REPUBLIC OF SENEGAL
NATIONAL OFFICE OF SANITATION OF SENEGAL
NATIONAL AGENCY FOR PUBLIC CLEANING OF SENEGAL

THE PROJECT FOR TREATMENT OF SEWAGE, RAINWATER AND WASTES IN KAOLACK CITY IN THE REPUBLIC OF SENEGAL

FINAL REPORT

Volume I: Summary

MARCH 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CTI ENGINEERING INTERNATIONAL CO., LTD
EARTH AND HUMAN CORPORATION

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COMPOSITION OF FINAL REPORT

Volume I	**:**	**Summary**
Volume II	**:**	**Main Report**
Volume II	**:**	**Main Report** **Drawings and Design Notes**

CURRENCY EXCHANGE RATES USED IN "PART I: MASTER PLAN STUDY" OF THIS REPORT:

EUR 1.00 =	FCFA 655.957 =	USD 1.305 = JPY 109.545
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(As of December 2012)

CURRENCY EXCHANGE RATES USED IN "PART II: FEASIBILITY STUDY" OF THIS REPORT:

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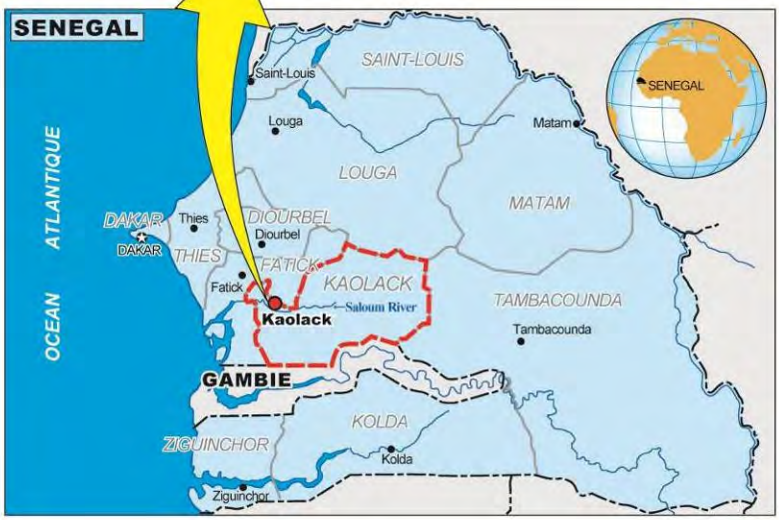
JPY 100.00 =	FCFA 505.051 =	USD 1.019 = EUR 0.769

(As of August 2013)

Note: Tables and Figures without indication of source were made based on data or information collected directly or analyzed independently by the JICA Expert Team.



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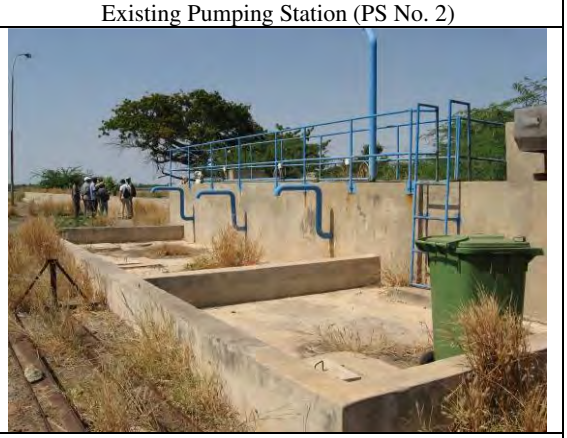

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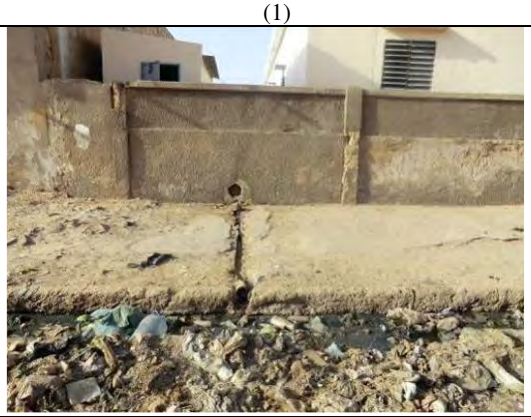
Illegal Dumping of Solid Waste and Sediment in Drain (2)



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ABBREVIATIONS

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Organizations, Programs and Projects

ADB	:	Asian Development Bank
BASD	:	Banque Asiatique de Développement
ADM	:	Municipal Development Agency
	:	Agence de Développement Municipal
AfDB	:	African Development Bank
BAD	:	Banque Africaine de Développement
AGETIP	:	Public Works and Employment Agency
	:	Agence d'Exécution des Travaux d'Intérêt Public contre le sous-emploi
ANAMS	:	Senegal National Meteorological Agency
	:	Agence Nationale de la Météorologie du Sénégal
ANSD	:	National Statistics and Demography Agency
	:	Agence Nationale de la Statistique et de la Démographie
APROSEN	:	National Agency for the Cleanliness of Senegal
	:	Agence Nationale pour la Propreté du Sénégal
APROFES	:	Association for the Promotion of Senegalese Women
	:	Association pour la Promotion de la Femme Sénégalaise
ASDES	:	Senegalese Association for Fair and Common Development
	:	Association Sénégalaise pour un Développement Equitable et Solidaire
BOAD	:	West African Development Bank
	:	Bank Ouest Africaine De Developpement
BTC	:	Belgian Technical Cooperation
CTB	:	Coopération Technique Belge
CBO	:	Community-Based Organization
OCB	:	Organisation Communautaire de Base
CDQ	:	Committee for the District Development
	:	Comité de Développement de Quartier
CODEKA	:	Committee for Development of Kaolack City
	:	Comité de Développement de la Commune de Kaolack
CRD	:	Regional Development Committee
	:	Comité Régional de Développement
DEEC	:	Directorate of Environment and Classified Establishments
	:	Direction de l'Environnement et des Etablissements Classés
DREEC	:	Regional Division of Environment and Classified Establishments
	:	Direction Régionale de l'Environnement et des Etablissements Classés
DTGC	:	Department of Geographical works and Mapping
	:	Direction des Travaux Géographiques et Cartographiques
EU	:	European Union
UE	:	Union Européenne
GIE	:	Economic Interest Group
	:	Groupements d'Intérêt Economique
IDA	:	International Development Association
	:	Association internationale de développement
IDB	:	Islamic Development Bank
BID	:	Banque Islamique de Développement
IMF	:	International Monetary Fund
FMI	:	Fonds Monétaire International
IU	:	Implementation Unit
	:	Unité de mise en œuvre
JICA	:	Japan International Cooperation Agency

	:	Agence japonaise de coopération internationale
LVIA	:	Lay Volunteers International Association
	:	Association internationale des volontaires laïcs
MEF	:	Ministry of Economy and Finance
	:	Ministère de l'Économie et des Finances
MEPN	:	Ministry of Environment and Nature Protection
	:	Ministère de l'Environnement et de la Protection de la Nature
ONAS	:	National Office of Sanitation of Senegal
	:	Office National de l'Assainissement du Sénégal
PAER	:	Kaolack Regional Environmental Action Plan
	:	Plan d'Action Environnemental Régional de Kaolack
PAQPUD	:	Dakar Peri-urban On-site Sanitation Program
	:	Programme d'Assainissement Autonome des Quartiers Périurbains de Dakar
PCLSLB	:	Project of Social Housing and Slum Prevention
	:	Projet de Construction de Logements Sociaux et de Lutte contre les Bidonvilles
PEPAM	:	Millennium Drinking Water and Sanitation Program
	:	Programme d'Eau Potable et d'Assainissement du Millénaire
PLT	:	Long Term water supply Project
	:	Projet eau à Long Terme
PMU	:	Project Management Unit
UGP	:	Unité de Gestion de Projet
PNAE	:	National Environmental Action Plan
	:	Plan National d'Action pour l'Environnement
PNGD	:	National Program for Solid Waste Management
	:	Programme National de Gestion des Déchets
PRECOL	:	Program of Strengthening and Equipping Local Government
	:	Programme de Renforcement et d'Equipement des Collectivités Locales
PSE	:	Water Sector Project
	:	Projet Sectoriel Eau
S/C	:	Steering Committee
C/P	:	Comité de Pilotage
SDE	:	Senegalese Water
	:	Sénégalaise Des Eaux
SENELEC	:	Senegal Electric Power Supply Company
	:	Societé Nationale d'Électricité
SONES	:	National Water Company of Senegal
	:	Société Nationale des Eaux du Sénégal
SOPROSEN	:	Company for the Cleanliness of Senegal
	:	Société pour la Propreté du Sénégal
SRA	:	Regional Sanitation Service
	:	Service Régional de l'Assainissement
STC	:	Service Technique Communal
	:	Service Technique Communal
T/C	:	Technical Committee
C/T	:	Comité Technique
UCG	:	Solid Waste Management Coordination Unit
	:	Unité de Coordination de la Gestion des déchets solides
UN	:	United Nations
ONU	:	Organisation des Nations Unies
UNDP	:	United Nations Development Programme
PNUD	:	Programme des Nations Unies pour le Développement

WB	:	World Bank
BM	:	Banque Mondiale

Technical Terms

AL	:	Aerated Lagoon
LA	:	Lagunage Aéré
ASP	:	Activated Sludge Process
PBA	:	Procédé à Boues Activées
BOD_5	:	Biochemical Oxygen Demand
DBO_5	:	Demande Biologique en Oxygène
B/S	:	Balance Sheet
	:	Bilan
COD_{Cr}	:	Chemical Oxygen Demand
DCO	:	Demande Chimique en Oxygène
EA	:	Environmental Audit
AE	:	Audit Environnemental
EIA	:	Environmental Impact Assessment
EIE	:	Etude d'Impact sur l'Environnement
HRT	:	Hydraulic Retention Time
TRH	:	Temps de Rétention Hydraulique
IEC	:	Information, Education and Communication
IEC	:	Information, Education et Communication
OD	:	Oxidation Ditch
FO	:	Fossé d'Oxydation
P/L	:	Profit-and-Loss
	:	Profits et pertes
RC	:	Reinforced Concrete
	:	Béton armé
SEA	:	Strategic Environmental Assessment
EES	:	Evaluation Environnementale Stratégique
SLSC	:	Standard Least Squares Criterion
	:	Critère des moindres carrés standard
STP	:	Sewage Treatment Plant
STEP	:	Station d'Epuration des eaux usées
SWM	:	Solid Waste Management
GDS	:	Gestion des Déchets Solides
TSS	:	Total Suspended Solids
	:	Total des Solides en Suspension
T-N	:	Total Nitrogen
	:	Azote total
T-P	:	Total Phosphorus
	:	Phosphore total
T/S	:	Transfer Site
	:	Site de transfert (relais)
PET	:	Polyethylene Terephthalate
	:	Polyéthylène Téréphtalate
PS	:	Pumping Station
SP	:	Station de Pompage
PVC	:	Polyvinyl Chloride
	:	Polyvinylchloride

Others

CM	:	Cubic Meter
	:	Mètre cube
DPES	:	Document of Economic and Social Policies
	:	Document de Politique Economique et Sociale
DSRP	:	Poverty Reduction Strategy Paper
	:	Document de stratégie pour la réduction de la pauvreté
EIRR	:	Economic Internal Rate of Return
TREI	:	Taux de Rentabilité Eonomique Interne
E/N	:	Exchange of Notes
	:	Echange de Notes
FC	:	Foreign Currency
	:	Monnaie étrangère
FCFA	:	Franc of the African Financial Community
	:	Franc de la Communauté Financière Africaine
FIRR	:	Financial Internal Rate of Return
TRFI	:	Taux de Rentabilité Financière Interne
F/S	:	Feasibility Study
E/F	:	Etude de Faisabilité
GDP	:	Gross Domestic Product
PIB	:	Produit Intérieur Brut
GNI	:	Gross National Income
RNB	:	Revenu National Brut
IEE	:	Initial Environmental Assessment
EEI	:	Evaluation Environnementale Initiale
IRR	:	Internal Rate of Return
TRI	:	Taux de Rendement Interne
JET	:	JICA Expert Team
EEJ	:	Equipe d'Experts de la JICA
L/A	:	Loan Agreement
A/P	:	Accord de Prêt
LC	:	Local Currency
	:	Monnaie locale
LPSERN	:	The Environment and Natural Resources Sector Policy Letter
	:	Lettre de Politique Sectorielle de l'Environnement et des Ressources Naturelles
MDGs	:	Millennium Development Goals
OMD	:	Objectifs du Millénaire pour le Développement
M/P	:	Master Plan
	:	Plan Directeur
NPV	:	Net Present Value
VAN	:	Valeur Actuelle Nette
NGO	:	Non-governmental Organization
ONG	:	Organisation Non Gouvernementale
O&M	:	Operation and Maintenance
	:	Exploitation et maintenance
OP	:	Operational Policy
PO	:	Politique Opérationnelle
ROC	:	Garbage Transportation by Carts
	:	Ramassage des Ordures par Charrettes
SCF	:	Standard Conversion Factor
FCS	:	Facteur de Conversion Standard

TOR	:	Terms of Reference
	:	Termes de Référence
USD	:	United States Dollar
	:	Dollar des Etats-Unis
VAT	:	Value Added Tax
TVA	:	Taxe à la Valeur Ajoutée
WTP	:	Willingness-To-Pay
VDP	:	Volonté De Payer

PART I MASTER PLAN

CHAPTER 1. INTRODUCTION

1.1 Background

Kaolack City is one of the major cities in the Republic of Senegal with a population of about 270,000 in 2012. However, sewage, rainwater and solid wastes are not being treated properly, resulting in its poor sanitary and environmental conditions. In addition, its Master Plan on hygienic environment has never been updated since its formulation in 1979. In order to improve the sanitary and environmental conditions overall, revision of the Master Plan is urgently necessary. In parallel with the Master Plan, a sewage treatment plant and a sewer network have been constructed in the early 1980's. A primary drainage canal network has been constructed as well, but only in the central part of the city.

Regarding solid waste management, deterioration of equipment has been so serious that the collection rate remained at 25% in 2007. Although three transfer stations and one final disposal site exist in the city, all of them employ the open dumping method and there are also no heavy equipment for land-leveling and truck scales. The situation is getting worse, not only due to the type of hauling system, but also because of the lack of proper transfer and disposal sites.

Kaolack City formulated a Master Plan for solid waste management (SWM) with the technical assistance from APROSEN in 2008. This Master Plan was not, however, implemented due to financial constraints. Therefore, the International Development Bank (IDB) integrated this Master Plan into its 4 major urban solid waste management projects, which formed the IDB's SWM Project. In this situation, solid waste management part of the Master Plan shall be limited to preliminary level including review of the APROSEN's Master Plan and the IDB project, and preparation of recommendations for future necessary actions.

Considering such conditions in Kaolack City, the Government of the Republic of Senegal (hereinafter called "the Government of Senegal") had requested assistance from the Government of Japan. In response to the request, the Government of Japan decided to conduct the "Project for Treatment of Sewage, Rainwater and Wastes in Kaolack City" (hereinafter called "the Project"). Accordingly, the Japan International Cooperation Agency (hereinafter called "JICA"), which is the official agency responsible for the implementation of technical cooperation programs of the Government of Japan, has jointly undertaken the Project with the authorities concerned in the Government of Senegal. The Project was commenced in November 2011 and completed in March 2014.

1.2 Project Objectives

The objectives of the Project are:

(1) To review the existing planning and current conditions of sewerage, stormwater drainage and solid waste management in Kaolack City;

(2) To compile the Master Plan of sewerage, stormwater drainage and solid waste management in Kaolack City;

(3) To conduct a Feasibility Study for highly prioritized areas; and

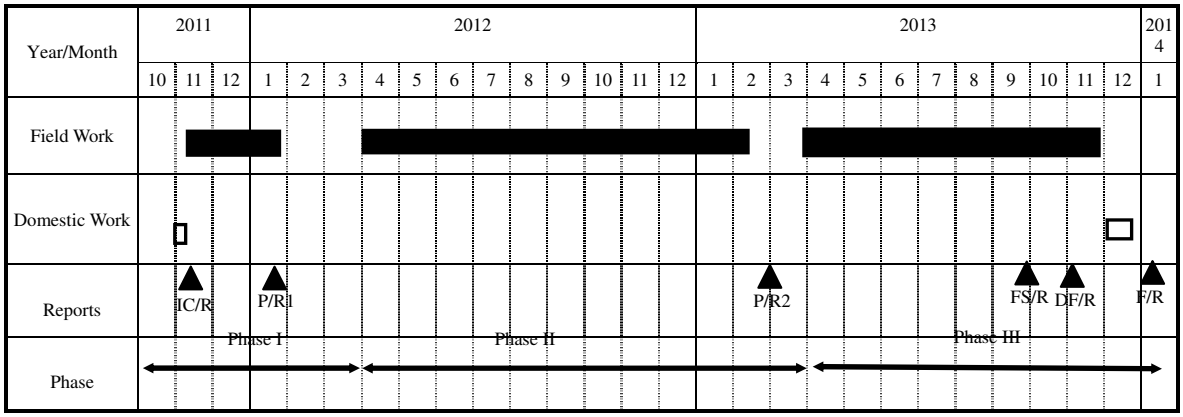
(4) To transfer relevant skills and technologies to personnel concerned in Senegal in the course of the Project.

1.3 Project Area

The Project is to cover the entire area of Kaolack City, Senegal.

1.4 Project Schedule

The Project is to be carried out in accordance with the schedule shown in **Fig. 1.1**. The project implementation period is about 27 months. Various reports are to be submitted periodically as shown in the same figure.



Legend : IC/R: Inception Report; P/R1: Progress Report 1; P/R2: Progress Report 2; FS/R: Feasibility Study Report; DF/R: Draft Final Report; F/R: Final Report

Phase I : Collection of basic information on sewerage, rainwater drainage and solid waste management

Phase II : Compiling of Master Plan of sewerage, rainwater drainage and solid waste management

Phase III : Feasibility Study on the highly prioritized projects

Fig. 1.1 Overall Project Schedule

1.5 Members of the JICA Expert Team

The JICA Expert Team members are as shown in **Table 1.1**.

Table 1.1 Members of the JICA Expert Team

Name	Designation / Field of Specialty
Kanehiro MORISHITA	Team Leader / Sewerage Planning (I) / Drainage Planning
Hitoshi SHIMOKOCHI	Co-Team Leader / Sewage Facilities Design / Sewerage Planning (II)
Koji KUSAKA	Sewer Design (Master Plan)
Kousiro YASUOKA	Sewer Design (Feasibility Study)
Kazuyoshi FUJIMOTO	Drainage Design
Keigo ITO	Solid Waste Management
Jun KAKINUMA	Environmental and Social Considerations
Tatsuji ITO	Construction Planning / Cost Estimate
Makoto YAJIMA	Economic and Financial Analysis / Institutional Considerations
Tsuyoshi KAWAMOTO	Administrative Coordination / Sewer Design Assistant
Louis HANEDA	Interpretation

CHAPTER 2. BASIC CONDITIONS

2.1 Outline of Kaolack City

2.1.1 General

Kaolack City, the capital of Kaolack Region, is located at about 190 km to the southeast of Dakar City, with crossover points of National Road Route No. 1 for the East-West border of Senegal, and Route No. 4 and No. 5 for the North-South. In addition, the City has road links with the 4 international borders; i.e., with Mali, Gambia, Guinea and Guinea Bissau. Located along the right bank of the Saloum River, the City has the land area of 145.14 km^2. Topographically, Kaolack City is very flat, and geologically, sandy and salty soils dominate the entire city area.

Kaolack City is under the following administrative structure of Kaolack Region and is divided into 43 districts based on the latest data in 2012 provided by the Kaolack City Government. The number of districts differs among the related documents from the viewpoint of urbanization.

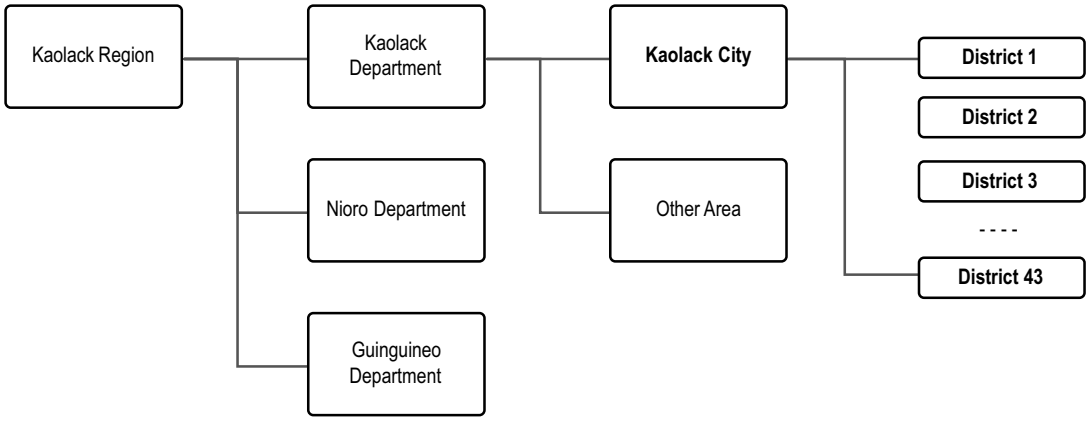


Fig. 2.1 Administrative Structure of Kaolack Region

Population data for Kaolack City have been collected from several sources. Since the numbers are not the same, issues regarding the population have been discussed further in Chapter 3.

2.1.2 Water Supply

In Kaolack City, groundwater is pumped up from deep wells and supplied from water towers to the households, commercial establishments and administrative facilities. The existing and near future expansion service areas are about 19.5 km^2 and 6.6 km^2. Based on the January 2007 to August 2011 data provided by the Senegal Water Company (SDE), water consumption in the City has been gradually increasing due to rapid urbanization, as shown in **Table 2.1** and **Fig. 2.2 (Left)**. Daily average of water consumption was calculated at 17,950 m^3/day, of which 14,515 m^3/day was for domestic and 3,435 m^3/day was for commercial use in 2011. The ratio of commercial to domestic in the 5 years approximately ranged from 0.20 to 0.25%.

Thus, the domestic water consumption of 70 and 45 L/capita/day, as well as the average of 58 L/capita/day, were estimated in 2011, as shown in **Fig. 2.2 (Right).**

Table 2.1 Daily Average Water Consumption in Kaolack City

	Unit	2007	2008	2009	2010	2011
Domestic	m^3/day	9,845	10,195	10,615	14,326	14,515
Commercial [1)]	m^3/day	2,373	2,229	2,076	3,654	3,435
Total	m^3/day	12,218	12,424	12,691	17,980	17,950
Ratio of Commercial to Domestic	Ratio	0.241	0.219	0.196	0.255	0.237

Note: 1) Commercial includes consumption for administrative use.

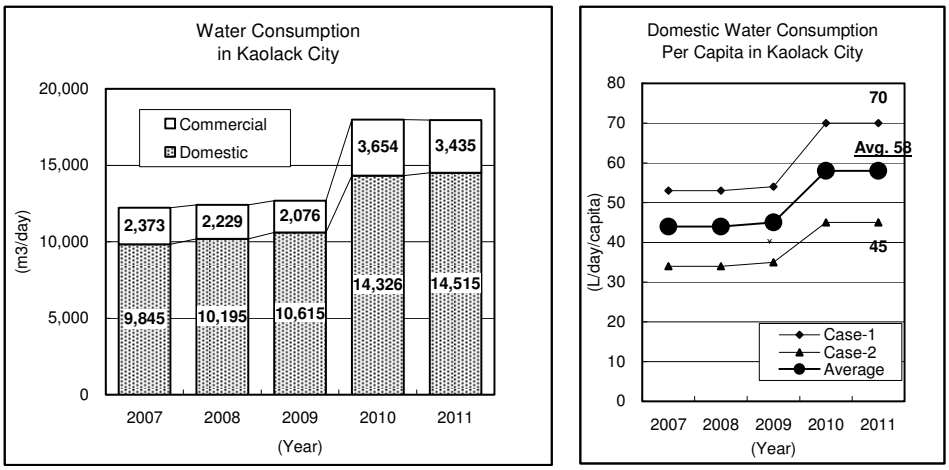


Fig. 2.2 Trend of Water Consumption in Kaolack City

2.1.3 Meteorology

(1) Data and Sources

A climatological station exists in Kaolack City, i.e., at 16°04 W in Longitude, 14°08 N in Latitude, and 6 m in altitude. In the Kaolack Climatological Station, there are two kinds of meteorological data stored: one is the summarized long-term meteorological record for the period 1971-2000, and the other is the monthly meteorological observation sheet from 1998 up to present.

Furthermore, short duration rainfalls at 10 minute interval were observed by the JICA Expert Team in the rainy season of 2012. Utilizing both daily and short duration rainfall data, the design rainfall has been prepared for the storm drainage improvement in the Project.

(2) Long-Term Monthly Temperature and Rainfall

Maximum, average and minimum values of long-term monthly temperature and monthly rainfall are summarized in **Table 2.2**, and **Fig. 2.3**. As indicated, there are two distinct local climates, the dry season from December to April resulting from the northeast winter winds, and the rainy season from June to October resulting from the southwest summer winds. The annual rainfall of about 560 mm mainly occurs between June and October. The maximum temperature of about 35°C and minimum of about 25°C are approximately constant in the wet season while the maximum temperature of about 35 to 40°C and minimum of about 20°C occur in the dry season.

Regarding monthly rainfall, 40% of the annual amount occurs in August, and about 87% of it concentrates only for 3 months, from July to September.

Table 2.2 Monthly Average Temperature and Rainfall in Kaolack

Month	Temperature (°C)			Rainfall (mm)
	Maximum	Average	Minimum	
January	34.4	26.0	17.6	1.0
February	37.1	27.9	18.7	1.0
March	38.8	29.4	20.0	0.0
April	40.3	30.7	21.1	0.0
May	39.8	31.0	22.2	3.0

June	37.2	30.6	23.9	31.0
July	34.7	29.6	24.4	122.0
August	33.3	28.7	24.1	222.0
September	33.7	28.8	23.9	139.0
October	36.2	29.9	23.6	40.0
November	37.1	29.0	20.9	1.0
December	34.6	26.2	17.8	1.0
Total				561.0

Source: Kaolack Climatological Station

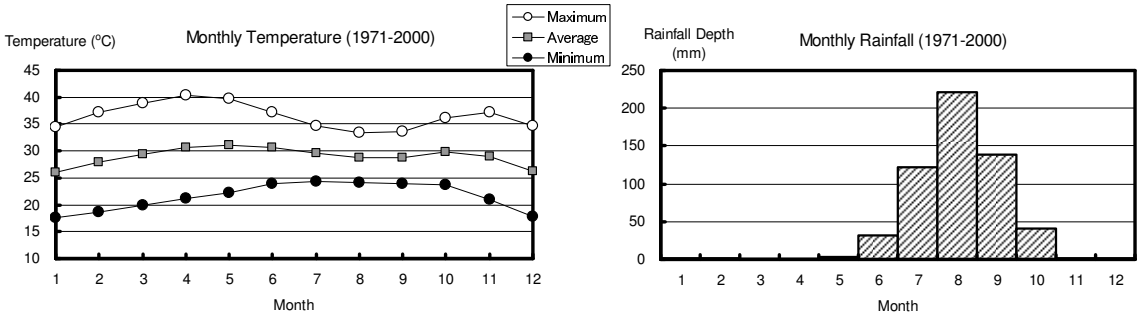


Fig. 2.3 Monthly Average Temperature and Rainfall in Kaolack for 30 Years from 1971 to 2000

(3) Design Rainfall

Among rainfall observation data at the Kaolack Climatologic Station of the Senegal National Meteorological Agency (ANAMS), probability analysis has been made for stormwater management planning using the annual maximum daily rainfall monitored for 14 years from 1998 to 2012. By comparing with the probable rainfall intensity curves prepared for Dakar, the following formulae have been developed: 2-year: I = 3,451.2 / (T+36.9); 5-year: I = 4,638.8 / (T+36.9); 10-year; I = 5,427.8 / (T+36.9); where, I is rainfall intensity in mm/hour, and T is its duration in minutes.

During the 2012 rainy season, the JICA Expert Team (JET) set up the monitoring instrument at the roof of the project office and observed short duration rainfall at 10 minute intervals. Based on the observation results, a 10-year design storm with 3 hours duration is proposed for the stormwater management in Kaolack City.

2.1.4 Others

Saloum River, whose flow and water level is influenced by tide, is located at the southern boundary of Kaolack City, receiving wastewater and stormwater collected in the City as well as treated water from the Kaolack STP. Unfortunately, no stream flow and water quality data was available, but the river width of about 300 m and the large volume of water together with the large-scale shipping of salt may be enough to dilute the water treated from the Kaolack STP.

Since no environmental water quality standard has been set for Saloum River, ONAS evaluated the STP's condition with the discharge criteria : BOD_5 = 40 mg/l, COD_{Cr} = 100 mg/l, TSS = 50 mg/l and Fecal coliform = 2,000 CFU/100ml.

In Kaolack City, surface water is not available except from Saloum River. However, the water quality of the Saloum River is not suitable for drinking and agriculture use due to the high saline concentration. Instead, the water is diverted to the salt farms for the production of salt.

The irrigation system in Kaolack City has not been developed. Small wells are utilized for small-scale farming.

2.2 Economy and Organizations

2.2.1 Economic Aspects of Senegal

(1) GDP

Senegal's per capita GDP was USD 1,119 in 2011, which was still below the USD 1,136 in 2008. Senegal experienced the influence of the world economic recession in 2008-2009, and the GDP was a little lower than the mean of Sub-Saharan African developing countries. Senegal has not recovered from the 2009 decline in 2011 and thus widening the difference with the Sub-Saharan African developing countries.

Table 2.3 Per Capita GDP (Current USD)

Year	2007	2008	2009	2010	2011
Senegal	986	1,136	1,055	1,034	1,119
Sub-Saharan Africa	1,097	1,220	1,131	1,293	1,424

Source: The World Bank

(2) Inflation

Before the economic recession in 2008-2009, Senegal's inflation rate has been increasing rapidly and it showed a negative figure in 2009. The inflation rate has always been lower than the mean for Sub-Saharan African developing countries, similar to the situations in the economic growth.

Table 2.4 Inflation (%, GDP Deflator)

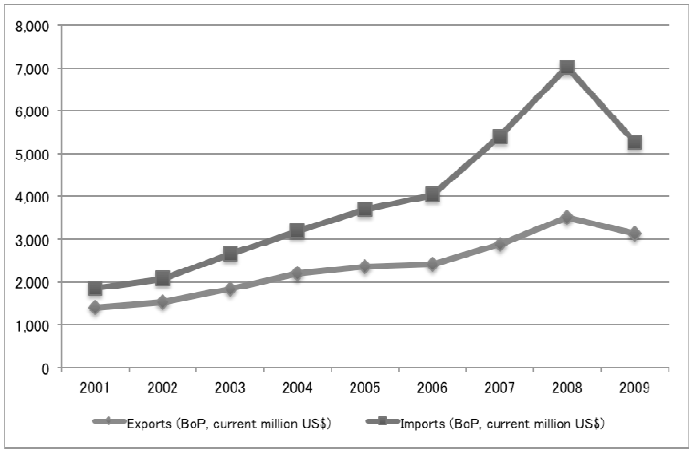
Year	2007	2008	2009	2010	2011
Senegal	5.6	6.5	-1.5	1.4	3.2
Sub-Saharan Africa	7.3	11.0	4.2	6.9	8.0

Source: The World Bank

(3) International Balance of Payments

Senegal has always shown a deficit in its balance of payment and the deficit is increasing.

Unit: Current Million USD



Source: The World Bank

Fig. 2.4 Exports and Imports of Goods and Services

2.2.2 Related Organizations

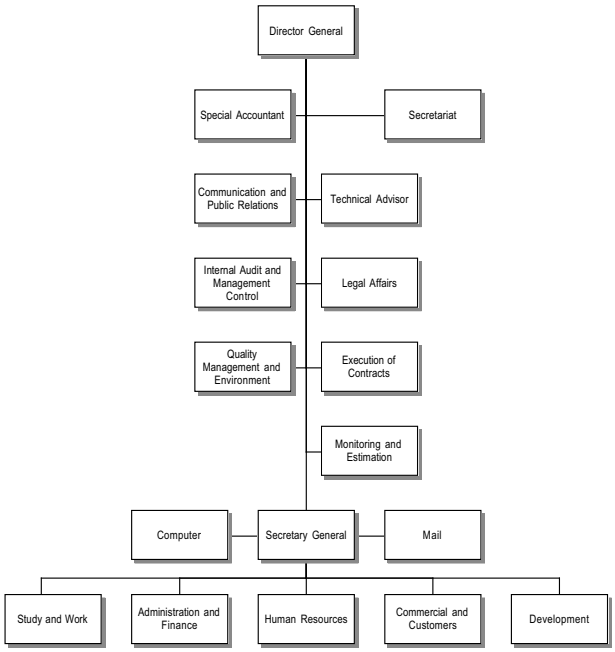
(1) National Office of Sanitation of Senegal (ONAS: Office National de l'Assainissement du Sénégal)

ONAS is the government agency under the Ministry of Hydraulics and Sanitation responsible for sanitation. It was established in 1996 and based on the enabling law and regulations, the missions of ONAS are as follows:

- Planning of projects on wastewater and stormwater infrastructure;
- Management of the projects;
- Operation and maintenance of wastewater and stormwater facilities;
- Development of on-site sanitation systems;
- Utilization of the sludge from wastewater treatment plants; and
- Management of sanitation fee.

In the ONAS budget, ordinary expenses are covered by sales of its services, while investment costs are covered by the government budget. ONAS has to report its expenditures to the Government every 3 months. In 2010, its total budget was 6.62 billion FCFA while its expenditure was 7.23 billion FCFA. Thus the balance of ordinary budget showed a deficit.

The total number of workers was 182 in 2009. The share of executives is high for over 30% of ONAS personnel and that of laborers is very low. The organizational chart of ONAS is shown in the following figure.



Source: ONAS

Fig. 2.5 Organizational Structure of ONAS

(2) National Agency for Public Cleaning of Senegal (APROSEN: Agence Nationale pour la Propreté du Sénégal)

APROSEN was established in 2010 under the supervision of the Ministry of Living for technical matters and the Ministry of Finance for financial matters. APROSEN aimed to establish and maintain a clean living environment by ensuring constant monitoring. Its missions were:

- To ensure all activities of public cleansing, recollection, collection, transport and storage of solid waste on behalf of local governments;
- To develop a pipeline of biochemical waste and slaughterhouse waste for disposal within acceptable environmental conditions;
- To manage all equipment and infrastructure for waste management;
- To support the government in the legislation of solid waste management;
- To conduct studies for improvement of living conditions; and
- To provide extensive information and public education on waste management.

APROSEN had 11 management staff and 46 support staff.

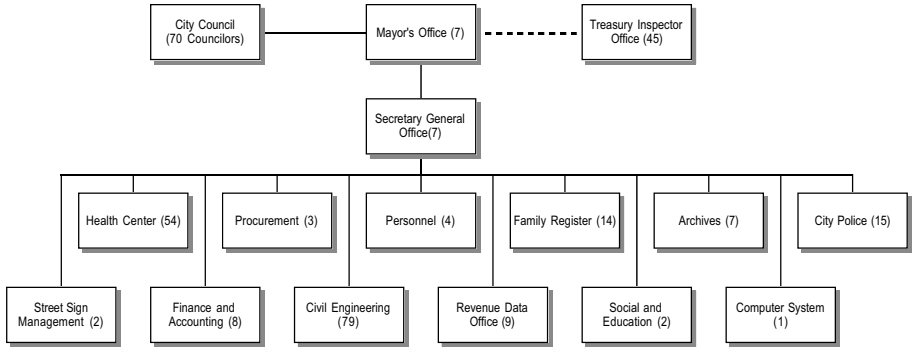
It has been abolished and only the APROSEN Kaolack office remained functional for the lending of

equipment and dissemination of information to the public in February 2013. APROSEN came under the Ministry of Regional Planning and Local Government, and its employees have remained as government employees of the Ministry. The National Assembly has to decide on the system to be set after the abolition of APROSEN.

(3) Kaolack City

The Mayor of Kaolack City is elected from among the city councilors by mutual voting. The City Council has 70 councilors elected by the city residents for a term of 5 years.

The number of staff was 280 (196 males, 84 females) as of December 2011. There are 2 types of promotion for the staff, namely; periodical promotion and special promotion. In periodical promotion, city personnel are automatically promoted every 2 years. Special promotion is decided by the 8 municipal advisors designated by the Mayor. Staff recruitment is made only by the Mayor. According to the regulation, city personnel cannot be removed from office even if the Mayor who recruited them is changed by election.



Note: Figures in parentheses indicate the number of office personnel.
Source: Kaolack City

Fig. 2.6 Organization of Kaolack City

Senegal's fiscal year begins on the 1st day of January and ends on the 31st day of December. If the budget in a fiscal year is not fully expended, the balance is carried over to the next fiscal year. The draft budget is approved by the City Council and then by the Ministry of Economy and Finance (MEF). The budget is eventually controlled by the central government. The reason why some amounts remain at the end of a fiscal year is because MEF allocates the budget to the account of the city government several months after the beginning of a fiscal year. The amount remaining at the end of a fiscal year is then carried over to the next fiscal year and used as the operating fund for salaries and some other necessary payments in the beginning of the next fiscal year.

As can be seen in many other developing countries, even if the draft budget is approved, the budget or amount of funds actually allocated to the account is usually less than the approved amount. Under this situation, it is very difficult for the city government to conduct business in accordance with its plans, or to draft long-term plans. The total budget and expenditures in the recent years are as shown below.

Table 2.5 Total Budget of Kaolack City

Unit: billion FCFA

Year	2009	2010	2011
Revenue	1.69	1.91	1.79
Expenditures	1.56	1.70	1.57

Source: Kaolack City

2.3 Sewerage

2.3.1 Sewer Network

A major part of the sewer network in Kaolack City has been installed in the 1980's, in parallel with the formulation of the Master Plan[1] in 1982. The remaining part has been constructed by the succeeding sewer network expansion projects under the World Bank and the IDB in the 2000's. In addition, PRECOL (Programme de Renforcement et d'Equipment des Collectivities Locales) has been developing the sewer network in the northeast area as of 2012. At present, as illustrated in **Fig. 2.7**, there is an existing trunk sewer of 7.97 km in length, and 4 pumping stations in the Kaolack sewer network excluding the area under PRECOL. The existing network covers a service area of 3.03 km^2, with about 17,330 population connected, as computed using 50% of connection rate to the network. Compared with the city center which has the total area of 19 km^2 and a population of 245,000 in 2012, the progress of the sewer service is estimated to be 16% of area and 7% of population at present.

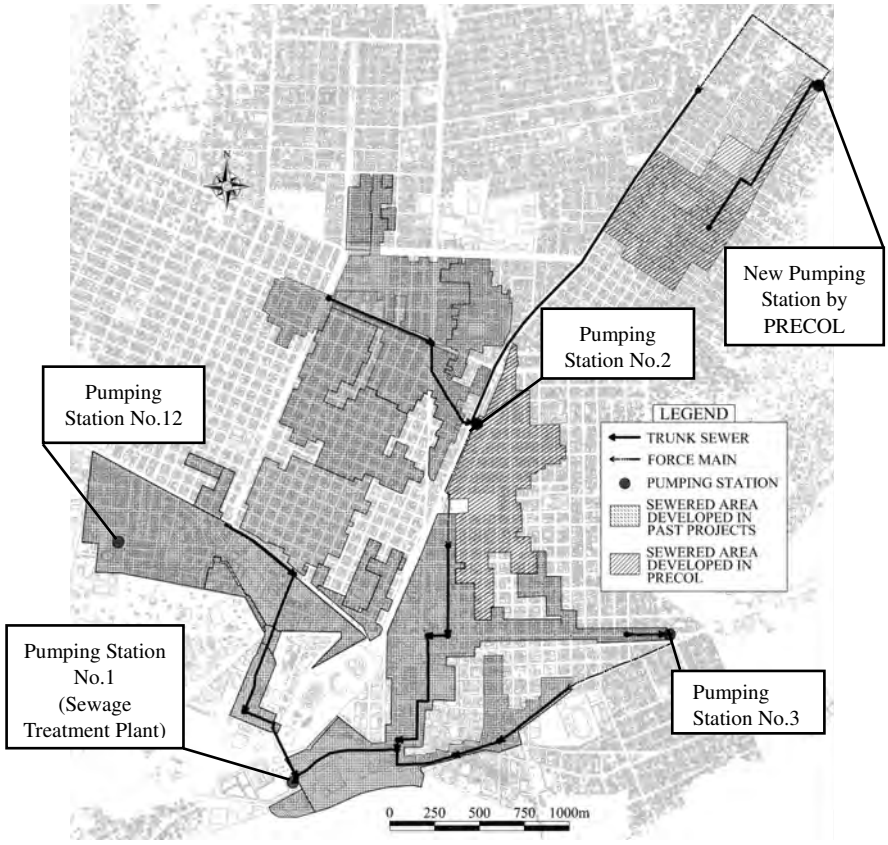


Fig. 2.7 Service Area and Sewer Pipe Network including PRECOL

The current issues identified in the existing sewer network are: (1) maintenance works against pipe clogging; and (2) deterioration/aging of installed pipes. The main maintenance work which is being implemented routinely is the "unblocking" of sewer pipes to clear the clogged portions of the sewer network by manual or hydrodynamic method. On the other hand, the sewer pipes made of asbestos concrete installed in the 1980's have significantly deteriorated and may collapse if mechanical hydro-pressure by water jet is applied. The asbestos concrete sewer pipes were installed in 1980s, and they were not replaced until now so that those pipes have been deteriorated significantly and some parts of the aged pipes have frequently collapsed.

[1] This Master Plan was formulated by the Department of Sewerage Services, Ministry of Hydraulics (Ministère de l'Hydraulique, Direction de l'Assainnissement), with the financial assistance from the Government of Italy.

2.3.2 Sewage Treatment Plant

The Kaolack Sewage Treatment Plant started operations in 1981 in parallel with the formulation of the previous Master Plan. With the initial capacity of 2,000 m^3/day, the treatment method was the lagoon type. In 2006, with the assistance from IDB, the construction of an aerated lagoon having the maximum capacity of 6,000 m^3/day was started by replacing one of the existing lagoons to augment the plant's capacity. Unfortunately, construction of the aerated lagoon was not completed, so that it was not completely handed over by IDB and hence it did not become operational. Some of the aerators in the aerated lagoon were turned over by IDB, and a part of the waterproof sheets were torn out.

As shown in **Fig. 2.8**, the treatment plant consists of the pumping station, the grit chamber, lagoons and the chlorination chamber. The pumping station has 2 units of pumping equipment with the capacity of 75 m^3/h and 95 m^3/h respectively. The grit chamber with a surface area of about 18 m^2 and constructed with the assistance from IDB, is located at the subsequent stage of the pumping station, but it is almost filled with sand and sludge because the installed desludging pumps could not be operated without being handed over from IDB.

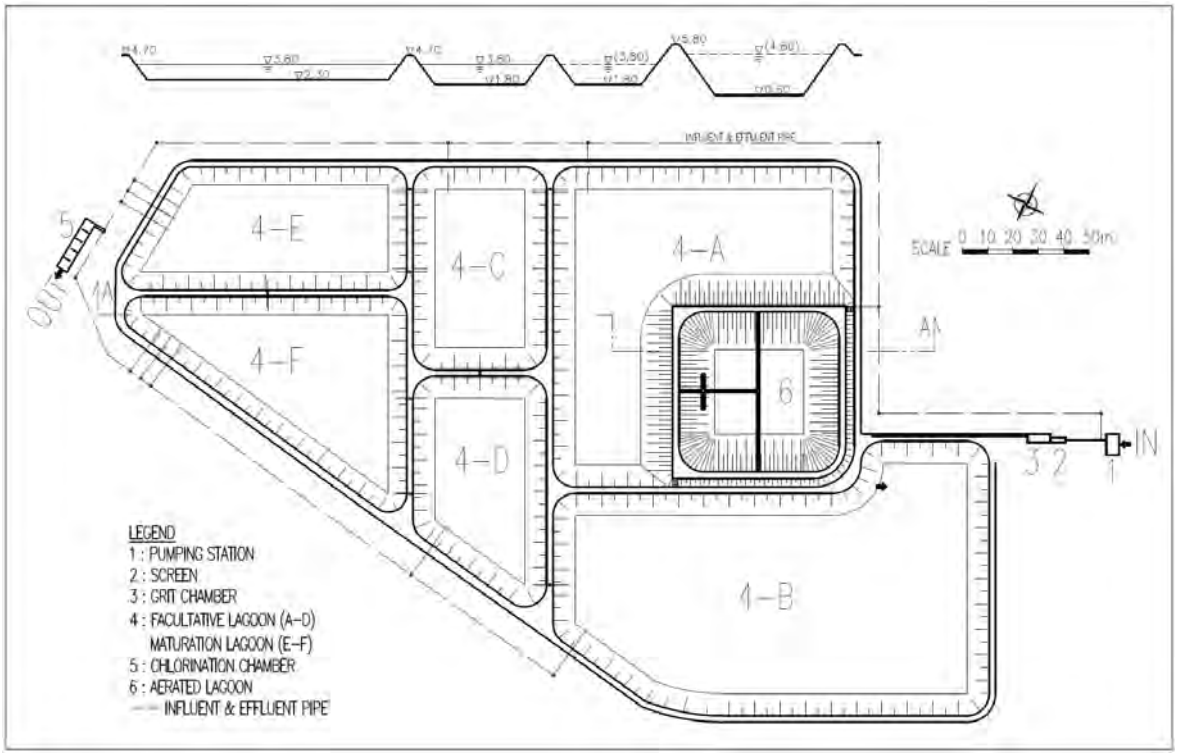


Fig. 2.8 General Plan of Kaolack Sewage Treatment Plant

The lagoon is initially comprised of 6 ponds, of which 4 ponds are facultative ones and the others are maturation ones. A facultative lagoon of 4-A in **Fig 2.8** is not functioning and dry up since influent pipe of the lagoon was removed when aerated lagoon was constructed. In the facultative lagoons, organic substances as well as suspended solids are removed by biodegradation and/or sedimentation. Residual organic substances not removed in the preceding facultative ponds are degraded and some disinfection is taken place in the maturation ponds. The chlorination chamber, which has a volume of about 40 m^3, might be the device to complete the disinfection. Treated water is finally discharged into the Saloum River.

The initial lagoon's hydraulic retention time (HRT) is 36 days against the initial design inflow of 2,000 m^3/day, which is relatively long and results in an advantage for overloading. Treatment capacity of 1,000 m^3/day of the current lagoon in which 5 ponds are operated could be maintained, in case of repairing the discharge weir and desludging of all the ponds. Regarding the monitored inflow to the STP, it generally exceeds 2,500 m^3/day in the rainy season while fluctuation of inflow is relatively big, from about 1,000 to 2,500 m^3/day in the dry season.

Regarding monitored inflow to the STP, it generally exceeded 2,500 m^3/day in the rainy season, while fluctuation of inflow was relatively big which ranges about 1,000 to 2,500 m^3/day in the dry season.

On the other hand, water quality of the inflow and outflow is sampled about 3 times a year, and the monitored parameters are 10 in total, namely; temperature, pH, TSS, COD_{Cr}, BOD_5, T N, T P, electric conductivity, salinity, and fecal coliform. BOD_5, COD_{Cr} and TSS concentrations of inflow in the recent two years, 2011 to 2012, ranged from 60 to 420 mg/l, 243 to 960 mg/l and from 94 to 507 mg/l, respectively, excluding the data when the STP malfunctioned or the trunk sewer was under maintenance by flushing. All the effluent BOD_5, ranging from 45 mg/l to 120 mg/l in this period, exceeded the discharge criteria of 40 mg/l (0% compliance with discharge criteria). All of the fecal coliform values also exceeded the discharge criteria, which might have arisen from insufficient chlorine dosing. However, some data of 70 to 120 mg/l in BOD_5 especially in the dry season were not so seriously deteriorated although the STP was overloaded. As for COD_{Cr} and TSS, compliance with the discharge criteria of 0% and 25% was achieved in the same period. To control the deterioration of water quality, the desludging of lagoons is urgently necessary.

