a result, sanitation environment would be considerably improved by providing on-site treatment where sewerage system is not feasible.

At both the plant, the JICA Study Team conducted hygiene education and awareness campaign, which was quite successful.

23.2.3 Efficiency

UASB and Jyokaso pilot plant achieved efficiencies of more than 90% BOD and SS reduction. In the M/P and F/S UASB process is evaluated as an effective method to meet national standards and all the requirements of effective water resources management

including water quality improvement of Niger river to desirable standards as per WHO guidelines.

The cost of electricity consumption in the UASB pilot plant for treatment of wastewater was only about 80 CFAF for per m^3/day of design flow, which is nearly the same as estimated in M/P. Compared to ASP, the electricity consumption in UASB plant is several times lower and almost the same in WSP if pumping is required. Whether pumping is required or not for UASB as well as WSP depends on the water level in the sewer and discharge point, and topography of the site. The gravity flow could be adopted to feed the UASB plant of the capacity of 5,000 m^3/day operating in India at Kanpur because UASB could be constructed under the ground level.

The construction cost of UASB was approximately 120,000 CFAF for per m^3/day of design flow, which is little higher compared to F/S cost. This is mainly because of the scale of the UASB and to some extent being first of this type plant in Niamey and design, supervision for civil and electro-mechanical equipment was outsourced. The construction cost for UASB estimated in the F/S is approximately 90,000 CFAF for per m^3/day of design flow. The construction and O&M cost of UASB plants has been estimated in Chapter 10.

Jyokaso was imported from Japan for this pilot study to transfer technology and concept in Niamey. It can be constructed in Niamey on the site itself using fiber reinforced concrete or RCC superstructure, and steel frames for partition walls, settling tank, disinfection tank, and effluent outlet purpose.

Jyokaso is an effective method for on site sanitation improvement and ground water pollution prevention.

23.2.4 Relevance

With population explosion, the pollution load in urban areas from wastewater, garbage and industrial waste is increasing in alarming proportion. At the same time, open areas and peripheral villages and agriculture lands are also being converted into urban settlements. This resulted in congestion in core areas of urban centers and increasing land cost in urban centers. Hence wastewater treatment technologies which can be decentralized, located in urban pockets, which need minimum land to treat wastewater, which permit reuse for horticulture, & revenue plantation have grained popularity. 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 liter 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 for wastewater treatment either of toilet wastewater alone or combination of toilet, and kitchen and washing wastewater.

23.2.5 Sustainability

The electricity consumption in the UASB plant is minimal. On the other hand, UASB produces bio-gas with 65-75% methane content and the power generated could be used to meet the needs of wastewater pumping. Bio- gas collected is about 800-900 normal liter per Kg COD removed, which excludes 25-30% gas escape with the treated effluent. The bio-gas power generation from the UASB plant not only meets the need of UASB plant but also provides power for 3-4 hours in the peak time to the wastewater pumping station. Hence, substantial electricity cost could be saved using UASB, which is a major portion of O&M cost.

There are no large rotating equipment, which need skilled maintenance and operation in UASB plant, except screens and grit chamber, which are essential pre-treatment steps for all the types of wastewater treatment technologies. Only sludge withdrawal schedule is required.

Dried sludge cake is sold as fertilizer and treated effluent is used for irrigation, which may recover the cost of O&M.

Counterparts from MET and CUN has been involved on the job training from selection of site, design, construction, and O&M of the pilot study. Operation manual has been prepared and O&M training has been provided using operation manuals under the JICA Study for the efficient operation of the plant.

University of Niamey has been involved in the water quality analysis and evaluation of the pilot study through which university has gained sufficient knowledge to carry out research on their own.

23.3 CONCLUSION

The ultimate goal of the pilot study is realization of UASB and Jyokaso as per M/P of the 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 the Niamey City. As a consequence, health condition of people will be improved with the decrease in water borne diseases (diarrhea, dysentery, hepatitis, cholera and typhoid fever).

It is necessary that the counterparts continue to operate the pilot plants after the departure of the JICA Study Team and gain more and more experience and training. The pilot plants are landmark of the Niamey city as the first domestic wastewater treatment plant based on the most appropriate technology for Niamey and should also be continued to use for public health education for mass awareness to improve the sanitation environment of Niamey, which is also the objective of the JICA Study.

CHAPTER 24. HYGIENE EDUCATION CAMPAIGN

CHAPTER 24. HYGIENE EDUCATION CAMPAIGN

24.1 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

24.2 PREPARATION

24.2.1 The Framework for the Campaign

(1) Basic Framework

From the point of view of expertise of hygiene education as well as in accordance with the discussion in Chapter 13, the JICA study team in cooperation with the counterpart team prepared a basic framework for the campaign to fully achieve the purposes of the campaign. The framework stands for the following;

- An approach to be taken
- The campaign sites
- The core program for the campaign (See Chapter 13)

(2) Approach

As discussed in Chapter 13, an approach to be employed for the campaign is participatory approach in the concept of community participation in order to expect a possible community involvement and their positive cooperation on the campaign.

(3) The Campaign Committee

Based on the basic idea of the participatory approach, the study team played a role as a facilitator for preparing and implementing the campaign after the preparation of the basic framework for the campaign. In place of the study team, a committee for the campaign (herein after referred to as the Campaign Committee or the Committee) was organized among the actors concerned to discuss the preparations and the implementation. (See Table 24.2-1)

(4) Campaign Sites

It is reasonable to suppose that two pilot projects prepared in the study can be used as a teaching tool for making the campaign an effective one in the scope of the study and the purposes of the campaign. Therefore the sites for the campaign were selected in the following pilot project sites.

- Pilot Project 1 : The *Jyokaso* Construction Site (at *Bandabari* Primary School II)
- Pilot Project 2 : The UASB and TF Construction Site (Next to *Deizebon* Primary School)

24.2.2 Explanatory Meetings

Followed by the first Community Explanatory Meeting held in the 23rd November 2000 (see Chapter 13), the explanatory meetings were held as a step of the community participation as well as a part of the campaign. The principal subjects and results in each meeting are summarized as follows.

(1) The 2nd Explanatory Meeting

1) The outline and the core program

In accordance with the basic framework for the campaign, the JICA Study Team explained the brief outline of the campaign and the core program prepared by the team.

2) The Campaign Committee

As mentioned previously in 24.2.1, the Campaign Committee was organized among the actors concerned in accordance with participatory approach. Therefore, the JICA Study Team had played a role as a facilitator for the campaign since the establishment of the Committee. The Committee consisted of the following entities:

Table 24.2-1 MEMBERS OF THE CAMPAIGN COMMITTEE

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

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3) The Committee's Tasks

The Committee discussed the tasks of each member of the Committee for preparing and implementing the campaign as shown in Table 24.2-2.

4) The Campaign Program

Based on the core program prepared by the Study Team, the Committee discussed the campaign program. The finalization of the program was carried over to the next meeting.

5) The Main Theme and Slogans for the Campaign

The Committee discussed and decided the main theme and slogans for the campaign as shown in Table 24.2-3.

