

CHAPTER 10
COST ESTIMATES



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10.1 Construction Cost

10.1.1 Basic Conditions

Construction cost for the project are estimated on the basis of the preliminary design of the Feasibility Study. Unit prices and lump sum prices are established considering of local conditions, subcontractors, hiring equipment, available construction equipment and materials and suitability of the construction method.

Assumptions and conditions applied for the cost estimate as follows:

- Price level : as of December 1996.
- Exchange rate : US\$ 1.00 = Z\$ 10.5 = J.Yen 115.0
- Foreign and local currency : expressed in Z\$.

The construction cost is divided into direct construction cost and indirect construction cost. The indirect construction costs are the ones required for land acquisition and compensation, administration expenses, engineering expenses and contingencies.

10.1.2 Direct Construction Cost

(1) Preliminary and Generals

The amount of preliminary and general (preparatory works) is estimated at 15 percent of the sum of direct construction cost.

(2) Civil Works

The cost of civil works are estimated by adopting unit rates including labor cost, material cost, equipment cost and contractor's overhead expenses and profits.

The labor cost is obtained from several general contractors and subcontractors. The daily labor cost is in 8 hours per shift per day. The labor cost is shown in Table 10.1.1, Section 10.1, Chapter 2, Supporting Report.

Most of construction materials are supplied from local market. The material cost is a price at work site delivery and sales tax of 15 percent is excluded. The material cost is shown in Table 10.1.2, Section 10.1, Chapter 2, Supporting Report.

The equipment cost is estimated mainly based on the hiring cost including fuel, operator, driver and maintenance cost. The hiring cost is obtained from several general contractors and subcontractors. However, the equipment cost except a hiring cost is estimated at normal depreciation basis. The foreign portion is to be depreciation and fuel, and the local portion is a cost of operator and driver. The equipment cost is shown in Table 10.1.3, Section 10.1, Chapter 2, Supporting Report.

The contractor's overhead expenses and profits are contributed to the unit rates of each item. These expenses are estimated at 30 percent of the above direct cost.

(3) Mechanical Works

The cost of pump equipment including pump, motor, pipe, valve and electrical works and so on is estimated at the budgetary quotation and information of Zimbabwe mechanical subcontractors and suppliers. The cost of sewage treatment equipment such as surface aerator, gear box, motor, sludge collector with mechanical bridge, etc. is estimated at the information of special contractors and engineering companies. The mechanical works will be done by the subcontractors employed by main contractor and the above cost includes also a contractor's charges.

(4) Constitution of Construction Cost

The direct construction cost comprises the following works ;

A. Sewer Reticulation

1. Sewer
2. Pump station at St.Marry's (New)
3. Rehabilitation of pump equipment

B. Expansion of Sewage Treatment Work

C. Rehabilitation Work

1. Rehabilitation of existing sewage treatment work
2. Irrigation facilities

3. Pre-treatment facilities for Tilcor Industrial area
4. Sludge disposal pit

10.1.3 Indirect Cost

(1) Land Acquisition and Compensation

All the required land for the project site is owned by the Municipality of Chitungwiza. The cost of land acquisition and compensation is not included in the construction cost.

(2) Administration Expenses

During the construction period, the Municipality will provide two engineers for the implementation of the project. The administration expenses of Z\$ 4,000,000 is included in the construction cost and this amount is obtained from the Municipality.

(3) Engineering Services

The cost of engineering services including detailed design, tender document, tendering and supervision is estimated at 9 percent of the sum of direct construction cost.

(4) Contingencies

The rate of physical contingency is to be 10 percent of the amount required for direct construction cost, administration expenses and engineering services.

The cost of price escalation is estimated over three years from 1997 to 1999 applying the inflation rate of 3 percent for foreign currency portion. The rate of local currency portion is to be 25 percent per annum from the Central Statistics Office.

10.1.4 Construction Cost

The summary of construction cost is listed in Table 10.1.1. The construction cost is shown in Table 10.1.4 to Table 10.1.6, Section 10.1, Chapter 2, Supporting Report. The work quantity, work item and unit rates and so on are shown in the detailed construction

Table 10.1.1 Summary of Construction Cost for Rehabilitation/Expansion Works of the Zengeza Sewage Works

Item	Description	Foreign Currency (Z\$)	Local Currency (Z\$)	Total (Z\$)	Total (US\$)
I.	Direct Construction Cost				
A.	Sewer Reticulation				
1	Sewer	5,811,313	9,773,323	15,584,636	1,484,251
2	Pump Station at St Mary's	3,177,520	1,342,000	4,519,520	430,430
3	Rehabilitation of Pump Equipment	4,354,141	2,372,429	6,726,570	640,626
	Total A	13,342,974	13,487,752	26,830,726	2,555,307
B.	Expansion of Sewage Treatment Works	82,702,390	55,934,844	138,637,234	13,203,546
C.	Rehabilitation Works				
1	Existing Sewage Treatment Works	2,584,330	5,894,303	8,478,633	807,489
2	Irrigation Facilities	770,000	167,814	937,814	89,316
3	Pre-treatment Facilities for Tilcor Industrial Area	373,668	305,561	679,229	64,688
4	Sludge Disposal Pit	5,267,575	2,350,511	7,618,086	725,532
	Total C	8,995,573	8,718,189	17,713,762	1,687,025
	Total A+B+C	105,040,937	78,140,785	183,181,722	17,445,878
II.	Land Acquisition and Compensation (Nil)	0	0	0	0
III.	Administration Expenses	0	4,000,000	4,000,000	380,952
IV.	Engineering Services (9%)	14,013,402	2,472,953	16,486,355	1,570,129
	Total I+II+III+IV	119,054,339	84,613,738	203,668,077	19,396,960
V.	Physical Contingency (10%)	11,905,434	8,461,374	20,366,808	1,939,696
	Total I+II+III+IV+V	130,959,773	93,075,112	224,034,885	21,336,656
VI.	Price Escalation	7,688,000	51,588,000	59,276,000	5,645,333
	Grand Total	138,647,773	144,663,112	283,310,885	26,981,989

Remarks : Escalation rates are used as follows.
 FC 3% per annum in US\$. (same rate is applied in above table.)
 LC 25% per annum in Z\$.

cost listed in Table 10.1.7 to Table 10.1.9, Section 10.1, Chapter 2, Supporting Report.

The disbursement schedule is also attached in Table 10.1.2. The detailed disbursement schedule is shown in Table 10.1.10, Section 10.1, Chapter 2, Supporting Report.

10.2 Operation and Maintenance Cost

10.2.1 Sewer Reticulation

The O & M cost of sewer reticulation is calculated for sewer and pump station, respectively. The Ghuza pump station is excluded from the calculation of O & M cost because it is located outside of administrative area of municipality.

(1) Sewer

The O & M cost of sewer is calculated for the site investigation, pipe cleaning and rehabilitation, respectively. The labor cost by classification is adopted referring to them in the Master Plan as shown in Table 10.2.1.

Table 10.2.1 Labor Cost by Classification

Classification	Labor Cost (Z\$/year)
Attendant	36,000
Foreman	24,000
Worker	12,000

1) Site investigation cost

Since the site investigation is performed by the staffs without any machines/ equipment, the O & M cost is calculated only for the labor cost as follows.

Attendant : 1 person x 36,000 = Z\$36,000/year

Worker : 2 persons x 12,000 = Z\$24,000/year

Total Z\$60,000/year

2) Pipe cleaning cost

The O & M cost for pipe cleaning are consisted of labor cost and transportation cost (mainly fuel charge) for removal of soils, silts and others. The O & M cost is presented as follows. The transportation cost is calculated assuming that it is

Table 10.1.2 Detailed Disbursement Schedule

Unit: ZS

Description	Total		1997		1998		1999	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
	Total	Total	Total	Total	Total	Total	Total	Total
1 Sewer Reticulation	13,342,974	13,487,752	0	0	13,342,974	13,487,752	0	0
2 Expansion of Sewage Treatment Works	82,702,390	55,934,844	0	0	35,926,142	26,557,929	46,776,248	29,376,915
3 Rehabilitation Works	8,995,573	8,718,189	0	0	4,299,621	4,427,969	4,695,952	4,290,220
Subtotal	105,040,937	78,140,785	0	0	53,568,737	44,473,650	51,472,200	33,667,135
4 Land Acquisition	0	0	0	0	0	0	0	0
5 Administration Expenses	0	4,000,000	0	0	0	2,000,000	0	2,000,000
6 Engineering Services	14,013,402	2,472,953	5,605,361	989,181	4,204,021	741,886	4,204,020	741,886
Subtotal (1 - 6)	119,054,339	84,613,738	5,605,361	989,181	57,772,758	47,215,536	55,676,220	36,409,021
7 Physical Contingency	11,905,434	8,461,374	560,536	98,918	5,777,276	4,721,554	5,567,622	3,640,902
Total (1 - 7)	130,959,773	93,075,112	6,165,897	1,088,099	63,550,034	51,937,090	61,243,842	40,049,923
8 Price Escalation	7,688,000	51,588,000	92,000	136,000	2,892,000	21,102,000	4,704,000	30,350,000
Grand Total	138,647,773	144,663,112	6,257,897	1,224,099	66,442,034	73,039,090	65,947,842	70,399,923

Note: F.C. = Foreign Currency
L.C. = Local Currency

equivalent to 10 % of labor cost.

Attendant	: 1 person x 4 teams x 36,000 =	Z\$144,000/year
Foreman	: 1 person x 4 teams x 24,000 =	Z\$96,000/year
Worker	: 4 person x 4 teams x 12,000 =	Z\$192,000/year
<u>Transportation cost (10 % of labor cost) =</u>		<u>Z\$43,200/year</u>
Total		Z\$475,200/year

3) Rehabilitation cost

The rehabilitation of sewer is classified into two types, replacement of sewer and repair of a part of sewer structures, and their percentage against the total damaged lengths are assumed to be 50 % and 50 %, respectively.

The construction cost function of AC pipe in Master Plan is adopted for the unit cost of replacement. The replacement cost of trunk sewer is calculated based on the unit construction cost of 450 mm diameter pipe (intermediate diameter from 250 to 675 mm) because no data is available on diameter of the existing trunk sewers. While, the repair cost is calculated assuming that 50 % of replacement cost is equivalent. The total and per year cost of rehabilitation are shown in Table 10.2.2.

a Unit replacement cost

Trunk sewer (AC pipe and 450 mm^{dia}) : 105.05US\$ x 10.5Z\$/US\$ = Z\$1,100/m

Lateral sewer (AC pipe and 150 mm^{dia}) : 20.98US\$ x 10.5Z\$/US\$ = Z\$250/m

b Unit repair cost

Trunk sewer (AC pipe and 450 mm^{dia}) : Z\$1,100/m x 0.50 = Z\$550/m

Lateral sewer (AC pipe and 150 mm^{dia}) : Z\$250/m x 0.50 = Z\$125/m

c Required length of replacement and repair

Required length of replacement : Trunk sewer ; 10,230 x 0.50 = 5,115 m
: Lateral sewer ; 90,720 x 0.50 = 45,360 m

Required length of repair : Trunk sewer ; 10,230 x 0.50 = 5,115 m
: Lateral sewer ; 90,720 x 0.50 = 45,360 m

Table 10.2.2 Rehabilitation Cost for Damaged Sewers

Rehabilitation	Sewer	Unit Cost (Z\$/m)	Length (m)	Total Cost (x 10 ³ Z\$)	Cost per Year (x 10 ³ Z\$)
Replacement	Trunk	1,100	5,115	5,627	563
	Lateral	250	45,360	11,340	1,134
Repair	Trunk	550	5,115	2,813	281
	Lateral	125	45,360	5,670	567
Sub-total		-	100,950	25,451	2,545
Labor		Unit Cost (Z\$/year)	Number (person)	Total Cost (x 10 ³ Z\$)	Cost per Year (x 10 ³ Z\$)
Attendant (Supervision)		36,000	2	72	72
Total		-	-	-	2,617

(2) Pump station

The rehabilitation/repair cost for the existing pump station were discussed in the Sub-section 10.1.1. The O & M cost of 4 pump stations are calculated as follows.