2.4 Stormwater Drainage

2.4.1 Existing Stormwater Drainage Network

In 1982, "The Urban Storm and Wastewater Sanitation Master Plan[2] in Kaolack" was formulated with the target year of 2000. Both urban storm drainage and wastewater sanitation works were set up in the step-wise improvement program in the Master Plan. At present, however, only a brief report on the Master Plan could be accessed. There are no design drawings available, including longitudinal canal profile and cross section of the canal system, as well as the planning details for stormwater management.

Data on the existing drainage system is very limited. The Kaolack City has a list of the 34 existing drains maintained by the city, however, it has no location map and no specific data such as type, and dimensions including length. Therefore, an inventory survey on the existing drains was carried out to identify in this Study. ONAS has a drainage network map in AutoCAD file, but there is also no specific data. Aside from the 34 existing drains mentioned above, however, some drains are additionally shown in this map. According to Kaolack City, there were earth canals and drainage pipes installed in the past, but it could not find the drainage pipes during the inventory survey. However, Kaolack City requested that the drainage data in the map should be kept for future drainage planning reference.

A stormwater drainage network has been installed in the central part of Kaolack City. The total length of drains which maintained by Kaolack City is 19.96 km, and consist of 12.38 km long open drains and 7.58 km long covered drains. The existing drainage system covers 7.79 km^2 of the drainage area in Kaolack City.

Most of the open drains are clogged with sediment and various kinds of refuse as shown in **Photo 2.1**. Garbage disposal into the canals, as well as sediment accumulation, has strongly affected the flow capacity of canals.

[2] This Master Plan was formulated by the Department of Sewerage Services, Ministry of Hydraulics (Ministère de l'Hydraulique, Direction de l'Assainnissement), with the financial assistance from the Government of Italy.

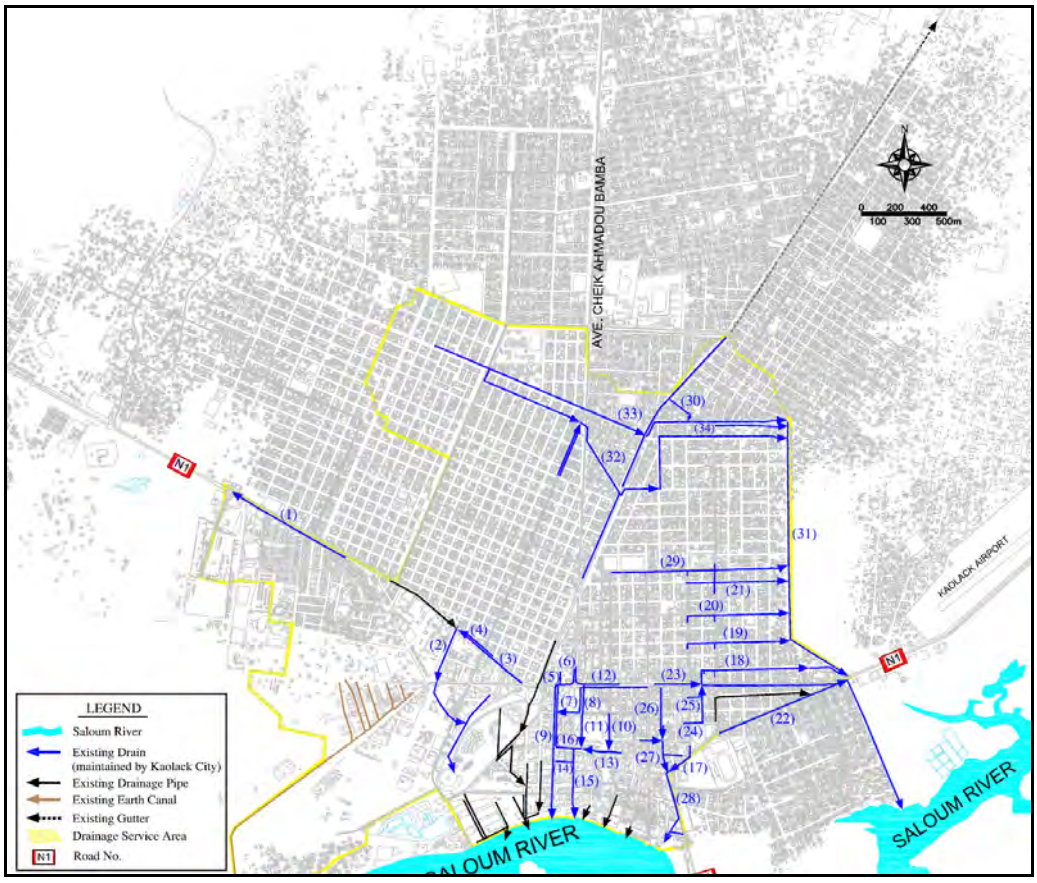


Fig. 2.9 Existing Drainage Networks in Kaolack

Drain No. (32)

Drain No. (21)

Photo 2.1 Drainage Canal Clogged with Sediment and Refuse

A number of sewers are connected to the open drains as shown in **Photo 2.2**. In the dry season, water mainly composed of domestic wastewater stagnates and thus worsening the urban environment due to the offensive odor and bad scenery.

Drain No. (18)

Drain No. (19)

Photo 2.2 Sewer Pipes from Residence

2.4.2 Maintenance of Drainage Network

The Kaolack City Government is the organization responsible for the maintenance of drainage networks in Kaolack. The STC (Service Technique Communal) of Kaolack City with a total of 99 personnel is in charge of operation and maintenance works. STC has a maintenance plan to clean the drainage networks once a year before the onset of the rainy season, and it entrusts the cleaning work to a private company selected by tender. The cost of cleaning works was about 10.4 million FCFA in 2011. The cleaning work consists of removal of garbage and hauling them to a dumping site.

2.4.3 Flooding Conditions

In Kaolack City, there is no system to monitor the flooding condition such as inundation depth and duration. Therefore, records on past floods are very limited. Flooding conditions were, therefore, clarified through the interview survey with the households. Habitual flooding areas were identified based on the results of discussion with STC, ONAS and Fire Station, and the field survey. There were 10 habitual flooding areas identified. Details of the flooding condition are shown in **Fig. 2.10**.

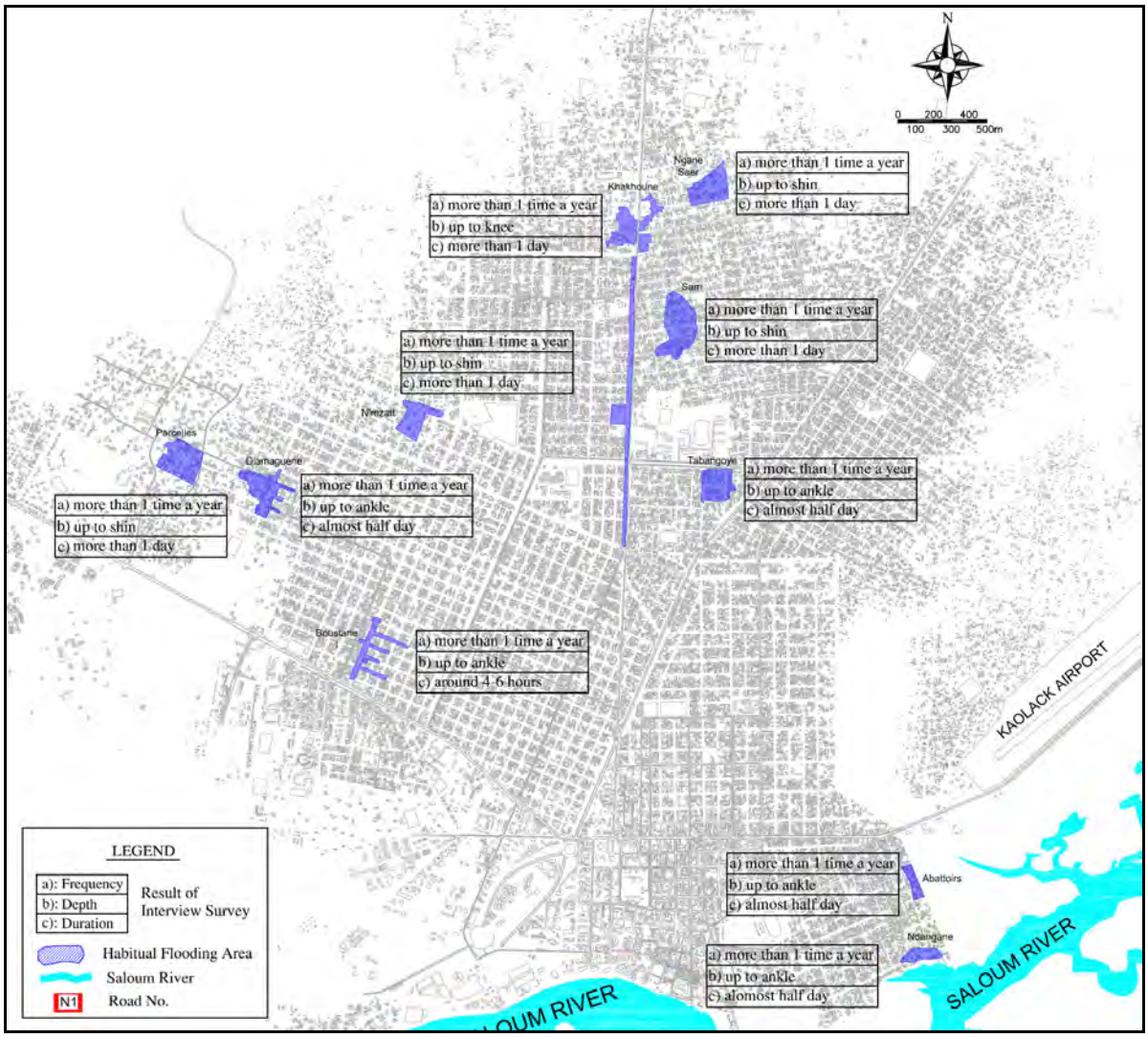


Fig. 2.10 Flooding Condition in Kaolack City

2.5 Solid Waste Management

2.5.1 General Condition of Solid Waste Management

In Kaolack City, the deterioration of equipment for collection and transportation is so serious that the waste collection rate remained at 25% in 2007, covering only the central part of the city and the markets. The condition is getting worse, and there are now many illegal waste disposal areas in the residential areas. There is a final disposal site for the city, but it employs the open dumping method. Besides, there are no heavy equipment for land-leveling and truck scales at the site.

On the other hand, a Master Plan of solid waste management (SWM) for Kaolack City was prepared with technical assistance from APROSEN in 2008. The City Government had endorsed the Master Plan, and intended to undertake the SWM in accordance with the plan.

In the City Government of Kaolack, the Technical Services is in charge of SWM issues. The Technical Services has 7 sections, namely; Clean-up & Road Construction, Electricity, Wood Work, Masonry Work, Mechanical, Drainage, and Open Space. The Clean-up & Road Construction Section has jurisdiction over not only SWM but also the construction of roads which is done by contract with private contractors.

The annual budget for SWM is allocated from the general revenue. The budget for clean-up & roads (waste services) in 2010 was 242 million FCFA or 65.7% of the budget for technical services. On the

other hand, 126 million FCFA or 52.2% of the budget was expended for the Clean-up and Road Construction Section.

2.5.2 Master Plan

Kaolack City formulated the Master Plan for SWM in 2008 with technical assistance from APROSEN, and prepared the report of "Study for the Operational Implementation System of Solid Waste Sustainable Management in Kaolack City, 2007 & 2008".

The Master Plan had set up the overall objective of SWM for the city, as well as the objectives of each sector, including road/street cleaning, pre-collection and collection, final disposal, and IEC (Information, Education and Communication) campaign, as summarized in the following table. According to the Technical Services, the 2008 Master Plan is being used as the comprehensive plan of SWM for the city.

Table 2.6 Objective of the 2008 Master Plan for Kaolack City

Overall Objective	To realize a technically possible, financially feasible and sustainable SWM for the city.
Road/Street Cleaning	To keep city roads and streets clean.
Collection	To ensure the application of selectable waste collection means as well as transportation means to a final disposal site.
Final Disposal	To ensure the construction of a technically possible and environmentally feasible final disposal site in accordance with the related laws and ordinances.

Source: Kaolack City

2.5.3 Current Solid Waste Management System

(1) Collection and Transportation System

In 2007, the City's waste collection system covered only 5 districts, namely; Leona, Kasnack Noro, Kasnack Sud, Kassaville and Bongre, including the central market areas. At that time, there were 5 compactors (capacity: 16 m^3/vehicle) for the collection and transport of wastes, i.e., 4 of the 5 compactors were used to cover all of the 5 districts and 1 compactor for the central markets. The total waste generation of Kaolack City in 2007 was estimated at about 125 tons/day based on the specific generation rate of 0.49 kg/person/day, and the collection rate was 30 ton/day. On the other hand, in 2010, there were only 2 compactors (capacity: 20 m^3/vehicle) for the same 5 districts including the central markets. The situations are summarized in **Table 2.7**.

Based on the above estimates, the collection rate of 25% in 2007 was reduced to 12% or the waste generation amount of 17 tons/day in 2010. According to the collected information, however, 1 of the 2 compactors which were used by the contracted private service provider had become nonfunctional, and as a result, the collection rate dropped to only 6% in the entire city area of Kaolack in 2011.

Table 2.7 Waste Generation and Collection in 2007 and 2010

Year	Waste Generation [1)] (ton/day)	Amount Collected (ton/day)	Collection Rate (%)	Collection Equipment	Coverage Area
2007	125	30	25	5 compactors (capacity: 16 m^3/vehicle)	Leona, Kasnack Noro Kasnack Sud, Kassaville Bongre, including central markets
2010	136	17	12	2 compactors (capacity: 20 m^3/vehicle)	

Note [1)]: Waste generation is calculated using specific generation of 0.49 kg/person/day
Source: APROSEN, Kaolack City

Due to very poor current collection system of waste disposals in the city, unofficial private citizens have now made up groups and collect the charge fee of 750[3] FCFA per household for waste collection in some districts. However, in pre-collective process, most of them carry pre-collected wastes by donkey-truck and dump them at illegal waste sites in the districts of the City. The current waste collection and transportation system in Kaolack City is categorized into the following

[3] This value is a minimum one, compared with the average monthly waste collection fee of 1,000 FCFA/ household in Kaolack.

2 ways.

Table 2.8 Current Waste Collection and Transportation System in Kaolack City

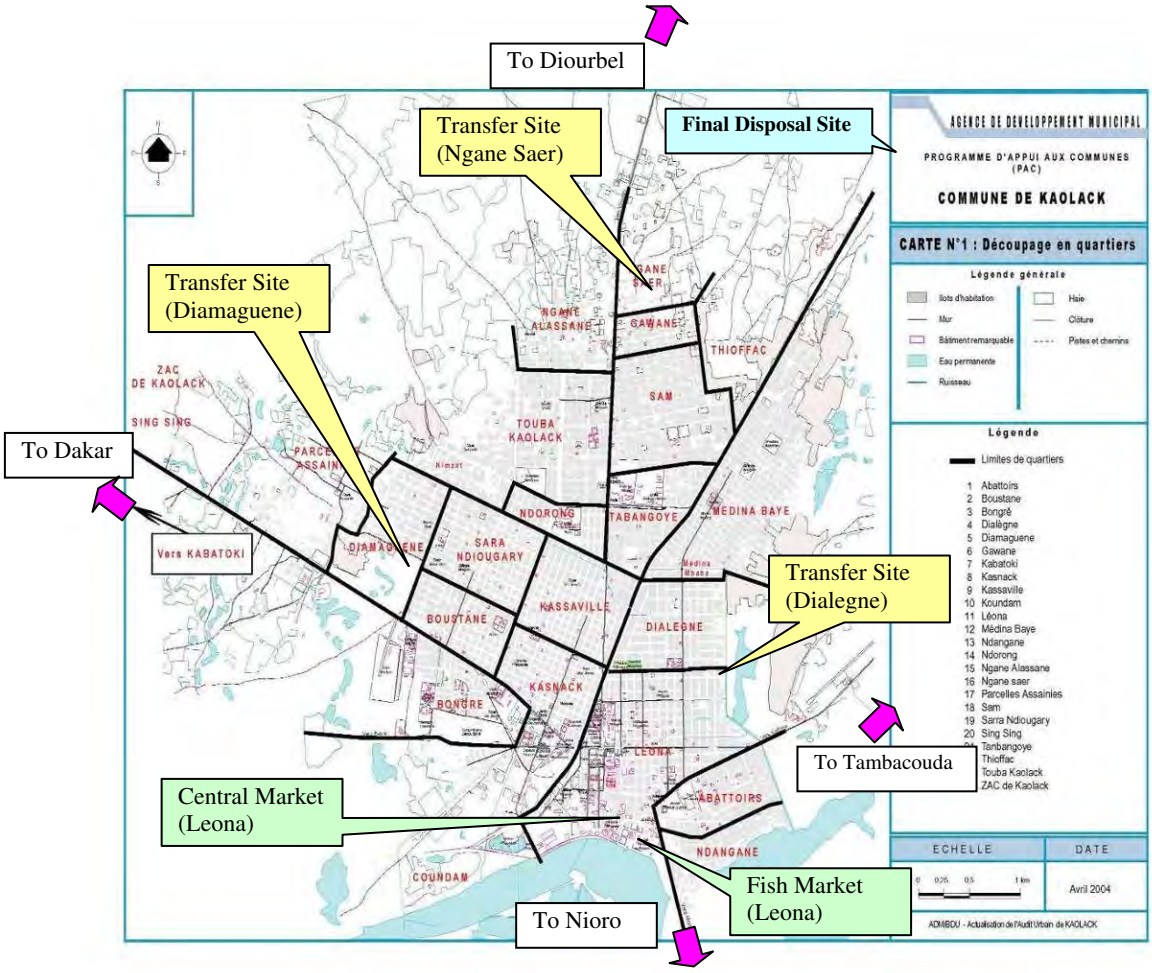
Area	Stage		
	Pre-collection (each household)	Collection (each household to a final disposal site or transfer site)	Transportation to the final disposal site in Mbadakhoune
City's services for waste collection and transportation are available	By city compactors (2 units) by service provider in 2011, covering the areas of 5 districts only and 7 public markets and 2 bus stations.	By city compactors (2011) By a rental truck (2012)	By city compactor to the final disposal site by service provider (2011). By a rental truck (2012)
City's services are not available; the services are provided by private groups (associations, etc.)	By donkey-trucks (ROC system)/ monocycle	Illegal dumping sites in the city	No transportation to the final disposal site

(2) Transfer Site

Transfer sites are the tentative stockyards used to store domestic wastes directly transported manually or by donkey-trucks (ROC system) from households (pre-collection services). There are 3 transfer sites for SWM, i.e., in the districts of Diamaguene Extension, Ndargoundaw (Down Dialegne) and Ngane Saer of the city (refer to **Fig. 2.11**). However, two of the transfer sites, Diamaguene Extension, Ndargoundaw (Down Dialegne), are no longer functioning, so that only the Ngane Saer transfer site is operational at present.

(3) Illegal Waste Disposal Sites

There are 12 major illegal waste disposal sites in Kaolack City, identified through the field survey in the late 2011. Some flood-prone areas like the districts of Dialegne, Medina, etc., are located at low-lying depressions. In these districts, low-income residents try to protect their houses against flooding in the rainy season by heightening the ground level or by embankment around their houses using wastes instead of soil materials. On the other hand, APROSEN carried out a field survey on waste disposal sites in four cities including Kaolack City in 2011, and 71 illegal waste disposal sites were found in Kaolack City.



Source: ADM, Kaolack City, APROSEN Kaolack

Fig. 2.11 Location Map of Final Disposal Site and Transfer Sites in Kaolack City

(4) Final Disposal Site

With regard to the Kaolack City SWM, a final disposal site exists at Mbadakhoune Rural Community in Region[4], just next to Thioffack District (refer to **Fig. 2.11**). The landfill site is located at about 6 km north of city center of Kaolack with the estimated area of about 15 ha. The site was utilized as a sand quarry for construction works until 2009 and open dumping was carried out by trucks (compactors) of the city in the later part of 2011. There are no environmental regulations against fire in the site as well as the segregation of disposed wastes such as medical equipment, drug bins and containers, etc. Also, there are no structural facilities such as perimeter fence and control office, and there is no heavy equipment like bulldozer and wheel-loader to prepare the area for final disposal. According to the Kaolack City Government, only 2 registered compactors of the City can enter the site for waste disposal and no other private waste trucks are allowed. At the time of the field survey, about 10 waste-pickers were collecting reusable waste materials such as iron, hard plastics, etc.

In September 2011, Kaolack City and the Mbadakhoune Rural Community made a verbal agreement on the use of the site at Mbadakhoune as Kaolack's final disposal site. Up to the present, however, no written agreement has been executed between the officials of both parties, so that Kaolack City still has no legal right to use the land as its disposal site.

As for the IEC (Information, Education and Communication) activities, annual cleanliness

[4] Mbadakhoune Rural Community in Kaolack Region is located in "Other area" in **Fig.2.1**.

movements were carried out for the environmental campaign in 2007, 2008 and 2009 by the city communities including Kaolack City, Kaolack Region, APROSEN, NGOs, students, volunteers, etc. There were no such activities in 2010 and 2011.

(5) Industrial Wastes and Medical Hazardous Wastes

In Kaolack City, 4 major factories are currently in operation, namely; two peanut cocking oil factories, a salt producing factory, and a plastics factory. According to the Technical Services of the City Government, industrial wastes shall have to be controlled and disposed appropriately in accordance with the Environmental Code of Senegal.

There is one major hospital (El Hadji Ibrahima Niass) and several small clinics and healthcare centers in Kaolack City. There is only one incinerator used in the hospital and there are two incinerators used by the healthcare centers. The ashes from the incinerator of the hospital are buried on the ground at a specific location inside the hospital compound.

2.6 Environmental and Social Considerations

2.6.1 Laws and Guidelines on Environmental Considerations

In the National Environmental Code of Senegal (Law No. 200 01, January 15, 2001), Articles 48 to 54 of Chapter V, Impact Study, include Strategic Environmental Assessment (SEA), Environmental Impact Assessment (EIA) and Environmental Audits (EA), and describe the mandated impact studies on the environment. Article 49 stipulates the procedures of implementation of impact studies and the study report that should be submitted to DEEC (Direction de l'Environnement et des Etablissements Classees/Directorate of the Environment and of Classified Establishments) in the Ministry of Environment, Protection of Nature, Retention Ponds and Artificial Lakes (MEPLBA: Ministre de l' Environment, de la Protection de la Nature, des Bassins de retention et des Lacs Artificiels).

Articles 38A to 44A also explain the administrative procedures for the environmental impact studies. The scopes and categories of environmental impact studies are the following:

Category 1: For projects that are likely to have significant impacts on the environment, the study to assess the impacts shall include environmental considerations in the economic and financial project analysis, so that this category requires an environmental analysis. The projects related to urban environmental improvement are: (a) infrastructure works; and (b) waste disposal and management.

Category 2: For projects that have limited impacts on the environment, the impacts can be mitigated by implementing measures or changes in their design, so that this category is the subject of an initial environmental review. The projects related to this urban environmental improvement are: (a) irrigation and drainage at a small scale; and (b) urban and rural water supply and sanitation.

Moreover, the Environmental Law stipulates the necessary environmental studies in accordance with the scale and treatment methodology of wastewater and waste management, as enumerated in **Table 2.9**.

Table 2.9 Required EIA by Classified Facilities

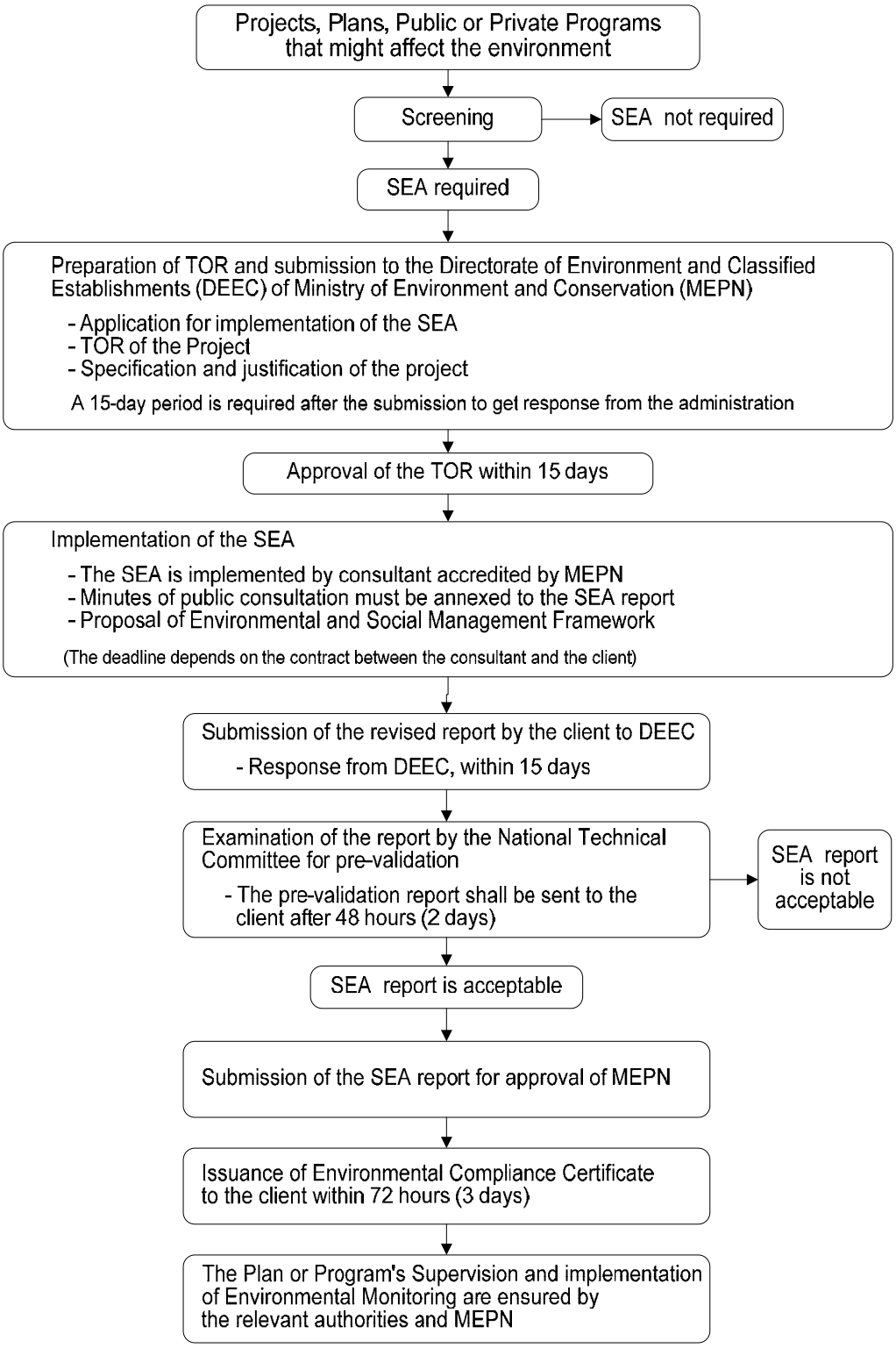
Facilities	Type of Classified Facilities	Type of Required EIA	Required Procedure Prior to the Start
Sanitation and Water Treatment (Capacity of Daily Treatment of Wastewater)	More than or equal to 5000 population equivalent	EIA	Authorization
	More than 500 and less than 5000 population equivalent	IEE	Authorization
Waste Management (Whatever Capacity)	Sorting or grouping facility of waste towards elimination	EIA	Authorization
	Waste elimination, treatment and valuation facility	EIA	Authorization
	Incineration and co-incineration facilities	EIA	Authorization
	Landfill	EIA	Authorization

2.6.2 SEA/EIA Process

The difference between EIA and SEA procedures is not explained in the Reference Guide for Sectoral Environment Impact Assessment. In addition, the detailed steps for implementation of EIA/SEA are not suggested in the reference. Based on the interview and information provided by DEEC to the JET, however, the EIA and SEA procedures have been confirmed as shown in **Fig. 2.12** and **Fig 2.13**. The charts show that the main difference between SEA and EIA is the public hearing process (holding of public hearing and preparation of report by the DEEC within 48 hours), which is only included in the EIA process.

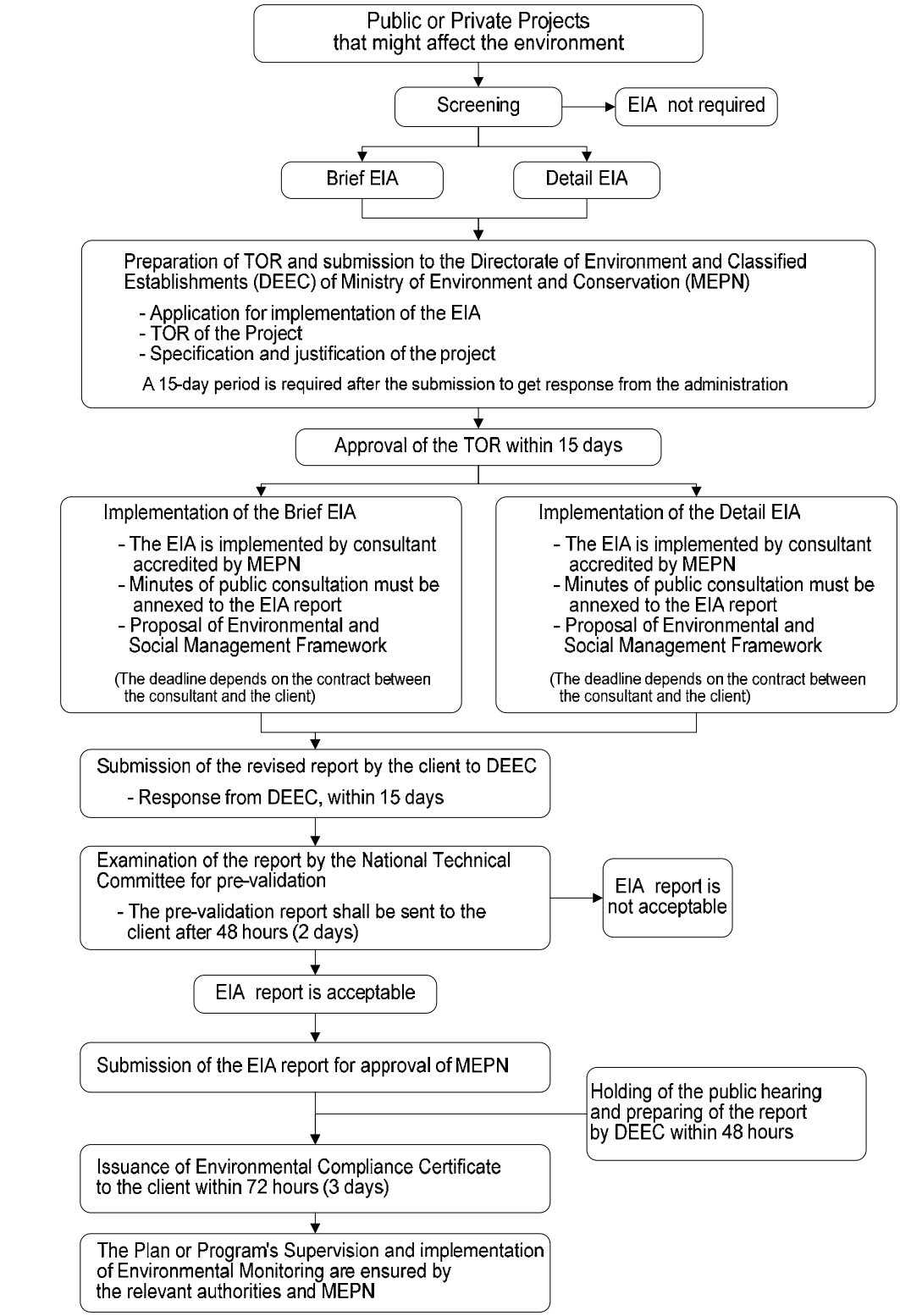
There are no official SEA/EIA application forms to be submitted to DEEC and/or the Regional DEEC (DREEC). Usually, the SEA/EIA Terms of Reference (TOR) is prepared on the basis of the project documents submitted to DEEC/DREEC by the client and the registered consultant. However, the submission place of TOR is not specified, i.e., DEEC and/or DREEC.

Based on the recommendation by DREEC in Kaolack that copies of the TOR and other documents on EIA/SEA shall be submitted to the regional government office because this office has the responsibility to chair the regional technical committee on environmental impact studies, the TOR and application form for SEA were, therefore, submitted to DEEC on the 2nd day of January 2012. Copies of documents were submitted to DREEC and the Governor's Office in Kaolack as well. Finally, the SEA report was approved by DEEC in January 2013.



Source: JET (Based on interview with DEEC.)

Fig. 2.12 Procedure of Strategic Environmental Assessment (SEA)



Source: JET (Based on interview with DEEC)

Fig. 2.13 Procedure of Environmental Impact Assessment (EIA)

2.6.3 Environmental Plan and Policy in Senegal

Following the elaboration of the PNAE (The National Environment Action Plan) in 1997, Senegal's environmental policy was defined in "The Environment and Natural Resources Sector Policy Letter (LPSERN 2009 2011)." This letter, which defines the strategic directions and areas of intervention in the field of environment and natural resources, was approved in 2009. Based on the opinion of the environmental sector, the overall goal of the environmental policy is to ensure sound management of the environment and natural resources in order to contribute to the reduction of poverty in a sustainable development perspective.

2.6.4 Environmental and Social Conditions in Kaolack City

(1) Natural Conditions

There are flood-prone areas called "tannes/spots" in Kaolack City. The report of APROSEN in 2007 points out that "the districts of Diallgne and Matar Medina are located on the tannes/spots where the conditions of habitat and hygiene are precarious" due to high acidity and salinity.

Sandy soil and groundwater (high water table and salty) are critical issues in Kaolack City. The construction of hygienic facilities is difficult in some districts. For instance, installation of septic tanks is disturbed by sand and high groundwater table (less than one meter depth) especially in Medina Mbaba, Abattoirs and Touba Kaolack districts, and salty groundwater causes the rusting of tanks and other construction materials.

(2) Social Conditions

Disposal of desludged septage is a cause of conflict with rice farmers in Sing Sing. The trucks carrying the septage into the fields hinder the cultivation of farm lands in the rainy season due to the muddy road condition, which has negative impacts on the neighboring people's hygiene.

Despite the various laws and regulations for environmental protection, the information and knowledge about them may not have been disseminated well. In addition, it might be very difficult to change people's habit. For instance, several NGOs and associations have been trying to enlighten CDQs on the improvement of hygienic conditions through training and radio programs. ASDES support school cleaning activities, but the constraint is based on traditional gender bias that cleaning is admittedly a woman's work; therefore, school girls are only the ones participating in the project in some schools. The basic educational system also affects environmental improvement.

Plastic recycling is one of the best practices for the improvement of environment and income generation. Unfortunately, the utilized material is limited only to hard plastics such as containers of oil, buckets and so on. PET bottles are not recycled due to lack of suitable cutting machine for the work.

CHAPTER 3. OVERALL PLANNING CONCEPT

3.1 National Development Context

Since the Senegal Government shouldered a heavy debt in 2000, the government implemented development projects through its comprehensive strategy of poverty reduction. The "Document of Growth Strategy for Reduction of Poverty (DSRP-I)," defining the planning period of 2003 to 2005, was prepared to improve the growth targets of the program of post devaluation and to correct its negative incidences with the social and political development plans. The incidences of poverty were still relatively high and the distribution of income remained particularly uneven in Senegal. These facts invited more vigorous measurements to reduce poverty and clearly underlined the challenge of redistribution of the fruits of growth.

During the period of 2006 to 2010 as stipulated in the DSRP-II, the planned strong growth of the GDP and quality improvement of people's living standards was hardly attained due to the food and energy crises and the economic and financial depression in 2008. The projections of poverty carried out over the period of 2005 to 2009 thus suggested a stagnation of the indicators of poverty, and the growth rate of the GDP per capita showed only 0.5% on average a year.

Based on the assessment of the implementation of the DSPR-II, the five-year national strategy known as the "Document of Policy on Socio-economy (DPES)," was formulated for the target period of 2011 to 2015. Regarding sanitation improvement, the DPES set the target access rates of 63% for rural areas, and 78% for urban areas in 2015. According to the DPES evaluation, the actual access rate of 63.1% in 2010 was attained in entire urban areas in Senegal. Historical actual and planned figures on access rates to the improved sanitation were compiled referring to DSPR II and DPES, and **Fig. 3.1** depicts their tendency. It clearly shows that the access rates are going to increase continuously by various related projects year by year in both rural and urban areas.

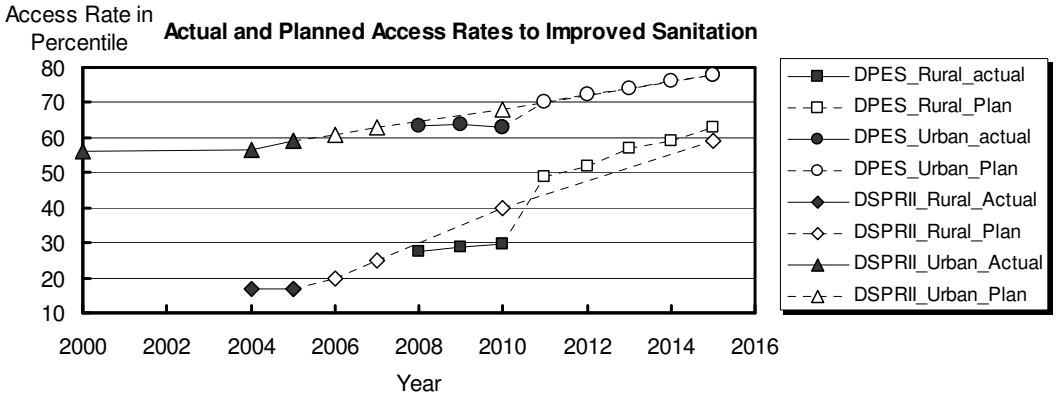


Fig. 3.1 Historical Changes of Access Rates to Improved Sanitation in the National Strategies

The present access rate in Kaolack City, however, might range from 50 to 65% according to the officials in the relevant offices and NGOs, since statistical data is lacking. Furthermore, the target access rate of 78% in 2015 could not be achieved in Kaolack City in consideration of the present situation of improvement activities.

3.2 Planning Concept

3.2.1 Visions and Objectives

The target year of the Millennium Development Goals (MDGs) is set at the year 2015. Since the target year has been drawn, the UNDP is developing the next stage for the MDGs. The visions on Kaolack environmental infrastructure improvement under the Master Plan shall cover the improvement concepts of the MDGs and the national development context.

The visions for Kaolack urban environmental infrastructural improvement are "access to sustainable urban environmental infrastructures and services augments beyond the Millennium Development Goals in a reasonable and equitable manner in the territory of Kaolack City." Following the improvement visions, the overall improvement objectives of the Kaolack urban environment are as listed below based on the discussion made in the steering and technical committee meetings in the course of the Master Plan formulation:

- To promote the proper management of solid and liquid wastes and stormwater in an integrated and effective manner to enhance the urban environment through improvement and updating of the urban environmental infrastructures, and supporting the daily public services for sewerage treatment and solid waste collection and disposal;
- To develop the urban stormwater management to alleviate the recurrent flooding in the habitual flood-prone areas during the rainy season;
- To improve the institutional framework of the sectors managing sewage including wastewater treatment and sewerage network, stormwater and solid waste for their smooth and sustainable implementation;
- To promote positive changes of people's behavior on sanitation and solid waste disposal through the people's awareness campaign and participatory activities; and
- To finally realize the sound urban environment of the Kaolack City by producing the synergistic effects through the above-mentioned comprehensive approaches.

3.2.2 Target Year and Planning Area

The target year of the Master Plan is set at 2030 as discussed between the Senegal counterparts and the JICA preliminary survey mission. The original project area is defined as the entire area of Kaolack City as also discussed simultaneously. For practical reasons, the actual planning area shall be the urban areas consisting of the districts. Thus the planning area is defined as the city center as described below, of which area is 19.82 km^2.

From the technical nature of three study components, wastewater, solid waste and stormwater, the planning area shall follow the district boundary for solid waste management, the natural drainage boundary for stormwater management, and some intermediate areas between natural and administrative boundaries for wastewater management. Therefore, each component has to define slightly different planning areas.

3.3 Population Projection of Kaolack City

The estimation of population of Kaolack City for 2012 was made based on the reports of district chiefs in 2012. The "City Center" is defined here as the districts located in the area where the City has been developing so far and have high population density. Project components which require large amounts of funds will be mainly considered for this area as "Target Area" for the efficiency of investment. As a result, the population projected in 2012 was agreed among the steering committee members as 270,000 in the whole city and 245,000 in the city center.

Considering the growth rate of population in each district in the past and some cap of the density of 300 persons/ha, the future population is projected in 5-year intervals. The projected population in 2030 is 403,000 in the whole city and 382,000 in the city center as shown in **Table 3.1**.

Table 3.1 Projection Results

Year	All the City	City Center
2012	270,000	245,000
2015	291,000	270,000
2020	335,000	314,000
2025	373,000	352,000
2030	403,000	382,000

CHAPTER 4. SEWERAGE/SANITATION SYSTEM IMPROVEMENT PLAN

4.1 Planning Concept

4.1.1 Planning Objectives

The planning objectives are: (1) to improve and update the present sewerage system (sewer pipe network, pumping stations and treatment plant) considering the applicability of technologies, the efficiency of wastewater collection/treatment, the capacity of human recourses in ONAS and cost effectiveness; and (2) to improve the sanitation condition of the inhabitants, as well as the water environment of Kaolack City.

4.1.2 Planning Strategy

In the sewerage/sanitation system improvement plan, the sewerage planning area is set up with the following considerations as presented in **Fig. 4.1**.

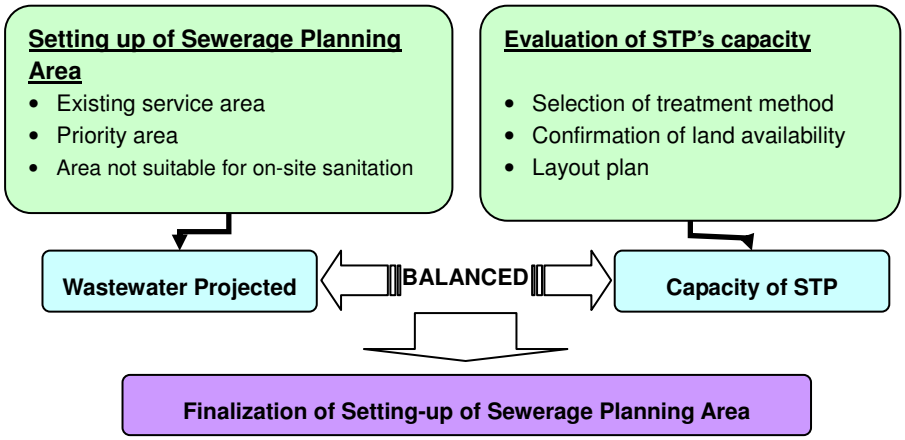


Fig. 4.1 Schematic Diagram of the Setting-up of Sewerage Planning Area

4.1.3 Target Year

The target year of the Master Plan is 2030, and the Master Plan has to be implemented in the following 3 terms:

- Short-Term for Phase 1 projects by end of 2020;
- Mid-Term for Phase 2 projects from 2021 to 2025; and
- Long-Term for Phase 3 projects from 2026 to 2030.

4.2 Future Improvement Frame Projection

4.2.1 Districts Related to the Sewerage/Sanitation System Improvement Plan

The districts related to the sewerage/sanitation system improvement plan, which covers the whole city center of Kaolack City as agreed with ONAS Kaolack in the T/C and S/C meetings are shown in **Fig. 4.2.** The total target area is about 19 km^2.

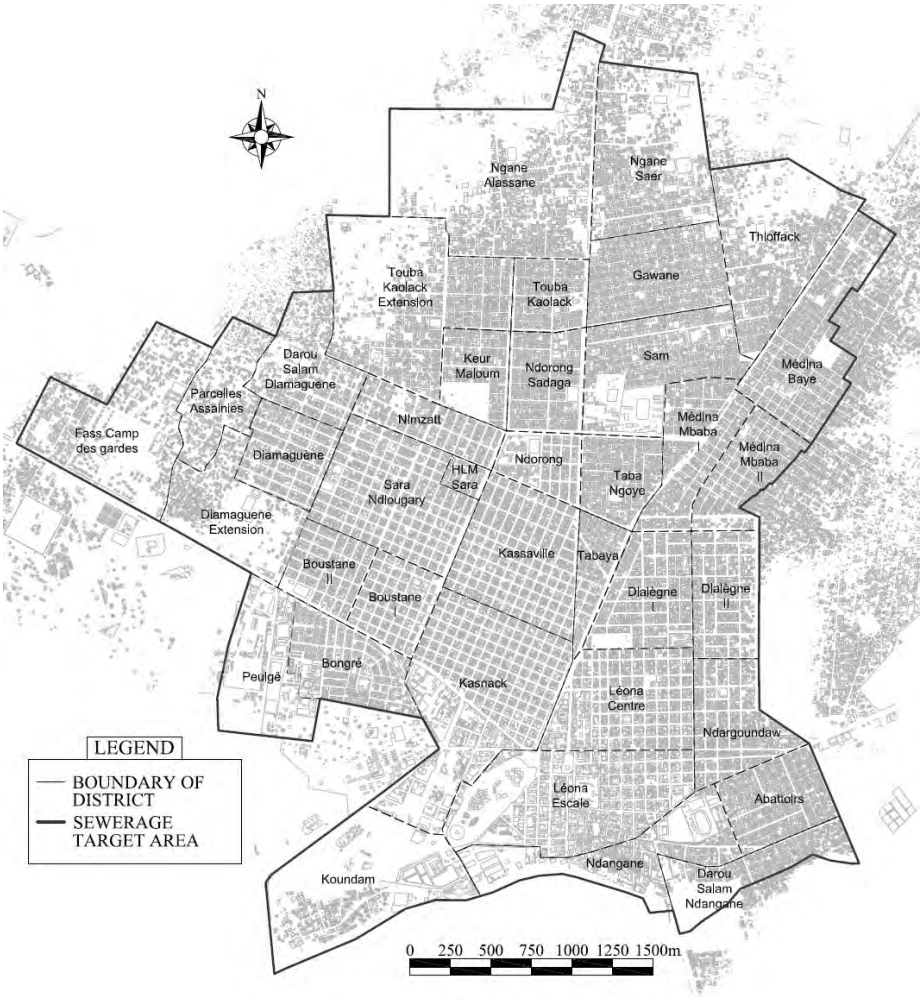


Fig. 4.2 Districts related to Sewerage/Sanitation System Improvement

4.2.2 Population

The sewered population has been estimated based on the population projection described in **Subsection 3.2.3**.