Table 24.2-2 MEMBERS' TASKS OF THE CAMPAIGN COMMITTEE

Tasks		Entities in Charge
1. Setting up the venues	- Tents, Chairs and Others - Transportation services - Reception	- NGOs - Chief of Quarters (*Quartiers*)
2. Observations & guides to the pilot projects	- *Jyokaso* Site - UASB & TF Site	- CUN - MET
3. Heightening Activities for Public Awareness on Hygiene and Sanitation		- DDS/CUN (District Health Directorate/CUN) - Hygiene section of Commune I, II, III - Hygiene section of Commune II - Hygiene section of Commune III - Technician, Health District 2 (MSP) - Public Affairs Officer, Health District 1(MSP) - PTA - Delegate of *Katako* Market - Delegate of *Tillabery* Bus Terminal
4. Preparation and Evaluation of a Drawing Contest (The Committee organized a sub-committee for the contest consisted of entities noted in the right column.)		- Director and Teachers of *Bandabari* School II - Chiefs of Education Services of Commune I, II, III - District Education Directorate (MEN) - MEN
5. Securities		- Police Station/CUN
6. Sits Cleaning		- NGOs
7. Publicity and Mobilization		- NGOs - Chiefs of Quarters (*Quartiers*)

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Table 24.2-3 THE MAIN THEME AND SLOGANS FOR THE CAMPAIGN

Item	No.	Contents	Panel No.
The Main Theme	1.	*Pour rester en bonne santé, il faut être propre sur soi et autour de soi* (For good health, keep clean yourself and your surroundings)	M-A_1
Other Slogans	2.	*La societé civile se mobilise contre l' insalubrité de la ville* (The civil society struggle against a unsanitary city)	M-A_2
	3.	*Un environnement salubre pour la protection de notrre cadre de vie* (Healthy environment is necessary for our living condition)	M-A_3
	4.	*Une ordure de plus des sous de moins* (Plenty of waste cause a waste of money)	M-A_4
	5.	*l'Usine Jyokaso notre bijou veillons à son entretien* (The *Jyokaso* is our treasure, take care of it)	M-A_5
	6.	*La propreté de la ville est l' affaire de tous* (Cleanliness of the city is our duty)	M-A_6
	7.	*Vire mieux c'est vivre propre* (Better life is from clean life)	M-A_7
	8.	*Une saleté de moins une saleté de plus* (Decreasing waste is improving health)	M-A_8

Note1: Translations of the main theme and the slogans in French into English are not authorized
Note2: The Panel No. See Table 24.3-1
Table: The JICA Study Team

(2) The 3rd Explanatory Meeting

1) Panels

The JICA Study Team produced some ten panels, most of which are painted about the main theme and the slogans decided by the Committee. For further details, see Table 24.3-1.

2) Management of a Drawing Contest

The Committee organized a sub-committee to manage and to evaluate a drawing contest. (See Table 24.2-2)

3) An Educational Video Film

The Committee discussed to borrow an educational video film on sanitation available in the MSP for a video-show program in the campaign, and decided that the Committee in cooperation with the MSP may select a film suitable for the show (see Section 24.2.4).

4) Finalizing the Campaign Program

The draft campaign program was modified in accordance with several opinions and requests expressed in the last meeting. The modified program was accepted and finalized by the Committee. (See Section 24.2.3)

5) Attendance and Questionnaire surveys

The JICA Study Team asked the Committee member to get their cooperation in the attendance and questionnaire surveys, which were planed to execute at each campaign site.

(3) The 4th Explanatory Meeting

1) The Committee's Tasks for the Campaign at the UASB & TF site

The Committee discussed the tasks of each member of the Committee for preparing and implementing the campaign at the UASB & TF site.

2) The Campaign Program of the UASB & TF site

As a review of the campaign at the *Jyokaso* site, it was apparent that the number of participants in the afternoon was less than in the morning on the first day. As well, most of the number of the participants (excluding schoolchildren) in the afternoon was less than in the morning on the second day (See Table 24.4-1). Therefore, some modification on the program of the UASB & TF site was made to expect a positive participation in the afternoon program in accordance with the review. The modification was that the program at the UASB & TF site might start at early in the morning and end at early stage in the afternoon without a launch break for three hours as a *Nigerian* custom. That is to say, the afternoon program was advanced to the last of the morning program. Finally, the committee accepted the modification.

3) The Final Explanatory Meeting

An announcement regarding the final explanatory meeting for evaluating each campaign, which might be hold at a suitable timing after the end of the campaign at the UASB & TF site was made to the Committee member.

(4) The 5th Explanatory Meeting (for the evaluation)

The Committee discussed and evaluated from preparation to implementation of the campaign. After the evaluation, the Committee made a recommendation for further activities on the campaign. For full details, see Section 24.4.4.

The meetings excluding the 1st meeting (see Chapter 13) are summarized in Table 24.2-4.

Table 24.2-4 EXPLANATORY MEETINGS

	The 2nd Explanatory Meeting	The 3rd Explanatory Meeting
Date	22nd June 2001	26th June 2001
Time	16:00. – 19:00	16:00 – 18:30
Venue	CUN Conference Room	CUN Conference Room
Participants	- Directors and Teachers of Elementary schools at each pilot project - Representatives of each district of the pilot projects - Representatives of local associations of each district of the pilot projects - Private Companies - NGOs - MET, MSP, MEN, CUN, Commune I, II,III - JICA Study Team - Others	- Directors and Teachers of Elementary schools at each pilot project - Representatives of each district of the pilot projects - Representatives of local associations of each district of the pilot projects - Private Companies - NGOs - MET, MSP, MEN, CUN, Commune I, II,III - JICA Study Team - Others
Main Topics	1. Explanation of an outline of the campaign and the core program prepared by the study team 2. Organizing a committee for the campaign 3. Discussion on tasks for each member of the committee 4. Discussion on the program for the campaign 5. Discussion the main theme and slogans for the campaign	1. Explanation on setting panels on *Jyokaso* and toilet at *Bandabari* School II 2. Drawing contest and it's management 3. Selections of educational video films in cooperation with MSP 4. Finalizing the campaign program 5. Explanation on questionnaire surveys and participants list at the campaign sites
	The 4th Explanatory Meeting	**The 5th Explanatory Meeting (Evaluation)**
Date	6th July 2001	20thJuly 2001
Time	16:00. – 19:00	16:30 – 19:00
Venue	CUN Conference Room	CUN Conference Room
Participants	- Directors of Elementary schools - Representatives of each district of the pilot projects - Representatives of local associations of each district of the pilot projects - Private Companies - NGOs - MET, MSP, MEN, CUN, Commune I, II,III - JICA Study Team - Others	- Directors and Teachers of Elementary schools at each pilot project - Representatives of each district of the pilot projects - Representatives of local associations of each district of the pilot projects - Private Companies - NGOs - MET, MSP, CUN, Commune I, II - JICA Study Team - Others
Main Topics	1. Discussion on tasks for each member of the committee for the campaign at *Deizebon* 2. Discussion on a modification of the program for the campaign 3. Announcement on the final explanatory meeting for evaluating the campaign	1. Evaluation on the preparation 2. Evaluation on the campaign implementation 3. Discussion on the results of the campaign 4. Recommendation

The JICA Study Team

24.2.3 The Campaign Program

The Committee discussed and finalized the campaign program as shown in Table 24.2-5 in accordance with the basic framework considered by the JICA Study Team and the following important points.

- To be schoolchildren and community oriented.
- To be a mutual cooperation between the private sector and the public sector.
- To be a mutual relationship between both campaign sites.
- To involve the Commune III.
- To coordinate the camping dates suitable for expecting a positive participation.