1) St.Mary's No.1 pump station

Motor power : 25.0 kw
 Pump unit number : 3 units (1 standby)
 Operation time : 8 hr
 Electric consumption : $25.0 \times 2 \times 8 = 400$ kwh
 Electricity unit cost : 0.45 Z\$/kwh
 Cost per year : $400 \times 0.45 \times 365 = 65,700$ Z\$/year
 Maintenance & repair : $65,700 \times 0.2 = 13,140$ Z\$/year
Labor Cost (Worker) : $12,000 \times 4 = 48,000$ Z\$/year
 Total : 126,840 Z\$/year

2) St.Mary's No.2 pump station

Motor power : 5.0 kw
 Pump unit number : 2 units (1 standby)
 Operation time : 8 hr
 Electric consumption : $5.0 \times 1 \times 8 = 40$ kwh
 Electricity unit cost : 0.45 Z\$/kwh

Cost per year	: $40 \times 0.45 \times 365 = 6,570$ Z\$/year
Maintenance & repair	: $6,570 \times 0.2 = 1,314$ Z\$/year
<u>Labor Cost (Worker)</u>	: $12,000 \times 4 = 48,000$ Z\$/year
Total	: 55,884 Z\$/year

3) Tilcor pump station

Motor power	: 18.0 kw
Pump unit number	: 3 units (1 standby)
Operation time	: 8 hr
Electric consumption	: $18.0 \times 2 \times 8 = 288$ kwh
Electricity unit cost	: 0.45 Z\$/kwh
Cost per year	: $288 \times 0.45 \times 365 = 47,304$ Z\$/year
Maintenance & repair	: $47,304 \times 0.2 = 9,461$ Z\$/year
<u>Labor Cost (Worker)</u>	: $12,000 \times 4 = 48,000$ Z\$/year
Total	: 104,765 Z\$/year

4) St.Mary's New pump station

Motor power	: 50.0 kw
Pump unit number	: 3 units (1 standby)
Operation time	: 8 hr
Electric consumption	: $50.0 \times 2 \times 8 = 800$ kwh
Electricity unit cost	: 0.45 Z\$/kwh
Cost per year	: $800 \times 0.45 \times 365 = 131,400$ Z\$/year
Maintenance & repair	: $131,400 \times 0.2 = 26,280$ Z\$/year
<u>Labor Cost (Worker)</u>	: $12,000 \times 4 = 48,000$ Z\$/year
Total	: 205,680 Z\$/year

(3) Total O & M cost

The total O & M cost for sewer reticulation is shown in Table 10.2.3.

Table 10.2.3 Total O & M Cost for Sewer Reticulation

Sewer Reticulation	O & M Items/Pump Station	O & M Cost per Year (Z\$/Year)
Sewer	Site investigation	60,000
	Pipe cleaning	475,000
	Pipe rehabilitation	2,617,000
	Sub-total	3,152,000
Pump Station	St.Mary's No.1	127,000
	St.Mary's No.2	56,000
	Tilcor	105,000
	New St.Mary's	206,000
	Sub-total	494,000
Total		3,646,000 *(1,029,000)

Note: * = Exclude the pipe rehabilitation cost

10.2.2 Sewage Treatment Works

The summary of annual O & M cost for sewage treatment works by BNR line and TF line are shown as Table 10.2.4 and the breakdown of their cost are shown in Table 10.2.1 to 10.2.5, Section 10.2, Chapter 2, Supporting Report.

Table 10.2.4 Annual O & M Cost for Zengeza STW

Sewage Treatment Line	O & M Cost (Z\$/year)
BNR Line	6,540,000
TF Line	2,529,000
Total	9,069,000

CHAPTER 11

**INSTITUTIONAL,
LEGISLATIVE AND FINANCIAL STUDY**



CHAPTER 11 INSTITUTIONAL, LEGISLATIVE AND FINANCIAL STUDY

11.1 Institutional Development

11.1.1 Organization for Project Implementation

(1) Supervising and Coordinating Agency at Central Government Level

At central government level, the Department of Development Planning and Coordination (DDPC) of the Ministry of Local Government, Rural and Urban Development (MLGRUD) will assume the supervising and coordinating functions for smooth implementation of the priority project. Figure 11.1.1 shows the proposed organizational framework for implementation of the priority project : rehabilitation and expansion of the Zengeza Sewage Works (Municipal Sewerage System).

As this priority project is entirely a "municipal" undertaking, there would be no need to establish an ad hoc project coordination unit under the DDPC. Coordination and supervision at central government level will be carried out directly by the Director of DDPC and his staffs. Instead, the institutional mechanism for project coordination should be duly consolidated at municipal level.

In the Master Plan Study, it is recommended to establish the Upper Manyame River Authority (UMRDA) consisting of the Water Pollution Control Board (WPCB) and its subordinate inter-ministerial supporting organizations such as Water Pollution Control Coordinating Committee (WPCCC), Water Pollution Control Information Center (WPCIC), Water Pollution Monitoring Unit (WPMU) and Project Monitoring Unit (PMU). The establishment of such an overall framework for water pollution control is a time-consuming enterprise and to be realized with a long-range plan.

Since an integrated regional and inter-ministerial approach is prerequisite to water pollution control, it is proposed, as a first step, to set up a "Water Pollution Control Coordinating Committee" by materializing the existing Steering Committee formed for the Study on Water Pollution Control in the Upper Manyame River Basin. This Committee will be composed of the Directors or Deputy Directors of the central government agencies and local authorities concerned: MLGRUD, MLWR, MET,

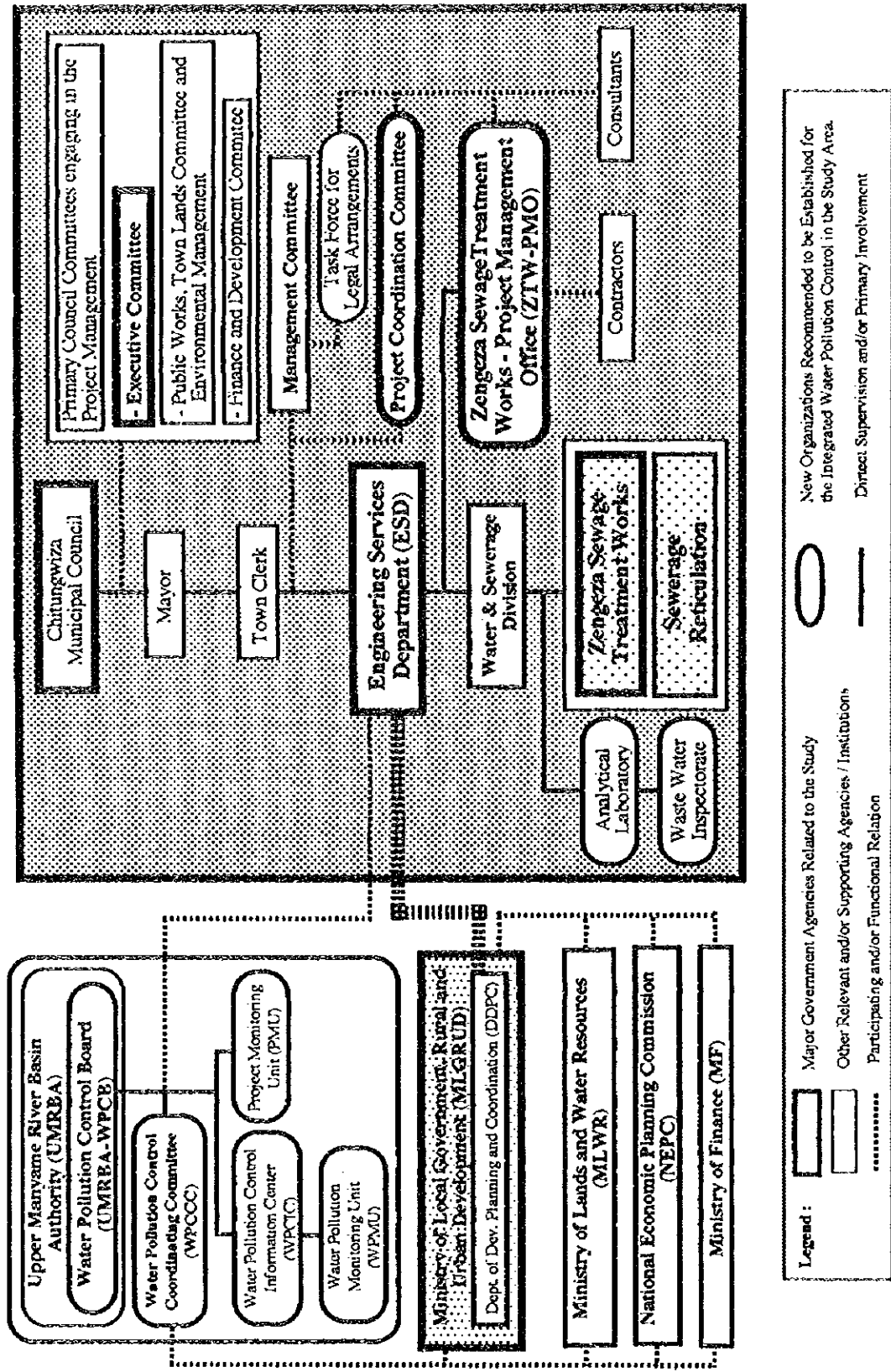


Figure 11.1.1 Proposed Organizational Framework for Implementation of the Priority Project : Rehabilitation and Expansion of the Municipal Sewerage System

MHCW, MA, MF, NEPC, City of Harare, Chitungwiza Municipality and others. The Committee will be chaired by the Director of the Department of Development Planning and Co-ordination of MLGRUD.

(2) Coordinating and Implementing Organization at Municipal Level

As described in Section 3.2.2 (1), the Municipal Council in Chitungwiza is a top decision-making organ at municipal level. Under this Council, there exist six (6) Council Committees composed of Councilors (refer to Figure 3.1.2). The matters/issues related to the priority project would be mostly discussed in the following three Committees: Executive, Finance and Development, and Public Works, Town Lands and Environmental Management (as to the functions of each Committee, refer to Figure 3.2.3). Among the above three committees, the Executive Committee will play a major role in formulating a basic policy on project implementation and provide directives to the lower coordinating and executing bodies.

To support substantially the decision-making functions of the municipal administrative system, there is a need to strengthen the managerial capabilities of the existing "Management Committee". Then, it is proposed to create newly a "Project Coordination Committee (PCC)" which is to exclusively deal with the matters/issues of the priority project. This PCC will be composed of a Town Clerk and five Directors of the Municipal Council. Main functions of the PCC are as follows :

- to monitor project activities and review/ adjust annual working plan with budget allocation, and
- to supervise progress of project implementation and report the results to the respective Committees concerned and then to the Municipal Council for final approval.

(3) Executing Body at Municipal Level

As the Zengeza Sewage Treatment Works and municipal sewerage reticulation are under the supervision of the Director of Engineering Services, the ESD (Engineering Services Department) will become the direct executing body for implementation of the Zengeza Sewage Works Rehabilitation/Expansion Project. Consequently, the Director of ESD will be appointed as a Project Director of the Project.

Considering the fact that the Engineering Services Department is now supervising four (4) technical Divisions which deal with almost all technical matters/issues of the Municipality, it is not realistic nor effective to entrust an additional load to its staff engaging in daily routine works and services for the municipal people. To ensure the smooth implementation of the Project, it is proposed to establish a "Project Management Office (PMO)" under the Director of ESD (Project Director).