4.2.3 Future Demand Projection

(1) Wastewater Generation per Capita

The following factors have been adopted for the estimation of wastewater generation:

- **Domestic Water Consumption:** A 58 L/capita/day of the domestic water consumption in 2011 increases linearly toward the target year in parallel with the improvement of living standard of people in Kaolack City. A 70 L/capita/day, which is the typical value in residential areas in Kaolack City, is set for the target year 2030. Interpolation is applied to project the value for 2015, 2020 and 2025.
- **Commercial and Administrative Use:** Amounts of commercial and administrative water use are estimated based on the maximum ratio of commercial to domestic water use of 0.25 in the 5 years (2007-2011) since commercial water consumption corresponds to 25% of domestic use.
- **Wastewater Generation Ratio:** The wastewater generation ratio is set as the project's wastewater generation per capita since a part of water used for gardening, laundry and washing-up in the yard is not discharged into the sewerage network. The typical wastewater generation ratio of 85% is employed for wastewater projection, which means that 15% of consumed water will not be collected by the sewer system.

- **Groundwater Inflow:** Ten percent (10%) of groundwater inflow is employed in the Master Plan, using the estimation method applied in the JICA Study for Dakar in 1994.

Based on the above explanations, wastewater generation per capita for the years 2015, 2020, 2025 and 2030 have been estimated as summarized in the following table.

Table 4.1 Summary of Wastewater Generation per Capita

Item	Unit	2012 (Present)	2015	2020	2025	2030	Remarks
Water consumption							
Domestic	lpcd	59	61	64	67	70	(a)
Commercial & Administrative	lpcd	15	15	16	17	18	(a)×25%
Total	lpcd	74	76	80	84	88	
Wastewater Generation ratio	%	85	85	85	85	85	
Wastewater Generation [1)]	lpcd	63	65	68	71	75	
Groundwater Inflow	%	10	10	10	10	10	

Note: [1)] Wastewater generation includes commercial consumption
lcpd: liters per capita per day

(2) Pollution Load Generation

BOD_5, which represents organic pollution load, has been set as the basic parameter for designing the treatment plant. In the M/P, the typical BOD_5 load of 40 g/capita/day was set for the target year (this value was also employed in the IDB's project). The BOD_5 load of 40 g/capita/day includes pollution load of domestic and commercial water use. On the other hand, the BOD_5 load per capita of 28 g/capita/day in 2012 was estimated by using the annual average BOD_5 inflow of Kaolack STP monitored in 2011 and the sewered population. Concentrations of COD_{Cr} and TSS, which are the supplementary parameters for designing a treatment plant, were estimated by employing the ratio of BOD_5:COD_{Cr}:TSS=1.00:2.00:1.25, monitored in 2011. The following table summarizes BOD_5 load per capita and concentrations of the 3 parameters (BOD_5, TSS and COD_{Cr}).

Table 4.2 Pollution Load Generation per Capita

Item	Unit	2012 (Present)	2015	2020	2025	2030	Remarks
BOD_5 Load per Capita	gpcd	28	30	34	36	40	(a)
Wastewater Generation	lpcd	63	65	68	71	75	(b)
Groundwater Inflow	%	10%	10%	10%	10%	10%	(c)
Concentration							
BOD_5	mg/l	404	420	455	461	485	(d) [1)]
COD_{Cr}	mg/l	808	840	910	922	970	(d)×2.00
TSS	mg/l	505	525	569	576	606	(d)×1.25

[1)] : (d)=(a)/{(b) × (100+(c))/100} × 1,000

4.2.4 Design Conditions

(1) Sewer Network and Pumping Stations

The sewer network has been designed using gravity flow, basically. The sewer pipe diameter was designed based on the hourly maximum sewage flow with given allowance in order to cope with the hourly fluctuation and to secure enough flow velocity that will prevent stagnancy and accumulation of wastes and sediment. The major design criteria and calculation formula are listed in **Table 4.3**.

Table 4.3 Design Criteria and Calculation Formula

Item	Criteria, Formula
Flow velocity formula	Gravity flow: Manning's Formula Pressure flow: Hazen-William's Formula
Flow velocity	From 0.6 m/s to 3.0 m/s
Ratio of peak flow and allowance	Hourly peak flow: 2 times of daily average flow Allowance: (i) more than 100% for pipe diameter up to 600 mm, and (ii) 50% to 100% for diameter of more than 700 mm
Earth covering	Not less than 1.0m

Item	Criteria, Formula
Pipe material	Diameter ≤ 500mm: PVC pipe, n = 0.010 600 mm ≤ Diameter : RC pipe, n = 0.013 Force main: Cast iron pipe, C = 110

(2) Sewerage Treatment Plant

Treatment facilities have been designed to meet the discharge criteria of BOD_5=40 mg/l, COD_{Cr}=100 mg/l, TSS=50 mg/l and Fecal coliform=2,000 CFU/100ml.

4.3 Development Concept of Sewerage/Sanitation System

4.3.1 Alternative Study for Improvement of Sewerage System

(1) Approach to Selection of Wastewater Treatment Method

Prior to the setup of sewerage planning area, the wastewater treatment method and capacity for the Kaolack STP has been evaluated and figured out in consideration of land availability.

At present, in Senegal, nine wastewater treat plants are in operation, adopting three treatment methods, namely; (i) activated sludge process (4 locations); (ii) aerated lagoon (1 location); and (iii) lagoon (5 locations), as shown in the following table. Of the 3 methods, the activated sludge process is large in number but is adopted only in Dakar and its major neighboring city, Thies. In addition, some of the activated sludge plants are small in scale so that they can be categorized into "community plants." In fact, major cites other than Dakar and Thies adopt the lagoon and/or aerated lagoon only.

Table 4.4 List of Wastewater Treatment Plants in Operation in Senegal

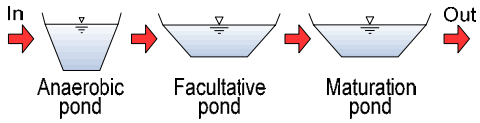
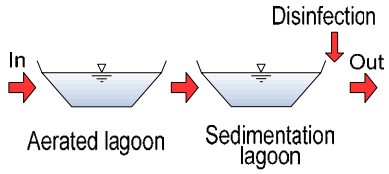
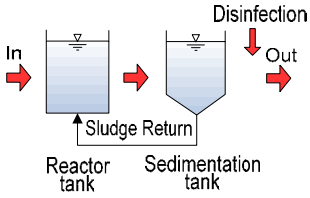
Name of STP	Treatment Method	Target Sewered Population	Capacity (m^3/day)
Cambérène	ASP	200,000	19,200
SHS (Guediawaye)	ASP	Unknown	595
Niayes (Pikine)	ASP	Unknown	875
Rufisque	Lagoon	45,403	2,856
Keur saib ndoye (Thies)	ASP/Lagoon	70,000	3,000
Saint-Louis	Lagoon	20,000	600
Saly	Lagoon	600	1,020
Luga	Lagoon	20,000	600
	AL	12,000	720
Kaolack	Lagoon	20,000	390

ASP: Activated Sludge Process, AL: Aerated Lagoon

Based on the study results, Kaolack STP has difficulties even in the operation of lagoons due to sedimentation and malfunction of discharge weir and so on. In addition, the aerated lagoons could not be operated without being handed over by the donor. Considering these situations, adoption of the conventional activated sludge process is too early for Kaolack.

Accordingly, the treatment method for Kaolack STP should be evaluated, focusing on lagoon, aerated lagoon and at maximum oxidation ditch (one of the simplified activated sludge process). The following table shows the outline of the 3 treatment methods.

Table 4.5 Outline of the Proposed Treatment Methods for Kaolack

Method	Typical Flow Sheet	Salient Features
Lagoon		• Wastewater is treated without machinery. Oxygen is introduced into the lagoon by photonic synthesis and thus wastewater is purified. • Among the three methods, O&M is the easiest and unit cost for treatment is the lowest. On the other hand, land requirement is the largest.
Aerated lagoon		• By installing aerators in lagoons, treatment efficiency is upgraded and reduction in land requirement is achieved compared to Lagoon • O&M is easier than that of OD
Oxidation ditch (OD)		• Endless channel is employed for wastewater circulation. Equipment is simplified and easier O&M is achieved compared to activated sludge process. • Land requirement is smaller than that of aerated lagoon • Construction cost is biggest among the three methods.

(2) Expansion and Capacity of STP

The operation of more than one location of STP is not favorable because operation and maintenance becomes inefficient and thus additional staff (team) will be required. In addition, the STP should be located near the Saloum River to avoid installation of a discharge pumping station. Therefore, the acquisition of an area adjacent to the existing STP is proposed for the augmentation of treatment capacity. The existing area is 9.0 ha, which is shown by solid line, and the expansion area is 11.3 ha, which is shown by broken line. Land owner of the existing area is ONAS and the expansion area belongs to public and private owners. (see **Fig. 4.3**)

Fig. 4.3 Existing STP and Proposed Expansion Area

(3) Expansion of Sewer Network

The expansion area of sewer network, alignment of trunk sewers and design of sewer pipes has been studied in consideration of the following aspects:

- Expansion area of sewer network is determined considering the boundary of watershed, districts and present sewered area;
- New sewer network is connected to the existing network in order to utilize the existing sewer network including pumping stations and to minimize the construction cost;

- Capacity of sewer pipes and pumping stations is designed to discharge total quantity of wastewater generation in 2030 with 100% connection; and
- New pumping stations are constructed in vacant spaces to avoid the resettlement.

(4) Alternative Setting

The following alternatives are selected in consideration of the above explanations.

(a) No Action

Appropriate engineering interventions are required in Kaolack City, considering rapid urbanization, as well as present sanitary issues such as low sewer connection, malfunction of sewage treatment plants and inappropriate septage management. Therefore, "No Action" (Alternative 0) is not discussed in detail here.

(b) Alternative 1

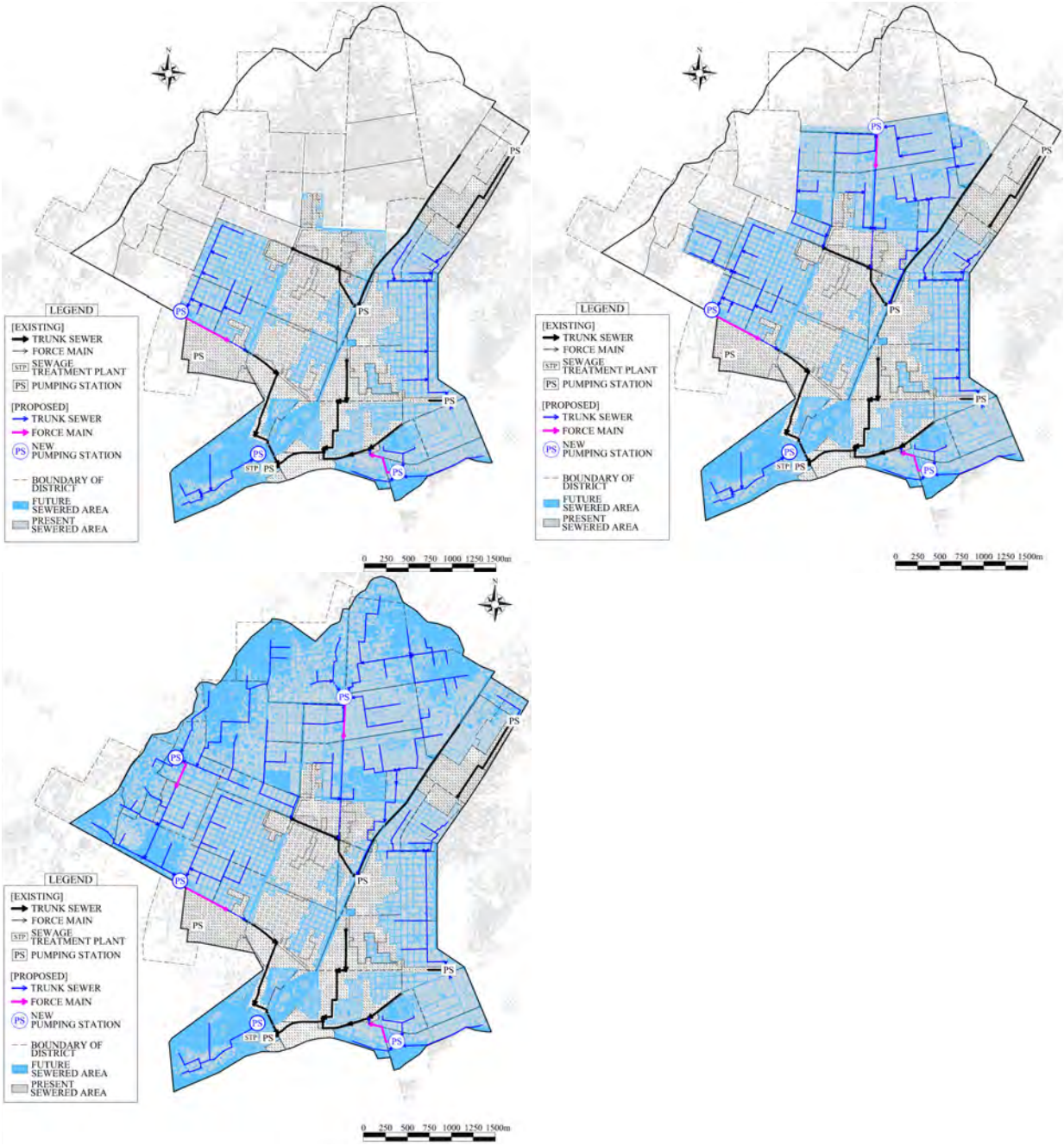
Expansion of sewered area is set to correspond to the STP's capacity with the treatment methods of lagoon and aerated lagoon (Total capacity: Q=15,000 m^3/day: **Fig. 4.5** shows the layout plan). In the alternative, the sewered area covers the southern part of Kaolack City, as shown in **Fig. 4.4**. In addition, 3 new pumping stations are constructed (PS No. 1 North, PS Boustane, PS Darou Salam Ndangane). New trunk sewer with the total length of 15.0 km including force main is installed.

(c) Alternative 2

Expansion of sewered area is set to correspond to the STP's capacity with the treatment methods of aerated lagoon (Total capacity: Q=21,000 m^3/day: **Fig. 4.5** shows the layout plan). In the alternative, the sewered area covers the area of Alternative 1 and Touba Kaolack Ndorong Sadaga, Keur Maloum, Gawane and Diamaguène districts, as shown in **Fig. 4.4**. In addition, 4 new pumping stations are constructed [same 3 pumping stations in Alternative 1 and PS Touba Kaolack]. New trunk sewer with the total length of 27.7 km including force main is installed.

(d) Alternative 3

In this Alternative 3, sewered area covers the whole city center, as shown in **Fig. 4.4**. To treat the wastewater, oxidation ditch process is employed with total capacity of Q=32,000 m^3/day (**Fig. 4.5** shows the layout plan). In addition, 5 new pumping stations are constructed [same 4 pumping stations in Alternative 2 and PS Darou Salam Diamaguène]. New trunk sewer with the total length of 45.1 km including force main is installed.



Note: Upper left: Alternative 1, Upper right: Alternative 2, Lower left: Alternative 3

Fig. 4.4 Layout Plan of Alternatives (Sewer Network)

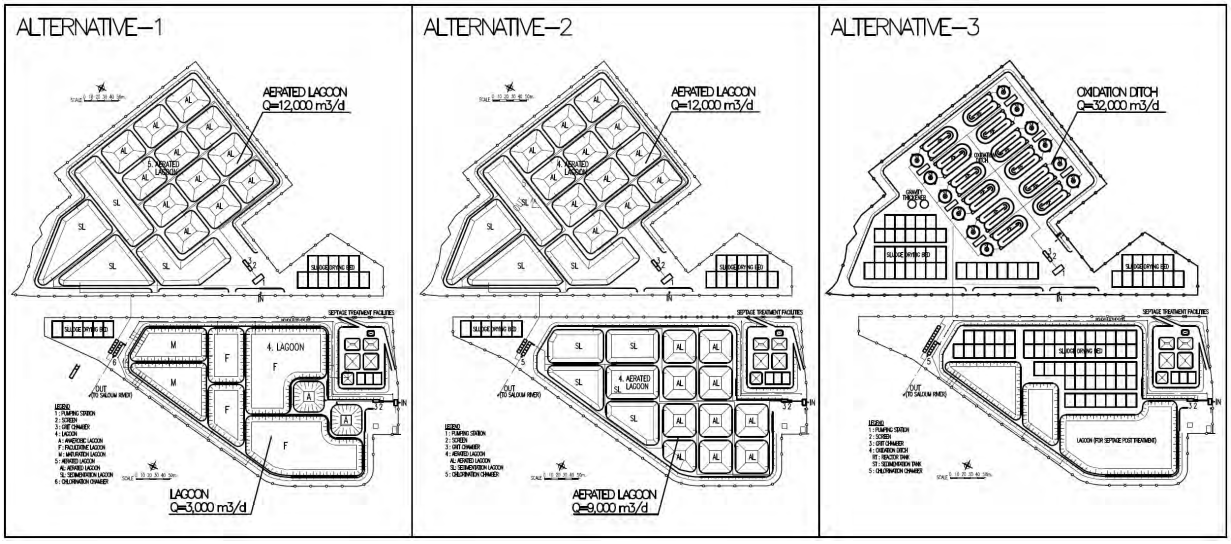
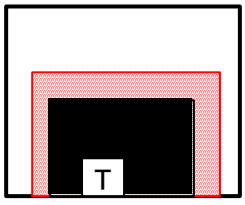
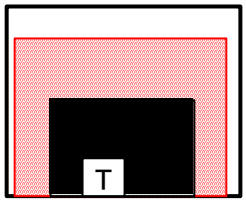
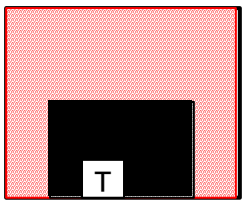


Fig. 4.5 Layout Plan of Alternatives (STP)

(5) Outline of Alternatives

The alternatives, including construction and operation and maintenance cost, are as summarized in the following table.

Table 4.6 Outline of Alternatives (STP)

		Alternative 1	Alternative 2	Alternative 3
Schematic diagram of setting up sewered area				
Sewered area (ha)		1,020	1,340	1,930
New trunk sewer (km)		15.0	27.7	45.1
Number of new P/S		3	4	5
Treatment Method and capacity (m^3/day) in STP		Lagoon : 3,000 Aerated lagoon : 12,000	Aerated lagoon: 21,000	Oxidation ditch: 32,000
		Total : 15,000	Total : 21,000	Total : 32,000
Sewered population in 2030		178,000	252,000	379,000
Wastewater projection in 2030 (m^3/d)		14,685	20,790	31,270
Coverage Ratio (%)[1]	Sewerage system	47%	66%	99%[2]
	On-site sanitation	53%	34%	1%
Construction cost (mil. FCFA)	Trunk Sewer	5,950	8,954	14,170
	Pumping stations	2,316	3,148	4,671
	STP[3]	6,042	9,459	22,065
	Sub-total	14,308	21,561	40,906
	Brunch sewer[4]	11,757	17,720	28,875
	Grand total	26,065	39,281	69,781
O&M cost (mil. FCFA)	Sewer network & PSs[5]	375	504	750
	STP[3]	433	741	1,255
	Total	808	1,245	2,005

Legend: T :STP : Existing service area : Expansion area : Boundary of ctiy center

Note:
1) Coverage ratio of sewerage system is percentage to total population of 382,000 in City Center.
2) Coverage is not 100% because some part of the city cannot be feasibly covered by sewerage system mainly due to topological reason.
3) Including septage facilities. Construction cost of lagoon and aerated lagoon are calculated by bill of quantity method; oxidation ditch is calculated using cost function of $C=1.5\times912\times Q^{0.79}=1.368\ Q^{0.79}$ (C: mil FCFA, Q=1,000 m^3/day), by referring to the Study on Urban Drainage and Wastewater Systems in Dakar City and its Surroundings" in 1994, JICA, in consideration of price escalation.
4) Cost of branch sewer in the unserviced and expansion area under the assumption that the length of branch sewer is 260 m/ha.
5) O&M cost of sewer network includes that of trunk sewer and branch sewer.

(6) Comparison of Alternatives

The comparison of alternatives is discussed below.

(a) Evaluation Criteria

The following evaluation criteria are discussed in the comparison of alternatives:

- Sewered population;
- Ease of operation and maintenance /Reliability;
- Operation and maintenance cost; and
- Environmental impact.

(b) Evaluation of Alternatives

Based on the above discussion, a ranking of 1.0 to 3.0 is given to each criterion with 1.0 being the least favorable, as shown in the following table.

Alternative 1 is the most favorable in terms of ease of operation and maintenance/reliability, as well as operation and maintenance cost. However, sanitary improvement is limited due to the limited sewer expansion.

Alternative 3 is the most favorable in terms of sewered population. However, the alternative is less favorable in terms of ease of operation and maintenance/reliability because it requires the

oxidation ditch process, which requires higher operational know-how than those of lagoon and aerated lagoon. Moreover, the highest operation and maintenance cost will be a financial burden to ONAS. Further, large-scale and long-duration construction work covering the whole city center, might cause more negative impacts, compared with Alternative 2.

Alternative 2 is less favorable than Alternative 3 in terms of sewered population, but it could cover more than 66% of the city center. Considering the actual septic tank installation ratio of about 50% in Kaolack City, sanitary improvement facilities (sewer network and septic tanks) could cover more than 80[5]% of the city center in 2030. In terms of operation and maintenance cost, Alternative 2 is more favorable than Alternative 3.

Considering the above evaluation and discussions, Alternative 2 has been selected as the optimum. Thus, the sewerage improvement Master Plan was formulated based on Alternative 2.

Table 4.7 Ranking of Alternatives

	Alternative 1	Alternative 2	Alternative 3
Sewered Population	1	2	3
Ease of O&M / Reliability	3	2	1
O&M Cost	3	2	1
Environmental Impact	1	3	2
Total	8	9	7
Overall Ranking[1)]	2nd	1st	3rd

1) Ranking of "1st" is most favorable.

4.3.2 On-Site Sanitation Treatment System

(1) Background

As of November 2011, 1,600 houses/buildings have been connected to the sewer network in Kaolack City. On the assumption of average number of 10 residents in a household, the sewered population has been estimated at 16,000, which is equivalent to 6.4% of the total population of 249,000 of the city center in 2012. This fact means that the remaining 93.6% of residents in the city center have to rely on some sort of on-site sanitation system at present. The city center is defined as built-up areas in the city excluding four districts, Kabatoki, Lyndiane, Sama Moussa and Sing Sing, which are located in the outskirts of the city.

In the urban area of Kaolack, the major on-site sanitation facility is the septic tank with two compartments, which is connected to the infiltration pit with gravel base. Soak pit latrine and pit latrine are not popular in the urban areas due to the poor infiltration capacity of soil. Furthermore, the design and installation of septic tanks should basically be approved by ONAS, but residents have installed their own-sized tanks without approval according to ONAS Kaolack. On the other hand, the soak pit latrine and pit latrine are popular in rural areas extending in the outskirts of Kaolack City.

It is required that not only human waste but wastewater from kitchen, laundry and bathroom should go together into the septic tank at private houses, which is, however, not always the case. Sludge accumulation occurs gradually at the bottom of the tank, and treatment efficiency will drop in parallel with the decrease of effective volume of the tank.

Thus the sludge should be removed periodically once in every two to five years. Each household should be responsible for the desludging septage, but it is not clear if they maintain the tank properly. There is no regulation on desludging of septage accumulated in septic tanks. The desludging is made at the owner's decision.

Under the circumstances, septage desludged from septic tanks in Kaolack City is exposed to the environment without any treatment. The desludging trucks dispose them into the fields in the suburbs of Sing Sing, Kaolack. Septage is disposed into ponds dug on the riverbed of Saloum River

[5] Sewered population (66%) + 50% of people in on-site sanitation area (34%) could reach more than 80%.

in the dry season, while hauling trucks that could not reach the ponds dispose them over the riverbed on the way to the pond in the rainy season due to poor accessibility. On the other hand, manual desludging by labors locally called as "Baay Pelles" is also popular in Kaolack due to cheaper cost. After the manual desludging of septage, the removed sludge is disposed in the holes dug near the houses. According to the interview results, residents pay 30,000 FCFA for desludging by tank truck, while they pay only 3,000 to 5,000 FCFA for manual desludging. According to the interview survey by JET, the average household income per month is 145,285 FCFA.

The present septage disposal system is regarded as a kind of land disposal and/or land spreading, of which methodology has been widely and commonly applied over the world where applicable wide land is available near the towns/cities. This kind of treatment, however, can be implemented on the premise that the residents and the related communities around the disposal site will accept this kind of simple technology from social and environmental aspects. In Kaolack City, environmental degradation occurs in parallel with septage disposal, particularly, in the rainy season, and the residents also oppose the present disposal system. Thus a study on a suitable septage treatment system should be made as discussed below.

(2) Characteristics of Septage

Septage is generally defined as the liquid and solid material extracted from a septic tank during cleaning. Its high waste strength is due to accumulation of sludge and scum in the septic tank. Typically a septic tank will retain 60 to 70% of suspended solids and oil and grease introduced from the dwelling served. The bulk of the suspended solids settle to the bottom of the tank, and the oil and grease and other floatable materials are retained between the inlet and outlet baffles. Over a period of time, the sludge and scum can build up to a point where it occupies from 20 to 50% of the total septic tank volume.

Septage generation rate reported in literatures vary widely. In the F/S report made in 2005 for Kaolack, Saint Louis and Louga by IDA, the design septage generation rate of 0.3 l/capita/day was used. Normally, it is between 200 to 300 l/capita/year in developed countries. Thus 0.3 l/capita/day (= 110 l/capita/year) might be relatively small due to differences of water usage and living style between developed and developing countries.

According to the F/S report, the following septage parameters were used so that this project study refers to the same values as well:

- BOD_5: 3,540 mg/l
- COD_{Cr}: 1,700 mg/l
- TSS: 7,555 mg/l
- $N\text{-}NH_4$: 816 mg/l

(3) Selection of Suitable Septage Treatment Techniques

In general, there are three basic methods of treating and disposing septage, namely; (a) land disposal; (b) co-treatment; and (c) independent treatment. The co-treatment process of septage together with wastewater in the existing sewage treatment plant (STP) is selected, since the existing one has been functional since the 1980's. Pre-treatment process is proposed utilizing wastewater stabilization ponds technology, same as the existing STP in Kaolack, since this method is particularly suitable for tropical climates under strong sunlight and ambient high temperature.

(4) Septage Treatment Planning

The basic parameters of septage, target of treatment level, matters that could be discharged into the STP, and the necessary treatment process are summarized in the following table.

Table 4.8 Basic Planning Parameters for Septage Treatment

Parameter	Planning Value	Source/Remarks
Septage Generation	0.3 l/capita/day	Average figure in Senegal referring to F/S Report
Planning Population	230,000 people	Projected realistic figure of average population depending on the septic tank system in Kaolack City

Parameter	Planning Value	Source/Remarks
Total Daily Septage Generation	70 m^3/day	0.3 l/capita day × 230,000 people
BOD_5 Concentration of Septage	3,540 mg/l	Laboratory of ONAS Camberene
BOD_5 Daily Load	250 kg/day	3,540 mg/l × 70 m^3/day

The following allowable capacity of septage acceptable to the STP could be set, referring to the F/S report:

- Target year of the STP capacity is set at the year of 2020 as the first step of improvement works in the STP, as described in **Subsection 4.7.1**. If the year is set at a later date, the capacity will increase and the allowable capacity will also increase. As a result, the septage treatment system shall be designed to a much simpler one. Thus, the target year 2020 might be appropriate.
- Existing lagoons and malfunctioning aerated lagoons will be upgraded into lagoons, which consists of anaerobic, facultative and maturation lagoons with capacity of 3,000 m^3/day in 2020.
- To be on the safe side, the present BOD_5 concentration of inflow of 240 mg/l on average, according to the laboratory of ONAS Camberene, is applied to set the allowable BOD_5 load of septage treatment facilities of the STP.
- Based on the above conditions, BOD_5 load of sewage inflow in 2020 is estimated as 720 kg/day (= 240 mg/l x 3,000 m^3/day).
- Referring to the IDA F/S report, necessary pretreatment level of septage is set at 10% of the STP capacity, so that the minimum requirement for pretreatment is 72 kg/day in BOD_5 load.

(5) Septage Treatment Facility Plan

The septage treatment process is illustrated in **Fig. 4.6**. This process is the standard process of treatment using the wastewater stabilization pond system. If the outflow of the anaerobic pond exceeds the minimum requirement in BOD_5 of 72 kg/day load for pretreatment, additional treatment by facultative pond will be necessary after the anaerobic pond.

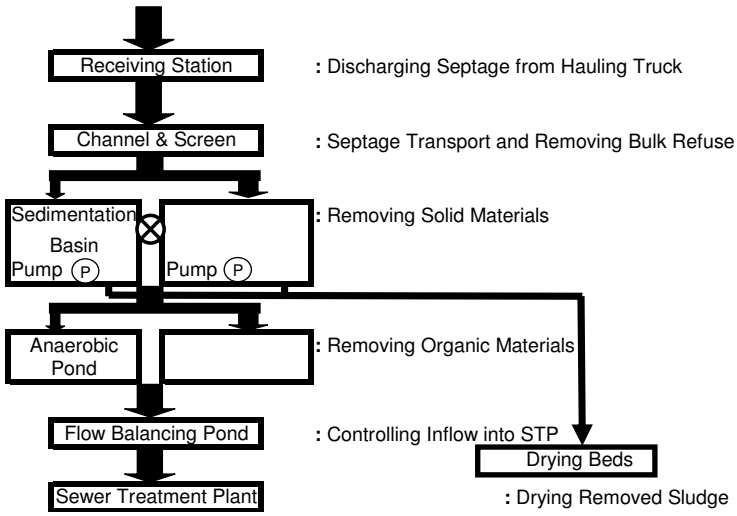


Fig. 4.6 Conceptual Septage Treatment Process

The final configuration of the proposed septage treatment system is shown in the following figure. Land requirement of the septage treatment facilities is about 0.8 ha, which includes treatment facilities, hauling road and embankment. The septage treatment facilities are operated and maintained by ONAS. Desludging vacuum trucks can enjoy the benefit of the facilities by lower cost gained by the shorter distance to the disposal site and thus the residents in Kaolack using septic tank can also enjoy the benefit of the facilities.

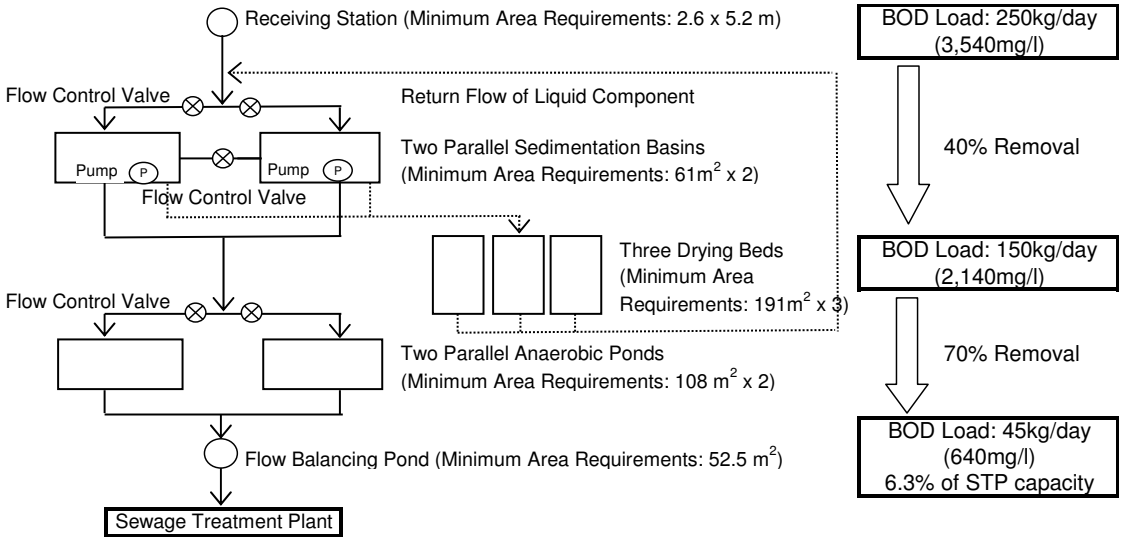


Fig. 4.7 Schematic Diagram of Proposed Septage Treatment System

4.4 Structural Sewerage System Improvement Plan

4.4.1 Sewer Network

Sewer network improvement consists of three components, namely; installation of new sewer pipes, replacement of existing sewer pipes, and installation/rehabilitation of pumping stations. These are summarized in **Tables 4.9 to 4.11** and **Fig. 4.8**. In the Master Plan, length of branch sewer in the expansion and existing unserviced area is estimated at 260 m/ha considering length of road typical city blocks in the area.

Table 4.9 Length of Proposed New Trunk Sewer Pipes

Diameter of Pipe (mm)		Total Length of Pipe (km)	Covering Depth (m)
Trunk Sewer (by gravity)	200	12.8	1.00 – 2.82
	250	5.1	1.00 – 3.93
	300	1.8	1.00 – 3.19
	400	5.4	1.00 – 3.39
	500	0.9	1.00 – 3.54
	TOTAL	26.0	
Trunk Sewer (Force Main)	150	1.0	-
	200	0.7	-
	TOTAL	1.7	

Table 4.10 Stretches of Asbestos Concrete Trunk Sewer Pipes for Replacement

Stretch		Length (m)	Reason of Replacement
(1)	Upstream of PS No.2	570	Malfunction due to sedimentation
(2)	Upstream of PS No.3	280	Significant deterioration
(3)	Upstream of STP	710	ditto
(4)	Along National Road from Bongré to Kasnack district	500	ditto
(5)	Upstream of stretch (1)	690	Lack of capacity for 2030
(6)	From PS2 to upstream end of Stretch (3)	2,140	ditto
(7)	From PS3 to upstream end of Stretch (3)	1,800	ditto
(8)	From downstream end of Stretch (4) to PS1 South	1,280	ditto
	Total	7,970	

Table 4.11 Improvement of Pumping Stations

	Name of PS	Design inflow (m^3/min)	Pumps installed		Capacity (m^3/min)	Remarks
			m^3/min	unit		
Replacement/ rehabilitation	PS No.1 South	12.0	3.0	2	12.0	
			6.0	1		
			6.0	1	Stand-by pump	
	PS No.2	12.9	3.2	2	12.9	
			6.5	1		
			6.5	1	Stand-by pump	
	PS No.3	4.2	2.1	2	4.4	
			2.1	1	Stand-by pump	
	PS No.12	0.3	0.3	1	0.3	
			0.3	1	Stand-by pump	
	PS Médina Baye	1.3	1.3	1	1.3	
			1.3	1	Stand-by pump	
New construction	PS No.1 North[1)]	15.9	4.0	2	16.0	Land owner: public Land requirement: 100 m^2
			8.0	1		
			8.0	1	Stand-by pump	
	PS Touba Kaolack	2.6	1.3	2	2.6	Land owner: public Land requirement: 200 m^2
			1.3	1	Stand-by pump	
	PS Darou Salam Ndangane	1.8	0.9	2	1.8	Land owner: public Land requirement: 150 m^2
			0.9	1	Stand-by pump	
	PS Boustane	3.8	1.9	2	3.8	Land owner: private Land requirement: 200 m^2
			1.9	1	Stand-by pump	

Note: 1) Installed in the expansion area of STP

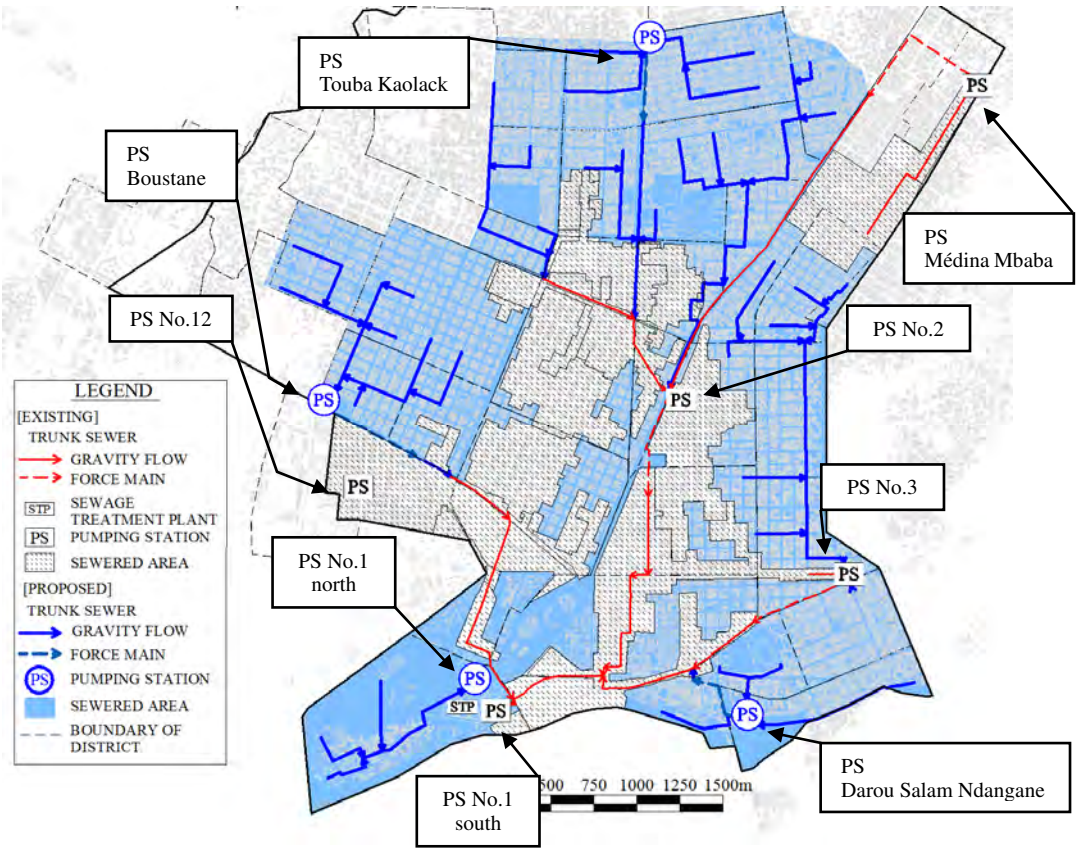


Fig. 4.8 Layout of Sewer Network Improvement

4.4.2 Sewage Treatment Plant and Septage Treatment Facilities

The structural improvement plan of the sewage treatment plant and septage treatment facilities, are summarized in the following table. Wastewater treatment facilities consist of aerated and sedimentation lagoons and a chlorination chamber. Accumulated sludge and treated water are separated in sedimentation lagoons. Sludge accumulated in the aerated lagoon and sedimentation lagoons is desludged and dried up in the sludge drying beds. Septage treatment facilities are installed in the expansion area located north of the existing P1 pumping station. Effluent water from septage facilities is treated in the lagoons.

Table 4.12 Treatment Facilities in STP

		Specifications	Remarks
Septage treatment facilities			
Receiving Station, Channel & Screen		2.6 m (W) × 5.2 m (L) × 0.8 m (D) × 1 (Nos.)	New construction
Sedimentation basin		8.0 m (W) × 8.0 m (L) × 2.0 m (D) × 2 (Nos.)	ditto
Anaerobic pond		10.0 m (W) × 11.0 m (L) × 3.0 m (D) × 2 (Nos.)	ditto
Flow balancing pond		7.5 m (W) × 7.5 m (L) × 2.0 m (D) × 1 (Nos.)	ditto
Drying bed		191 m^2 × 3 (Nos.)	ditto
Sewage treatment plant			
Aerated lagoons	Expansion area	Area 970 m^2 × 4.0 m (D) × 12 (Nos.) Aerator 7.5 kw ×5 (Nos.) ×12 (lagoons)	New construction (Capacity: Q=12,000 m^3/day)
Sedimentation lagoons	Expansion area	Area 4,550 m^2 × 2.0 m (D) × 4 (Nos.) [1)]	
Chlorination chamber		5.0 m (W) × 25.6 m (L) × 2.0 m (D)	Rehabilitation
Aerated lagoons	Existing area	Area 875 m^2 × 4.0 m (D) × 10 (Nos.) Aerator 7.5 kw ×5 (Nos.) ×10 (lagoons)	New construction
Sedimentation lagoons	Existing area	Area 2,680 m^2 × 2.0 m (D) × 4 (Nos.) [1)]	(Capacity: Q=9,000 m^3/day)
Chlorination chamber		5.0 m (W) × 19.2 m (L) × 2.0 m (D)	New construction
Sludge drying beds		Area 270 m^2 × 0.3 m (D)×15 (Nos.) Area 360 m^2 × 0.3 m (D)× 6 (Nos.)	New construction

Note: Depth of 2.0 meter includes sludge allowance of 1.0 meter.
W: Width, L: Length, D: Depth

4.5 Operation & Maintenance Plan

4.5.1 Sewer Network

Based on the estimation of work volume for cleaning the network to be improved, the recommendable cleaning work plan of the sewer network after expansion is as summarized below:

- All sewer pipes shall be cleaned in every 5 years, at least, so as not to degrade the present service level;
- Cleaning work shall be carried out by vacuum cleaning truck with water jet; and
- At least one cleaning team with a vacuum cleaning truck shall be formed in ONAS Kaolack.

4.5.2 Pumping Station

Maintenance work for pumping stations is indispensable to keep the sound condition of sewer network. Maintenance works and inspection items are as listed in **Table 4.13.**

Table 4.13 Maintenance Works and Inspection Items

		Items
Scheduled Inspection	Annual Inspection	- Detail condition of mechanical and electrical equipment - Deterioration condition of concrete and architectural facilities - Comparison with past inspection data
	Monthly Inspection	- Condition while full load driving - Condition of various driving mode - Condition of driving by sub power supply

	Items
Daily Inspection	- Condition while stopping of pump driving - Condition while usual pump driving
Maintenance works for screen and grit chamber	- Removal of residues (Screen) - Removal of accumulated sludge (Grit chamber)
Inspection after natural disaster	- Damage by the disaster - Operation of equipment - Condition of concrete and architectural facilities

4.5.3 Sewage Treatment Plant and Septage Treatment Facilities

Inspections and maintenance works for the sewage treatment plant and septage treatment facilities are as summarized in **Table 4.14**.

Table 4.14 Inspection and Maintenance in STP and Septage Treatment Facilities

	Items	Frequency
Septage Treatment Facilities		
Screen	Removal of residue	Daily
Pond and basin	Removal of scum and waterweed	Once in 2 weeks
Sludge drying bed	Check on thickness of sludge layer	Weekly
	Desludging	Once in 3 weeks
Sewage Treatment Plant		
Inlet channel	Recording of water flow	Daily
Aerated lagoons and sedimentation lagoons	Check on water level, odor and water temperature	Ditto
	Inspection of water leakage from embankment	On demand
	Removal of scum and waterweed	Once in 2 weeks
	Cleaning and greasing of aerators	2 time in a year
	Desludging	At least once a year
Chlorine chamber	Check on quantity of chlorine consumed	Daily
Water quality monitoring[1)]	pH, DO, BOD_5, TSS, COD_{Cr}, fecal coliform	At least 4 times in a year [2)]

Note: 1) Monitoring samples shall be sent and the water quality analysis shall be implemented in the laboratory in Camberene STP, as in the past.
2) Two times in the dry season and 2 times in the rainy season.

4.6 Preliminary Estimation of Project Cost

4.6.1 Construction Cost

Construction cost is calculated based on the various cost information obtained from ONAS Dakar, ONAS Kaolack, and "The Study on Urban Drainage and Wastewater Systems in Dakar City and its Surroundings, 1994, JICA." The following are the general conditions for the cost estimate:

- Construction cost is estimated at the 2012 price level;
- Annual price escalation rate of 3% up to 2012 is assumed for cost data on past projects;
- All necessary costs other than direct construction cost are included in construction cost;
- Unit rate for open-cut method which is the most common method in Senegal is assumed for the all necessary excavation works; and
- Cost is classified into foreign and local currency portions based on the information on the procurement obtained in Senegal.

4.6.2 Project Cost

The element of project cost and the percentages other than construction cost is assumed from the data of past projects in Senegal or other countries. In addition, price escalation during the project period from 2014 to 2030 is assumed utilizing the past 10 years' data on the inflation rate of the World Bank. In addition, VAT of 18% of Project Cost is included. The following are the major components of Project Cost:

- Construction Cost
- Engineering Cost: 10% of construction cost

- Project Administration Cost: 2% of construction cost
- Physical Contingency: 10% of construction cost and engineering cost
- Soft Component (Support by Specialist)
- Price Escalation during the Project Period (2014 to 2030): annual inflation rates are 3% for local currency, and 2% for foreign currency

The total project cost amounts to approximately 75,897 million FCFA at the 2012 price level, in which 64,619 million FCFA is the local currency portion and 11,278 million FCFA is the foreign currency portion.

Table 4.15 Project Cost

Cost Item	Work Item		L/C (million FCFA)	F/C (million FCFA)	Total (million FCFA)
Direct Construction Cost	Trunk Sewer	New Construction	5,514	0	5,514
		Replacement	3,440	0	3,440
		Sub-Total	8,954	0	8,954
	Pumping Station		1,259	1,889	3,148
	Sewage Treatment Plant (including septage treatment facilities)		6,621	2,838	9,459
	Branch Sewer		17,720	0	17,720
	Sub-Total		34,554	4,727	39,281
Engineering Service			1,186	2,766	3,952
Government Administration			790	0	790
Physical Contingency			3,912	435	4,347
Soft Component			31	126	157
Price Escalation			14,253	1,504	15,757
VAT			9,893	1,720	11,613
Total (million FCFA)			64,619	11,278	75,897

4.6.3 Operation and Maintenance Cost

Annual operation and maintenance cost for sewer network facilities is approximately 1,245 million FCFA.

4.7 Implementation Plan

4.7.1 Phased Projects and Project Components

Considering population and its density, local urgency of the sewer network improvement, environmental impacts by zone divided into 9 areas, two projects of two packages each are formed as shown in the following figure.

Project	Zone	Package	Items	Phase 1 (-2020)	Phase 2 (2021-2025)	Phase 3 (2026-2030)
Project-1	Zones 3, 5, 6 & 7	Package P1-1	Major facilities construction [1)]	■		
		Package P1-2	Branch sewer installation and Soft component		■	
Project-2	Zones 1, 2, 4, 8 & 9	Package P2-1	Major facilities construction [1)]			■
		Package P2-2	Branch sewer installation and Soft component			■

Note: 1) trunk sewer, pumping stations and sewage treatment plant

Fig. 4.9 Phased Projects and their Project Packages

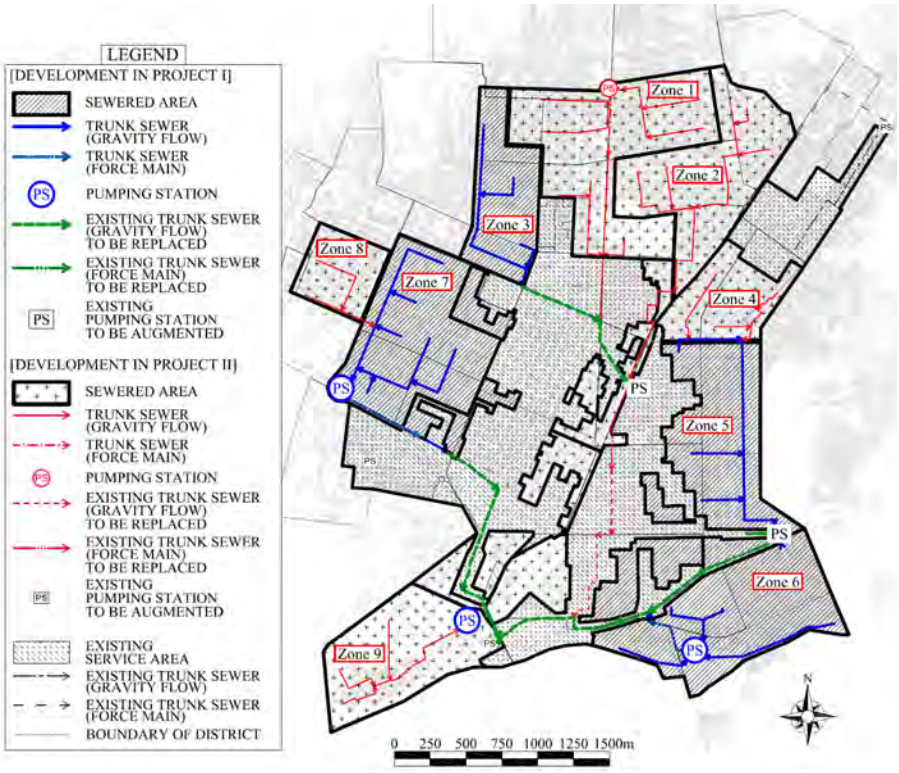


Fig. 4.10 Project Components (Trunk Sewer and Pumping Stations)

Regarding the step-wise improvement of STP, the following considerations should be made:

- In accordance with the progress of the sewer network, connection ratio, sewered population and finally, wastewater inflow to the STP will increase so that the capacity of the stepwisely improved STP could envelop the increments of wastewater inflow in a temporal change.
- Initial connection ratio of 50% is applied to existing sewered area and PRECOL area, considering actual connection ratio in Kaolack City. The connection ratio increases linearly and reaches up to 100% in 2030.

