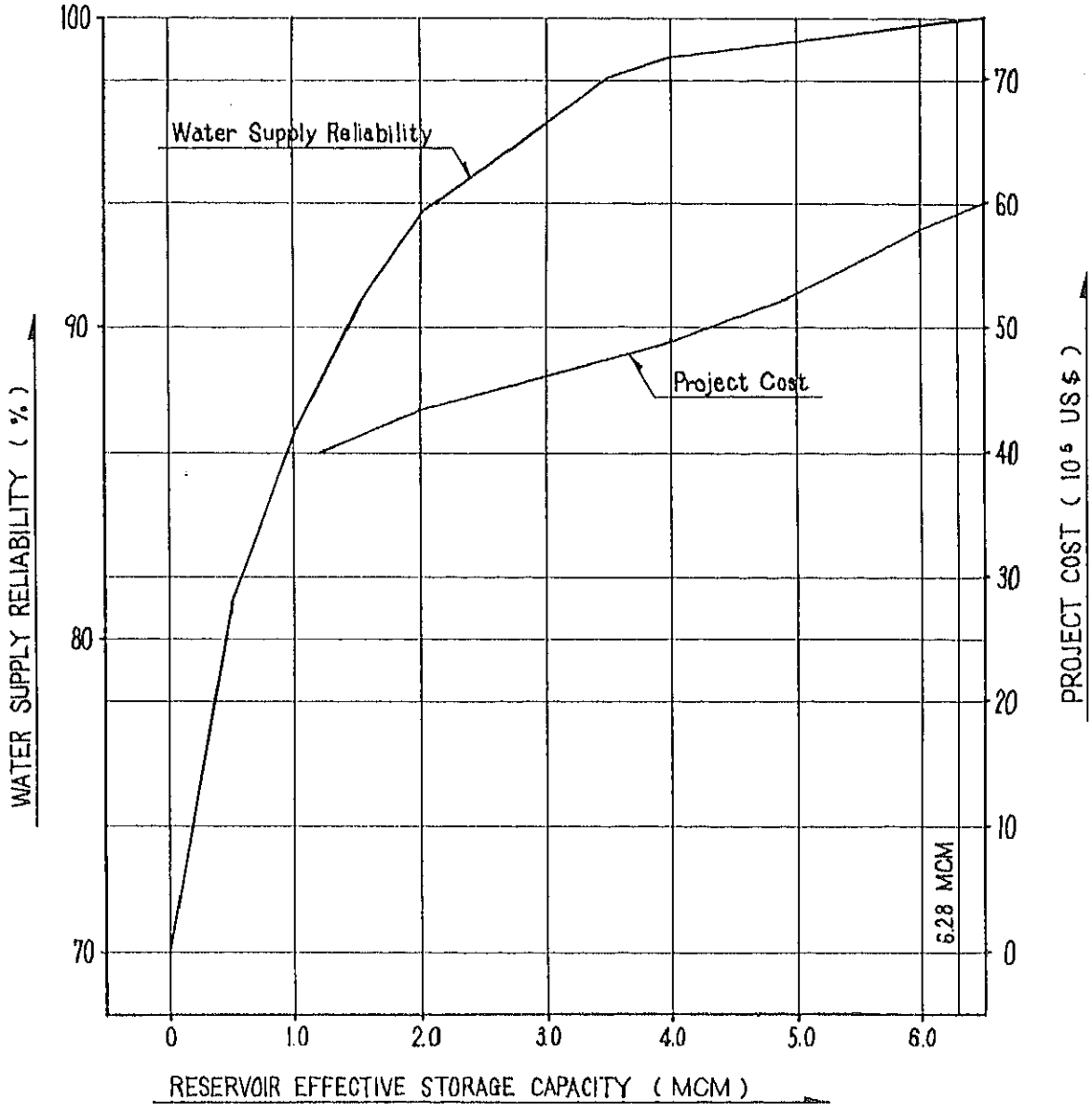
FIGURES

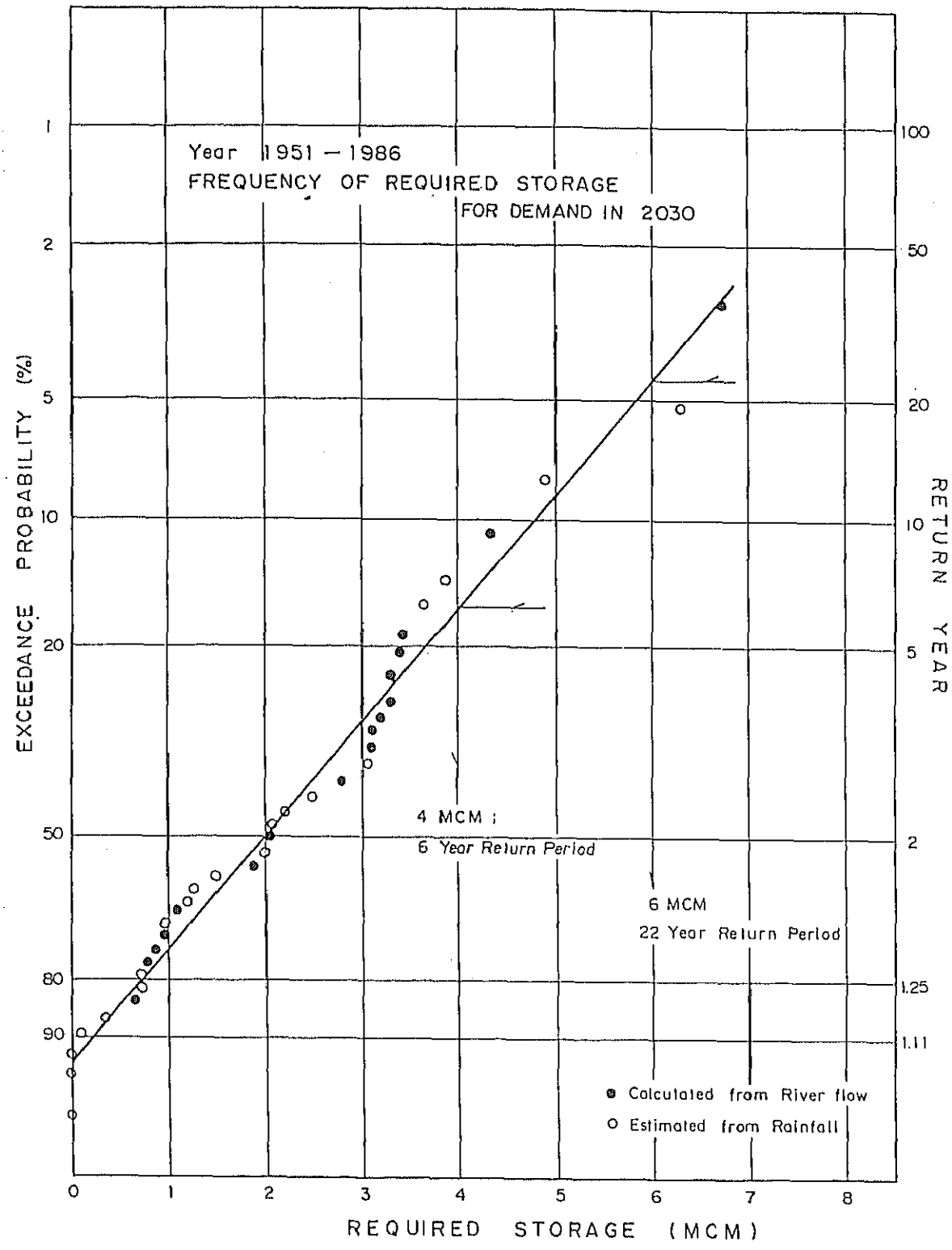
Fig. 3.1.1



RELATION AMONG WATER SUPPLY RELIABILITY, PROJECT COST AND EFFECTIVE STORAGE CAPACITY

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

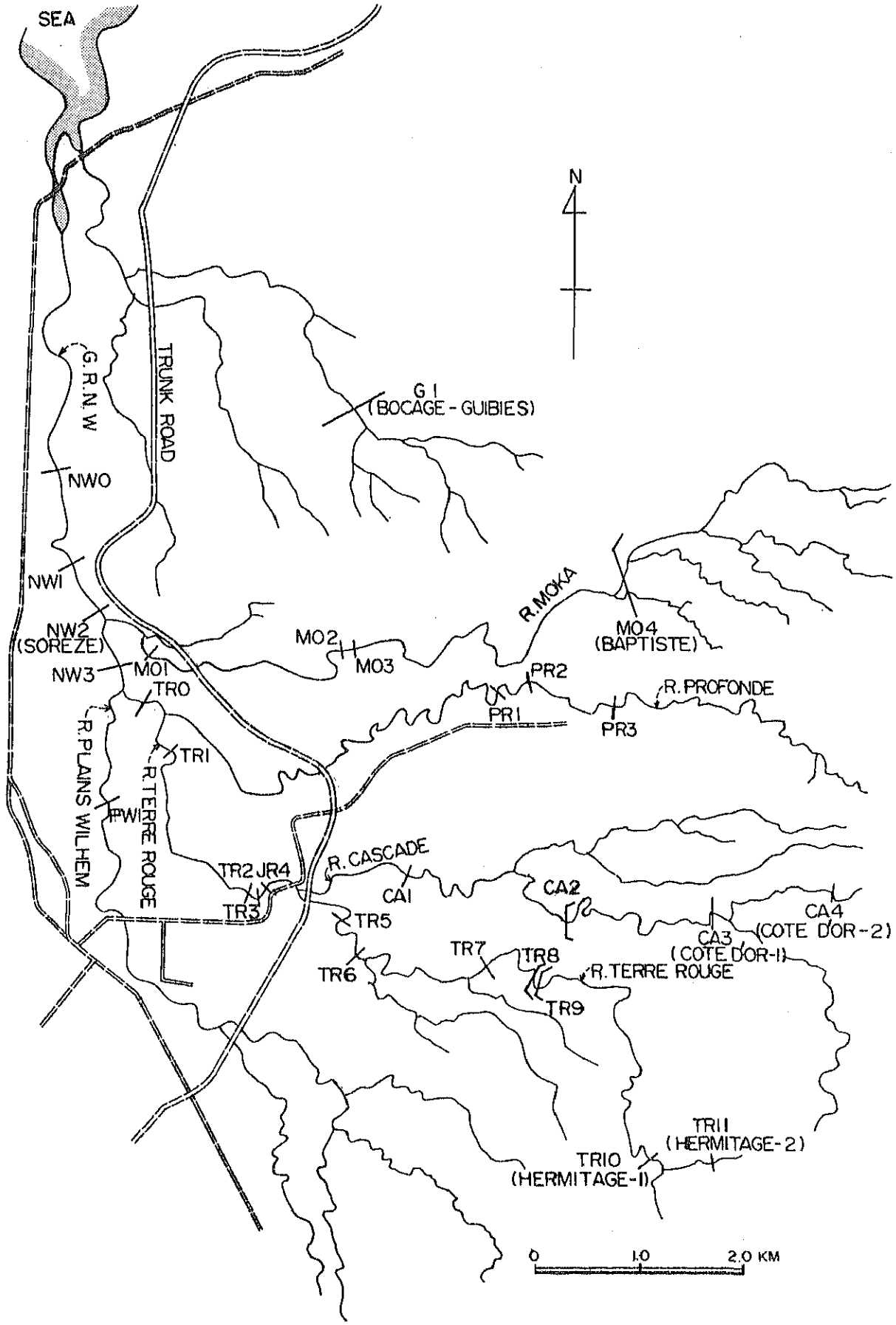
JAPAN INTERNATIONAL COOPERATION AGENCY



PROBABILITY OF ANNUAL REQUIRED STORAGE

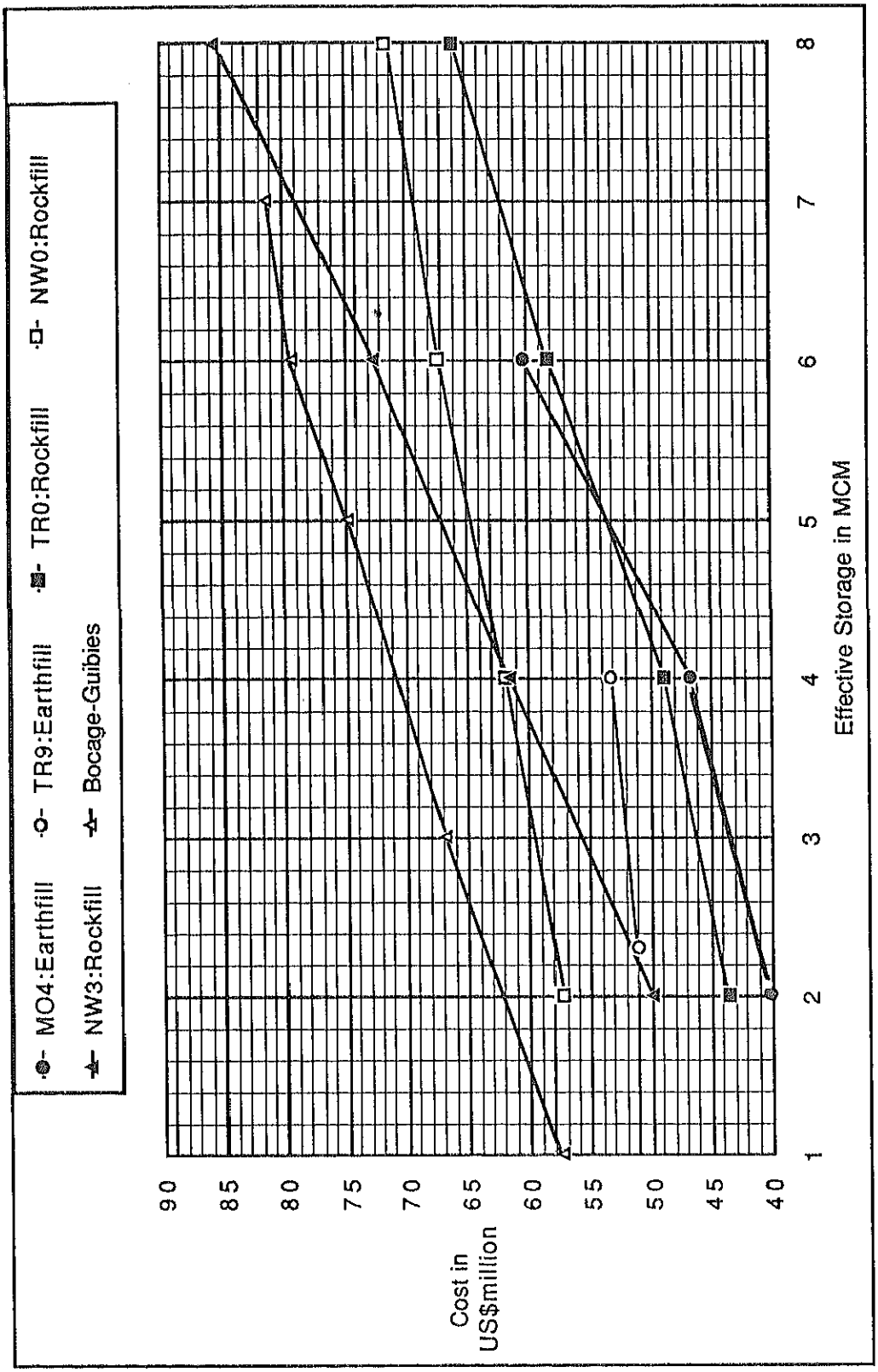
GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.2.1



LOCATION MAP OF POSSIBLE DAMSITES	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.2.2

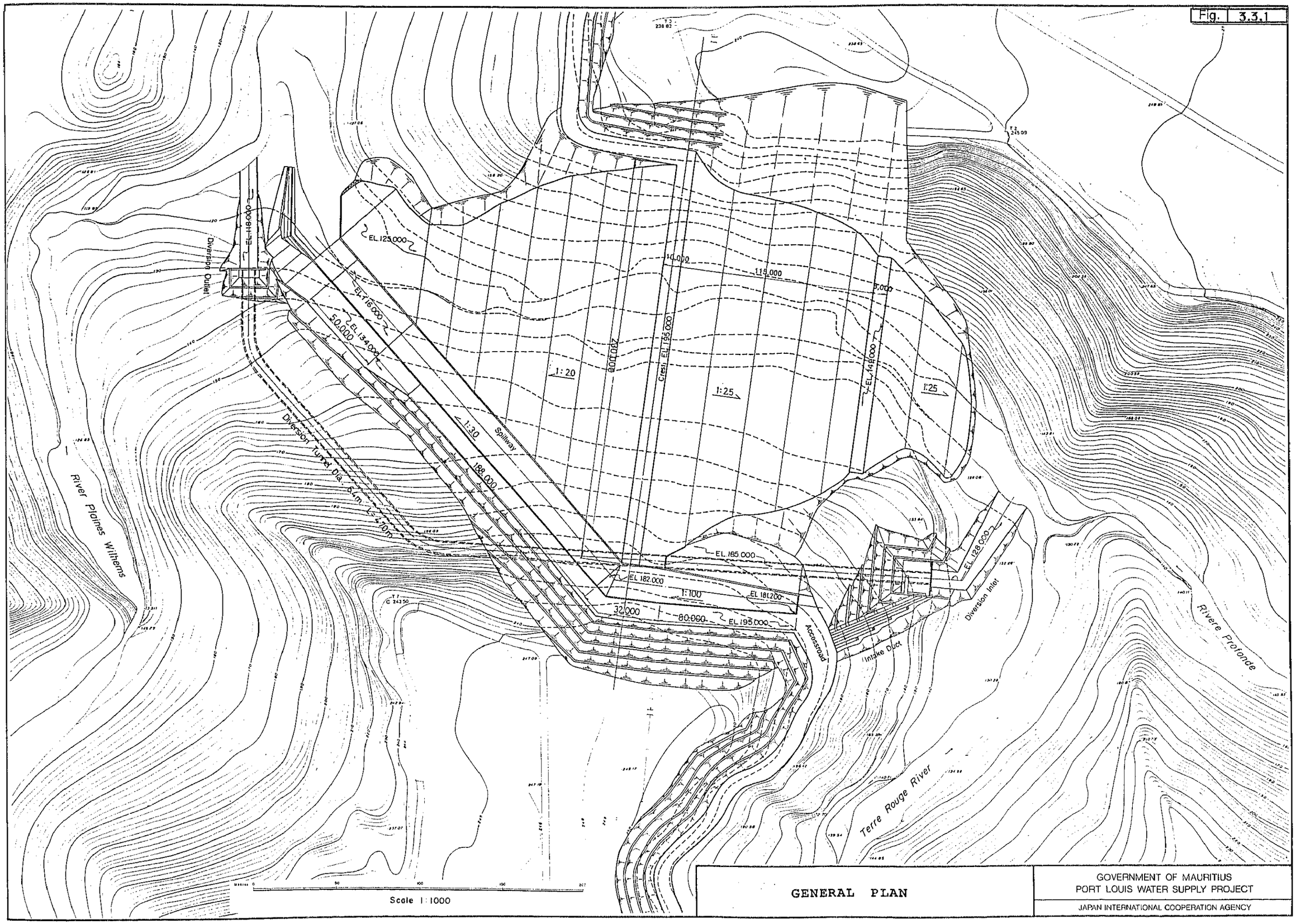


Cost - Storage Curve for alternative Dam Schemes

RELATIONSHIP BETWEEN DAM COST AND EFFECTIVE CAPACITY

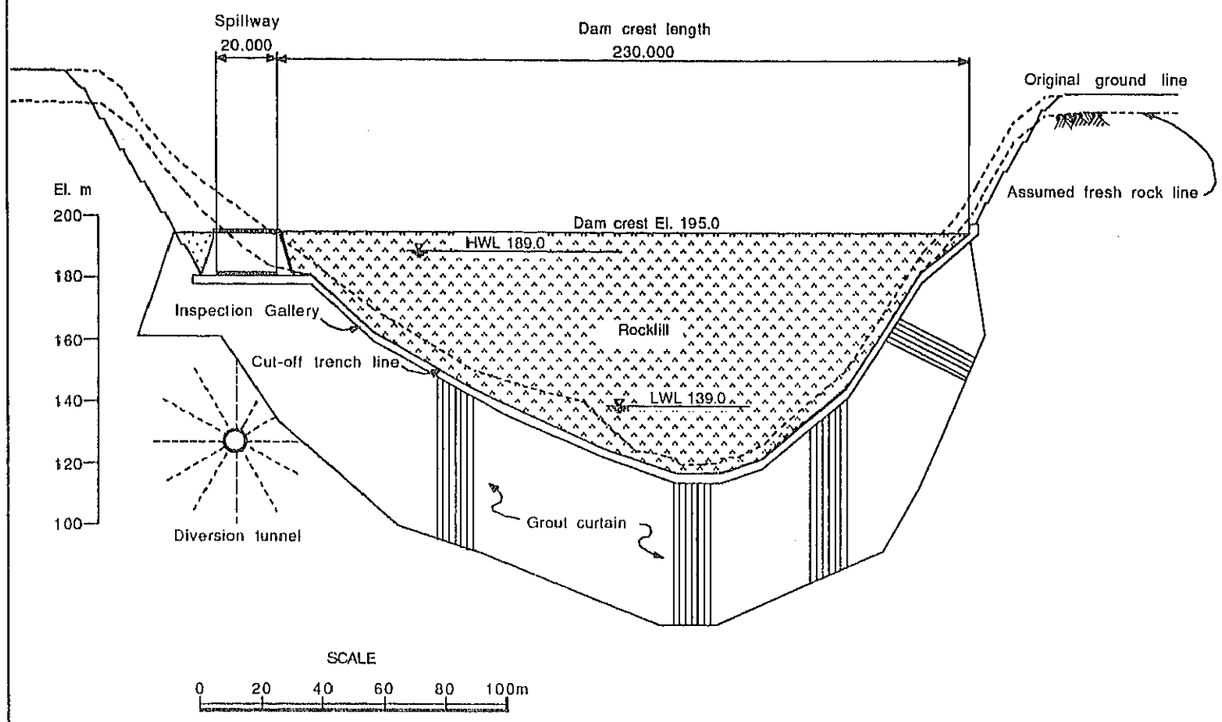
GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.3.1

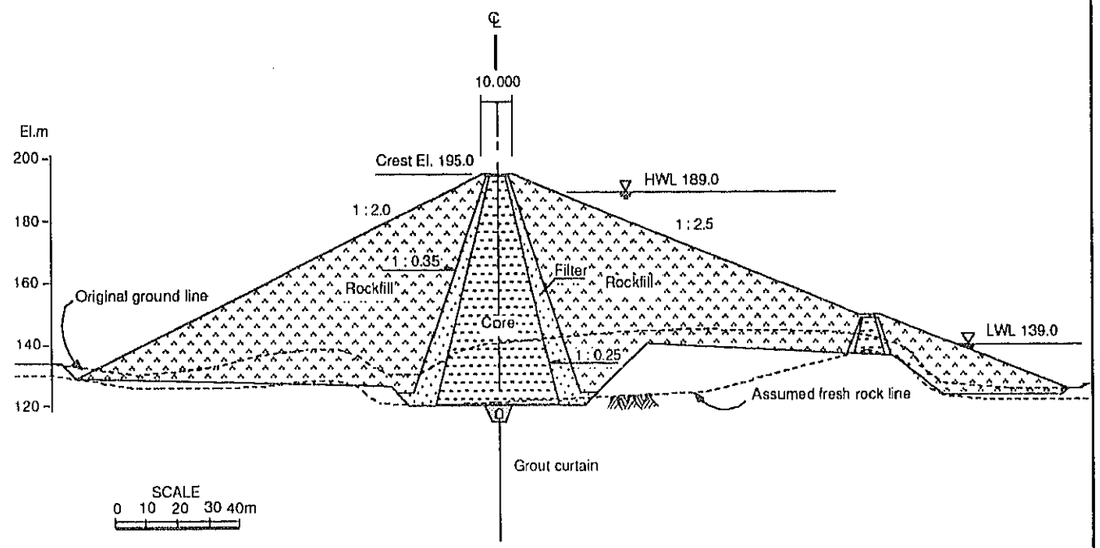


GENERAL PLAN

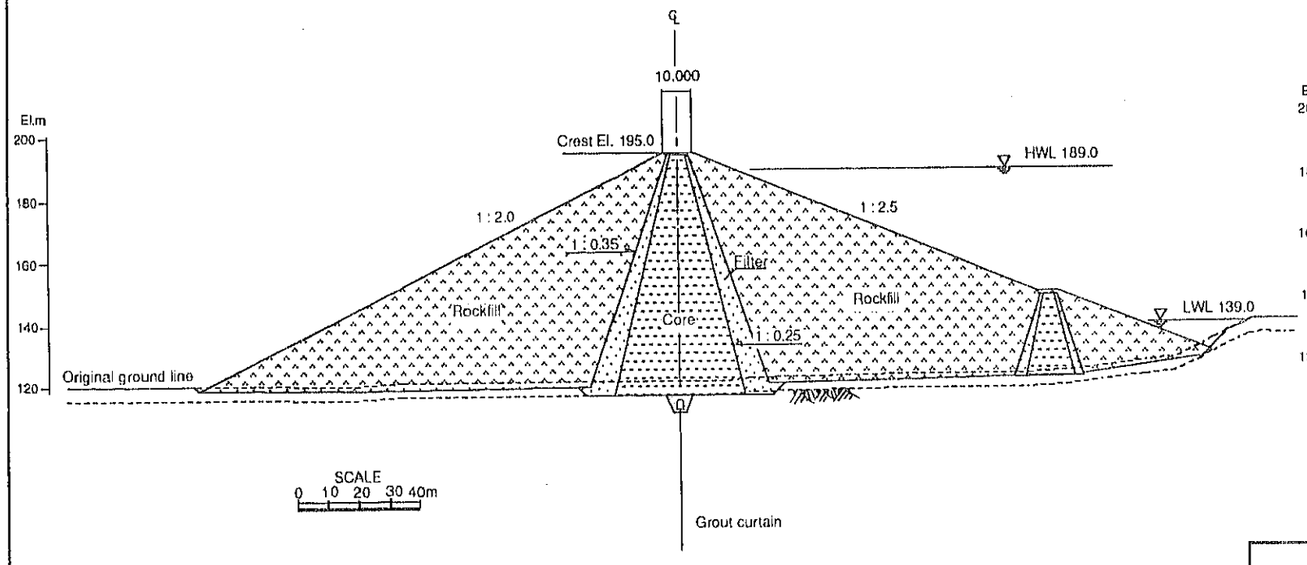
GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY



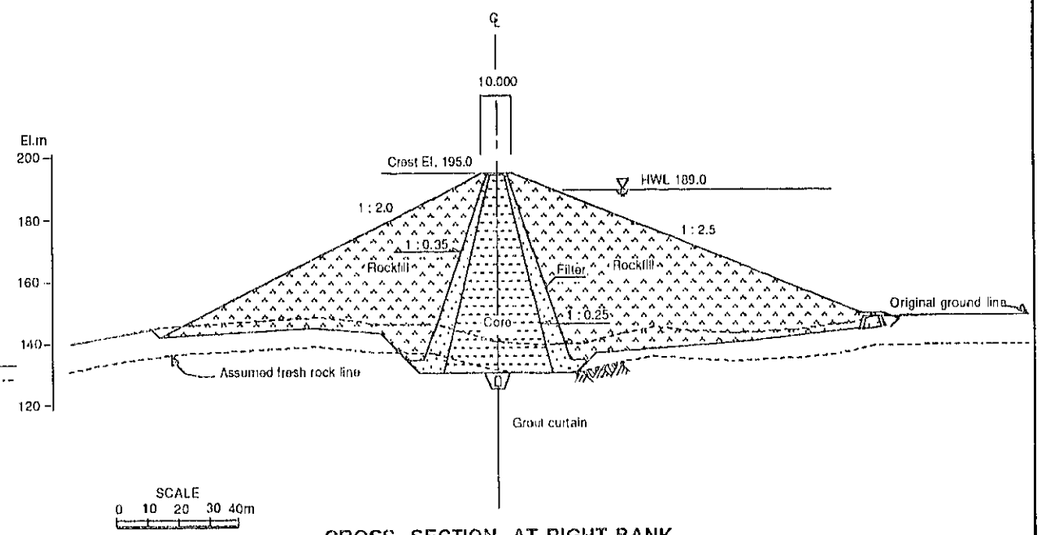
DAM PROFILE
(Upstream view)



CROSS SECTION AT LEFT BANK
(Ground El. 140 at dam axis)