Institutional set-up plan for the project implementation, including establishment of PMO, appointment of the personnel to be assigned and their responsibilities/functions, etc., would be drawn up at Project Coordination Committee. Then, the plan will be taken into deliberation at the Executive Committee and with its recommendations, it will be sent to the Municipal Council for final approval.

The basic functions of the Project Management Office (PMO) will be, but not limited to the following :

- 1) to arrange all the legal and procedural requirements for implementation of the Project,
- 2) to carry out the survey and investigation necessary for design and quality control of the works,
- 3) to make tender for the procurement of the contractor,
- 4) to execute the construction supervisory works, and
- 5) to undertake accounting and auditing of the contract works.

The PMO will be headed by a Project Manager and composed of technical and administrative specialists with enough experiences in each field. The proposed staffing pattern of the PMO is indicated below with their respective required qualifications :

Posts (No.)		Qualifications
- Project Manager	(1)	Degree in Engineering or Planning, with at least 5 years post qualification experience
- Resident Engineer *	(1)	B.Sc. in Water/Sewerage Engineering (Professional Consultant), with at least 3 years post qualification experience in sewerage project
- Inspector of Works *	(1)	Diploman in Civil Engineering, with at least 5 years post qualification in supervision of civil works

Posts (No.)		Qualifications
- Accountant *	(1)	Degree in Business Studies, majoring in Accountancy with at least 3 years post qualification experience
- Secretary *	(1)	Certificate or Diploma in Secretary Courses, with at least 2 years post qualification experience

Note: * Staffs are to be newly hired or employed.

11.1.2 Organization for Operation and Maintenance of the Facilities

Once construction is completed and the water pollution control works are placed into operation, it is essential to ensure that the facilities will be properly and continuously operated and that the expected pollution abatement targets are achieved. Certain steps should be taken during the planning and construction stages of the project to support efficient operations.

(1) Strengthening the Sewerage Sector

The sewerage service sector in the Municipality consists of the Zengeza Sewage Treatment Works and sewerage reticulation. The Water and Sewerage Division (WSD) under the Engineering Services Department (ESD) is responsible for management and operations of the Zengeza Sewage Treatment Works, sewerage reticulation and water distribution system as well within the Municipality.

The WSD will have direct and overall responsibility for the operations and maintenance of the project facilities. The main roles of WSD with respect to sewerage service sector should be defined as follows:

- to operate and maintain efficiently the sewerage system for controlling water pollution and providing proper sanitation to the municipal people,
- to operate sewage treatment works so as to conform with the acceptable effluent standards,
- to operate a self enterprise that will allow sufficient financial reserve for development and proper maintenance of sewerage services, and
- to supply better sanitation/ sewerage services to the municipal user-beneficiaries to enable the municipal revenue section to implement an efficient billing and revenue collection and maintain a sound accounting system.

To ensure their smooth and efficient O&M, it is proposed to strengthen the WSD, especially the sewerage sector in terms of manpower and monitoring. The existing organization for O&M is adequate in general sense, but is advised to reorganize slightly the sewerage sector as shown in Figure 11.1.2.

Firstly, it is recommended to clearly demarcate the responsibilities/duties of the staffs working for the Sewage Treatment Works (STW) and sewerage reticulation. Expedious decision making should be facilitated through the streamlining of the organizational structure and holding of regular meetings and reports among the major staffs.

Secondly, the number of staffs in both the STW and Sewerage Sections need to be augmented as a result of rehabilitation/expansion of the STW and increased capacity of sewerage services. After completion of the rehabilitation/expansion works, the total number of O&M staffs will reach to 160 in the Municipal Sewerage System. Table 11.1.1 shows the staffs placement proposed for O&M of the rehabilitated/expanded new facilities in the Zengeza Sewage Treatment Works. As to the qualifications required for new staffs to be employed, refer to Table 11.1.2.

(2) Establishment of the Chemical Laboratory and Waste Water Inspectorate

It is strongly recommend to construct a "Chemical Laboratory" for water quality monitoring and strengthen its capacity for water pollution control. This Chemical Laboratory will undertake regular samplings of the pretreated and final effluents at Zengeza STW, and analyses of trade effluents from Tilcor Industrial Area. Table 11.1.2 shows the proposed staffing and required qualifications of each staff.

In addition, for efficient enforcement of the Trade Effluent Control regulations, it is recommended to establish an operational unit to be called as the "Waste Water Inspectorate (WWI)". The main functions of WWI are the following :

- a) Regular monitoring of pollutant loads, water quality, and trade effluents at the designated points,

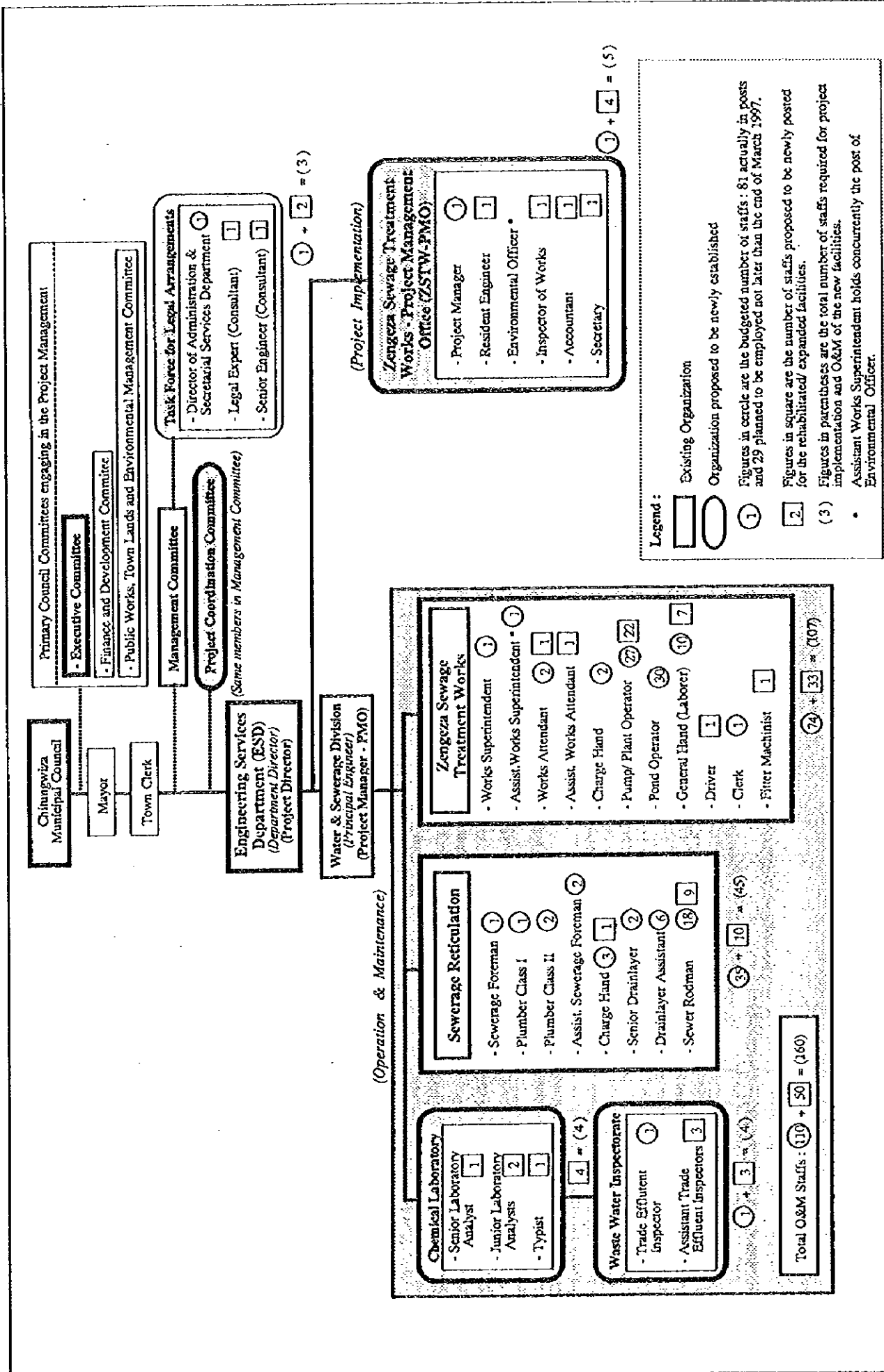


Figure 11.1.2 Proposed Organizational Strengthening for Project Implementation and O&M of the Municipal Sewerage System

Table 11.1.1 Proposed Staffs Placement for O&M of the Rehabilitated/ Expanded New Facilities in the Municipal Sewerage System

Coverage / New Facilities	Positions (Proposed)	No. of Staff (Proposed)	Expected Grade	Remarks
<i>(Sewage Treatment Works)</i>				
1. Whole New System	Works Attendant	1	9	
	Assist. Works Attendant	1	6	
2. Screen & Grit Chamber	Operator	10	5	8 Shiftsmen 2 Loaders
3. BNR Reactor & Secondary Sedimentation Tank	Operator	4	5	Shiftsmen
4. Primary ST & Sludge Digester	Operator	3	4	
5. Sludge Thickener & Drying Bed	Operator	4	4	
6. Sludge Storage Yard	Operator	1	6	Loading machine Dump truck
	Driver	1	6	
7. Cleaning & Scavenging	General Hand (Laborer)	7	1 - 3	
Sub-Total		32	-	
<i>(Annex Facilities)</i>				
8. Chemical Laboratory	Senior Labo. Analyst	1	9	
	Junior Labo. Analyst	2	6	
	Typist	1	6	
9. Waste Water Inspectorate	Trade Effluent Inspector	(1)	9	(Already Advertised)
	Assistant T. E. Inspector	3	8	
10. Repair Shop	Fitter Machinist	1	7 - 8	Fitter & Turner
Sub-Total		8	-	
<i>(Sewerage Reticulation)</i>				
11. Sewer System	Charge Hand	1	6	
	Sewer Rodmen	9	4	
Sub-Total		10	-	
Grand Total		50	-	

Notes : All staffs for the above positions will be newly employed for operation and maintenance of the rehabilitated/ expanded facilities in the municipal sewerage system.
The number of personnel is determined upon consultation with the primary technical staffs of the Municipality.