Based on the above considerations, population projection in the sewered area and the relation between wastewater inflow and capacity of STP is as presented in **Fig. 4.11**, and the schematic diagram of phased construction of STP is as shown in **Fig. 4.12**.

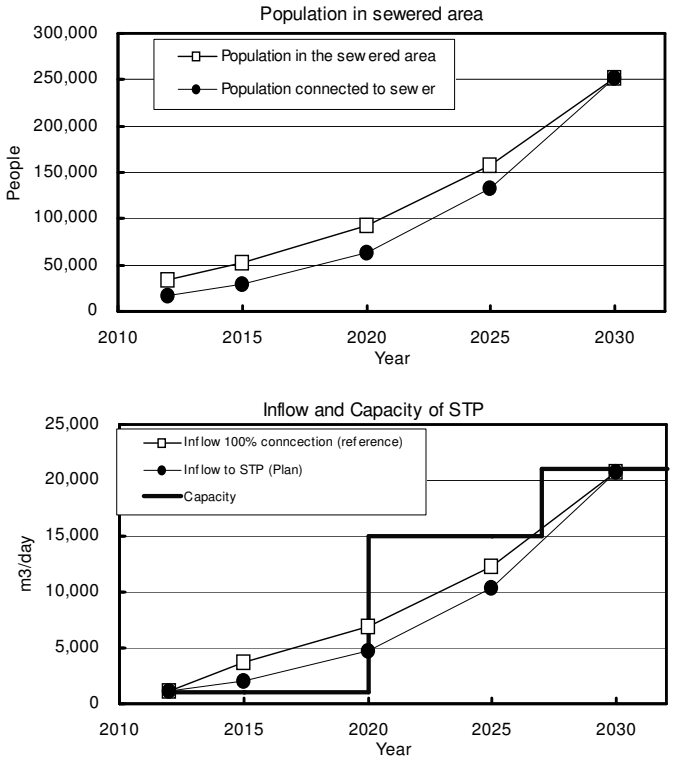


Fig. 4.11 Future Projection of Population Sewered Stepwise, Wastewater Inflow and Capacity of STP

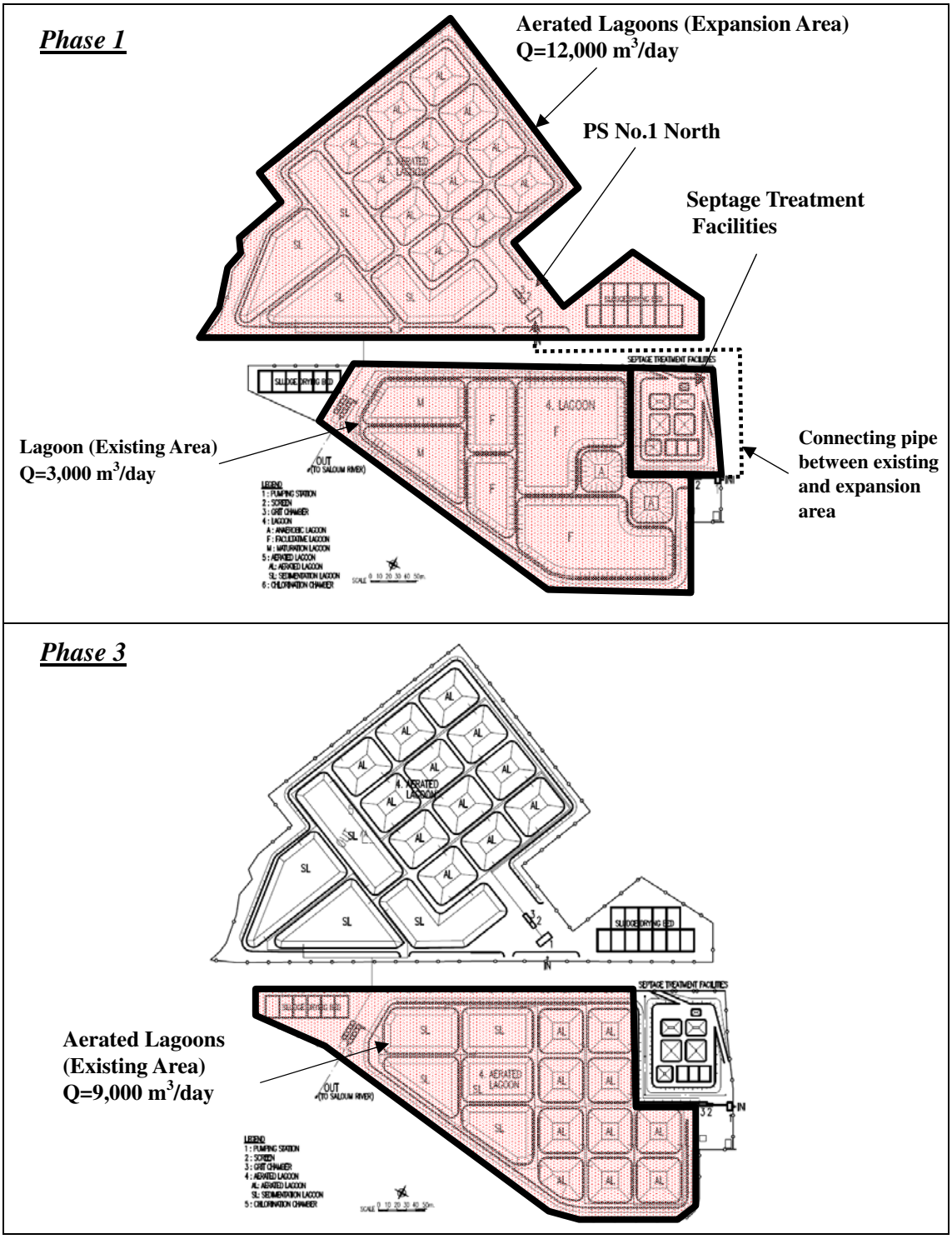


Fig. 4.12 Phased Construction of STP

Furthermore, in order to optimize the sewerage facilities especially the sewer network, increase of house connection in the sewered area is indispensable. Installation of septic tanks also should be encouraged to improve sanitary conditions in the on-site sanitation area. Soft components are, therefore, proposed to promote sewer connections in the sewer service area and installation of septic tanks in on-site sanitation

area. The soft components consist of: (i) campaign for sewer connection; and (ii) campaign for septic tank installation and desludging of septage, as summarized with their activities in the following table.

Table 4.16 Outline of Soft Components

Work Items	Activities
Campaign for sewer connection	• Development of campaign material including basic information on the mechanism of sewerage system, advantage of sewer connection and cost for sewer connection. • Assistance for holding briefing session on sewer connection implemented by ONAS in the sewer sewered area
Campaign for septic tank installation and desludging of septage	• Survey on the status of septic tank installation in the on-site sanitation area. • Development of campaign material including advantage of septic tank installation, cost for septic tank installation, advantage of desludging, appropriate approach for desludging and cost reduction of desludging by the installation of septage treatment facilities in sewage treatment plant. • Assistance for holding briefing session on septic tank installation and appropriate desludging of septage, implemented by ONAS in the on-site sanitation area.

4.7.2 Priority Projects

In the M/P, the priority projects shall be selected based on urgency and efficiency of implementation. In the sewer network improvement, the selected priority projects shall involve the construction of new trunk sewer (12.33 km) and replacement of trunk sewer (5.83 km), and construction of new or replacement/augmentation of pumping stations (new construction of 3 pumping stations and replacement/augmentation of 3 pumping stations) as presented in **Fig. 4.13**.

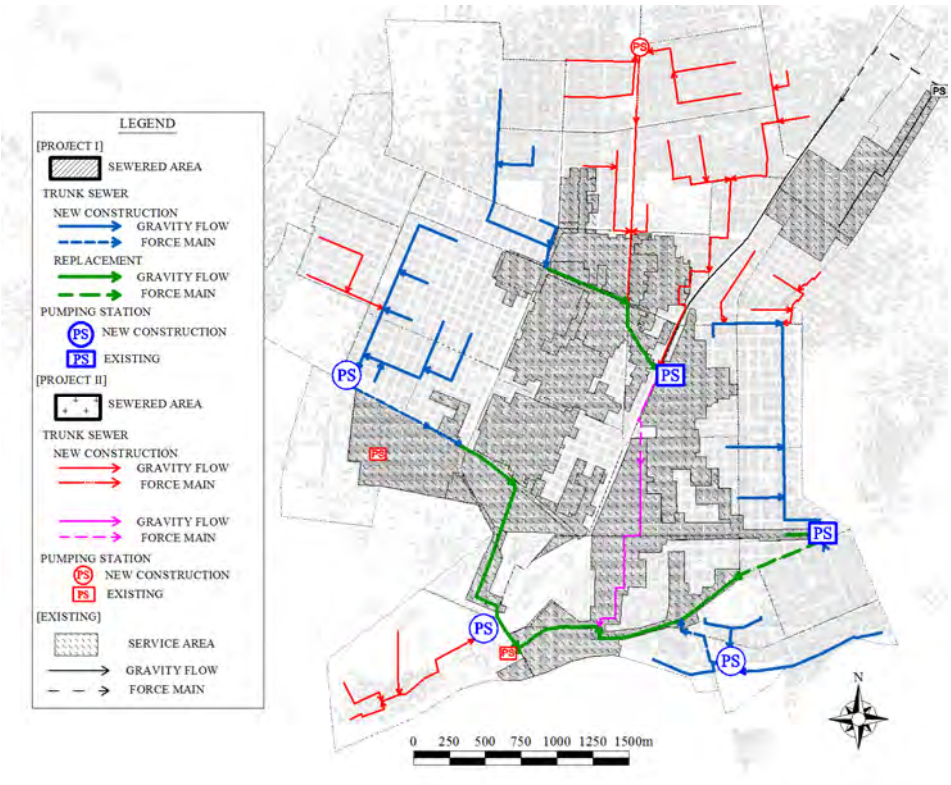


Fig. 4.13 Location of Priority Projects (Sewer Network and Pumping Stations)

Regarding the STP improvement, the priority projects include the rehabilitation of existing area (South Area) to the lagoon (capacity: Q=3,000 m^3/day) with the configuration of anaerobic, facultative and maturation lagoons, construction of aerated lagoon (capacity: Q=12,000 m^3/day) and construction of septage treatment facilities, as summarized in the following table.

Table 4.17 Priority Projects (Sewage Treatment Plant)

Work Items	Description	Capacity	Remarks
New Construction	Aerated Lagoon	12,000 m^3/day	Including chlorination chamber
	Septage treatment facilities	70 m^3/day	BOD_5 load : 250 kg/day
	Connection pipe	380 m	
Rehabilitation	Lagoon	3,000 m^3/day	

4.8 Economic Analysis

Major preconditions of the economic analysis are summarized below:

- Evaluation Period: 2014 to 2060 (30 years after the completion of the construction)
- Standard Conversion Factor (SFC): 0.84 (with reference to similar project of WB)
- Price Level: Year 2012
- Shadow Exchange Rate and Shadow Wage Rate: 1 (with reference to similar project of WB)
- Social Discount Rate: 12%

4.8.1 Project Cost

The following items are included in the cost calculation:

- Construction Cost
- Engineering Services Cost
- Physical Contingencies
- Administration Cost
- Capacity Development Cost (Soft component)
- O&M

Land acquisition cost is not included in the M/P stage under the assumption that the land is owned by the government. This cost item is converted into its economic value.

4.8.2 Project Benefits

Project contents, expected effects and their benefits are summarized below.

Table 4.18 Project Contents, Expected Effect and Benefit

Project Contents	Expected Effect	Benefit
Augmentation of capacity of sewage treatment plant	Improvement of sanitary condition in the area	Living environment of the residents in the area improves.
Rehabilitation of existing sewer network and expansion of the network	Improvement of sanitary condition in the area	Living environment of the residents in the area improves.
Installation of septage treatment plant	Improvement of sanitary condition in the area	Living environment of the residents in the area improves.
Capacity development (Soft component)	Improvement of management of sewerage and sanitation facilities	Since this content helps other contents realize their effects effectively, it has no additional benefit by itself.

Since the benefit of the component "improvement of living environment" cannot be attributed separately to each of the three contents, namely; (1) Augmentation of capacity of sewage treatment plant; (2) Rehabilitation of existing sewer network and expansion of the network; and (3) Installation of septage treatment plant, such three contents are treated in an integrated manner. Since the capacity development helps other contents realize their effects efficiently and since it has no additional benefit, the economic evaluation of this content is not conducted separately.

This project has positive effects on the improvement of living environment in the target area, whose benefit can be calculated by their willingness-to-pay (WTP). The targeted population includes those who connect to the sewerage system and the septic tank users. The total WTP in the target area is shown below.

Table 4.19 Total WTP for the Improvement of Living Environment in Target Area

	2012	2015	2020	2025	2030
Targeted Population (thousand)	–	169	259	339	403
WTP of 500 FCFA case (FCFA/person/year)	6,000	6,196	6,522	6,849	7,175
Total WTP for 500 FCFA case (million FCFA/year)	–	0	1,690	2,324	2,892
WTP of 1,000 FCFA case (FCFA/person/year)	12,000	12,392	13,044	13,697	14,350
Total WTP for 1,000 FCFA (million FCFA/year)	–	0	3,380	4,649	5,783
WTP of Weighted Average case (FCFA/person/year)	2,429	2,508	2,640	2,772	2,904
Total WTP for Weighted Average case (million FCFA/year)	–	0	684	941	1,170

4.8.3 Calculation Results

EIRR is calculated at 2.2 % for WTP of 500 FCFA and 9.1% for WTP of 1,000 FCFA and -9.3% for WTP of weighted average (202 FCFA) since its benefit is too low. WTP of 1,000 FCFA is of the same level as the solid waste collection fee presently paid by users, so that this amount can be realized by education and dissemination campaigns to the people.

4.9 Financial Analysis

4.9.1 Preconditions

Major preconditions of the financial analysis are as follows:

- Evaluation Period: 2014 to 2060 (30 years after the completion of construction)
- Price Level: Year 2012
- Exchange Rate: FCFA 1.00 = JPY 0.1487
- Social Discount Rate: 12% (with reference to similar project of WB)

4.9.2 Project Cost

The following items are included in the cost calculation:

- Construction Cost
- Physical Contingencies
- Consulting Services
- Administration Cost
- Capacity Development Cost (Soft component)
- VAT
- O&M

Land acquisition cost is not included in the M/P stage under the assumption that the land is owned by the government. This cost item is converted into its economic value.

4.9.3 Project Benefits

Project benefit is the revenue from: (1) sewerage charges, 8% of water supply charge which is collected with water supply charge for the people in sewerage area; and (2) septage treatment charge outside sewerage area. However, since sewerage charge is presently collected also from those who have no connection to the sewerage system, sewerage charge is applied to all the people for the purpose of benefit calculation.

Presently, sewerage charge for each concession is 10 FCFA/m^3 of water consumption up to 20 m^3 and 45.65 FCFA/m^3 of water consumption from 21 m^3 to 40 m^3. Unit average charge (FCFA/m^3) is

calculated with the average number of people in one concession, 9.45 in 2012 by Kaolack City. It is regarded as the base case to estimate how many times the charge should be increased in the calculation of FIRR.

Table 4.20 Total Revenue from Sewerage Charge

	2012	2015	2020	2025	2030
Targeted Population (thousand)	–	169	259	339	403
Water Consumption (lpcd)	74.0	76.0	80.0	84.0	88.0
Average Charge (FCFA/CM)	11.98	12.87	14.51	15.99	17.34
Total Water Consumption (thousand CM/yr)	–	4,682	7,566	10,406	12,944
Total Revenue (million FCFA)	–	0	111	166	225

4.9.4 Calculation Results

FIRR cannot be calculated with the base case because the benefit is too low, which means sewerage charge is set at a very low level. FIRR will be 0.0% if the sewerage charge is increased to 13.6 times and 12.0% (equal to Social Discount Rate) if 49.0 times.

CHAPTER 5. STORMWATER DRAINAGE MANAGEMENT PLAN

5.1 Planning Concept

5.1.1 Planning Objectives

Based on the encountered issues mentioned in Chapter 2, the stormwater drainage management in this study has the following objectives: (i) to minimize the inundation and damage caused by local rainfall by providing the new drainage system; (ii) to recover and maintain the original and potential functions of existing drainage systems; and (iii) to improve the hygienic condition of the urban environment for the residents.

5.1.2 Planning Area and Target Year

(1) Planning Area

The planning area for the Master Plan is about 24 km^2 in the city center of Kaolack City as agreed with Kaolack City through the T/C (Technical Committee) and the S/C (Steering Committee) meeting. The area covers the stormwater drainage basin of the center of Kaolack City, following topographic ridgelines. The target area of the Master Plan is as shown in **Fig. 5.1**.

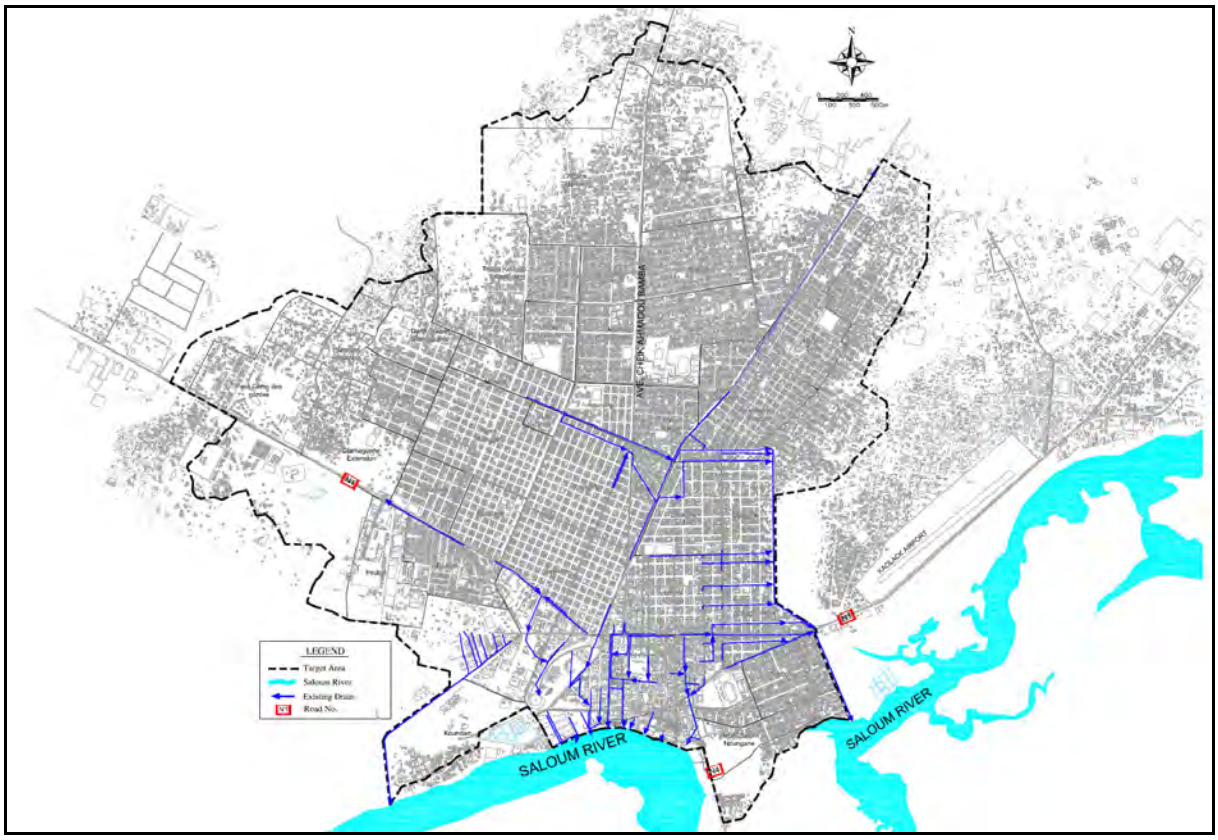


Fig. 5.1 Planning Area for Stormwater Drainage Improvement

(2) Target Year

The target year of the Master Plan is 2030. The Master Plan is to be implemented in three terms as follows: (i) Short-term for Phase 1 projects by end of 2020; (ii) Mid-term for Phase 2 projects from 2021 to 2025; and (iii) Long-term for Phase 3 projects from 2026 to 2030.

5.1.3 Planning Conditions

(1) Design Scale

Based on the observation results of rainfall in the 2012 rainy season, the 10-year design storm with 3 hours duration is adopted for the stormwater management in Kaolack City.

(2) Design Rainfall

Comparing probable daily rainfalls of Kaolack with those of Dakar, the following formula is developed in 10-year storm utilizing the probable rainfall intensity curves prepared for Dakar: I = 5,427.8 / (T+36.9), where I is rainfall intensity in mm/hour and T is its duration in minutes.

(3) Design Discharge

The sub-catchment areas are less than 10 km^2, so that the rational formula is applicable and suitable for the computation of design discharge. The computation process of peak discharge using the rational formula is quite easy and simple because the parameters are limited to two, runoff coefficient and rainfall intensity, depending on the concentration time needed.

5.1.4 Evaluation of Existing Drainage Network

As described in the **Section 2.4**, the installed drains which maintained by Kaolack City have reached the total length of 19.96 km, consisting of 12.38 km long open drains and 7.58 km long covered drains. The existing drainage system of 19.96 km long covers 7.8 km^2 of the territory of Kaolack City.

Manning's formula was used for evaluating the existing drainage system of 10-year storm. The existing drains were computed in accordance with the Manning's formula with value of n=0.015 corresponding to concrete drains. As a result, the existing drains were evaluated to have sufficient capacity for the peak discharge of 10-year storm.

5.1.5 Necessary Measure of Stormwater Drainage Management

In order to achieve the drainage improvement in Kaolack City, it is necessary to carry out integrated measures that include structural and supporting ones.

(1) Structural Measures

The structural measures aim to mitigate inundation by the installation of stormwater drainage network, construction of pumping stations and retention ponds, improvement of existing stormwater drainage canals, etc.

(2) Supporting Measures

The supporting measures aim to support and sustain the structural measures by improving and developing organizational aspects of operation and maintenance system, by preparing the cleaning plan for drainage facilities, and by enhancement of public awareness.

5.2 Alternative Study for Structural Stormwater Drainage Improvement

5.2.1 Alternative Setting

Three alternative layouts as presented in **Figs. 5.2** to **5.4** have been evaluated in order to select the optimum system design.

(1) No Action

If all of the sectors concerned in stormwater drainage do not take any action to improve stormwater drainage problems, the flooding condition will worsen in the target year 2030. In other words, the future flooding condition without improvement is considered in this case.

(2) Alternative 1

Alternative 1 is presented schematically in **Fig. 5.2**. This alternative consists of installation of drains, construction of pumping stations and improvement of existing drains. The planning area is divided into 5 sub-catchment areas such as North, Northwest, West, etc. For the North and West areas, they have a new drainage network and pumping stations. The drainage network of the Northwest area will be connected to the existing drain of the Central area by pumping; therefore, the existing drains will require improvement works with widening and deepening, and structural strengthening. There are two new main drains in the Southeast area and the new drains will be connected to the existing drain. This alternative does not include stormwater retention facilities.

(3) Alternative 2

Alternative 2 is presented schematically in **Fig. 5.3**. The number of sub-catchment areas, alignment of proposed drains and number of pumping station, and location of pumping station of this alternative are the same as Alternative 1. However, this alternative includes a retention pond as stormwater storage facility, so that the dimension of drains and the required pump capacity are reduced.

(4) Alternative 3

Alternative 3 is presented schematically in **Fig. 5.4**. This alternative consists of the installation of drains, construction of pumping stations and retention ponds, and rehabilitation of existing drains. For this alternative, the target area is divided into 4 sub-catchment areas. The proposed drain of the West area will not be connected to the existing drain in the Central area, and a relay pumping station is not necessary. Most of the runoff from the West area will be conveyed to the retention pond. This alternative requires a lesser number of pumping stations than the other alternatives.

The outline of the proposed facilities for each alternative is tabulated in **Table 5.1**.

Table 5.1 Proposed Facilities and Costs for Alternatives

Items		Alternative 1	Alternative 2	Alternative 3
Drain	Dimensions (m) (width × height)	1.3 × 1.3 ~ 8.0 × 2.0	1.3 × 1.3 ~ 8.0 × 2.0	1.3 × 1.3 ~ 3.2 × 3.2
	Total length (km)	28.38	28.38	28.31
Pumping Station	Number of stations	3	3	2
	Total required capacity (m^3/s)	41.93	28.67	21.85
Retention Pond	Number of ponds	0	2	2
	Total required volume (m^3)	0	70,300	112,300
Construction Cost	(Billion FCFA)	52.53	47.56	42.96
O&M Cost	(Million FCFA/Year)	33	35	35

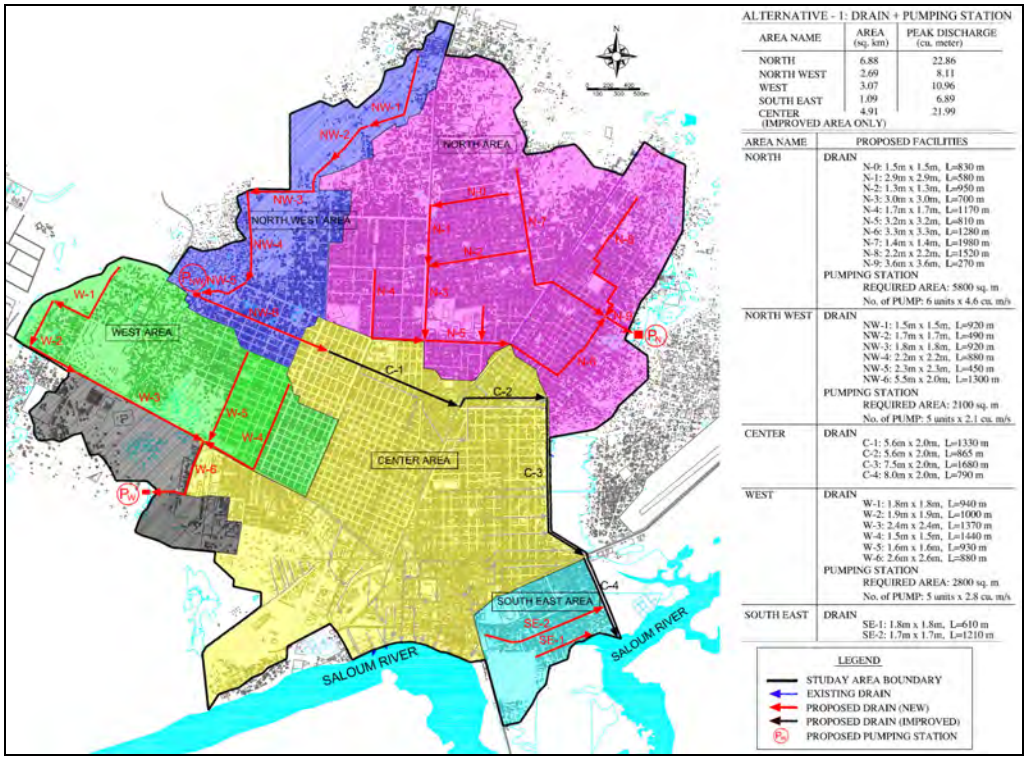


Fig. 5.2 Drainage Improvement Alternative 1

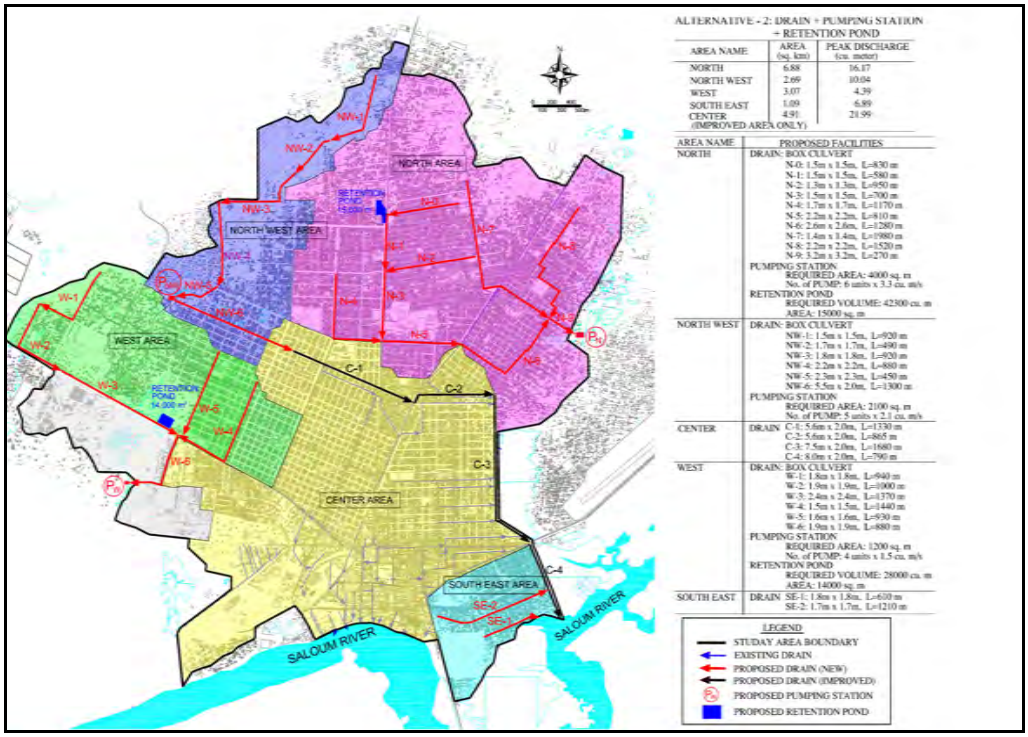


Fig. 5.3 Drainage Improvement Alternative 2

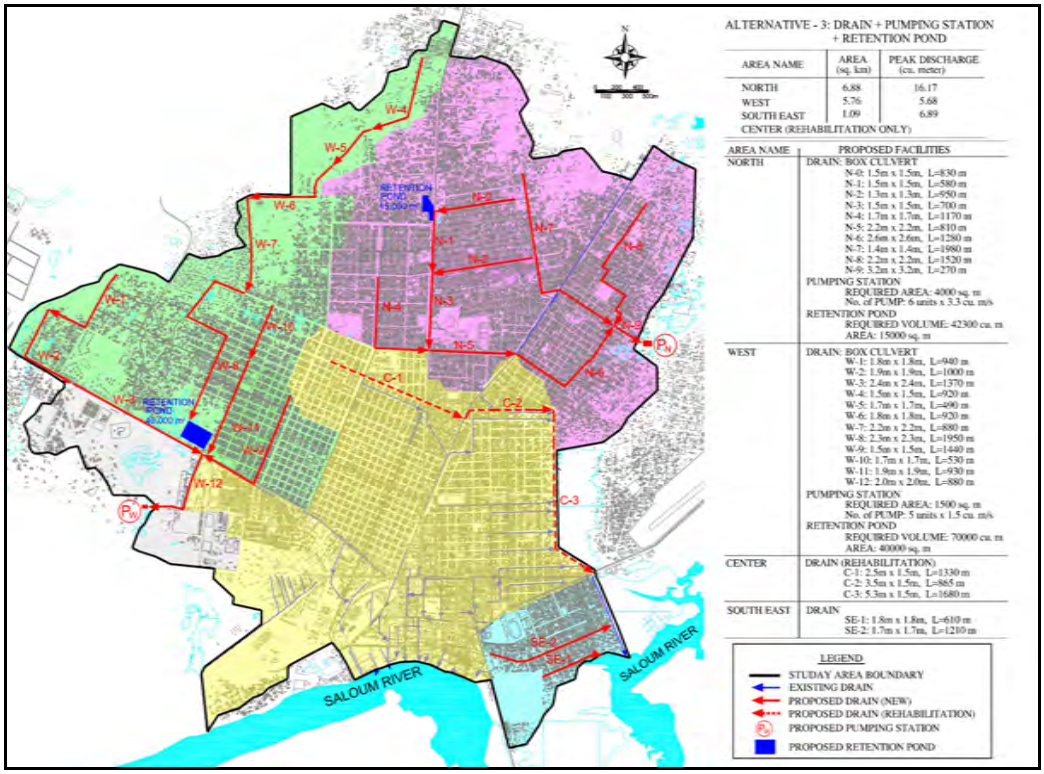


Fig. 5.4 Drainage Improvement Alternative 3

5.2.2 Comparison of Alternatives

Each plan alternative is ranked using the qualitative criteria. A ranking of 1 to 3 is given with 1 being the least favorable. Qualitative ranking of alternatives is shown in **Table 5.2**. Alternative 3 could be selected as the optimum plan.

Table 5.2 Qualitative Ranking of Alternatives

Item	Alternative 1	Alternative 2	Alternative 3
Reliability	1	2	3
Implementability	1	2	3
Environmental impact	1	2	3
Flexibility	3	2	1
Total	6	8	10
Overall ranking*)	3rd	2nd	1st

1) Ranking of "1st" is most favorable.

5.3 Structural Stormwater Drainage Improvement Plan

Based on the optimum plan of Alternative 3 through the above comparative study among the alternatives, the following structural plan is made for the preliminary design.

5.3.1 Structural Improvement Plan in the North Drainage Area

The catchment area of the North area is 6.88 km^2. At present, there is no drainage system and there are some low-lying areas in the districts of Ngane Saar, Ngane Alassane, Gawane, Touba Kaolack, Sam and Ndorong Sadaga. Therefore, inundation causes serious damage during the rainy season. The alignment of proposed drains and location of proposed pumping station and retention pond are shown in **Fig. 5.5**. Proposed site for the pumping station is located at the private land, and the site has at present no residents, houses, commercial facilities and so on. Proposed site for the retention pond is located in the public and private land and the site has at present no residents, houses, commercial facilities and so on.

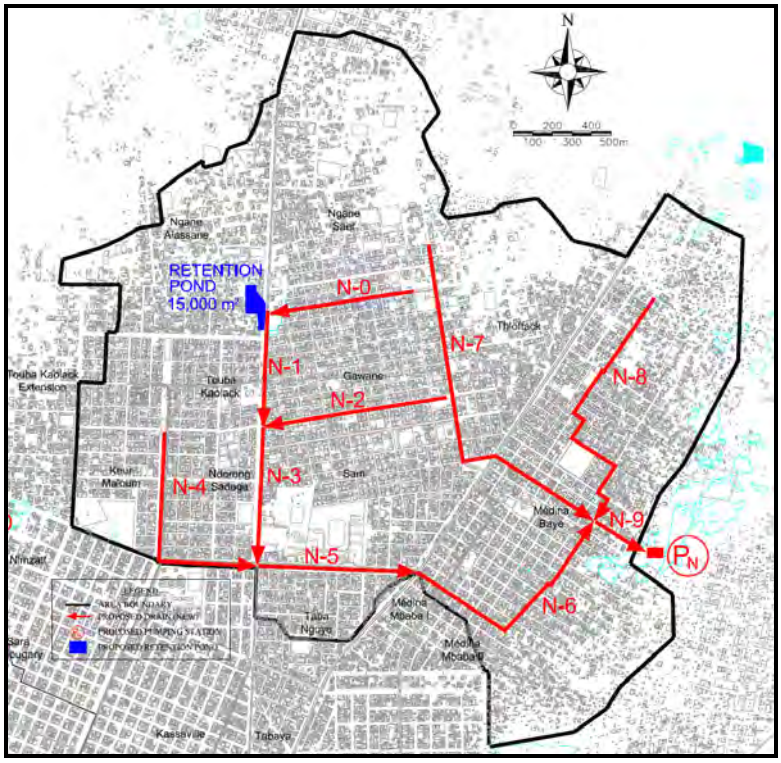


Fig. 5.5 Location of Proposed Drainage Facilities in the North Drainage Area

At the beginning point of N-1 Drain, a new retention pond is proposed to minimize the size of new drains. This proposed location of retention pond is called "Khakhoune" and it is a depressed area. In the rainy season, this area becomes a natural pond. The new pumping station proposed to collect stormwater

from the North area is to be located in lower elevations at the eastern side of Medina Baya District. Stormwater concentrates into the natural pond. Land of the pond is proposed taking account of the site condition to avoid compensation problem. Proposed drainage facilities are tabulated in **Table. 5.3**.

Table 5.3 Proposed Drainage Facilities in the North Drainage Area

Component	Specifications
Box Culvert	
N-0	1.5m × 1.5m, L= 830 m
N-1	1.5m × 1.5m, L= 580 m
N-2	1.3m × 1.3m, L= 950 m
N-3	1.5m × 1.5m, L= 700 m
N-4	1.7m × 1.7m, L=1,170 m
N-5	2.2m × 2.2m, L= 810 m
N-6	2.6m × 2.6m, L=1,280 m
N-7	2.2m × 2.2m, L=1,980 m
N-8	3.2m × 3.2m, L=1,520 m
N-9	1.4m × 1.4m, L= 270 m
Pumping Station (P_N)	No. of Pumps: 6 units × 3.3 m^3/s Required area: 4,000 m^2 Pump Total Head: 3.2 m
Retention Pond	Required volume: 42,300 m^3 Required area: 15,000 m^2

5.3.2 Structural Improvement Plan in the West Drainage Area

This area includes 11 districts and the catchment area is 5.76 km^2 with a gentle slope towards southwest. In this area, there is no drainage system and there are frequently inundated areas in Parcelles Assainies, Nimzatt, Diamaguene and Boustane I districts. The alignment of proposed drains and location of proposed pumping station and retention pond are as shown in **Fig. 5.6**.

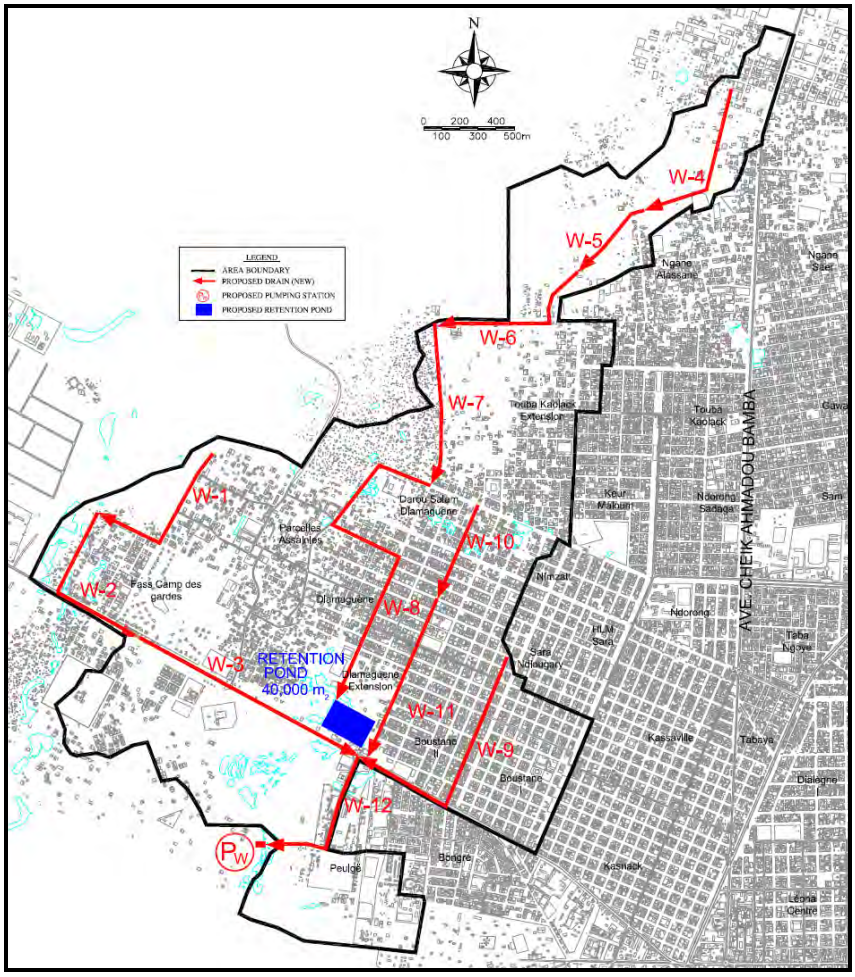


Fig. 5.6 Location of Proposed Drainage Facilities in the West Drainage Area

A new retention pond is proposed to minimize the size of new drains at Diamaguene Extension. This proposed area is low-lying so that it becomes a natural pond in the rainy season. The new pumping station proposed to collect stormwater from the basin is to be located in a lower elevation vacant area at the western side of Peulge District. At present, the proposed sites of pumping station and retention pond are located in the public land and have no residents, houses, commercial facilities and so on. Collected stormwater concentrates into the natural pond which is proposed taking into account of the site condition to avoid compensation problem. The proposed drainage facilities are tabulated in **Table. 5.4**.

Table 5.4 Proposed Drainage Facilities in the West Drainage Area

Component	Specification
Box Culvert	
W-1	1.8m × 1.8m, L= 940 m
W-2	1.9m × 1.9m, L=1,000 m
W-3	2.4m × 2.4m, L=1.370 m
W-4	1.5m × 1.5m, L= 920 m
W-5	1.7m × 1.7m, L= 490 m
W-6	1.8m × 1.8m, L= 920 m
W-7	2.2m × 2.2m, L= 880 m
W-8	2.3m × 2.3m, L=1,950 m
W-9	1.5m × 1.5m, L=1,440 m
W-10	1.7m × 1.7m, L= 530 m
W-11	1.9m × 1.9m, L= 930 m
W-12	2.0m × 2.0m, L= 880 m
Pumping Station (P_W)	No. of Pump: 5 units × 1.5 m^3/s

Component	Specification
	Required area: 1,500 m^2 Pump Total Head: 4.0 m
Retention Pond	Required volume: 70,000 m^3 Required area: 40,000 m^2

5.3.3 Structural Improvement Plan in the Southeast Drainage Area

This area is located along the Saloum River and the catchment area is 1.09 km^2. At present, there is no drainage system and there are frequently inundated areas in the Abattoirs and Darou Salam districts. The alignment of proposed drains is as shown in **Fig. 5.7**. The proposed drain will be connected to the existing open drains. Proposed drainage facilities are tabulated in **Table. 5.5**.

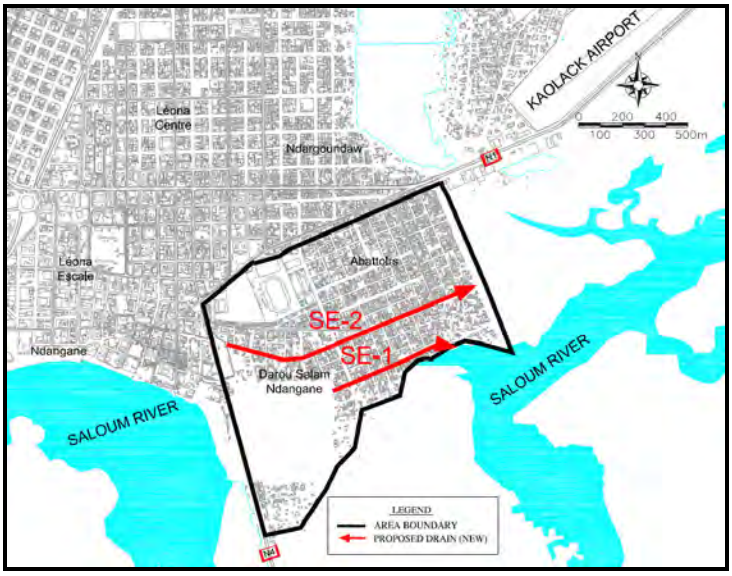


Fig. 5.7 Location of Proposed Drainage Facilities in the Southeast Drainage Area

Table 5.5 Proposed Drainage Facilities in the Southeast Drainage Area

Component	Specifications
Box Culvert	
SE-1	1.8m × 1.8m, L= 610 m
SE-2	1.7m × 1.7m, L=1,210 m

5.3.4 Structural Improvement Plan in the Central Drainage Area

This area is the core area of Kaolack City, where drainage systems started to be constructed in the 1980's. The installed drains reached the total length of 19.96 km and consist of 12.38 km long open drains and 7.58 km long covered drains. The existing drainage system of 19.96 km long covers 7.8 km^2 of the territory of Kaolack City and have the sufficient capacity for peak discharges of 10-year storm. However, the existing open drains are partially excavated earth canals of unsustainable structure and the original section has been reduced due to the accumulation of sediment and garbage. Therefore, The excavated earth canals should be reconstructed into reinforced concrete structures for sustainability and keeping the original cross-section area. The rehabilitation works is simple construction work and, Kaolack City will be able to conduct it. However, Kaolack City had strongly requested to include this rehabilitation work in the Master Plan. Therefore, Kaolack City and JET discussed the request deeply and selected the biggest main open drains as the target of rehabilitation work. The main purpose of the rehabilitation works is to revive the original section of the drainage channels, and to maintain their original functions. Accordingly, the rehabilitation target is to reconstruct the open drains into concrete structures. The target drainage channels are as shown in **Fig. 5.8**, and the drainage channels to be rehabilitated are enumerated in **Table. 5.6**.

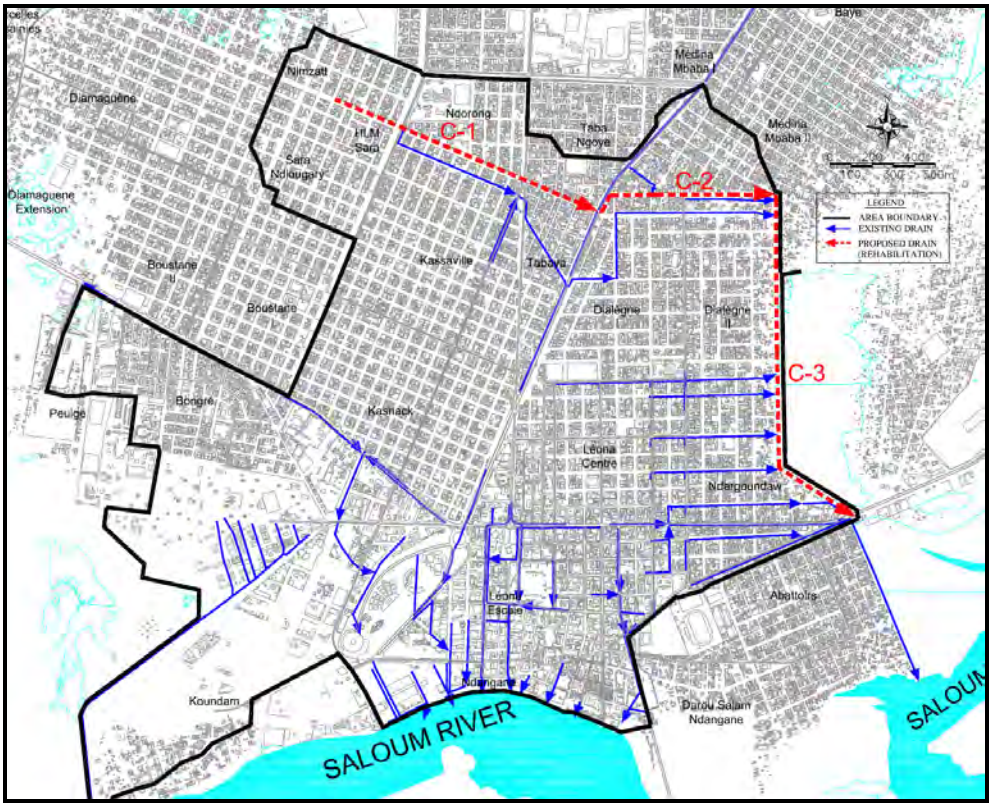


Fig. 5.8 Location of Rehabilitation Drainage Channels in the Central Drainage Area

Table 5.6 Rehabilitation of Drainage Channels in the Central Drainage Area

Component	Specifications
C-1	2.5m × 1.5m, L=1,330 m
C-2	3.5m × 1.5m, L= 865 m
C-3	5.3m × 1.5m, L=1,680 m

5.4 Operation and Maintenance Plan

5.4.1 Responsible Organization for Operation and Maintenance

The Service Technique Communal (STC) of the Kaolack City Government is the organization in charge of operation and maintenance of drainage facilities such as pumping station, retention pond and drains.