CROSS SECTION AT RIVER BED

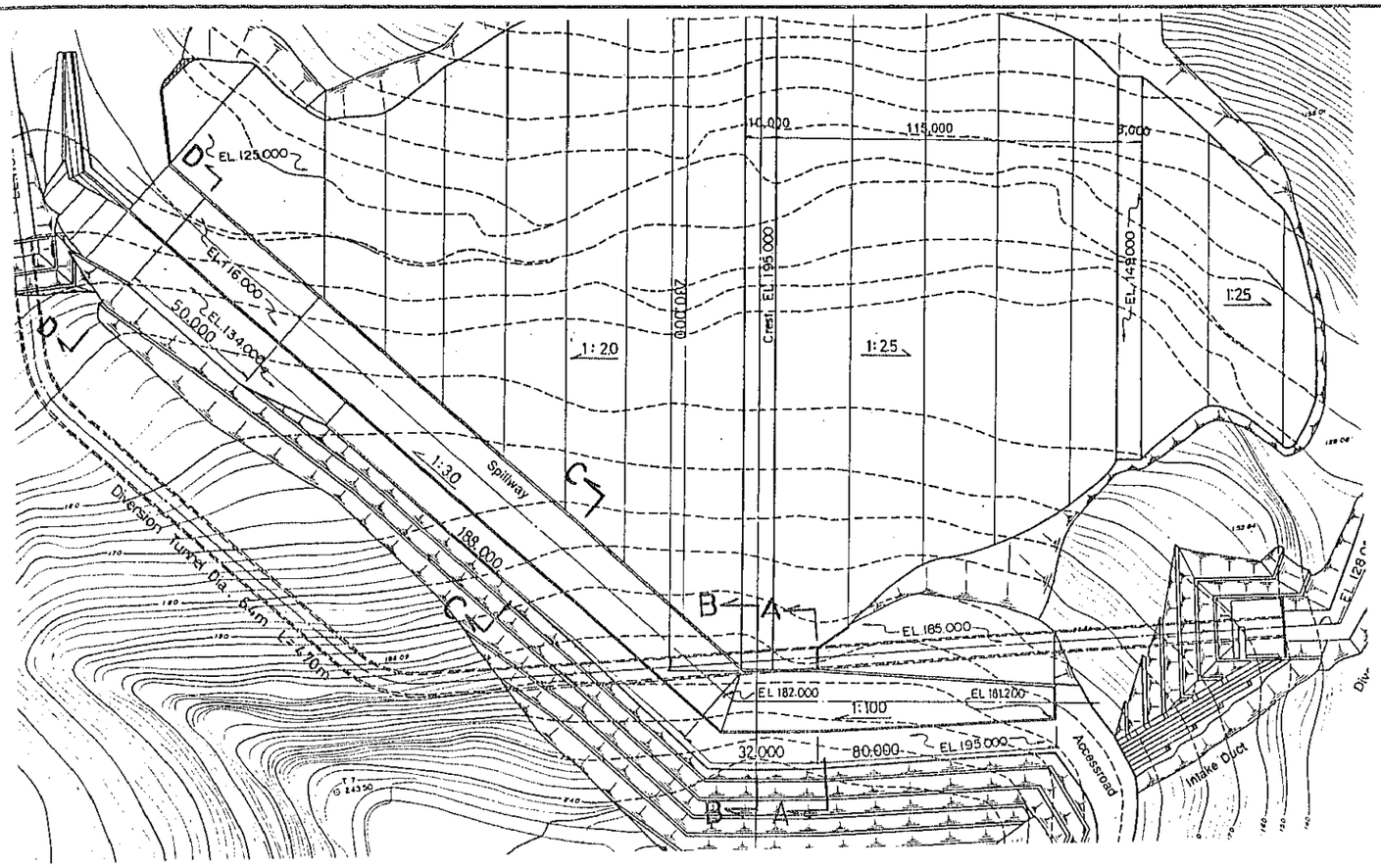


CROSS SECTION AT RIGHT BANK
(Ground El. 140 at dam axis)

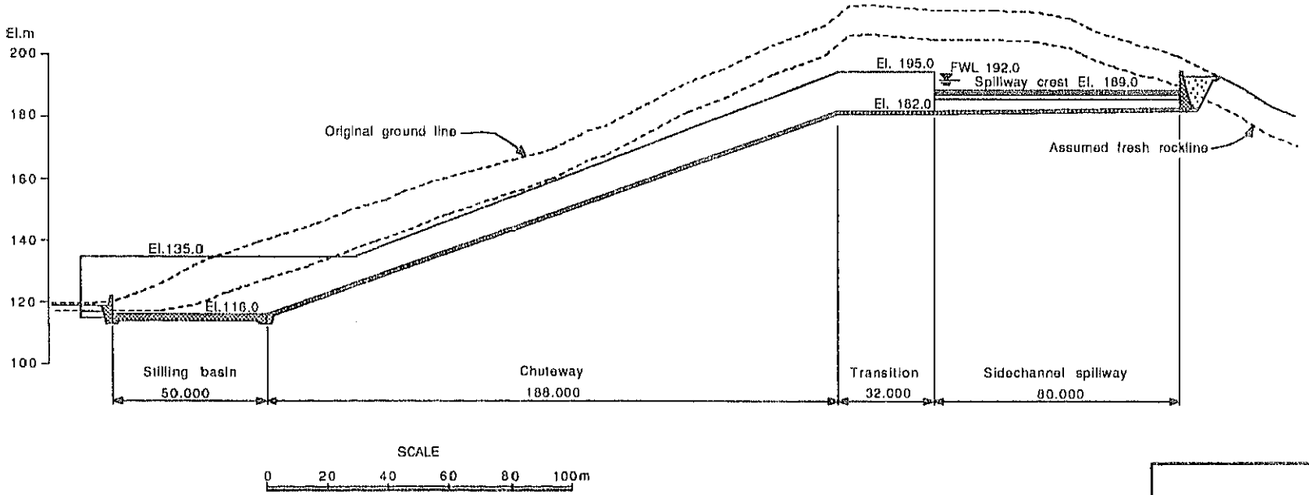
DAM PLAN, PROFILE & SECTION

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

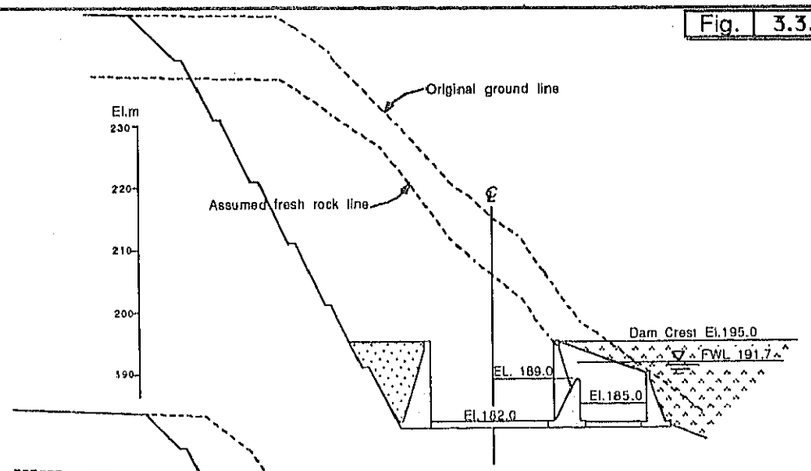
Fig. 3.3.3



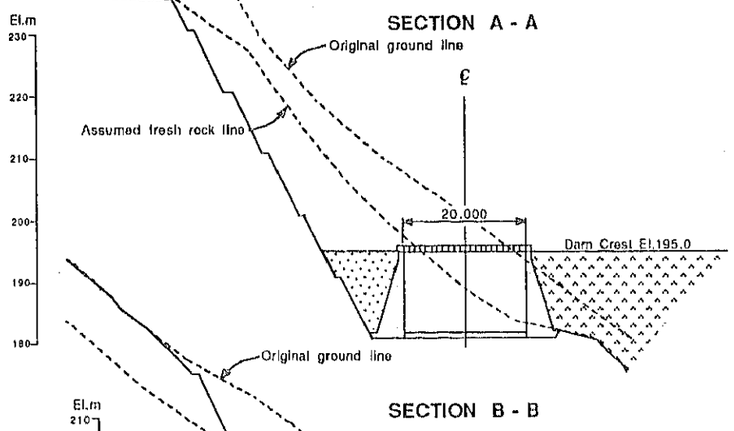
SPILLWAY PLAN



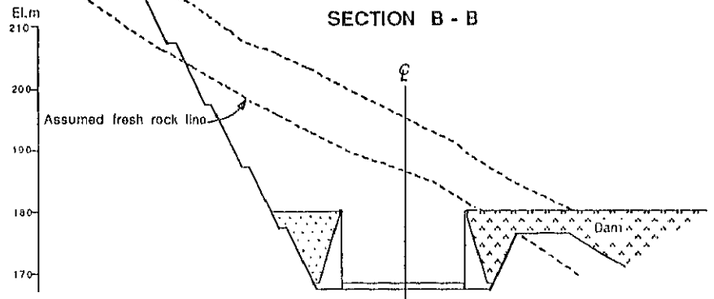
SPILLWAY PROFILE



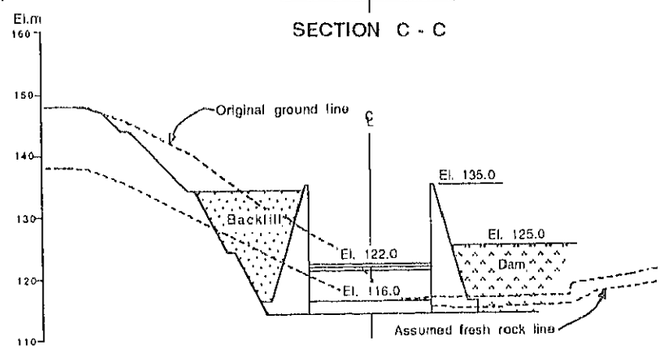
SECTION A - A



SECTION B - B



SECTION C - C

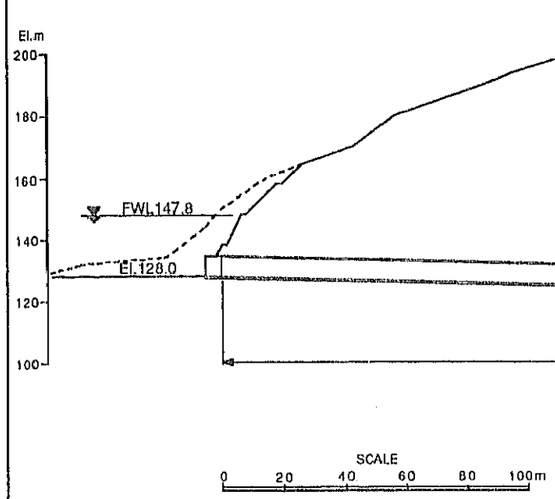


SECTION D - D

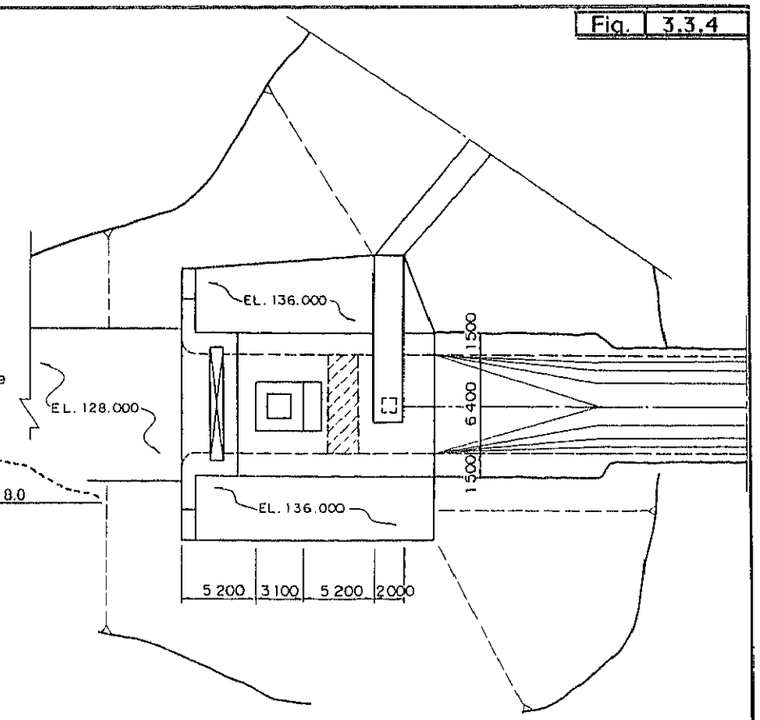
SPILLWAY PLAN, PROFILE & SECTION

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.3.4

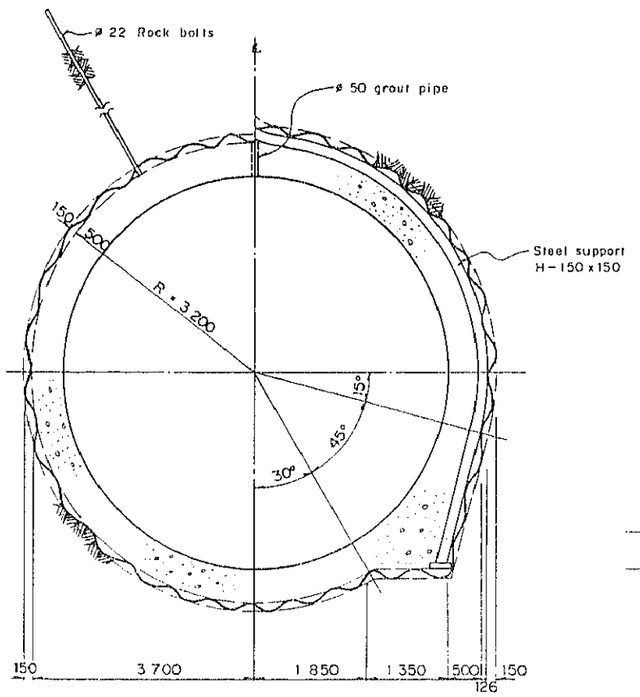


PROFILE OF RIVER DIVERSION



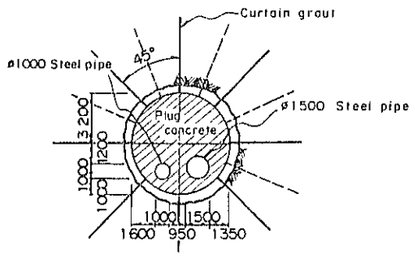
PLAN OF INLET

Scale 0 10M

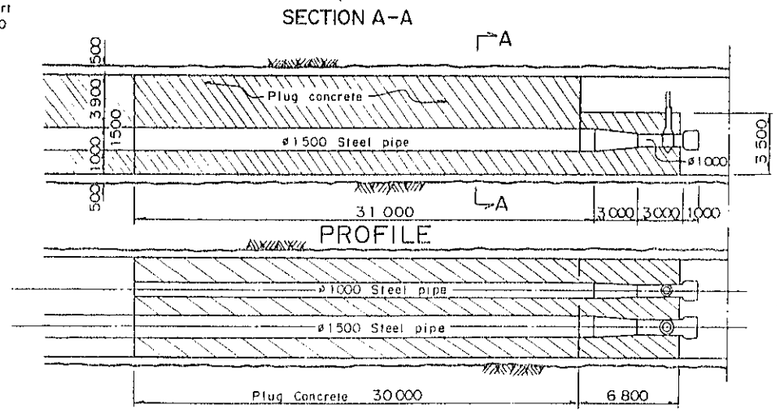


TYPICAL SECTION OF DIVERSION TUNNEL

Scale 0 1 2 3M



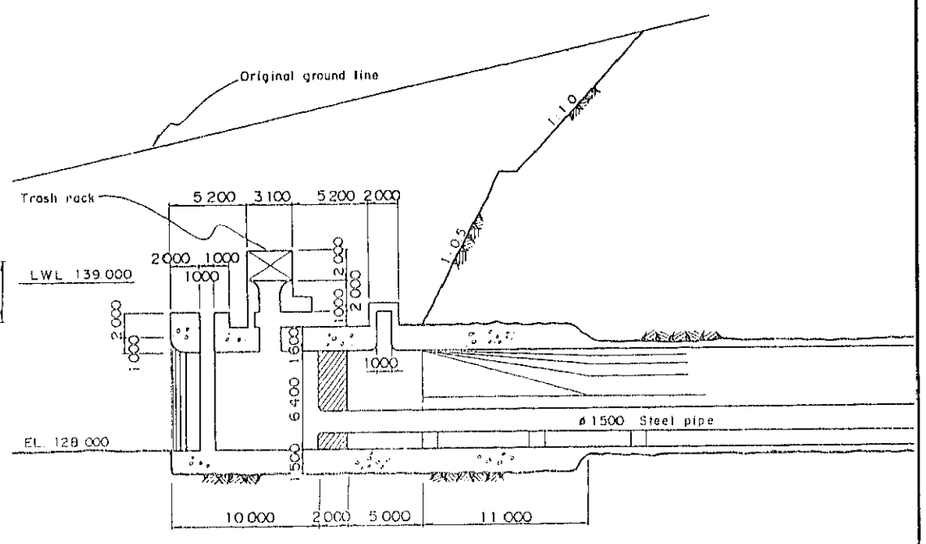
SECTION A-A



PLAN

RIVER OUTLET PROFILE PLAN & SECTION

Scale 0 10M

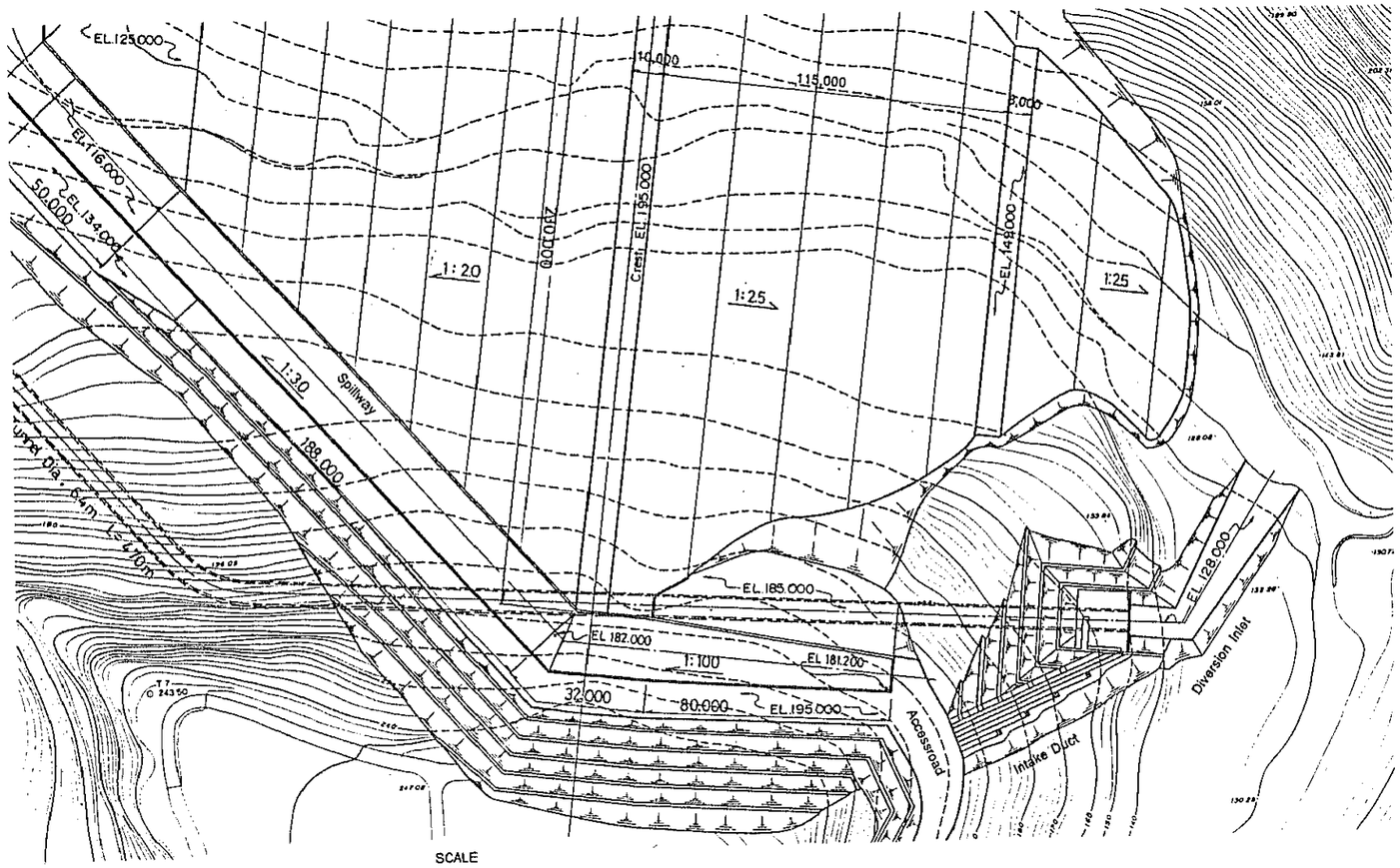


PROFILE OF INLET

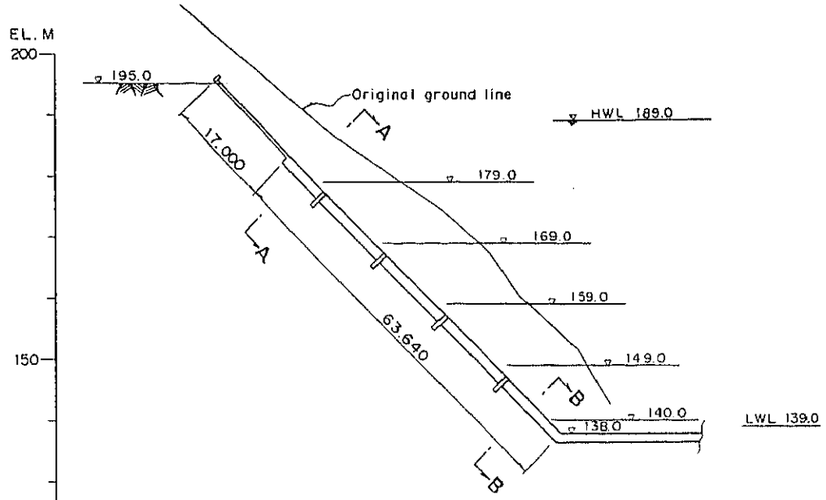
Scale 0 10M

DIVERSION & RIVER OUTLET PLAN, PROFILE & SECTION

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

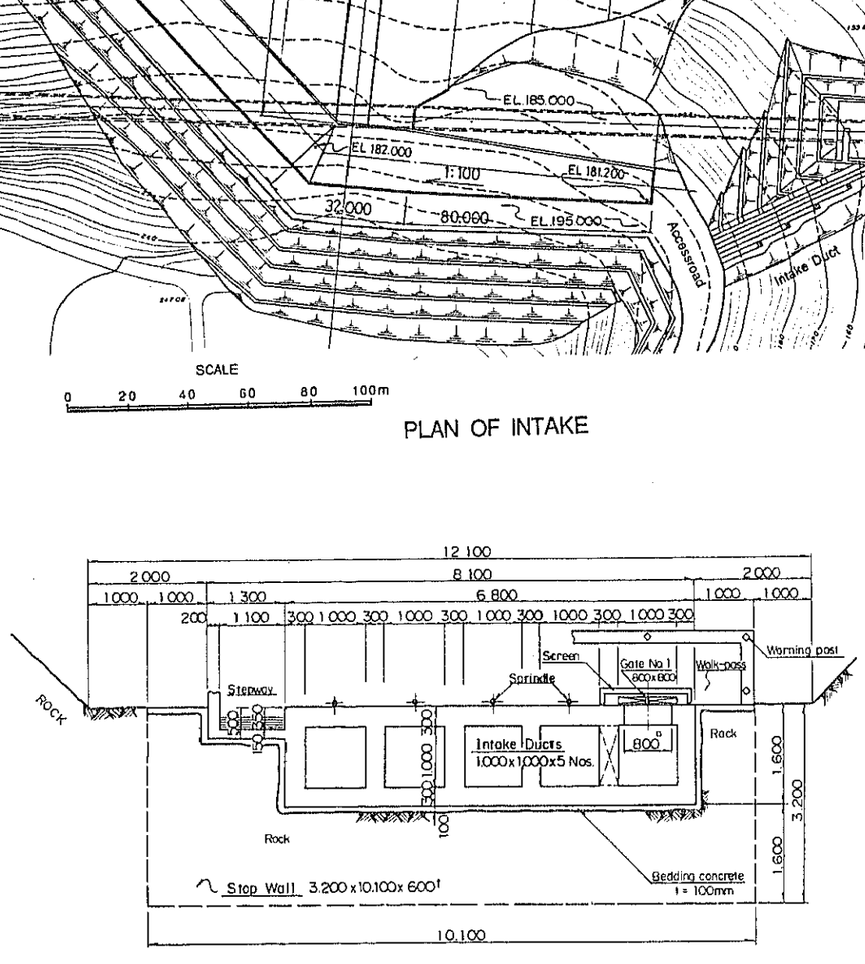


PLAN OF INTAKE



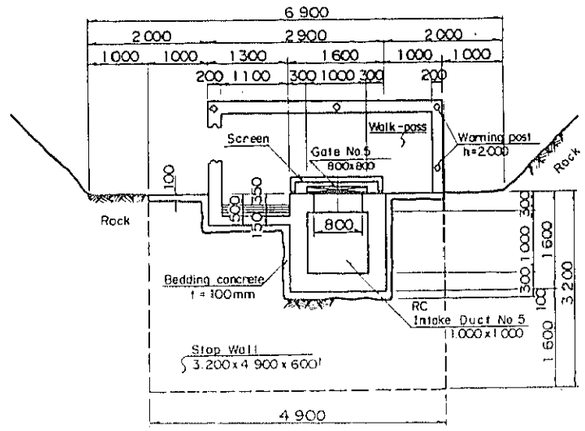
PROFILE OF INTAKE DUCT

Scale 0 50M



SECTION A-A

Scale 0 1 2M

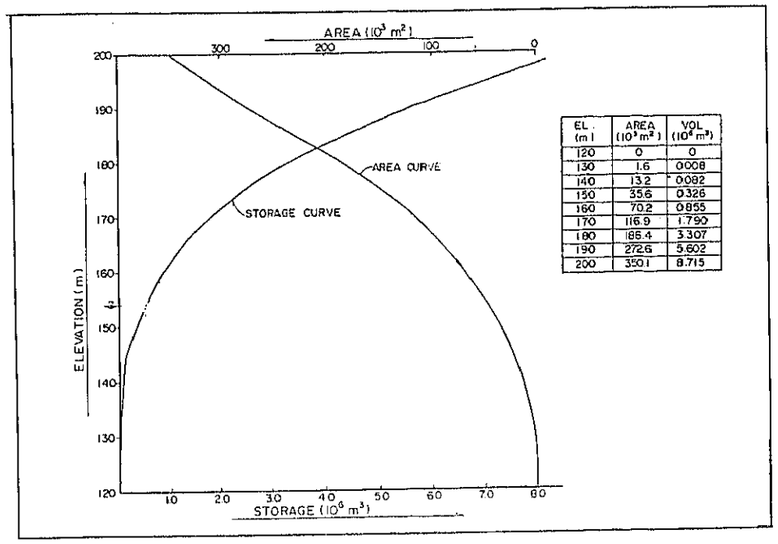


SECTION B-B

Scale 0 1 2M

INTAKE PLAN, PROFILE & SECTION	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.3.6



EL. (m)	AREA (10^3 m^2)	VOL (10^6 m^3)
120	0	0
130	1.6	0.008
140	13.2	0.082
150	35.6	0.326
160	70.2	0.855
170	116.9	1.790
180	186.4	3.307
190	272.6	5.602
200	350.1	8.715

