5.4 Design of Plugs in Diversion Tunnel

Tunnel plugs are provided at three (3) portions in the diversion tunnel, being named as No.1, No.2, and main plugs from the inlet to the outlet as shown in Fig.5.4.1 and as listed below :

Name	Starting point from inlet (m)	Length (m)	Location (around)
No.1	8.60	11.4	River outlet pit
No.2	27.80	11.0	Just downstream of intake pit
Main	201.00	30.0	Below dam axis

The No.1 and No.2 plugs have purposes to support the diversion gate, river outlet water supply pipes and the inlet portion, and to separate the water between the water supply intake and the river outlet.

The main plug has purposes to completely close the diversion tunnel and to install the water supply and river outlet facilities in it.
The main plug is provided with a length of 30 m of which determination depends on the standard to meet the minimum requirement to ensure a complete water stop and necessary resistible force against the water pressure.

The plug concreting will be made for a short period after installation of the diversion closing gate. Cracks due to shrinkage may occur in the plug concrete if the concrete temperature will become too high by the heat generated when hardening. To dissipate the heat generated in concrete when hardening and to avoid cracks due to shrinkage of the concrete the artificial pipe cooling system is provided at 0.3 m to 0.8 m interval horizontally in 5 lifts of 1 m to 1.4 m in thickness as shown in Fig.5.4.2. This cooling system is applied for the main plug only, considering the size of No.1 and No.2 plugs. The diameter of the cooling pipes is 25 mm, and the cooling will be made by using the river water.
The standard mentions that the difference between the highest concrete temperature and the final stable concrete temperature should be limited to about 20°C to avoid cracks due to shrinkage. Thus, the cooling will be continued to depress the maximum temperature rise below 40°C.

The pressure grouting for the purpose of filling up the interstice to be caused due to the shrinkage of concrete or due to difficulty to fill the concrete in the upper portion of the tunnel is also required in the main plug portion.
Hence, the grout pipe system will be embedded in the plug concrete.
The grout pipe system embedded in the plug concrete consists of supply headers, return headers, vent headers and vent return headers, all being steel pipes of 40mm in diameter, and of steel riser pipes of 25mm in diameter which connect supply header to grout outlets and vent headers to drilled holes as air inlets, as shown in Fig.5.4.2.

Safety of the plugs is examined by the following Henry's formula :

$$n = \frac{f \cdot x\ V + \tau\ x\ A\}}{H} \geq 4$$

where
- f : friction coefficient = 0.75
- V : weight of concrete plug (t)
- τ : shearing strength of mass concrete = 200 t/m^2
- A : area of sliding surface (m^2)
- H : horizontal pressure to the concrete plug (t)
- n : safety factor of sliding

The above equation is expressed as follows :

$$n = \frac{f \cdot r_c \cdot A_c \cdot L + \tau \cdot l \cdot L}{A_c \cdot P}$$

where
- r_c : unit weight of concrete in water = 1.3 t/m^3
- A_c : sectional area of concrete plug = 36.3 m^2
- L : plug length (m)
- l : contact length = 1/4 πD = 5.34 m
- P : pressure at the center of the plug = 81 t/m^2 (FWL = 212.5 m)(*)
- (*) : The project considers future expansion of dam by about 20 m in dam height, and water pressure acting to plugs takes this future increase into consideration.

Based on the above, necessary length of the plug is calculated at 11.0 m as follows :

$$\frac{0.75 \times 1.3 \times 36.3 \times L + 200 \times 5.34 \times L}{36.3 \times 81.0} = 4$$

1,103.4 x L = 11,761.2

L = 10.7 ≒ 11.0 (m)

The plugs are provided with length of 11.0 m or more, and therefore, are considered safe sufficiently. Although the main plug is provided with the length of 30 m, its determination depends on the standard to meet the minimum requirement to ensure a complete water stop as mentioned.