Table 11.1.2 Qualifications Required to Employ the New Staffs for O&M of the Rehabilitated/ Expanded Facilities

New Positions (Number of Staff)	Required Qualifications
<i>(Sewage Treatment Works)</i>	
1. Works Attendant (1)	<ul style="list-style-type: none"> - 5 GCE 'O' Level subjects with good passes in English, Mathematics, Science and others - Sewage Works Operator's Certificate (Part II / IWSD) - At least 3 years post qualification experience in Sewage Treatment Works
2. Assistant Works Attendant (1)	<ul style="list-style-type: none"> - 5 GCE 'O' Level subjects with good passes in English, Mathematics, Science and others - Sewage works Operator's Certificate (Part II / IWSD) - At least 1 year post qualification experience in Sewage Treatment Works
3. Fitter Machinist or Fitter & Turner (1)	<ul style="list-style-type: none"> - 5 GCE 'O' Level subjects with good passes in English, Mathematics, Science and others - Class 3 Fitter & Turner
4. Operators (22)	<ul style="list-style-type: none"> - 5 GCE 'O' Level subjects with good passes in English, Mathematics, Science and others
5. Driver (1)	<ul style="list-style-type: none"> - 5 GCE 'O' Level subjects with good passes - Clean Class 4 Driver's Licence - At least 3 years experience in driving
6. General Hand (Laborer) (7)	<ul style="list-style-type: none"> - Zimbabwe Junior Certificate (ZJC) with good passes in 5 subjects
<i>(Annex Facilities)</i>	
7. Senior Laboratory Analyst (1)	<ul style="list-style-type: none"> - Diploma in Analytical Chemistry - 5 GCE 'O' Level subjects with good passes in English, Mathematics, Science and others - At least 3 years experience in laboratory analyses
8. Junior Laboratory Analysts (2)	<ul style="list-style-type: none"> - Zimbabwe National Technician Certificate (ZNTC) or equivalent - 5 GCE 'O' Level subjects with good passes in English, Mathematics, Science and others - At least 3 years experience in laboratory analyses
9. Typist (1)	<ul style="list-style-type: none"> - Minimum 5 GCE 'O' Level Graduate - Advanced Typing Certificate - At least 1 year post qualification experience
10. Trade Effluent Inspector (1)	<ul style="list-style-type: none"> - Sewage Works Operator's Certificate or ZNTC - 5 GCE 'O' Level subjects with good passes in English, Mathematics, Science and others - Driver's Licence
11. Assistance Trade Effluent Inspectors (3)	<ul style="list-style-type: none"> - 5 GCE 'O' Level subjects with good passes in English, Mathematics, Science and others
<i>(Sewerage Reticulation)</i>	
12. Charge Hand (1)	<ul style="list-style-type: none"> - Class 3 Plumber
13. Sewer Rodmen (9)	<ul style="list-style-type: none"> - Zimbabwe Junior Certificate (ZJC) with good passes in 5 subjects

Note : Informations obtained through discussions with the primary representatives of the municipal sewerage system.

- b) Inspection of factories/ enterprises in the Municipality (without previous notice) to check on the volume and strength of effluents, especially the composition of industrial discharges based on the effluent standards (limitations),
- c) Issuance of orders for improvements in case of violation,
- d) Legal actions in case of no improvement, including procedures for prosecution and enforcement of penalties against defaulters,
- e) Check of the documents/ reports submitted from the factories/ enterprises about industrial activities, pollutants' sources and effluents, and
- f) Analytical services by request and preparation of bills for their fees to be collected together with the sewerage charges.

The proposed staffing and qualifications required for each position are indicated in Table 11.1.2.

The system of water quality monitoring and analyses should be consolidated, in both legal and organizational aspects. The following parameters need to be analyzed within the Zengeza Sewage Treatment Works (STW).

(On the Routine Basis)

- BOD (Biochemical Oxygen Demand)
- COD (Chemical Oxygen Demand)
- SS (Suspended Solids)
- T-N (Total Nitrogen) or Kjeldhal Nitrogen
- NH₄-N (Ammonia Nitrogen)
- NO₃-N (Nitrate Nitrogen)
- T-P (Total Phosphorous)
- PO₄-P

(At the Request or Required Basis)

- Chromium (Cr)
- Hexavalent Chromium (Cr⁶⁺)
- Lead (Pb)
- Copper (Cu)
- Cadmium (Cd)

- Zinc (Zn)
- Nickel (Ni)
- Iron (Fe)
- Total Manganese (Mn)
- Cyanide (CN⁻)
- Total Mercury (Hg)
- Arsenic (As)
- Oil
- Anionic Surfactant (MBAS)
- Chlorophyll (a)

Sampling analyses will be carried out preferably 4 times a week in the Zengeza STW.

For monitoring the trade effluents from the factories/enterprises, it is important to control them severely and intensively in accordance with the Trade Effluent Control By-laws. Parameters to be analyzed for trade effluent monitoring are shown in Table 11.1.3. Among the prescribed parameters, the following will be analyzed on the routine basis.

- Permanganate value in 4 hours
- Settleable solids
- pH
- Heavy metals

The monitoring frequency of trade effluents is proposed to be as often as possible at the contaminating source points; for instance, twice a week for problematic companies and once a week for good companies which comply with regulations.

As for the farms under final effluent irrigation, the seepage samples should be regularly analyzed : e.g. twice a month. The parameters to be analyzed include oxygen absorbed in 4 hours, COD, Ammonia (N/NH₃), Nitrite (N/NO₂), Nitrate (N/NO₃), Chloride (Cl), pH, Total Alkalinity (TA), Suspended Solids, Phosphate (P) and so on.

The sewerage service section is not provided with sufficient and adequate facilities for operations and maintenance of the municipal sewerage system. It is proposed to

Table 11.1.3 Trade Effluent Standards for Discharge into Municipal Sewers

(Unit: mg/l)

Item	Concentration
Total Suspended Solids	600
BOD5 at 20°C	1,000
COD	2,000
Detergents	20
Soaping oils and fats	50
Silver (Ag)	50
Arsenic (As)	Nil
Cadmium (Cd)	15
Chloride (Cl)	1,000
Cyanide (CN-)	Nil
Cyanide (CN) total	1
Cobalt (Co)	15
Total Chromium	10
Copper (Cu)	15
Mercury (Hg)	0.5
Nickel (Ni)	15
Lead (Pb)	10
Total Phosphate	30
Sulphate (SO4)	1,000
Pesticides	Nil
Bitumen	Nil
Organic Solvents	Nil
Calcium carbide	Nil
Settleable solids	Less than 10
Mineral oils	Nil
Ph	6.8 - 9.00
Temperature	Not exceeding 45°C
In addition, effluent should not contain any toxic matter or any matter that will cause blockage and damage to sewers. Inflammable material and tar should not be present in the final effluent entering the sewer.	

Note : The proposed standards are checked by the Chemical Laboratory staffs in the City of Harare. It is noted that revision is necessary for some parameters.

Source: JICA Study Team with cooperation of the Chemical Laboratory staffs in the City of Harare.

construct a new "Repair shop" within the STW yard with adequate maintenance equipment and tools, sewer cleansing apparatus, and transportation facilities. In this Repair shop, one fitter machinist will be placed to assure the efficient and reliable operations and maintenance of the facilities. As for the chemical laboratory to be newly constructed, it will be equipped with a complete set of analytical equipment necessary for analyses of the parameters mentioned above.

(3) Human Resources Development

Capability building constitutes a very important element both in the project implementation and operation of maintenance of the completed facilities. To ensure the long-term success of the priority project, it is recommended to start a "human resources development programme" during the project preparatory stage.

Although adequate qualifications and enough experiences are required for employment of the new personnel, the following training programme should be carried out for both the administrative and technical and the existing and new staffs, particularly for those undertaking the operations & maintenance of the sewage treatment works and water quality monitoring.

1) For the officers in charge of the project administration and management

- Management Training and Development Programmes in ZIPAM (Zimbabwe Institute of Public Administration and Management) and/or utilizing the other available training programmes,
- Seminars and/or workshops for the personnel concerned, by inviting the consultants and experts specialized in each field, and
- Trainings in foreign countries (ex. under the project typed technical assistance).

2) For the middle and senior level engineers and planners responsible for project implementation and supervision of O&M

- "Planning and O&M of Wastewater Systems" offered by the Institute of Water and Sanitation Development (IWSD) or a similar programme available in the other institutions;

3) To the staff directly engaging in the operations and maintenance of the sewage treatment works

- "Water and Wastewater Works Operators Course (Part III)" designed and offered by IWSD for the key staff at artisan level or a similar programme available in the other institutions;
- Seminars and/or workshops on the specific subjects as required.

As seen above, it should be noted that academic institutions for human resources development are by and large well developed in Zimbabwe, even for provision of the specific course like wastewater. It is possible to design and offer any specialized training programmes and courses to the staffs in charge of implementation of the priority project and its O&M.

Most of the staffs working in the Zengeza Sewage Treatment Works have no experience in operating and maintaining the BNR (Biological Nutrient Removal) typed facilities. Since some Sewage Treatment Works (STWs) in the City of Harare like Crowborough and Firlle are running this type of treatment facilities, it is recommended to organize there an on-the-job training for Zengeza O&M staffs before starting operations of the rehabilitated/ expanded facilities.

About the trade effluent control and wastewater inspection, only the City of Harare has rich experiences among the urban authorities. It is therefore advised to dispatch the staffs newly employed and appointed for such tasks to the Chemical Laboratory and Waste Water Inspectorate of the City of Harare so as to make them gain practical experiences in chemical analyses of water, sewage and trade effluent samples, and inspection of trade effluent in factories.

In this connection, it is important to realize that the capability building of the Municipality mainly depends upon its financial viability and consolidation, and deeply coupled with the commitment of adequate financial resources.

11.2 Legal Arrangements

11.2.1 Proposed Short-Term Action on Water-related Legislation

In order to ensure effective and efficient environmental management and water pollution control, the legal arrangements proposed in the Master Plan are to be preferably accomplished as soon as possible, within the (Short-Term) Action Plan period up to the Year 2000.

The following are the primary arrangements necessary for legislative framework consolidation related to water pollution control :

- 1) Review of "Water Act"
- 2) Enactment of "Environmental Management Act"
- 3) Establishment of "Environmental Water Quality Standards"
- 4) Amendment of the existing "Effluent Regulations"
- 5) Review and updating of other legislation relating to water pollution control

11.2.2 Enactment of the Trade Effluent By-laws and Other Municipal Ordinances relating to Water Pollution Control

In order to control the water pollution in the Municipality area, specifically the trade effluents from the Tilcor Industrial Area, it is recommended to enact the "Trade Effluent Control By-laws" as soon as possible, by referring to those applied in the City of Harare.

Effluent limitations or standards should be established according to local conditions and be integrated into the proposed by-laws. For determining the parameters and their maximum permissible concentrations, it is necessary to carry out more detailed investigations taking into consideration the local conditions and factors. The draft Trade Effluent Standards are given in Table 11.1.3 as a basis for further discussions and investigations.

Besides, the setting and enforcement of laws & regulations and detailed standards are really complex tasks, which are both time consuming and open to legal challenges from affected industries and institutions. It is therefore proposed to set up a "Task Force for Legal Arrangements" under the Management Committee of the Municipality. This Task Force will take charge of preparation of draft by-laws and regulations/ standards and be composed of the following members :

- Director of Administration & Secretarial Services Department of the Municipality,
- Legal Expert specialized in Statutory Law (Professional Consultant), and
- Senior Engineer specialized in Sewerage including trade effluent (Professional Consultant).

To materialize the above legal arrangements by establishing the Task Force, it is necessary to appropriate the necessary funds in the next municipal budget which starts from July 1st, 1997. The primary assignments of this Task Force will be to draft the following laws and regulations relating to water pollution control in the area :

- Trade Effluent Control By-laws
- Model Building By-laws (regulations on septic tank installation)
- Waste Management By-laws

In addition to the above, the Task Force will also assume legal and procedural arrangements required for smooth and efficient implementation of the priority project. These include legal advisory services on the rules & regulations and procedures regarding to manpower development and charging system of the Municipality.

To improve the financial status of the Municipality, the system and procedure for charging trade effluents should be institutionalized or stipulated in the Trade Effluent Control By-laws. Trade effluent charges will be collected based on the volume and strength of effluents of the Potassium Permanganate (COD_{Mn}) consumption , as being practiced in the City of Harare.

11.3 Financial Study and Implementation Plan

11.3.1 Financial Study

(1) Basic Conditions and Assumptions

The project is to be listed as one component of PSIP of Urban Sector and Regional Development Project (USRDP) under the jurisdiction of MLGRUD. This is the fundamental condition for implementation of the Project, which implies that the Project will be executed on a loan basis. The Council acts as the executing body being responsible for construction and operation and maintenance while MLGRUD is defined as the implementing agency which functions as the supervising and coordinating body for loan disbursement in particular. The financial study is basically made from the aspect of the

executing body who borrows a massive amount of loan for implementation of the Project.

Prior to financial study, basic conditions and assumptions have to be spelled out in order to establish the base framework for analysis of financial capability of the Council.