Terre Rouge Resorvoir

Dam

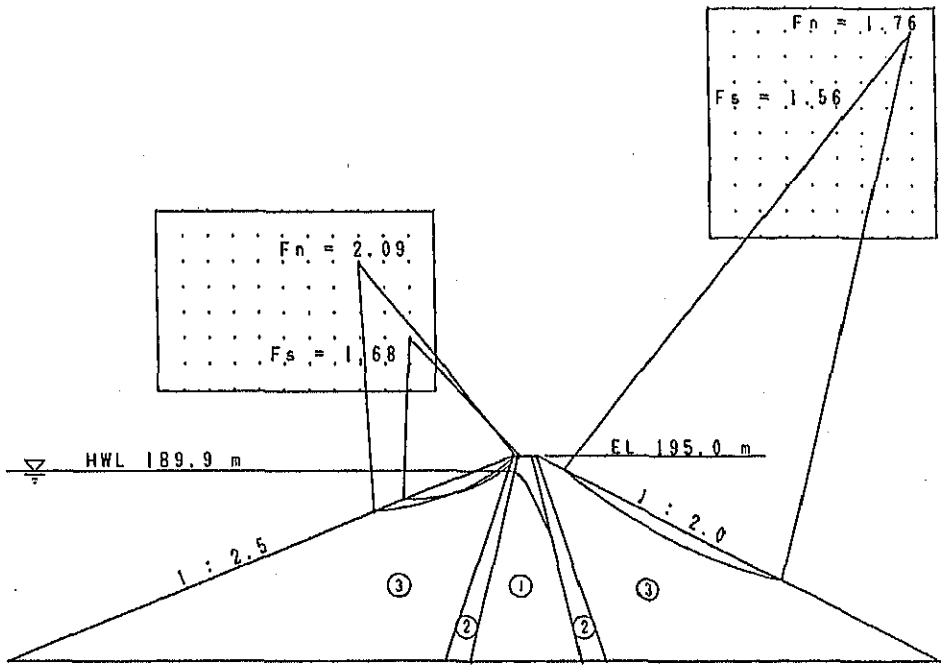
Spillway

SCALE
0 100 200 m

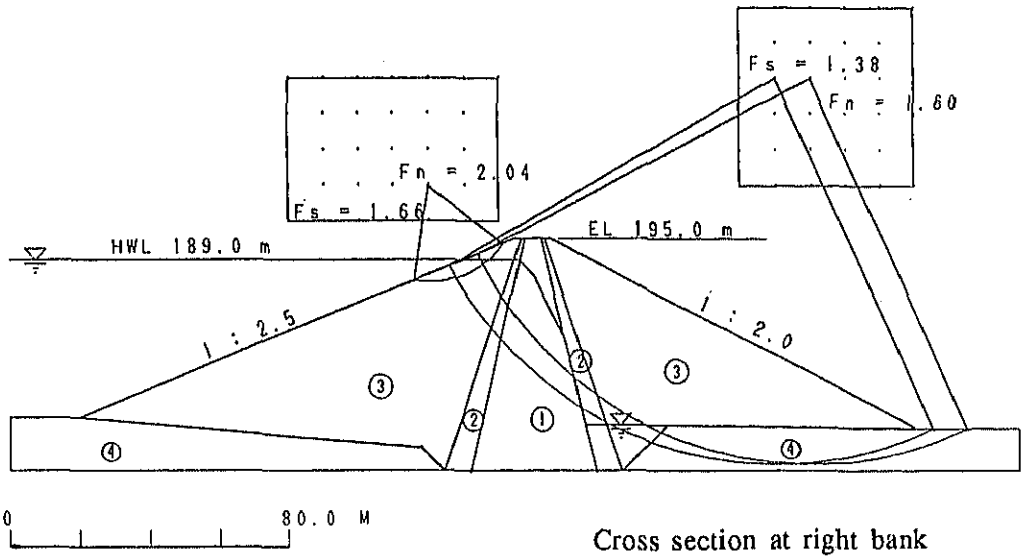
LEGEND [ ] : Resovoir Area at HWL 189.0m

RESERVOIR AREA

GOVERNMENT OF MAURITIUS
PORT Llouis WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY



Cross section at river bed



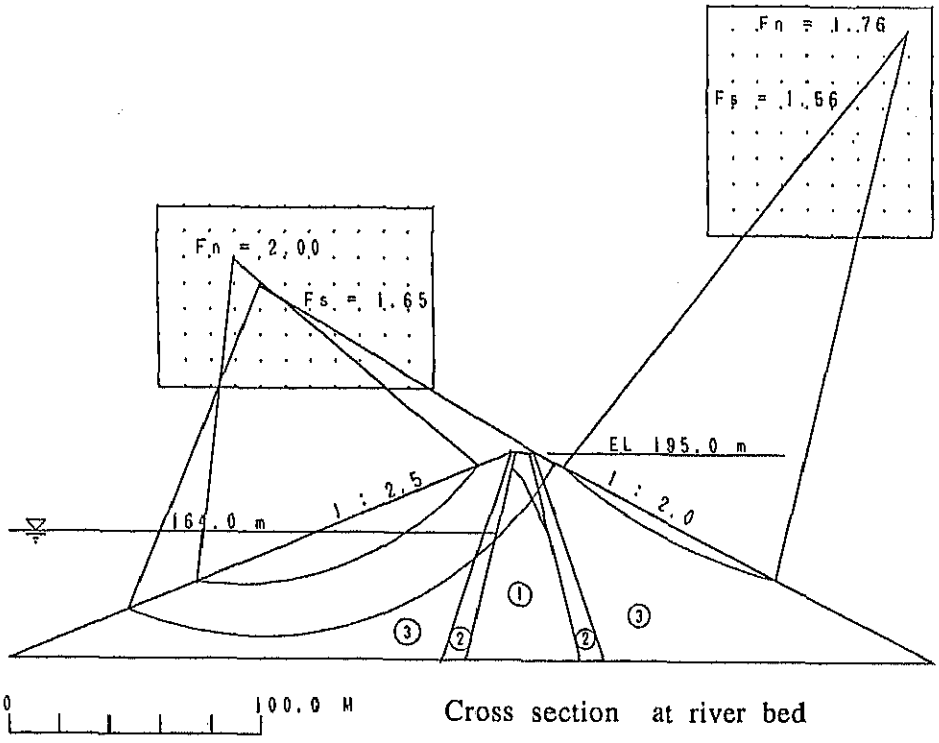
Cross section at right bank
(ground El. 140 m)

Notes :
Fn : *Safety factor in normal*
Fs : Safety factor in seismic

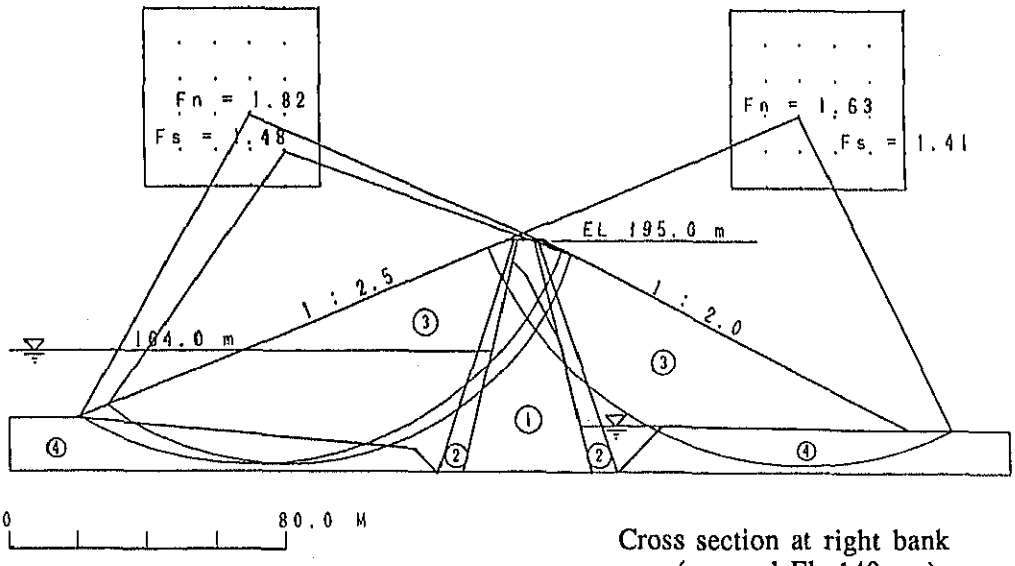
Zone : 1 Core 3 Rock
2 Filter 4 Talus deposit

STABILITY ANALISIS OF TR-0 DAM CASE(1) Reservoir water level at HWL	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.3.7(2)



Cross section at river bed



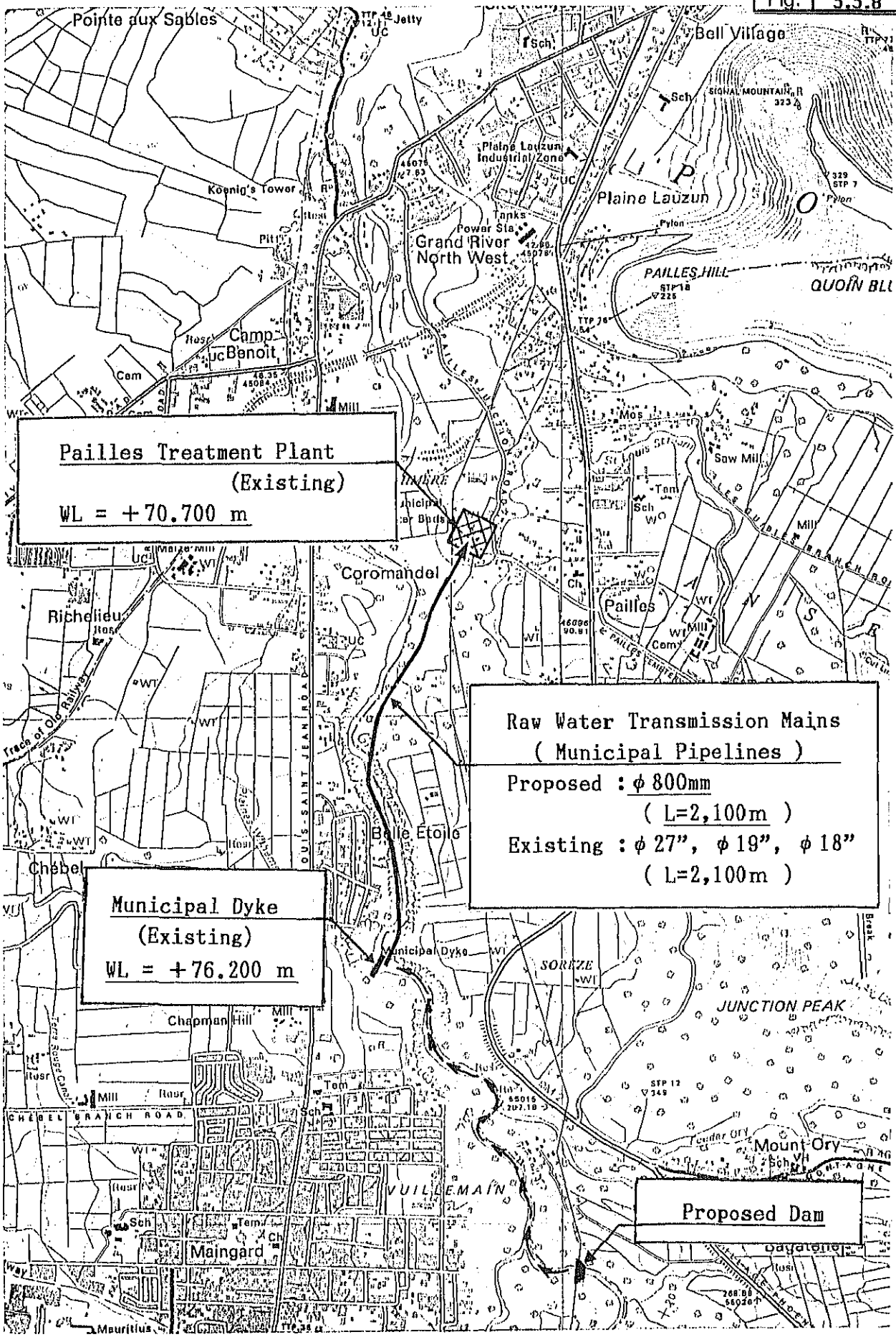
Cross section at right bank
(ground El. 140 m)

Notes :
Fn : Safety factor in normal
Fs : Safety factor in seismic

Zone : 1 Core 3 Rock
2 Filter 4 Talus deposit

STABILITY ANALISIS OF TR-0 DAM CASE(2) Rapid drawdown	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

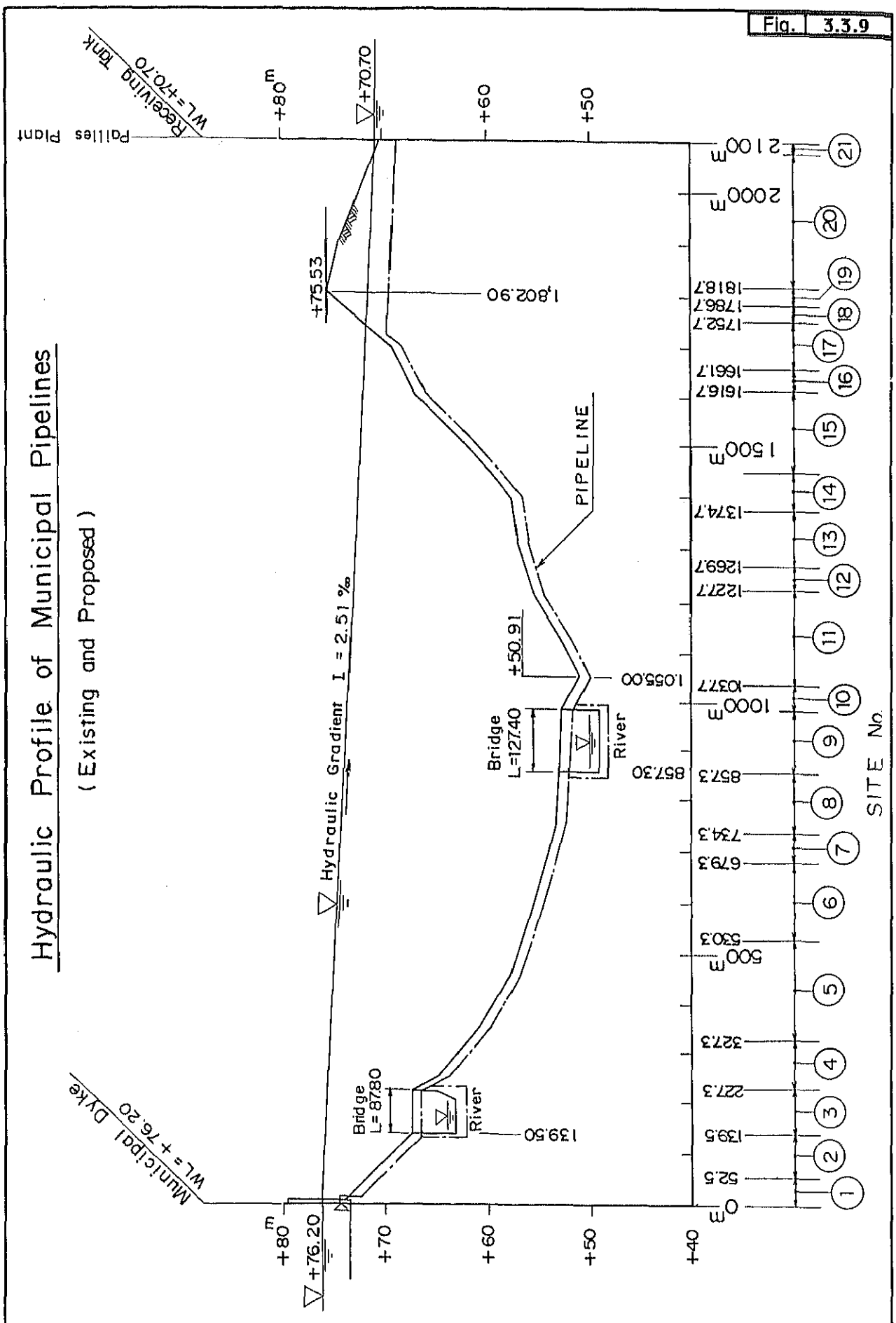
Fig. 3.3.8



LOCATION MAP
(RAW WATER TRANSMISSION PIPELINE)

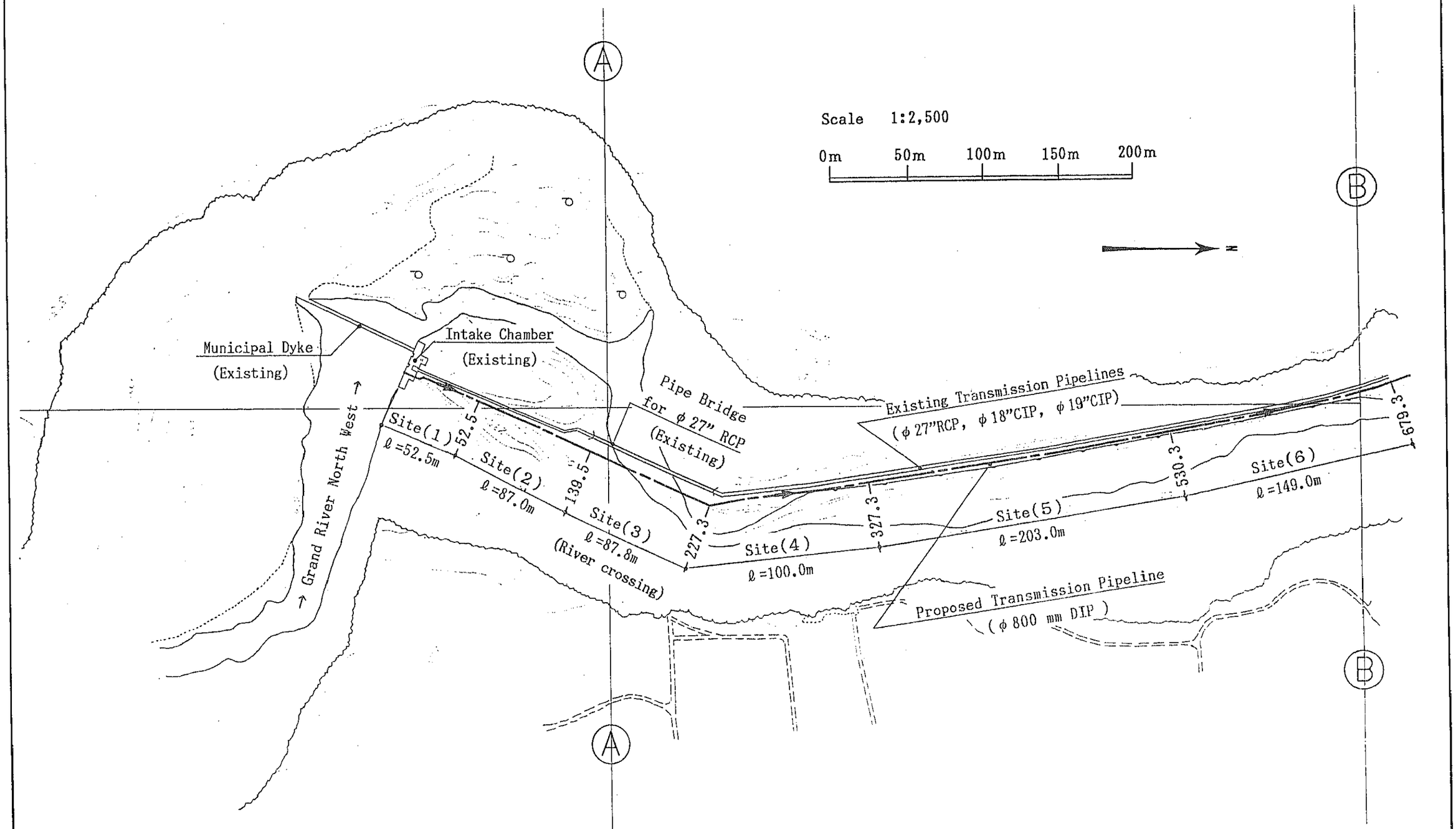
GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

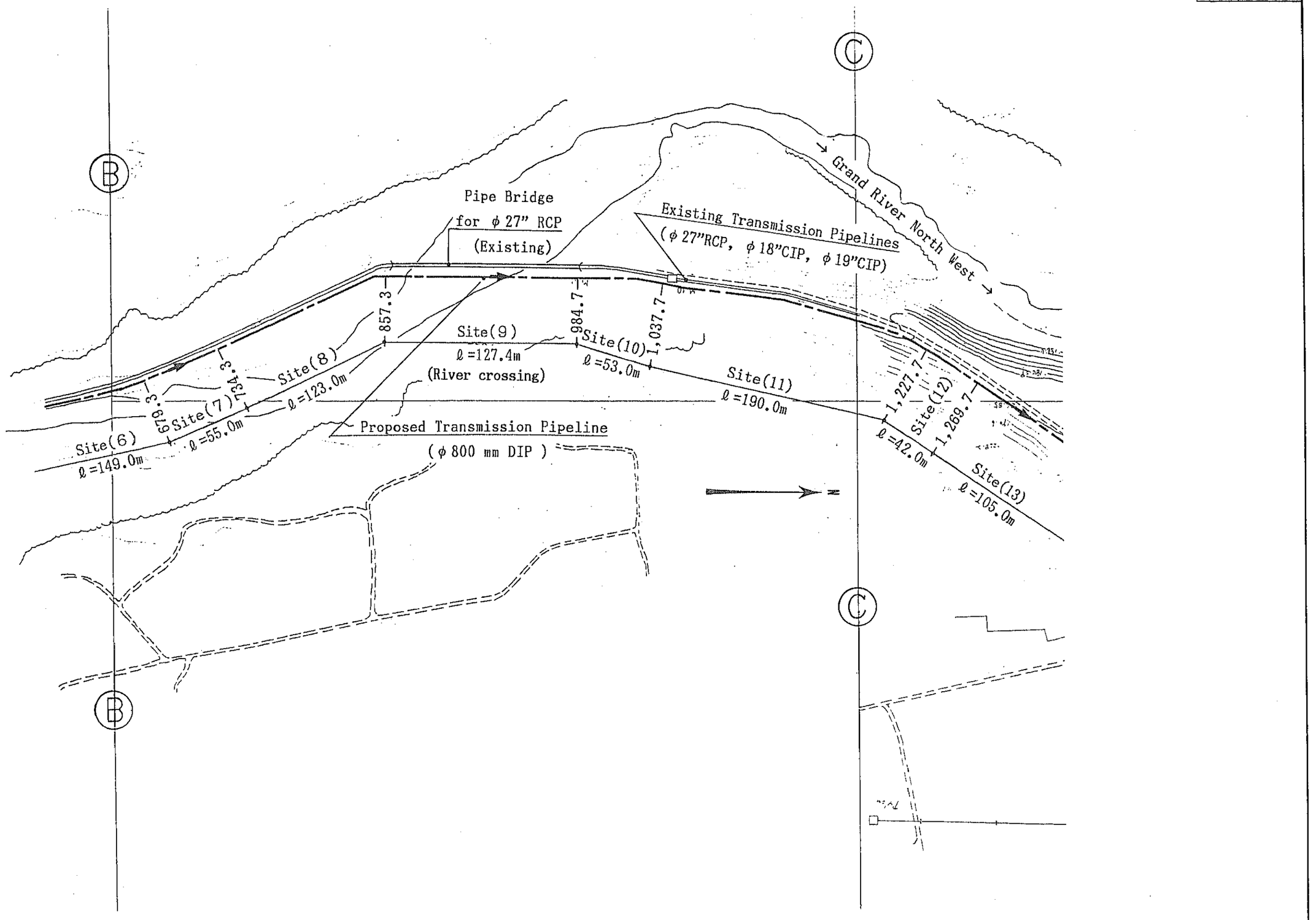


HYDRAULIC PROFILE OF PIPELINE
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY



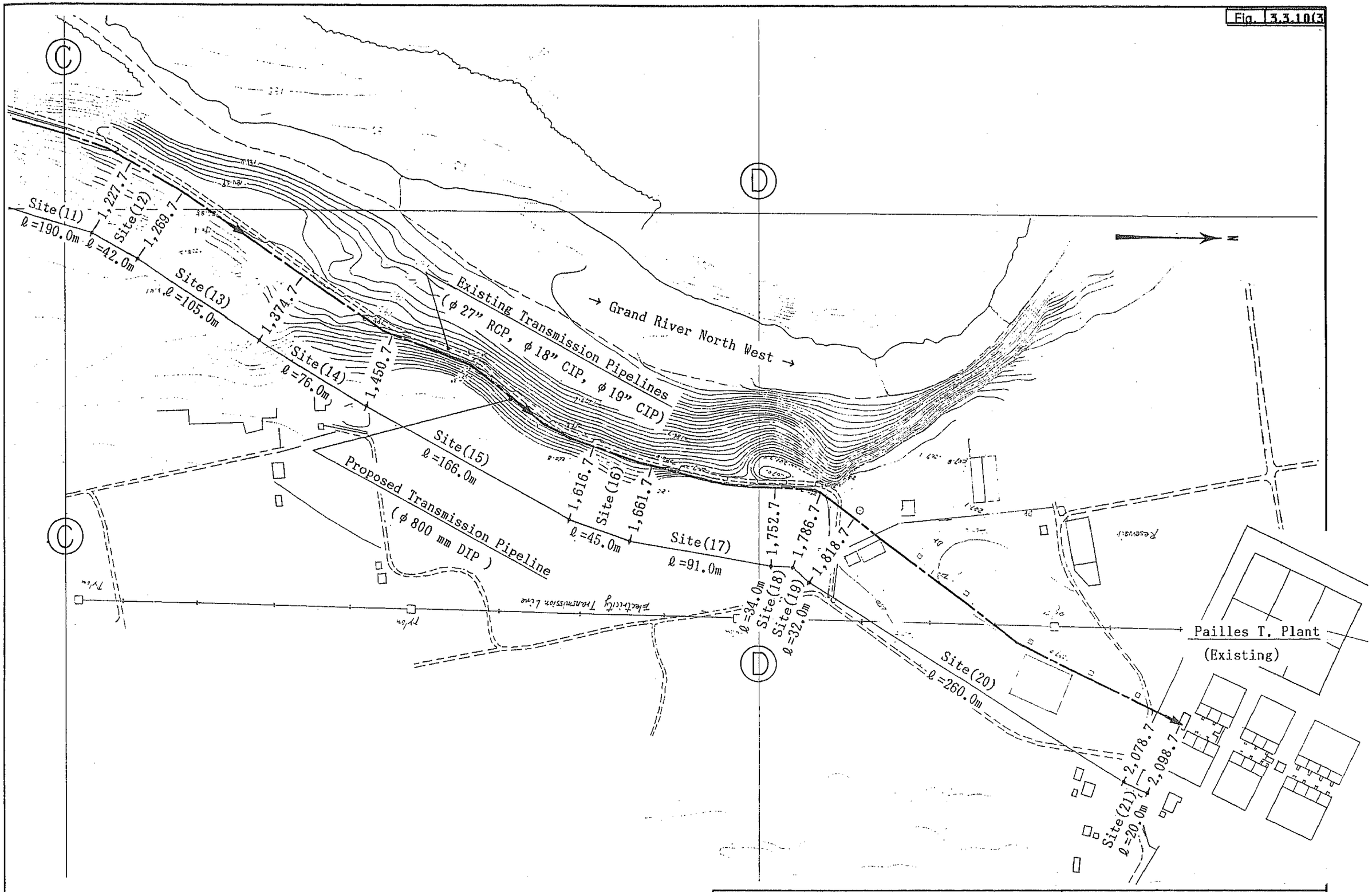
GENERAL PLAN OF PIPELINE (1) (RAW WATER TRANSMISSION PIPELINE)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY



GENERAL PLAN OF PIPELINE (2)
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

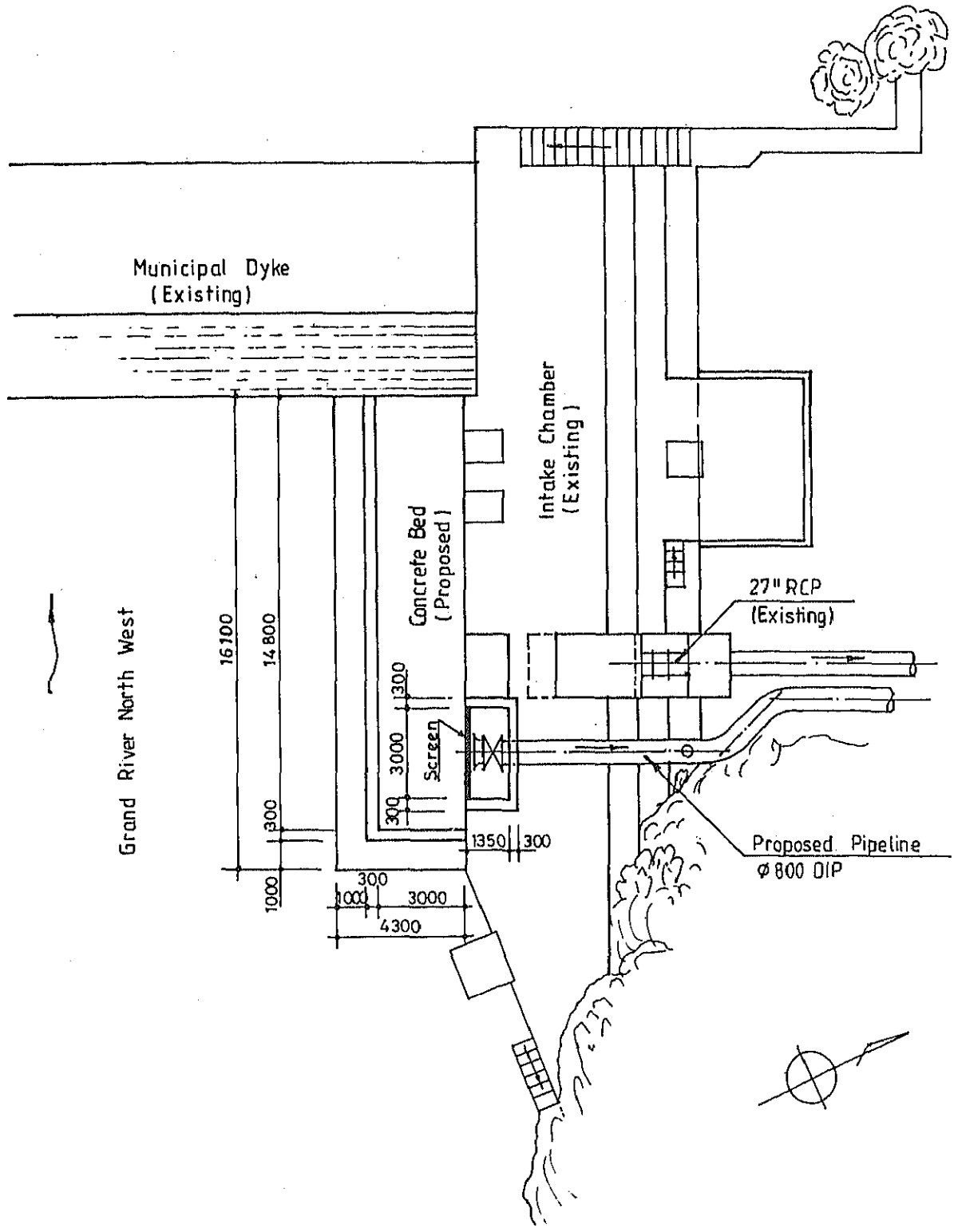
Fig. 3.3.10(3)