Table 24.2-5 THE CAMPAIGN PROGRAM

Sites	Date	Target Groups	Main Activities
Commune II (*Jhyokaso* System) site (*Bandabari* II School)	30th June (Saturday) & 1st July (Sunday) (Two-day campaign)	**1. Primary Target Group:** Schoolchildren of *Bandabari II* Primary School	**1. Observation** An observation tour to the *Jyokaso* system site
		2. Secondary Target Group: The teachers, the family members of the children and the community	**2. Exhibitions** **a. Exhibition 1:** Brief explanations of mechanism of the *Jyokaso* system and how to use the *Jyokaso* and the toilet facility with painted panels (two kinds) **b. Exhibition 2 :** Instructions of information on environmental sanitation and health with painted panels (ten different kinds) **c. Exhibition 3:** A showing of a video related to health and sanitation in cooperation with the MSP
			3. Special Program A chorus of variation songs on sanitation and a picture story show by the pupils of the school
			4. Drawing Contest A contest for drawing idea of sanitation improvement (Special target group : the fifth and the sixth grade pupils of the school)
			5. Strip Cartoon Distributing a strip cartoon on hygiene education to the participants. (five pages with five colors)
Commune I (UASB + TF system) site (Next to *Deizeibon* School)	7th July (Saturday) & 8th July (Sunday) (Two-day campaign)	**1. Primary Target Group:** Schoolchildren of *Deizebon* Primary School	**1. Observation** An observation tour to the UASB &TF site and a brief explanation of a mechanism of the UASB & TF system.
		2. Secondary Target Group: The teachers, the family members of the children and the community	**2. Exhibition** A showing of a video related to health and sanitation in cooperation with the MSP
			3. Strip Cartoon Distributing a strip cartoon on hygiene education to the participants. (five pages with five colors)
			4. Demonstration A demonstration of a cleansing activity at those of unsanitary locations in the commune.
			5. Presentations and Discussions **a.** A presentation and a discussion of experiences on sanitation improvement activities by the Director of *Bandabari* School II **b.** A presentation and a discussion of experiences on a toilet construction activity by the Commune III.

The JICA Study Team

24.2.4 Tools and Equipment for the Campaign

(1) Panels

Total 12 panels were produced and set up at the *Jyokaso* project site by the Study Team to explain and instruct related information on hygiene and sanitation to the pupils of the school. (See Table 24.3-1)

(2) A Strip Cartoon

A strip cartoon (five pages at four colors) was prepared by the Study Team to instruct related information on heightening public awareness on hygiene and sanitation in association with two pilot projects of the *Jyokaso* and the UASB & TF to the participants in the campaign. (See Appendix 1) The important points for considering the story are as follows;

- To be schoolchildren and community oriented.
- To be an attractive story to read.

- To inform briefly sanitation manners in association with two pilot projects.
- To inform briefly activities of the JICA Study Team.

(3) Tools for the Drawing Contest

The following tools were prepared by the Study Team to hold the drawing contest to the school pupils of the *Bandabari* School II.

- 300 sets of colored pencils (six colors)
- 300 sheets of a drawing paper
- Prizes (note books, pencils, rulers, compasses, others)

(4) The Educational Video Film

The Committee borrowed the educational video related to health and sanitation from the Ministry of Public Health (MSP) to hold the video-show in the campaign of which purposes were as follows;

- To heighten public awareness on sanitation through the video presentation
- To promote a multi-sectorial cooperation, namely the community side and the MSP.
- To utilize available equipment and tools at present in Niamey, namely the video film.

The video film was selected in cooperation with the MSP as shown in Table 24.2-6.

Table 24.2-6 THE SELECTED VIDEO FILM

The Title	: *Problematique des déchets solides et l'hygiéne environnmentale* (Problems on Solid Waste and Environmental Hygiene)
Produced by	: The Ministry of Public Health (MSP)
Production Year	: 1987
Languages	: *Haoussa* and *Zarma* (Local languages)
Time	: 120 minutes (60 min. / each language)

Source: The MSP
Note: (*The translation of the video title in French into English is not authorized*)

(5) Posters and Banners

Posters (A3 sized with three colors, See Photo 24.2-1 and Appendix 2) and banners (3m × 1m, See Photo 24.3-23) were prepared to disseminate the related information on the camping and the slogans as shown in Table 24.2-7 and Table 24.2-8.

Table 24.2-7 THE POSTERS AND BANNERS

Sites	Types	Contents
Jyokaso (*Bandabari*)	Poster-B	To advertise the related information on the campaign at the *Bandabari* site in advance, which include date, time, venue, the host, etc. (total 12 posters)
	Banner-B	To inform the main theme, some slogans and the information on the campaign at the *Bandabari* site. (Five different banners)
UASB&TF (*Deizebon*)	Poster-D	To advertise the related information on the campaign at the *Deizebon* site in advance, which include date, time, venue, the host, etc. (total 12 posters)
	Banner-D	To inform the main theme, some slogans and the information on the campaign at the *Deizebon* site. (Five different banners)

The JICA Study Team

Table 24.2-8 DISPLAYED LOCATIONS FOR THE POSTERS

The Posters for the Campaign at *Jyokaso* Site		The Posters for Campaign at UASB & TF Site	
CUN	1	CUN	1
Community I,II,III (One poster/ each)	3	Community 1, 2, 3 (One poster/ each)	3
Bandabari Primary School II	1	*Deizeibon* Primary School	1
MET	1	MET	1
A Gus Station	1	*Katako* Market	1
A sound car	1	*Tillabery* Bus Terminal	1
A quarter of *Bandabari*	2	A quarter of *Deizebon*	2
NGO's Offices (two offices)	2	NGO's Offices (two offices)	2
Total (Posters)	**12**	**Total** (Posters)	**12**

Note: The poster is A3sized with three colors (Red, Green and Black).
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(6) Audio -Visual Aids

Audiovisual-aids including a video deck, TV set and a public-address system were prepared for implementing the video-show and for convenience of the campaign.

(7) A Sound Car

In order to give advance publicity on the campaign to the population in *Niamey*, a sound car was prepared to go round *Niamey* for disseminating the related information as shown in Table 24.2-9. (See Photo 24.2-2)

Table 24.2-9 THE ADVANCE ADVERTISEMENT WITH A SOUND CAR

The Campaign	Implementation Date	Total Hours for the Advertisement		
		a.m. (hours)	p.m. (hours)	Total (hours)
For the Campaign at *Jyokaso* Site	29th June 2001	3	2	5
For the Campaign at UASB & TF Site	6th July 2001	2	2	4
Total	2 (days)	5	4	9

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(8) Others

The following were prepared for the implementation and convenience of the campaign.

- Invitation letters
- Day-by-day Programs
- Tents and Chairs
- Participants' registration lists
- Questionnaires

Photo 24.2-1 THE POSTER
(at the CUN Hall)

Photo 24.2-2 THE SOUND CAR

24.3 IMPLEMENTATION

The primary language used in the campaign was French. In addition to French, however, local languages of *Haoussa* and *Djerma* were appropriately and properly used as spoken languages.