Basic conditions for evaluation

- 1) Base year : The year of 1996
- 2) Price : -ditto-
- 3) D/D, Construction time : 3 years from 1997 to 1999
- 4) Evaluation period : 27 years from 1996 to 2022 including loan repayment duration (25 years)
- 5) Price escalation rate : 25% per annum
- 6) Duration of price : 3 years from 1997 to 1999 when the construction escalation of the Project completes,
- 7) Discount rate : 12%
- 8) Growth rate in real term : 4% per annum based on GDP at 1990 constant price from 1980 to 1991

Share of GOZ and donor funds

The lesson from Urban II suggests that insufficient allocation of GOZ fund caused the delay of Urban II projects, resulting in partial utilization of IBRD loan. In order to avoid the delay on work progress of the Project, it is desirable that the share of donor fund to finance the Project cost should be as large as possible. In this regard, the direct construction costs consisting of sewer reticulation, expansion/rehabilitation of the Zengeza STW would be preferably financed by donor fund. The share of GOZ and donor to be expected would be as follows.

About Z\$ 27 million is expected to be financed by GOZ. The allocation of GOZ fund for sewerage component of PSIP for 1996/97 is about Z\$ 59 million. Thus the amount of Z\$ of 26 million is within the budget range to be mobilized by the national government.

unit : Z\$ 1,000

Cost Items	GOZ	Donor	Total
(1) Direct construction cost		183,182	183,182
(2) Engineering Services	16,486		16,486
(3) Administration charges	4,000		4,000
sub-total	20,486	183,182	203,668
(4) Physical contingency	2,049	18,318	20,367
Total	22,535	201,500	224,035
(5) Price contingency	4,459	54,817	59,276
Grand total	26,994	256,317	283,311

Alternative financial schemes

To alleviate financial burden on the borrower (the Council) is the primal concern for financial study. To do so, the national government is expected to take the two subsidiary actions. One is the application of government grant to investment requirement shared by GOZ. The other is that foreign exchange premium would be borne by the government. Both proposals are contemplated to be the government subsidy to be extended to the borrower. To subsidize foreign exchange premium is not under responsibility of MLGRUD, but the matter handled by MOF. Such a premium is perhaps accounted into Subsidies of Current Account of the national budget. Alternative financial schemes are shown as follows.

Alternative Case	Type of Fund		Premium
	GOZ	Donor	
Base	Loan	Loan	Charge
Alt 1	Grant	Loan	Charge
Alt 2	Loan	Loan	Subsidy
Alt 3	Grant	Loan	Subsidy

The base case corresponds to the existing financial scheme that projects loan are on-lent to borrowers with foreign exchange premium. To subsidize the premium is actually a time-consuming option needing institutional coordination between MLGRUD and MOF. Perhaps the probability that the option of premium subsidy is accepted by the government would be low. Alternative cases are arranged from 1 to 3 in order in terms of probability.

Loan conditions

The key to alleviate financial burden on the borrower is identification of donor fund with preferential loan conditions. Lending rate is the primal concern for the borrower. The comparison of interest rates lent to GOZ by major donors suggests that the lending rate of 3 % per annum would be the preferable loan condition for the project. MIGRUD is requested to negotiate with such a single bilateral donor that offers the preferential lending rate.

The premium is the difference between lending and on-lending rates. The lending conditions of Urban II Programme is as follows.

IBRD loan	Lending	Premium	On-lending
Interest Rate	7%	8%	15%

IBRD loans are lent to GOZ by US\$. To judge whether the current premium rate (8%) is appropriate or not is virtually difficult as nobody knows to what extent the exchange rate of Zimbabwe dollar against US dollar will fluctuate in the future. The premium of 8% would probably be necessary as a part of repayment cost for foreign exchange fluctuation during a long range span.

The government loan has been lent to the Council for implementation of the on-going Sewerage Augmentation Works (Phase 1 and II). The lending rate is fixed at 9.75% per annum. The following table shows the proposed on-lending rates by source of fund and alternative scheme.

unit : %

Alternative Case	GOZ			Donor		
	Lending	Premium	On-lending	Lending	Premium	On-lending
Base	9.75	0	9.75	3.0	8.0	11.0
Alt 1	0	0	0	3.0	8.0	11.0
Alt 2	9.75	0	9.75	3.0	0	3.0
Alt 3	0	0	0	3.0	0	3.0

The other loan conditions are almost identical whatsoever type of loan is secured for the Project. The following is the standard conditions with respect to grace and repayment duration.

- Grace period : 3 years
- Repayment period : 25 years

Both 3 years of grace period and 25 years of repayment duration are equally applied to alternative financial scheme as the common condition.

Debt service schedule of existing liabilities

The existing liabilities consist of loan committed by previous work and those for the on-going sewerage augmentation work (Phase I and II). The conditions of existing liabilities are summarized in the following table. Loan outstanding is about Z\$ 45 million, out of which about 70% is shared by the on-going works. Previous loans will have to be repaid until 2005 with no grace period, while the uniform conditions are given to GDL disbursed for the on-going works in respect of grace period and repayment duration. CDF is the Council's internal loan transferred from surplus accounts without grace duration.

Existing liabilities	Loan out-standing (Z\$,000)	Interest rate (%)	Grace period	Repayment period
<u>Previous loans</u>				
GDL	11,316	9.75	none	(-2005)
CDF	1,787	10.50	none	(-2005)
sub-total	13,103			
<u>Phase I and II</u>				
GDI				
1st	14,073	9.75	94/95-95/96	(-2019)
2nd	14,996	9.75	95/96-96/97	(-2020)
CDF	2,815	10.50	none	(-2005)
sub-total	31,884			
Total	44,987			

All existing liabilities are assumed to repaid with the condition of annual equal installment. The debt service schedule of the existing liabilities is estimated as follows.

unit : Z\$ 1,000

Debt service	1996/97	1997/98-2005	2006-2019	2020
<u>Previous loan</u>				
GDL	1,964	1,964	-	-
CDF	310	310	-	-
sub-total	2,274	2,274		
<u>Phase I and II</u>				
GDL	3,046	3,272	3,272	1,688
CDF	489	489	-	-
sub-total	3,535	3,761	3,272	1,688
Total	5,809	6,035	3,272	1,688

(2) Projection of revenue

Revenue is only a source of income to recover operating expenses and debt services. Potential revenue consists of the following components.

- Sewerage charges collected based on flat tariffs imposed per water closet and urinals inside home, commercial and industrial stands,
- Effluent charges given the condition that the collection system of such a charge will be firmly established, and

Revenue increase in the future is firstly forecast in real term and then in nominal term with price escalation. Revenue increase in real term is caused by two factors. One is the real growth of household or corporate incomes. The other is expansion of revenue base. Real growth of income can be somehow projected on the basis of the potential growth rate of GDP achieved in the past. Expansion of revenue base is largely correlated to socio-economic parameters such as population, land use and commercial/industrial development. In this section, revenue projection is made in line with scenario discussed above.

Projection of revenue bases

The future framework of socio-economic condition is shown as follows.

Parameter	Present	2000	2015
1) Residential area (km ²)			
Low	0.00	0,00	2.14
Medium	3.35	3,35	8.26
High	19.47	21.22	26.67
Total	22.82	24.57	37.07
2) Population	405,000	489,000	768.00
3) Nos. of industrial employees	2,500	3,100	32.800

Revenue bases can be projected on the basis of socio-economic parameters projected.

Revenue bases	Present	2000	2015
1) Home stands			
Low	-	-	2,140
Medium	5,600	5,600	13,770
High	25,530	28,650	42,300
total	31,130	34,250	58,210
2) Commercial/public stands	367	410	700
3) Industrial stands	46	62	650
4) Water consumption (m ³ /day)	34,420	41,560	65,280

1) Home stands

The assumptions used to estimate home stands are as follows.

(a) Housing development area

The ratio of housing development area to residential area to be developed is assumed to be 0.5, which is based on land development plan of high density area of St. Mary's for the target year of 2000.

(b) Average stand area

Average area per stand is assumed to be as follows.

- Low density : 500 m²
- Medium density : 300 m²
- High density : 200 m²

2) Commercial/public stands

Commercial/public stands share about 1.2% of home stands at present. Commercial stands are assumed to increase in proportion to the number of home stands.

3) Industrial stands

The average number of industrial employees per stand is about 50 at present. Industrial stands are estimated based on the assumption that average number of employees per stand continues to be same in the future.

Revenue projection in real term

Revenue projection valued at 1996 constant price comprises of two factors. One is the real growth of income. The other is expansion of revenue bases. The constant value of revenue is assumed to increase in proportion to annual growth rate of income. Annual growth rate of income is assumed to be 4% on the basis of GDP at 1990 constant price from 1980 to 1991. Revenue projection in real term is made in the following way.

1) Sewerage charge at present

The existing sewerage charge per water closet and urinals is weight-averaged per unit as follows.

Consumer Category	Water closet		urinals		Weighted average per unit (Z\$ per month)
	Present charge per unit (Z\$ per month)	Nos. of water closet	Present charge per unit (Z\$ per month)	Nos. of urinals	
Residential	23.70	31,130	-	-	23.7
Commercial	70.56	750	46.37	638	59.4
Industrial	117.60	313	69.55	137	103.0

2) Sewerage charge based on expansion of revenue base

The number of water closets and urinals by category in the future is estimated based on revenue bases projected.

consumers	Present	2000	2015
Residential	31,130	34,250	58,210
commercial	1,388	1,560	2,660
Industrial	450	610	6,370

Then the existing tariffs are multiplied by the number of water closets and urinals in order to estimate sewerage charges per year attributed to the expansion of revenue bases.

unit: Z\$ million

Consumers	Present	2000	2015
Residential	8.85	9.74	16.55
Commercial	0.99	1.11	1.90
Industrial	0.56	0.75	7.87
Total	10.40	11.60	26.32

3) Projection of sewerage charge in real term

Finally the real growth rate of 4% per annum is multiplied by sewerage charges projected based on revenue bases in order to estimate sewerage charges in real term.

unit: Z\$ million

Consumers	Present	2000	2015
Residential	8.85	11.39	34.87
Commercial	0.99	1.30	4.00
Industrial	0.56	0.88	16.58
Total	10.40	13.57	55.45

4) Estimation of effluent charge

Provided that effluent charge is introduced into Chitungwiza, the charge is estimated to be 5.4% of total sewerage charges (Z\$10.4 million) at present. This ratio is multiplied by sewerage charges in real term projected in order to estimate potential effluent charges in the future.

unit: Z\$ million

New charge	Present	2000	2015
Effluent charge	0.56	0.73	2.99

5) Gross revenue as cost recovery source

Sewerage and effluent charges, and water revenue surplus are aggregated to calculate gross revenue per year as recovery source.

unit: Z\$ million

Cost recovery source	Present	2000	2015
Sewerage charge	10.40	13.57	55.45
Effluent charge	0.56	0.73	2.99
Total	10.96	14.30	58.44

Revenue projection in nominal term

The price escalation rate of 25% per annum is taken into account to estimate gross revenue in nominal term. Price escalation is applied to the duration from 1997 to 1999 when the construction of the Project will complete. Revenue projection in nominal term is estimated as follows.

unit: Z\$ million

	Present	2000	2015
G. revenue	10.96	27.93	114.14

(3) Operation and maintenance cost

The contrast of construction schedule to operation and maintenance by work is useful to estimate O & M cost year by year.

	1997	1998	1999	2000
Construction Schedule				
Reticulation		-----		
Expansion/Rehabilitation of STW		-----		
O & M Works				
Reticulation				
STW				

Note : O & M works

----- O & M works for the existing facilities.