5.4.2 Operation and Maintenance Method

(1) Drainage Network

Adequate operation and maintenance work of the drainage network shall involve the following procedures:

(a) Maintenance and Inspection

In the "Guidelines for Optimization of Operation and Maintenance of Sewage Works in Developing Countries (issued by the Infrastructure Development Institute, Japan, October 2001)," the inspection frequency is about once in every 5 years for pipes without any particular problem. According to the records, the inspection frequency in urban areas in Japan is once in every 3 to 7 years.

It has been confirmed in the site investigations that the existing drainage system in many parts are clogged with debris combined with sediment and garbage. In consideration of this situation,

it is preferable to execute inspection at the frequency of about 1 in every 3 to 5 years for the drainage box culverts constructed under the Project.

(b) Cleaning and Dredging

Garbage and sludge deposits in box culverts reduce flow capacity. Therefore, it is essential to carry out regular inspections and remove deposits when observed.

(c) Renewal and Repair of Drainage Pipes

Deterioration of pipes proceeds over the surface as a whole, and renewal and repair will take a considerable time. Therefore, it is necessary to implement renewal and repair according to the plan established on the basis of the results of inspections and surveys to prevent accidents beforehand.

(2) Pumping Station and Retention Pond

Pumping stations are essential facilities for a drainage system. Pumping stations that do not function will cause serious damage to the city by flooding. Therefore, it is necessary to understand the specifications and characteristics of pumps for operation and maintenance. There is no drainage pumping station in the Kaolack City so that it is necessary to attempt technology transfer to pump operating staff through the initial operation guidance carried out by the supplier/manufacturer of equipment and machineries newly introduced.

Retention ponds have the function to store stormwater temporarily. It is preferable to execute the cleaning work on retention ponds once a year before the onset of the rainy season. STC has to designate a cleaning work team composed of about 10 members. Since a retention pond is an open space, the workers can go inside to clean and remove the deposits and garbage manually using shovels. Alternatively, the work for retention pond cleaning can be subcontracted to a private contractor based on inspection results.

5.5 Preliminary Project Cost Estimate

5.5.1 Construction Cost

The construction cost is calculated based on the various cost information obtained from ONAS Dakar, ONAS Kaolack, and the "Study on Urban Drainage and Wastewater Systems in Dakar City and its Surrounding by JICA in 1994." The following are the general conditions for the construction cost estimate:

- The Construction cost is estimated at the 2012 price level;
- The annual price escalation rate of 3% up to 2012 is assumed from the cost data of past project;
- All necessary costs other than direct construction cost are included in the construction cost;
- The unit rate for open-cut method which is the most common method in Senegal is assumed for the all necessary excavation works; and
- The cost is classified into foreign and local currency portions based on the information on procurement obtained in Senegal.

5.5.2 Project Cost

The element of project cost and the percentage other than the construction cost is assumed from the data of the past project in Senegal or other countries. In addition, the price escalation during the project period from 2014 to 2030 is assumed utilizing the past 10 years' data on the inflation rate of the World Bank. In addition, VAT of 18% of Project Cost is included.

- Construction Cost
- Engineering Cost: 10% of construction cost
- Project Administration Cost: 2% of construction cost
- Physical Contingency: 10% of construction cost and engineering cost
- Price escalation during the Project Period (2014 to 2030): annual inflation rate of 3% of local currency and 2% of foreign currency

The total project cost amounts to approximately 84,002 million FCFA at the 2012 price level, in which 73,516 million FCFA is the local currency portion and 10,486 million FCFA is the foreign currency portion. The details are tabulated below.

Table 5.7 Project Cost

Cost Items	Work Items	L/C (million FCFA)	F/C (million FCFA)	Total (million FCFA)
Direct Construction Cost	Drain (Box Culvert)	35,153	0	35,153
	Pumping Station	2,736	4,104	6,840
	Retention Pond	962	0	962
	Sub-Total	38,851	4,104	42,955
Engineering Service		1,289	3,007	4,296
Government Administration		859	0	859
Physical Contingency		4,253	472	4,725
Price Escalation		17,050	1,303	18,353
VAT		11,214	1,600	12,814
Total (million FCFA)		73,516	10,486	84,002

5.5.3 Operation and Maintenance Cost

The total annual operation and maintenance cost for related facilities aggregates 34,657 thousand FCFA after completion of the Project. This total figure consists of 15,457 thousand FCFA for pumping stations, 4,200 thousand FCFA for box culvert, and 15,000 thousand FCFA for retention ponds.

5.6 Prioritization of the Project and Implementation Plan

5.6.1 Prioritization of the Project

The planning area is divided into 4 drainage areas, namely; North, Center, West and Southeast. A drainage improvement plan is formulated in each drainage area and some projects consist of several packages. For dividing the project package, scale of construction work, situation of the project area and social impact are taken into consideration. For each project package, it is necessary to decide its priority ranking. The compositions of the project and the project packages are as shown in **Fig. 5.9**.

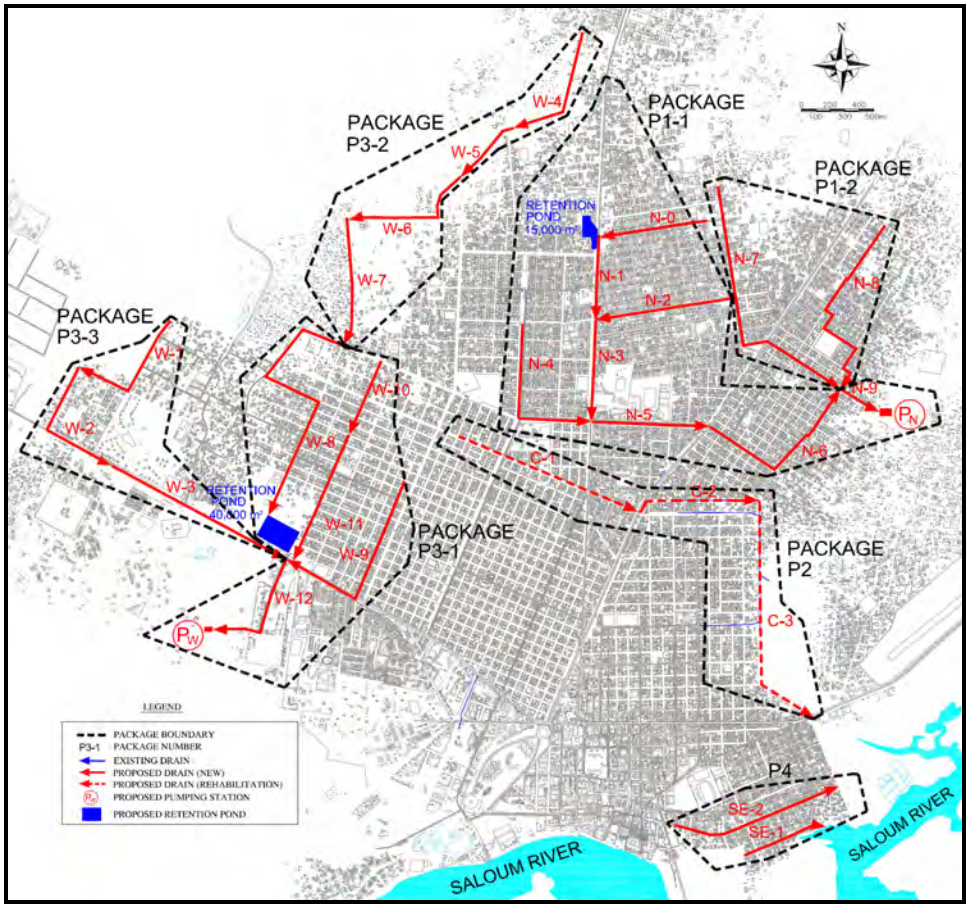


Fig. 5.9 Packaging of the Project

For giving the priority to project packages, points to be evaluated are: (i) population number in the drainage area; (ii) inundation area in the drainage area; (iii) request from the City Government through residents' demand; and (iv) environmental impacts. Final prioritization is made using the summarized score.

5.6.2 Implementation Plan

The phased implementation program for the project is based on the following:

- The whole drainage improvement measures proposed are divided into 3 phases to be completed by the target year 2030; and
- For phasing the implementation schedule of proposed measures, priority given in the preceding section is taken into consideration.

The drainage improvement project packages and their implementation plans are as summarized in **Table 5.8** after basic and detailed design works and tendering are conducted in the beginning of each phase.

Table 5.8 Project Components and Implementation Periods

Projects	Package	Components	Specifications	Remarks
Project-1 (North Area)	P1-1	Box Culvert		
		N-0	1.5m × 1.5m, L= 830 m	New Construction
		N-1	1.5m × 1.5m, L= 580 m	
		N-2	1.3m × 1.3m, L= 950 m	
		N-3	1.5m × 1.5m, L= 700 m	
		N-4	1.7m × 1.7m, L=1,170 m	
		N-5	2.2m × 2.2m, L= 810 m	

Projects	Package	Components	Specifications	Remarks
		N-6 N-9	2.6m × 2.6m, L=1,280 m 1.4m × 1.4m, L= 270 m	
		Pumping Station (P_N)	No. of Pump: 6 units × 3.3 m^3/s Required area: 4,000 m^2 Pump Total Head: 3.2 m	New Construction
		Retention Pond	Required volume: 42,300 m^3 Required area: 15,000 m^2	New Construction
	P1-2	Box Culvert N-7 N-8	 2.2m × 2.2m, L=1,980m 3.2m × 3.2m, L=1,520m	New Construction
Project-2 (Center Area)	P2	Open Channel C-1 C-2 C-3	 2.5m × 1.5m, L=1,330 m 3.5m × 1.5m, L=8,65 m 5.3m × 1.5m, L=1,680 m	Rehabilitation
Project-3 (West Area)	P3-1	Box Culvert W-8 W-9 W-10 W-11 W-12	 2.3m × 2.3m, L=1,950 m 1.5m × 1.5m, L=1,440 m 1.7m × 1.7m, L= 530 m 1.9m × 1.9m, L= 930 m 2.0m × 2.0m, L= 880 m	New Construction
		Pumping Station (P_W)	No. of Pump: 5 units × 1.5 m^3/s Required area: 1,500 m^2 Pump Total Head: 4.0 m	New Construction
		Retention Pond	Required volume: 70,000 m^3 Required area: 40,000 m^2	New Construction
	P3-2	Box Culvert W-4 W-5 W-6 W-7	 1.5m × 1.5m, L= 920 m 1.7m × 1.7m, L= 490 m 1.8m × 1.8m, L= 920 m 2.2m × 2.2m, L= 880 m	New Construction
	P3-3	Box Culvert W-1 W-2 W-3	 1.8m × 1.8m, L= 940 m 1.9m × 1.9m, L=1,000 m 2.4m × 2.4m, L=1,370 m	New Construction
Project-4 (South East)	P4	Box Culvert SE-1 SE-2	 1.8m × 1.8m, L= 610 m 1.7m × 1.7m, L=1,210 m	New Construction

5.6.3 Priority Project

The projects proposed for Phase 1 in the Master Plan are selected as the priority projects. Since Package P1-1 of Project-1 has the top priority in the Master Plan, Package P1-1 of Project-1 has been selected as the priority project for the succeeding Feasibility Study. The structural components of the priority project are shown in **Table 5.9**.

Table 5.9 Structural Components in the Priority Project

Project	Package	Components	Specifications	Remarks
Project-1 (North Area)	P1-1	Box Culvert N-0 N-1 N-2 N-3 N-4 N-5 N-6 N-9	 1.5m × 1.5m, L= 830 m 1.5m × 1.5m, L= 580 m 1.3m × 1.3m, L= 950 m 1.5m × 1.5m, L= 700 m 1.7m × 1.7m, L=1,170 m 2.2m × 2.2m, L= 810 m 2.6m × 2.6m, L=1,280 m 1.4m × 1.4m, L= 270 m	New Construction
		Pumping Station (P_N)	No. of Pump: 6 units × 3.3 m^3 Required area: 4,000 m^2 Pump Total Head: 3.2 m	New Construction
		Retention Pond	Required volume: 42,300 m^3 Required area: 15,000 m^2	New Construction

5.7 Economic Analysis

5.7.1 Project Cost

The following items are included in the cost calculation:

- Construction Cost
- Engineering Services Cost
- Physical Contingencies
- Administration Cost
- O&M

Land acquisition cost is not included in the M/P stage under the assumption that the land is owned by the government. This cost item is converted into its economic value.

5.7.2 Project Benefit

The benefit of the drainage components is to reduce the down time of economic activities due to inundation. Economic down time is estimated by the estimated inundation depth. It is assumed that the severest inundation (70 cm) will last for about 1 to 2 weeks and others last pro rata. This down time is converted to an economic value with per capita GDP projection. Finally, the total benefit is calculated including the multiplier effect. Based on the data of the World Bank, the multiplier of 10.75 is adopted. The estimation results are shown in **Table 5.10**.

Table 5.10 Value of Down Time in Economic Activities

	2012	2015	2020	2025	2030
Total Affected Population	6,216	13,180	24,787	36,394	48,001
Per Capita GDP Projection (US$)	1,166	1,204	1,267	1,330	1,394
Total Down Duration (days x persons)	20,795	34,159	68,781	118,897	187,274
Total Time Value (US$)	66,410	112,646	238,768	433,392	715,167
Total Time Value with Multiplier Effect (US$)	716,628	1,215,559	2,576,545	4,676,734	7,717,369
Total Time Value with Multiplier Effect (million FCFA)	371	629	1,333	2,419	3,992

Source: JET and the World Bank

5.7.3 Calculation Results

EIRR has been calculated at 6.7%. Although this figure is less than 12.0% of Social Discount Rate, the project seems fully reasonable, considering that it is an infrastructure development project.

5.8 Financial Analysis

Solution or mitigation of stormwater drainage is one of the tasks of the municipal or national government, which should be implemented as infrastructure development. Thus, all costs should be managed under the government budget and it is inappropriate to collect charges from residents. It means that it is inappropriate to calculate the benefit for the purpose of the financial analysis. For example, the World Bank's document (Report No. 66451-SN), *Project Appraisal Document for a Stormwater Management and Climate Change Adaptation Project*, April 12, 2012, describes, "There is no financial analysis to be done in this context (Financial Analysis of the proposed flood prevention component) since the drainage system is considered as a public good that will need to be funded and maintained by the national and/or municipal budget directly through force account or indirectly through the contracting out of private services to perform the drainage management."

CHAPTER 6. SOLID WASTE MANAGEMENT PLAN

6.1 Existing Kaolack SWM Master Plan

6.1.1 Outline of the Kaolack SWM Master Plan

Kaolack City formulated its Master Plan for Solid Waste Management (SWM) in 2008 with technical assistance from APROSEN, and prepared the report "Study for the Operational Implementation System of Solid Waste Sustainable Management in Kaolack City, Volume I and Volume II, 2007 and 2008." According to the Technical Services Section of the Kaolack City Government, this Master Plan is being used as the comprehensive plan of SWM for the city. **Tables 6.1 and 6.2** summarize the objectives and outline of the 2008 SWM Master Plan.

Table 6.1 Objective of the Kaolack's SWM Master Plan of 2008

Overall Objective	To realize a sustainable, technically possible and financially feasible SWM for the city.
Road/Street Cleaning	To keep city roads and streets clean.
Collection	To ensure the application of selectable collection means and ensure to use the waste transportation means to a final disposal site.
Final Disposal	To ensure that a technically possible and environmentally feasible final disposal site is constructed in accordance with the related laws and ordinances.

Source: Kaolack City

Table 6.2 Outline of Kaolack's SWM Master Plan

Name of Study	SWM Master Plan by APROSEN/ Kaolack City
Study Year	2007/2008 (1.5 years)
Estimated Project Cost	818,125,000 FCFA
Legislation	Environment Code (Law No.2001-01 of 15 January 2001) and other related decrees
Target Year	Year 2010 (4 years: 2007 to 2010)
Target Collection Rate	100% (2010)
Estimated Waste Amount Generated	125 t/day (2007), 129 t/day (2008), 132 t/day (2009), 136 t/day(2010)
Zoning	Zone 1 to Zone 6
Solid Waste Management (1) Pre-collection/Collection:	ROC system would be replaced gradually by tricycles in over 3 years. House-to-house collection by ROC trucks to transfer stations and motorized tricycles: (59 units) Transfer Stations: 4 (Zones 1, 3, 4, 5); Containers: 16 Refuse Box Structures (10m x 9m size): 11 Communal Collection: Containers ($15m^3$): 34 Public Containers ($12m^3$, markets and bus-stations): 22
(2) Transportation:	Skip Trucks (polybenne trucks): 6 Container Tractors: 2 Dump truck: 1
(3) Landfill Site:	Landfill site has not been decided yet at the time of the Master Plan but Mbadakhoune was included just as an alternative landfill site. Sanitary landfill site: 2 landfill-cells of 170m x 150m x 5m high each, Cell construction by alternation of clay layer and waste layer Bulldozer: 1; wheel loader: 1; dump truck: 1
Remarks:	This Master Plan was not implemented by the authorities concerned due to financial problems.

6.1.2 Present Status and Comments on the Existing Kaolack SWM Master Plan

Unfortunately, the Master Plan was not implemented by the authorities concerned in Kaolack City due to financial constraints. However, the IDB included the recommendations of the Master Plan of Kaolack City in the 4 major urban solid waste management projects which formed the IDB SWM Project.

So far, there has been no study on a drainage system from the disposal area at Mbadakhoune to the Saloum River, i.e., on whether or not an excess of stormwater above a certain water level at the site (for

example, Elevation 0 m) will expand the inundation water area and produce an impact on the sanitary landfill area. A study on the drainage system for the sanitary landfill site is required to be implemented.

Although the Master Plan assumed that the ROC system in Kaolack City would be replaced by motorized tricycles in over 3 years, it is expected that, in order to replace the ROC system by tricycles, the economy should be more activated and the infrastructure system including road pavement works from the sandy, bare way is needed progressively. Thus, the present operation and maintenance of ROC system should be carefully monitored in Kaolack City.

6.2 Proposed IDB Project

6.2.1 Outline of the Project

There is an IDB project for SWM in the targeted 4 major cities of Dakar, Kaolack, Tivaouane and Touba, based on the Master Plan study results on urban SWM endorsed by APROSEN and completed in December 2010. The APROSEN's SWM project for Kaolack was approved by IDB in May 2011, and IDB's assistance for the 4 urban SWM projects was agreed officially by IDB and Senegal in June 2011. Project cost has been estimated at about USD 35 million (or 17.51 billion FCFA).

6.2.2 SWM Project for Kaolack City

The IDB SWM Project in Kaolack City consists mainly of 5 components, namely; (a) infrastructure development; (b) waste collection and transportation equipment; (c) institutional support and capacity building; (d) engineering and consulting services; and (e) project management.

The IDB has estimated the Kaolack SWM Project to be about USD 9.0 million (or 4.5 billion FCFA), including USD 5.4 million (or 2.7 billion FCFA) for infrastructure development (1 sanitary landfill, 1 transfer station, 20 collection points), USD 1.45 million (or 0.73 billion FCFA) for waste collection and transportation equipment, for USD 0.14 million (or 0.07 billion FCFA) for institutional support and capacity building, USD 0.38 million (or 0.19 billion FCFA) for engineering and consulting services, USD 0.44 million (0.22 billion FCFA) for project management, and USD 1.17 million (or 0.59 billion FCFA) for contingencies, based on the exchange rate of 1 USD = 500 FCFA.

6.2.3 Recommendations

The following are recommended for the IDB project in Kaolack City:

- Since IDB and the Senegal Government already executed an agreement for the Kaolack SWM Project in June 2011, the new government administration will make a good decision on the early implementation of the Project. (As of November 2012, the Bank was still waiting for a response to its proposal for the Project from the new government. It is said that at the end of this JICA Study in November 2013, the Bank is still waiting for the response on its proposal for the Project.)
- It is recommended that during implementation of the Kaolack SWM Project with support from IDB, the progress should be monitored carefully and any necessary action should be taken immediately to realize completion of the Project.
- The number of equipment required for Kaolack City's SWM as listed by IDB seems to be for an urgent SWM work of short-term duration only and not for the mid- or long-term plan phase of SWM. The number of heavy equipment might be for about 5 years only, not more than that. Therefore, it is recommended that a more comprehensive SWM plan study shall be required for the estimation of number of equipment needed for an integrated SWM plan of the mid- or long-term plan phase for Kaolack City.
- Since there seems to be no skilled mechanic in the workshop of the city government, training at the workshop is required using a certain number of tools and mechanical equipment in order to increase their knowledge.
- For the completion and sustainability of project implementation, all entities concerned such as the central and local government agencies, state companies, CDQ, NGOs and so on, should be involved and take the necessary actions immediately.

6.3 Preliminary Kaolack SWM Plan

6.3.1 Issues and Interview Survey Results on SWM in Kaolack

(1) Issues on SWM in Kaolack City

In order to reflect the present condition of SWM and the results of revision of the SWM Master Plan by APROSEN and the IDB SWM project for Kaolack City, the major issues to be addressed shall be as follows:

a) Waste collection rate decreased from 25% in 2007 to 12% in 2010, 6% in 2011 and less than 6% in 2012. Combination of the measures of hard, soft and administrative support against SWM issues shall be appropriately structured.

b) Donkey-carts (ROC system) and wheelbarrows are more suitable for Kaolack City because the roads are sandy and unpaved and are inundated in the rainy season. Tricycle motorization is also technically not reliable for solid waste collection in Kaolack due to mechanical problems as experienced in 2007, according to ASDES.

c) Composition of solid waste by weight shows more than 50% of sands and stones. Collection equipment like compactor would be easily damaged by fine sandy materials. More careful operation and maintenance are indispensable, according to ASDES.

d) Existing illegal disposal sites should be controlled. Suitable transfer sites should be selected.

e) Solid waste transportation system should be established between transfer sites and the final disposal site. Furthermore, a combination of suitable transportation systems from the generation sources to the final disposal site is required as a whole.

f) The final disposal site should be designed to have the capacity to dump all the collected solid wastes towards 2030.

g) SWM sector wide capacities should be strengthened through IEC campaign among the City Government, APROSEN, related agencies, residents, NGOs, and private sectors.

h) Institutional strengthening is required to support smooth management of the total system of SWM.

(2) JICA Interview Survey Results

The interview survey on SWM in Kaolack City was conducted by the JICA Expert Team (JET) for 100 households selected in January 2012. Major survey results are summarized as follows.

- ROC system by private associations (about 89%) is used for pre-collection, and 6% for dumping into canals or open spaces;
- At least two times of waste collection services per week are supported by 67% of households;
- About 90% of households can afford waste collection services;
- 1,000 FCFA (54%) per month is affordable for the solid waste collection services;
- 77% of households are satisfied with the present collection services;
- 94% of households remain unconcerned about the environmental impacts caused by waste dumping into channels or open spaces; and
- 98% of households put their trust on the private associations and not the municipality for solid waste collection services.

6.3.2 Planning Concept

(1) SWM Planning Concept

Formulation of the preliminary SWM plan for Kaolack City is based on the following.

a) Projected collection rate of solid waste is set at more than 60% in 2020 and 100% in 2030.

b) All the city areas except the self-disposal area (Zone 6) are to be served with waste collection, transportation and disposal by Kaolack City.

c) New collection and transportation system will be introduced:
   - Pre-collection system: ROC carts (90% in 2012) is supposed to be maintained as long as possible until the access roads to the transfer stations will be paved. Automobiles like tricycles and three-wheel vehicle will gradually increase towards 2030,
   - Collection system to a final landfill site.
   - New transfer stations: Number will increase from the existing 3 stations to 10 stations including one transfer station center for composting and recycling as proposed in the APROSEN's Master Plan and the IDB Project.

d) Improvement of the transportation system from transfer stations to the final disposal site.

e) The Kaolack City Government informed that the final sanitary landfill site for the city is to be constructed in Mbadakhoune Rural Community and the official agreement is now under the signing process by the two parties. For construction of the final sanitary landfill site, recommended is the "Fukuoka Method" developed by Fukuoka University and Fukuoka City in Japan, which is a type of sanitary landfill based on the semi-aerobic landfill structure and technology offering improved landfill site simply and at low cost utilizing materials readily available in developing countries, and environmentally friendly.

f) All solid waste generation areas of Kaolack are divided into two SWM system areas, namely; (a) Population in collection service areas (Zones 1 to 5, population of 253,300/386,000 in 2013/2030); and, (b) Population in self-disposal area (Zone 6, population of 16,700 in 2013). The self-disposal area of Zone 6 is located at a remote area of about 16 km distance from the final disposal site at Mbadakhoune. Zone 6 is, therefore, selected as a self-disposal area.

(2) Related Laws and Regulations

In the National Environmental Code of Senegal (Law No. 200-01 of January 15, 2001), Chapter I defines "Waste" and "Waste Management," and Chapter III describes the mandates of "Waste Management" from Articles 30 to 43. "Waste" is defined as all solids, liquids, gaseous matters, or residues from production, transformation process or from utilization of every other substances eliminated, intended to be eliminated or that must be eliminated in accordance with the laws and regulations in force. On the other hand, "Waste Management" is defined to include collection, transportation, storage, recycling and wastes elimination including the surveillance of elimination sites. In Chapter III, all the categories of wastes including biomedicine wastes are mandated.

On the other hand, there is the Local Government Code (Law No. 96-06 of 22 March 1996). It confirms the transfer of authority to regions, communes, and rural communities regarding environmental and natural resources management. The authority on solid waste management has been handed down to the local governments.

The responsibility, duty, authority, regulations, etc., of the local government such as Kaolack City mandated by legislation will be the key elements to formulate the SWM plan. In order to determine the policy on SWM, the responsibilities of each party concerned shall have to be clarified. Such responsibilities may be as follows:

- The government shall be responsible for the provision of financial sources, technology development and legislative set up;
- The local authority shall be responsible for the provision of sufficient facilities and regulations of SWM services; and,
- The beneficiaries shall be responsible for co-operating with the local authority on the discharge of waste and on bearing the charges.

The responsibility of the local authority is the most important to establish an efficient municipal solid waste management system for Kaolack City.

(3) Planning Objectives

The primary objectives of the solid waste management are proposed to be applied commonly by the City of Kaolack to achieve the goals of better living environment such as the following 3 items:

(a) Improvement of Public Cleanliness;
(b) Improvement of Public Health and Hygiene; and
(c) Protection of the Environment.

According to the "IDB project document" in December 2010, the primary objective of SWM is to promote public health and provide environmental protection through the improvement of conditions of hygiene and cleansing in an urban environment, by a healthy and durable management of the urban solid waste by setting up systems viable at the environmental plan, technically feasible, socially acceptable, suitable for eliminating the risks from infections and guaranteeing a healthy and clean environment.

6.3.3 Planning Preconditions

(1) Solid Waste Collection and Treatment Systems for their Respective Zone Areas

According to the existing SWM Master Plan, the whole city area is divided into 6 zones for the communal territories of the SWM system as shown in the following table.

Table 6.3 Zoning of Communal Territories in Kaolack City

Zone	District	Remarks
Zone 1	1. Leona Center, 2. Leona Escale, 3. Ndangane, 4. Darou Salam Ndangane, 5. Abattoirs, 6. Ndargoundaw, 7. Dialegne I, 8. Dialegne II	8 districts
Zone 2	1. Medina Mbaba I, 2. Medina Mbaba II, 3. Medina Bave, 4. Taba Ngove, 5. Sam	5 districts
Zone 3	1. Thioffack, 2. Gawane, 3. Ngane Saer, 4. Ngane Alassane	4 districts
Zone 4	1. Touba kaolack, 2. Touba kaolack Extension, 3. Ndorong Sadaga, 4. Keur Maloum, 5. Ndorong, 6. Tabaya, 7. Kassaville, 8. Nimzatt, 9. HLM Sara, 10. Sara Ndiougary, 11. Diamaguene Extension, 12. Diamaguene, 13. Darou Slam Diamaguene, 14. Fass Camp des Gardes, 15. Parcelles Assainies	15 districts
Zone 5	1. Kasnack, 2. Boustane I, 3. Boustane II, 4. Bongre, 5. Peulge, 6. Koundam, 7. Sama Moussa	7 districts
Zone 6	1. Sing-Sing, 2. Lyndiane, 3. Kabatoki, 4. Ngade	4 districts, Self-Disposal Zone
Total		43 districts

Source: APROSEN Report 2008, Kaolack City and JET.
Note: Number of Districts increased to 43 in 2012.

(2) Projection of Future Solid Waste Generation Amount

Future solid waste generation amount by the year 2030 is projected based on the population projection in Kaolack City. In order to estimate the future solid waste generation amount, taken into consideration are the population and per capita GDP.

(a) Population Projection in Kaolack City

The most direct influence on waste generation is the change in population. The population projection of Kaolack City for the planning period until 2030 is shown in **Table 6.4**.

Table 6.4 Future Population Projection of Kaolack City

(Unit: person)

Zone	Year				
	2012	2015	2020	2025	2030
Zone 1	52,248	54,490	58,500	62,881	67,669
Zone 2	37,335	38,381	40,221	42,193	44,306
Zone 3	26,886	31,375	40,686	52,930	65,973
Zone 4	98,780	110,189	135,737	151,292	158,123
Zone 5	38,097	39,985	43,473	47,101	50,006
Zone 6	16,654	16,654	16,654	16,654	16,654

Zone	Year				
	2012	2015	2020	2025	2030
City Center (Zone 1to Zone 5)	253,346	274,419	318,618	356,397	386,076
Total (Whole City)	270,000	291,000	335,000	373,000	403,000

Source: Kaolack City

(b) Relationship between Gross Domestic Product (GDP) and Solid Waste Discharge

GDP is one of the important indicators which may represent levels of social welfare, industrial technology and import of goods. The growth rate in GDP is thus expected to have a larger impact on the solid waste amount per capita of developing countries and it will also remarkably result in the change of composition of waste at a certain welfare level. The annual growth rate in per capita GDP is projected at 1.09% in 2012 and 0.92% in 2030.

In proportion to the growth of per capita GDP, the annual waste generation amount per capita could increase. On this assumption, waste generation amount per capita from 2012 towards 2030 is computed, namely; at 0.52 kg/capita/day in 2012 and 0.6 kg/capita/day in 2030, based on the waste generation amount of 0.49 kg/capita/day in 2007 in the SWM Master Plan of Kaolack City.

(c) Projection of Future Solid Waste Generation Amount

The solid waste generation until 2030 has been estimated for each zone in Kaolack City as shown in **Table 6.5.**

Table 6.5 Projection of Solid Waste Generation Amount in Kaolack City

(Unit: ton/day)

Zone	2012	2015	2020	2025	2030
Zone 1	27.0	29.1	32.7	36.6	40.9
Zone 2	19.3	20.5	22.5	24.6	26.8
Zone 3	13.9	16.7	22.7	30.8	39.9
Zone 4	51.1	58.8	75.8	88.1	95.6
Zone 5	19.7	21.3	24.3	27.4	30.2
Zone 6	8.6	8.9	9.3	9.7	10.1
Total	139.7	155.2	187.2	217.2	243.5

(Notes)
Domestic Waste: (Projected population) x (Projected average daily solid waste generation) x (Projected growth rate of per capita GDP).
Commercial Waste: considered as part of domestic waste.
Market Waste: 0.01 kg/capita/day/market is used in the APROSEN Report 2008
Road Waste: considered as already included in the domestic wastes.

The collection rate of 100% is ideal. The collection rates of more than 60% in 2020 and 100% in 2030 in the preliminary SWM plan were set up to realize the current SWM situation of the very low collection rate (for example, 12% in 2010, 6% in 2011 and less than 6% in 2012) to the visible improvement progressively of the environmental and sanitary condition at the target years of 2020 and 2030.

The target collection rate and waste amount estimated in the whole Kaolack City are summarized in **Table 6.6**.

Table 6.6 Target Collection Rate and Waste Amount of Kaolack City

Year	2013	2015	2020	2025	2030
Collection Rate (%)	20	40	65	90	100
Waste Amount (t/day)	26	59	116	187	233

6.3.4 Improvement Concept in the SWM System

(1) Collection Service Plan

According to CARITAS (NGO), there are currently 110 ROCs (donkey-trucks) recorded in the City by CDQ, GIE and private associations, and the number of ROCs is slightly increasing or maintained year by year, covering about 39 districts out of the 43 districts in all the city area. In Kaolack City, it is significant that since the City Government engages only in waste collection in city markets and bus stations, the ROC system has a very important role in the pre-collection stage of SWM and covers most of the districts in the city. Therefore, the City Government should recognize the importance of the ROC system for SWM and provide support to maintain the private associations' capacity in the collection and transportation system for SWM as much as possible. It has to be noted that the number of ROC trucks increased from 109 in 2009 to 123 in 2012 (ASDES/CARITAS).

(2) Transfer Station (T/S)

There used to be three existing transfer stations: at the districts of Ndargoundaw, Ngane Saer and Diamaguene. However, two of them (Ndargoundaw and Diamaguene) have been abandoned and the remaining (Ngane Saer) is not being maintained well. It is, therefore, proposed that the three transfer stations be improved/renovated, and more transfer stations be provided at the other districts to improve the waste collection system of Kaolack City.

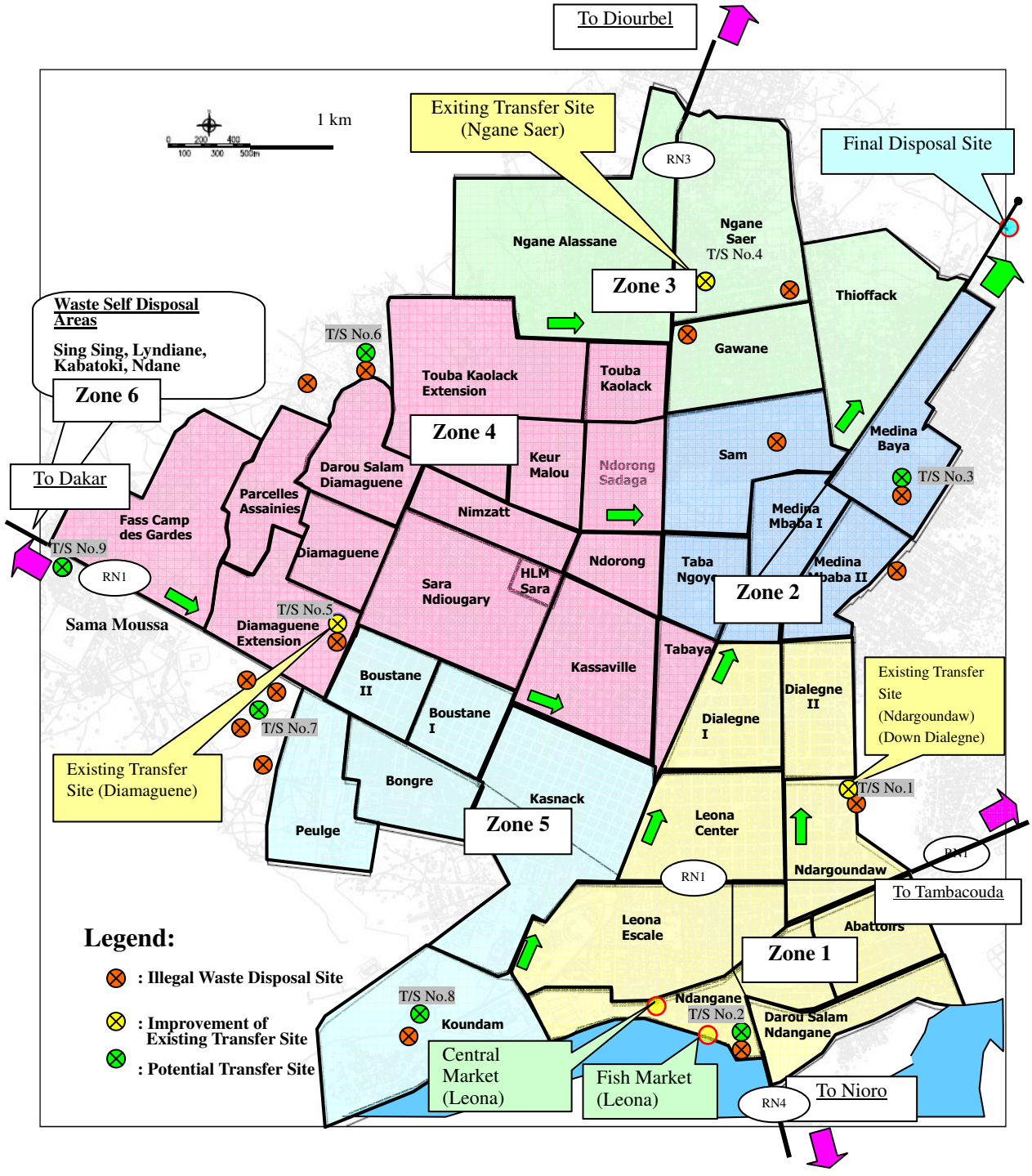
There are ten potential transfer stations in Kaolack City, namely; the above three transfer stations and the newly proposed transfer stations (7 stations[6]) selected by JET from the illegal disposal sites already investigated by APROSEN and JET and which provide conveniently situated uncontrolled refuse disposal.

(3) Collection Points

In the new collection system for wastes, Kaolack City shall plan to set a waste collection point at each district where the residents can carry their wastes on their heads or on wheelbarrows and dispose them manually into the specified containers. The collection point should be located within a walking distance from the dwellings. Kaolack City is supposed to decide on the suitable location of collection points at the districts in collaboration with the district residents before the new collection system is applied.

Due to unpaved or sandy grounds, large capacity collection vehicles such as the 8-ton or 10-ton class are not recommended to avoid their getting stuck, or slipping, during rainy days. It is also recommended that the residents' turn system for doing cleaning duty be applied for cleaning collection points and communal stations at each district. Those collection points are shown in **Fig. 6.1**.

[6] Among 7 stations, location of one station is not shown in **Fig. 6.1** because its location is not proposed yet.



Source: New administrative district boundary of Kaolack City (2012), ADM, APROSEN.
Notes : Zoning system (Zone 1 to Zone 6) of new waste collection system with new transfer station system.
Locations of "Illegal Waste Disposal Sites", "Improvement of Existing Transfer Site" and "Potential Transfer Site", also represent those of collection points.

Fig. 6.1 Waste Collection Zoning and New Collection, Transportation and Disposal System in Kaolack City

(4) Final Landfill Plan

As of November 2012, there has been no official agreement between Kaolack City and Mbadakhoune Rural Community on the lease of land for the final landfill site. It may take more than one year for the parties to finalize the lease agreement for landfill use.

The geographical feature before the use of Mbadakhoune dumpsite area presents a former sand quarry. The land to be used for landfill is located at lower elevations of about 2 to 4 m high with a total area of a dozen of hectares including the impounding water ponds. The entire area of the proposed landfill site to be leased is not yet known as shown in **Photo 6.1**. The detailed features of the contract such as land area boundary, land area, lease period, etc., will be disclosed after the formal agreement is signed by the two parties. But the estimated area is about 15 ha.

Existing final disposal site (Nov. 2012)
(Mbadakhoune Rural Community)

Proposed new final disposal site (Nov. 2012)
(Mbadakhoune Rural Community)

Photo 6.1 Present Conditions of Final Disposal Sites (Nov. 2012)

A drainage system will be required at the present landfill site in future. In November 2012, the inundation water almost occupied the maximum surface area and the waterside reached the current open dumping sites. It is, therefore, planned that excess wastewater above a certain maximum water level (for example, Elevation 0 m) should be drained through an open channel to the Saloum River, to avoid inundation of the landfill facilities and to function well. This matter should be considered when the proposed landfill facilities are brought to the implementation and design stages.

6.3.5 Hazardous Waste

According to Kaolack City, at present, there is no national legislation to guide the city in the management of hazardous waste. The city recognizes that effective management of industrial and medical wastes is difficult under the present situation. The following are the interview survey results on the current situation of waste treatment in the industrial factories and medical facilities, in May 2012.

(1) Industrial Waste

According to the Technical Services of the City Government, industrial wastes shall be controlled and disposed adequately by the dischargers in accordance with the polluter-pays principle. The industrial factories are not very well developed. The JET conducted an interview survey at the following factories in May 2012, to obtain information on the industrial waste.

- SUNEOR : Peanut cooking oil
- NOVASEN : Peanut cooking oil
- SALIN DU SALOUM : Salt
- USINE KOUDAME : Plastic products

It has to be noted that even though the JET was not able to inspect all the conditions in the factories, there seems to be no hazardous waste, and the wastes were collected on the monthly basis and treated by the respective factories at their own responsibility. The storage area is strictly secured and no one could enter without the permission of the manager, and the visitor should be

accompanied by the person-in-charge only.

(2) Medical Hazardous Waste

There is a Decree that aims at governing all activities related to biomedical waste management in Senegal (Decree No. 2008-1007 of 18 July 2008). This decree applies to health facilities regardless of level (hospital, health care center, community health care, medical analysis laboratory, clinic, and consulting-room), veterinary facilities, industries and research facilities managing waste. All biomedical waste operators shall obtain an approval from the ministry in charge of health. There is one regional hospital and several small clinics and healthcare centers in Kaolack City. The interview survey at the medical facilities was conducted by the JET.

There is only one incinerator being used by the hospital facility and there are two incinerators being used by the healthcare centers in Kaolack City. In the hospital, ashes taken out from the incinerator are buried on the ground at a specific area of the hospital compound. Medical wastes are currently assumed at 1.5 t/day, and projected to be about 2.3 t/day in 2030 in Kaolack City.

(3) Recommendations

The following are the recommendations to be considered in the improvement and development of the hazardous waste management system in Kaolack City:

- To provide a separate cell at the proposed sanitary landfill for the ashes of incinerated hazardous wastes in future;
- The Environmental Management and Coordination Act involving the ministries concerned in hazardous waste should be implemented properly and enhanced with common standards;
- The related policies or guidelines for the hazardous waste management system should be implemented by the Central Government through the City Council of Kaolack; and
- Proper treatment system of hazardous wastes including biomedical waste management should be needed in conformity with the related legislations (the Environmental Code and decrees).

6.3.6 Financial Considerations

(1) Basic Principles

The costs of SWM services for households are divided into two categories, namely; (1) capital investments including vehicles and facilities as a part of improvement in social capital, which produces services continuously for their lives; and (2) operating costs for services of individual households which are produced from capital investments or private services.

Considering the definitions given above, the following could be the general principles for financing SWM services:

- In principle, public services (capital investments) should be financed by general taxation or subsidies from the national government;
- Operating costs should be covered wherever possible through a waste charge rather than through general taxation;
- Cost recovery should be improved by reforming the budget system and improving the efficiency of SWM operations on step-by-step basis; and
- When operating costs cannot be fully recovered through the waste charge after improving cost efficiencies, deficits should be financed through general taxation or subsidies.

(2) Non-Governmental Sector Participation

It is possible for government to work with community groups, NGOs and cooperatives for the conduct of solid waste services. It should be considered for the services of low-income households and the recycling of secondary materials.

In many developing countries, the non-governmental sectors provide waste collection services to low-income households, especially, in Latin America where the government cannot provide appropriate solid waste collection service for those living in marginal zones since so many people

have migrated to the urban area. It is common to see these areas served by individuals with donkey-carts or old dump trucks. Since such collectors cannot travel far with their equipment to the official dumping site, they are prone to dump solid waste illegally.

Kaolack City has been facing the same situation with the ROC system mentioned above. For this reason, it is worthwhile for the city to explore these collections into a cooperative and developing a franchise arrangement whereby the rights and responsibilities of the collectors are defined.

6.3.7 Recommendations

- It is expected that, in order to replace the ROC system with tricycles, the economy should be more activated and that infrastructure development including road pavement works for the sandy bare way is needed progressively. The ROC system operation and maintenance should be carefully monitored by Kaolack City.
- It is expected that, since the Kaolack SWM Project was already approved and signed by IDB and the Senegal Government in June 2011, the new government administration will make a good decision on the early implementation of the Project. As of November 2012, the Bank has been waiting for a response regarding its proposal for the Project from the new government.
- It is recommended that during implementation of the Kaolack SWM Project supported by IDB, the progress should be monitored carefully and all necessary actions should be taken immediately to realize the completion of the Project.
- The number of equipment required for SWM listed by IDB seems to be for an urgent SWM work of short-term duration only and not for the mid- or long-term plan phase of SWM for Kaolack City. The number of heavy equipment might be for about five years only and not more than that. Therefore, it is recommended that an overall SWM plan study shall be required for the estimation of number of required equipment needed for an integrated SWM plan of the mid-term for Kaolack City.
- Since there seems to be no skilled mechanic at the workshop in the city, some training for the mechanics at the workshop are required with a sufficient number of tools and mechanical equipment to improve their knowledge.
- There has been no study on a drainage system from the disposal area at Mbadakhoune to the Saloum River as to whether or not an excess of stormwater ponding above a certain maximum water level at site (for example, Elevation 0 m) will expand the inundation water area and produce an impact on the sanitary landfill area. A study on a drainage system for the sanitary landfill facility is required for further implementation.
- For the completion and sustainability of project implementation, all the parties concerned such as central and local government agencies, state companies, CDQ, NGOs and so on should be involved and take the necessary actions immediately.
- In order to improve the current SWM system in the city, all the concerned government offices, related agencies, citizens, and NGOs, private sector involvement shall enhance their capabilities through the IEC campaign.
- Introduction of the contracting of private service provider system for the city SWM services should be considered.
- IDB will support the structural solid waste management system in Kaolack City. In addition, United Nations Industrial Development Organization (UNIDO) utilizing Global Environmental Facility (GEF) would assist the solid waste management in Kaolack City including domestic, medical and industrial wastes, according to recent information. Issues of SWM in Kaolack City should be solved through proper collaboration of both projects.

CHAPTER 7. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

7.1 Implementation of SEA at the Master Plan Stage

In accordance with the Environmental Law of Senegal and the Regulations on Environmental Impact Assessment, the authorized consultant of DEEC (iDEV) has been conducting the Strategic Environmental Assessment (SEA) since January 2012. The first technical committee meeting on the SEA report was held in Kaolack on 25 July 2012, and several comments and recommendations were raised by the committee. DEEC summarized the results of the meeting and submitted it through a letter to the consultant.

The second technical committee meeting was held on 7 November 2012, to confirm the revised SEA report in accordance with the letter from DEEC and to validate it. Twenty-five participants (aside from JET and iDEV) attended the meeting and further reviewed the revised SEA report. Finally, the committee approved the SEA report with some conditions (request for additional corrections). Copies of the draft final report were distributed to the participants of the SEA validation meeting. The SEA report was finally approved by DEEC in January 2013. Therefore, the comprehensive contents and recommendations in the SEA report shall be referenced and utilized for the formulation of the Master Plan.