24.3.1 The Campaign at the *Jyokaso* Site

(1) The First Day

1) The Morning Program

a. Opening

The campaign opened with prayer by religious priests and singing of variations of songs by a group of the pupils of *Bandabari* School II. Then the official opening addresses were given.

b. Observation to the *Jyokaso* Systems

All participants visited and observed the *Jyokaso* systems (includes the toilet facility and the ecological-pond). During the observation, an expert of the JICA Study Team explained briefly the mechanisms of the systems to the participants. (See Photo 24.3-1 and Photo 24.3-2)

Photo 24.3-1 THE *JYOKASO* SYSTEM

Photo 24.3-2 THE ECO-POND

c. Special Program by the school pupils of *Bandabari* School II

The school pupils sang several variations of songs on cleaning and sanitation, and told stories illustrated with picture cards related to health and the *Jyokaso* system. (See Photo 24.3-3 and Photo 24.3-4)

Photo 24.3-3 VARIATIONS OF SONGS
Explanation on Panels

Photo 24.3-4 STORIES ILLUSTRATED WITH PICTURE CARDS

The JICA study team explained 12 panels shown in Table 24.3-1, set up at the *Jyokaso* site, to the participants. (See Photo from 24.3-5 to 24.3-16, Table 24.2-3 and Appendix 3 and 4)

Table 24.3-1 PANELS

Size	Type	Contents
Large Sized (80×80cm)	Panel L-A	A brief illustrated explanation of the mechanism of the *Jyokaso* system and the water cycle in the environment.
	Panel L-B	A brief illustrated instruction of how-to use the pour flush toilet facility connecting with the *Jyokaso* system.
Medium Sized (50×30cm)	Panel M-A	A slogan (includes the main theme) with a symbolized illustration (Eight different panels; those eight slogans were discussed and selected by the campaign committee)
	Panel M-B	A brief instruction with a symbolized illustration on hand wash practices after toilet (Two different panels; one for the male toilet and another for the female toilet)

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Photo 24.3-5 PANEL L-A
(The *Jyokaso* Systems)

Photo 24.3-6 PANEL L-B
(How-to use the Toilet Facility)

Photo 24.3-7 PANEL M-A$_1$

Photo 24.3-8 PANEL M-A$_2$

Photo 24.3-9 PANEL M-A$_3$

Photo 24.3-10 PANEL M-A$_4$

Photo 24.3-11 PANEL M-A$_5$

Photo 24.3-12 PANEL M-A$_6$

Photo 24.3-13 Panel M-A$_7$

Photo 24.3-14 Panel M-A$_8$

Photo 24.3-15 PANEL M-B$_1$
(Wash your hand after toilet)
(for the female toilet)

Photo 24.3-16 PANEL M-B$_2$
(Wash your hand after toilet)
(for the male toilet)

2) Afternoon Program

As mentioned in Section 24.2.4, the video film titled "*Problematique des déchets solides et l'hygiéne environnementale*" was shown in the afternoon program (See Table 24.2-6). After the show a discussion (include a brief explanation) on the film was carried out among the participants, especially for the school children.

(2) The Second Day

1) The Morning Program

a. Drawing Contest

Some two hundred pupils of *Bandabari* School II participated in the drawing contest. For the subject of the contest, the sub-committee adopted the main theme of the campaign, which is "*Pour rester en bonne santé, il faut être propre sur soi et autour de soi* (for good health, keep clean you and your surroundings)". For approximately one hour, every pupil freely drew each idea on paper with six different colored pencils. (See Photo 24.3-17)

After the drawing time, the sub-committee gathered all paper from the pupils and evaluated them. (See Photo 24.3-18)

Photo 24.3-17 DRAWING CONTEST

Photo 24.3-18 EVALUATION

b. Cleaning Demonstration

During the contest, a cleaning demonstration program was implemented for other participants.

2) The Afternoon Program

a. The Results of the Drawing Contest

The sub-committee, consisted of 22 persons, announced the results of the drawing contest. As for the evaluation for the contest, the sub-committee established criteria for evaluating the contest. The criteria are that how much the following topics are incorporated into each drawing.

- Environmental Hygiene
- Corporal Cleanliness
- Expressive Sense

Based on the criteria, the sub-committee awarded the commendations for the contest to the certain number of the schoolchildren as shown in Table 24.3-2. (See Appendix 5)

Table 24.3-2 THE COMMENDATIONS AND PRIZES

Commendations	The Winners
The First Prize	6
The Second Prize	14
The Third Prize	21
The Participation and Encouragement Prize	165
The Total	206

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b. Distribution of the Strip Cartoon

Copies of the strip cartoon were distributed to the participants. (See Photo 24.3-19)

c. The Closing and Handing Over Ceremony

In the closing ceremony for the campaign at the *Jyokaso* site, the panels were handed over from JICA Study Team to *Bandabari* School II. (See Photo 24.3-20)

Photo 24.3-19 THE STRIP CARTOON

Photo 24.3-20 HANDING OVER (PANELS)

24.3.2 The Campaign at the UASB & TF site

The campaign was planned to hold in the UASB & TF site at first. However, due to the delay of the construction schedule of the plants, the venue was changed to *Deizebon* School, which is located at just next to the UASB & TF site.

(1) The First Day

1) The Morning Program

a. Opening

The campaign opened with prayer by religious priests and singing of variations of songs by a group of the pupils of *Bandabari* School II, the special participants in the campaign. Then the official opening addresses were given.

b. Observation to the UASB & TF site

All participants visited and observed the UASB & TF systems. In the observation, experts of the JICA Study Team and the counterpart team explained briefly the mechanisms of the systems to the participants. (See Photo 24.3-21 and Photo 24.3-22)

Photo 24.3-21 OBSERVATION (UASB)

PHOTO 24.3-22 OBSERVATION (TF)

2) The Afternoon Program

a. The Video Show

As mentioned in Section 24.2.4, the video film titled "*Problematique des déchets solides et l'hygiéne environnementale*" was shown in the afternoon program (See Table 24.2-6).

b. Discussion

After the show, a discussion (include a brief explanation) on the film was carried out among the participants, especially for the school children in cooperation with a health expert of the Commune I.

(2) The Second Day

1) The Morning Program

a. Presentation 1

The Director of *Bandabari* School II implemented a presentation regarding sanitation issues in *Niamey* and experiences on hygiene education to the school pupils.

b. Presentation 2

A Counterpart of the MET explained briefly the mechanism of the UASB + TF systems.

c. Presentation 3

A teacher of *Bandabari* School II told a story illustrated with picture cards related to sanitation. (The Commune III's presentation was cancelled for an emergency official duty.)

c. Observation to the UASB & TF site

Participants visited and observed the UASB & TF systems.

2) The Afternoon Program

a. A Cleaning Demonstration

A cleaning demonstration was carried out in the *Tillabery* Bus Terminal, next to the UASB & TF project site, to heighten public awareness on hygiene and sanitation to the participants as well as the workers in the terminal. (See Photo 24.3-22)

b. Distribution of the Strip Cartoon

Copies of the strip cartoon were distributed to the participants.

c. The Closing and Handing Over Ceremony

In the closing ceremony, two banners, which say the main theme and one of the slogans, were handed over from JICA Study Team to *Deizebon* School. (See Photo 24.3-23)

Photo 24.3-22 THE DEMONSTRATION

Photo 24.3-23 THE BANNERS

24.4 RESULT AND EVALUATION

24.4.1 The Campaign Process

The campaign process from preparation stage to evaluation stage is illustrated as follows.