_____ O & M works for the proposed facilities.

Operating expenditures of the existing facilities is about Z\$ 5.05 million in the year of 1995/96. Although operating expenditures are not separately accounted for reticulation

and STW respectively, the share is reported to be 20% for reticulation and 80% for the Zengeza STW. The operating expenditures from 1997 to 2000 is estimated at 1996 constant price on the basis of O & M works for existing and proposed facilities.

unit: Z\$ million

O & M works	1997	1998	1999	2000
Reticulation	1.01	1.01	3.25	3.25
STW	4.04	4.04	4.04	9.07
Total	5.05	5.05	7.29	12.32

Price escalation rate of 25% per annum is applied to the duration of 3 years from 1997 to 1999 to estimate operating expenditures in nominal term. Operating expenses are forecast at the mid-year.

unit: Z\$ million

	1997	1998	1999	2000
O & M cost	5.68	7.10	12.81	21.66

(4) Debt service of the Project

This section aims to estimate debt services of the project by alternative financial scheme.

Capital disbursement of the project is rearranged for source of fund and by year.

unit: Z\$ million

Source of Fund	1977	1998	1999
Donor Fund			
Base cost		98.04	85.14
Physical contingency		9.80	8.51
Price contingency		22.40	32.41
Total		130.24	126.06
GOZ			
Base cost	6.59	6.94	6.94
Physical contingency	0.66	0.69	0.69
Price contingency	0.23	1.59	2.64
Total	7.48	9.22	10.27

The loan conditions of donor and GOZ funds are already stated by alternative financial scheme so that this section shows cash flow of debt service by scheme.

1) Base case

unit: Z\$ million

Source of fund	1997	1998	1999	2000	2021	2022
Donor	0	14.33	28.20	31.01	31.01	31.01
GOZ	0.73	1.63	2.63	3.01	3.01	0
Total	0.73	15.96	30.83	34.09	34.09	31.01

2) Alternative 1

unit: Z\$ million

Source of fund	1997	1998	1999	2000	2021	2022
Donor	0	14.33	28.20	31.01	31.01	31.01
GOZ	0	0	0	0	0	0
Total	0	14.33	28.20	31.01	31.01	31.01

3) Alternative 2

unit: Z\$ million

Source of fund	1997	1998	1999	2000	2021	2022
Donor	0	3.91	7.69	15.59	15.59	15.59
GOZ	0.73	1.63	2.63	3.01	3.01	0
Total	0.73	5.54	10.32	18.66	18.66	15.59

4) Alternative 3

unit: Z\$ million

Source of fund	1997	1998	1999	2000	2021	2022
Donor	0	3.91	7.69	15.59	15.59	25.59
GOZ	0	0	0	0	0	0
Total	0	3.91	7.69	15.59	15.59	25.59

5) Financial analysis

The performance of cost recovery could be checked by the balance between projected revenue and expenditures consisting of operating expense and debt services as expressed by the following equation.

$$\text{Balance} = \text{Revenue} - \text{O \& M cost} - \text{debt services.}$$

Cash flow statements are prepared to analyze loan repayment in terms of annual and accumulated balance with the following results.

1) Base case

unit: Z\$ million

	2000	2005	2010	2015	2020	2022
Annual in the target year	-34	-17	12	55	57	60
Accumulated	-70	-193	-189	-7	270	386

2) Alternative 1

unit: Z\$ million

	2000	2005	2010	2015	2020	2022
Annual in the target year	-31	-14	-15	58	60	60
Accumulated	-62	-169	-150	47	339	459

3) Alternative 2

unit: Z\$ million

	2000	2005	2010	2015	2020	2022
Annual in the target year	-18	-2	28	70	72	75
Accumulated	-24	-69	11	270	625	772

4) Alternative 3

unit: Z\$ million

	2000	2005	2010	2015	2020	2022
Annual in the target year	-15	1	31	74	75	75
Accumulated	-16	-46	50	325	694	845

The financial study reveals that the project implementation on a loan basis is virtually impossible in terms of cost recovery.

11.3.2 Implementation Plan

Implementation plan for rehabilitation and expansion of the Zengeza Sewage Works encompasses physical development plans, institutional development, legal arrangements and financial arrangements. In view of the urgency that the priority project is scheduled to

commence immediately after completion of the feasibility study, it is strongly recommended for the authorities concerned to take smooth actions for implementation of Action Programs.

(1) Action Programs

Institutional development

Institutional development to be proposed comprises of the organization for project implementation, and operation and maintenance. The essence of institutional development plan is summarized given below.

- Establishment of a “Water Pollution Control Coordinating Committee” for the supervising and coordinating body for the priority project. This Committee will be established as a result of the re-shaped organization of the existing Steering Committee formed for the Study on Water Pollution Control in the Upper Manyame River Basin at central government level.
- Establishment of a “Project Coordination Committee” at the Council level, which is exclusively to deal with the matters/issue of the priority project.
- Establishment of a “Project Management Office” under the Director of the Engineering Services Department of the Council. The PMO will be basically responsible for overall project management.
- Strengthening of sewerage section of the Water and Sewerage Division under the Engineering Services Department in terms of the clear-cut split of the responsibilities between the STW and reticulation, and augmentation of staffs working in sewage works.
- Establishment of a “ Chemical Laboratory” with monitoring and laboratory test staffs for regular surveillance of treated effluent at the Zengeza STW and trade effluents from the Tilcor Industrial Area.
- Human resources development to sustain capability building as the necessary element in the project implementation. For this purpose, training programs should be required in the fields of administration, and operation and maintenance.

In order to facilitate institutional development proposed, the following actions will be immediately required by the concerned authorities.

- 1) Preparation for Water Pollution Control Coordinating Committee (WPCCC)
 - Establishment of a working Committee under the existing Steering Committee. implementation of the priority project, the matter of financial arrangements in particular.
 - Appointment of regular members of WPCCC.

- 2) Preparation for Project Coordination Committee (PCC)
 - Establishment of a inter-departmental Working Committee chaired by the Director of Engineering Service Department.

This Committee is designed to discuss preparatory works for execution of institutional development at the Council level and report the discussed results to the existing "Management Committee".

- Appointment of regular members of PCC.

- 3) Preparation for Project Management Office (PMO)
 - Preparation of TOR for PMO.
 - Preparation of a tender to recruit competent staffs working in PMO.
 - Prior coordination for the necessity of PMO at the level of the "Management Committee".

All the preparatory works shall be initiated by the Engineering Services Department.

- 4) Preparation for operation and maintenance
 - Preparation of comprehensive plans to improve sewerage operation and maintenance works in terms of responsibilities and staffs to be required including training programs.
 - Preparation of a proposal for Chemical Laboratory in terms of staffs to be required, their qualification, water quality parameters to be monitored and tested, and the methodology of effluent charge system.
 - Preparation of a human resource development plan towards O & M works after the priority project completes.

These preparatory works will be done by PMO to be established.

Legal arrangements

The legal arrangement proposed in the Master Plan are preferably taken within the period up to the year of 2000.

1) Legal measures

- a. Review of "Water Act"
- b. Enactment of "Environmental Management Act"
- c. Establishment of "Environmental Water Quality Standards"
- d. Amendment of the existing "Effluent regulations"

In order to control the water pollution in the Municipality area, specifically trade effluents from the Tilcor Industrial Area, it is recommended to enact the "Trade Effluent Control By-law" as soon as possible. It is therefore proposed to set up a "Task Force for legal Arrangements (TFLA) under the Management Committee. TFLA will take charge of preparation of draft by-laws and regulations.

2) Preparation TFLA

- Recruit of a legal expert specialized in Statutory Law and a Senior engineer specialized in trade effluent.
- Budget preparation for recruit of special staffs.

These preparatory works will be done by the Director of Administration & Secretarial Service Department.

Financial arrangements

Financial support system is absolutely necessary for implementation of the Project requiring a huge amount of capital. Financial assistance from central government will be vital to ease financial burden on the borrower since the Council borrows funds from central government on a loan basis. Financial instruments to be proposed are:

- Import tax exemption,
- Identification of a single donor with preferential loan conditions,
- Provision of the GOZ grant to finance administration charge and engineering services, and
- Exemption of foreign exchange premium.

The Ministry of Finance, as the lead agency to facilitate financial support system, is recommended to take the following actions.

1) Financial support system

- Preliminary study on impact of financial instruments on budget
- Inter-ministerial coordination for use of the GOZ grant to finance the project.
- Financial management of premium subsidy in the framework of current budget system.

These preparatory works are primarily to be done by the Water Pollution Control Coordinating Committee to be established.

Detailed design

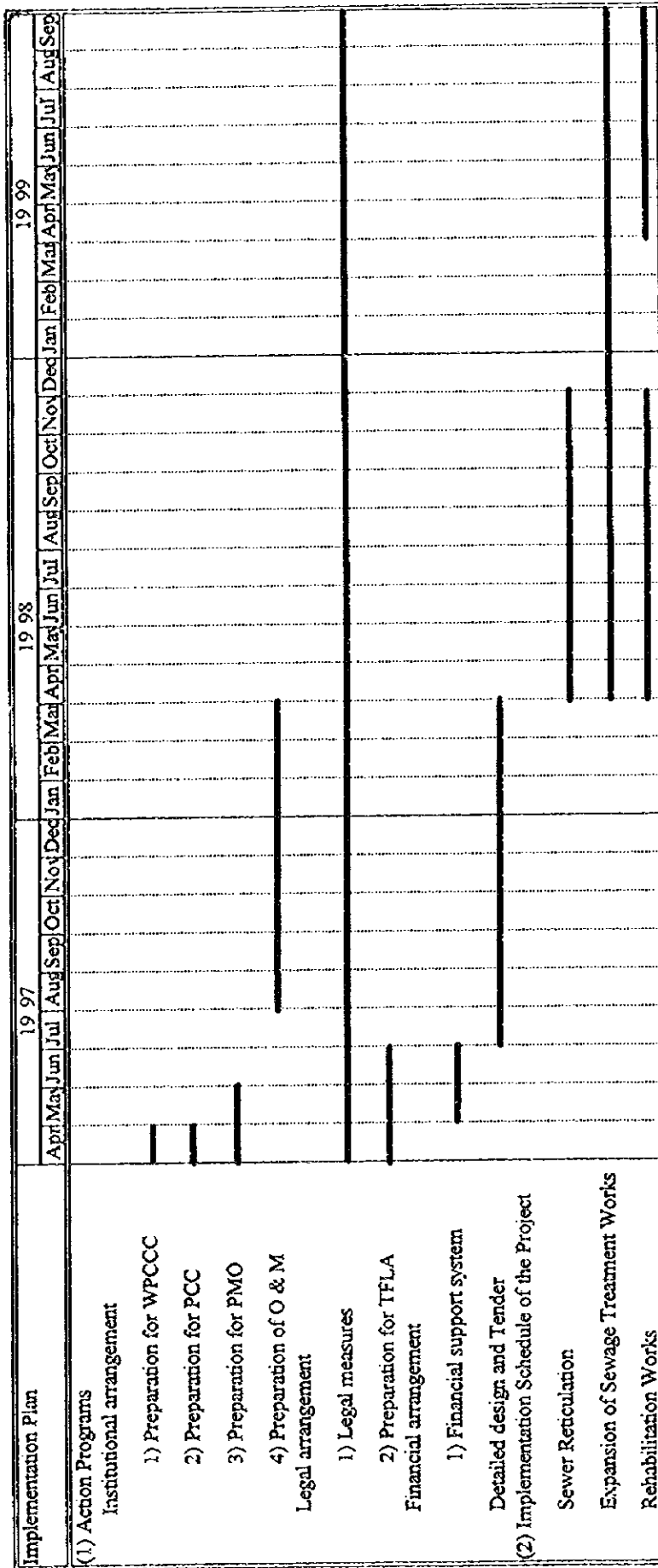
Immediately after completion of the Feasibility Study, the government shall proceed to the implementation of detailed design of the project.