7.2 Environmental and Social Considerations for the Alternatives

7.2.1 Evaluation of Alternatives/Projects from the Environmental and Social Considerations

Based on the environmental laws and regulations in Senegal (e.g., Ministerial Order No. 9471 of 28 November 2001 which contains the terms of reference for impact studies), the JICA SEA report (draft version) and the JICA Guidelines for Environmental and Social Considerations, JET selected the essential environmental and socio-economic impacts for the evaluation criteria. Then, JET prepared an evaluation table to compare the impacts of alternatives/projects from the environmental and social considerations and select the most preferable alternative for the Master Plan.

JET proposed the evaluation table to DREEC, and through the discussions, DREEC accepted it for evaluating the prospective natural and socio-economic impacts of alternatives/projects. On the Feasibility Study level, the detailed EIA or IEE shall be conducted in accordance with the categorization of environmental laws and regulations in Senegal.

Moreover, DREEC and JET have agreed on the alternatives/projects which are to be compared, not only from environmental and social considerations, but also from financial, technical and other perspectives. DREEC recommended that JET should refer to "the EIA Guidelines Annex 4 4.1A, Reminder of the mission objectives and the methodology of conducting studies," which emphasizes that explanation is needed for every step of implementation of the study.

The evaluation from environmental and social considerations has been conducted by not only reviewing several documents but also reflecting the results of field survey in the target areas with the technical experts of JET.

7.2.2 Evaluation of Alternatives for the Master Plan

(1) Sewerage System Component for Master Plan

Alternatives for the sewerage system component of the Master Plan have been evaluated as shown in the following table.

Table 7.1 Evaluation of Alternatives for Sewerage System Components of the Master Plan

	Likely Impacts	Evaluation Point	Alternatives		
			1	2	3
Natural Environment	Biology	Impact on biology (forest, farmland, aquatic life)	+	++	++
	Air Pollution	Impacts on atmosphere(various gas , dust)	－	－	－－
	Climate Change	Impact on climate change(emission of CO_2, methane)	－－	－	－
	Soil Contamination	Impact on soil contamination in proposed areas by improvement of sewerage system	+	++	++
	Erosion/Salinization	Impact on erosion/salinization in proposed area	－	－	－
	Water Pollution	Impact of drained water	+	++	++
	Offensive Odor	Impact on the local population	－－	－	－
	Noise/Vibration	Impact on the local population	－	－	－－
	Waste	Impact on the local population (soil, materials)	－	－	－－
Socio-economic Environment	Economy	Impact on economic loss from sanitation problem (health care cost, nuisance,)	+	++	++
	Health and Hygiene	Impact on waterborne diseases (cholera, typhoid)	+	++	++
	Infection and Risks	Impact on infection of HIV/AIDS and respiratory disorder	－	－	－－
	Land Use	Impact on land use in the proposed sites (effective land use, land value)	+	++	++
	Accidents	Impact on the local communities	－	－	－－
	Conflicts	Impact on the local population (illegal discharge of septage)	+	++	++
	Traffic	Impact on traffic in proposed sites(traffic control)	－	－	－－
	Women/Vulnerable People	Impact on women and vulnerable groups in proposed areas(high water table areas)	+	++	++
	Resettlement	Impact on the local communities	No	No	No
Total Number of Items of Positive and Negative Impacts					
		++	0	8	8
		+	8	0	0
		－	7	9	3
		－－	2	0	6
		No	1	1	1
Total Number of Plus (+) and Minus (－)					
		+	8	16	16
		－	11	9	15
Balance of Plus (+)and Minus(－)			－3	+7	+1

(Note)

＋＋	Significant positive impact expected
＋	Positive impact expected
－	Negative impact expected
－－	Significant negative impact expected
No	No impact expected

Considering the difference of total number of plus and minus, Alternative 2 may be selected for the Master plan from the environmental and social considerations.

(2) Drainage Management Component for the Master Plan

Alternatives for the drainage management component of the Master Plan have been evaluated as shown in the following table.

Table 7.2 Evaluation of Alternatives for the Drainage Management Component of the Master Plan

	Likely Impacts	Evaluation Points	Alternatives		
			1	2	3
Natural Environment	Biology	Impact on biology (forest, farmland, aquatic life)	No	+	++
	Air Pollution	Impacts on atmosphere(various gas , dust)	－－	－－	－
	Climate Change	Impact on climate change (effects from flood and drought)	+	+	++
	Soil Contamination	Impact on soil contamination in proposed areas by construction work	+	+	+
	Erosion/Salinization	Impact on the erosion/ salinization in proposed area	－	－	－－
	Water Pollution	Impact of drained water	+	+	+
	Offensive Odor	Impact on the local population	No	No	No
	Noise/Vibration	Impact on the local population	－－	－－	－
	Waste	Impact on the local population (soil, materials)	－	－	－－
Socio-economic Environment	Economy	Impact on the economic loss from floods	++	++	++
	Health and Hygiene	Impact on waterborne diseases (malaria, diarrhea)	++	++	++
	Infection and Risks	Impact on infection of HIV/ AIDS and respiratory disorder	－－	－	－
	Land Use	Impact on land use in the proposed sites (utilization of land during dry and rainy seasons)	+	+	++
	Accidents	Impact on the local communities	－－	－	－
	Conflicts	Impact on the local population caused by floods(thief, dispute about embankment)	++	++	++
	Traffic	Impact on traffic in proposed sites(traffic control)	－－	－	－
	Women/Children /Vulnerable People	Impact on women, children and vulnerable groups in flood areas	+	+	+
	Resettlement	Impact on the local communities	No	No	No
Total Number of Items of Positive and Negative Impacts					
		++	3	3	6
		+	5	6	3
		－	2	5	5
		－－	5	2	2
		No	3	2	2
Total Number of Plus (+) and Minus (－)					
		+	11	12	15
		－	12	9	9
Balance of Plus (+)and Minus(－)			－1	+3	+6

(Note)

＋＋	Significant positive impact expected
＋	Positive impact expected
－	Negative impact expected
－－	Significant negative impact expected
No	No impact expected

Considering the difference of total number of plus and minus, Alternative 3 may be selected for the Master Plan from the environmental and social considerations.

7.2.3 Evaluation of Priority Projects

(1) Evaluation of Sewerage/Sanitation System Improvement Priority Projects

Evaluation results for the selection of priority projects of sewerage/sanitation system improvement, are as shown in the following table.

Table 7.3 Evaluation for the Selection of Sewerage/Sanitation System Improvement Priority Projects

	Likely Impacts	Evaluation Point	Project	
			1	2
Natural Environment	Biology	Impact on biology (forest, farmland, aquatic life)	++	+
	Air Pollution	Impacts on atmosphere(various gas , dust)	－	－
	Climate Change	Impact on the climate change(emission of CO_2, methane)	－	－
	Soil Contamination	Impact on soil contamination in proposed areas by improvement of sewerage system	++	+
	Erosion/Salinization	Impact on erosion/salinization in proposed area	－	－
	Water Pollution	Impact of drained water	++	+
	Offensive Odor	Impact on the local population	－	－
	Noise/Vibration	Impact on the local population	－	－
	Waste	Impact on the local population(soil, materials)	－－	－
Socio-economic Environment	Economy	Impact on economic loss from sanitation problem (health care cost, nuisance,)	++	+
	Health and Hygiene	Impact on waterborne diseases (cholera, typhoid)	++	+
	Infection and Risks	Impact on infection of HIV/AIDS and respiratory disorder	－	－
	Land Use	Impact on land use in the proposed sites (effective land use, land value)	++	+
	Accidents	Impact on the local communities	－	－
	Conflicts	Impact on the local population (illegal discharge of septage)	++	+
	Traffic	Impact on traffic in proposed sites(traffic control)	－－	－
	Women/Vulnerable People	Impact on women and vulnerable groups in proposed areas(high water table areas)	++	+
	Resettlement	Impact on the local communities	No	No
Total Number of Items of Positive and Negative Impacts				
		++	8	0
		+	0	8
		－	7	9
		－－	2	0
		No	1	1
Total Number of Plus (+) and Minus (－)				
		+	16	8
		－	11	9
Balance of Plus (+)and Minus(－)			+5	－1

(Note)

＋＋	Significant positive impact expected
＋	Positive impact expected
－	Negative impact expected
－－	Significant negative impact expected
No	No impact expected

Considering the difference of total number of plus and minus, Project-1 may be selected as a priority project from the environmental and social considerations.

(2) Evaluation of Stormwater Drainage Management Projects

Evaluation results for the selection of stormwater drainage management priority projects are as shown in the following table.

Table 7.4 Evaluation for the Selection of Stormwater Drainage Management Priority Projects

	Likely Impacts	Evaluation Point	Project Package						
			P1-1	P2	P3-1	P4	P1-2	P3-3	P3-2
Natural Environment	Biology	Impact on biology (forest, farmland, aquatic life)	+	No	++	No	No	No	No
	Air Pollution	Impacts on atmosphere(various gas , dust)	－	－	－－	－	－	－－	－
	Climate Change	Impact on climate change(effects from flood and drought)	++	+	++	+	+	+	+
	Soil Contamination	Impact on the soil proposed areas by construction work	++	++	++	+	+	+	+
	Erosion/Salinization	Erosion/salinization in proposed areas	－－	－	－－	－－	－	－	－
	Water Pollution	Impact of drained water	++	++	++	+	+	+	+
	Offensive Odor	Impact on the local population	No	No	No	No	No	No	No
	Noise/Vibration	Impact on the local population	－	－	－－	－	－	－－	－
	Waste	Impact on the local population （soil, materials）	－－	－	－－	－	－	－－	－
Socio-economic Environment	Economy	Impact on economic loss from floods	++	+	++	+	+	+	+
	Health and Hygiene	Impact on waterborne diseases (malaria, diarrhea)	++	+	++	+	+	+	+
	Infection and Risks	Impact on infection of HIV/AIDS and respiratory disorder	－	－	－－	－	－	－－	－
	Land Use	Impact on land use in the proposed sites (utilization of land during dry and rainy seasons)	++	+	++	+	+	+	+
	Accidents	Impact on the local communities	－	－	－－	－	－	－－	－
	Conflicts	Impact on the local population caused by floods (thief, dispute about embankment)	++	+	++	+	+	+	+
	Traffic	Impact on traffic in proposed sites	－	－	－－	－	－	－－	－
	Women/Children/ Vulnerable People	Impact on women, children and vulnerable groups in flood areas	++	++	++	++	+	+	+
	Resettlement	Impact on the local communities	No	No	No	No	No	No	No
Total Number of Items of Positive and Negative Impacts									
		++	8	3	9	1	0	0	0
		+	1	5	0	7	8	8	8
		－	5	7	0	6	7	1	7
		－－	2	0	7	1	0	6	0
		No	2	5	2	3	3	3	3
Total Number of Plus (+) and Minus (－)									
		+	17	11	18	9	8	8	8
		－	9	7	14	8	7	13	7
Balance of Plus (+)and Minus(－)			+8	+4	+4	+1	+1	-5	+1

(Note)

＋＋	Significant positive impact expected
＋	Positive impact expected
－	Negative impact expected
－－	Significant negative impact expected
No	No impact expected

Considering the difference of total number of plus and minus, Project package P1-1 may be selected as a priority project from the environmental and social considerations.

7.2.4 Environmental Impacts without Projects (Zero Option) and Environmental Projection

(1) Without-Project

As analyzed in the SEA report, the current environment management in Kaolack City is facing serious difficulties. The function of the stormwater drainage system has deteriorated due to wastewater discharge and waste disposal by residents. On the other hand, the sewer network has also deteriorated due to aging of the asbestos pipes. The following table summarizes the current situation in Kaolack City.

Table 7.5 Situation of Without-Project

Facilities	Sewerage	Storm water drainage	Solid waste management
Current Situation	6% coverage	38.5% coverage	6% capacity
Problems	- Deterioration of asbestos pipes. - Reduced capacity of sewerage treatment plant	- Low flow capacity due to clogging with sediments and various wastes.	- Lack of logistics. - Lack of workforce. - Lack of organization and competence. - NGOs lack capacity to solve issues.

At the technical, socio-economic, and socio-sanitary level, this situation will bring the following consequences:

- Continuous and advanced deterioration of facilities and infrastructure.
- Very high prevalence of water- and sanitation-related diseases, in addition to the persisting smell and other nuisance.
- Significant economic losses related to health care and absenteeism cost.

(2) Environmental Projection

It has been concluded that the option “without-project” is not advisable, and considering the dynamics for the time horizons, 2015, 2020, 2025 and 2030, the following situations are expected:

- Increase in the prevalence of water-related diseases and degradation of the living environment;
- Increase in economic losses related to health care and absenteeism costs;
- Decrease in job opportunities due to lack of preferable infrastructure; and
- Increase in population protesting floods and the state of unhealthy living environment.

PART II FEASIBILITY STUDY

CHAPTER 8. ORGANIZATIONAL SETUP FOR PROJECT IMPLEMENTATION

8.1 Organizations/Actors Related to the Project

A lot of organizations are involved in the Project, aiming to improve the environmental and sanitary conditions in Kaolack City. They are, mainly, the Ministry of Hydraulics and Sanitation, Kaolack City, and the other government agencies and urban development entities attached to these ministries. Non-governmental organizations as well as community-based organizations are also active.

8.1.1 Ministries and Agencies on the National Level

On the national level, the ministries and agencies related to the Project are as outlined below.

(1) Ministry of Hydraulics and Sanitation

Department of Urban Sanitation: It is in charge of planning and monitoring studies and implementation of urban sanitation programs in collaboration with ONAS.

ONAS: It is a public entity, industrial and commercial in nature, created in 1996 and in charge of sanitation management. It manages the sewerage network, wastewater treatment plant and pumping stations in Kaolack City.

SONES and SDE: SONES (National Water Company of Senegal) is the state asset holding company of water supply system and SDE (Senegalese Water) is the private operating company responsible for the production and distribution of drinking water in the major cities and towns of the country. SONES is in charge of investments in infrastructure, and regulation of SDE. SDE is responsible for operation, regular maintenance, some investment for system expansion, as well as billing and collection.

(2) Ministry of Environment and Sustainable Development

APROSEN: It has been a public entity endowed with management autonomy and vested with a public service mission for solid waste management. APROSEN had offered technical and material support to local governments on solid waste management. It was dissolved and its mission was transferred to UCG (Coordination and Solid Waste Management Unit) in 2012.

DEEC (Department of Environment and Classified Establishments): It is responsible mainly for (1) prevention and control of pollutions and nuisances; (2) monitoring of activities of various entities and organizations which are affecting the environment; (3) drawing up of legal instruments concerning environment; (4) checking/monitoring of conformity in environmental management of projects; and, (5) validating the SEA report in the Technical Committee for EIA validation.

(3) Ministry of Urban Development and Housing

Department of Urban Development and Architecture: It conducts investigations and issues documents regarding urban planning, supports local governments in drawing up the Master Plan on urban development, and controls urban planning as well as formulating building and architecture standards.

(4) Ministry of Regional Planning and Local Governments

UCG: It was established in 2011 and assumed, tentatively, the mission of APROSEN in 2012 for the transition period until the new entity was established. Since PNGD (National Program for Solid Waste Management) was officially established in July 2013, the mission on solid waste management will be transferred to PNGD, and UCG will be integrated into PNGD as its administrative unit.

PNGD: Its goal is to support local governments with regard to the improvement of their solid waste management. Its mission includes: (1) the revision of laws and regulations of the sector; (2) realization of waste management infrastructure development; (3) reduction of illegal damping; (4) provision of technical and financial support to local governments; (5) conduct of dissemination and capacity development; and (6) coordination, monitoring and evaluation of programs.

(5) Ministry of Restructuring and Development of Inundation Areas

PCLSLB (Project of Social Housing and Slum Prevention): It was established in 2006, originally, as a measure against inundation and relieves the suffering of flood victims by relocating them to safer places and providing them with housing and necessary infrastructures. So far, it has provided accommodation to about 2,000 households out of about 5,000 which lost their houses by flood.

(6) Non-Profit Organizations for Development

ADM (Municipal Development Agency): It is an association of private non-profit organizations created in 1997. Its mission is to undertake activities that will ensure a better management of municipal development on the contract basis.

AGETIP (Public Works and Employment Agency): It is not a public entity, but a private non-profit entity that is financed entirely by fees for the services it provides, without receiving government or donor funds to cover its administrative expenses. It provides mostly small-scale basic infrastructure services (roads, water supply, sanitation, health centers, hospitals, schools, etc.).

8.1.2 Related Organizations/Actors at the Regional Level

Organizations/actors related to the Project at the regional level are as outlined below.

(1) Governor of Kaolack Region

The Governor is the delegate of the President of the Republic at the regional level. Thus, he is responsible for the enforcement of laws and rules, as well as the economic and social development of the Region. In terms of environment, the Governor chairs the Regional Environmental Monitoring Committee on Development Projects and approves the Regional Environmental Action Plan and the Regional Land Planning Scheme.

(2) Prefect of Kaolack Department

The Prefect coordinates the activities of all public services in the Department. He checks legal conformity of the activities by the Mayor and the City Council, and also approves the activities that the City Government has taken in certain fields. Thus, in accordance with the Sanitation Code, the Prefect is responsible for the approval of the Master Plan of sanitation for the management of sewage and storm water in Kaolack Department.

(3) Regional Department of Environment and Classified Establishments (DREEC) of Kaolack

DREEC plays the role as Secretariat of the Regional Environmental Monitoring Committee on Development Projects. The DREEC of Kaolack also collaborates with the City Council of Kaolack to which it gives technical support.

(4) Regional Sanitation Service (SRA) of Kaolack

In urban areas, SRA supervises the regional services of ONAS which is the operational organization. However, the collaboration between these entities is not necessarily effective because ONAS is highly autonomous, owing to its status as a public establishment with industrial and commercial functions.

(5) Regional Delegation of APROSEN

APROSEN offers technical and material support to the City Council of Kaolack which is the authority on solid waste management. Since the dissolution of APROSEN in 2012, UCG assumed

its mission but did not locate regional delegates.

(6) Regional Department of Town Planning and Architecture

Its missions are, among others, to conduct and issue town planning documents, to support local governments in drawing up the Master Plan on urban development, and to control urban planning as well as formulate building and architectural standards as the regional delegate of the Ministry of Urban Development and Housing.

(7) Regional Service of Regional Planning

It is responsible for the coordination and implementation of regional planning as Regional Delegate of the Ministry of Regional Planning and Local Governments.

(8) Regional Hygiene Service

Its missions pertain to the application of the Hygiene Code, activities of prevention and awareness-raising on hygiene, and training of extension agents in waste management as the regional delegate of the Ministry of Hydraulics and Sanitation.

(9) Regional Environmental Monitoring Committee of Development Projects

The Governor of Kaolack Region set up the Regional Environmental Monitoring Committee of Development Projects by the Order of 13 August 2010. The Committee is chaired by the Governor personally, and the head of the DREEC is in charge of the Secretariat. The Committee includes all regional technical services concerning environmental issues.

(10) Regional Development Committee (CRD)

Chaired by the Governor of the Region, the Regional Development Committee serves as the consultation, coordination and grass-root participation framework.

8.1.3 Related Organizations/Actors at City and Local Community Level

(1) Mayor and City Government

The Mayor has municipal police powers and is in charge of peace and order, safety, security and public health. With regard to planning, the City Government shall draw up and carry out the Local Investment Plan and the Local Action Plan for Environment. The management of solid waste produced within the area falls within the responsibility of the City Government.

(2) NGOs and Community-Based Organizations

In the project area, there are quite a few NGOs and community-based organizations (CBOs) with a strong field experience in sanitation in the sphere of local development. They can be tapped as senior partners in program implementation. Such experienced NGOs and CBOs include CARITAS, ASDES and CODEKA (Committee for Kaolack Development) in the sector of solid waste management.

8.2 Capacity Assessment of Organizations/Actors

8.2.1 Background

The capacity assessment has been held as a part of the public consultation in SEA conducted in 2012 based on open and/or semi-structured interviews using a checklist. These interviews have helped ensure the thorough exploration of key sanitation issues. The purpose of those open interviews was, among others, to collect opinions, concerns and recommendations related to various adverse impacts generated by the project.

8.2.2 Results of Capacity Assessment

The results of capacity assessment are summarized as follows:

- The government is the institutional supervising body of the Steering Committee and consultation frameworks. As such, it deserves to benefit from capacity building in environmental management.

- Regional delegates of ministries/agencies have wide experiences in sanitation, but their experience on human, financial and material resources are still limited.
- The local governments have at its disposal service units and comparatively enough employees but their execution capacity is still limited and, therefore, there is a need for capacity building in logistics, techniques and organization.
- NGOs and CBOs have developed significant experiences and expertise, but they still have a limited execution capacity because their budgets are small.

8.3 Organizational Setup for Project Implementation

Based on the results of examination on organizations/actors related to the Project and the consultations with ONAS Kaolack and Kaolack City, the organizational setup for project implementation can be recommended to basically consist of the Steering Committee, the Technical Committee, and the Implementation Unit (IU) for each project component, namely; sewerage and stormwater drainage. A third IU shall be added to this setup when the solid waste management component is started. The organizational setup is as discussed below.

(1) Steering Committee

The Steering Committee (S/C) shall be chaired by the Governor of the Kaolack Region to ensure a higher level of coordination and policy support. It shall be comprised of representatives of the related agencies in charge of urban development, sanitation, environment and the local government. The S/C shall be responsible for providing overall project oversight, ensuring policy support, strategic planning and coordination with other urban development programs. To facilitate the work of the S/C, ONAS Kaolack shall function as the Secretariat.

(2) Technical Committee

The Technical Committee (T/C) shall supervise the Project from the technical viewpoint and assist the S/C on technical issues. T/C shall meet once a month and the results of the meeting shall be reported to S/C.

(3) Implementation Unit for Each Project Component

An Implementation Unit (IU) shall be setup for each project component, namely; sewerage and stormwater drainage, at the implementation stage. These units shall be composed within the implementing agencies, namely; ONAS Kaolack and Kaolack City. Both IUs shall be supervised by the S/C as well as the T/C. Detailed tasks of IU should be drafted in the preconstruction stage, considering the actual conditions of implementation. Their responsibilities are expected to be as follows:

- To supervise the contractor for the construction of facilities with assistance by the consulting engineer;
- To approve requests by the consulting engineer;
- To hold IU meetings periodically (i.e., weekly) in order to check the progress of the construction with attendance of the contractor and the consulting engineer; and
- To report to T/C and S/C and to attend T/C and S/C meetings.

IUs are to be dissolved and staff members are expected to be incorporated into an operation and maintenance team of the implementation agencies after the construction is finished.

CHAPTER 9. SEWERAGE AND SANITATION IMPROVEMENT PLAN

9.1 General

9.1.1 Introduction

As discussed in the Master Plan, the sewerage and sanitation facilities of Kaolack City have been constructed in the 1980's and are seriously deteriorated due, mainly, to aging. In addition, the population projection and wastewater generation for the target year shows a rapid urbanization and increase in the amount of sewage from the serviced area. Considering the above conditions, a Feasibility Study has been conducted for the improvement and expansion of coverage of the sewerage/sanitation system in Kaolack City, focusing on the priority projects.

9.1.2 Component of the Priority Projects

Components of the priority projects are summarized in **Tables 9.1** to **9.3**, and their locations are as indicated in **Fig. 9.1**. Branch sewer installation is not among the project components because the Feasibility Study was conducted focusing on the major facilities (trunk sewer, pumping stations and treatment plant), as discussed in the Master Plan.

Table 9.1 Project Components of Feasibility Study (Trunk Sewer Network)

Trunk Sewer	Size (Diameter in m)	Total Length (in m)	Remarks
New Construction	200 - 500	12,862.6	
Replacement	250 – 1,000	5,608.1	
Total		18,470.7	

Table 9.2 Project Components of Feasibility Study (Pumping Stations)

	Design Inflow [1] (m^3/min)	Pumps installed		Capacity (m^3/min)	Total head (m)	Remarks
		m^3/min	unit			
New construction						
PS No.1 North	15.9	4.0	2	16.0	12	Land owner: public
	(15.9)	8.0	1			Land requirement: 100 m^2
		8.0	1	Stand-by pump		
PS Darou Salam	1.6	0.9	2	1.8	12	Land owner: public
Ndangane	(1.8)	0.9	1	Stand-by pump		Land requirement: 150 m^2
PS Boustane	2.8	1.9	2	3.8	10	Land owner: private
	(3.8)	1.9	1	Stand-by pump		Land requirement: 200 m^2
Rehabilitation						
PS No.1 South	4.0	3.0	2	6.0	13	Land owner: ONAS
	(12.0)	6.0	1	Stand-by pump		Land requirement: 100 m^2
Replacement of pumping equipment						
PS No.2	5.7	3.2	2	6.4	15	Land owner: ONAS
	(12.9)	6.5	1	Stand-by pump		Existing area: 700 m^2
PS No.3	2.9	2.1	2	4.2	13	Land owner: ONAS
	(4.2)	2.1	1	Stand-by pump		Existing area: 500 m^2

Note 1) Values in parenthesis are design inflow in 2030

Table 9.3 Project Components of Feasibility Study (Sewage/Septage Treatment Plant)

Name	Capacity/Quantity	Remarks
New Construction		
Aerated Lagoon	12,000 m^3/day	
Septage Treatment Facilities	70 m^3/day	BOD_5 load: 250 kg/day
Connecting Pipe (diameter 800 mm)	382 m	
Rehabilitation		
Lagoon	3,000 m^3/day	

Fig. 9.1 Location of Proposed Facilities

9.2 Preliminary Design of Sewerage and Sanitation Facilities

9.2.1 Preconditions for the Design

(1) Target Year

Target year has been set at 2020, as discussed in the Master Plan.

(2) Basic Data

The following basic data have been developed and referred in the preliminary design.

(a) Topographic Maps

Topographic survey has been conducted in the beginning of the Feasibility Study, and the results of cross-section survey (ground level) at major points (50 m interval), as well as the longitudinal profile survey (ground elevation), were utilized for the designing of pipe network and related facilities.

(b) Soil Conditions

Soil survey through boring and soil analysis has been conducted in the Feasibility Study stage.

(c) References

In principal, design conditions for facilities design are set up following the reports or design example in Kaolack and other city in Senegal such as Dakar. If the design condition is unclear or unavailable, the following reports and/or guidelines have been employed for the design of facilities: (i) The Study on Urban Drainage and Wastewater Systems in Dakar City and its surroundings, JICA, 1994; (ii) Urban Storm and Wastewater Sanitation Master Plan in Kaolack, Sanitation Department, Ministry of Hydraulic, 1982; (iii) Guideline for Planning and Design of Sewerage Facilities, Japan Sewage Works Association, 2009; (iv) Domestic Wastewater Treatment in Developing Countries, Duncan Mara; (v) Wastewater Stabilization Ponds, Principles of Planning & Practice, WHO; and (vi) Wastewater Engineering, Treatment and Reuse, Metcalf & Eddy.

(3) Setup of Capacity of Facilities

The wastewater projected in the Master Plan has been employed to set the capacity of facilities.

9.2.2 Trunk Sewer Network

(1) Design Conditions

The following conditions have been applied to the design of sewer network.

- Circular pipe is applied with pipe materials of: (i) reinforced concrete (diameter of 600 mm and more than 600 mm); (ii) PVC (diameter of less than 600 mm); and (iii) cast iron for force main.
- Minimum covering of 1.0 m is applied in accordance with the "Guideline for Planning and Design of Sewerage Facilities, Japan Sewage Works Association, 2009".
- Minimum velocity of 0.6 m/s is set to prevent sedimentation, and maximum velocity of 3.0 m/s is adopted so as not to damage the pipes.
- Allowance of pipe capacity for design flow is set at: (i) more than 100% for pipe diameter of up to 600 mm; and (ii) 50% to 100% for pipe diameter of more than 700 mm.
- Direct foundation is, in principle, applied to support sewer pipes.
- Manholes with cast iron covers are installed at such locations as major intersections, points of changing size and/or direction with a maximum interval of 35 m to maintain the pipes and to connect inlet pipes.

(2) Preliminary Design of Trunk Sewer Network

The proposed routes of trunk sewer network are as shown in **Fig. 9.1**. Total length of newly constructed and rehabilitated trunk sewer pipes is about 12,863 m and 5,608 m, respectively.

9.2.3 Sewage Pumping Station

As shown in **Table 9.2**, new pumping stations will be constructed at 4 locations. The other 2 pumping stations will be reinforced while one station will be rehabilitated in the sewage treatment plant. All pumping stations use the submergible type of pump which is the same type as those installed in the existing pumping stations. All the new pumping stations will be equipped with diesel generators as emergency power source. In PS No. 2 and PS No. 3, the pumping equipment is replaced to augment their capacities.

9.2.4 Sewage Treatment Plant

As discussed in the Master Plan, in order to improve and expand the existing sewage treatment plant, (i) rehabilitation of existing lagoon in the existing area; (ii) aerated lagoons in the expansion area; and (iii) septage treatment facilities, are to be planned and/or designed in the Feasibility Study.

(1) Alternative Study on the Location of Expansion Area

Fig. 9.2 presents the location of existing treatment plant and expansion area in the two alternatives. Alternative 1, which was proposed in the Master Plan, has its expansion area located adjacent to the existing treatment plant as shown in **Fig. 9.2**. In this alternative, aerated lagoons including a sedimentation lagoon are constructed in the expansion area. This layout is a modification of the one proposed in the Master Plan. Aerated lagoons are shifted to the center of the plant encompassed by sedimentation lagoons to prevent diffusion of offensive odor, as shown in **Fig.9.3**. Septage treatment facilities are constructed adjacent to the existing area.

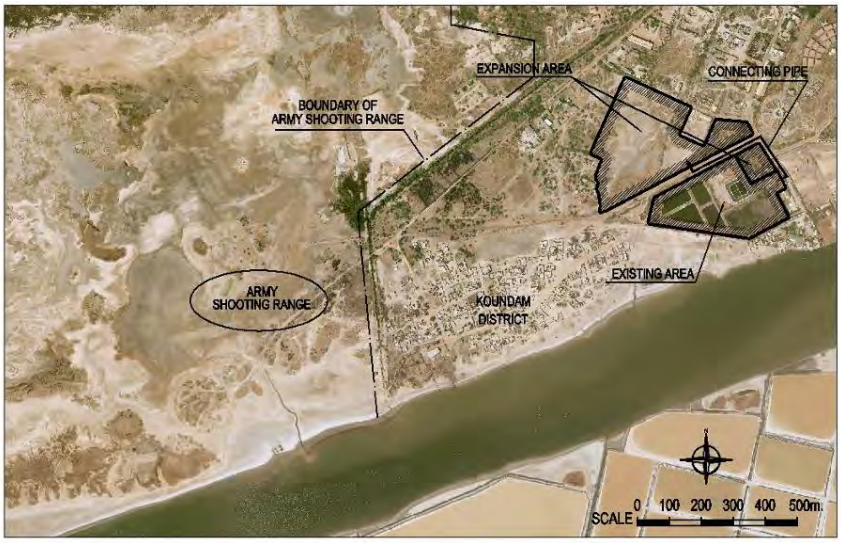
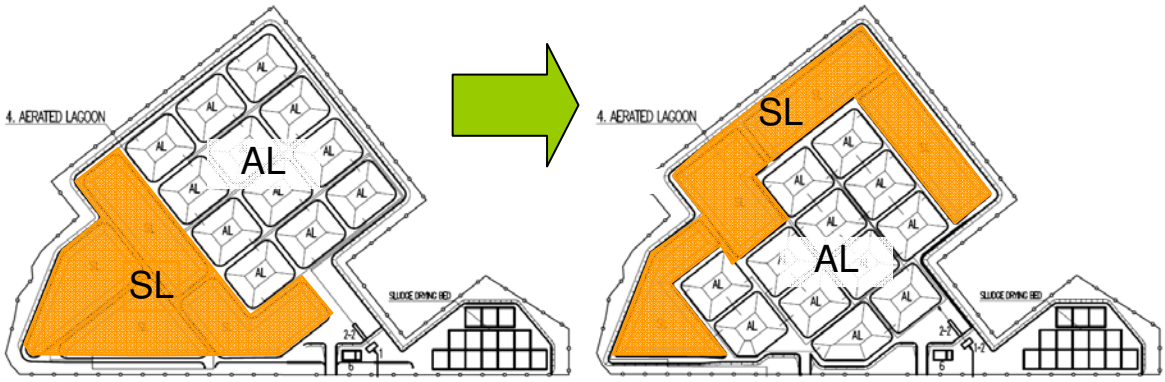


Fig. 9.2 Layout of Expansion Area in Alternative 1



Note: AL: Aerated lagoon, SL: Sedimentation lagoon

Fig. 9.3 Modified Layout of Aerated and Sedimentation Lagoons in the Expansion Area

As shown in **Fig. 9.4,** the expansion area in Alternative 2 is more than 500 m away from the nearest residential house and building in accordance with the Environmental Law of Senegal. The expansion area in this alternative is proposed to be within the army shooting range because no other area which can meet the above regulation is found in the area neighboring the existing STP. In the alternative, aerated lagoon as well as septage treatment facilities are constructed in the expansion area.

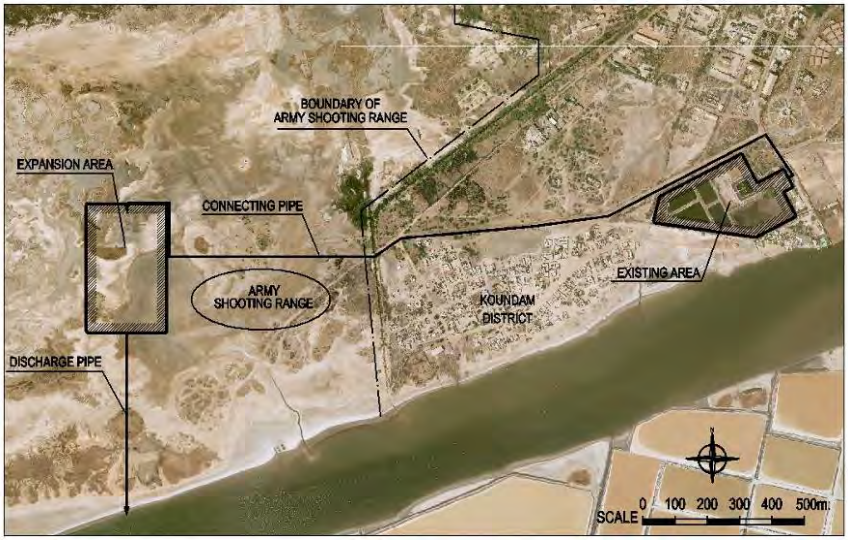
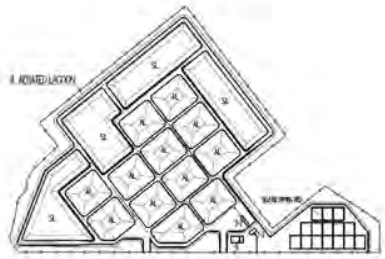


Fig. 9.4 Layout of Expansion Area in Alternative 2

Based on the two alternatives, the detailed layout plans of the existing and expansion areas are as shown in **Table 9.4**, together with information on the facilities to be laid out in each area as well as the lengths of connecting pipe (a pipe connecting the existing and expansion areas).

Table 9.4 Detailed Layout Plan of Expansion Area of Alternatives 1 and 2

	Alternative 1	Alternative 2
Expansion area (layout)		
Facilities	Aerated lagoon (Capacity: 12,000 m^3/day)	Aerated lagoon (Capacity: 12,000 m^3/day)
	-	Septage treatment facilities
Existing area (layout)		
Facilities	Lagoon (Capacity: 3,000 m^3/day)	Lagoon (Capacity: 3,000 m^3/day)
	Septage treatment facilities	-
Connecting pipe	382 m (Diameter 800 mm)	2,500 m (Diameter 800 mm)

Based on the detailed layout plans, the two alternatives have been compared as to: 1) construction cost; 2) O&M cost; 3) environmental impact; 4) ease of O&M; and 5) time period for completion of the project. In each item, a score of "+2" is given to the best alternative while a score of "+1" is given to the second alternative for ranking, as shown in **Table 9.5**.

As shown in the table below, Alternative 1 is better than Alternative 2. Thus, individual sewage and septage treatment facilities have been designed based on Alternative 1.

Table 9.5 Results of Alternative Study on the Location of Expansion Area

Items	Alternative 1	Alternative 2
Construction cost (million FCFA)	9,120 +2	10,876 +1
O&M cost per year (million FCFA)	500 +2	547 +1
Environmental impact	Environmental impact is larger than that of Alternative 2 to some extent. However, the major potential impact, i.e., diffusion of odor could be minimized by the proposed layout of aerated and sedimentation lagoons, as well as planting of such trees as Eucalyptus on the boundary of STP site. In addition, impact to people in the neighboring area (Koundam District) is very limited since wind direction data of Kaolack shows that north, south and west wind direction dominates in Kaolack. EIA in the Feasibility Study reveals that (i) the regulation of 500 m distance in the environmental law of Senegal is not applicable to industrial area, and (ii) the expansion area of this alternative is located in industrial area. +1	Environmental impact to the neighboring area of expansion area is smaller than that of Alternative 1. +2

Items	Alternative 1	Alternative 2
Ease of O&M	Expansion area is adjacent to the existing area (existing STP), so that operation and maintenance work is easier than that of Alternative 2. +2	Distance of about 2.5 km between existing and expansion area requires more operation and maintenance works. +1
Time period for completion of the project	Time is shorter than Alternative 2 because time period for securing the land in the army shooting range is not required. +2	It will take a long time to reach agreement with the agencies concerned in order to secure land in the army shooting range. +1
Evaluation	Best option Total: +9	Second option Total: +6

(2) Septage Treatment Facilities

Septage treatment facilities shall be constructed at the adjacent area of existing lagoon. Treated water in the septage treatment plant is introduced and treated in the subsequent rehabilitated lagoon. Septage treatment facilities consist of receiving station from each vacuum car in which channel and screen are installed, sedimentation basin, anaerobic pond and flow balancing pond, as shown in **Fig. 9.5**. Sludge accumulated in the sedimentation basin is pumped up and conveyed to sludge drying beds.

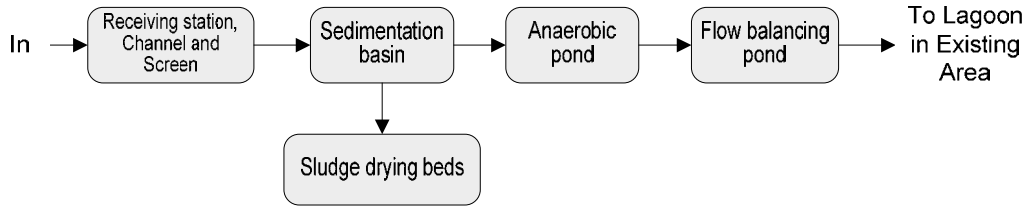


Fig. 9.5 Configuration of Septage Treatment Facilities

The septage treatment facilities have been designed to accommodate 250 kg/day of BOD_5 load, which corresponds to the planning population of 230,000. The population has been determined based on the maximum population in the planning horizon up to 2030. Design parameters and specifications are as delineated in **Table 9.6**. Layout plan and section of the facilities are as shown in **Fig. 9.6**.

Table 9.6 Design Parameters and Specifications of Septage Treatment Facilities

Parameters	Unit	Design Conditions	Remarks
Characteristics of Inflow			
Amount of Septage	m^3/day	70	
BOD_5 Load	kg/day	250	
BOD_5 Concentration	mg/l	3,540	
Design Specifications			
Receiving station Channel and Screen		[Receiving station] 2.6 m (W) × 2.0 m (L) × 0.8 m (D) × 1 (Nos.) [Converging section (at downstream end)] 0.5 m (W) × 1.5 m (L) × 2 (Nos.) [Channel and screen] 0.5 m (W) × 1.7 m (L) × 2 (Nos.)	Free board 0.5 m Screen space 25.0 mm
Sedimentation Basin		8.0 m (W) × 8.0 m (L) × 2.0 m (D) × 2 (No.)	Freeboard: 0.5 m
Anaerobic Pond		10.0 m (W) × 11.0 m (L) × 3.0 m (D) × 2 (No.)	Freeboard: 0.5 m
Flow Balancing Pond		7.5 m (W) × 7.5 m (L) × 2.0 m (D) × 1 (No.)	Freeboard: 0.8 m
Sludge Drying Beds		194 m^2 × 3 (Nos.)	

Note: W: Width, L: Length, D: Depth

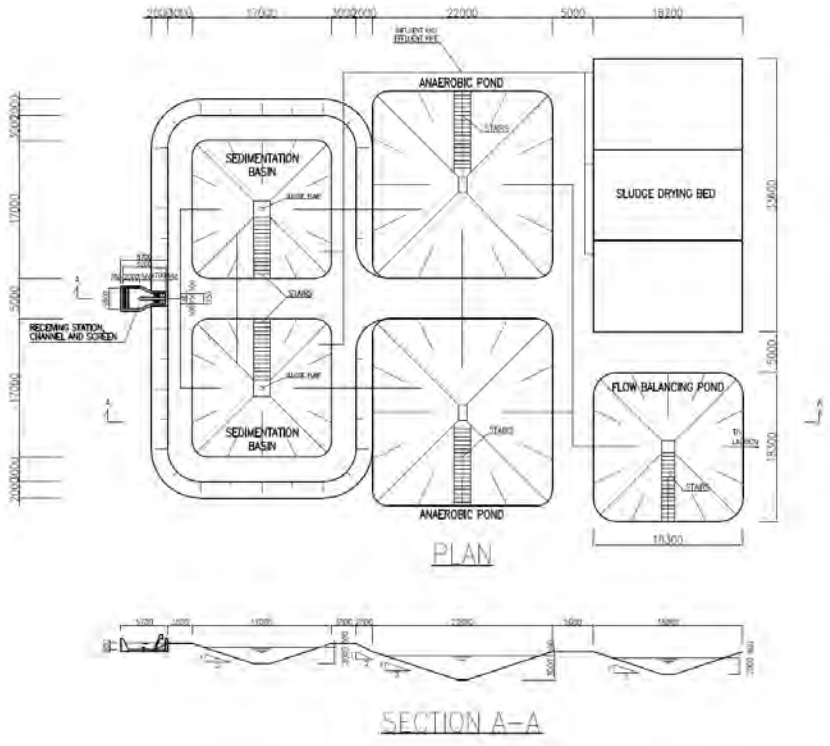


Fig. 9.6 Layout Plan and Section of Septage Treatment Facilities

(3) Rehabilitation of Existing Lagoon

Rehabilitation of the existing lagoon shall be implemented focusing on the existing facultative lagoon and aerated lagoon which have not been handed over yet.

(a) Design Conditions

Design conditions are shown in **Table 9.7**. Inflow and water quality have been calculated based on the mixture of sewage and preliminary treated water in the septage treatment facilities. Lagoons have been designed to meet the discharge criteria of BOD_5=40 mg/l, TSS=50 mg/l, COD_{Cr}=100 mg/l, and Fecal Coliform=2,000 CFU/100 ml.

Table 9.7 Design Parameters for the Rehabilitation of Existing Lagoon

Items	Unit	Calculation		Remarks
Inflow				
Sewerage	m^3/day	3,000		
Septage Facilities	m^3/day	70		
Total	m^3/day	3,070		
Water Quality				
		Influent	Effluent (Criteria)	
BOD_5	mg/l	489[1)]	40	
TSS	mg/l	611	50	611=489 × 1.25[2)]
COD_{Cr}	mg/l	978	100	978=489 × 2.00[2)]
Fecal Coliform	CFU/100 ml	1.0×10^7	2.0×10^3	3)

Note: 1) BOD_5 of 489 mg/l is that of mixing liquor consisting of (1) sewerage: 3,000 m^3/day (BOD_5=485 mg/l), and, (2) septage: 70 m^3/day (BOD_5=640mg/l).
2) Influent BOD_5:TSS:COD_{Cr}=1.00:1.25:2.00 as discussed in the Master Plan
3) Influent fecal coliform is set considering water quality monitoring data in 2011

(b) Configuration

The existing facultative lagoon (including the aerated lagoon which is not functional) has to be rehabilitated following the configuration shown in **Fig. 9.7**. Thus, the existing facultative

lagoon and the aerated lagoon are replaced by an anaerobic lagoon and a facultative lagoon respectively.

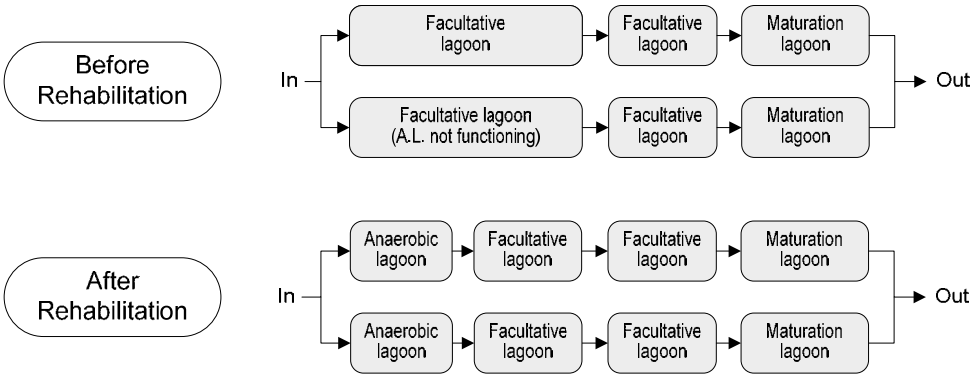


Fig. 9.7 Configuration of Existing Lagoon System in the Existing STP

(c) Specifications

Specifications of lagoons are summarized in **Table 9.8**.

Table 9.8 Specifications of Rehabilitated Lagoons

Facilities	Specifications	HRT (days)
Rehabilitated Anaerobic Lagoon	Area 900 m^2 × 3.0 m (D) × 2 (Nos.)	1.8
Existing Facultative Lagoon	Area 9,685 m^2 × 2.0 m (D) × 2 (Nos.) Area 2,795 m^2 × 2.0 m (D) × 2 (Nos.)	16.6
Maturation Lagoon	Area 3,810 m^2 × 1.5 m (D) × 2 (Nos.)	4.0

Note: D: Depth

(4) Aerated Lagoons in Expansion Area

Aerated lagoons to be constructed in the expansion area shall have the following conditions.

(a) Design Conditions

The Aerated Lagoon in the expansion area is designed to have a capacity of 12,000 m^3/day and to meet the discharge criteria of BOD_5=40 mg/l, TSS=50 mg/l, COD_{Cr}=100 mg/l and Fecal Coliform= 2,000 CFU/100 ml, as shown in **Table 9.9**.

Table 9.9 Design Parameters of Aerated Lagoon

Parameters	Unit	Design Conditions		Remarks
Inflow				
Sewerage	m^3/day	12,000		
Water quality				
		Influent	Effluent (Criteria)	
BOD_5	mg/l	485	40	
TSS	mg/l	606	50	606=485 x 1.25[1)]
COD_{Cr}	mg/l	970	100	970=485 x 2.00[1)]
Fecal coliform	CFU/100 ml	1.0 × 10^7	2.0 × 10^3	2)

Note: 1) Influent BOD_5:TSS:COD_{Cr}=1.00:1.25:2.00 as discussed in the Master Plan
2) Influent fecal coliform is set up considering water quality monitoring data in 2011

(b) Configuration

Aerated lagoons consisting of aerated lagoons, sedimentation lagoons and chlorination chamber are to be designed and configured as illustrated in **Fig. 9.8**. After chlorination, the treated water is mixed with the treated water from lagoons in the existing area, and then discharged into the Saloum River through the newly constructed discharge pipe.