GENERAL PLAN OF PIPELINE (3)
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

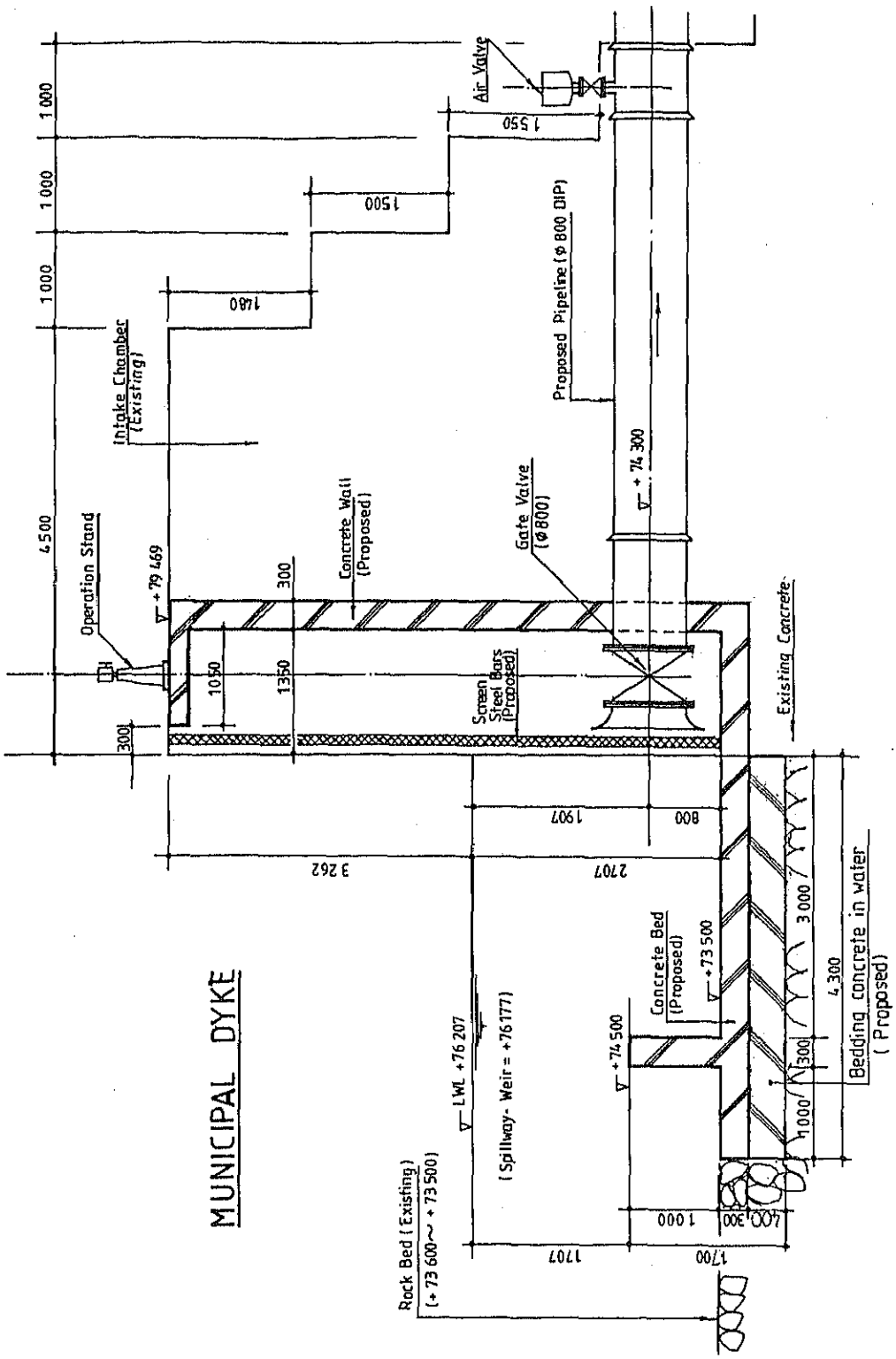
Fig. 3.3.11



INTAKE FACILITY AT MUNICIPAL DYKE
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

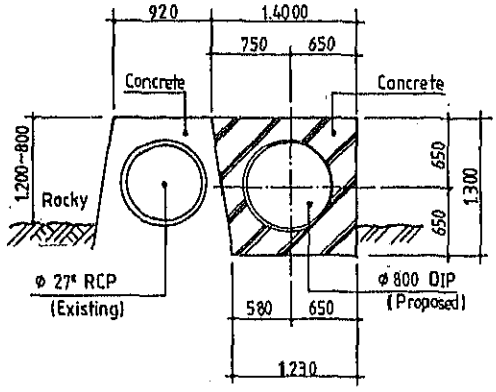
Fig. 3.3.12



INTAKE CHAMBER (RAW WATER TRANSMISSION PIPELINE)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

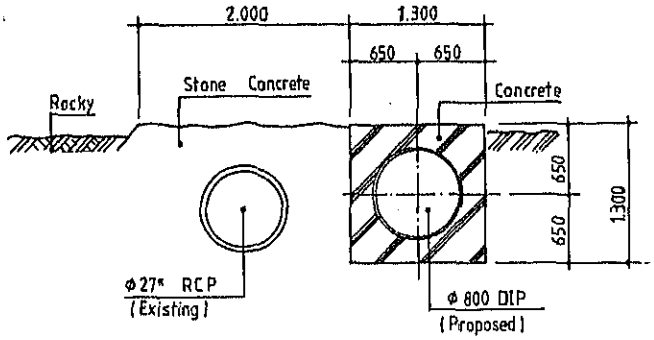
SITE — (1)

(L = 52.5m)



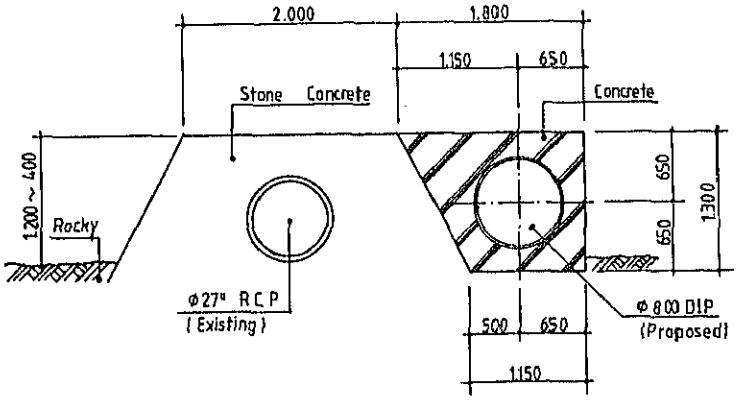
SITE — (2)

(L = 87.0 m)



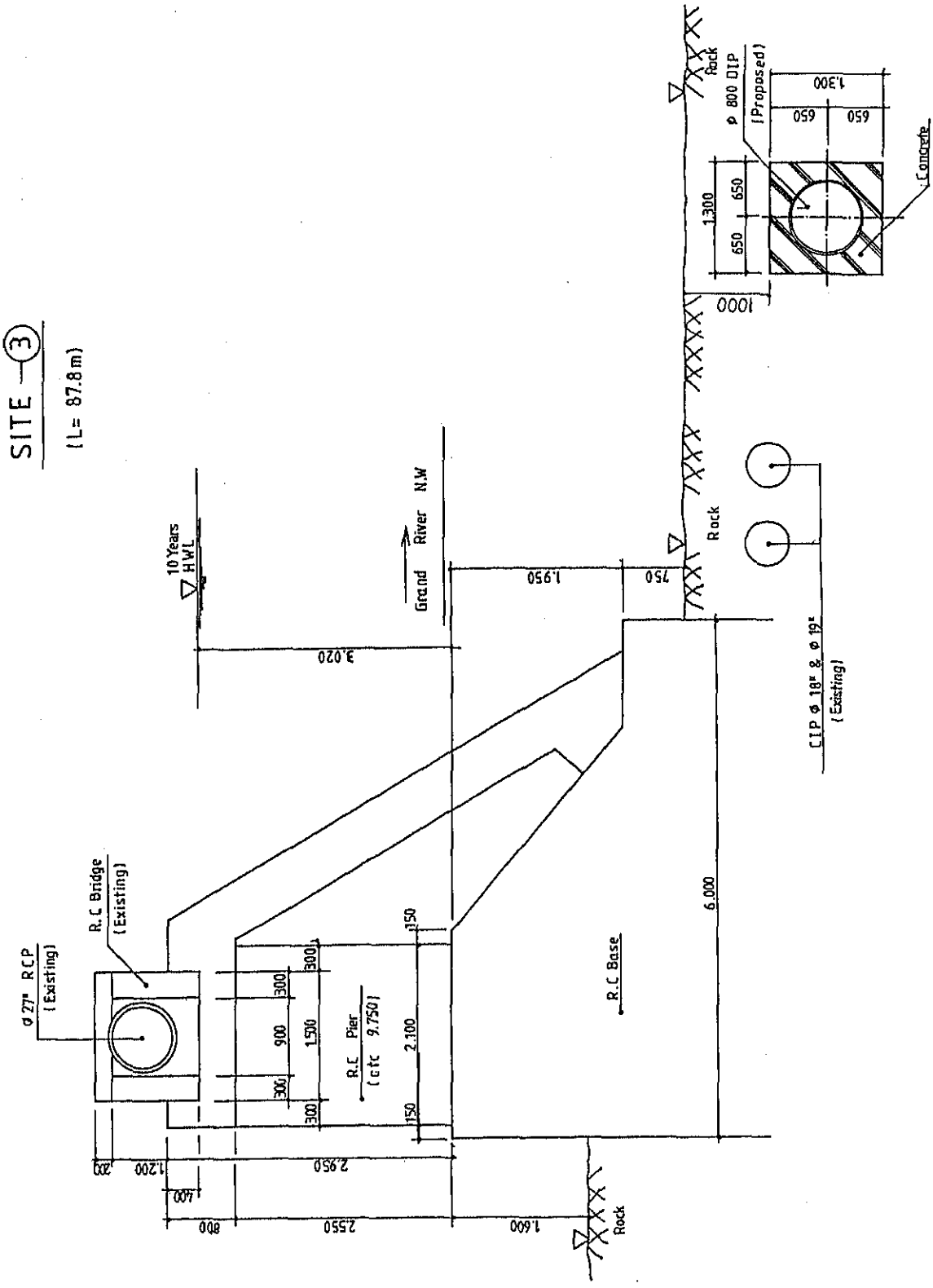
SITE — (4)

(L = 100,0 m)



SECTION OF PROPOSED PIPELINE (1) (RAW WATER TRANSMISSION PIPELINE)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.3.13(2)

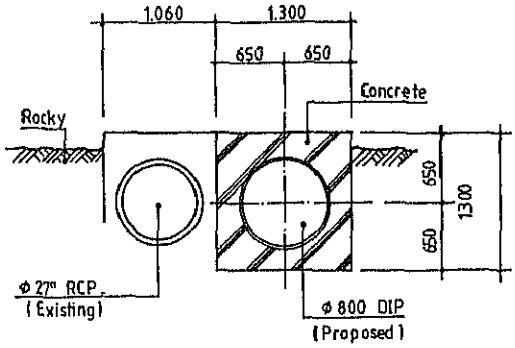


SECTION OF PROPOSED PIPELINE (2)
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

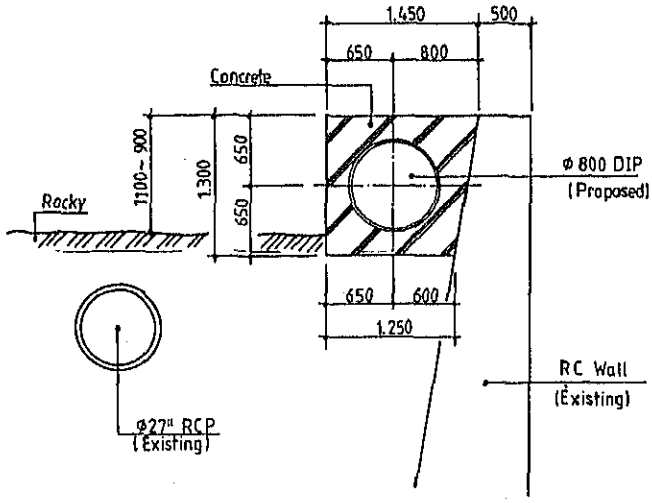
SITE — (5)

(L= 203.0m)



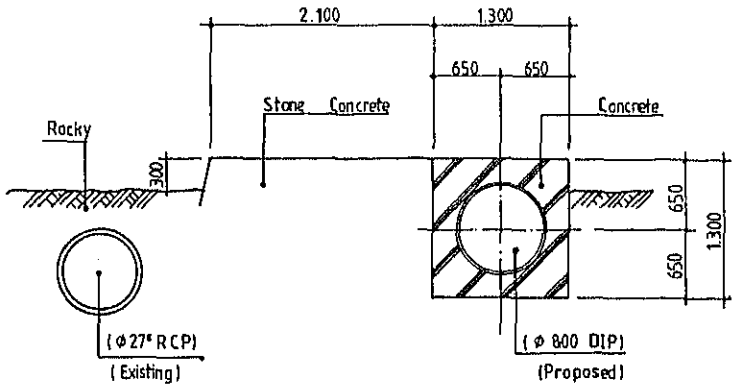
SITE — (6)

(L = 149.0m)



SITE — (7)

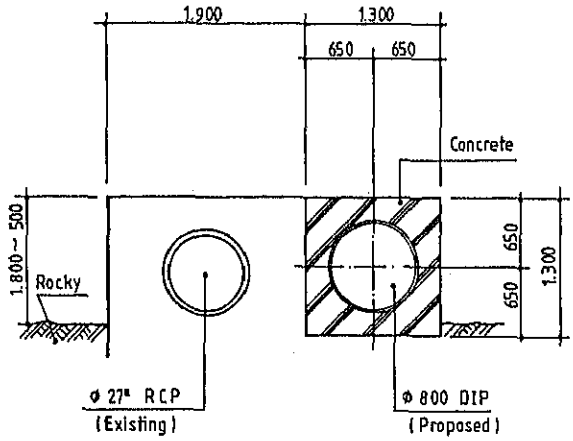
(L = 55.0 m)



SECTION OF PROPOSED PIPELINE (3) (RAW WATER TRANSMISSION PIPELINE)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

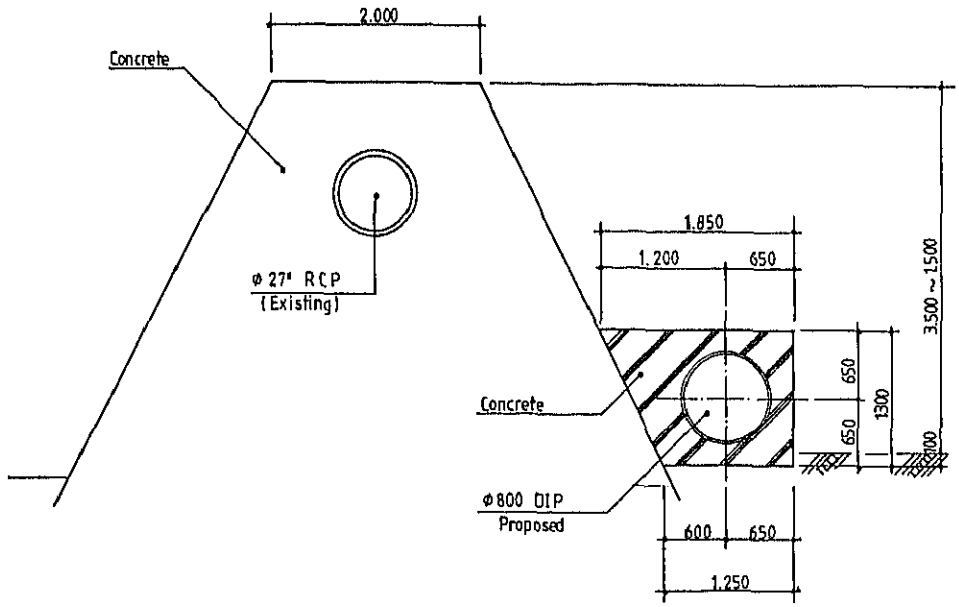
SITE — ⑧

(L = 123.0m)



SITE — ⑩

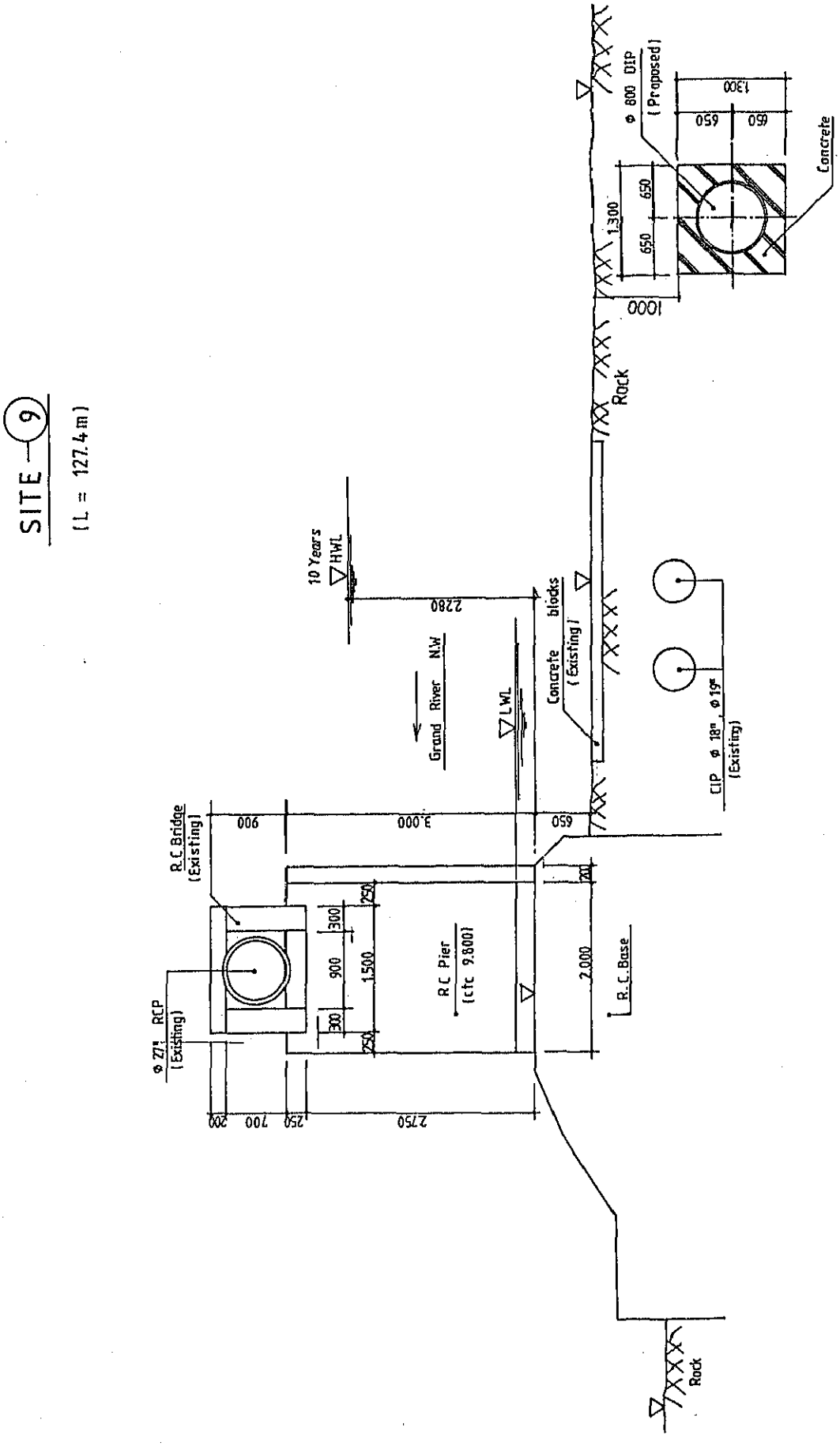
(L = 53.0m)



SECTION OF PROPOSED PIPELINE (4)
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.3.13(5)

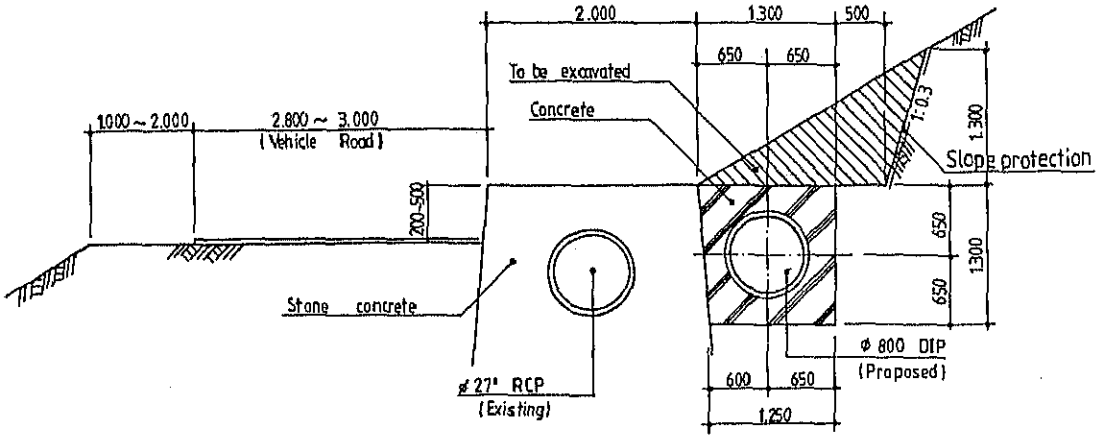


SECTION OF PROPOSED PIPELINE (5)
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

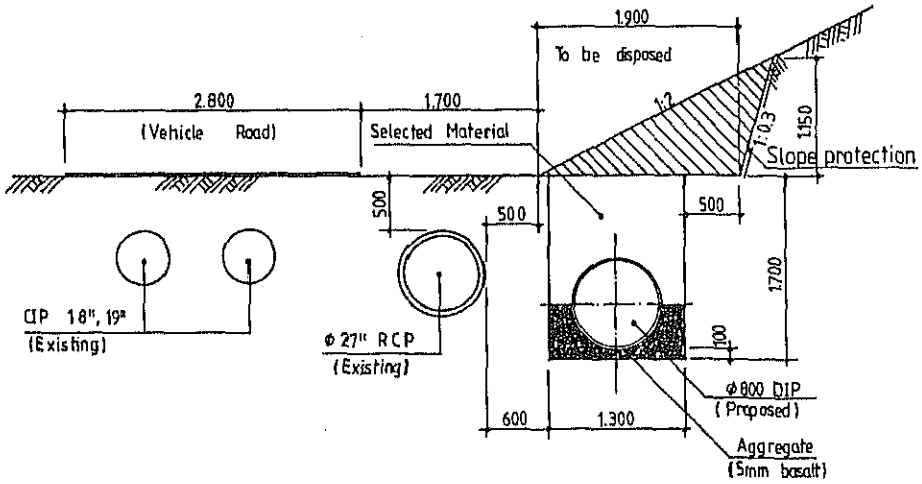
SITE -(11)

(L = 190.0 m)



SITE -(12)

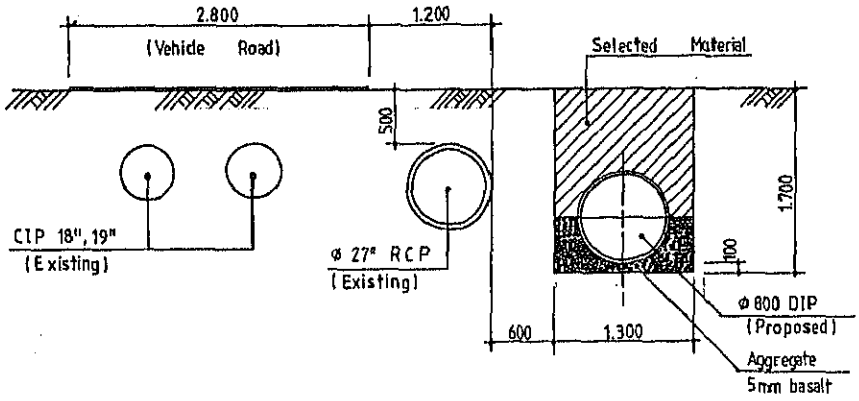
(L = 42.0 m)



SECTION OF PROPOSED PIPELINE (6) (RAW WATER TRANSMISSION PIPELINE)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

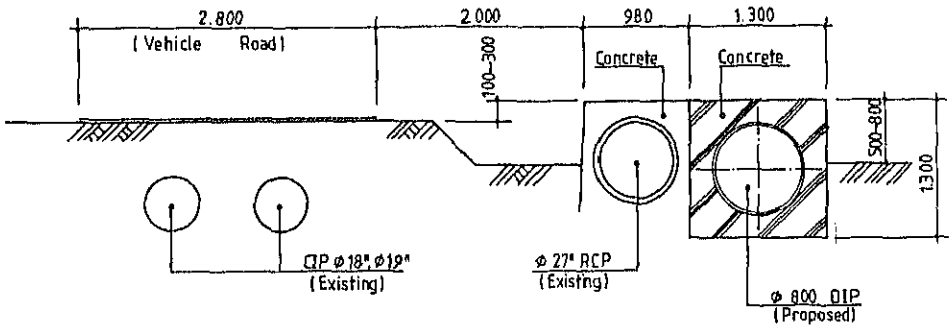
SITE – (13)

(L = 105.0m)



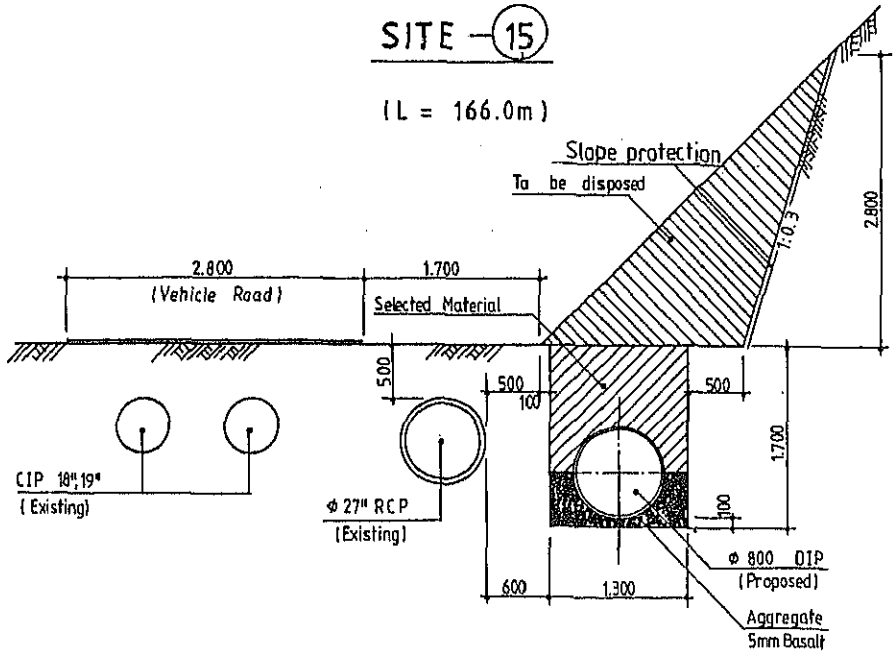
SITE–(14)