(2) Implementation Plan

The implementation plan showing the details of action programs and the project works is depicted Figure 11.3.1. Immediately after the completion of the Feasibility Study in March 1997, implementation period is broadly divided into three stages.

- First : Most of Action Programs covering institutional, legal (April to June, 1997) : and financial arrangements should be carried out.
- Second stage : Implementation of detailed design (July 1997 to March 1998)
- Third stage : Construction of the Project (April 1998 to Set. 1999)

Figure 11.3.1 Implementation Plan



CHAPTER 12
PROJECT EVALUATION

CHAPTER 12 PROJECT EVALUATION

12.1 General

The metropolitan area encompassing the capital city and Chitungwiza will face a chronic water shortage against a growing water demand, despite of the Harare's effort to implement the on-going work of Harare Water Supply Project Phase 2. The delay of the next water source development, Kunzi dam would make the matter worse, so that the water demand will outstrip supply capacity by the year 2000. In addition to the water shortage for the water supply, deterioration of water quality in the subject basin affects water uses and ecological conditions.

Under these conditions, Zengeza Sewage Works in Chitungwiza municipality was selected as an urgent project in terms of physical development and institutional strengthening coupled with legal arrangements.

The project evaluation was made in this section identifying the urgency of the Project, benefits/effects and viability for the implementation of the Project. A comprehensive evaluation of the Project is finally made summarising technical, environmental, institutional and economic/financial aspects

12.2 The Urgency of the Project

The eutrophication problem of Lake Chivero and Lake Manyame has been recognised since 1970s and the identified causes are treated sewage effluent and raw sewage overflowing from deteriorated sewers/STWs, partially treated industrial wastewater and other pollutants.

Among water pollution sources the rehabilitation and expansion of the existing sewage works are recommended as potential and practical countermeasures.

The Zengeza STW in Chitungwiza municipality, where the population increase has been considerable in recent years, was recommended as the result of the comprehensive study on concerned factors; technical, cost effectiveness, financial soundness, environmental improvements, institutional arrangements and social acceptability. The major reasons for the selection of the Zengeza STW are as follows:

(1) Technical Aspect

Of the larger three STWs in the basin, only Zengeza STW does not have facilities to discharge treated effluent to the water course . The offensive odour at the treatment site

and its surroundings is prevalent at the Zengeza STW. In addition, the possible overflow of treated effluent/raw sewage from the STW is employed by the shortage of treatment capacity (about 70% overloaded to design capacity of the existing STW).

Plans and designs for immediate - to medium - term rehabilitation/expansion projects were prepared for those in Harare. The expansion of nutrient removal facilities at the fire STW is also under way, while there is no established plan for the Zengeza STW.

(2) Environmental Improvements

The improvement of water environment in the lakes can be expected with reference to the reduction of TN by the expansion project of the Zengeza STW, as discussed later in this section. Water replenishment (20,000 m³/d) can also be achieved for water sources together with the same arrangements by Harare City. Furthermore, the mitigation of the water pollution problem downstream of the maturation pond at Imbgwa farm would be brought through the improvement of effluent quality of the existing STW.

The existing treatment facilities at the Zengeza STW will be effectively used with reference to the proposed expansion facilities.

12.3 Benefits and Justification of the Project

The benefits derived from the project implementation are itemised as follows:

- (1) Contribution to mitigate eutrophication problem of the impoundments
- (2) Prevention of emergency case of raw sewage discharge into the water body
- (3) Conservation of water environment in the receiving water body and replenishment to water sources
- (4) Functional recovery of existing sewage treatment facilities and a proper reuse of treated effluent
- (5) Improvement of sanitation condition
- (6) Sludge reuse
- (7) Provision of the opportunities for sustainable organization and management through the future
- (8) Provision of employment opportunities

The following are benefits and justifications for the Project by item.

- (1) Contribution to mitigate eutrophication problem of the impoundments

The extents of the contribution to the water pollution of the subject water bodies by different pollution source were analysed at present and in the future in the preparation of water pollution control M/P. It was concluded that all local authorities concerned shall provide countermeasures as recommended in the M/P entailing development/expansion of existing sewerage systems. In this connection, influences by the Chitungwiza municipality to the water pollution assumed to be large due to the population of the municipality with about one third of total population in the basin.

The discharged pollution loads from the municipality are discussed with reference to those discharged from the entire basin.

1) Impact of discharged pollution loads from Zengeza STW to the rivers comparing those between present (the time when effluent was discharged) and the year 2000

- Nyatsime river just downstream of Zengeza STW
Zengeza STW discharged more than 50% of pollution loads of the total discharged loads from the sub-basin (represented by COD, TN and TP) to the Nyatsime river.

After realization of the Project, the share of the pollution loads will be reduced to around 20%. Especially, TN will be considerably reduced from 64% to 22% (about 1/3), even if the population of the municipality is expected to increase rapidly.

- Manyame river before inflow to the Lake Chivero
When the treated effluent was discharged into the river, about 40 to 60% (COD, TN, TP) of total pollution loads from the sub-basin are attributed to those discharged from the Zengeza STW. In consideration of the inflow of pollution loads from major part of Harare City in this sub-basin, the weight of discharged loads from the STW were indispensable. Upon completion of the Project, the contribution by the Zengeza STW will be reduced up to around 10%. Especially, TN is expected to be 1/4 of the present contribution.

2) Impact of discharged pollution loads from Zengeza STW to Lake Chivero

About 20 to 40% of the total pollution loads (COD, TN, TP) inflowing into the lake in the last ten years are attributed to those discharged from the Zengeza STW. After completion of the Project, the shares are expected to become 2 to 4 % (the contribution will be reduced to 1/10 of present one).

The pollution control M/P recommended that all existing STWs shall be rehabilitated/expanded to treat increasing pollution loads timely to roughly maintain the water quality on the present level. Under such requirements, a drastic reduction of TN by the Zengeza STW is effective, since TN is a control factor to the eutrophication of the lake.

(2) Prevention of emergency case of raw sewage discharge into the water body

A lot of fish was died at the mouth of Lake Chivero and in the lakes in the last few years accidentally caused by the discharge of raw sewage from the STWs and factory. The water environment is easily affected by the discharge of raw sewage, especially during dry season in the fact that an average inflow volume to the Lake Chivero is less than $4\text{m}^3/\text{sec}$. The Project entails emergency countermeasures not to discharge raw sewage/incompletely treated sewage into the river both for existing and new facilities.

(3) Conservation of water environment in the receiving water body and replenishment to water sources

One of the major concern of the Government is to tackle the chronic water shortage. The MLWR is planning to introduce water from outside of subject basin, even if for the limited water amount available and non-economical transmission distance.

Local authorities concerned fully recognize the need of effluent discharge to the rivers as experienced during drought in the past (about 25% of water supply amount was supplemented by treated effluent of STWs).

Treated effluent volume discharged from the STWs was discussed with reference to river water flow as follows:

- The percentage of treated effluent volume discharged by Zengeza STW to river flow during dry season

Nyatsime river downstream of Zengeza STW : about 60% to river flow

Manyame river before inflow to Lake Chivero : about 10% to river flow

- Treated effluent volume at present and in 2000

At the present time, a total of $46,800\text{ m}^3/\text{day}$ is discharged into the rivers from the two STWs in Harare City, while remaining effluent is sent to farm land for reuse and disposal. For the target year 2000, about $200,000\text{m}^3/\text{day}$ is planned to be discharged into the water bodies including proposed Zengeza STW project. If the plan will be

realized, about 30% of water demand in 2000 could be supplemented by the effluent from STWs. The effluent volume of the Zengeza STW to the total effluent volume planned is about 10%.

The effluent volume (20,000 m³/day) planned to discharge by the Zengeza STW is essential under the critical conditions of water source available and government's decision to introduce supplemental water from other watershed. The project would be a good reference to extend such arrangements by the municipality through the future as a major potential source of water.

(4) Functional recovery of existing sewage treatment facilities and a proper reuse of treated effluent

The sewage inflow at the Zengeza STW is currently about 36,000 m³/day against design capacity of 21,750 m³/day. The overloaded condition affects the treatment efficiency considerably (effluent quality is similar to raw sewage) and causes offensive odour.

Upon completion of new sewage treatment facilities, existing treatment facilities can receive design sewage flow enabling the proper treatment efficiency (BOD 60mg/l, COD 180mg/l). The effluent quality will meet the national regulation for irrigation reuse.

(5) Improvement of sanitation conditions

Chitungwiza, where overflowed sewage runs freely across doorsteps suffers from the chronic stench problem which might pose unsanitary or offensive condition to the local residents. The stench problem was reported at the places around the existing pump stations at St. Mary's and the 30 problem spots scattered in the residential areas of St. Mary's, Zengeza and Seke. The major reason for the sewage overflow is attributed to the decrease of pump efficiency or damaged sewers and manholes, for which the proper maintenance has not been worked out. The rough estimation of the resident population haunted by stench problem would be as follows.

Total length of municipal roads	:	47.5km
Length of affected roads	:	7.3km
Population of Chitungwiza	:	405,000
Estimation of affected population	:	62,200

The affected population is simply estimated based on the ratio of length of affected roads to that of the entire municipal roads. About 15% of the municipality population or 62,200 is assumed to be haunted by the current stench problem. The rehabilitation/modification

of the existing sewer reticulation will certainly improve sanitation condition of the problem spots in terms of stench to be removed. Local people will enjoy their daily life free from stench and health hazard.

(6) Sludge reuse

Sludge disposal to gum plantation has been put into practice in Bulawayo, Mutare and some other cities. There exists anxiety of whether there is a market for the sludge on the surrounding farms. The following is the statistics on eucalyptus plantation area in the province of Mashonaland East to which Chitungwiza belongs.

	unit : ha	
	M.E	Nation
Commercial/industrial	3,308	10,160
Non-commercial	6,802	14,340
Total	10,110	24,500

About 40% or 10,110 ha of gum plantation area is widely scattered in the Mashonaland East. In addition to existing plantation, the Forestry Commission plans to expand gum plantation area by 250 ha per year in Mashonaland East. The demand for the sludge would be sustainable due to the existing and planned plantation area. Though sludge has no market value, economic value would be substantial as a useful organic fertilizer. The use of sludge contributes to earning of sustainable agricultural income.

The proposed sludge drying bed would assure quality of sludge in terms of dark brown humus condition, which can be reused as a good organic fertilizer for edible crops. The sludge heap is wetted with further effluent from a biological filter bed once a week, so that the heap will be found to be in a dark brown condition, reasonably safe to be used in gardens.

Digested sludge contains high mineral constitutes such as nitrogen, phosphates and potash. The sludge has certainly the equivalent value of compost sold in the domestic market.

(7) Provision of the opportunities for sustainable organization and management through the future

Currently, the administrative capability of the Council is not in a position of sustaining or dealing with a growing demand for public services including water and sewerage. The implementation of the proposed institutional strengthening and legal arrangements would certainly lead to capability building of the Council functioning as a reliable executing body which furnishes the better services with local recipients. Perhaps the Council might be also a recipient being favoured with the project management know-how and the sophisticated system for operation and maintenance. The Project would bring the favourable effects on the concerned agencies, which is presented as follows :

At the level of central government

- 1) The establishment of a WPCCC gives the concerned agencies the valuable opportunity of how to sustain the better coordinating function. It is apparent that the successful coordinating work entirely depends on the strong initiative of MLGURD. The effects to be expected from a WPCCC would be as follows.

Smooth implementation of institutional and financial arrangements for execution of the Project.

Both coordinating and monitoring works of the on-going Urban II projects are undertaken by PCMU organized by the consultants employed. The establishment of a WPCCC entails the direct involvement of the concerned agencies with the project management. In particular, MLGURD would get the valuable lesson from a WPCCC regarding project management.