Fig. 9.8 Configuration of Aerated Lagoons in the Expansion Area

(c) Specifications

Specifications of aerated lagoons, chlorination chamber and discharge pipe are as shown in **Table 9.10**.

Table 9.10 Specifications of Aerated Lagoons in the Expansion Area

Facilities	Specifications	HRT	Remarks
Aerated Lagoon	Area 972 m^2 × 4.0 m (D) × 12 (No.)	3.7 days	Free board 1.0 m
Aerator	7.5 kw ×5 (No.) ×12 (lagoons)	-	
Sedimentation Lagoon	Area 4,570 m^2 × 2.0 m (D) × 4 (No.) [1)]	1.5 days	Free board 0.5 m
Chlorination Chamber	5.0 m (W) × 25.6 m (L) × 2.0 m (D)	30 min	
Sludge drying beds	Area 270 m^2 × 0.3 m (D)×15 (Nos.)	-	Free board 0.2 m
Discharge Pipe	Diameter: 1, 000 mm × 250 m	-	

Note: Depth of 2.0 meter includes sludge allowance of 1.0 meter.
W: Width, L: Length, D: Depth

The typical layout plan and section of aerated lagoon are as shown in **Fig. 9.9**

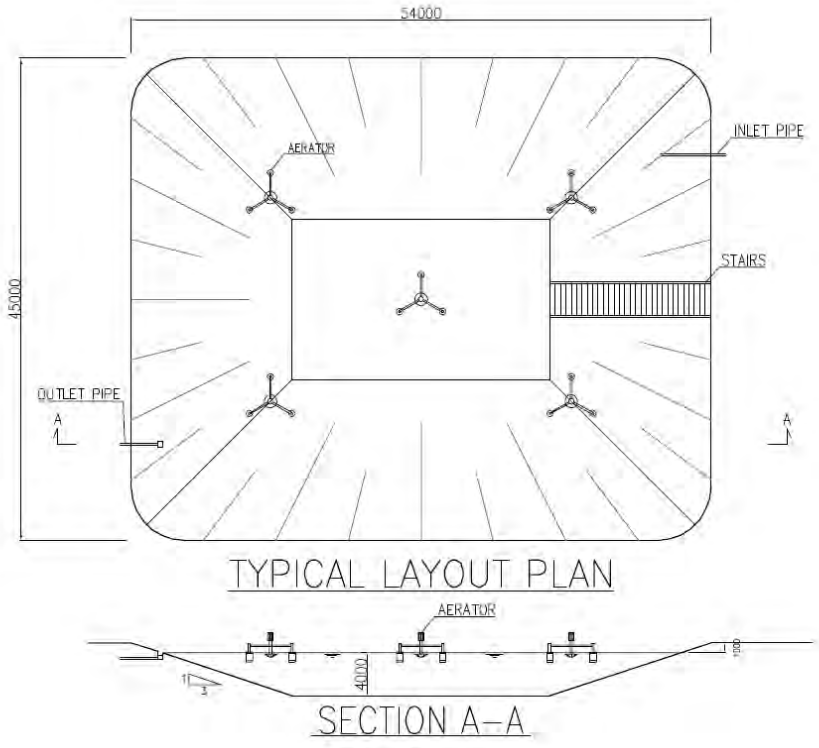


Fig. 9.9 Typical Layout Plan and Section of Aerated Lagoon

Based on the above discussion, the general layout plan of STP has been prepared, as shown in **Fig. 9.10**.

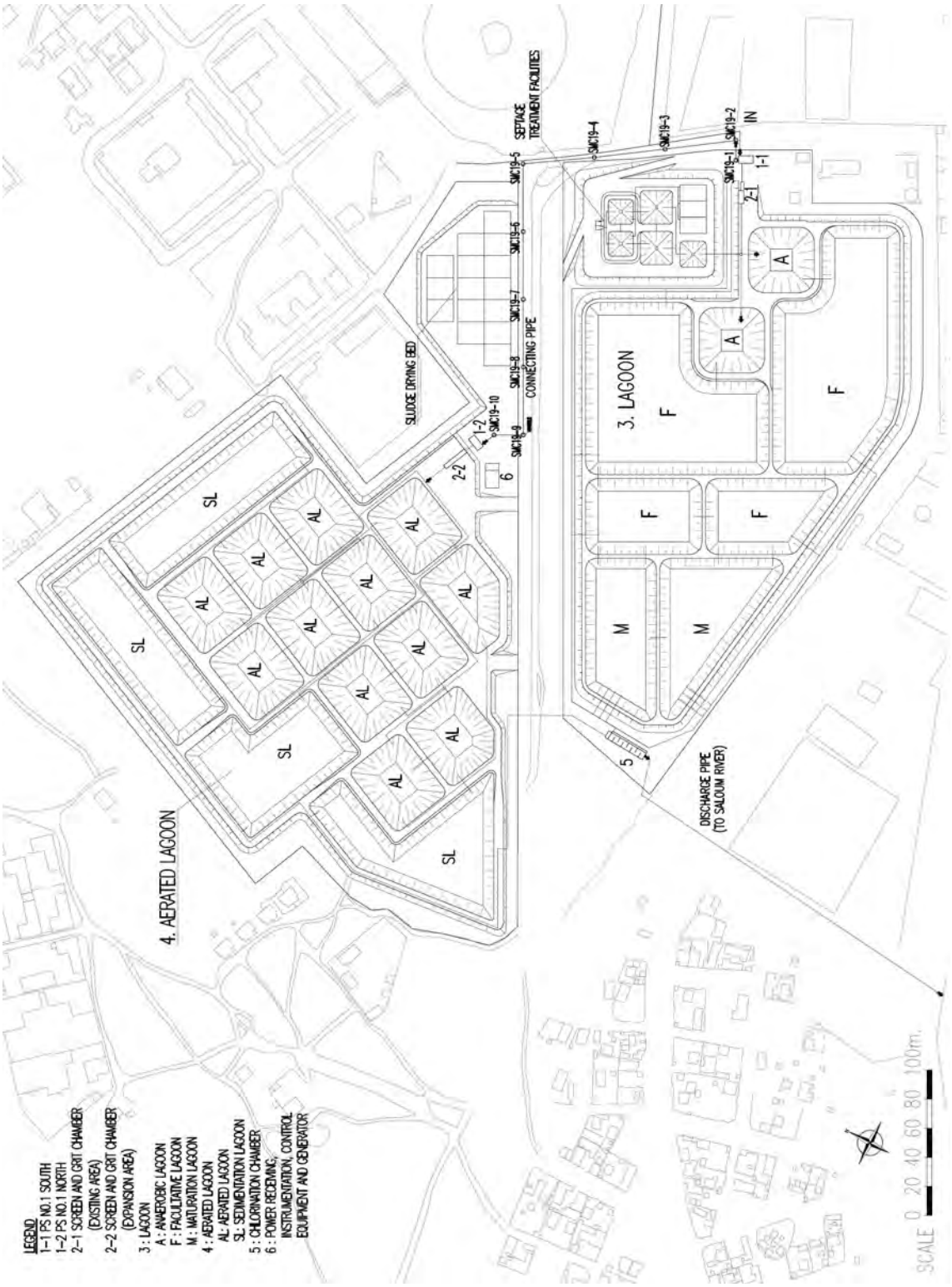


Fig. 9.10 General Layout Plan of STP

9.3 Construction Plan

(1) Basic Consideration

Based on various limitations such as construction materials and methods and mechanical/electrical devices in Senegal, the following conditions have been considered for the construction of sewer network, sewage pumping stations, and sewage treatment plant:

- In general, open-cut excavation shall be applied.
- During excavation below underground water, it is necessary to lower the water table by using submersible water pumps.
- On-site batching plant for both concrete and asphalt shall be set up.
- Where enough width for the road cannot be kept due to open excavation, the existing road shall be used as temporary detour road to maintain the flow of traffic.
- Use of temporary steel shoring is considered only for the construction of pump well and the connection pipe (RC diameter of 800 mm), that is, 90 m in length out of 380 m, due to space limitation.
- Usable sand shall be considered up to 300 mm above the sewer pipe. Remaining backfilling up to the finish level of subgrade shall be carried out by using selected excavated soil. The suitable material for the sub-grade shall be selected, carefully.
- Location of disposal yard for both excess excavated soil and concrete debris shall be about 15 km away from the center of Kaolack.
- Location of borrow pit for usable soil is about 20 km away from the center of Kaolack

(2) Major Construction Machinery

The major construction machineries to be used for the Project are as shown in the table below.

Table 9.11 Major Construction Machineries

Works	Construction Machineries
Earth Works	(1) 0.7 to 1.2 m^3 Excavators; (2) 10 ton Dump Trucks; (3) 3 to 16 ton Bulldozers; (4) 1 ton Compacting Rollers; and (5) Tamping Rammer
Piling Works	(1) Piling Rigs; and (2) 20 to 50 ton Truck (or Rough Terrain) Cranes
Concrete Works	(1) 20 to 25 ton Truck (or Rough Terrain) Cranes; (2) Concrete Pump Trucks; and (3) 1 m^3 Concrete Hoppers (Base Machine 20 to 25 ton Crane)
Road Works	(1) Giant Breakers; (2) 12 to 16 ton Bulldozers; (3) 1 m^3 Wheel Loader; (4) Motor Graders; (5) 10 ton Macadam Rollers; (6) 20 ton Tire Rollers; (7) Asphalt Pavers; and (8) Concrete Pavers
Mechanical Works	(1) 20 to 25 ton Truck (or Rough Terrain) Cranes; and (2) 100 ton Crawler Cranes

9.4 Cost Estimate

9.4.1 Construction Cost and Engineering Cost

(1) Construction Cost

Construction Cost has been calculated based on the various cost information obtained from ONAS Dakar, ONAS Kaolack, local firms and Japanese firms. The followings are the general conditions for the construction cost estimate. Cost of branch sewer installation is not included in the construction cost because the branch sewer installation is not included in the project components.

- Construction cost is estimated at the 2013 price level.
- Annual price escalation rate of 3% is applied when using cost data of past project.
- The cost is classified into foreign and local currency portions based on the information on procurement obtained in Senegal.

(2) Engineering Cost

Engineering cost is calculated based on the cost information obtained from the local firms in the following manner:

- Engineering cost is estimated at 2013 price level:
- The following durations are assumed for the consulting services:
  - Detailed design, pre-construction phase services: 18 months
  - Construction supervision: 30 months
- Price escalation is included (FC: 2.0%; LC: 3.0%).
- Physical contingency is included (10%).

9.4.2 Project Cost

Estimate conditions of the project cost are as follows.

- Price Escalation: annual rate FC: 2%; LC: 3% for construction cost:
- Physical Contingency: 10% of construction cost
- Land Acquisition Cost: 25,000 FCFA/m^2 for STP and 10,000 to 12,500 FCFA for pumping stations, inclusive of the price escalation and physical contingency that is the same percentage of construction cost and engineering cost
- Project Administration Cost: 2% of total amount construction cost, engineering cost and land acquisition cost
- VAT: 18%
- Import Tax: 9%
- Interest Rate during Construction of Project: annual rate of 1.4% for construction cost, 0.01% for engineering cost
- Front-End Fee: 0.2% of total amount for construction cost, engineering cost and interest during construction

Project cost is estimated based on the abovementioned conditions. Total project cost amounts to approximately 31,713 million FCFA at the 2013 price level, of which 25,162 million FCFA is the local currency portion and 6,551 million FCFA is the foreign currency portion.

Table 9.12 Project Cost

Cost Items	Work Items	L/C (million FCFA)	F/C (million FCFA)	Total (million FCFA)
Construction Cost	Trunk Sewer Network	5,774	0	5,774
	Pumping Station[1)]	213	386	599
	Sewage Treatment Plant			
	Aerated Lagoon[2)]	3,964	3,413	7,377
	Septage Treatment Facilities	385	52	437
	Rehabilitation of Lagoon[3)]	1,217	89	1,306
	Subtotal (STP)	5,566	3,554	9,120
	Total	11,553	3,940	15,493
Price Escalation		1,824	395	2,219
Physical Contingency		1,338	434	1,772
Engineering Service		2,127	1,164	3,291
Land Acquisition		3,270	0	3,270
Government Administration		521	0	521
VAT		4,100	0	4,100
Import Tax		429	0	429
Interest during Construction		0	571	571
Front-end Fee		0	47	47
Total (million FCFA)		25,162	6,551	31,713

Note: 1) Including PS Boustane, PS Darou Salam Ndangane, PS No.2 and PS No.3. Cost of PS No.1 North and PS No.1 South is included in the cost of sewage treatment plant.
2) Including PS No.1 North
3) Including PS No.1 South

9.4.3 O&M Cost

Annual operation and maintenance cost of sewerage and sanitation improvement facilities have been estimated as follows. The cost includes cleaning work, sludge disposal, electricity, and personal expenses.

Table 9.13 Annual O&M Cost

Facility	Cost (million FCFA)
Sewer Network and Pumping Stations	289
STP[1)]	500
Total	789

Note: 1) Cost including O&M cost PS No.1 North and South

9.5 Economic and Financial Analysis

9.5.1 Economic Analysis on Priority Project

Project cost is shown in **Tables 9.12**. This project has positive effects on the improvement of living environment in the target area, whose benefit can be calculated by people's willingness-to-pay (WTP). The results of Socio-economic Survey conducted by the JICA Expert Team have already been presented in **Tables 4.19** in the Master Plan part.

EIRR has been calculated at 5.2% for WTP of 500 FCFA and 13.3% for WTP of 1,000 FCFA and -4.2% for WTP of 202 FCFA (weighted average) since the benefit is too low. WTP of 1,000 FCFA is around the same level as the solid waste collection fee which is presently paid by users, so that this amount can be realized by education and dissemination campaigns to the people.

9.5.2 Financial Analysis on Priority Project

Project benefits are the revenue from: (1) sewerage charge, that is, 8% of the water supply charge which is collected together with water supply charge from residents of the sewerage area; and (2) septage treatment charge outside the sewerage area. However, since sewerage charge is presently collected also from those who have no connection to the sewerage system, sewerage charge has been applied to all the people for the purpose of benefit calculation.

Presently, sewerage charge for each concession is 10 FCFA per CM of water consumption up to 20 CM and 45.65 FCFA per CM of water consumption from 21 CM to 40 CM. Average charge per CM is calculated on average number of people in one concession, i.e., 9.45 in 2012 by Kaolack City. It is regarded as the base case to estimate how many times the charge should be increased in calculating FIRR.

Table 9.14 Total Revenue from Sewerage Charge

	2012	2015	2020	2025	2030
Target Population (thousand)	–	169	259	339	403
Water Consumption (lpcd)	74.0	76.0	80.0	84.0	88.0
Average Charge (FCFA/CM)	11.98	12.87	14.51	15.99	17.34
Total Water Consumption (thousand CM/yr)	–	4,682	7,566	10,406	12,944
Total Revenue (million FCFA)	–	0	103	126	148

FIRR cannot be calculated with the base case because the benefit is too low, which means that the sewerage charge is set at a very low level. FIRR will be 0.0% if the sewerage charge is increased to 10.5 times, and 12.0% (equal to Social Discount Rate) if 35.5 times.

9.5.3 Financial Analysis on ONAS

ONAS Dakar, the implementation agency of the sewerage component, submits its financial statements (Balance Sheet [B/S] and Profit and Loss [P/L] Statement) to the government every year.

Based on the P/L statements, ONAS had been making operating deficits of more than 4,000 million FCFA for the last three years, which amounts to more than half of the operating income. These deficits

are offset by the more than 1,000 million FCFA of operating subsidies every year. The P/L statement clarifies the very low income, i.e., very low sewerage charges which can be seen in the financial analysis of the project. The Chief Accountant of ONAS explained that the subsidies from the government are mandated in case of deficit. However, the subsidies are not enough and hence the amount of ordinary deficits are calculated and input in the "Reversals of Non-Ordinary Activities in Non-Ordinary Profit".

Very low sewerage charges can be clarified from the viewpoint of "Total Asset Turnover", which is calculated as "[Sales] / [Total Assets]" and which indicates how efficiently the assets are utilized to realize the sales revenue. It means that, if the figure is less than 1, some parts of assets do not contribute to make sales mainly due to the very low revenues. The Total Asset Turnover of ONAS is 0.04 to 0.05, which means that all assets will contribute to realize the sales revenue in 20 to 25 years.

Since the sewerage charge is levied with the water charge of SDE, the sewerage charge revenue would increase if water charge revenue increases. There are two ways for increasing the water charge revenue. One is to increase water tariff and the other is to decrease non-revenue water. However, increase in water tariff is very difficult due to political reasons. Decrease in non-revenue water is also very difficult because the non-revenue rate is presently around 20%, which is very low, compared with the other developing countries, for example, 40% in Pakistan, which has the same level of per capita GDP.

9.6 Environmental Impact Assessment

9.6.1 Project Component

The project essentially consists of:

1) Improvement of sewage system including the installation of main collector as well as the construction of new pumping stations; and,
2) Expansion and rehabilitation of sewage treatment plants.

9.6.2 Activities Requiring Environmental Consideration

Main activities requiring environmental considerations are as follows:

- Demolition of asbestos cement pipes;
- Excavation;
- Installation of new pipes; and
- Rehabilitation (expansion) and construction of pumping stations and wastewater/sludge treatment plants.

9.6.3 Project Area Outlook and Scopes of Assessment

(1) Sewage Treatment Plant (STP) in Koudum

The existing STP project site as well as its expansion site is located in Koudum District, where 279 households with 2,322 people reside. This area is a part of the urbanization zone of Kaolack City, which includes the administrative and commercial areas. The expansion of STP site was planned in the industrial area of Koundam District. There is a plastic recycling factory in the industrial area, but a large part of the area is bare land. The City Government has a plan to establish a protected beach in Koundam District, to be located adjacent to the largest tourist hotel in Kaolack City (Hotel Relais) and the existing STP site. No specific concern like ethnic groups, national or natural parks, precious wildlife and historical memorials has been observed over the area.

(2) Pumping Station in Darou Salam Ndangane

The planned pumping station is located at Garage Nioro in Darou Salam Ndangane District south-east of Kaolack City, where there is also a commercial center and an industrial area. The location of the site is about 200 m away from a market and 100 m from the main road to Nioro. The place is muddy with lots of solid waste. A workshop for dump trucks is next to the site.

(3) Pumping Station in Boustane

A pumping station is planned in Boustane, the western periphery of Kaolack City, at the right side

of the trunk road (R1) to Dakar. The area is one of the centers of transportation in Kaolack City, and there is a bus terminal in the south side of R1. The site belongs to an Islamic school along R1.

9.6.4 Considerations on Natural and Social Environment

Possible adverse impacts on both natural and social environment during the construction and operation phases of the sewerage/sanitation system improvement are summarized in **Table 9.15**.

Table 9.15 Possible Adverse Impacts by Sewerage/Sanitation System Improvement

Phase	Impact	Intensity	Extended	Importance
Natural Environment				
Construction	Scattering of waste debris in the site	Low	Local	Minor
	Soil contamination by sewage spills or waste oil			
	Water contamination by infiltrated sewage			
	Odor nuisance (H_2S)			
	Temporary displacement of wildlife			
	Degradation of air quality			
Operation	Contamination of soil, surface/groundwater by the wastewater discharged from the site	Strong		Major
	Odor nuisance			
	Losses and occasional release of wastewater during malfunction of the river			
	Pouring of wastewater from the ponds by defective sealing walls			
Social Environment				
Construction	Inhalation of asbestos (high exposure)	Low	Local	Minor
	Momentary interruption of sewage service on the existing network			
	Outbreak of infectious diseases (mainly by contaminated water)			
	Traffic jam and accidents	Strong		Major
	Destruction of public infrastructure			
Operation	Odor during the winter season			
	Contamination of the river by sporadic spurts during mechanical malfunction or power failure at the site.			

9.6.5 Alternatives of "With-Project"

(1) Site Selection for Expansion of STP

The expansion areas of STP have been compared between two alternatives, and "Site No. 1 (neighboring area of existing STP)" has been selected as a suitable area for expansion of the STP, as shown in **Table 9.16**.

Table 9.16 Comparison of Expansion Area of STP

Site	Evaluation
Site No. 1 (Industrial area in Koundam)	Since the site is near the existing STP, long connecting pipes are not needed. Currently, most of the land belongs to the State Government. In case of malfunction of the existing STP, the risk of pollution may be less than that in "Site No. 2". Since this site is located in the center of Kaolack City, there is concern about offensive odor to the neighborhood. Also, some plots of land belong to the local people.
Site No. 2 (Army Shooting Range in Koundam)	This site is located in an open area in Koundam. Connection from this site to the network behind Ngadé in Koundam Subdivision may be possible. However, investment cost is higher due to the 1 km distance from the existing STP. Since the land now belongs to the Army, the possibility of obtaining the land from the Army may be low. There is risk of contamination in case of failure of connecting pipes.

(2) Sewage Treatment Method for Expansion Area of STP

Sewage treatment methods have been compared focusing on: (1) aerated lagoon; (2) lagoon; and (3) activated sludge process. As shown in **Table 9.17**, aerated lagoon is recommended

because: (1) enough land is not available in the expansion area to apply the lagoon system; and, (2) activated sludge process needs high energy consumption.

Table 9.17 Comparison of Applicable Sewage Treatment Method

Method	Evaluation
Aerated Lagoons (Proposed method in F/S)	Energy consumption is higher than that in lagoon system. However, this can be offset by a small required area and more possibility of treated wastewater for reuse.
Alternative 1 (Lagoons)	Lagoon system consumes no energy and investment cost is low. However, this method requires a large area.
Alternative 2 (Activated sludge process)	This alternative requires a smaller area than the others. However, energy, construction and maintenance costs are quite high.

(3) Sludge Treatment for Expansion Area of STP

The EIA report had evaluated the most favorable sludge treatment method. As shown in **Table 9.18**, the sedimentation basin and drying beds are recommended for sludge treatment considering land requirement and workload for O&M.

Table 9.18 Comparison of Applicable Sludge Treatment Method

Method	Evaluation
Sedimentation basin and drying beds (Proposed method in F/S)	Removal rate of BOD_5, COD_{Cr} and TSS is high. The volume of sludge is small after treatment. However, maintenance works for pumps and pipes are needed.
Alternative 1. (Unplanted drying beds)	O&M is easy. Removal rates of BOD_5, COD_{Cr} and TSS are high. However, the volume of sludge is large with liquid portion and need a long time to dry sludge.
Alternative 2 (Constructed wetlands: planted drying beds)	It might be good for landscape and odor is reduced. However, removal rate will depend on the variety of plants, and additional activities are needed to keep the plants in healthy condition.

9.6.6 Environmental Management and Monitoring

Based on the possible adverse impacts by sewerage/sanitation system improvement, mitigation and minimizing measures as well as monitoring plans are proposed. The following table summarizes the mitigation and minimizing measures as well as the monitoring plans, focusing on the items of "Intensity is Strong and Importance is Major".

Table 9.19 Mitigation/Minimizing Measures and Monitoring Plan of Sewerage/Sanitation System Improvement

Phase	Impact	Mitigation/Minimizing Measures	Monitoring Plan
Natural Environment			
Operation	Contamination of soil and surface or groundwater by wastewater discharged from the site	• To install stand-by facilities such as pump and by-pass pipe to divert wastewater to another channel or treatment unit so as not to contaminate the soil and surface water around the STP site. • To form a lining on the surface of the lagoons. • To keep water-tightness of the discharge pipe.	Water quality analysis (such parameters as BOD_5, COD_{Cr}, TSS, fecal coliform) [Frequency: at least 4 times in a year]
	Odor or foul smell (which is predicted especially in the STP site)	• To lay out aerated lagoons which are the major sources of odor or foul smell in the sedimentation lagoon expansion area of the STP. • To plant trees such as Eucalyptus along the boundary of STP site.	Interview with the inhabitants around the STP site [Frequency: when required]
	Losses and occasional release of wastewater during malfunction of facilities.	• To install standby facilities such as pump and bypass pipe to divert wastewater to another channel or treatment unit. • To install electric power generators for emergency use.	Observation of the facilities [Frequency: everyday]
	Spillage of wastewater	• To install electric power generators for	Check the surface of the lagoons

Phase	Impact	Mitigation/Minimizing Measures	Monitoring Plan
	from the ponds by defective sealing walls	emergency use.	[Frequency: once a year]
Social Environment			
Construction	Traffic jams and accidents	• To remove and transport excavated soil as fast as possible. • To establish diversion road, traffic signs, boards and warning lights at the construction site.	Observation of traffic volume and traffic jams [Frequency: once every 3 months]
	Destruction of public infrastructure	• To minimize the excavated area on public roads especially in installing sewer pipes. • To utilize temporary materials such as sheet piles as far as practicable.	Observation [Frequency: once every 3 months]
Operation	Odor or foul smell during winter season	• To lay out aerated lagoons which are the major sources of odor or foul smell inside the sedimentation lagoon expansion area of the STP. • To plant trees such as Eucalyptus along the boundary of the STP site.	Interview with the inhabitants around the STP site [Frequency: when required]
	Contamination of river by sporadic spurts of smoke or gas during malfunction of mechanical equipment or power failure)	• To install stand-by facilities such as pump and by-pass pipe to divert wastewater to another channel or treatment unit so as not to contaminate soil and surface water around the STP site. • To install generators for the emergency use.	Observation [Frequency: when malfunction of facilities occur]

9.6.7 Role of Implementing Agencies

(1) ONAS

ONAS is in charge of wastewater treatment, so that its regional delegate, ONAS Kaolack, is the core stakeholder for implementation and monitoring of the Project. All decisions by ONAS Kaolack fully depend on the ONAS Headquarters in Dakar.

ONAS Kaolack does not have a bank account and no cash, so that all operation and maintenance expenditures are managed by the ONAS Headquarters. In case of repair of STP facilities, ONAS Dakar makes a contract directly with a mechanical agency in Dakar, which shall dispatch an engineer or mechanic to Kaolack. Payments of repair costs are made directly by ONAS Dakar to the contractor. All personnel appointments are also under the control of ONAS Dakar.

Under the circumstances, it is essential to communicate and make detailed agreements on financial and human resource management with the ONAS Headquarters in Dakar for effective implementation and monitoring of the Project and also avoid risks similar to the uncompleted IDB project in 2006.

(2) NGOs

Soft components such as people's awareness and participation are essential to increase the effectiveness of the Project. There are several NGOs in Kaolack City which are operating for environmental improvement with DEEC/DREEC and other donors like EU. For instance, ASDES implements school cleaning and waste management projects. CARITAS has been recycling hard plastics for the building of toilets, and distributes and teaches poor people how to use them. Coordination with these NGOs including the monitoring is inevitable through the Project.

9.7 Implementation Program

9.7.1 Basic Conditions

The implementation program has been formulated in consideration of feasible construction procedure to complete all the construction works by the target year 2020 and subsequent cost estimate. The implementation program for the proposed project is based on the following:

- Assumed commencement of project is November 2014.

- Project needs to be completed by the target year 2020.

On the assumption of loan project, the implementation program is formulated with available data/information collected from WB, AfDB, IDB, etc. The preparatory stage prior to the project construction could be set as follows:

- Fund arrangement (E/N, L/A) and procurement of consultant: 12 months
- Detailed design, tender and the contract of the contractor: 18 months

9.7.2 Implementation Plan

To formulate the implementation plan for sewerage and sanitation facilities, the following points shall have been taken into account:

- Annual amount of rainfall in Kaolack, which mainly occurs between July and September, is about 560 mm. In the rainy season, monthly rainfall ranges from 120 mm to 220 mm. Compared to Japan or the Southeast Asian countries, this is much less. Thus there are no special conditions which strongly affect productivity. In conclusion, work stop coefficient of 1.35, which is applied for normal condition, is used based on JICA's cost estimate manual. Besides, regional coefficient for labor and equipment, that is, 2.0 for simple labor works, 3.5 for skilled labor works, and 70% for work by machinery in a region of Africa, is applied.
- In principle, the works for sewer network shall be carried out from downstream to upstream.
- The works for sewer networks, pumping stations and sewage treatment plant shall be commenced concurrently so that it will be possible to complete the entire works within 30 months. In addition, the works for branch sewer, which are not included in the scope of this Project, will also be possible to proceed concurrently within 30 months. However, in such a case, the coordination between both projects is required in terms of the construction schedule to minimize the unfavorable effect to the existing traffic flow and to avoid the risk of accidents due to overlapped or closed work areas.
- Judging from work volume and sequence, construction works for a total length of 18 km sewer network is apparently on the critical path. The following are the sequences of work for the construction of sewer networks: (i) demolition of existing asphalt road; (ii) excavation; (iii) backfilling by imported sand below sewer line; (iv) pipe laying; (v) backfilling surrounding pipe; (vi) backfilling by using selected excavated soil; (vii) laying of granular sub base course, (viii) laying of aggregate base course; and (ix) laying of wearing course.

9.7.3 Consultancy Services

(1) Scope of Services

The consultancy services have been divided into three phases as follows:

- Detailed Design Phase
- Pre-Construction Phase
- Construction Phase

(2) Reporting

The Consultant shall prepare and submit various reports and documents to ONAS, in accordance with the project stage and progress. These are: (i) the inception report; (ii) the bimonthly progress reports; (iii) the definitive plan report; (iv) the detailed design report; (v) the pre-qualification evaluation report; (vi) the tender evaluation report; (vii) the operation and maintenance manual; (viii) the environmental monitoring and management report; and (ix) the service completion report.

(3) Work Schedule

Each component of the consulting engineering services shall be completed within the time specified as follows:

(i) Detailed Design : 12 months
(ii) Pre-Construction : 6 months
(iii) Construction : 30 months
(iv) Transfer of Knowledge : 1 month

A total of 48 months of consulting engineering services will be required for the Project.

(4) Expert Required

In total, 32 experts and 290.4 man-months are required for the consulting engineering services, among which 15 experts and 113.8 man-months are for foreign consultants, and 17 experts and 176.6 man-months are for local ones.

9.7.4 Implementation Schedule

Details of the implementation schedule are as shown in **Fig. 9.11**.

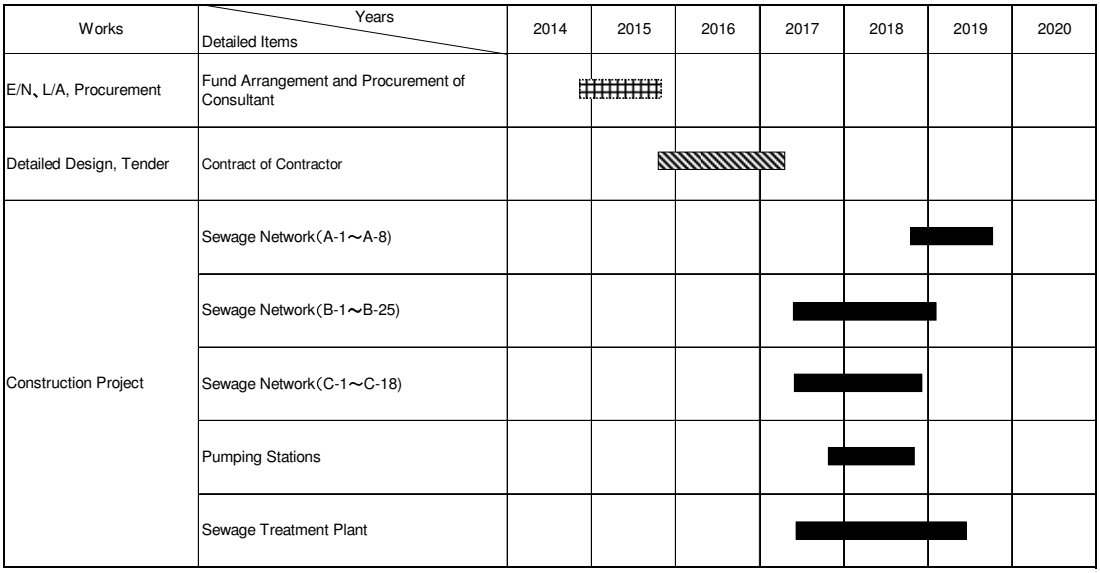


Fig. 9.11 Implementation Schedule for the Construction of Sewerage/Sanitation Improvement Facilities

9.7.5 Disbursement Schedule

Based on the implementation schedule, the cost disbursement schedule, of which the total cost is 31,713 million FCFA consisting of 6,551 million FCFA of foreign currency portion and 25,162 million FCFA of local one, is proposed for the project period of 2014 to 2019.

9.8 Operation and Effect Indicators

In order to evaluate the impact of implementing the priority project in the field of sewerage and sanitation improvement, the indicators with the target year of 2022 (two years after the completion of the projects), are as shown in the following table.

Table 9.20 Operation and Effect Indicators

Indicators	Unit	Year		Remarks
		2012 (Present)	2022 (Target year)	
(1) Operation indicators				
Population served by sewerage facilities	person	17,330	91,600	
Population served by septage facilities	person	-	118,800[1)]	
Rate of facility utilization (STP)	%	Overloaded	47	
Influent BOD_5 concentration	mg/l	377	454	
Effluent BOD_5 concentration	mg/l	88	40	

Indicators	Unit	Year		Remarks
		2012 (Present)	2022 (Target year)	
BOD_5 treatment efficiency	%	77	91	
(2-1) Effect indicators (For Project area)				
Percentage of population served	%	30	75	
Percentage of population connected	%	15	68	
Total length of trunk sewer	km	7.96	20.61	
(2-2) Effect indicators (For Entire City Center)				
Percentage of population served	%	13	36	
Percentage of population connected	%	6	28	
Total length of trunk sewer	km	13.61	26.26	

Note: All values of 2022 were obtained by interpolation using values of 2020 and 2025 in the implementation of the Master Plan. Population of project area includes those of the existing sewered area.
1) This value is equivalent to 50% of people in on-site sanitation area. This 50% is a present percentage of people using on-site sanitation, which was obtained by the interview with the related agencies and NGOs.

9.9 Project Evaluation

Based on the preceding discussion, the priority projects of sewerage and sanitation improvement were evaluated as follows:

- The sewage treatment capacity of 15,000 m^3/day and the area covered by trunk sewer of 848 ha can be obtained with the construction of sewerage facilities of trunk sewer, pumping station and sewage treatment plant. As a result, sanitation condition in the area would improve gradually and significantly if the construction is done together with branch sewer installation. ONAS is to be responsible for the branch sewer installation. Financial assistance for the branch sewer installation is expected from the donors such as the WB and/or the Government of Senegal through ADM, which are involved in related sewerage project in Kaolack. Construction of septage treatment facilities would be beneficial also to the people in the on-site sanitation area.
- Technologies applied to pumping station and sewage treatment plant are technically sound in operation and maintenance because all the proposed pumping stations use the submergible type of pump as already used in the existing pumping stations. Furthermore, sewage treatment plant is designed based on the lagoon and aerated lagoon which are the most simplified treatment methods.
- No resettlement is required since all proposed facilities are constructed and/or installed under public roads or empty areas.
- During the construction stage, negative impacts such as traffic interruption especially during the installation of sewer pipes, as well as noise, dust and vibration, would be unavoidable. However, the impacts could be minimized by introducing remedial measures such as diversion road, sprinkling with water and selecting low-noise and/or low-vibration type construction equipment as far as practicable.
- To implement the priority projects, financial assistance by the Government of Senegal is strongly required.
- Considering the low connection ratio of sewer network in Kaolack City, house connection to the sewer network should be accelerated with financial assistance of the Government of Senegal to optimize the sewerage system. The typical cost of pipe from house inlet to inside of household (50,000 to 100,000 FCFA), which is equivalent to about 42 to 83% of the average monthly income of 120,000 FCFA/household, will creates a financial burden to each household. Under the circumstances, financial assistance from the Government of Senegal is required to improve the low connection ratio of sewer network in Kaolack City.
- Administrative advice by ONAS, as well as Kaolack City to the companies providing desludging service, is strongly recommended to make them utilize septage treatment facilities and thus reduce their desludging service charge to each household.

CHAPTER 10. STORMWATER DRAINAGE MANAGEMENT PLAN

10.1 General

10.1.1 Component of Priority Projects

The components of the projects for the Feasibility Study are shown below.

Table 10.1 Project Components for Feasibility Study

Facilities		Specifications (Width × Height, Length)	Remarks
Box Culvert	N-0	1.7m × 1.7m, L= 761.5 m	New Construction
	N-1	2.0m × 1.8m, L= 568.2 m	
	N-2	1.2m × 1.2m, L= 970.5 m	
	N-3	2.2m × 2.0m, L= 711.1 m	
	N-4	1.6m × 1.6m, L=1,151.5 m	
	N-5	2.5m × 2.4m, L= 859.6 m	
	N-6	2.7m × 2.6m, L=1,265.5 m	
	N-9	2.9m × 2.9m, L= 374.3 m	
	N-PE	(2.1m × 1.6m) × 3, L=1,619.5 m	
Pumping Station (P_N)		No. of Pumps: 5 units × 3.2 m^3/s Required area: 4,300 m^2 Pump Total Head: 3.2 m	New Construction
Retention Pond		Gross storage capacity: 39,000 m^3 Bottom surface area: 14,250 m^2 Depth of pond: 2.5 m	New Construction

Locations of proposed drainage facilities are as indicated in **Fig. 10.1**.

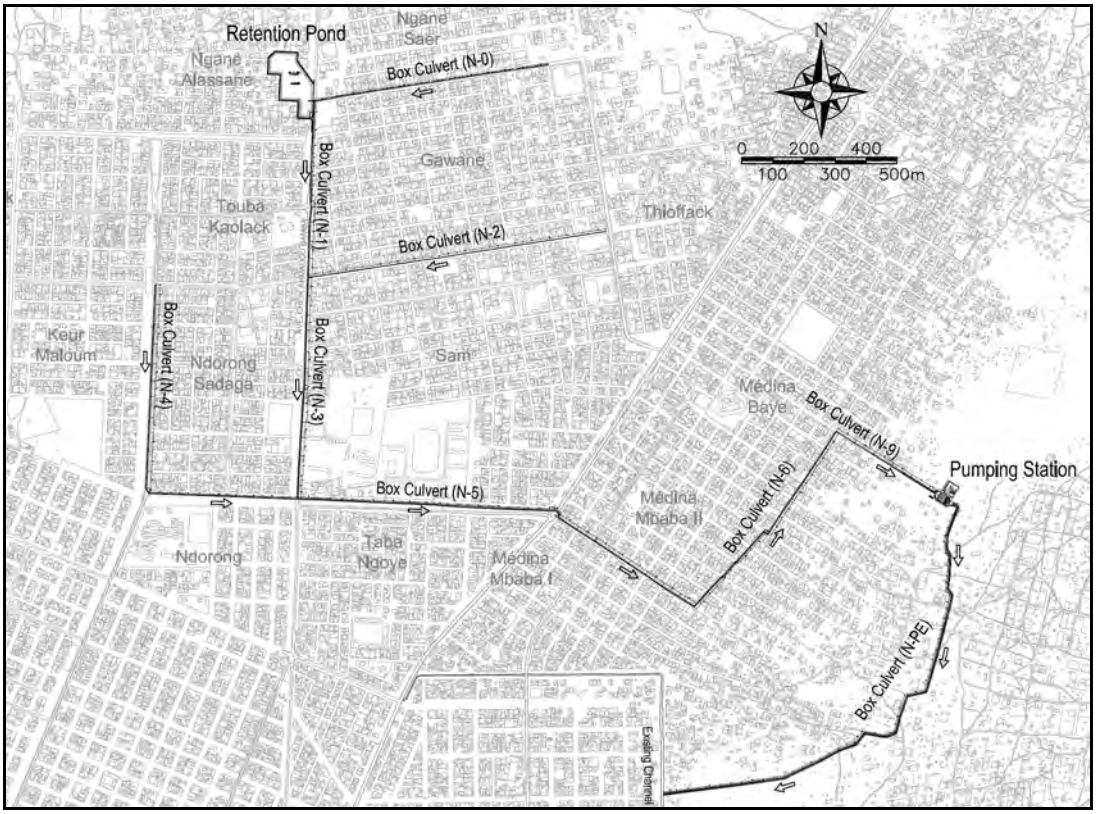


Fig. 10.1 Locations of Proposed Drainage Facilities

10.2 Preliminary Design of Drainage Facilities

10.2.1 Design Conditions

(1) Design Scale

For drainage planning, the10-year design storm is adopted for Kaolack City.

(2) Basic Data Used

The basic data used in the preliminary design are as described below.

(a) Topographic Maps

Topographic survey is conducted in the Feasibility Study stage. Cross-sections (ground level) at major points (50 m interval) and longitudinal profiles (ground elevation) surveyed are used as basis in the design of box culvert.

(b) Soil Conditions

Soil investigation by boring and soil analysis is conducted in the Feasibility Study stage. Major soil data obtained from the above is utilized in the design of drainage facilities such as drainage box culvert, pumping station and retention pond, and construction method.

(c) References

The following reports and/or guidelines are employed for the design of facilities: (i) The Study on Urban Drainage and Wastewater Systems in Dakar City and its surroundings, JICA, 1994; (ii) Urban Storm and Wastewater Sanitation Master Plan in Kaolack, Sanitation Department, Ministry of Hydraulic, 1982; (iii) Guideline for Planning and Design of Sewerage Facility, Japan Sewage Works Associations, 2009; and (iv) The Standard Civil Design Drawings, Ministry of Land Infrastructure Transport and Tourism, Japan.

(3) Hydraulic Analysis

Design discharges of drainage facilities estimated in the Master Plan stage are applied.

10.2.2 Drainage Box Culvert

(1) Basic Directions for New Drainage Box Culvert Installation

The following are the basic directions for new drainage box culverts installation:

- Box culvert is constructed by concreting in situ, in principle.
- Basically, the minimum earth cover is adopted, i.e., 0.5 m, in accordance with the Standard Civil Design Drawing for box culvert. In case that the earth cover is less than 0.5 m, box culvert shall be analyzed as to whether or not it can sustain the necessary loads and forces as required and designed.
- Longitudinal bed slope is set from gentle to rough towards upstream. The minimum velocity value of 0.8 m/s is maintained to avoid sediment deposition. The maximum velocity of 3.0 m/s shall be adopted, to reduce energy dissipation.
- Direct foundation is applied as the foundation structure of box culvert considering soil and geological conditions.
- Manhole is installed at major intersections, points of changing size and pipe junction except for connections to houses or buildings.

(2) Proposed Route and Design Discharge

The proposed route of new drainage box culvert is as shown in **Fig. 10.2**, mostly under the road. Total length of new box culvert is about 8,280 m. The estimated design discharge for new drainage box culverts is the 10-year storm as also presented in the figure.

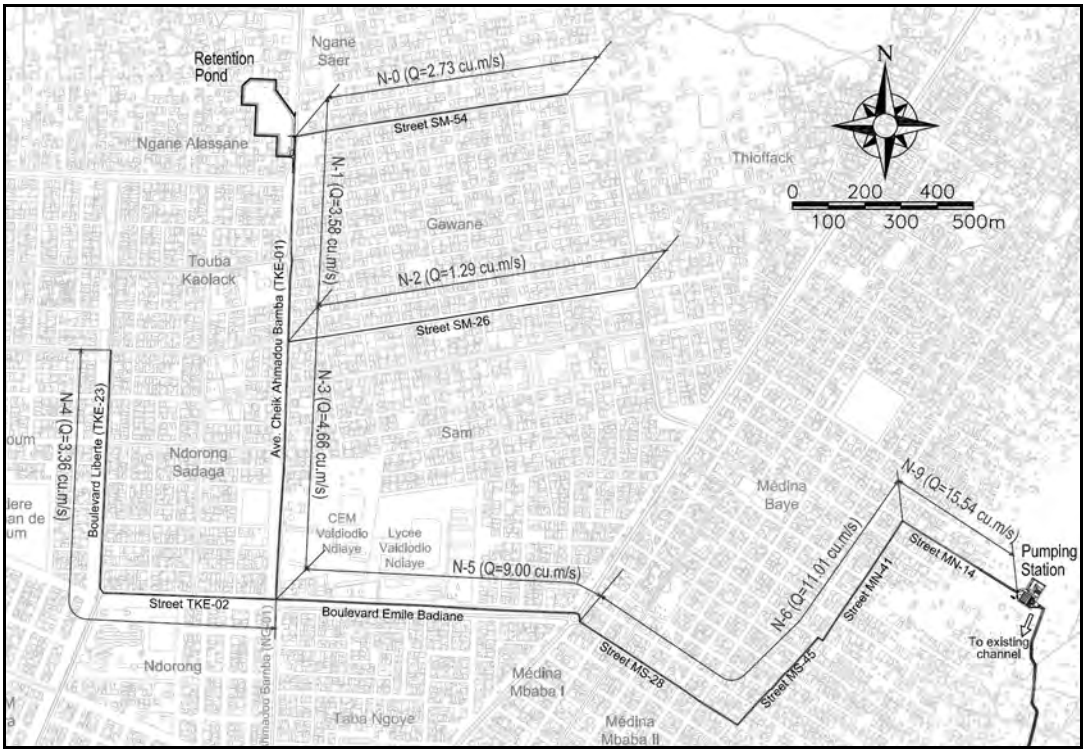


Fig. 10.2 Proposed Route and Design Discharge for New Drainage Box Culvert

(3) Preliminary Design

In accordance with the design criteria for drainage facilities, the new drainage box culvert is designed. The proposed routes of new drainage box culvert are as tabulated in **Table 10.2**. Total length of new box culvert is about 8,280 m. Major features of the drainage box culvert are enumerated in **Table 10.3**.

Table 10.2 Proposed Route of New Drainage Box Culverts

Proposed Box Cuvert	Street Number/Name	Type of Pavement
N-0	Street SM-54	Asphalt
N-1	Ave. Cheik Ahmadou Bamba (TKE-01)	Asphalt
N-2	Street SM-26	No pavement (earth road)
N-3	Ave. Cheik Ahmadou Bamba (TKE-01)	Asphalt
N-4	Boulevard Liberte (TKE-23), Street TKE-02	Concrete
N-5	Boulevard Emile Badiane	Asphalt
N-6	Street MS-28, Street MS-45, Street MN-41	No pavement (earth road)
N-9	Street MN-14	No pavement (earth road)
N-PE	No street number	No pavement (earth road)

Table 10.3 Major Features of Drainage Box Culverts

Box Cuvert Segment	Size (width x depth)	Length (m)	Number of Manhole
N-0	1.7m × 1.7m	761.5	14
N-1	2.0m × 1.8m	568.2	13
N-2	1.2m × 1.2m	970.5	18
N-3	2.2m × 2.0m	711.1	15
N-4	1.6m × 1.6m	1,151.5	20
N-5	2.5m × 2.4m	859.6	17
N-6	2.7m × 2.6m	1,265.5	22
N-9	2.9m × 2.9m	374.3	6
N-PE	(2.1m × 1.6m) × 3	1,619.5	28
TOTAL		8,281.7	153

To drain the road surface flow into the box culvert smoothly and effectively, new inlets and inlet pipes are installed at intersections. Images of inlet and inlet pipe are shown in **Fig. 10.3**.