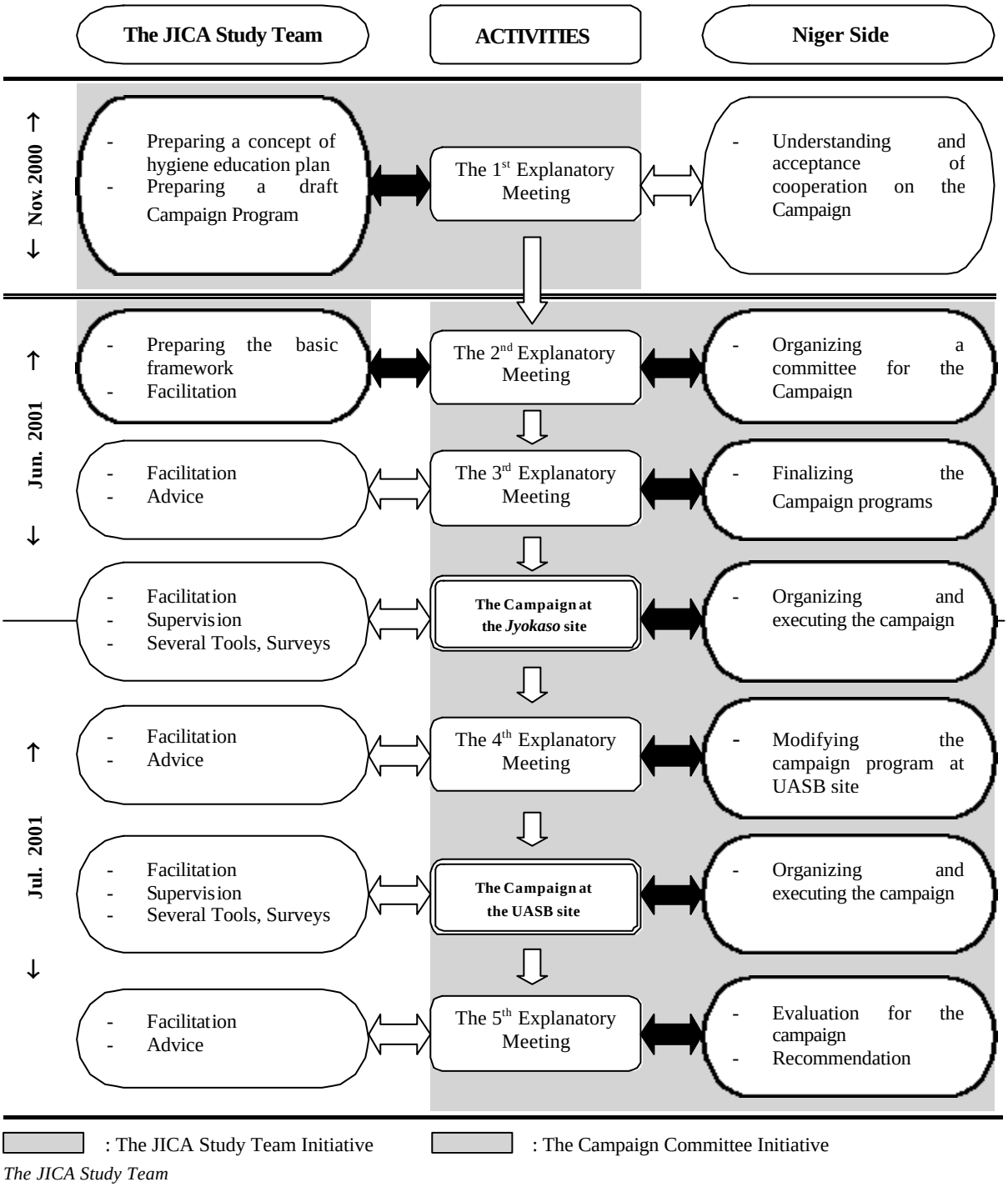

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Figure 24.4-1 THE CAMPAIGN PROCESS

24.4.2 The Participants

Table 24.4-1 shows data of the participants in the campaign as the results of the participation rate survey (see Appendix 6). According to the data, the participation in the campaign is evaluated as follows;

(1) The *Jyokaso* site (at *Bandabari* Primary School II)

- For each campaign-day at the *Jyokaso* site, total participants were more than 1,000 peoples as expected.
- The participants in the afternoon were less than the morning on the first day, as well as most of the participants excluding the categories of the schoolchildren and private companies & NGOs were the same on the second day.
- It may be supposed that the less participation in the afternoon was owing to the lunch break for three hours as a *Nigerian* custom.
- It is evaluated that the primary target group and the secondary group, especially the private sector, positively participated in the campaign.

(2) The UASB + TF site (at *Deizebon* Primary School)

- The total number of the participants in the first day was about 70% as expected, as well as in the second day was about 55%.
- It seems that the low participation, especially school children's participation, in both days was owing to the beginning of the long-term school vacation from July to October.
- It may be considered that the community showed relatively less interest in the campaign at *Deizebon* due to the implementation after one week of the campaign at the *Jyokaso* site.
- In spite of the negative circumstances above, however, it is evaluated that the primary target group and the secondary group, especially the private sector, adequately participated in the campaign.

Table 24.4-1 NUMBER OF THE PARTICIPANTS IN THE CAMPAIGN

SITE	DAY		The Target Groups							TOTAL
			Primary	Secondary						
			School Pupils	Pupils' Parents	School Teachers	Individuals	Community Delegates	Private Companies & NGOs	The Public Entities	
Jyokaso Site	The 1st day	a.m.	362	14	17	315	15	223	18	964
		p.m.	258	6	14	105	13	190	6	592
		total	620	20	31	420	28	413	24	1,556
	The 2nd day	a.m.	410	7	20	285	3	107	7	839
		p.m.	560	4	20	175	3	175	3	940
		total	970	11	40	460	6	282	10	1,779
	Subtotal 1		1,590	31	71	880	34	695	34	3,335
UASB & TF Site	The 1st day (am+pm)		260	20	4	320	7	60	20	691
	The 2nd day (am+pm)		140	12	6	140	3	220	31	552
	Subtotal 2		400	32	10	460	10	280	51	1,243
TOTAL (Subtotal 1+2)			1,990	63	81	1,340	44	975	85	4,578

The JICA Study Team

For the four days as a whole, however, the total participants were counted more than 4,000 peoples as expected.

24.4.3 Questionnaire Surveys

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.

(1) The Methodology

The method of the surveys is summarized as follows;

- The surveys firstly were conducted with questionnaire forms prepared in French on the sits every day.
- Secondly, for the participants who can not identify French, oral interview surveys in local languages were implemented in accordance with the questionnaire forms.
- As the samples, 100 participants were surveyed at random every day as shown in Table 24.4-2.

Table 24.4-2 THE SAMPLE NUMBER

Site	Day	Sample Number
Jyokaso Site	The 1st day	100
	The 2nd day	100
UASB & TF Site	The 1st day	100
	The 2nd day	100

The JICA Study Team

(2) The Survey Results

1) Participants

a. The Male-Female Ratio

Table 24.4-3 shows data on the male-female ration according to the age group of the participants in the campaign. According to the data, it can be identified that the total number of the male participants was larger than the total number of the female participants every day.