TABLES

Table 5.2.1 (1): STRUCTURAL ANALYSIS OF INCLINED SHAFT BY SLOPE-DEFLECTION METHOD

(1) Load Term Calculation

$$\alpha = \frac{I_2}{I_1} \cdot \frac{h}{l} = 1.0 \times \frac{3.2}{2.9} = 1.103$$

$$\beta = \frac{I_3}{I_1} \cdot \frac{h}{l} = 1.0 \times \frac{3.2}{2.9} = 1.103$$

$$N_1 = 2 + \alpha = 2 + 1.103 = 3.103$$

$$N_2 = 2 + \beta = 2 + 1.103 = 3.103$$

$$C_{AD} = \frac{W_2 l^2}{12} = \frac{66.8 \times 2.9^2}{12} = 46.816 \text{ t-m}$$

$$C_{BC} = \frac{W_1 l^2}{12} = \frac{66.8 \times 2.9^2}{12} = 45.358 \text{ t-m}$$

$$C_{AB} = \frac{h^2}{60}(3P_2 + 2P_1) = \frac{3.2^2}{60} \times (3 \times 66.4 + 2 \times 63.2) = 55.569 \text{ t-m}$$

$$C_{BA} = \frac{h^2}{60}(2P_2 + 3P_1) = \frac{3.2^2}{60} \times (2 \times 66.4 + 3 \times 63.2) = 55.023 \text{ t-m}$$

$$\theta_A = \frac{N_1 (C_{AB} - C_{AD}) - (C_{BC} - C_{BA})}{N_1 N_2 - 1}$$

$$= \frac{3.103\,(55.569 - 46.816) - (45.358 - 55.023)}{3.103 \times 3.103 - 1} = 4.268 \text{ t-m}$$

$$\theta_B = \frac{N_2 (C_{BC} - C_{BA}) - (C_{AB} - C_{AD})}{N_1 N_2 - 1}$$

$$= \frac{3.103\,(45.358 - 55.023) - (55.569 - 46.816)}{3.103 \times 3.103 - 1} = -4.490 \text{ t-m}$$

(2) End Moment Calculation

$$M_{AB} = 2\theta_A + \theta_B - C_{AB} = 2 \times 4.268 + (-4.490) - 55.569 = -51.523$$

$$M_{AD} = \beta\theta_A + C_{AD} = 1.103 \times 4.268 + 46.816 = 51.524$$

$$M_{BA} = 2\theta_B + \theta_A + C_{BA} = 2 \times (-4.490) + 4.268 + 55.023 = 50.311$$

$$M_{BC} = \alpha\theta_B - C_{BC} = 1.103 \times (-4.490) - 45.358 = -50.310$$

$$\Sigma M_A = M_{AB} + M_{AD} = -51.523 + 51.524 \doteqdot 0$$

$$\Sigma M_B = M_{BA} + M_{BC} = 50.311 - 50.310 \doteqdot 0$$

(3) Calculation of Shear and Maximum Moment

Upper Beam

$$S_B = S_C = \pm\frac{W_1 l}{2} = \pm\frac{64.72 \times 2.90}{2} = \pm 93.844 \text{ t}$$

$$M_C = \frac{W_1 l^2}{8} - M_B = \frac{64.72 \times 2.9^2}{8} - 50.311 = 17.726 \text{ t-m}$$

Bottom Beam

$$S_A = S_D = \pm\frac{W_2 l}{2} = \pm\frac{66.8 \times 2.90}{2} = \pm 96.860 \text{ t}$$

$$M_C = \frac{W_2 l^2}{8} - M_A = \frac{66.8 \times 2.9^2}{8} - 51.523 = 18.701 \text{ t-m}$$

Side Beam

$$S_A = \frac{P_1 h}{2} + \frac{(P_2 - P_1)\, h}{3} - \frac{M_{AB} + M_{BA}}{h}$$

$$= \frac{63.2 \times 3.2}{2} + \frac{3.2 \times 3.2}{3} - \frac{-51.523 + 50.311}{3.2} = 104.912 \text{ t}$$

$$S_B = -\frac{P_1 h}{2} - \frac{(P_2 - P_1)\, h}{6} - \frac{M_{AB} + M_{BA}}{h}$$

$$= -\frac{63.2 \times 3.2}{2} - \frac{3.2 \times 3.2}{6} - \frac{-51.523 + 50.311}{3.2} = -102.448 \text{ t}$$

$$M_{max} = R_A \cdot \chi + \frac{P_2 - P_1}{6h}\chi^3 - \frac{P_3}{2}\chi^2 + M_{AB}$$

$$= 104.912 \times 1.599 + \frac{3.2}{6 \times 3.2} \times 1.599^3 - \frac{66.4}{2} \times 1.599^2 + (-51.523)$$