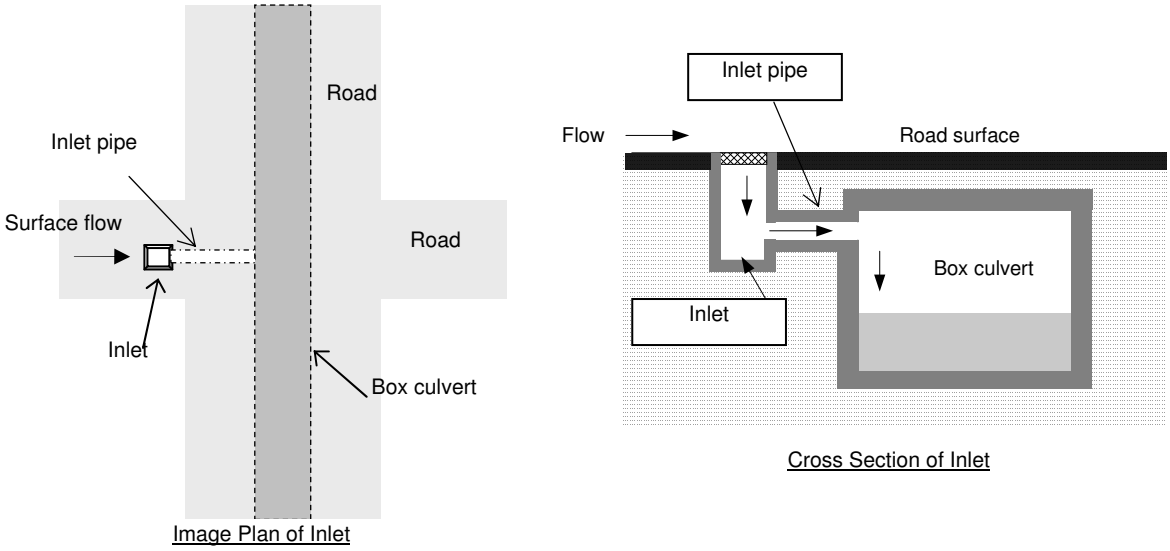


Fig. 10.3 Images of Inlet and Inlet Pipe

10.2.3 Pumping Station

(1) Basic Directions for Construction of New Pumping Station

The pumping station is designed in accordance with the "Guideline for Planning and Design of Sewerage Facility, Japan Sewage Works Associations, 2009". Based on economic and design considerations, the pumping station is located in a low-lying area.

(2) Proposed Location

The pumping station is necessary to remove stormwater from the northern area of Kaolack City. The new pumping station is to be located at the end point of proposed drainage box culvert network. Based on the result of discussion with the Kaolack City Government in consideration of the available area, the location of new pumping station is to be determined, as shown in **Fig. 10.1**. Total required area is about 4,300 m^2. This proposed site is a public land.

(3) Preliminary Design

The design discharge for the new pumping station estimated in the Master Plan stage is applied. The required total pump capacity is 16.0 m^3/s. The number of pumps is set at 5 units with unit pump

capacity of 3.2 m^3/s (pump total head:3.2 m), considering operation and maintenance and available area for pumping station. Submergible type is selected for the new pumping station in consideration of the required pump space, operation, installation works and maintenance. The plan of the pumping station is shown in **Fig. 10.4**.

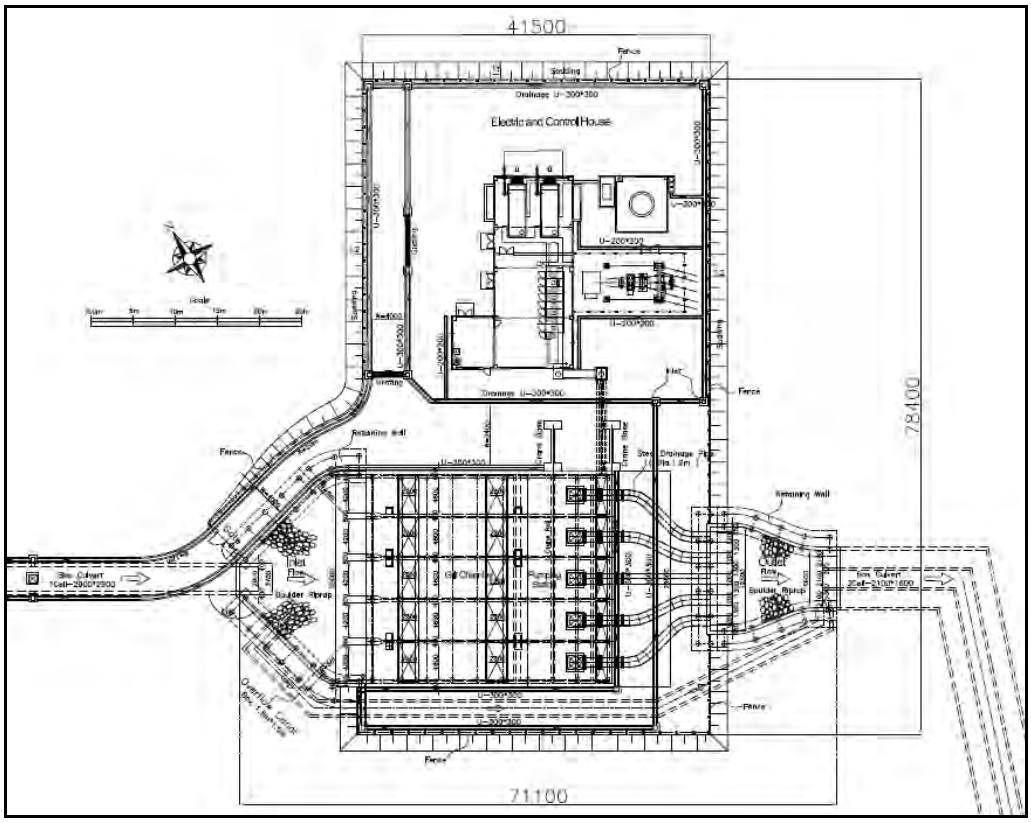


Fig. 10.4 Plan of New Pumping Station

10.2.4 Retention Pond

The retention pond is proposed as flood mitigation facilities which have the function of temporarily storing runoff discharge and attenuating the peak runoff discharge.

(1) Basic Directions for the Design of Retention Pond

Facilities are designed hydraulically to ensure fulfillment of their flood control functions. The retention pond is designed in accordance with "Technical Standards for Planning and Design of Stormwater Retention Pond (Draft), Japan Sewage Works Associations". In consideration of topographic features and present site conditions, the excavated pond is applied.

(2) Proposed Location

The proposed location of the retention pond is a low-lying area as shown in **Fig. 10.1**. Therefore, during the storm period, stormwater is to be drained to the proposed site through the road surface following the local topography. There are public and private land in the proposed site.

(3) Preliminary Design

In accordance with the above design criteria, the retention pond is designed. General plan of the retention pond is shown in **Fig. 10.5**. Major features of the retention pond are summarized in **Table 10.4**.

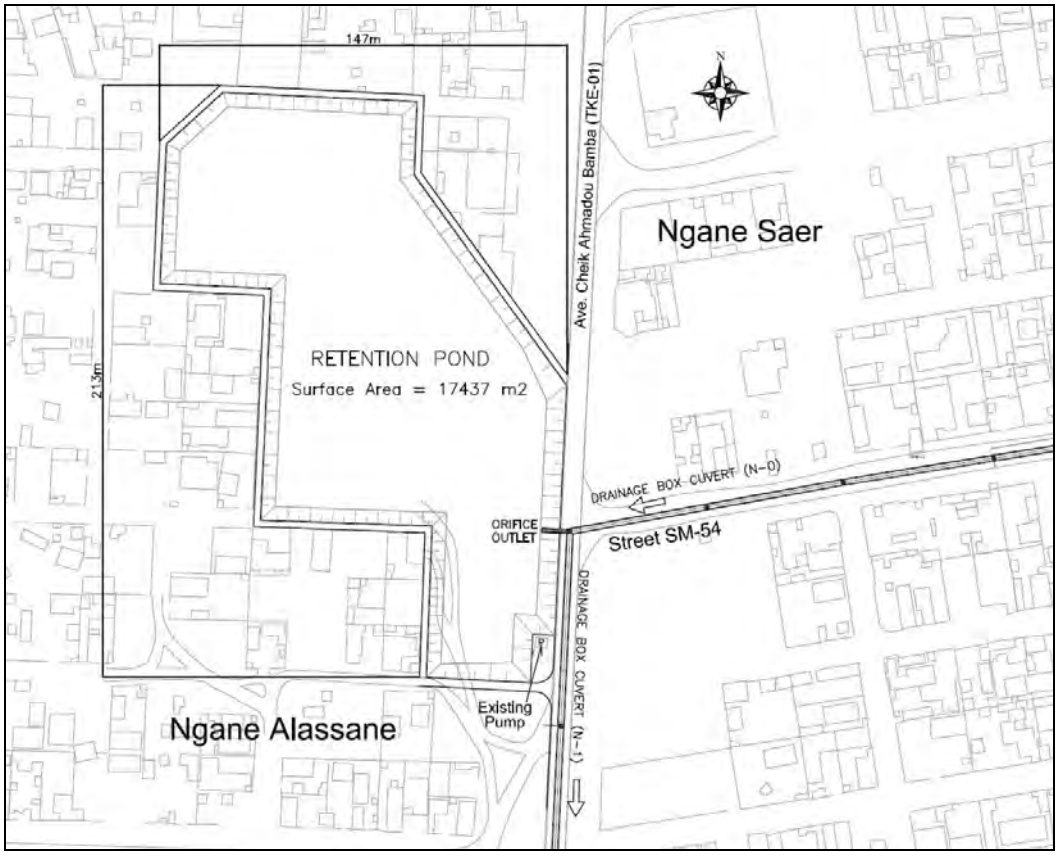


Fig. 10.5 General Plan of Retention Pond

Table 10.4 Major Features of the Retention Pond

Surface Area (m^2)	Bottom of Surface Area (m^2)	Bottom Elevation (EL.m)	Gross Storage Capacity (m^3)	Maintenance Road Elevation (EL. m)
17,437[7]	14,250	0.85	39,000	3.35

- Minimum freeboard of the retention pond above the design high water level in the facility is set at 0.6 m.
- 2.5 m of berms width is adopted considering proper construction procedure. Berms are covered with concrete pavement.
- Side slope of excavation is designed at more than 1.0 vertical to 2.0 horizontal to secure the slope's stability.
- The retention pond is surrounded by a grid wire fence for security.
- Vegetation provides erosion control and enhances site stability. Side-sloping areas are planted with native grasses.
- Typical cross section of the retention pond is shown in **Fig. 10.6**.

[7] In the Master Plan, surface area of retention pond was roughly estimated at 15,000 m^2.

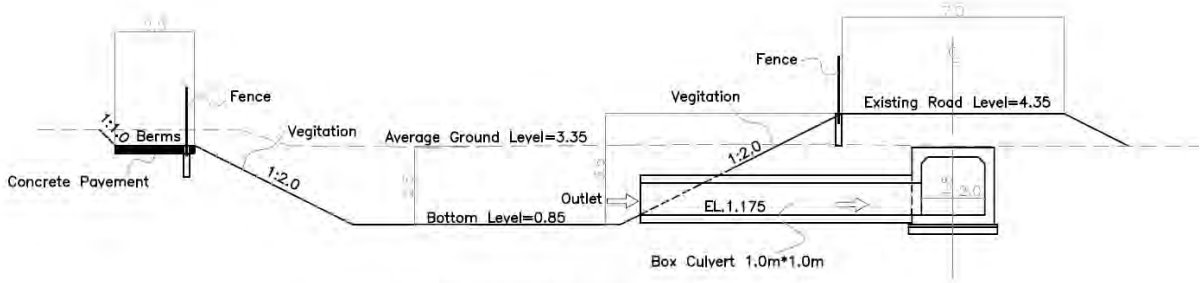


Fig. 10.6 Typical Cross Section of Retention Pond

- The retention pond has an orifice outlet with 1.0 m x 1.0 m at downstream end. Discharge volume is calculated by the following formula:

$H \leq 1.2D \quad Q = 1.75 \times B \times H^{3/2}$

$H \geq 1.8D \quad Q = C \times B \times D \times \sqrt{2g(H - D/2)}$

In case of 1.2D < H <1.8D, discharge volume Q is a linear interpolation using the Q of the two equations above.

Where;

Q = discharge volume, m^3/sec
C = coefficient of discharge (=0.6)
B, D = B: width, D: depth, m
H = effective head on the orifice, from the center of orifice to the water surface, m
g = acceleration of gravity, m^2/sec

Detailed plans and sections of the retention pond are shown in the "Drawings and Design Notes."

10.3 Construction Plan

(1) General Circumstances

To consider the construction plan for drainage facilities, it is necessary to collect and examine the general circumstances related to the availability of the construction materials. The remarkable points on the procurement of construction materials are as follows:

- Available steel materials are very limited so that the temporary use of steel materials for earth works and/or structural works is not a common method in Senegal.
- Mechanical items such as pumping equipment need to be imported from foreign countries.
- There is no commercial batching plant for both ready-mixed concrete and asphalt. Only major contractors in Dakar have their own batching plants.

(2) Construction Plan

Based on the general circumstances in Senegal, the following are considered as the conditions for the construction for drainage facilities, i.e., drainage box culvert, pumping station, and retention pond:

- Open-cut excavation is applied.
- During excavation below underground water, it is necessary to lower the water table by using submersible water pumps.
- As shown in the following typical cross section of excavation for box culvert, 1.0 m width beside box culvert is considered as working space. For the purpose of slope stability, 1.0 m width of temporary berm and 1:1 slope above the berm are assumed.

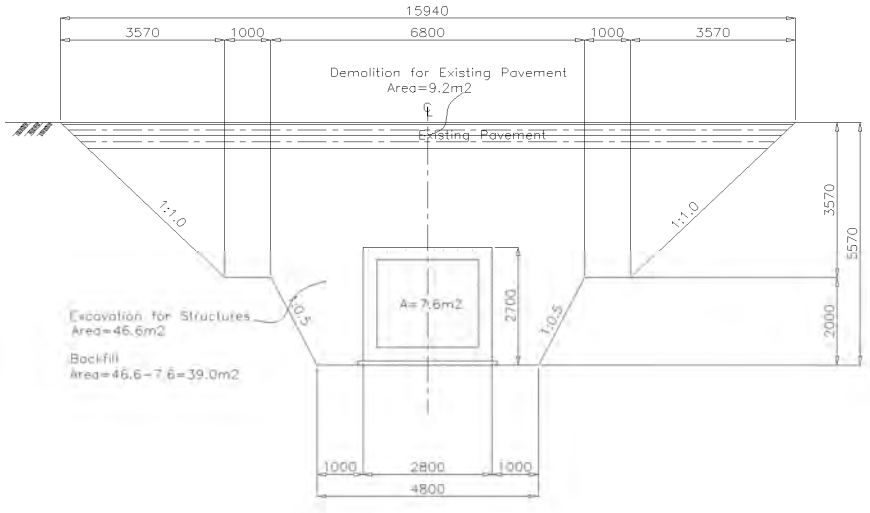


Fig. 10.7 Typical Cross Section of Excavation for Box Culvert

- On-site batching plant for both concrete and asphalt shall be set up.
- Where enough width for the road cannot be kept due to open excavation, the existing road shall be used as temporary detour road to keep the traffic.
- Judging from the width of open cut excavation for box culvert and huge quantity of its excavated soil, there is no space to stockpile the excavated material beside excavated area so that it will be necessary to carry the soil to the disposal yard (15 km away from the site). Therefore, the use of imported soil from the borrow pit is assumed for the backfilling.
- Location of disposal yard for both excess excavated soil and concrete debris is about 15 km away from the center of Kaolack.
- Location of borrow pit for imported soil is about 20 km away from the center of Kaolack.
- Judging from the boring data, it is assumed that the soil condition downstream of proposed pumping station is soft. Therefore, ground improvement works underneath the proposed Box Culvert N-PE (L=1,619.5 m) by using the soil replacement method (use of imported sand) is considered.

(3) Major Construction Machinery

Major construction machineries to be used for the Project are as follows:

Table 10.5 Major Construction Machineries

Works	Construction Machineries
Earth Works	(1) 0.7 to 1.2 m^3 Excavators, (2) 10 ton Dump Trucks, (3) 3 to16 ton Bulldozers, (4) 1 ton Compacting Rollers, (5) Tamping Rammer
Piling Works	(1) Piling Rigs, (2) 20 to 50 ton Truck (or Rough Terrain) Cranes
Concrete Works	(1) 20 to 25 ton Truck (or Rough Terrain) Cranes, (2) Concrete Pump Trucks, (3) 1 m^3 Concrete Hoppers (Base Machine 20 to 25 ton Crane)
Road Works	(1) Giant Breakers, (2) 12 to 16 ton Bulldozers, (3) 1 m^3 Wheel Loader, (4) Motor Graders, (5) 10 ton Macadam Rollers, (6) 20 ton Tire Rollers, (7) Asphalt Pavers, (8) Concrete Pavers
Mechanical Works	(1) 20 to 25 ton Truck (or Rough Terrain) Cranes, (2) 100 ton Crawler Cranes

10.4 Cost Estimate

10.4.1 Construction Cost and Engineering Cost

(1) Construction Cost

Construction Cost has been calculated based on the various cost information obtained from ONAS Dakar, ONAS Kaolack, local firms and Japanese firms. The following are the general conditions for the construction cost estimate:

- Construction cost is estimated at the 2013 price level.
- Annual price escalation rate of 3% is applied when using cost data of past project.
- The cost is classified into foreign and local currency portions based on the information on procurement obtained in Senegal.

(2) Engineering Cost

Engineering cost has been calculated based on the cost information obtained from the local firms in the following manner:

- Engineering cost is estimated at the 2013 price level.
- The following durations are assumed for the consulting services:
  - Detailed design, preconstruction phase services: 18 months
  - Construction supervision: 36 months
- Price escalation (FC 2.0%, LC 3.0%) is included.
- Physical contingency (10%) is included.

10.4.2 Project Cost

Estimate conditions of the project cost are as follows.

- Price Escalation: annual rate, FC: 2%, LC: 3% for construction cost
- Physical Contingency: 10% of construction cost
- Land Acquisition Cost: 15,000 FCFA/m^2 for pumping station and 12,500 FCFA for retention pond, inclusive of the price escalation and physical contingency that is the same percentage of construction cost and engineering cost
- Project Administration Cost: 2% of total amount for construction cost, engineering cost and land acquisition cost
- VAT: 18%
- Import Tax: 9%
- Interest Rate during Construction Project: annual rate 1.4% for construction cost, 0.01 % for engineering cost
- Front-End Fee: 0.2% of total amount for construction cost, engineering cost and interest during construction

Project Cost has been estimated based on the abovementioned elements. The total project cost amounts to approximately 37,640 million FCFA at the 2013 price level, of which 31,480 million FCFA is the local currency portion and 6,160 million FCFA is the foreign currency portion.

Table 10.6 Project Cost

Cost Items	Work Items	L/C (million FCFA)	F/C (million FCFA)	Total (million FCFA)
Construction Cost	Box Culvert	15,295	0	15,295
	Pumping Station	1,621	3,120	4,741
	Retention Pond	426	0	426
	Total	17,342	3,120	20,462
Price Escalation		2,937	298	3,235
Physical Contingency		2,028	342	2,370
Engineering Service		2,479	1,301	3,780
Land Acquisition		379	0	379
Government Administration		604	0	604
VAT		5,372	0	5,372
Import Tax		339	0	339
Interest during Construction		0	1,037	1,037
Front-end Fee		0	62	62
Total (million FCFA)		31,480	6,160	37,640

10.4.3 O&M Cost

Annual operation and maintenance cost of drainage facilities has been estimated as follows. Annual cost for operation and maintenance activities is 19.1 million FCFA.

Table 10.7 Annual O&M Cost

Facilities	Cost (mil FCFA)	Remarks
Box Culvert	2.9	Cleaning work: 4 km length in a year
Pumping Station	10.5	Including electric fee, personal expense and miscellaneous expense
Retention Pond	5.7	Cleaning work: one time in a year
TOTAL	19.1	

10.5 Economic and Financial Analysis

10.5.1 Economic Analysis on Priority Project

Projects cost is shown in **Tables 10.6**. This project has positive effects on the reduction of down time of economic activities due to inundation. Details of estimated inundation depth and duration are shown in **Table 5.10** of the Master Plan.

EIRR has been calculated at 3.1%. Although this figure is less than 12.0% of Social Discount Rate, a project seems reasonable, considering it is the infrastructure development. The reason why the EIRR of the Priority Project is lower than that of the Master Plan (6.7%) is that the former focuses on such areas where the population density is high in 2012, but assumed to stop increasing in later years and excludes such areas where the population density is low in 2012 but it is getting higher in later years. These areas are covered in the later project phase of the Master Plan.

10.5.2 Financial Analysis on Priority Project

Solution or mitigation of stormwater drainage is one of the tasks of the municipal or national government, which should be implemented as infrastructure development. Thus, all the cost should be managed by the governmental budget and it is inappropriate to collect charges from residents. This means that it is inappropriate to calculate the benefit for the purpose of the financial analysis.

(1) Review on Kaolack City Budget

The City budget is eventually controlled by the central government, or the Ministry of Economy and Finance (MEF). The budget is not all expended. Therefore, some amounts remain in a fiscal year and carried over to the next fiscal year. The reason why there is a remaining amount is that, usually the budget is allocated by the MEF to the account of the City Government after several months from the beginning of the fiscal year, and the remaining amount is used for the operating funds including salaries and some other necessary payments in the beginning of the next fiscal year.

The budget for the drainage canal cleaning is shown below.

Table 10.8 Budget for Drainage Canal Cleaning of Kaolack City

Year	Final Forecast	Realization	%
2005	19,122,950	19,080,000	99.78%
2006	14,659,280	14,640,000	99.87%
2007	10,000,000	0	0.00%
2008	19,999,976	19,998,564	99.99%
2009	10,000,000	9,917,699	99.18%
2010	10,000,000	5,031,048	50.31%
2011	15,000,000	4,548,192	30.32%
2012	23,000,000	7,085,000	30.80%

Source: Ministry of Economic and Finance and Kaolack City

The realization percentage has been low since 2010 because the tax revenue was low due to the global economic recession. Even in 2012, however, the realization rate was still low, less than one-third. Thus, support or subsidies from the national government is strongly required for the improvement of the drainage system.

10.6 Environmental Impact Assessment

10.6.1 Project Components

The project components essentially consist of:

- Development of drainage channel network (8.3 km in length)
- Development of a retention pool (17,437 m^2 in area)
- Construction of a pumping station

10.6.2 Activities Requiring Environmental and Social Considerations

Major activities requiring environmental and social considerations in the work are as follows:

- Supply of construction materials (sand, cement, iron/steal, etc.);
- Dredging, excavation and construction of canals, retention ponds and pumping stations;
- Transportation and disposal of solid wastes from the cleaning basin; and
- Closure of streets affected by the work.

10.6.3 Project Area Outlook and Scopes of Assessment

(1) Retention Pond in Touba Kaolack

The planned retention pond is located at Khakhout in Touba Kaolack District, the right side of the trunk road (R4) to Gossas. Since the land is depressed and unused, it becomes a natural pond in the rainy season. Touba Kaolack District is located in the northern periphery of Kaolack City, which is characterized with low population and lack of socio-economic and cultural facilities. In proposed site, resettlement would not be required since there is no residence, commercial facilities and informal settlers at present.

(2) Pumping Station in Medina Baye

The pumping station at Medina Fass 2 in Medina Baye District is located in the northern periphery of the City as well. There is a cultural heritage of mosque in the center of the district. The site is located at about 350 m east from the mosque and 300 m from the main road behind the mosque. The area is huge, bare and swampy (tannes) lands, and it is difficult to access the site by car in the rainy season. In the proposed site, resettlement will not be required since there are no residence, commercial facilities and informal settlers at present.

10.6.4 Considerations on Natural and Social Environment

Possible adverse impacts on both natural and social environment by the stormwater drainage management during construction and operation phases are summarized in **Table 10.9.**

Table 10.9 Possible Adverse Impacts by Stormwater Drainage Management

Phase	Impact	Intensity	Extended	Importance
Natural Environment				
Construction	Soil contamination by hydrocarbons and drained oil	Low	Local	Minor
	Soil erosion in the sampling sites			
	Recovery of landfill wastes during excavation and construction			
	Degradation of air quality			
	Degradation or destruction of public infrastructure	Strong		Major
Operation	Pre-winter flushing for channels	Low	Local	Minor
	Rainwater retention (in Touba and East Kaolack)	Strong		Major
Operation	Discharge pressure from the pump station (at the outlet of North Medina)	Low	Local	Minor
Social Environment				
Construction	Inhalation of dust	Low	Local	Minor
	Outbreak of infectious diseases (mainly by contaminated water)			

Phase	Impact	Intensity	Extended	Importance
	Traffic jam and accidents	Strong		Major
	Destruction of public infrastructure			
Operation	Injury or accidents (e.g., falling into open canals)			

10.6.5 Alternatives "With-Project"

(1) Drainage System

Three alternatives have been compared and the proposed drainage system in the Feasibility Study (drainage channel and one retention pond and one pumping station) was selected as the most favorable one, considering cost effectiveness, as shown in **Table 10.10**.

Table 10.10 Comparison of Stormwater Drainage System

Method	Drainage Channel (km)	Retention Pond (location)	Pumping (location)	Cost
Proposed System in Feasibility Study	8.3	1	1	Lowest
Alternative 1	8.3	0	1	2nd Highest
Alternative 2	8.3	0	2	Highest

(2) Drainage Canals

Open and close canal types have been evaluated and the closed channel (box culvert) was selected as the most suitable drainage channel, as shown in **Table 10.11**.

Table 10.11 Comparison of Stormwater Drainage System

Canal Type	Evaluation
Drainage channel proposed in Feasibility Study (Closed Canal)	Closed canals are less visible after construction, and there is no impact on the landscape. There is no risk to inhabitants by solid wastes dumped into the canal.
Alternative 1 (Open Canals)	Construction cost is not high and maintenance is easy. However, there are risks that open canals are used for dumping solid wastes, resulting in deterioration of sanitary condition in the Project site. Good IEC (Information-Education-Communication) of cleaning canals is required.

10.6.6 Environmental Management and Monitoring

Based on the possible adverse impacts by stormwater drainage management, the mitigation and minimizing measures as well as monitoring plans are proposed. The following table summarizes the mitigation and minimizing measures as well as the monitoring plans, focusing on the items of "Intensity is Strong and Importance is Major".

Table 10.12 Mitigation/Minimizing Measures and Monitoring Plan of Stormwater Management

Phase	Impact	Mitigation/Minimizing Measures	Monitoring Plan
Natural Environment			
Construction	Degradation or destruction of public infrastructure	• To minimize the excavated area on the public road especially in installing sewer pipes. • To utilize temporary material such as sheet piles as far as practicable.	Observation [Frequency: once every 3 months]
Operation	Rainwater retention (in Touba and East Kaolack)	• To remove sediments in the Box Culvert periodically. • To remove sludge and garbage in the existing open channels (at the discharge point of the pumping station).	Observation [Frequency: once every 3 months]
Social Environment			
Construction	Induction of traffic jam and accidents	• To remove and transport the excavated soil as fast as possible. • To establish diversion road, traffic signs, boards and warning lights at the construction site.	Observation of traffic volume and traffic jam [Frequency: once every 3 months]

Phase	Impact	Mitigation/Minimizing Measures	Monitoring Plan
	Destruction of public infrastructure	• To minimize the excavated area on the public road especially in installing sewer pipes. • To utilize temporary material such as sheet piles as far as practicable.	Observation [Frequency: once every 3 months]
Operation	Injury or accidents	• To maintain the fence constructed on the boundary of the retention pond	Observation [Frequency: when required]

10.6.7 Roles of Implementing Agency of Kaolack City Government

Management of stormwater is the responsibility of the Kaolack City Government, which is technically supported by ONAS Kaolack and the Fire Station in Kaolack.

The City Government allocates an annual environmental operation budget of 200 to 300 million FCFA for such works as cleaning of roads and sanitation, including materials and labor. The Regional Environmental Committee also supports the environmental improvement activities for the City Government.

10.7 Implementation Program

10.7.1 Basic Conditions

The implementation program has been formulated in considerations of feasible construction procedure to complete all the construction works by the target year 2020 and subsequent cost estimate. The implementation program for the proposed project is based on the following:

- Assumed commencement of project is November 2014.
- Project needs to be completed by the target year 2020.

On the assumption of loan project, the implementation program has been formulated with available data/information collected from WB, AfDB, IDB, etc. The preparatory stage prior to the project construction could be set as follows:

- Fund arrangement (E/N, L/A) and procurement of consultant: 12 months
- Detailed design, tender and the contract of the contractor: 18 months

10.7.2 Implementation Plan

To formulate the implementation plan for drainage facilities, the following points have been taken into account:

- Annual amount of rainfall in Kaolack, which mainly occurs between July and September, is about 560 mm. In the rainy season, monthly rainfall ranges from 120 mm to 220 mm. Compared to rainfall amount in Japan or Southeast Asian Countries, the amount is much less. Thus, there are no special conditions which strongly affect productivity. In conclusion, work stop coefficient of 1.35, which is applied for normal conditions, is used based on JICA's cost estimate manual. Besides, regional coefficient for labor and equipment, that is, 2.0 for simple labor works, 3.5 for skilled labor works, and 70% for work by machinery in a region of Africa, is applied.
- In principle, the works for drainage box culvert shall be carried out from downstream to upstream.
- The works for box culvert, pumping station and retention pond shall be commenced concurrently, so that it will be possible to complete the overall works within 36 months.
- Judging from work volume and sequence, construction works of drainage box culverts of about 8.3 km is apparently on the critical path. The following are the working sequence for the construction of box culvert: (i) demolition of existing asphalt road; (ii) excavation; (iii) laying of lean concrete; (iv) rebar, formwork for base; (v) casting base concrete; (vi) rebar, formwork, scaffolding for wall; (vii) casting wall concrete, (viii) rebar, formwork, support for top slab; (ix) casting top slab concrete; (x) backfilling by using imported soil; (xi) granular sub base course; (xii) aggregate base course; and (xiii) wearing course.

10.7.3 Consultancy Services

(1) Scope of Services

Consultancy services have been divided into three phases as below.

- Detailed Design Phase
- Pre-Construction Phase
- Construction Phase

(2) Reporting

The Consultant shall prepare and submit the various reports and documents to the Kaolack City Government, in accordance with the project stage and progress. These are: (i) the inception report; (ii) the bimonthly progress reports; (iii) the definitive plan report; (iv) the detailed design report; (v) the pre-qualification evaluation report; (vi) the tender evaluation report; (vii) the operation and maintenance manual; (viii) the environmental monitoring and management report; and (ix) the service completion report.

(3) Work Schedule

Each component of the consulting engineering services shall be completed within the time specified below.

(i)	Detailed Design	:	12 months
(ii)	Pre-Construction	:	6 months
(iii)	Construction	:	36 months
(iv)	Transfer of Knowledge	:	1 month

A total of 54 months of consulting engineering services will be required for the Project.

(4) Experts Required

In total, 31 experts and 322.8 man-months are required for the consulting engineering services, among which 15 experts and 125.8 man-months are for foreign consultants and 16 experts and 197.0 man-months are for local ones.

10.7.4 Implementation Schedule

The implementation for drainage facilities has been schedule is formulated, as shown in **Fig. 10.8**.

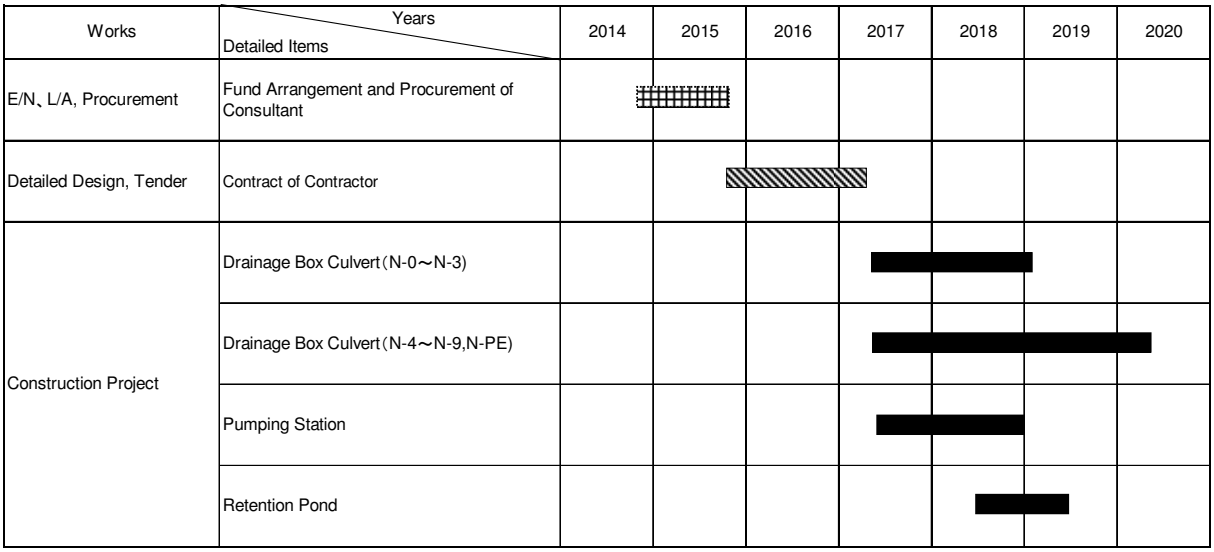


Fig. 10.8 Implementation Schedule for Drainage Facilities

10.7.5 Disbursement Schedule

Based on the implementation schedule, the cost disbursement schedule, of which the total cost is 37,640 million FCFA consisting of 6,160 million FCFA of foreign currency portion and 31,480 million FCFA of local one, is proposed for the project period of 2014 to 2119.

10.8 Operation and Effect Indicators

In order to evaluate the impact of implementing the priority projects in the field of stormwater drainage management, the indicators with the target year 2022 (two years after the completion of the projects), have been set as shown in the following table.

Table 10.13 Operation and Effect Indicators

Operation and Effect Indicators		Unit	Year		Remarks
			2012 (Present)	2022 (Target Year)	
(1) Operation indicators					
	Pump Capacity on North Pumping Station	m^3/s	-	11.1	
	Gross Storage Capacity of Retention Pond	m^3	-	39,000	
(2)-1 Effect indicators (For Project Area)					
	Total inundated area at the maximum rainfall	ha	20	2[8]	
	Total length of drainage main	km	0	8.3	
(2)-2 Effect indicators (For Entire City Center Area)					
	Total inundated area at the maximum rainfall	ha	35	74	
	Total length of drainage main	km	20.0	28.3	

10.9 Project Evaluation

Based on the above discussion, the priority projects of stormwater management have been evaluated as follows:

- Inundation area in north area of Kaolack is reduced to one-tenth by installing the proposed drainage system.
- Proposed stormwater conveyance system, comprised of box culverts is better than the open channel to prevent people from dumping garbage into the drainage channels. As a result, sanitary condition in the project area will improve.
- Proposed box culvert, pumping station and retention pond are technically sound in operation and maintenance because no complicated technology is not applied.
- No resettlement is required since all proposed facilities are constructed and/or installed under public roads or in empty areas.
- As with the construction works of sewage facilities, negative impacts such as traffic interruption especially in installing box culvert, as well as noise, dust and vibration, would be unavoidable during the construction stage. However, the impacts could be minimized by introducing countermeasures such as diversion road, sprinkling of water and selecting low-noise and/or low-vibration type of construction equipment as far as practicable.
- To implement the priority projects, financial assistance by the Government of Senegal is strongly required.

[8] 10-years design rainfall is adopted for drainage planning. However, in the case of rainfall, it is impossible to avoid the possibility of occurrence of inundation due to the uncertainties such as rainfall in excess of design rainfall, differences in rainfall pattern and change of land use. Assumed inundation area in 2022 is estimated at 10 % of the present inundation area

CHAPTER 11. CONCLUSION AND RECOMMENDATION

11.1 Conclusion

In Kaolack City, sewerage system, consisting of sewer network, pumping station and sewage treatment plant, has been in operation since 1980s. The sewerage facilities, in particular sewer pipes, are however gradually deteriorated due to aging and the sewage treatment plant is overloaded by poor maintenance and lack of augmenting treatment capacity. In addition, house connection rate in the sewered area still remains low due to high connection fee.

In order to improve sewerage and sanitation condition in Kaolack City, three alternatives are selected and compared in the Master Plan with evaluation criteria of: sewered population; ease of operation and maintenance/reliability; operation and maintenance cost; environmental impact. Kaolack City is, as a result, divided into two areas: (i) sewerage area and (ii) on-site sanitation area, with 66% and 34% in population for the target year of 2030, in consideration of technical, institutional and financial level of ONAS Kaolack, which is main implementation body.

Based on the planning setup, the Master Plan proposes sewage treatment facilities with total capacity of 21,000 m^3/day applying aerated lagoon method to treat wastewater generation from sewerage area and septage treatment facilities for benefit of on-site sanitation facilities users. Feasibility Study is then conducted targeting trunk sewer, pumping station and sewage treatment plant including rehabilitation of existing lagoon and new construction of aerated lagoon and septage treatment facilities in the expansion area for the target year of 2020.

Kaolack City is vulnerable to floods and stormwater because of its low-lying topography, hydrological conditions and no proper drainage systems. There are some habitual flooding areas. The flood and inundation affected residents, causing traffic and disturbing commercial activities in Kaolack City. Habitual flooding occurs in the depressed topography so that its lowest elevation without stormwater drainage system causes further difficulty to drain out flooded stormwater. The Kaolack City Hall had already installed a drainage system consisting of drainage pipes, open canals and manholes in the city center only. However, the drainage open canals require improvement because they have mostly lost their original drainage capacities by the heavy deposits of solid waste/silt illegally dumped into drainage open canals.

The Master Plan proposes, as the most effective drainage improvement measures, the construction of new drainage facilities for the severe inundation areas and the recovery and improvement of the original drainage capacities by dredging and re-construction of drainage open canals.

The proposed Master Plan and Priority Projects for the Kaolack City are effective in terms of technical, economic, social and environmental aspects for drainage improvement in the Kaolack City. By the implementation of the proposed drainage improvement plan, the severe inundation area will significantly be reduced and improved. It is recommended for the Government of the Senegal to take immediate actions for the implementation of the proposed measures, because the Kaolack City is very important economically and socially in the country.

As for SWM in Kaolack City, some recommendations on issues for further implementation of SWM are given based on the review of the APROSEN Master Plan and the IDB project.

11.2 Recommendations

Various issues have been encountered in the course of the Master Plan formulation and Feasibility Study. To realize the sound urban environment drawn by the Master Plan and Feasibility Study for the selected priority projects, these issues shall be resolved in an integrated manner involving wide stakeholders. Thus the following recommendations are given to accelerate project realization.

Expectation of Synergistic Effects

- The Master Plan is the first challenge to improve the overall urban environmental issues in Senegal by integrating the environmental elements, such as wastewater, stormwater and solid wastes. There are three planning components proposed in the Master Plan in accordance with the urban environmental elements, namely; sewer/sanitation system improvement; stormwater drainage management; and solid waste management. Since these three plans are closely related and affect each other, they shall be implemented simultaneously to produce the synergistic effects and realize the sound urban environment expected for Kaolack City.
- The Kaolack City Government had informed that the solid waste management project funded by the IDB will be commenced soon (as of November 2013). Even though the project focuses on short-term improvement of solid waste issues encountered in Kaolack City, the present situation of scattered garbage and many locations of illegal dumping sites in the city will be improved through the project's implementation. Furthermore, garbage accumulated in the drainage canal system will be periodically excavated and transported to the final disposal site using the procured heavy equipment and hauling trucks, contributing to the restoration and recovery of the existing drainage system.
- Following such improvement of urban environment, the proposed sewerage system including sewer treatment plant, septage treatment plant and sewerage network will be constructed sequentially. The wastewater as well as human waste disposal issues affecting, negatively, the residents' living conditions could be solved with the improved and well-functioning sewerage system. If the proposed stormwater drainage system is finally constructed, the urban environment would also completely improve.
- The above-mentioned improvement mechanism utilizing structural measures can attain enhancement of the living conditions as well as the urban environment with the synergistic effects. As a result, the present downward spiral to deterioration of the urban environment could change to upward spiral to sound urban environment of Kaolack City.

Sewerage and Sanitation Improvement

- Since wastewater inflow to the STP is already overloaded to the treatment capacity of it, it is most urgent to rehabilitate the malfunctioning lagoon system, to extend the plant adding an upgraded treatment method (aerated lagoon) and to install the septage treatment plant additionally. After completion of this treatment system, sewer network improvement and expansion could be much easier.
- Branch sewer installation is not included in the priority projects. However, the installation of branch sewer is indispensable to optimize the major facilities such as trunk sewer, pumping stations and sewage treatment plant. ONAS is responsible for the installation of branch sewers, it should look for the financial source for the installation. The financial support may come from donors such as the WB and/or the Government of Senegal through ADM, which involved in the funding of related sewerage projects in Kaolack. The schedule of branch sewer installation will be very challenging to ONAS, based on the construction volume for each year (about 100 ha) and the latest historical achievement of branch sewer installation. For example, about 90 ha was achieved with funds from the WB and 92 ha in the PRECOL area by ADM from 2003 up to the present. Under the circumstances, ONAS would require an extraordinary effort and involvement to secure funds from the available donors and/or the Government of Senegal in order to install the branch sewer network, more than ever.
- Considering low connection ratio of sewer network in Kaolack City, house connection of sewer network should be accelerated by financial assistance of Government of Senegal to optimize the sewerage system.
- The septage desludged from the septic tanks of households without connection to the sewer network is illegally disposed to the dry riverbed even in the dry season due to poor accessibility to the disposal pond. The environment in the areas surrounding the disposal site of Sing Sing District is getting worse every year. Furthermore, the frequency of desludging the septic tanks might become higher compared with the common septic tank in the other area due to the very poor

infiltration capacity of soils in Kaolack City. Therefore, the installation of septage treatment plant is also indispensable in Kaolack City

- Administrative guidance by ONAS as well as Kaolack City to the companies providing desludging service, is strongly recommended to make them utilize septage treatment facilities and thus to reduce their desludging service charge to each household.
- Along with the financial assistance of house connection and administrative guidance, public awareness of sewerage system and sanitation facilities is essential. It is recommendable to disseminate information to the inhabitants about advantage of sewer connection or septic tank installation, advantage of desludging and cost reduction of desludging by the installation of septage treatment facilities in sewage treatment plant.
- At present, ONAS Kaolack records operation and maintenance activities of sewerage facilities such as sewer pipe, pumping station and sewage treatment plant in the Monthly Report. On the other hand, ONAS has no well-organized ledger including information on the exact location of sewer pipe, manhole and house inlet, invert level of pipes and covering and so on. In parallel with the implementation of the project, well-organized ledger shall be formulated using the base map and design drawings prepared in the project.

Stormwater Drainage Management

- The construction works of the new drainage facilities such as drainage box culverts, pumping station and the retention pond, shall be conducted according to the proposed schedule in order to prevent/mitigate the damages caused by floods and inundation in the Kaolack City. The Priority Projects identified in the Master Plan shall require immediate actions, and be conducted duly according to the schedule.
- The existing stormwater drainage facilities are composed of open drains, covered drains and manholes. Most of the drains could not meet their discharge capacities because of heavy deposits caused by illegal dumping of solid waste. Therefore, it is strongly recommended to conduct the proper maintenance works such as cleaning and dredging for the existing drainage.
- At present, the annual maintenance work plan of the STC includes only drainage length to be cleaned. The STC doesn't have existing drainage map and specific data of drainage lines. In order to conduct the proper operation and maintenance work, the cleaning plan will be needed and base map and database will be necessary to prepare the cleaning plan. Therefore, it is recommended to prepare the base map and database for drainage facilities.
- Most of the existing open canals are simply excavated earth canals in unsustainable condition. Therefore, they get easily damaged and collapse. These open canals have large flow capacities so that they are considered as key facilities of the stormwater drainage system and should be sustained by proper rehabilitation, because they have been working effectively in improving the stormwater drainage.
- Public participation should be promoted by enhancement of public awareness for stormwater drainage management in order to improve and maintain the drainage facilities including various community-involved activities.
- The implementing agency shall be decided and organize a coordination committee for the implementation of the Master Plan and Priority Projects, because the implementation of the Master Plan and Priority Projects shall require various concerned central and local government agencies and stakeholders.
- As designed on the stormwater drainage network in the Master Plan, big investment is necessary to install complete drainage system due to flat topography. Meanwhile portable pumps are utilized for draining inundated stormwater in the habitual flooding areas in the rainy season. Two pumps, which were procured through Japan's Program Grant Aid for Environment and Climate Change, are also well working for this purpose in the 2013 rainy season. Such solutions could bridge between inconvenience situations of habitual flooding and necessary big investment as urgent immediate measures.

Solid Waste Management

- IDB will support the structural solid waste management system in Kaolack City. In addition, United Nations Industrial Development Organization (UNIDO) utilizing Global Environmental Facility (GEF) would assist the solid waste management in Kaolack City including domestic, medical and industrial wastes, according to recent information. The garbage issues are central in the vicious cycle worsening urban environment, due to clogged canals with thrown garbage, producing offensive odor and deteriorated scenery. Thus the solid waste management could be an engine for synergy effects of enhancing the urban environment, if its management system is well working through proper collaboration of both projects.
- The ROC system is working as the pre-collection process of house garbage. Unless the road conditions particularly the alley conditions are upgraded with asphalt pavement in parallel with the activation of the regional economy, the solid waste management system has to rely on the ROC system for the pre-collection of wastes. Until then, the workable integration of the ROC owners, reasonable coverage of ROC service, and capacity development of ROC drivers are necessary.
- Transfer stations are to be constructed to upgrade the existing illegal dumping sites. Firstly, land ownership shall be solved for land utilization as transfer stations. Afterwards, a well-functioning management system for the stations shall be established in a sustainable manner.
- The hauling system for solid waste from the transfer stations to the final disposal site is also needed to be managed in a sustainable manner with enough budgets.
- After construction of the final disposal site, a site as a sanitary landfill using heavy equipment is also needed to be managed in a sustainable manner with enough budgets.
- Heavy equipment used for solid waste management will normally deteriorate due to the various kinds of waste. Therefore, the workshops shall be upgraded or new ones established for the repair of damaged heavy equipment and hauling trucks. In addition, the workers shall be trained to improve their skill in managing the workshops, properly.

Necessity of People's Awareness of the Environment and their Participation

- People's habit of throwing garbage indiscriminately into the canals or the roadsides is one of the obstacles to the enhancement of urban environment. Although IEC (Information, Education and Communication) campaigns are done by the NGOs, community associations and the City Government, clear effects do not appear in the environment. Such kinds of efforts should be made incessantly in order to eradicate the undesirable habit permanently.
- Participatory activities in a community are also effective to enhance the environment. Residents can help clean the roadsides and open spaces and fill the small-scale depressed lands with soil brought from nearby higher places to solve the small-scale inundation in the rainy season. In parallel with these activities, educational activities to change their consciousness are crucial to develop people's interest in improving the environment through their own efforts.

Strengthening of the Main Actors in Urban Environmental Improvement

- The main actors in the urban environmental improvement are Kaolack City and ONAS Kaolack. Both organizations have similar weaknesses in implementation capability; that is, budgetary constraint and lack of human resources. Against budgetary constraint, there might be no rapidly effective solution except for the central government to increase its subsidies to the local governments and the government-affiliated organizations.
- Structural reform needs a long period, such as taxation and charging system for the collection of sewerage charges. Regarding lack of human resources, some capacity development projects and activities shall be requested from the donors to enhance the actor's poor capacity, by increasing the number of skilled technicians and engineers in the urban environmental management field, in particular.

Immediate tasks of implementation/responsible agencies

- Implementation/responsible agencies for the urban environmental improvement as targeting in the Project are ONAS and Kaolack City. In order to realize the sound urban environment which the

Master Plan and the Feasibility Study delineated, immediate tasks of the both agencies are summarized below.

Agencies	Fields	Immediate Tasks
ONAS	Sewerage Improvement (Sewerage Treatment Plant and Sewer Network)	Year 2014 to 2015 To implement the projects in the both fields, ONAS will find the suitable donors and will prepare the fund arrangement to them.
	Stormwater Management	
Kaolack City	Solid Waste Management	After the year 2014 Through the IDB project for about four years, Kaolack City will establish the solid waste management system, and will make an effort of capacity development and necessary budgetary arrangement to keep the sustainability for the system after completion of the project.