Table 24.4-3 THE MALE-FEMALE RATIO BY THE AGE GROUP (%)

Site	***Jyokaso* Site**						**UASB&TF Site**					
Day	1st day			2nd day			1st day			2nd day		
Sex	M	F	T	M	F	T	M	F	T	M	F	T
7-13	13	14	27	20	19	39	7	5	12	8	2	10
14-20	3	10	13	11	4	15	8	8	16	16	12	28
21-50	43	16	59	27	14	41	56	10	66	47	14	61
50-Over	1	0	1	2	3	5	5	1	6	1	0	1
Total	60	40	100	60	40	100	76	24	100	72	28	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

b. The Participants' Position and Status

Position and status of the participants was as shown in Table 24.4-4. According to the date, it can be evaluated that school pupils participated in the campaign the most every day, which were followed by the individuals and NGOs.

Table 24.4-4 POSITION AND STATUS OF PARTICIPANTS (%)

Site	***Jyokaso* Site**						**UASB&TF Site**					
Day	1st day			2nd day			1st day			2nd day		
Sex	M	F	T	M	F	T	M	F	T	M	F	T
a. A School Pupil	14	19	33	24	19	43	14	9	23	17	11	28
b. A School Teacher	5	3	8	1	0	1	2	4	6	2	3	5
c. A Parent of a School Pupil	6	1	7	1	1	2	5	1	6	3	2	5
d. An individual	13	7	20	11	14	25	25	5	30	5	1	6
e. A community entity	1	1	2	0	0	0	0	0	0	3	1	4
f. A NGO	12	3	15	22	5	27	20	5	25	24	3	27
g. A private company	3	2	5	0	1	1	1	0	1	8	3	11
h. A Municipal Official	1	0	1	0	0	0	3	0	3	3	0	3
i. A Commune Official	0	0	0	0	0	0	1	0	1	2	0	2
j. A Central Government Official	3	0	3	0	0	0	2	0	2	0	0	0
k. Other official entity	1	0	1	1	0	1	1	0	1	4	1	5
l. Others	1	4	5	0	0	0	2	0	2	2	1	3
Total	60	40	100	60	40	100	76	24	100	72	28	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

c. Information Sources

The information sources on the campaign are summarized as shown in Table 24.4-5. According the table, it is identified that 30-43 % of the participants got the information on the campaign in advance from local NGOs, which were followed by schoolteachers, the sound car, and the invitation letters.

Table 24.4-5 INFORMATION SOURCES ON THE CAMPAIGN (PEOPLES)

Site	***Jyokaso* Site**						**UASB&TF Site**					
Day	1st day			2nd day			1st day			2nd day		
Sex	M	F	T	M	F	T	M	F	T	M	F	T
a. Your Child of a School Pupil	1	2	3	2	1	3	2	1	3	0	0	0
b. A Schoolteacher	10	11	21	12	13	25	8	5	13	11	6	17
c. The Invitation Letter	3	3	6	8	4	12	13	2	15	7	6	13
d. A Community Entity	1	4	5	1	0	1	1	0	1	0	1	1
e. The CUN	2	0	2	8	2	10	3	0	3	2	1	3
f. Your Commune	0	0	0	0	0	0	0	0	0	1	1	2
g. A NGO	28	7	35	24	19	43	23	7	30	26	8	34
h. A Central Government Entity	0	0	0	0	0	0	1	0	1	0	0	0
i. The Poster	3	2	5	1	0	1	4	0	4	10	1	11
j. The Sound Car	9	11	20	4	1	5	20	9	29	6	1	7
k. The Mass Media	2	0	2	0	0	0	1	0	1	7	3	10
l. Others	1	0	1	0	0	0	0	0	0	2	0	2
Total	60	40	100	60	40	100	76	24	100	72	28	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

2) The Campaign Program

a. The *Jyokaso* Site (*Bandabari* Primary School II)

a.1. The most impressionable program

Table 24.4-5 shows data on the most impressionable program of the *Jyokaso* site campaign. It is identified that the observation tour to the *Jyokaso* systems was the most impressionable program in the first day, and the drawing competition was the most impressionable program in the second day.

Table 24.4-5 THE MOST IMPRESSIONABLE PROGRAM IN THE *JYOKASO* SITE

Day	Programs	M	F	T
The 1stday	a. The observation tour to the *Jyokaso* systems	23	8	31
	b. The Explanation on the *Jyokaso* systems and the toilet	9	8	17
	c. The variation of songs & stories illustrated with picture cards	2	9	11
	d. Explanation on the Panels	7	4	11
	e. Video show	8	4	12
	f. All programs of the 1st day	11	7	18
	total (1st day)	60	40	100
The 2nd day	a. Drawing Competition	23	19	42
	b. The demonstration	5	4	9
	c. Strip Carton and discussion on sanitation with participants	11	5	16
	d. Handing over ceremony for panels	2	1	3
	e. All programs of the 2nd day	19	11	30
	total (2nd day)	60	40	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

a.2. Not so impressionable program

Table 24.4-6 shows data on "not so impressionable program" of the *Jyokaso* site campaign. According to the data, it can be evaluated that about 40% of the participants fully satisfied with the program of both days.

Table 24.4-6 NOT SO IMPRESSIONABLE PROGRAM IN THE *JYOKASO* SITE

Day	Programs	M	F	T
The 1stday	a. The observation tour to the *Jyokaso* systems	9	9	18
	b. The Explanation on the *Jyokaso* systems and the toilet	9	4	13
	c. The variation of songs & stories illustrated with picture cards	7	8	15
	d. Explanation on the Panels	7	2	9
	e. Video show	5	2	7
	f. Nothing at all	23	15	38
	total (1st day)	60	40	100
The 2nd day	a. Drawing Competition	18	16	34
	b. The demonstration	6	3	9
	c. Strip Carton and discussion on sanitation with participants	4	3	7
	d. Handing over ceremony for panels	3	3	6
	e. Nothing at all	27	14	41
	(invalid answers due to a misprint in the questionnaire)	(2)	(1)	(3)
	total (2nd day)	60	40	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

a.3. The Panels

Table 24.4-7 shows evaluation for the panels. According to the data, it can be said that 50% of the participants in each day evaluates the panels are suitable for the explanation.

Table 24.4-7 THE PANELS IN THE *JYOKASO* SITE

Day	Evaluation	M	F	T
The 1st day	a. Suitable panels for the explanation	32	22	54
	b. Too childish information	4	3	7
	c. Too complicated information	1	0	1
	d. Not suitable for the explanation	8	3	11
	e. More information is necessary for the explanation	10	12	22
	f. I do not know	3	0	3
	g. Others	2	0	2
	total (1st day)	60	40	100
The 2nd day	a. Suitable panels for the explanation	29	20	49
	b. Too childish information	6	3	9
	c. Too complicated information)	3	1	4
	d. Not suitable for the explanation	0	1	1
	e. More information is necessary for the explanation	6	6	12
	f. I do not know	16	9	25
	g. Others	0	0	0
	total (2nd day)	60	40	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

a.4. Satisfaction with the Program

Table 24.4-8 shows feeling of the satisfaction with the program. According to the data, it is said that most of the participants (82%-96%) were satisfied with the program of the both days.