At the level of Council

- 2) Perhaps, the Project is the biggest public investment programme the Council has ever experienced. The Council is required to take the entire management of the force account work as an executing body. The establishment of PCC and PMO certainly leads to a smooth project cycle encompassing timely reporting system, the decision-making and execution.
- 3) Employment of legal experts as well as the execution of training programme becomes the firm base for capability building of the Council. Human resource development is a key factor to implement the Project successfully. The disregard for this aspect often results in the poor operation and maintenance.

Whatever results may come out, the execution of institutional and legal reinforcement would become the valuable lesson to the other city or municipalities which might undertake similar projects.

(8) Provision of employment opportunities

The implementation of the Project will allow for the employment opportunities during construction of the facilities, and operation and maintenance of the facilities on a continuous base. The chances will be given not only laborer but also engineers and expert in the sewerage sector.

12.4 Viability of the Project

12.4.1 Technical Aspects

(1) Sewage treatment process

In accordance with current policy of the MLWR, treated effluent from STWs shall be discharged into the water body to supplement water source and for the preservation of the water environment along the upper Manyame River. In addition to meet the effluent regulation, the efficiency of the nutrient removal must be carefully analysed to determine an appropriate sewage treatment process. Table 12.4.1 presents alternative processes used widely.

Table 12.4.1 Comparison of Alternative Sewage Treatment Processes

Treatment Process	Description	Advantage & Disadvantage	Removal Rate (%)			Cost	
			COD	TN	TP	Const.	O&M
Conventional Activated Sludge (AS)	biological treatment: a mixture of sewage and activated sludge, sludge sedimentation removal	-land area reduction -energy consumable -equipment needs	85-90	15-40	20-45	△	△
Trickling Filter (TF)	aerobic micro organism on the filter media, sludge sedimentation removal	-Stable to load fluctuation -O&M is easier than AS -flies and odour problem	75-90	15-40	20-30	○	○
Waste water Stabilization Pond (WSP)	biological oxidation	-minimal equipment need -O&M is easy -large area need	70-90	50	30	○	◎

Treatment Process	Description	Advantage & Disadvantage	Removal Rate (%)			Cost	
			COD	TN	TP	Const.	O&M
Biological Nutrient Removal (BNR)	Combination of anoxic, anaerobic and aerobic processes	-sludge has a relatively high phosphorous (for fertilizer)	85-95	70-95	70-90	○	○
BNR with chemical Addition	nutrient removal with chemical addition	-a higher phosphorous removal than BNR -increase of sludge amount	85-95	70-95	75-95	○	△

Note :-

	<u>Construction</u>	<u>O&M</u>	<u>Remarks</u>
⊙	low	low	Evaluation is marked assuming
○	mid.	mid.	The TF as a standard.
△	high	high	

Biological Nutrient Removal (BNR) process was selected in consideration of low cost construction, and easy and low cost operation and maintenance of the facilities with an emphasis on nutrient removal. The operation of this process has also sufficient experience in Harare City.

The sewage to be treated is planned to restrict to domestic sewage with a fixed volume of 20,000 m³/day to ensure stable and design quality of treated effluent.

(2) Construction, and operation and maintenance of STW

The sewage and sludge treatment facilities proposed are common in Zimbabwe. The implementation of the project is feasible in use of conventional methods and technical experiences in the country.

12.4.2 Environmental Aspects

A Preliminary Environmental Impact Assessment (PEIA) has been carried out for the Project. The conclusions of the PEIA are summarized as follows.

- 1) The PEIA has identified no fatal environmental flaws for the Project.

2) Aquatic ecology impacts

The high-quality effluent will be discharged into the Nyatsime River. The increase in flow would favor species which are better equipped to live under continuous flow conditions.

3) Water quality impacts

The rehabilitation of the existing STW alleviates the BOD concentration of treated effluent from the existing trickling filters. Under such a circumstance, the impact on water quality on surrounding areas would be less serious than in the case of "without project".

4) Waste impacts

The disposal of wastewater sludge for agricultural use appears to be the most feasible and environmentally acceptable disposal option. A countermeasure should be undertaken to prevent wastewater sludge from penetrating into groundwater.

5) Air pollution, Aesthetics, Noise and vibration impacts

The impacts in these areas are expected to minimal and mainly temporary whilst construction takes place. The current stench problem will be greatly alleviated.

6) Social impact

Employment opportunities will be created by the construction and operation of the STW expansions. No access control to the STW site is undertaken to prevent illegal waste dumping.

Based on the PBJA, the following actions are recommended to ensure to minimize environmental concerns.

- 1) An equitable agreement needs to be reached regarding the discharge and use of the treated effluent from the STW expansions between local farmers and the relevant authorities.
- 2) An acceptable and secure long term sludge disposal means must be found.
- 3) The sludge produced at the expansions to the STW needs to be regularly sampled so that the agricultural uses to which the sludge can be applied are established. Sampling of groundwater and surface water near to where the sludge is used should also take place to ensure that contamination does not occur.

- 4) The environmental impact of transport of the sludge to its final use should also be closely managed and controlled to prevent public nuisance.
- 5) The STW site would preferably be fenced and access to the site controlled.
- 6) A structured and regular water quality monitoring system should be put into practice to ensure the effluent discharged to the Nyatsime River.

12.4.3 Financial Aspects

The financial study reveals that the revenue consisting of the fixed and new effluent charges is sufficient to cover O & M costs as well as debt services of the existing liabilities, but not large enough to repay the new debt services of the Project. The results of the study are summarized as follows.

	unit: Million Z\$				
	2000	2005	2010	2015	2020
(1) Revenue	27.93	44.65	71.39	114.14	114.14
(2) O & M expenses	21.66	21.66	21.66	21.66	21.66
(3) Debt services of existing liabilities	6.04	6.04	3.27	3.27	1.69
(4) Balance	0.23	16.95	46.46	89.21	90.79
(5) New debt services					
Base	34.09	34.09	34.09	34.09	34.09
Alt 1	31.01	31.01	31.01	31.01	31.01
Alt 2	18.66	18.66	18.66	18.66	18.66
Alt 3	15.59	15.59	15.59	15.59	15.59
(6) Balance					
Base	-33.86	-17.14	12.37	55.12	56.70
Alt 1	-30.78	-14.06	15.45	58.20	59.78
Alt 2	-18.43	-1.71	27.80	70.55	72.13
Alt 3	-15.36	1.36	30.87	73.62	75.20

Note: Balance (6) = (4) - (5)

The item (4) is the balance indicating whether or not both O & M costs and debt services of the existing liabilities can be recovered by revenue. No deficit would be expected in the future, so the projected revenue will be sufficient to recover O & M cost and debt services of the existing liabilities. The serious constraint is, when the new debt services come in cash flow, that the sound repayment schedule can not be made even under the case of the most favoured loan conditions such as Alternative 3. This implies that the project implementation on a loan basis is virtually impossible in terms of cost recovery. Obviously the difficulty in cost recovery is the most serious constraint for project implementation.

12.4.4 Economic Aspects

Out of the variety of benefits/effects attributable to the Project the quantifiable benefits would be confined to water replenishment and avoidable costs of maturation ponds, and summarized as follows :

Economic Benefits	Quantification
(1) Water replenishment	Annual benefit : Z\$ 9.5 million
(2) Avoidable costs of maturation ponds	year of 2010 : Z\$ 41 million year of 2015 : Z\$ 197 million

The market benefit is high-quality effluent from the BNR treatment plant, which will be the raw water source of potable water supply in the Upper Manyame River Basin. The water price of Z\$ 1.3 per m³ is based on the ZESA's purchasing price of raw water for the purpose of cooling the generator operating in the dermal power plant. Annual benefit of water replenishment is estimated as follows.

$$\text{Annual benefit (Z\$ 9.5 million)} = \text{Z\$ 1.3 per m}^3 \times 20,000 \text{ m}^3/\text{day} \times 365 \text{ days}$$

Treated effluent is currently conveyed from the Zengeza STW to the Imbgwa farm where effluent is stored and retained on maturation ponds so as to meet the effluent quality for irrigation reuse. Without the Project, it is anticipated that augmentation of effluent would put an increasing pressure on the existing maturation ponds in terms of BOD removal, resulting in requirement of further expansion of ponds. With the project, such an unnecessary cost required for expansion of maturation ponds can be avoided. The construction cost of maturation ponds to be expanded is estimated to be Z\$ 41 million for 2010 and Z\$ 197 million for 2015.

The project costs for construction and O&M are estimated at Z\$ 283 million and Z\$ 9 million per year, respectively. Compared to these costs, the benefit of water replenishment is marginal, and the benefit of avoidable costs will be considerably discounted on the present value basis. As a result, economic viability of the project is difficult to prove quantifiably, though the project would be justifiable from socio-economic viewpoints, indicating that the project actually generates a variety of benefits/effects.

12.4.5 Institutional Aspect

The Council is basically endowed with the executing capabilities for project implementation, and operation and maintenance. This would be proven by the following facts or conditions.

- 1) As for the operation and management of the municipal sewerage system, the Council appropriated for the personnel costs for operation and maintenance in the 1995/96 budget. The Council actually strove to fill up 29 vacant posts up to the end of the fiscal year 1995/96. In this regard, the Council has the institutional/financial capabilities for operation and maintenance work of the sewerage system.
- 2) For project implementation, there exist local consultants and contractors having sufficient experience in the field of public works including sewage works in this country. No serious problem would occur provided that the Council executes project management in cooperation with competent local consultants and contractors.
- 3) With respect to human resources development, local academic institutions are, by and large, well developed, even for provision of specific course regarding wastewater management. It is possible to design and offer any specialized training programs and courses to the Council's staffs in charge of the project management, and operation and maintenance.

Considering the given facts and conditions, it is not too much to say that the institutional capability of the Council would not constrain implementation of the Project. Perhaps the key issue would be the prompt establishment of a "Water Pollution Control Coordinating Committee" and a "Project Coordination Committee" at the levels of central government and the Council, respectively. The well-coordinating function to be inherent in both Committees is regarded as the necessary input of project implementation.

12.5 Comprehensive Evaluation

The Project is comprehensively evaluated from technical environmental, financial and economic and institutional aspects and summarized as follows:

Aspects	Evaluation
(1) Technical	<ol style="list-style-type: none">1) Employment of the BNR plant to meet both objectives of water pollution control (contribution to control on eutrophication in the Upper Manyame River Basin) and water replenishment.2) Full use of the existing STW
(2) Environmental	<ol style="list-style-type: none">1) No fatal environmental flows for the project as a result of PEIA.2) Despite of no adverse environmental impacts, the sludge disposal should be duly taken into account to minimize the following environmental concerns.<ul style="list-style-type: none">- Acceptable and long term disposal means- Sampling of groundwater to prevent contamination from occurring
(3) Financial	<ol style="list-style-type: none">1) Revenue would be sufficient to recover O&M expenses.2) The difficulty in project implementation on a loan basis even under the most preferential loan condition.
(4) Economic	<ol style="list-style-type: none">1) The difficulty in proving economic viability of the project.2) Socio-economic justification would be secured taking into account the variety of benefits.
(5) Institutional	<ol style="list-style-type: none">1) Competent capability of the council to execute the project implementation and O&M works.

As a result of comprehensive evaluation, the serious constraint was identified in financial aspect. Though the generation of sewerage revenue will be sufficient to recover O&M expenses, the prospect that revenue is not large enough to recover new debt services will be the irresistible constraint. Two options would be conceivable. One is mobilization of water revenue surplus and the other is application of external grant to the project. The possibility of these options would be subject to financial performance of water account, and candidates of donors with respect to the provision of grant.





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