$$= 32.027 \text{ t-m}$$

where,

$$A = \frac{\Delta P}{h} = \frac{P_3 - P_1}{h} = \frac{3.2}{3.2} = 1.0$$

$$\therefore \chi = \frac{P_2 - \sqrt{P_2^2 - 2A \cdot R_A}}{A} = \frac{66.4 - \sqrt{66.4^2 - 2 \times 1.0 \times 104.912}}{1.0}$$

$$= 1.599 \text{ m}$$

Table 5.2.2 STRESS ANALYSIS OF INCLINED SHAFT

Member Spot		
M	t.m	51.50
Q	t	78.70
N	t	96.90
b	cm	100.00
h	cm	96.60
u	cm	38.30
d	cm	86.60
d'	cm	10.00
d'/d		0.12
M' = M + N.u	t.m	88.61
M'/(b.d.d)	kg/cm^2	11.82
Q/(b.d)	kg/cm^2	9.09
f = M/N + u	cm	91.45
f/d		1.06
As	cm^2	19.36
As'	cm^2	19.36
As'/As		1.00
n		15.00
np = n.As/(bd)		0.034
C		4.86
S		6.45
Z		1.16
Sigma c	kg/cm^2	57.4
Sigma s	kg/cm^2	1,143.6
Tau	kg/cm^2	10.6
Sigma ca	kg/cm^2	78.0
Sigma sa	kg/cm^2	2,340.0
Tau a	kg/cm^2	5.2

Table 5.2.3 (1) Examination on diameter of water supply conduit

(1) Calculation of Head Loss :

Pipe Dia. D (m)	Flow Area A (m^2)	Flow Velocity V (m/s)	$V^2/2g$	Head Loss (Friction loss) h_f (m)
1.2	1.131	7.956	3.231	23.620
1.3	1.327	6.780	2.346	15.413
1.4	1.539	5.846	1.744	10.381
1.5	1.767	5.093	1.323	7.185
1.6	2.011	4.476	1.022	5.093
1.7	2.270	3.965	0.802	3.686
1.8	2.545	3.537	0.638	2.717
1.9	2.835	3.174	0.514	2.036
2.0	3.142	2.965	0.419	1.549

where, $h_f = f \cdot L \cdot \frac{V^2}{2g}$

h_f : Head loss (m)

f : Coefficient $\{f = \frac{124.5 \cdot n^2}{D^{4/3}}\}$

n : Roughness coefficient (n = 0.012)

L : Pipe length (L ≒ 520 m)

V = Q/A

Q : Discharge (Q = 9.0 m^3/s)

(2) Calculation of Energy Loss :

Pipe Dia. D (m)	Head Loss h_f (m)	Annual Energy Loss (MWh)	Annual Loss Amount (US$)
1.3	15.413	2,405	168,350
1.5	7.185	1,121	78,470
1.7	3.686	575	40,250
1.8	2.717	424	29,680
2.0	1.549	242	16,940

where, $E_l = E_t \cdot \frac{h_f}{H}$

E_l : Annual energy loss (MWh)

E_t : Average annual total energy (E_t ≒ 11,000MWh)

H : Head (H = 189.0 - 118.5 = 70.5m)

Annual loss amount = E_l x US$ 70/MWh

Table 5.2.3 (2) Examination on diameter of water supply conduit

(3) Calculation of Pipe Cost :

Pipe Dia. D (m)	Pressure Rise Δp (%)	Total Pressure P (kg/cm²)	Pipe Thickness t (cm)	Pipe Weight W (ton)	Pipe Cost (US$)	Annual Pipe Cost (US$)
1.5	70	12.16	1.09	218	1,057,300	106,639
1.8	60	11.44	1.21	290	1,406,500	141,860
2.0	50	10.73	1.25	333	1,615,000	162,894

where,

$$P = (189.0 - 117.5) \times (1 + \frac{\Delta p}{100}) \times 0.1$$

$$t = \frac{P \times D}{2 \times \sigma_a \times \eta} + \varepsilon$$

σa : Allowable stress (σa = 1,200 kg/cm²)

η : Coefficient for joints (η = 0.85)

ε : Corrosion allowance (ε = 0.2 cm)