Table 24.4-8 THE SATISFACTION WITH THE PROGRAM OF THE *JYOKASO* SITE

Day	Evaluation	M	F	T
The 1st day	a. Satisfied	50	32	82
	b. Not Satisfied	4	6	10
	c. I do not know	6	1	7
	d. Others	0	1	1
	total (1st day)	60	40	100
The 2nd day	a. Satisfied	60	36	96
	b. Not Satisfied	0	1	1
	c. I do not know	0	3	3
	d. Others	0	0	0
	total (2nd day)	60	40	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

b. The UASB & TF Site (*Deizebon* Primary School)

b.1. The most impressionable program

Table 24.4-9 shows data on the most impressionable program of the UASB & TF site campaign. It is identified that the observation tour to the UASB & TF systems was the most impressionable program in the first day as well as in the second day.

Table 24.4-9 THE MOST IMPRESSIONABLE PROGRAM IN THE UASB & TF SITE

Day	Programs	M	F	T
The 1stday	a. The observation tour to the UASB & TF systems	41	9	50
	b. The Explanation on the UASB & TF systems	3	3	6
	c. The Video Show	13	4	17
	d. All programs of the 1st day	19	7	26
	e. The variation of songs & stories illustrated with picture cards	0	1	1
	total (1st day)	76	24	100
The 2nd day	a. The Explanation (UASB)	0	0	0
	b. The Presentation (*Bandabari*)	3	1	4
	b-1. The Discussion	3	1	4
	c. The observation on the UASB + TF	23	8	31
	d. The Demonstration	8	1	9
	e. All program of the 2nd day	16	7	23
	f. No answer	19	10	29
	total (2nd day)	72	28	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

b.2. Not so impressionable program

Table 24.4-10 shows data on "not so impressionable program" of the UASB & TF site campaign. According to the data, it can be evaluated that about 40% of the participants fully enjoyed all programs in the first day and 65 % of the participants fully enjoyed all programs in the second day.

Table 24.4-10 NOT SO IMPRESSIONABLE PROGRAM IN THE UASB & TF SITE

Day	Programs	M	F	T
The 1stday	a. The observation tour to the UASB & TF systems	21	8	29
	b. The Explanation on the UASB & TF systems	19	2	21
	c. The Video Show	5	5	10
	d. All programs of the 1st day	31	9	40
	e. The variation of songs & stories illustrated with picture cards	0	0	0
	total (1st day)	76	24	100
The 2nd day	a. The Explanation (UASB)	3	1	4
	b. The Presentation (*Bandabari*)	2	1	3
	b-1. The Discussion	3	1	4
	c. The observation on the UASB + TF	11	4	15
	d. The Demonstration	5	3	8
	e. All program of the 2nd day	47	18	65
	f. No answer	1	0	1
	total (2nd day)	72	28	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

b.3. The Satisfaction with the program

Table 24.4-11 shows feeling of the satisfaction with the program. According to the data, it is said that most of the participants (89%-90%) were satisfied with the program of both days.

Table 24.4-11 THE SATISFACTION WITH THE PROGRAM OF THE UASB & TF SITE

Day	Evaluation	M	F	T
The 1st day	a. Satisfied	68	21	89
	b. Not Satisfied	1	0	1
	c. I do not know	4	1	5
	d. Others	1	1	2
	No answer	2	1	3
	total (1st day)	76	24	100
The 2nd day	a. Satisfied	64	26	90
	b. Not Satisfied	7	0	7
	c. I do not know	1	2	3
	d. Others	0	0	0
	total (2nd day)	72	28	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

c. Willingness of further activities on hygiene campaigns

c.1. Hygiene campaigns

Table 24.4-12 shows data on willingness to participate in future hygiene campaigns. According to the data, it is evaluated that most of the participants (74%-89%) have willingness to participate in future hygiene campaigns.

Table 24.4-12 WILLINGNESS TO PARTICIPATE IN FUTURE HYGIENE CAMPAIGNS

Site	*Jyokaso* Site						UASB&TF Site					
Day	1st day			2nd day			1st day			2nd day		
Sex	M	F	T	M	F	T	M	F	T	M	F	T
a. Willingness to participate	48	30	78	53	36	89	58	16	74	61	21	82
b. Do not participate	3	3	6	2	1	3	2	0	2	5	5	10
c. I do not know	9	7	16	5	3	8	16	8	24	6	2	8
Total	60	40	100	60	40	100	76	24	100	72	28	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

c.2. Cooperation

Table 24.4-13 shows data on willingness to cooperate on future hygiene campaigns. According to the data, it is evaluated that most of the participants (78%-85%) have willingness to cooperate on future hygiene campaigns.

Table 24.4-13 WILLINGNESS TO COOPERATE ON FUTURE HYGIENE CAMPAIGNS

Site	*Jyokaso* Site						UASB&TF Site					
Day	1st day			2nd day			1st day			2nd day		
Sex	M	F	T	M	F	T	M	F	T	M	F	T
a. Willingness to Cooperate	53	25	78	50	35	85	65	20	85	61	21	82
b. Do not Cooperate	1	2	3	2	1	3	2	1	3	2	3	5
c. I do not know	6	12	18	8	4	12	9	3	12	9	4	13
Total	60	40	100	60	40	100	76	24	100	72	28	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

c.3. The Fields of the Next Campaign

Table 24.4-14 shows a field most suitable for the next related campaign in the field of sanitation. According to the data, it can be evaluated that solid waste issues as well as wastewater issues are suitable for the fields of the next campaign.

Table 24.4-14 THE FIELDS OF THE NEXT CAMPAIGN

Site	***Jyokaso* Site**						**UASB&TF Site**					
Day	1st day			2nd day			1st day			2nd day		
Sex	M	F	T	M	F	T	M	F	T	M	F	T
a. Solid waste issues	15	15	30	14	5	19	37	11	48	18	4	22
b. Wastewater issues	27	11	38	19	16	35	19	9	28	43	14	43
c. Heath and sanitation link	5	1	6	8	10	18	10	1	11	18	3	18
d. Urban environment	4	0	4	0	2	2	2	0	2	8	2	8
e. I do not know	4	1	4	4	2	6	5	3	8	7	4	7
f. Others	5	12	17	15	5	20	3	0	3	2	1	2
Total	60	40	100	60	40	100	76	24	100	72	28	100

The JICA Study Team
Note: M: Male, F: Female, T: Total

24.4.4 The Evaluation Meeting

(1) Evaluation for the Campaign

As mentioned at Section 24.2.2, at the 5th explanatory meeting, the Campaign Committee discussed and evaluated from preparation to implementation of the campaign. The evaluation can be summarized as follows.

1) The Preparation

- The schedule for the preparation was relatively tight.
- Information on the campaign in advance was 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.
- There were no alternative programs for the cancelled programs
- The awarded drawings were not utilized after the contest.
- 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*.

(2) 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 (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.

CHAPTER 25. RECOMMENDATIONS OF F/S

CHAPTER 25. RECOMMENDATIONS OF FEASIBILITY STUDY

25.1 SEWERAGE / DRAINAGE SYSTEM OUTLINE

25.1.1 General

The Feasibility Study area, Deizebon Zone (C3) has been selected as a priority project area. The area covers the already developed and highly urbanized Boukoki Zones.

The existing drainage facilities have been utilized as "combined sewer system". However these facilities neither cover all of the area nor some of them have enough capacity to drain all of the collected storm water. In addition, there is no wastewater treatment plant except the pilot UASB plant, which was constructed under the programs of this Study.

In this section, the effects of implementing of this project and the evaluations considering future developments are mentioned, as below.