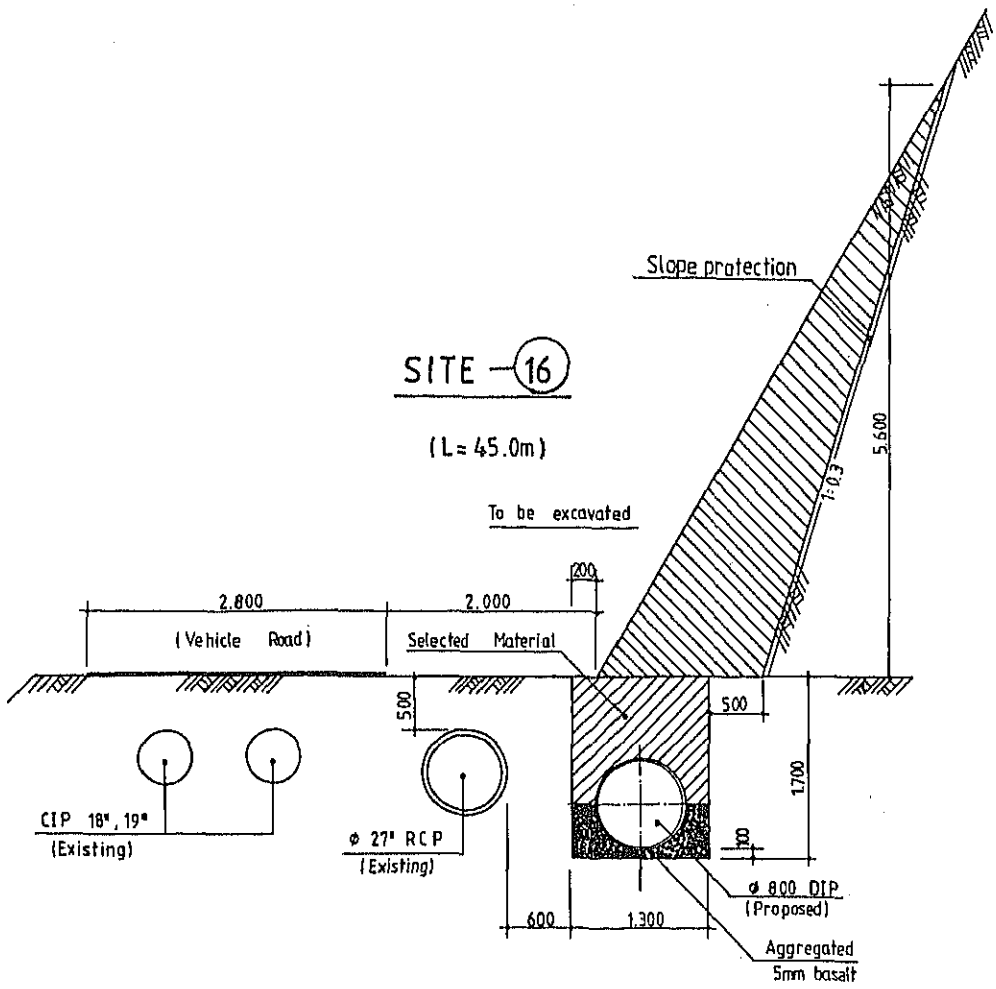
(L = 76.0 m)



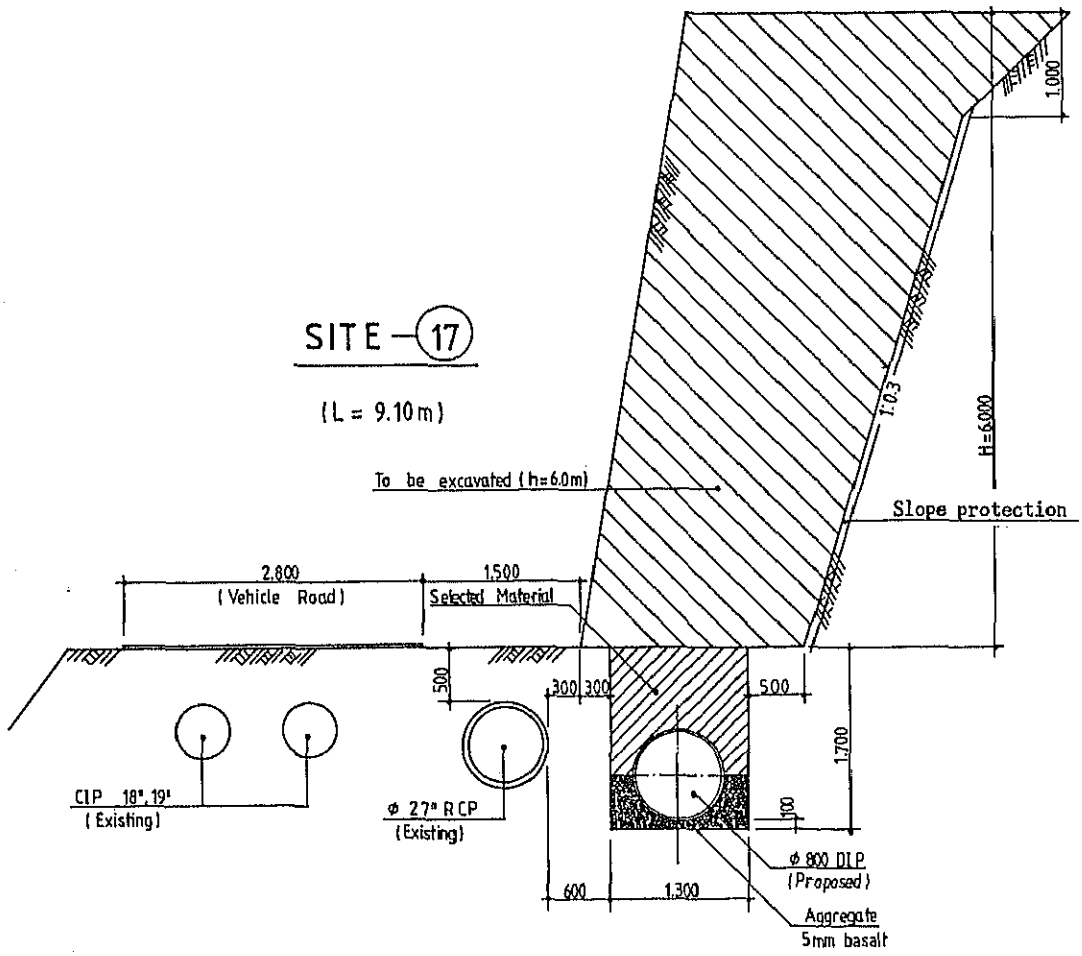
SECTION OF PROPOSED PIPELINE (7)
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY





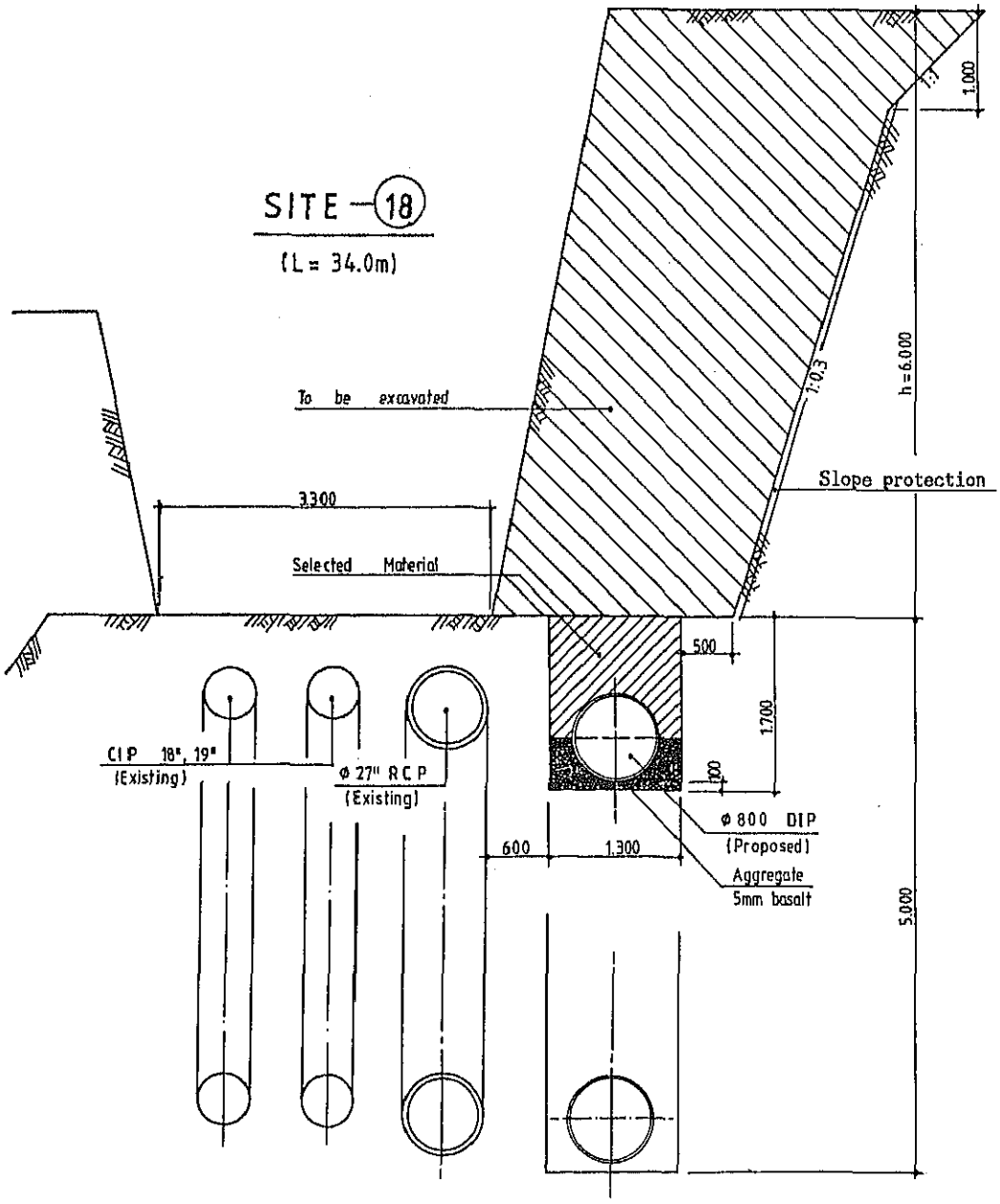
SECTION OF PROPOSED PIPELINE (8) (RAW WATER TRANSMISSION PIPELINE)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY



SECTION OF PROPOSED PIPELINE (9)
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



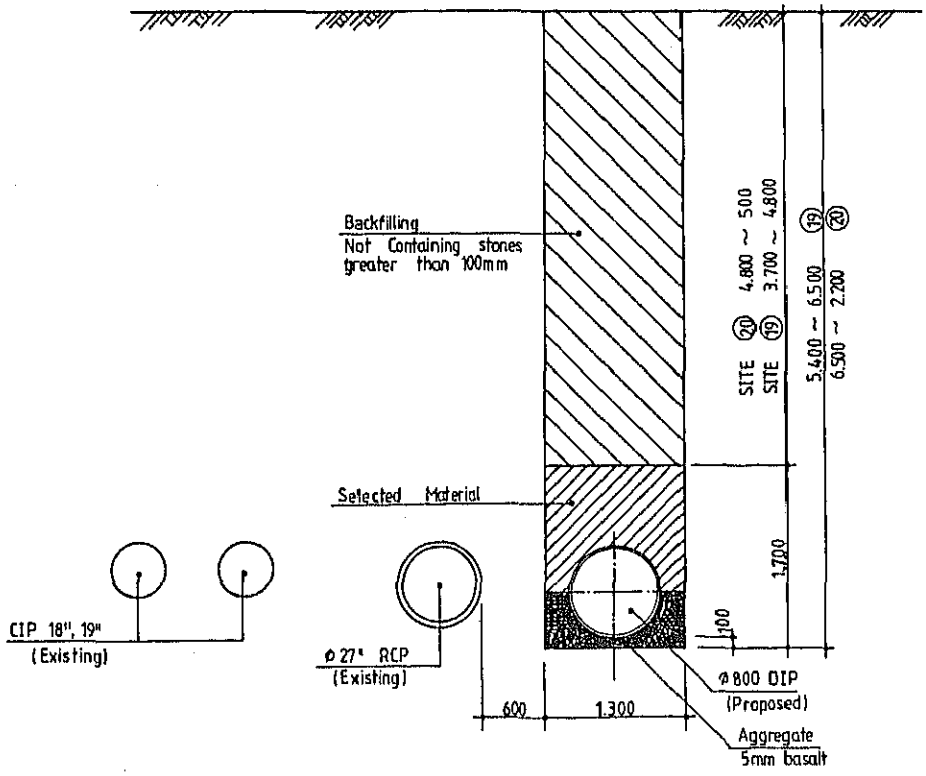
SECTION OF PROPOSED PIPELINE (10)
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

SITE – (19) & SITE – (20)

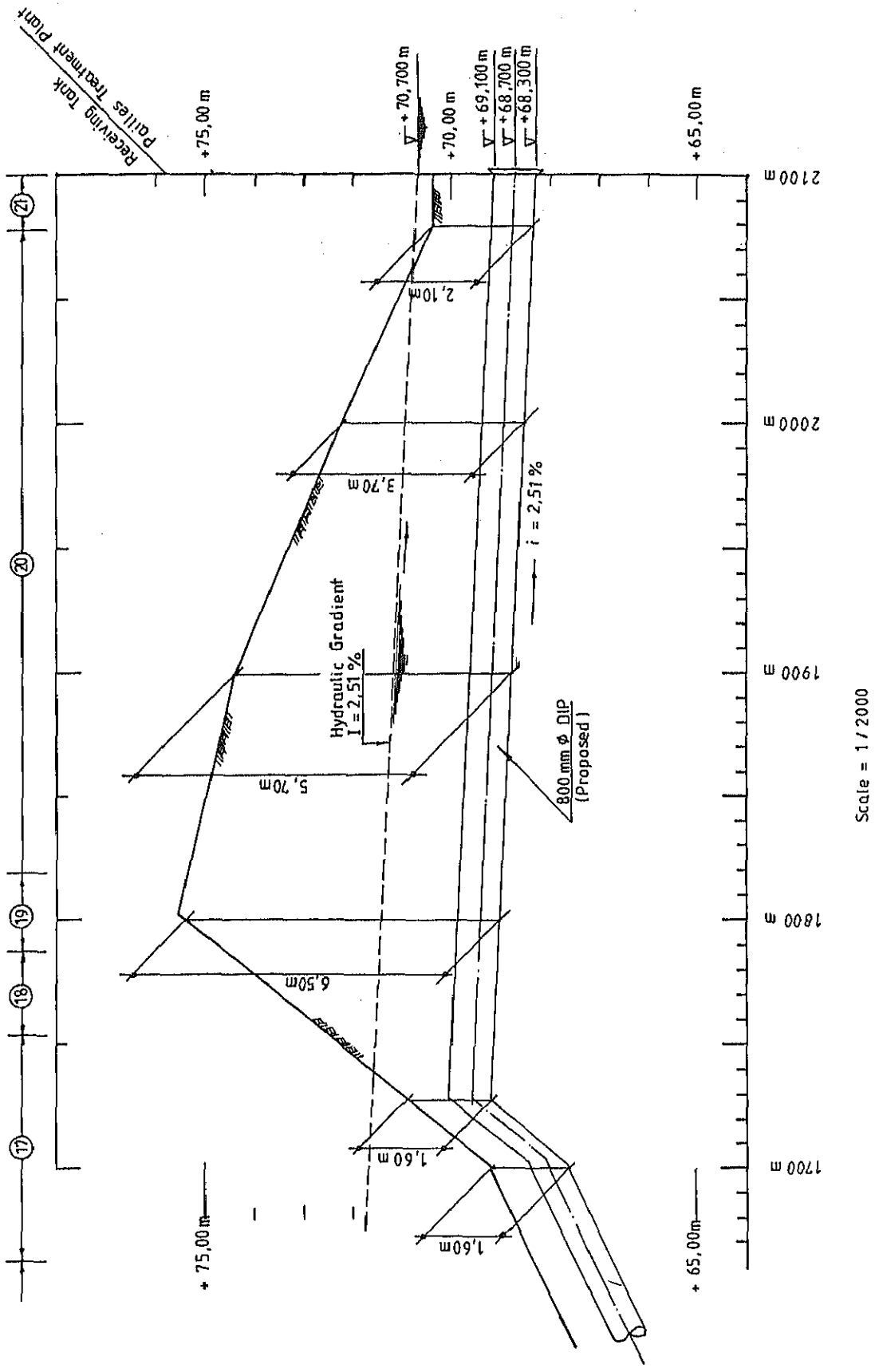
(L = 32.0m) (L = 260.0m)



SECTION OF PROPOSED PIPELINE (11)
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.3.14

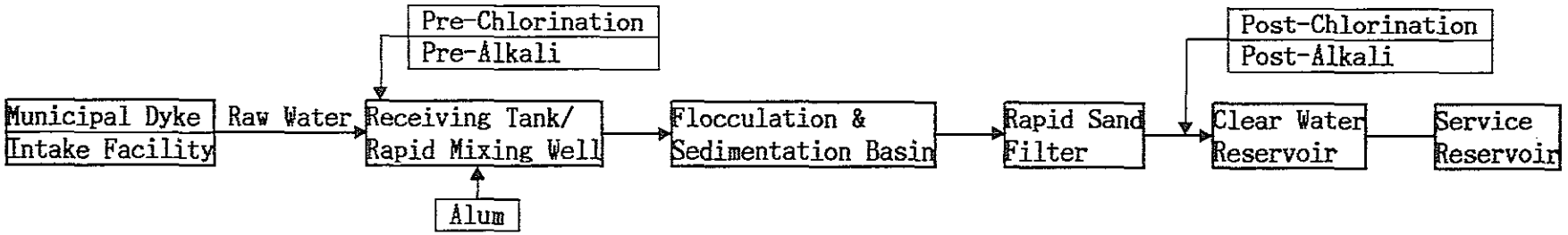


PIPELINE PROFILE NEAR PAILLES PLANT
(RAW WATER TRANSMISSION PIPELINE)

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

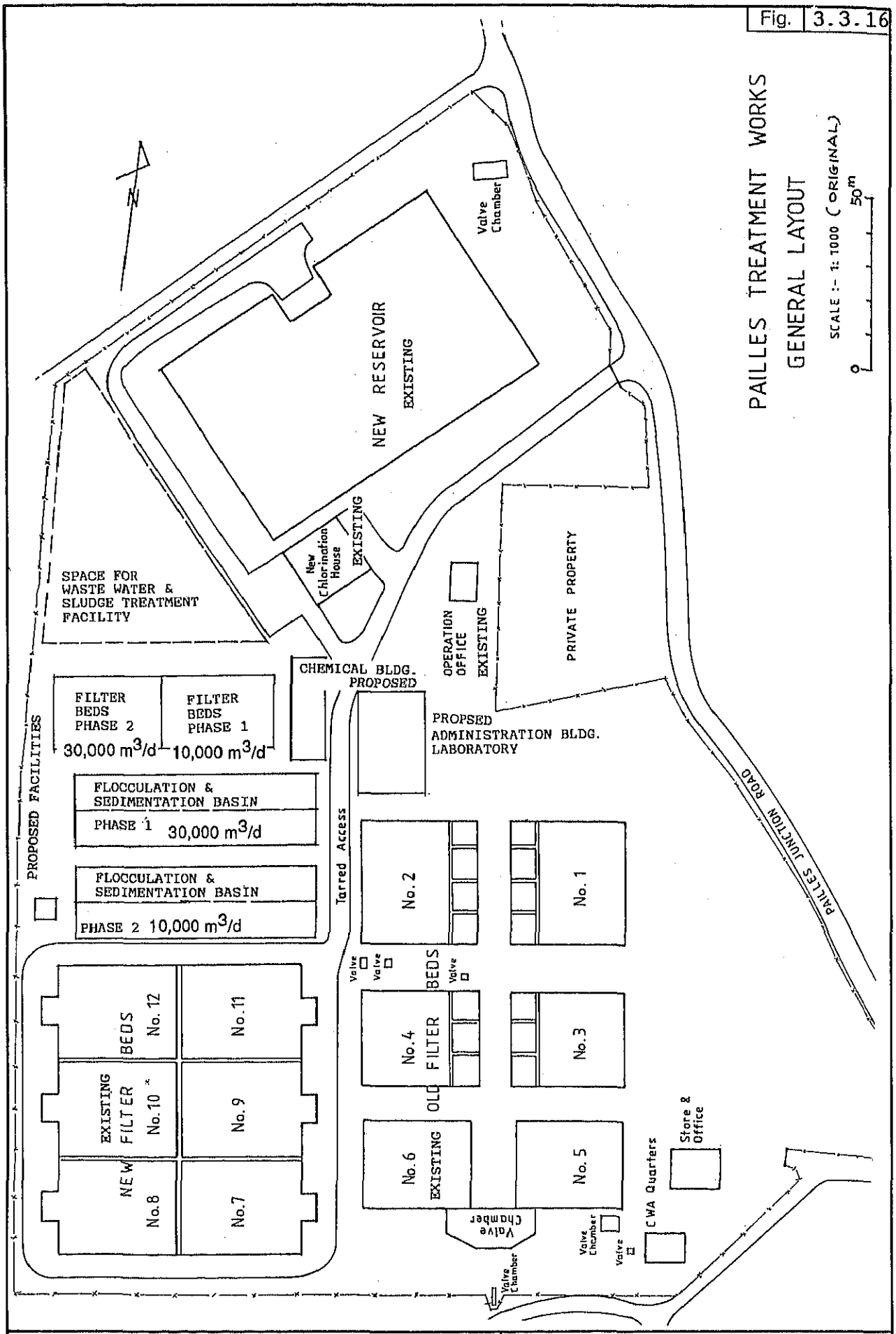
PROPOSED WATER TREATMENT PROCESS
(Rapid Sand Filtration)



1) Pre-Chlorination : Pre-chlorination will be required to prevent growth of algae in the treatment facilities, kill plankton and remove iron and manganese in the raw water
2) Pre-Alkali : Alkalinity in the raw water in the wet seasons may be 10 - 20 ppm, when turbidity of source water rises. For treatment of such water, pre-alkali dosage is necessary. In the dry seasons, alkalinity may be rather high, 50 - 70 ppm, not requiring pre-alkali treatment.
3) Post-Alkali : Alum consumes Alkalinity in water treatment, (Alum of 1 ppm consumes Alkalinity of 0.45 ppm), and pH value falls accordingly. Therefore, to protect pipe and the water supply system from corrosion, pH value of water for distribution must be raised by alkali treatment.
4) Post-Chlorination : To ensure the safety of the treated water, post-chlorination will be needed, even though break-point pre-chlorine should be applied, considering chlorine consumption during treatment processes.
5) Rapid Mixing : Mechanical type, turbin or agitator mixer
6) Flocculation : End-around baffle flow channel
7) Sedimentation : Horizontal flow/ conventional type
8) Rapid Sand Filter : Single media sand

Fig. 3.3.15

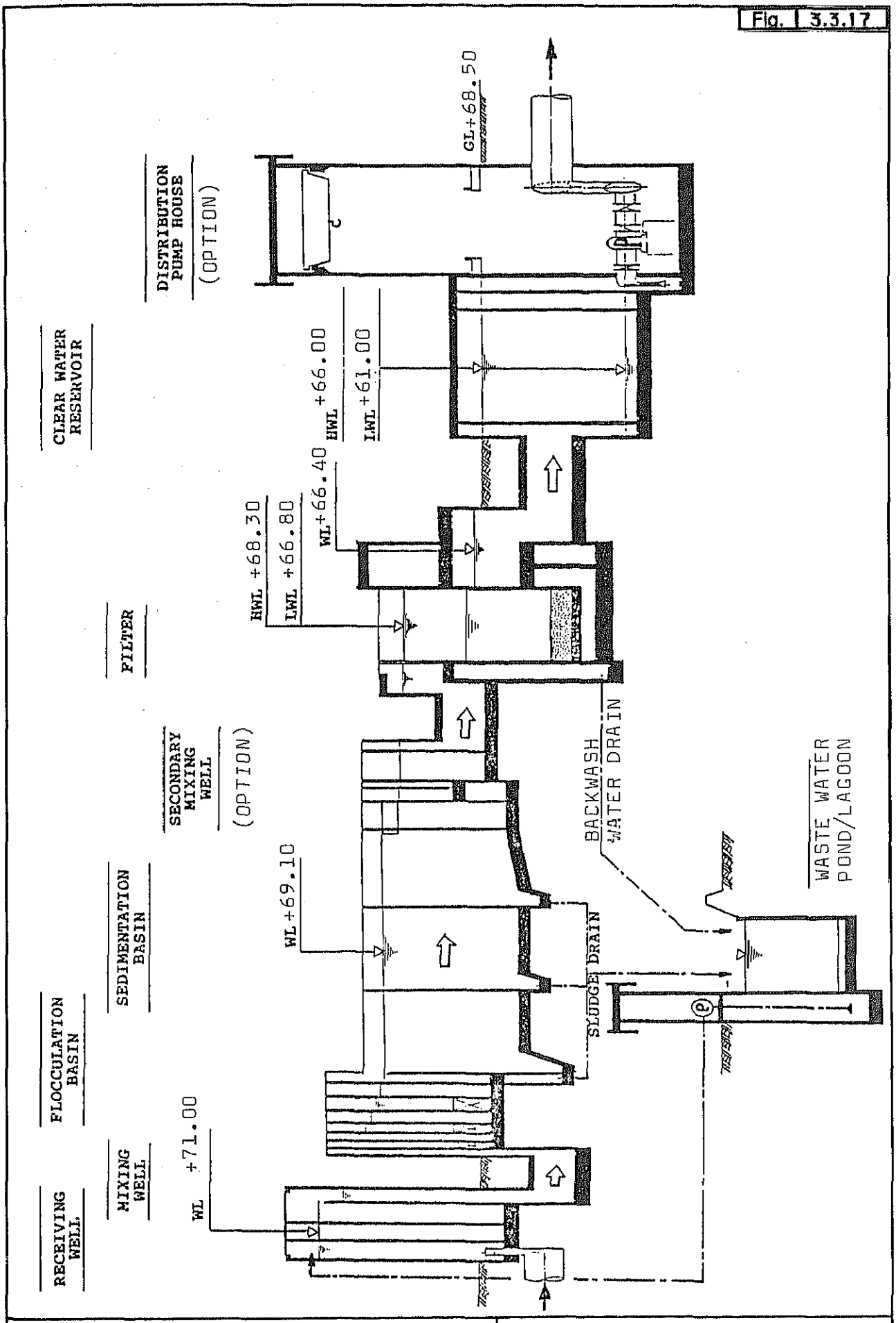
Fig. 3.3.16



GENERAL LAYOUT OF PILLES TREATMENT PLANT

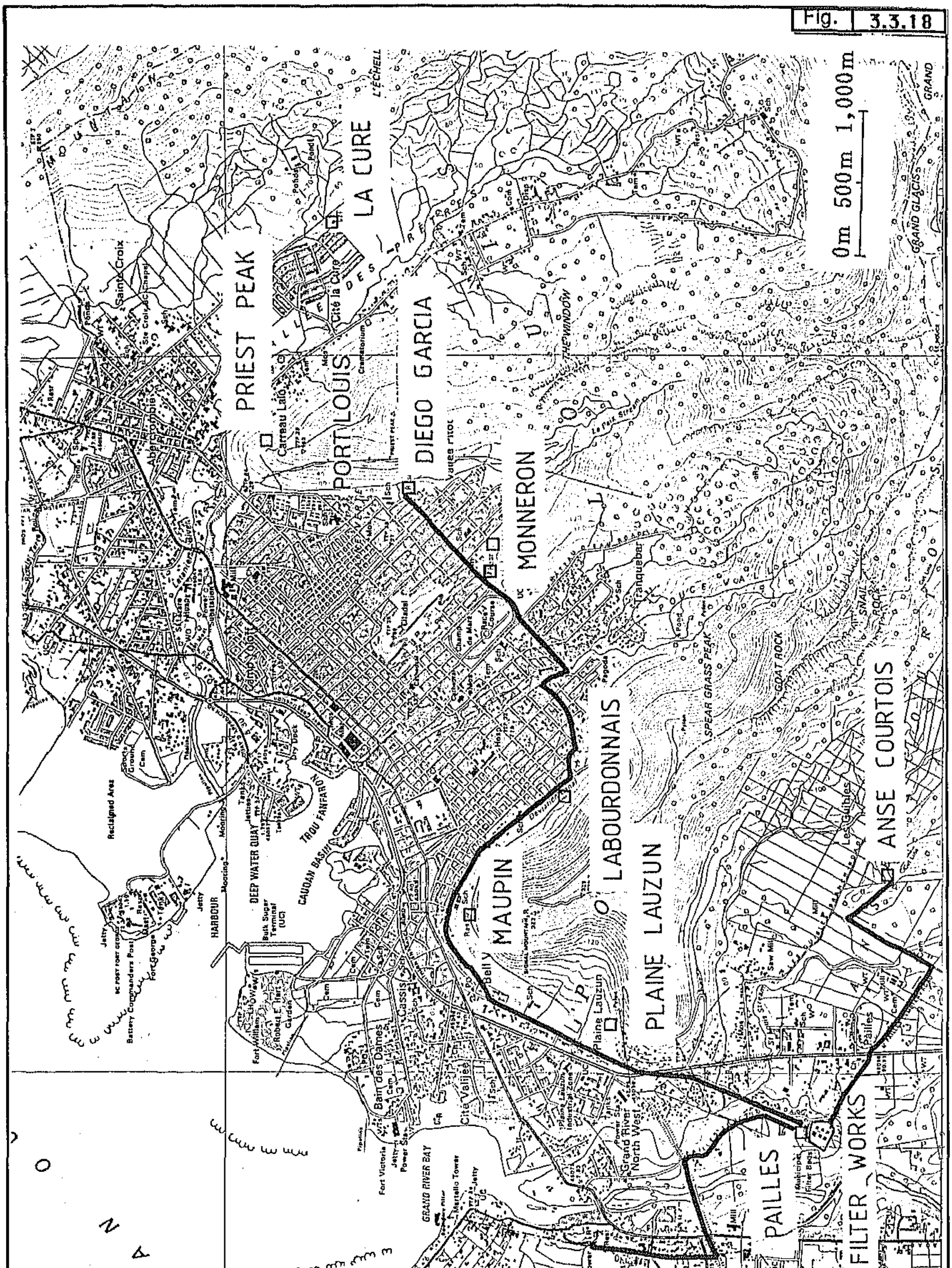
GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.3.17