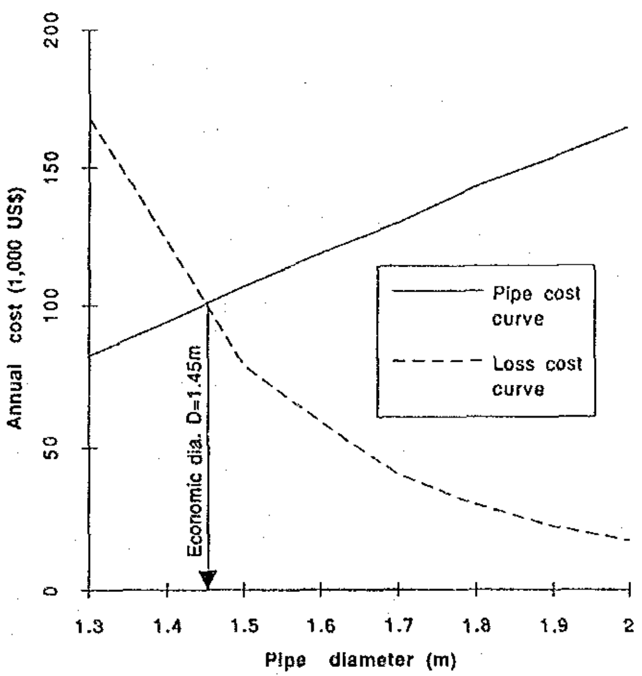
$W = \pi \cdot D \cdot t \cdot L \times 7.85 \times 1.04 \times 10^{-6}$ (ton)

Pipe cost = W x US$4,850/ton

Annual pipe cost = pipe cost x capital recovery factor

Capital recovery factor = 0.10086

(4) Determination of Economic Diameter :



Note :
Although economic diameter is calculated at 1.45 m,pipe diameter is determined to be 1.5 m with some allowance.

Table 5.3.1: CALCULATION RESULT OF TENSILE STRESS DUE TO INTERNAL PRESSURE

	Do	To	Material	σa	Pa	Pi
Water supply	1500	10	SM41	1300	12.5	9.0
River outlet	1500	10	SM41	1300	12.5	8.0

Corrosion allowance = 2 (mm)

Welding joint efficiency = 0.9

Do : Internal diameter (mm)

To : Pipe shell thickness (mm)

σa : Allowable tensile stress (kgf/cm^2)

Pa : Allowable internal pressure (kgf/cm^2)

Pi : Internal pressure (kgf/cm^2)

Pa > Pi

Table 5.3.2: CALCULATION RESULT OF BUCKLING PRESSURE OF PIPE SHELL

Case	Do	To	σa	σy	Pe	Pk	Sf
Embedded	1500	10	1300	2500	8.0	12.169	1.52

Corrosion allowance = 2 (mm)

Welding joint efficiency = 0.9

Do : Internal diameter (mm)

To : Pipe shell thickness (mm)

σa : Allowable stress (kgf/cm^2)

σy : Yield point (kgf/cm^2)

Pe : External pressure (kgf/cm^2)

Pk : Critical buckling pressure (kgf/cm^2)

Sf : Safety factor = Pk/Pe

Sf > 1.5

Table 5.3.3 (1): DIMENSIONS, QUANTITIES AND WEIGHTS OF MEMBERS (Intake Gate Leaf)