25.1.2 Network of Sewerage/Drainage

In order to meet the environmental requirement and wastewater quality for the planning horizon, the implementation of the Sewerage/Drainage works will be necessary to the year 2005.

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)

25.1.3 Wastewater Treatment Plant

Based on the consideration of F/S, it is recommended to select a small Sewerage Zone for wastewater treatment. For the F/S area, Deizebon Wastewater Treatment Plant (WWTP) is chosen for a proposed site, which is located at Boukoki Area. The design capacity of Deizebon WWTP is calculated as 2,500 m^3/day based on daily average flow, and the treatment process adopted is UASB technology followed by polishing pond.

25.1.4 Appropriate Wastewater Treatment Process in Niger

According to the evaluation of Pilot Study, it is recommended that the UASB Process is suitable for domestic wastewater in Niger because of favorable climatic condition. Taking into consideration of the characteristics of raw sewerage, process design was carried out with high precision.

25.1.5 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.

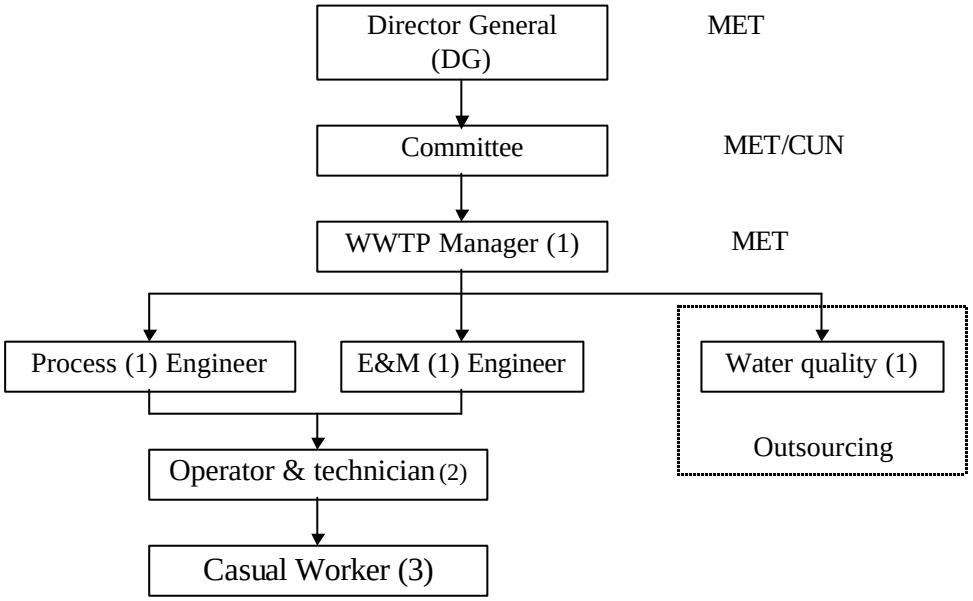
25.1.6 Recommendation for Management of Sewerage Project

1) Views on financial status in the future

The FIRR for this project considering the period until 2015 is still critical, though afterward it will improve. 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.

2) Review of organization to cope with the operation and maintenance of sewerage facilities

In the Master Plan a new organization that will later become public service corporation is proposed. However, to be more realistic, the existing organization, shown in Figure 25.1-1 has been set-up for operating and maintaining the Pilot Plant. And also the functions of each member in the existing organization are summarized in Table 25.1-1.



Note: Number in parenthesis shown the number of employees deployed.

Figure 25.1-1 TENTATIVELY PROPOSED ORGANIZATION CHART

In fact the existing organization's number of staffs is not enough for operating the Wastewater Plant of the Feasibility Study. The Study Team has already carried out the on the job Training and technical transfer to MET's Engineers and CUN's Technicians, and as of end of the Feasibility Study, they will acquire sufficient know-how of the plant operation through several months of pilot plant operation.

However, the existing organization should be expanded in accordance with future increase works in consultation with MET and CUN.

It is anticipated that difficulties may arise in the recruitment or the outsourcing process since qualified professionals in the field of wastewater treatment plant are neither sufficiently available within the existing MET's organization nor in local labor market. However,

securing the qualified engineers and experts either by recruitment or outsourcing, is an important aspect of the organizational arrangement especially at the initial stage of the Project.

Table 25.1-1 NECESSARY FUNCTIONS IN WWTP

Section Person in Charge	Functions
1. WWTP Manager	Organize, manage, check and evaluate the over all technical and administrative work of WWTP. Coordinate administrative and O&M activities and give proper orders to section heads. Report the development and progress of activities to the senior management.
2. Administrative Section Finance & Accounting Procurement Coordination and Public Relation Miscellaneous Works	 Make financial and accounting reports of WWTP operation. Take charge of procurement, supply and inventory control of materials used for O&M of WWTP operation. Coordinate with external organization in terms of Public relation about WWTP operation. - Perform secretarial works, clerical works, and guard facilities.
3. Process Section Section Head Operator / Technician Diver / Labor	 Take charge of O&M and monitoring of treatment process of each facility. Assist the section head. Take charge of direct control and supervision of routine O&M in treatment process in facilities. Drive vehicles and transport staff and sludge. Clean WWTP and perform miscellaneous tasks.
4. Mechanical & Electrical (M&E) Section Section Head Operator / Technician	 Take charge of O&M and monitoring of mechanical facilities. Assist the section head. Take charge of direct control and supervision of routine O&M, M&E facilities. Clean M&E facilities and perform miscellaneous tasks.
5. Water Quality Section (Outsourcing) Section Head Assistant / Staff	 Take charge of water quality analysis and operation of the laboratory. Take charge of direct control and supervision of routine O&M of laboratory facilities. Carry out on site wastewater quality tests and sampling for laboratory tests.

Under the circumstances that experienced and qualified staff is not readily available, it is important for MET & CUN staff, especially key personnel to go through proper training and acquire necessary skills and knowledge. The basic knowledge about O&M primarily comprises: (1) Role required for plant operator, (2) Process involved in WWTP, (3) Equipment used in WWTP, (4) Routine operation procedures, (5) Preventive maintenance procedures and (6) Safety.

25.2 SOLID WASTE MANAGEMENT

25.2.1 Pre-Collection and Sand Recycling

As described in Chapter 21.2, waste pre-collection and recycling sand activities shall be carried out by the private operators in close cooperation with CUN and Communes. 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 Niamey, 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 services fees of about 100 FCFA 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.

25.2.2 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 future development and further consideration for environment protection. The minimum project cost for the landfill site, as analyzed in the Master Plan, is shown the following Table 25.2-1 and 25.2-2 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 following Tables.

TABLE 25.2-1 PROJECT COST FOR DISPOSAL SITE KOUBIA

(1,000 FCFA)

Works	Land	Direct Cost	Engineering Cost	Contingency	Total
(1) Construction as Master Plan	255,000	141,304	14,130	61,565	**472,000**
(2) Addition 1 Grading and banking		1,214,850	121,485	200,450	**1,536,785**
(3) 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 25.2-2 PROJECT COST FOR DISPOSAL SITE BENGALE TOROMBI

(1,000 FCFA)

Works	Land	Direct Cost	Engineering Cost	Contingency	Total
(1) Construction as Master Plan	50,250	57,281	5,728	16,989	**130,248**
(2) Addition 1 Grading and banking		496,600	49,660	81,939	**628,199**
(3) 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**