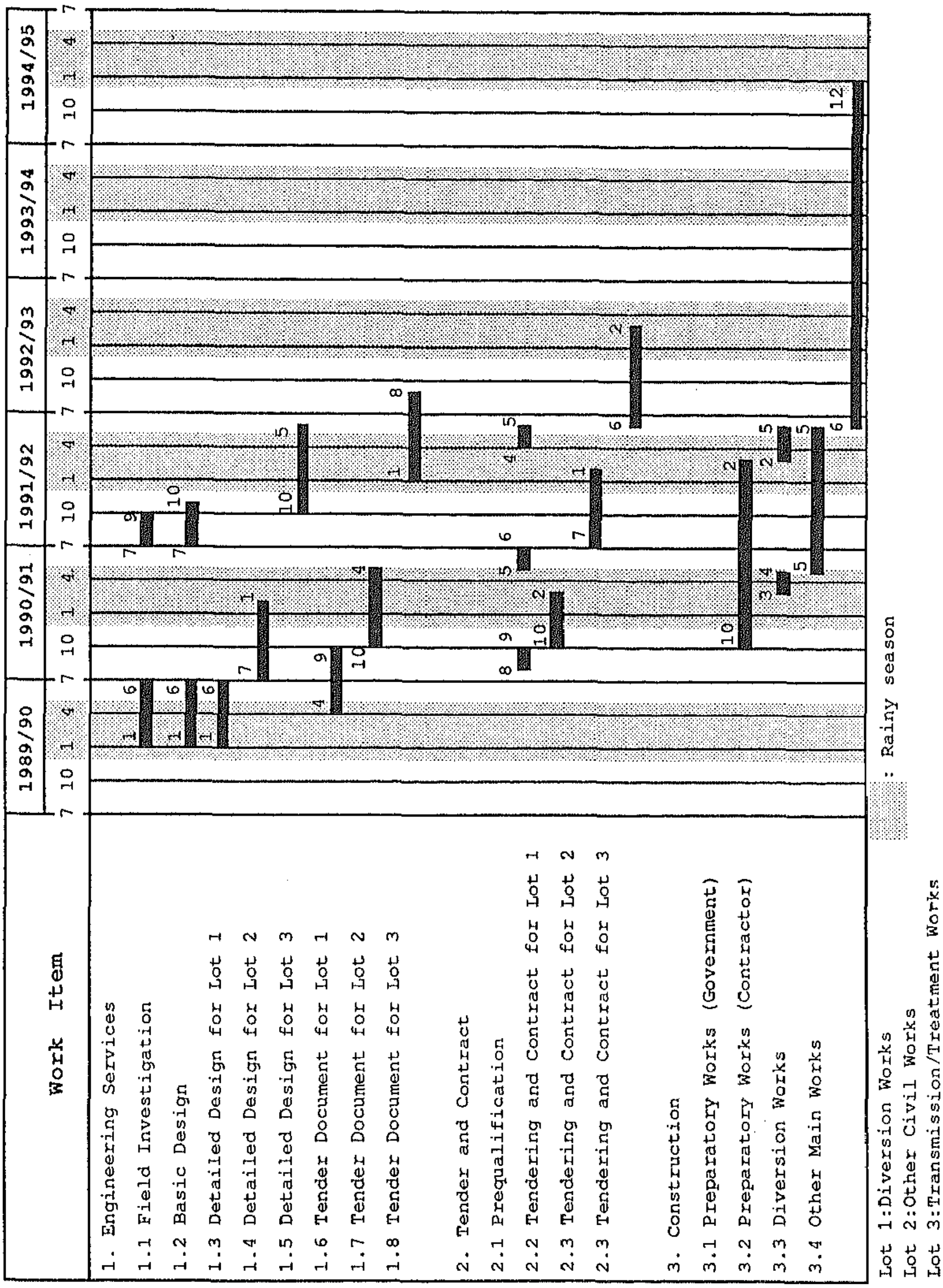
HYDRAULIC FLOW OF
PAILLES TREATMENT PLANT

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY



EXISTING AND PROPOSED SUPPLY ZONE	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.4.1

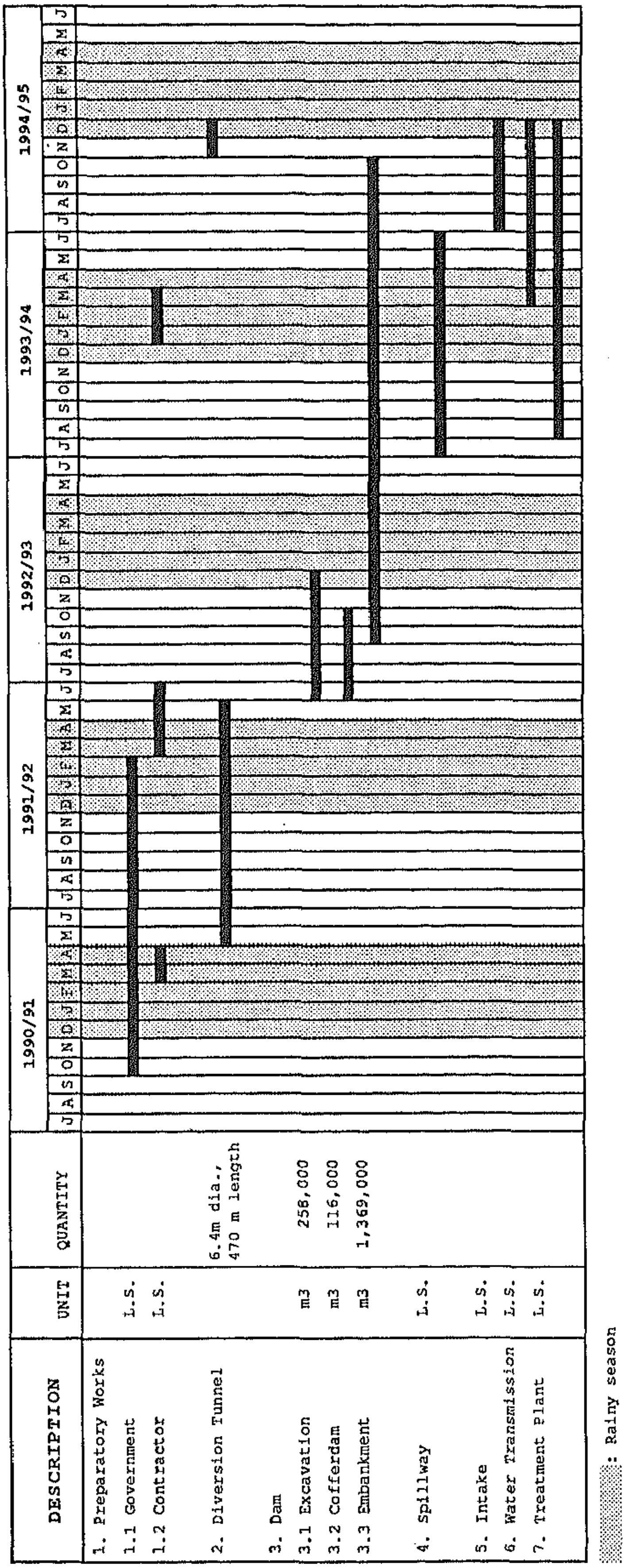


IMPLEMENTATION SCHEDULE OF TERRE ROUGE DAM PROJECT

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

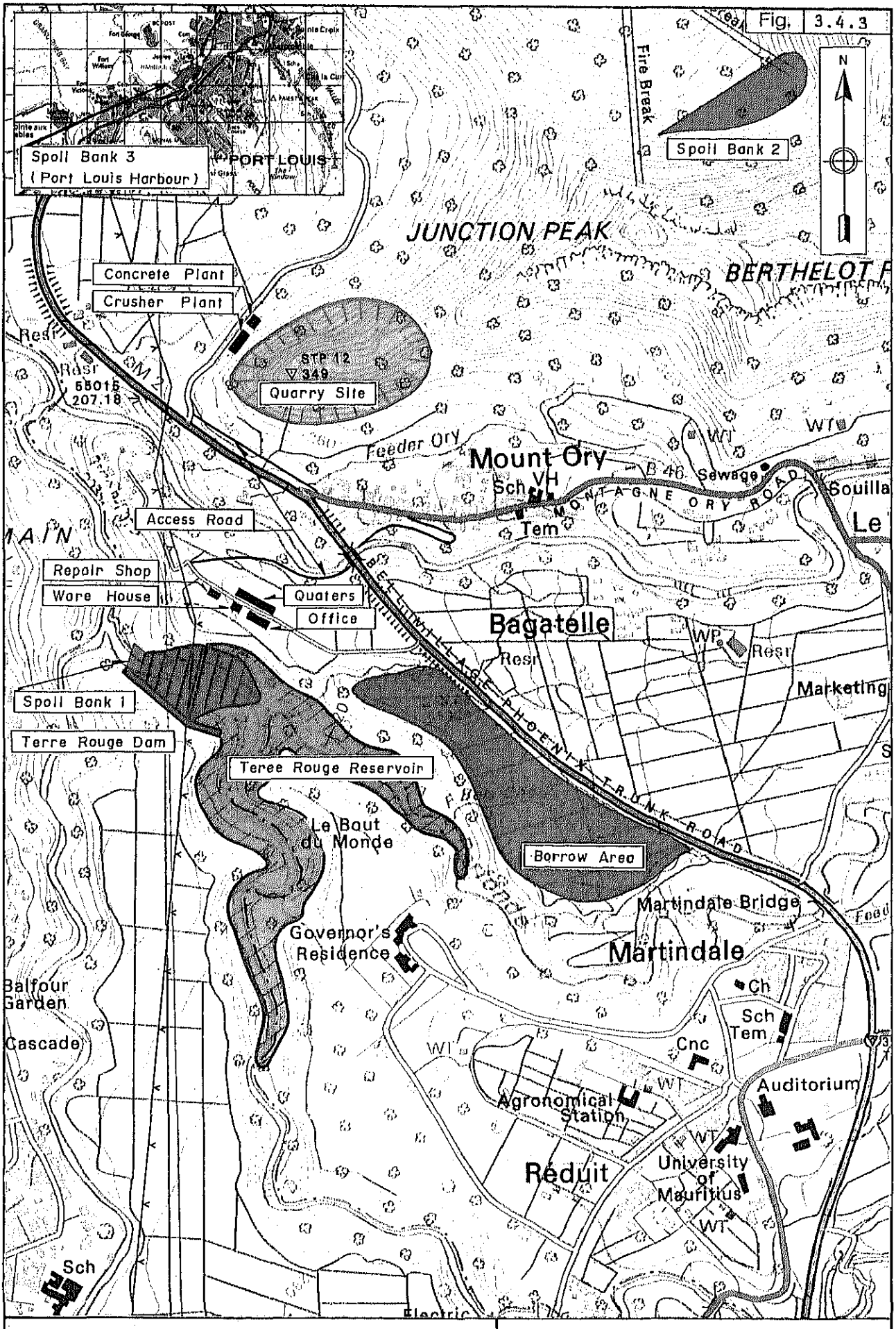
Fig. 3.4.2



CONSTRUCTION SCHEDULE OF
PORT LOUIS WATER SUPPLY PROJECT

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



LAYOUT OF CONSTRUCTION FACILITIES

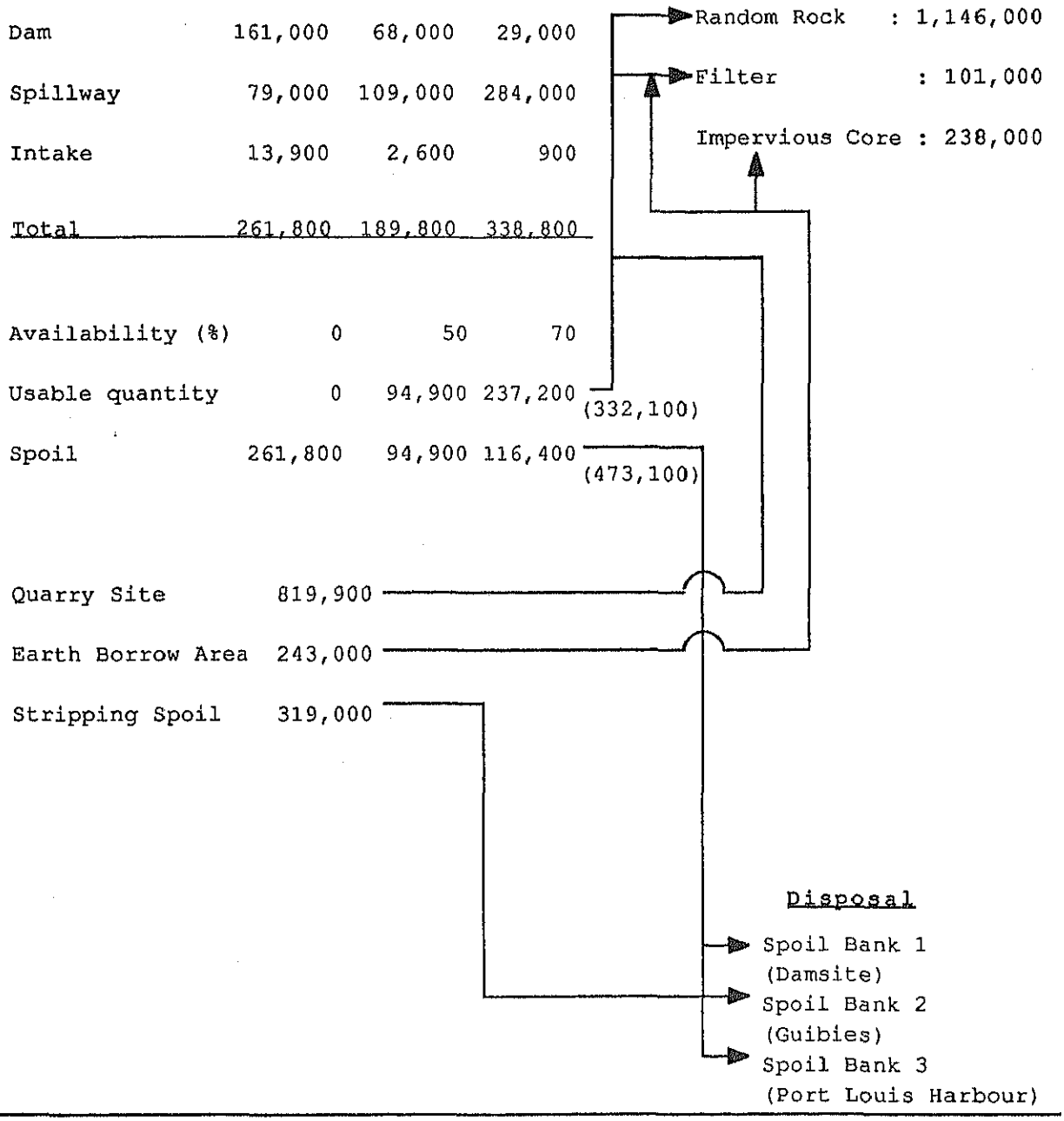
GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.4.4

Unit:m^3

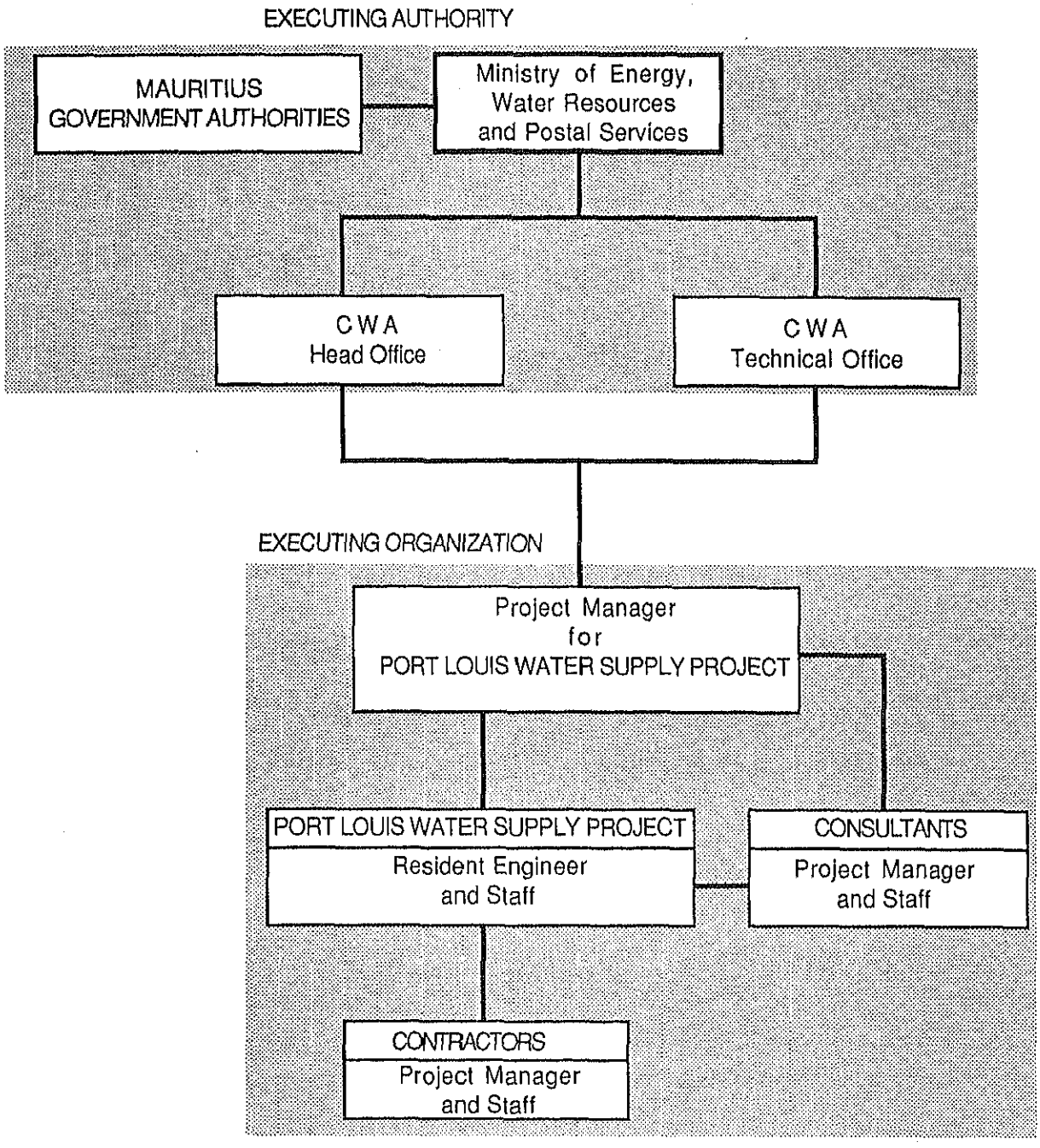
Excavation Site	Common	Weathered Rock	Fresh Rock
Diversion Tunnel	7,900	10,200	24,900
Dam	161,000	68,000	29,000
Spillway	79,000	109,000	284,000
Intake	13,900	2,600	900
Total	261,800	189,800	338,800
Availability (%)	0	50	70
Usable quantity	0	94,900	237,200
Spoil	261,800	94,900	116,400



DISTRIBUTION PLAN OF CONSTRUCTION MATERIALS

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.4.5

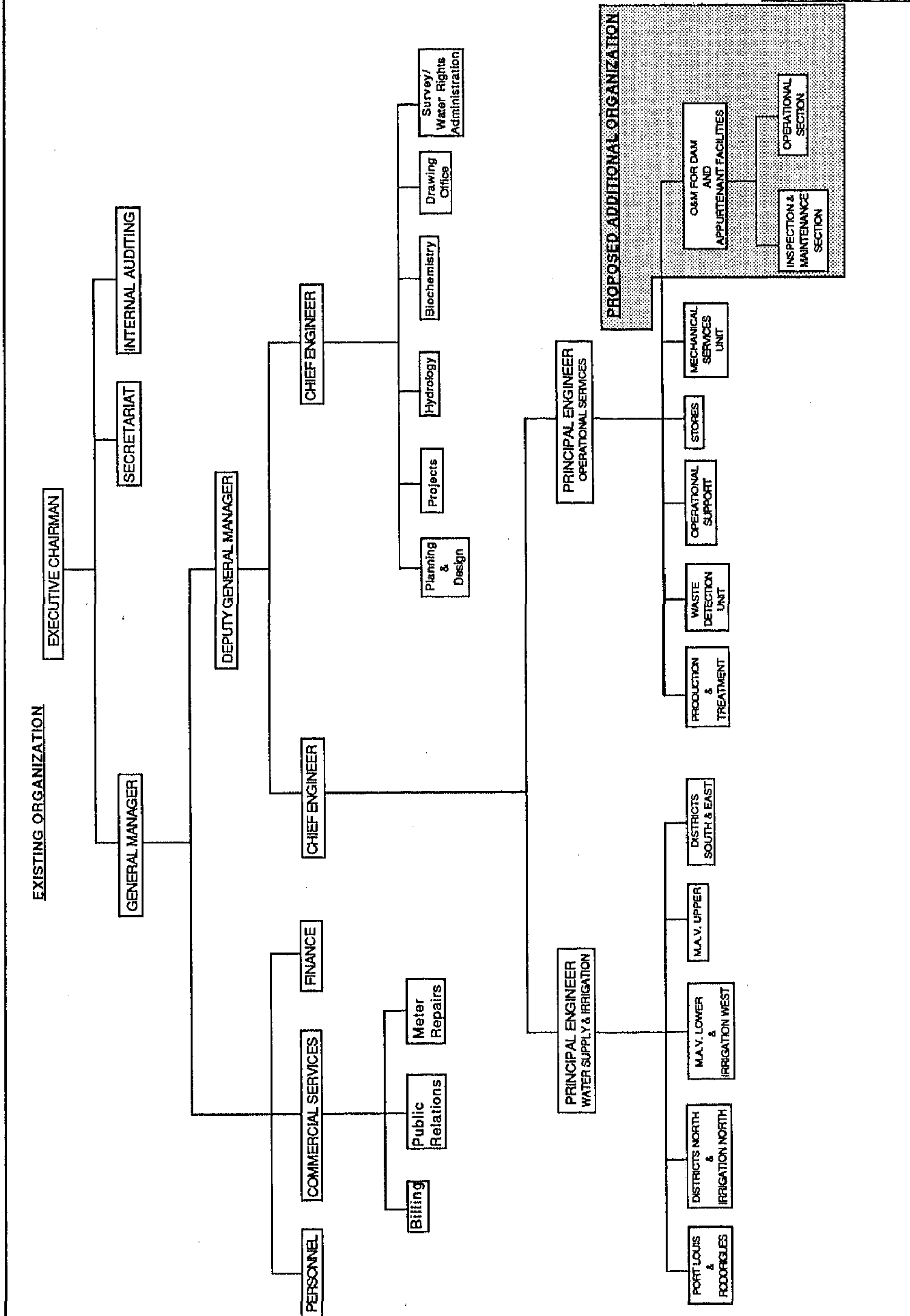


WORK ORGANIZATION CHART

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.4.6

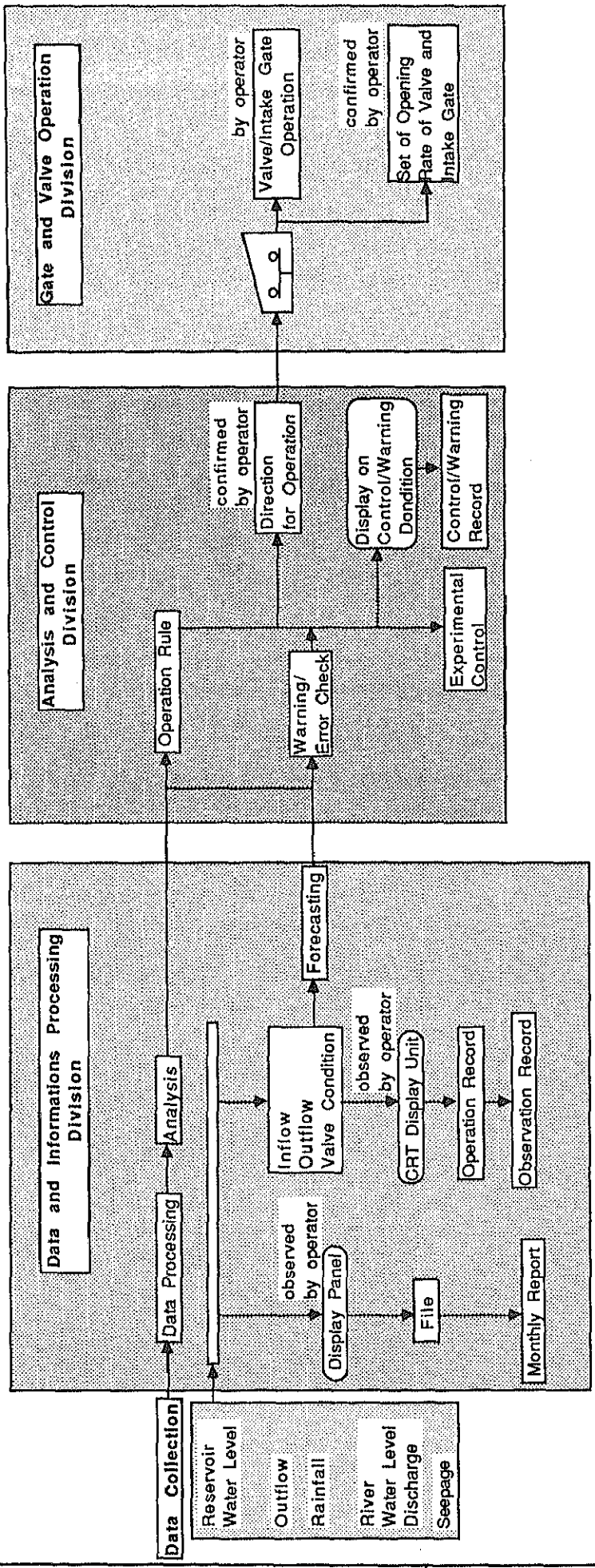


PROPOSED ORGANIZATION FOR OPERATION AND MAINTENANCE

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.4.7



FUNCTION OF OPERATION AND MAINTENANCE

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

4. ECONOMIC AND FINANCIAL EVALUATION

4.1 Economic Analysis

4.1.1 General

The economic feasibility of a project is usually evaluated on the basis of estimation of the economic internal rate of return (EIRR). Economic cost of the project is calculated based on the conversion factor and financial cost based on the market prices in Mauritius. Economic benefit of the project consists of direct benefit and indirect benefit. Of them indirect benefit covers several intangible benefit such as improvement of public health and decrease of mortality and morbidity. Therefore economic analysis represents only quantitative benefit, which results in rather safety or negative side of economic viability.

For the economic evaluation, the following basic assumptions are applied;

- The project life is taken as 50 years after construction,
- Construction begins in 1990 and operation commences in 1995,
- The current prices as of 1989 are used in this evaluation,
- The exchange rate of Mauritian Rupee is taken to be Rs.13.7 equivalent to US$ 1.

4.1.2 Construction and O & M costs

(a) Conversion factor for economic prices

Tariff and trade restrictions introduce a distortion in the price relationship between traded goods and non-traded goods. In order to evaluate the project cost and benefit comparable to the international market prices , a standard conversion factor (SCF) is calculated by following equation;

$$SCF = \frac{(FOB + CIF)}{(FOB + CIF + ID + OIT + DT)} ,$$

$$= 0.82$$

where,

FOB : Annual export , FOB price (5,955,000 Rs. in 1984/85)
CIF : Annual export , CIF price (7,307,000 Rs. in 1984/85)
ID : Import duties (890,000 Rs. in 1984/85)
OIT : Other indirect tax (1,532,000 Rs. in 1984/85)
DT : Direct tax (424,000 Rs. in 1984/85)

The construction of the project facilities is carried out by equipment, materials, skilled and unskilled labours. For the economic analysis,the following conversion factors are applied;

1) Trade component

This component includes imported materials. Since it is traded, the conversion factor is 1.00. This category occupies 66 % of the capital cost.

2) Non-trade component

This component includes skilled labour and locally manufactured materials, The SCF of 0.85 is used as the conversion factor, and 32 % of the capital cost belongs to this category.

3) Unskilled labour

Unskilled construction labour for the project would likely come from farm household,for which the opportunity to be sacrificed by the project is agricultural activities. In addition, due consideration would be required to the extent of some extra premium owing to rather severe temporary work despite the existing majority of underemployment in rural area. Thus the wages paid to seasonal farm workers are more

indicative of the opportunity costs of unskilled construction labour. Consequently, the economic opportunity cost of unskilled construction labour is determined to be less than financial wage rate.

But, cost of this category covers 7 % of local currency portion and only 2.4 % of total capital cost and this conversion factor does not effect much on total economic cost of the project.

Thus, the conversion factor of 0.82 is applied for local portion of the capital cost of the project. The CCF (the weighted average of the above components) is calculated at 0.94.

(b) Economic cost

Economic cost of construction and O & M on the Project are estimated based on the conversion factor mentioned above and the market prices of equipments, materials and labor to be purchased for the implementation of the Project. Construction cost is estimated to be Rs. 901,480 x 10^3 in total, comprising Rs. 660,400 x 10^3 foreign currency and Rs. 241,080 x 10^3 local currency. Assumptions and conditions applied for estimating construction cost were explained in detail in Section 3.5 "Cost Estimate".

Investment cost used in cash flow analysis is based on the disbursement schedule explained in Section 3.5. O & M cost is also estimated as explained in Section 3.5.

4.1.3 Benefit of the Project

Quantitative effect of the project on the economy of Mauritius is divided into two items, one is a) Water supply for domestic use. Another is b) Water supply for non-domestic and Government. The former can be estimated by willingness of household to pay. The latter is estimated from the effect on Gross Domestic Product (GDP) of several sectors

which are served by water supply from CWA.

Benefit of the Project is calculated based on the projected incremental volume of water supply by category and appropriate unit economic benefit by categories mentioned above, i.e., a) domestic, b) non-domestic + governmental uses. Water tariff of these to categories is assumed to be constant as in 1989 .

Benefit of the Project in each category is calculated as follows:

(a) Incremental Volume of Water Supply

Incremental volume of water supply in each year is calculated as follows:

Year	Demand ($1000m^3$/year)			Rate of Contribution by Project	Incremental Volume ($1000m^3$/year)		
	Domes-tic	Non-Domestic	Govern-ment		Domes-tic	Non-Domestic	Govern-ment
1990	8,883	4,507	913	0.020	177.7	90.1	18.3
2000	11,183	6,111	913	0.050	559.0	305.5	45.6
2010	11,870	7,305	913	0.215	2,552.0	1,570.0	196.0
2030	12,918	8,766	913	0.283	3,655.0	2,480.0	258.0

(b) Benefit by domestic use

According to the Country Report for Mauritius and three other neighbouring countries (No.2, 1988) published by the Economist Intelligence Unit,UK, share of water expenditure in the average household income is 2 % (2.91 Rs./m^3). Limit of this share is thought to be 3 % (4.37 Rs./m^3) by CWA as capability to pay for water supply,or, one and half times of present expenditure. Water tariff of domestic use corresponding to willingness-to-pay is hard to assess, therefore capability to pay is applied in place of willingness-to-pay. Thus, incremental economic benefit in the future is expected as follows,

Incremental Economic Benefit (Domestic use)

(Rs.1000/year)

Year			
1990	2000	2010	2030
776.5	2,442.8	11,152.2	15,972.4

(c) Benefit by non-domestic and government activities

Economic benefit,both direct and indirect, created by water supply for non-domestic and government use is reflected in gross domestic product (GDP) . GDP is determined by many variables such as water supply, climate, international relations and government policy,et al.

Therefore sensitivity of GDP caused by water supply is,if any, the appropriate economic benefit. The following is the mathematical background of the description;

$$G = G (W, X_1, X_2, X_3, \ldots, X_n)$$

thus,

$$dG = \sum_{i=1,n} D(G, X_i) \, dX_i$$

where, G : GDP (x Rs. 10^6)

W : Water supply volume (x 10^3 m^3/year)

X_i : i-th variable of G

dG : differentiation of G

$D(G,x)$: Partial differentiation on variable X

Letting $dW=0$, we can get dG_o which is differentiation of G under the condition that W=constant. This differentiation means long-term tendency of growth of GDP independent of water supply.

Then the second equation can be written as,

$$dG = (D(G,W)) dW + dG_0$$

transformed this equation to finite-difference form (annual difference),

$$\Delta G = (D(G,W)) \Delta W + \Delta G_0$$

Relationship between annual growth of GDP at constant 1982 prices (ΔG) and increase of water supply volume for non-domestic and government use (ΔW) from 1982 to 1986 is shown in Table 4.1. Consequently, the linear function can be acceptable to the relation of these two factors. The slope, intercept and correlation coefficient by means of regression analysis are 0.06015 , 262.68 and 0.90 respectively.

Thus, net increase of indirect benefit by unit water supply for non-domestic and government use, that is, unit benefit of these water supply categories, is estimated to be 60.15 Rs./m^3 at constant 1982 prices . unit benefit at 1989 cost is estimated 88.11 Rs./m^3 by multiplying 1.465, consumer price index of 1989 to 1982.

Incremental economic benefit on these categories in the future is as follows,

Incremental Economic Benefit (Non-domestic and Government)

(Rs.1000/year)

Year			
1990	2000	2010	2030
9,551	30,935	155,602	241,245

4.1.4 Economic and social viability of the project

(a) Economic internal rate of return (EIRR)

Based on the economic cost and benefit streams shown in Table 4.1.2, EIRR is estimated at 8.7 %, which can be considered as a

reasonably high value for a water supply project. Sensitivity is tested in Table 4.1.3 to 4.1.5. The sensitivity test indicates EIRR=8.0 % at 15 % cost up, EIRR=7.9 % at 15 % benefit down, and EIRR=7.2 % at the combination of 15 % cost up and 15 % benefit down. As seen, the economic viability is not so sensitive, implying economic soundness.

(b) Intangible benefit

Implementation of the Project would mitigate the water shortage which has occurred quite frequently in the past and would continue to be so in the future unless the Project is realized. The Project, by regulating the river flow during rainy and dry seasons, would guarantee more stable water supply and thereby bring healthy life of the residents and sound development of the industries, though these benefits are difficult to be quantified. The intangible and indirect benefits, which are of significant value, although not quantifiable, include the followings:

i) Supply of clean water contributes to the improvement of public health. Mortality and morbidity caused by water-borne and parasitic diseases will be reduced. This will lead to reduced demand for public health facilities.

ii) Enhanced supply of clean water contributes to accelerating the local economic growth. Local industries will have easier access to stable water supply at lower cost. This will stimulate manufacturing and commercial activities of Port Louis. Taking into account multiplier effect as well, the Project will significantly contribute to the expansion of the local economy.

iii) The implementation of the Project will contribute to the local economic growth through providing employment opportunities and procuring materials and equipments during construction as well.

4.2 Financial Evaluation

4.2.1 General

The financial viability of the Project is evaluated by calculating the financial internal rate of return (FIRR) as well as assessing loan repayability of the Project with regard to the loan assumed to be extended for covering the construction costs of the Project.

4.2.2 Construction and O & M Costs

Construction and O & M costs of the Project are estimated based on the market prices of equipments, materials and labor to be purchased for the implementation of the Project. Construction cost is estimated to be Rs. 1,152,100 x 10^3 in total, comprising Rs. 758,700 x 10^3 foreign currency and Rs. 393,300 x 10^3 local currency. Assumptions and conditions applied for estimating construction cost were explained in detail in Section 3.5 "Cost Estimate".

Investment cost used in cash flow analysis is based on the disbursement schedule explained in Section 3.5. O & M cost is also estimated as explained in Section 3.5.

4.2.3 Revenue of the Project

Revenue of the Project is calculated based on the projected incremental volume of water supply by category and average water charge by category i.e., domestic, non-domestic/industrial and governmental uses. Water tariff or average water charge is assumed to be revised every three years based on the assumed rate of increase of consumer price index (CPI), 7.2 % per annum.

Revenue of the Project in each year is calculated as follows:

(a) Incremental Volume of Water Supply

Incremental volume of water supply in each year is the same as applied for economic analysis .

(b) Water Tariff

Water tariff is assumed to be revised in accordance with the assumed rate of increase of consumer price index, 7.2 % per annum. Then, the tariff is revised as shown below.

Year	Domestic	Non-Domestic	Gov.
1989	2.91	5.94	5.70
2000	6.70	13.68	13.13
2010	15.44	31.51	30.24
2030	53.96	110.15	105.70

(3) Annual Revenue

Annual revenue in each year is calculated as follows:

Year	Description	Domes-tic	No-Domestic	Gov.	Total
2000	Incremental Vol. (1000 m^3/year)	559.0	305.5	45.6	
	Water tariff (Rs/m^3)	6.70	13.68	13.13	
	Annual revenue (Rs 1000)	3,748	4,180	599	8,527
2010	Incremental Vol. (1000 m^3/year)	2,552.0	1,570.0	196.0	
	Water tariff (Rs/m^3)	15.44	31.51	30.24	
	Annual revenue (Rs 1000)	39,396	49,490	5,936	94,823
2030	Incre. Vol. (1000 m^3/year)	3,655.0	2,480.0	258.0	
	Water tariff (Rs/m^3)	53.96	110.15	105.7	
	Annual revenue (Rs 1000)	197,274	273,247	27,271	497,830

4.2.4 Financial viability of the project

(a) Financial Internal Rate of Return (FIRR)

Based on the financial cost and revenue streams shown in Table 4.2.1, FIRR is estimated at 6.8 %, which can be considered as a reasonably high value for a water supply project. Sensitivity is tested in Table 4.2.2 to 4.2.4. The sensitivity test indicates FIRR=6.2 % at 15 % cost up, FIRR=6.1 % at 15 % revenue down, and FIRR=5.5 % at the combination of 15 % cost up and 15 % revenue down. As seen, the financial viability is not so sensitive, implying financial soundness.

(b) Loan Repayability

The following conditions are assumed to assess the loan repayability of the Project.

Local portion of the construction cost:

To be funded by the Government or financed by CWA through its own funds (internal reserve, depreciation or others)

Foreign portion of the construction cost:

To be financed by a loan with the following condition:

o Repayment period	30 years
o Grace period	6 years
o Interest rate	2.90 %

Cashflow statement is shown in Table 4.2.5.

As seen in the table, annual net revenue goes into black from the 13th year after the commencement of the Project ,and accumulated surplus go into black in the 24th year after the commencement or the last year of repayment period of 30 years, indicating that the loan is repayable, provided that some form of assistance is to be made by the Government, interest-free loan as an example, until the annual balance turns into black.

To further assess the financial viability of the Project, financing capacity of the Government and CWA for funding the local portion of the construction cost as well as the capacity-to-pay for the foreign loan principal and interest are examined based on the macro indices as follows:

i) The ratio of average annual disbursement of local construction cost to Government total expenditure in 1986/87 fiscal year is,

$$\frac{\text{Rs.393.3 million/year}}{\text{6 years}} \div \text{Rs.5,918 million} = 1.1\ \%$$

ii) That to Government Capital expenditure in 1986/87 is,

$$\frac{\text{Rs.393.3 million/year}}{\text{6 years}} \div \text{Rs. 1,164 million} = 5.6\ \%$$

iii) That to CWA total expenditure in 1985/86 fiscal year is,

$$\frac{\text{Rs.393.3 million/year}}{\text{6 years}} \div \text{Rs.173.5 million} = 37.8\ \%$$

iv) Ratio of repayment of foreign loan to f.o.b value of exports in 1986 is,

Rs.43.6 million ÷ Rs. 9,062 million = 0.5 %

v) That to Government total expenditure in the 1986/87 is,

Rs.43.6 million ÷ Rs.5,918 million = 0.7 %

vi) That to CWA total expenditure in the 1985/86 is,

Rs.43.6 million ÷ Rs.173.5 million = 25.1 %

The above ratios are calculated based on the latest figures of the Government and CWA expenditures and exports available at present. These figures are expected to increase in the future, resulting in lowering the above ratios.

The loan repayability is also examined in the severer loan condition for the foreign portion of construction cost as follows:

- o Repayment period : 20 years
- o Grace period : 6 years
- o Interest rate : 7 % per annum

The result of examination is given in Table 4.2.6. As seen in the table, the deficit finance will unfavourably continue beyond the repayment period.

As such, it can be said that the loan would reasonably be repayable under a soft loan condition.

TABLES

TABLE 4.1.1 BENEFIT OF WATER SUPPLY
(NON-DOMESTIC & GOVERNMENT SECTOR)

Item\ Year	1982	1983	1984	1985	1986
GDP at constant 1982 prices (unit: Rs.10^6)[1]					
(a) Total	10020	10063	10541	11264	12155
(b) Agriculture	1530	1331	1341	1492	1613
(c) Mining&Quarrying	17	17	17	17	18
(d) Manufacturing	1560	1576	1768	2038	2380
GDPw; GDP which CWA water supply is concerned					
(e) = (a)-(b)-(c)-(d)	6913	7139	7415	7717	8144
D(GDPw) ;Annual growth of GDPw	-	226	276	302	427
Water Supply (unit: 10^3 m^3)					
(f) Non Domestic	5816	5098	5287	6162	8141
(g) Government	1828	1605	1966	2411	2500
W ; (h)=(f)+(g)	7644	6703	7253	8573	10641
D(W); Annual increase of W	-	-941	550	1320	2068

Result of regression analysis

$$D(GDPw) = 0.06015 \times D(W) + D(GDPw)_0 \quad \text{(corelation coefficient:0.90)}$$

where, $D(GDPw)_0$; Annual increase of GDP when W is constant (= 262.68 million Rs.)

Thus, net increase of indirect benefit by unit water supply for non-domestic and government use represented by the following equation;

$$D(GDPw-GDPw_0)/D(W),$$

is estimated to be 0.06015 ,or, 60.15 Rs./m^3 at constant 1982 prices. Consumer price index of 1989 to 1982 is 1.46[2] ,therefore benefit of non-domestic and government use at 1989 price is estimated at 88.11 Rs./m^3 .

1) : Central Statistical Office,Government of Mauritius
2) : International Finance Statistics June,1989 , IMF

TABLE 4.1.2 ECONOMIC ANALYSIS

Dam reservoir : 6.675 MCM UNIT: Rs.1000

No.	Year	Cost F/C	Cost L/C	O/M (L/C)	Total	Revenue	Net Benefit
1	1988	0	0	0	0	0	0
2	1989	17,307	7,508	0	24,815	0	-24,815
3	1990	21,027	23,554	0	44,581	0	-44,581
4	1991	93,317	49,176	0	142,493	0	-142,493
5	1992	151,039	35,873	0	186,912	0	-186,912
6	1993	314,212	100,757	0	414,969	0	-414,969
7	1994	63,523	24,246	0	87,769	0	-87,769
8	1995			4,565	4,565	21,856	17,291
9	1996			4,565	4,565	24,161	19,596
10	1997			4,565	4,565	26,467	21,902
11	1998			4,565	4,565	28,773	24,208
12	1999			4,565	4,565	31,078	26,513
13	2000			4,565	4,565	33,384	28,819
14	2001			4,565	4,565	46,728	42,163
15	2002			4,565	4,565	60,071	55,506
16	2003			4,565	4,565	73,415	68,850
17	2004	7,306	3,832	4,565	15,702	86,759	71,056
18	2005	7,306	3,832	4,565	15,702	100,102	84,400
19	2006			4,565	4,565	113,446	108,881
20	2007			4,565	4,565	126,790	122,225
21	2008			4,565	4,565	140,133	135,569
22	2009			4,565	4,565	153,477	148,912
23	2010			4,565	4,565	166,821	162,256
24	2011			4,565	4,565	171,345	166,780
25	2012			4,565	4,565	175,870	171,305
26	2013			4,565	4,565	180,394	175,829
27	2014			4,565	4,565	184,918	180,353
28	2015			4,565	4,565	189,443	184,878
29	2016			4,565	4,565	193,967	189,402
30	2017			4,565	4,565	198,491	193,926
31	2018			4,565	4,565	203,016	198,451
32	2019			4,565	4,565	207,540	202,975
33	2020			4,565	4,565	212,064	207,499
34	2021			4,565	4,565	216,589	212,024
35	2022			4,565	4,565	221,113	216,548
36	2023			4,565	4,565	225,637	221,073
37	2024			4,565	4,565	230,162	225,597
38	2025			4,565	4,565	234,686	230,121
39	2026			4,565	4,565	239,211	234,646
40	2027			4,565	4,565	243,735	239,170
41	2028			4,565	4,565	248,259	243,694
42	2029			4,565	4,565	252,784	248,219
43	2030			4,565	4,565	257,308	252,743
44	2031			4,565	4,565	257,308	252,743
45	2032			4,565	4,565	257,308	252,743
46	2033			4,565	4,565	257,308	252,743
47	2034			4,565	4,565	257,308	252,743
48	2035			4,565	4,565	257,308	252,743
49	2036			4,565	4,565	257,308	252,743
50	2037			4,565	4,565	257,308	252,743
51	2038			4,565	4,565	257,308	252,743
52	2039			4,565	4,565	257,308	252,743
53	2040			4,565	4,565	257,308	252,743
54	2041			4,565	4,565	257,308	252,743
55	2042			4,565	4,565	257,308	252,743
56	2043			4,565	4,565	257,308	252,743
57	2044			4,565	4,565	257,308	252,743

Conversion factor
0.82

Net Present Value as of 1989

	Cost	Benefit	B/C
(7%)	724,670	1,016,344	1.40
(8%)	690,882	791,778	1.15
(9%)	659,983	625,147	0.95

EIRR = 8.7%

TABLE 4.1.3 ECONOMIC ANALYSIS FOR SENSITIVITY

Dam reservoir : 6.675 MCM — UNIT: Rs.1000

No.	Year	Cost				Revenue	Net Benefit
		F/C	L/C	O/M (L/C)	Total		
1	1988	0	0	0	0	0	0
2	1989	19,903	8,634	0	28,537	0	-28,537
3	1990	24,181	27,087	0	51,268	0	-51,268
4	1991	107,315	56,553	0	163,867	0	-163,867
5	1992	173,695	41,254	0	214,949	0	-214,949
6	1993	361,344	115,870	0	477,214	0	-477,214
7	1994	73,051	27,883	0	100,934	0	-100,934
8	1995			5,250	5,250	21,856	16,606
9	1996			5,250	5,250	24,161	18,912
10	1997			5,250	5,250	26,467	21,217
11	1998			5,250	5,250	28,773	23,523
12	1999			5,250	5,250	31,078	25,829
13	2000			5,250	5,250	33,384	28,134
14	2001			5,250	5,250	46,728	41,478
15	2002			5,250	5,250	60,071	54,822
16	2003			5,250	5,250	73,415	68,165
17	2004	8,401	4,407	5,250	18,058	86,759	68,701
18	2005	8,401	4,407	5,250	18,058	100,102	82,045
19	2006			5,250	5,250	113,446	108,196
20	2007			5,250	5,250	126,790	121,540
21	2008			5,250	5,250	140,133	134,884
22	2009			5,250	5,250	153,477	148,228
23	2010			5,250	5,250	166,821	161,571
24	2011			5,250	5,250	171,345	166,096
25	2012			5,250	5,250	175,870	170,620
26	2013			5,250	5,250	180,394	175,144
27	2014			5,250	5,250	184,918	179,669
28	2015			5,250	5,250	189,443	184,193
29	2016			5,250	5,250	193,967	188,717
30	2017			5,250	5,250	198,491	193,242
31	2018			5,250	5,250	203,016	197,766
32	2019			5,250	5,250	207,540	202,290
33	2020			5,250	5,250	212,064	206,815
34	2021			5,250	5,250	216,589	211,339
35	2022			5,250	5,250	221,113	215,863
36	2023			5,250	5,250	225,637	220,388
37	2024			5,250	5,250	230,162	224,912
38	2025			5,250	5,250	234,686	229,437
39	2026			5,250	5,250	239,211	233,961
40	2027			5,250	5,250	243,735	238,485
41	2028			5,250	5,250	248,259	243,010
42	2029			5,250	5,250	252,784	247,534
43	2030			5,250	5,250	257,308	252,058
44	2031			5,250	5,250	257,308	252,058
45	2032			5,250	5,250	257,308	252,058
46	2033			5,250	5,250	257,308	252,058
47	2034			5,250	5,250	257,308	252,058
48	2035			5,250	5,250	257,308	252,058
49	2036			5,250	5,250	257,308	252,058
50	2037			5,250	5,250	257,308	252,058
51	2038			5,250	5,250	257,308	252,058
52	2039			5,250	5,250	257,308	252,058
53	2040			5,250	5,250	257,308	252,058
54	2041			5,250	5,250	257,308	252,058
55	2042			5,250	5,250	257,308	252,058
56	2043			5,250	5,250	257,308	252,058
57	2044			5,250	5,250	257,308	252,058

Conversion factor
0.82

Sensitivity

Cost Up : 15 %
Benefit Down : 0 %

Net Present Value as of 1989

	Cost	Benefit	B/C
(7%)	833,371	1,016,344	1.22
(8%)	794,515	791,778	1.00
(9%)	758,981	625,147	0.82

EIRR = 8.0%

TABLE 4.1.4 ECONOMIC ANALYSIS FOR SENSITIVITY

Dam reservoir : 6.675 MCM UNIT: Rs.1000

No.	Year	Cost				Revenue	Net Benefit
		F/C	L/C	O/M (L/C)	Total		
1	1988	0	0	0	0	0	0
2	1989	17,307	7,508	0	24,815	0	-24,815
3	1990	21,027	23,554	0	44,581	0	-44,581
4	1991	93,317	49,176	0	142,493	0	-142,493
5	1992	151,039	35,873	0	186,912	0	-186,912
6	1993	314,212	100,757	0	414,969	0	-414,969
7	1994	63,523	24,246	0	87,769	0	-87,769
8	1995			4,565	4,565	18,577	14,012
9	1996			4,565	4,565	20,537	15,972
10	1997			4,565	4,565	22,497	17,932
11	1998			4,565	4,565	24,457	19,892
12	1999			4,565	4,565	26,416	21,852
13	2000			4,565	4,565	28,376	23,811
14	2001			4,565	4,565	39,718	35,154
15	2002			4,565	4,565	51,061	46,496
16	2003			4,565	4,565	62,403	57,838
17	2004	7,306	3,832	4,565	15,702	73,745	58,042
18	2005	7,306	3,832	4,565	15,702	85,087	69,385
19	2006			4,565	4,565	96,429	91,864
20	2007			4,565	4,565	107,771	103,206
21	2008			4,565	4,565	119,113	114,549
22	2009			4,565	4,565	130,456	125,891
23	2010			4,565	4,565	141,798	137,233
24	2011			4,565	4,565	145,643	141,079
25	2012			4,565	4,565	149,489	144,924
26	2013			4,565	4,565	153,335	148,770
27	2014			4,565	4,565	157,181	152,616
28	2015			4,565	4,565	161,026	156,461
29	2016			4,565	4,565	164,872	160,307
30	2017			4,565	4,565	168,718	164,153
31	2018			4,565	4,565	172,563	167,998
32	2019			4,565	4,565	176,409	171,844
33	2020			4,565	4,565	180,255	175,690
34	2021			4,565	4,565	184,100	179,536
35	2022			4,565	4,565	187,946	183,381
36	2023			4,565	4,565	191,792	187,227
37	2024			4,565	4,565	195,638	191,073
38	2025			4,565	4,565	199,483	194,918
39	2026			4,565	4,565	203,329	198,764
40	2027			4,565	4,565	207,175	202,610
41	2028			4,565	4,565	211,020	206,455
42	2029			4,565	4,565	214,866	210,301
43	2030			4,565	4,565	218,712	214,147
44	2031			4,565	4,565	218,712	214,147
45	2032			4,565	4,565	218,712	214,147
46	2033			4,565	4,565	218,712	214,147
47	2034			4,565	4,565	218,712	214,147
48	2035			4,565	4,565	218,712	214,147
49	2036			4,565	4,565	218,712	214,147
50	2037			4,565	4,565	218,712	214,147
51	2038			4,565	4,565	218,712	214,147
52	2039			4,565	4,565	218,712	214,147
53	2040			4,565	4,565	218,712	214,147
54	2041			4,565	4,565	218,712	214,147
55	2042			4,565	4,565	218,712	214,147
56	2043			4,565	4,565	218,712	214,147
57	2044			4,565	4,565	218,712	214,147

Conversion factor
0.82

Sensitivity
Cost Up : 0 %
Benefit Down : 15 %

	Net Present Value as of 1989		
	Cost	Benefit	B/C
(7%)	724,670	863,893	1.19
(8%)	690,882	673,011	0.97
(9%)	659,983	531,375	0.81

EIRR = 7.9%

TABLE 4.1.5 ECONOMIC ANALYSIS FOR SENSITIVITY

Dam reservoir : 6.675 MCM — UNIT: Rs.1000

No.	Year	Cost				Revenue	Net Benefit
		F/C	L/C	O/M (L/C)	Total		
1	1988	0	0	0	0	0	0
2	1989	19,903	8,634	0	28,537	0	-28,537
3	1990	24,181	27,087	0	51,268	0	-51,268
4	1991	107,315	56,553	0	163,867	0	-163,867
5	1992	173,695	41,254	0	214,949	0	-214,949
6	1993	361,344	115,870	0	477,214	0	-477,214
7	1994	73,051	27,883	0	100,934	0	-100,934
8	1995			5,250	5,250	18,577	13,328
9	1996			5,250	5,250	20,537	15,287
10	1997			5,250	5,250	22,497	17,247
11	1998			5,250	5,250	24,457	19,207
12	1999			5,250	5,250	26,416	21,167
13	2000			5,250	5,250	28,376	23,127
14	2001			5,250	5,250	39,718	34,469
15	2002			5,250	5,250	51,061	45,811
16	2003			5,250	5,250	62,403	57,153
17	2004	8,401	4,407	5,250	18,058	73,745	55,687
18	2005	8,401	4,407	5,250	18,058	85,087	67,029
19	2006			5,250	5,250	96,429	91,179
20	2007			5,250	5,250	107,771	102,522
21	2008			5,250	5,250	119,113	113,864
22	2009			5,250	5,250	130,456	125,206
23	2010			5,250	5,250	141,798	136,548
24	2011			5,250	5,250	145,643	140,394
25	2012			5,250	5,250	149,489	144,239
26	2013			5,250	5,250	153,335	148,085
27	2014			5,250	5,250	157,181	151,931
28	2015			5,250	5,250	161,026	155,777
29	2016			5,250	5,250	164,872	159,622
30	2017			5,250	5,250	168,718	163,468
31	2018			5,250	5,250	172,563	167,314
32	2019			5,250	5,250	176,409	171,159
33	2020			5,250	5,250	180,255	175,005
34	2021			5,250	5,250	184,100	178,851
35	2022			5,250	5,250	187,946	182,696
36	2023			5,250	5,250	191,792	186,542
37	2024			5,250	5,250	195,638	190,388
38	2025			5,250	5,250	199,483	194,234
39	2026			5,250	5,250	203,329	198,079
40	2027			5,250	5,250	207,175	201,925
41	2028			5,250	5,250	211,020	205,771
42	2029			5,250	5,250	214,866	209,616
43	2030			5,250	5,250	218,712	213,462
44	2031			5,250	5,250	218,712	213,462
45	2032			5,250	5,250	218,712	213,462
46	2033			5,250	5,250	218,712	213,462
47	2034			5,250	5,250	218,712	213,462
48	2035			5,250	5,250	218,712	213,462
49	2036			5,250	5,250	218,712	213,462
50	2037			5,250	5,250	218,712	213,462
51	2038			5,250	5,250	218,712	213,462
52	2039			5,250	5,250	218,712	213,462
53	2040			5,250	5,250	218,712	213,462
54	2041			5,250	5,250	218,712	213,462
55	2042			5,250	5,250	218,712	213,462
56	2043			5,250	5,250	218,712	213,462
57	2044			5,250	5,250	218,712	213,462

Conversion factor
0.82

Sensitivity
Cost Up : 15 %
Benefit Down : 15 %

	Net Present Value as of 1989		
	Cost	Benefit	B/C
(7%)	833,371	863,893	1.04
(8%)	794,515	673,011	0.85
(9%)	758,981	531,375	0.70

EIRR = 7.2%

TABLE 4.2.1 FINANCIAL CASH FLOW

Dam reservoir : 6.675 MCM UNIT: Rs.1000

No.	Year	Cost				Revenue	Net Revenue
		F/C	L/C	O/M (L/C)	Total		
1	1988	0	0	0	0	0	0
2	1989	17,861	9,815	0	27,676	0	-27,676
3	1990	22,394	33,009	0	55,403	0	-55,403
4	1991	102,565	73,880	0	176,445	0	-176,445
5	1992	171,320	57,775	0	229,095	0	-229,095
6	1993	367,808	173,954	0	541,762	0	-541,762
7	1994	76,738	44,874	0	121,611	0	-121,611
8	1995			9,057	9,057	4,542	-4,515
9	1996			9,709	9,709	5,018	-4,691
10	1997			10,408	10,408	5,494	-4,914
11	1998			11,158	11,158	7,354	-3,803
12	1999			11,961	11,961	7,941	-4,020
13	2000			12,822	12,822	8,527	-4,295
14	2001			13,745	13,745	14,526	781
15	2002			14,735	14,735	18,547	3,812
16	2003			15,796	15,796	22,569	6,773
17	2004	12,093	11,656	16,933	40,682	32,757	-7,925
18	2005	12,480	12,495	18,152	43,127	37,711	-5,416
19	2006			19,459	19,459	42,665	23,205
20	2007			20,860	20,860	58,663	37,802
21	2008			22,362	22,362	64,765	42,403
22	2009			23,972	23,972	70,868	46,896
23	2010			25,698	25,698	94,823	69,124
24	2011			27,549	27,549	97,203	69,654
25	2012			29,532	29,532	99,583	70,050
26	2013			31,659	31,659	125,610	93,952
27	2014			33,938	33,938	128,542	94,604
28	2015			36,381	36,381	131,474	95,093
29	2016			39,001	39,001	165,578	126,577
30	2017			41,809	41,809	169,190	127,381
31	2018			44,819	44,819	172,802	127,982
32	2019			48,046	48,046	217,328	169,282
33	2020			51,506	51,506	221,778	170,272
34	2021			55,214	55,214	226,228	171,014
35	2022			59,189	59,189	284,177	224,988
36	2023			63,451	63,451	289,658	226,207
37	2024			68,020	68,020	295,140	227,121
38	2025			72,917	72,917	370,343	297,426
39	2026			78,167	78,167	377,096	298,929
40	2027			83,795	83,795	383,849	300,054
41	2028			89,828	89,828	481,192	391,364
42	2029			96,296	96,296	489,511	393,215
43	2030			103,229	103,229	497,830	394,601
44	2031			110,662	110,662	613,290	502,628
45	2032			118,629	118,629	613,290	494,660
46	2033			127,171	127,171	613,290	486,119
47	2034			136,327	136,327	755,527	619,200
48	2035			146,142	146,142	755,527	609,385
49	2036			156,665	156,665	755,527	598,862
50	2037			167,944	167,944	930,753	762,808
51	2038			180,036	180,036	930,753	750,716
52	2039			192,999	192,999	930,753	737,754
53	2040			206,895	206,895	1,146,618	939,723
54	2041			221,791	221,791	1,146,618	924,826
55	2042			237,760	237,760	1,146,618	908,857
56	2043			254,879	254,879	1,412,547	1,157,668
57	2044			273,231	273,231	1,412,547	1,139,317

Net Present Value as of 1988

	Cost	Benefit	B/C
(6%)	1,316,295	1,586,788	1.21
(7%)	1,171,640	1,107,471	0.95
(8%)	1,062,117	785,350	0.74

FIRR = 6.8%

TABLE 4.2.2 FINANCIAL CASH FLOW FOR SENSITIVITY ANALYSIS

UNIT: Rs.1000

No.	Year	Cost				Revenue	Net Revenue
		F/C	L/C	O/M (L/C)	Total		
1	1988	0	0	0	0	0	0
2	1989	20,540	11,288	0	31,827	0	-31,827
3	1990	25,753	37,961	0	63,714	0	-63,714
4	1991	117,950	84,962	0	202,912	0	-202,912
5	1992	197,018	66,441	0	263,459	0	-263,459
6	1993	422,979	200,047	0	623,026	0	-623,026
7	1994	88,248	51,605	0	139,853	0	-139,853
8	1995			10,416	10,416	4,542	-5,874
9	1996			11,165	11,165	5,018	-6,147
10	1997			11,969	11,969	5,494	-6,475
11	1998			12,831	12,831	7,354	-5,477
12	1999			13,755	13,755	7,941	-5,814
13	2000			14,745	14,745	8,527	-6,218
14	2001			15,807	15,807	14,526	-1,281
15	2002			16,945	16,945	18,547	1,602
16	2003			18,165	18,165	22,569	4,403
17	2004	13,907	13,404	19,473	46,784	32,757	-14,027
18	2005	14,352	14,369	20,875	49,596	37,711	-11,885
19	2006			22,378	22,378	42,665	20,286
20	2007			23,989	23,989	58,663	34,673
21	2008			25,717	25,717	64,765	39,049
22	2009			27,568	27,568	70,868	43,300
23	2010			29,553	29,553	94,823	65,270
24	2011			31,681	31,681	97,203	65,522
25	2012			33,962	33,962	99,583	65,621
26	2013			36,407	36,407	125,610	89,203
27	2014			39,029	39,029	128,542	89,513
28	2015			41,839	41,839	131,474	89,635
29	2016			44,851	44,851	165,578	120,727
30	2017			48,080	48,080	169,190	121,110
31	2018			51,542	51,542	172,802	121,260
32	2019			55,253	55,253	217,328	162,075
33	2020			59,231	59,231	221,778	162,547
34	2021			63,496	63,496	226,228	162,731
35	2022			68,068	68,068	284,177	216,109
36	2023			72,969	72,969	289,658	216,690
37	2024			78,222	78,222	295,140	216,918
38	2025			83,854	83,854	370,343	286,489
39	2026			89,892	89,892	377,096	287,204
40	2027			96,364	96,364	383,849	287,485
41	2028			103,302	103,302	481,192	377,890
42	2029			110,740	110,740	489,511	378,771
43	2030			118,713	118,713	497,830	379,117
44	2031			127,261	127,261	613,290	486,029
45	2032			136,424	136,424	613,290	476,866
46	2033			146,246	146,246	613,290	467,043
47	2034			156,776	156,776	755,527	598,751
48	2035			168,064	168,064	755,527	587,463
49	2036			180,164	180,164	755,527	575,363
50	2037			193,136	193,136	930,753	737,617
51	2038			207,042	207,042	930,753	723,711
52	2039			221,949	221,949	930,753	708,804
53	2040			237,929	237,929	1,146,618	908,688
54	2041			255,060	255,060	1,146,618	891,558
55	2042			273,425	273,425	1,146,618	873,193
56	2043			293,111	293,111	1,412,547	1,119,436
57	2044			314,215	314,215	1,412,547	1,098,332

Net Present Value as of 1988

Sensitivity		Cost	Benefit	B/C
	(6%)	1,513,740	1,586,788	1.05
Cost up : 15 %	(7%)	1,347,386	1,107,471	0.82
Benefit down : 0 %	(8%)	1,221,435	785,350	0.64
		FIRR = 6.2%		

TABLE 4.2.3 FINANCIAL CASH FLOW FOR SENSITIVITY ANALYSIS

UNIT: Rs.1000

No.	Year	Cost				Revenue	Net Revenue
		F/C	L/C	O/M (L/C)	Total		
1	1988	0	0	0	0	0	0
2	1989	17,861	9,815	0	27,676	0	-27,676
3	1990	22,394	33,009	0	55,403	0	-55,403
4	1991	102,565	73,880	0	176,445	0	-176,445
5	1992	171,320	57,775	0	229,095	0	-229,095
6	1993	367,808	173,954	0	541,762	0	-541,762
7	1994	76,738	44,874	0	121,611	0	-121,611
8	1995			9,057	9,057	3,861	-5,196
9	1996			9,709	9,709	4,265	-5,444
10	1997			10,408	10,408	4,670	-5,738
11	1998			11,158	11,158	6,251	-4,906
12	1999			11,961	11,961	6,750	-5,211
13	2000			12,822	12,822	7,248	-5,574
14	2001			13,745	13,745	12,347	-1,398
15	2002			14,735	14,735	15,765	1,030
16	2003			15,796	15,796	19,183	3,388
17	2004	12,093	11,656	16,933	40,682	27,843	-12,838
18	2005	12,480	12,495	18,152	43,127	32,054	-11,073
19	2006			19,459	19,459	36,265	16,806
20	2007			20,860	20,860	49,863	29,003
21	2008			22,362	22,362	55,051	32,688
22	2009			23,972	23,972	60,238	36,266
23	2010			25,698	25,698	80,599	54,901
24	2011			27,549	27,549	82,622	55,074
25	2012			29,532	29,532	84,645	55,113
26	2013			31,659	31,659	106,769	75,110
27	2014			33,938	33,938	109,261	75,323
28	2015			36,381	36,381	111,753	75,371
29	2016			39,001	39,001	140,741	101,740
30	2017			41,809	41,809	143,811	102,002
31	2018			44,819	44,819	146,881	102,062
32	2019			48,046	48,046	184,729	136,683
33	2020			51,506	51,506	188,511	137,006
34	2021			55,214	55,214	192,293	137,079
35	2022			59,189	59,189	241,550	182,361
36	2023			63,451	63,451	246,210	182,759
37	2024			68,020	68,020	250,869	182,850
38	2025			72,917	72,917	314,792	241,875
39	2026			78,167	78,167	320,532	242,365
40	2027			83,795	83,795	326,272	242,477
41	2028			89,828	89,828	409,013	319,185
42	2029			96,296	96,296	416,085	319,789
43	2030			103,229	103,229	423,156	319,927
44	2031			110,662	110,662	521,296	410,635
45	2032			118,629	118,629	521,296	402,667
46	2033			127,171	127,171	521,296	394,126
47	2034			136,327	136,327	642,198	505,871
48	2035			146,142	146,142	642,198	496,056
49	2036			156,665	156,665	642,198	485,533
50	2037			167,944	167,944	791,140	623,195
51	2038			180,036	180,036	791,140	611,103
52	2039			192,999	192,999	791,140	598,141
53	2040			206,895	206,895	974,625	767,730
54	2041			221,791	221,791	974,625	752,834
55	2042			237,760	237,760	974,625	736,865
56	2043			254,879	254,879	1,200,665	945,786
57	2044			273,231	273,231	1,200,665	927,435

Net Present Value as of 1989

Sensitivity		Cost	Benefit	B/C
	(6%)	1,316,295	1,348,770	1.02
	(7%)	1,171,640	941,351	0.80
Cost up : 0 %	(8%)	1,062,117	667,547	0.63
Benefit down : 15 %				

FIRR = 6.1%

TABLE 4.2.4 FINANCIAL CASH FLOW FOR SENSITIVITY ANALYSIS

UNIT : Rs.1000

No.	Year	Cost				Revenue	Net Revenue
		F/C	L/C	O/M (L/C)	Total		
1	1988	0	0	0	0	0	0
2	1989	20,540	11,288	0	31,827	0	-31,827
3	1990	25,753	37,961	0	63,714	0	-63,714
4	1991	117,950	84,962	0	202,912	0	-202,912
5	1992	197,018	66,441	0	263,459	0	-263,459
6	1993	422,979	200,047	0	623,026	0	-623,026
7	1994	88,248	51,605	0	139,853	0	-139,853
8	1995			10,416	10,416	3,861	-6,555
9	1996			11,165	11,165	4,265	-6,900
10	1997			11,969	11,969	4,670	-7,300
11	1998			12,831	12,831	6,251	-6,580
12	1999			13,755	13,755	6,750	-7,005
13	2000			14,745	14,745	7,248	-7,497
14	2001			15,807	15,807	12,347	-3,460
15	2002			16,945	16,945	15,765	-1,180
16	2003			18,165	18,165	19,183	1,018
17	2004	13,907	13,404	19,473	46,784	27,843	-18,941
18	2005	14,352	14,369	20,875	49,596	32,054	-17,542
19	2006			22,378	22,378	36,265	13,887
20	2007			23,989	23,989	49,863	25,874
21	2008			25,717	25,717	55,051	29,334
22	2009			27,568	27,568	60,238	32,670
23	2010			29,553	29,553	80,599	51,046
24	2011			31,681	31,681	82,622	50,941
25	2012			33,962	33,962	84,645	50,683
26	2013			36,407	36,407	106,769	70,361
27	2014			39,029	39,029	109,261	70,232
28	2015			41,839	41,839	111,753	69,914
29	2016			44,851	44,851	140,741	95,890
30	2017			48,080	48,080	143,811	95,731
31	2018			51,542	51,542	146,881	95,339
32	2019			55,253	55,253	184,729	129,476
33	2020			59,231	59,231	188,511	129,280
34	2021			63,496	63,496	192,293	128,797
35	2022			68,068	68,068	241,550	173,483
36	2023			72,969	72,969	246,210	173,241
37	2024			78,222	78,222	250,869	172,647
38	2025			83,854	83,854	314,792	230,937
39	2026			89,892	89,892	320,532	230,640
40	2027			96,364	96,364	326,272	229,907
41	2028			103,302	103,302	409,013	305,711
42	2029			110,740	110,740	416,085	305,344
43	2030			118,713	118,713	423,156	304,442
44	2031			127,261	127,261	521,296	394,035
45	2032			136,424	136,424	521,296	384,873
46	2033			146,246	146,246	521,296	375,050
47	2034			156,776	156,776	642,198	485,422
48	2035			168,064	168,064	642,198	474,134
49	2036			180,164	180,164	642,198	462,034
50	2037			193,136	193,136	791,140	598,004
51	2038			207,042	207,042	791,140	584,098
52	2039			221,949	221,949	791,140	569,191
53	2040			237,929	237,929	974,625	736,696
54	2041			255,060	255,060	974,625	719,565
55	2042			273,425	273,425	974,625	701,201
56	2043			293,111	293,111	1,200,665	907,554
57	2044			314,215	314,215	1,200,665	886,450

Net Present Value as of 1989

Sensitivity		Cost	Benefit	B/C
	(5%)	1,740,728	1,963,266	1.13
	(6%)	1,513,740	1,348,770	0.89
Cost up : 15 %	(7%)	1,347,386	941,351	0.70
Benefit down : 15 %				

FIRR = 5.5%

TABLE 4.2.5 CASH FLOW FOR LOAN REPAYABILITY
(CASE I)

UNIT : Rs.1000

No.	Year	Loan Amount F/C	Loan Amount L/C	Loan Repayment	Interest	O/M Cost	Total Expenditure	Total Revenue	Cash flow	Accumulated Surplus
1	1989 /90	17,861	9,815	0	518	0	518	0	-518	-518
2	1990 /91	22,394	33,009	0	1,167	0	1,167	0	-1,167	-1,685
3	1991 /92	102,565	73,880	0	4,142	0	4,142	0	-4,142	-5,827
4	1992 /93	171,320	57,775	0	9,110	0	9,110	0	-9,110	-14,937
5	1993 /94	367,808	173,954	0	19,776	0	19,776	0	-19,776	-34,714
6	1994 /95	76,738	44,874	0	22,002	0	22,002	0	-22,002	-56,716
7	1995 /96	0	0	31,612	21,085	9,057	61,754	5,018	-56,736	-113,452
8	1996 /97	0	0	31,612	20,168	9,709	61,489	5,494	-55,995	-169,447
9	1997 /98	0	0	31,612	19,252	10,408	61,272	5,970	-55,302	-224,749
10	1998 /99	0	0	31,612	18,335	11,158	61,104	7,941	-53,164	-277,913
11	1999 /00	0	0	31,612	17,418	11,961	60,991	8,527	-52,464	-330,376
12	2000 /01	0	0	31,612	16,501	12,822	60,935	11,791	-49,144	-379,520
13	2001 /02	0	0	31,612	15,585	13,745	60,942	18,547	-42,394	-421,915
14	2002 /03	0	0	31,612	14,668	14,735	61,015	22,569	-38,446	-460,361
15	2003 /04	0	0	31,612	13,751	15,796	61,159	26,590	-34,569	-494,930
16	2004 /05	0	0	31,612	12,834	16,933	61,380	37,711	-23,669	-518,599
17	2005 /06	0	0	31,612	11,918	18,152	61,682	42,665	-19,017	-537,616
18	2006 /07	0	0	31,612	11,001	19,459	62,072	47,619	-14,454	-552,070
19	2007 /08	0	0	31,612	10,084	20,860	62,556	64,765	2,209	-549,861
20	2008 /09	0	0	31,612	9,167	22,362	63,142	70,868	7,727	-542,134
21	2009 /10	0	0	31,612	8,251	23,972	63,835	76,971	13,136	-528,998
22	2010 /11	0	0	31,612	7,334	25,698	64,644	97,203	32,558	-496,440
23	2011 /12	0	0	31,612	6,417	27,549	65,578	99,583	34,005	-462,435
24	2012 /13	0	0	31,612	5,500	29,532	66,645	101,963	35,318	-427,117
25	2013 /14	0	0	31,612	4,584	31,659	67,854	128,542	60,688	-366,429
26	2014 /15	0	0	31,612	3,667	33,938	69,217	131,474	62,257	-304,172
27	2015 /16	0	0	31,612	2,750	36,381	70,744	134,406	63,662	-240,510
28	2016 /17	0	0	31,612	1,833	39,001	72,446	169,190	96,744	-143,766
29	2017 /18	0	0	31,612	917	41,809	74,338	172,802	98,464	-45,302
30	2018 /19	0	0	31,612	0	44,819	76,431	176,414	99,982	54,680
31	2019 /20	0	0	0	0	48,046	48,046	221,778	173,732	228,412

Loan Condition for Foreign Portion : Interest rate = 2.9 %
Repayment period = 30 years
Grace period = 6 years

TABLE A.2.6 CASH FLOW FOR LOAN REPAYABILITY
(CASE II)

UNIT : Rs.1000

No.	Year	Loan Amount F/C	Loan Amount L/C	Loan Re-payment	Interest	O/M Cost	Total Ex-penditure	Total Revenue	Cash flow	Accumulated Surplus
1	1989 /90	17,861	9,815	0	1,250	0	1,250	0	-1,250	-1,250
2	1990 /91	22,394	33,009	0	2,818	0	2,818	0	-2,818	-4,068
3	1991 /92	102,565	73,880	0	9,997	0	9,997	0	-9,997	-14,066
4	1992 /93	171,320	57,775	0	21,990	0	21,990	0	-21,990	-36,055
5	1993 /94	367,808	173,954	0	47,736	0	47,736	0	-47,736	-83,792
6	1994 /95	76,738	44,874	0	53,108	0	53,108	0	-53,108	-136,900
7	1995 /96	0	0	54,192	49,315	9,057	112,563	5,018	-107,545	-244,445
8	1996 /97	0	0	54,192	45,521	9,709	109,422	5,494	-103,928	-348,373
9	1997 /98	0	0	54,192	41,728	10,408	106,328	5,970	-100,358	-448,731
10	1998 /99	0	0	54,192	37,934	11,158	103,284	7,941	-95,343	-544,074
11	1999 /00	0	0	54,192	34,141	11,961	100,294	8,527	-91,766	-635,841
12	2000 /01	0	0	54,192	30,347	12,822	97,361	11,791	-85,570	-721,411
13	2001 /02	0	0	54,192	26,554	13,745	94,491	18,547	-75,944	-797,354
14	2002 /03	0	0	54,192	22,761	14,735	91,687	22,569	-69,119	-866,473
15	2003 /04	0	0	54,192	18,967	15,796	88,955	26,590	-62,365	-928,838
16	2004 /05	0	0	54,192	15,174	16,933	86,299	37,711	-48,588	-977,426
17	2005 /06	0	0	54,192	11,380	18,152	83,724	42,665	-41,060	-1,018,486
18	2006 /07	0	0	54,192	7,587	19,459	81,238	47,619	-33,619	-1,052,105
19	2007 /08	0	0	54,192	3,793	20,860	78,846	64,765	-14,080	-1,066,185
20	2008 /09	0	0	54,192	0	22,362	76,554	70,868	-5,686	-1,071,871
21	2009 /10	0	0	0	0	23,972	23,972	76,971	52,999	-1,018,872
22	2010 /11	0	0	0	0	25,698	25,698	97,203	71,504	-947,368
23	2011 /12	0	0	0	0	27,549	27,549	99,583	72,034	-875,334
24	2012 /13	0	0	0	0	29,532	29,532	101,963	72,430	-802,904
25	2013 /14	0	0	0	0	31,659	31,659	128,542	96,884	-706,021
26	2014 /15	0	0	0	0	33,938	33,938	131,474	97,536	-608,484
27	2015 /16	0	0	0	0	36,381	36,381	134,406	98,024	-510,460
28	2016 /17	0	0	0	0	39,001	39,001	169,190	130,189	-380,271
29	2017 /18	0	0	0	0	41,809	41,809	172,802	130,993	-249,278
30	2018 /19	0	0	0	0	44,819	44,819	176,414	131,594	-117,684
31	2019 /20	0	0	0	0	48,046	48,046	221,778	173,732	56,048

Loan Condition for Foreign Portion : Interest rate = 7.0 %
Repayment period = 20 years
Grace period = 6 years

5. ENVIRONMENTAL ASSESSMENT

5.1 General

The environmental survey for the Port Louis Water Supply Project had the following objective: to make a detailed study for minimizing possible adverse effects on environmental conditions due to the Project.

Then, the survey and study were carried out in accordance with the following guidelines:

(a) To review and re-evaluate the previous studies on water supply in Mauritius as well as investigate present situation in Mauritius;

(b) To conduct literature reviews on environmental aspects resulting from the water resource development in Mauritius and other tropical and subtropical countries relevant to the study;

(c) To identify any significant effects due to the Port Louis Water Supply Project, utilizing the information obtained;

(d) To make a detailed study for minimizing possible adverse effects on the environmental conditions.

In accordance with the said guidelines, various data collection and analyses on them have been carried out during the study period. The following summarizes the findings obtained in the field investigation and the results of the study conducted.

5.2 Present Status of Water Pollution in Mauritius

5.2.1 Present Status

In Mauritius, the urban population has increased and the manufacturing industries have developed in recent years. However, the construction of sewerage facilities is backward here as compared with those of advanced industrial countries. The inadequate treatment of industrial wastes as well as city sewage have caused pollution of public water areas involving the sea, rivers, etc. year after year, giving rise to serious problems. The main problems of water pollution in Mauritius include damage to the river and coastal fisheries by effluent discharged from factories.

Factories in the Project area are widely distributed along the rivers such as Grand River North West, Seche, Perfonde, Terre Rouge and Plaines Wilhelms, particularly Grand River North West and Seche, flowing down to Port Louis area. Effluent discharge into surface waters then poses a health risk to local communities. Industrial wastes may also endanger public health by contaminating irrigated food crops, and by contaminating fishes which are a source of protein.

The flow of effluent may highly be seasonal, particularly from many industries which process agricultural products, and pollution problems will be increased if the peak discharge coincides with the season of low flow in the rivers.

Many different industrial process produce harmful wastes. Food and drink industries tend to discharge heavy organic pollution and oxygen demand to urban streams being used as water sources. A particular problem is dyes discharged from textile factories in Mauritius. With the rapid development of the textile industry, the demand for dye houses has been steadily increasing. During the last four years, the number of dye houses actually operating has increased from six to thirty. Already serious problems of water pollution have taken place along the rivers in which harmful effluents are discharged from dye houses.

As mentioned above, in recent years, every industrialized and densely populated area has suffered to some extent from pollution of surface- and ground-water. This is also particularly true in Mauritius.

The pollution can be removed by the self-purification process which takes places in the water. This process has effective limits, however, and when the quantity of effluents introduced exceeds those limits the national economy is impaired.

Some investigations to date have dealt with the effects of ordinary organic pollution derived from domestic effluents and various kinds of ordinary industrial effluents. In this connection, special attention should be paid to the effects of seasonal industries like sugar refinery and of the textile industry including dye houses.

Toxic substances produce effects similar to those from organic pollution. Toxic pollution is caused by the introduction of complex types of effluents such as those discharged from chemical works. It is not only large-scale industry that is responsible for toxic substances affecting the quality of water, but smaller commercial undertakings, which attract less publicity are also often responsible for considerable damage.

It must be noted that the danger resulting from the growth in the number of bacteria per unit volume is also of increasing importance.

5.2.2 Existing Countermeasures by the Government

As pointed out in the paper 1/, Mauritius has experienced rapid expansion of industrial development over the few years and is currently embarking upon a policy of industrial diversification. The Government is fully aware of the associated risk to the environment and the water resources in particular, and intends to introduce countermeasures necessary for environmental protection without inhibiting growth.

In February 1988, the Mauritius Government decided to create a Department of Environment and establish a National Environment Commission after considering a report prepared by the National Environment Committee. A World Bank team also visited Mauritius to carry out a study on the island, issued a report entitled "Economic Development and Environment Management - Strategies for Mauritius". In September 1988, a conference sponsored by the Mauritius Government was held on the Technical Aspects of Environmental Protection:

The responsibility for developing and maintaining water resources lies with the CWA. However, the responsibility for protecting the resources from pollution lies jointly with the Ministry of Health, who should ensure that acceptable water quality is supplied.

5.3 Existing Laws and Regulations on Water Pollution Control

Mauritius has inadequate environmental control legislation, and it is not always clear who has the responsibility, means and authority to enforce it adequately. It might be impossible to lay down standards in advance for all possible pollutants, and the most useful control measure is to empower a single agency such as the national water authority, to decide and enforce the standards to be applied in each case.

According to the information obtained from the Government of Mauritius, at present there is no law to prevent water pollution. Prevention of water pollution has to be undertaken by ministries concerned. Table 5.1 shows a list of respective laws and regulations.

1/: "Managing The Water Cycle" - Water is Life
Prepared for the Technical Seminar "Mauritius Environmental Protection Programme" held on 12-15 September 1988.

5.4 Specific Problems

5.4.1 Forestry and Wildlife

Several types of trees are found in the proposed reservoir area. Several adverse effects would be caused by clearance of forest for reservoir construction. However, this would be localized with minor adverse effects, because the proposed submerged area to be confined with steep gorge is quite small or 30 ha only.

The following is included in species of timbers found in the proposed reservoir areas. Canarium maurtianum, Eugenia glomerata, etc. Mimusops maxima, Cedrela spp., Acacia sp., Gmelina arborea, Dillenia speciosa. Details will be re-investigated in the detailed design stage.

Wildlife in the Project area and its surrounding areas is believed to be quite low in number. Advance impact due to the wildlife loss is relatively negligible.

5.4.2 Freshwater Aquaculture

Fishing might not be the main occupation for most villagers in the Project area. Even though fishing is conducted there, they might fish in their spare time and the device used are appropriate for family use.

In Mauritius, its endemic freshwater fauna is very limited. A number of fishes like the gourami (Osphronemua goramy), blackbass (Micropterus sp.), goldfish (Carassius auratus), blue gill (Lepomis macrochirus) were thus introduced and together with locally available species like the freshwater mullet (Agnostomus telfairi), carp (Dules rupestris) and the camaron (Macrobrachiumlar) were cultured by individual hobbyists.

Attempts at aquaculture in Mauritius stated only with the introduction of various species of tilapia (Sarotherodon spp. and

Tilapia spp.) during 1953-57. Experiments were conducted at the Curepipe Experimental Station. The production is about 500 kg/ha with supplemental feeding and fertilization. Tilapias have a prolific breeding habit which results in population explosions and stunted growth. Small sizes attained by these fishes have thus limited their market value.

As mentioned above, freshwater aquaculture has witnessed steady development with the introduction of a giant freshwater prawn (Macrobrachium rosenbergii) in 1972 and six species of Indian and Chinese carps in 1975 and 1976 respectively. There are now about 45 hectares of prawn and fish culture ponds in Mauritius. A commercial hatchery produces camaron postlarvae for stocking in this farm and other ponds on sugar estates.

Since 1984, carp fingerings have been produced in sufficient numbers to stock all aquaculture ponds and a number of water reservoirs with a view to making optimum use of water resources.

5.4.3 Water Quality of Reservoirs and Lakes

Water quality of reservoirs and lakes will deteriorate in the first few years of impoundment owing to the degradation of organic matters and others. The high nitrate content indicates probable contamination by human or animal wastes and precautions must be exercised because reservoirs and lakes have to serve for domestic water supply. After five years of impoundment, the phosphate content in the reservoirs and lakes can become comparatively high. This high level of nutrients may exceed assimilation capability, and so-called eutrophication will take place. Close monitoring of their concentration may be required to avoid instability.

Countermeasures to eutrophication of reservoirs and lakes are largely divided into three, namely a) Sewerage construction; b) Aeration and circulation of reservoirs and lakes; and c) Weed control.

Natural loadings of P and N are generally high in the tropical zone. Sewerage construction is a direct countermeasure to prevent or restore reservoirs' eutrophication. However, conventional sewage treatment processes cannot remove N and P efficiently.

In comparison with the sewerage construction, algae control and deep water oxygenation are essential for restoration of an eutrophication reservoir. Artificial circulation of impounded water by aeration can achieve both purposes above. Algae contained in the surface water are in turn carried down to deep and dark layers where conditions are not favourable for algae to survive. The odor produced by algae and H_2S will entirely disappear.

5.4.4 Recreation

Recreation activities associated with the Port Louis Project would be confined primarily to the reservoir areas. No specific project facilities will be constructed for recreation purposes. The relative isolation of the reservoirs detracts from their usefulness for recreation. Recreational visitors to the reservoir areas are therefore expected to be limited primarily to people living in the surrounding areas. As local living standards rise and the people have more leisure time for recreation, the use of the Project resources for recreational purposes would increase somewhat. Even with this increase, monetary benefits from recreational activities attributable to the Project are not expected to be significant. The reservoirs would provide intangible benefits as an inexpensive source of recreational for local people.

5.4.5 Resettlement

At some of the proposed reservoirs, in the case of the Baptiste area, various facilities would have to be cleared out. Those would include about 20 families and extensive sugarcane fields. The clearance, together with moving cost, temporary living allowance, facilities and administrative costs, etc. must be studied in the detailed design stage.