	Item	Size (mm)	Unit Weight (kg)	Q'ty	Weight (kg)
1	Main horizontal beams				
	No.1 gate	506 x 201 x 11 x 19 x 2600	268.0	3	804.0
	No.2 gate	500 x 250 x 16 x 18 x 2600	335.0	3	1005.0
	No.3 gate	550 x 250 x 16 x 22 x 2600	390.0	3	1170.0
2	Horizontal beams				
	No.1 gate	500 x 100 x 11 x 20 x 2600	185.0	2	370.0
	No.2 gate	500 x 150 x 12 x 16 x 2600	213.0	2	426.0
	No.3 gate	550 x 150 x 12 x 18 x 2600	236.0	2	472.0
3	Skin plate				
	No.1 gate	2200 x 2600 x 16	718.0	1	718.0
	No.2 gate	2200 x 2600 x 17	763.0	1	763.0
	No.3 gate	2200 x 2600 x 18	808.0	1	808.0
4	Vertical beams				
	No.1 gate	125 x 65 x 6 x 8 x 2200	30.0	4	120.0
	No.2 gate	150 x 75 x 6.5 x 10 x 2200	41.0	4	164.0
	No.3 gate	150 x 75 x 9 x 12.5 x 2200	53.0	4	212.0
5	Side beams				
	No.1 gate	506 x 201 x 11 x 19 x 2200	227.0	2	454.0
	No.2 gate	500 x 250 x 16 x 18 x 2200	284.0	2	568.0
	No.3 gate	550 x 250 x 16 x 22 x 2200	330.0	2	660.0
6	Roller and roller shaft				
	No.1 gate	D550 x 150, D170 x 200	315.0	4	1260.0
	No.2 gate	D560 x 150, D180 x 200	330.0	4	1320.0
	No.3 gate	D640 x 150, D200 x 200	428.0	4	1712.0

Total		
No.1 gate		3726.0 (kg)
	x 1.2 =	4.5 (ton)
No.2 gate		4246.0 (kg)
	x 1.2 =	5.1 (ton)
No.3 gate		5034.0 (kg)
	x 1.2 =	6.1 (ton)
Total weight of gate leaf		15.7 (ton)

Table 5.3.3 (2): DIMENSIONS, QUANTITIES AND WEIGHTS OF MEMBERS (Intake Gate Guide Frame)

	Item	Size (mm)	Unit Weight (kg)	Q'ty	Weight (kg)
1	Track frame	450x200x32x34x8100	1642.0	2	3284.0
2	Lintel beam	300x150x10x2700	95.4	1	95.4
3	Sill beam	200x150x6x9x3000	91.8	1	91.8
4	Side guide frame	150x75x6.5x10x4600	85.6	2	171.1
5	Side sealing frame	150x150x10x2100	49.5	2	98.9
6	Rail plate	200 x 23 x 8100	292.5	2	585.0
7	Sill plate	150 x 10 x 3100	36.5	1	36.5
6	Lintel sealing plate	150 x 10 x 2100	24.7	1	24.7
8	Side sealing plate	150 x 10 x 2100	24.7	2	49.5
Total					4436.9 (kg)
				x 1.2 =	5.4 (ton)

Total weight of guide frame 5.4 x 3 = 16.2 (ton)

Table 5.3.3 (3): DIMENSIONS, QUANTITIES AND WEIGHTS OF MEMBERS (Intake Gate Hoist)

	Item	Size (mm)	Unit Weight (kg)	Q'ty	Weight (kg)
1	Hoist with motor				
	(per each gate)	3.7kW	395.0	1	395.0
2	Hoisting spindle				
	No.1 gate	D114.3 x 6 x 66m	1060.0	1	1060.0
	No.2 gate	D114.3 x 6 x 90m	1440.0	1	1440.0
	No.3 gate	D114.3 x 6 x 115m	1840.0	1	1840.0

Total

No.1 gate		1455.0 (kg)
	x 1.2 =	1.8 (ton)
No.2 gate		1835.0 (kg)
	x 1.2 =	2.3 (ton)
No.3 gate		2235.0 (kg)
	x 1.2 =	2.7 (ton)

Total weight of hoist 6.8 (ton)

Table 5.3.3 (4): DIMENSIONS, QUANTITIES AND WEIGHTS OF MEMBERS (Intake Trash Rack)

(1) Front Trash Rack

	Item	Size (mm)	Unit Weight (kg)	Q'ty	Weight (kg)
1	Screen bar	100 x 12 x 3200	30.1	39	1175.6
2	Tie bolt	Dia 20 x 3000	7.4	9	66.6
3	Guide frame	100 x 100 x 10 x 3000	47.1	2	94.2
4	Guide frame	150 x 150 x 10 x 3000	70.7	2	141.3
Total (1)					1477.7 (kg)
			x 1.2 =		1.8 (ton)
			x 3 =		5.4 (ton)

(2) Top Trash Rack

	Item	Size (mm)	Unit Weight (kg)	Q'ty	Weight (kg)
1	Screen bar	100 x 12 x 1100	10.4	39	404.1
2	Tie bolt	Dia 20 x 3000	7.4	2	14.8
3	Guide frame	100 x 100 x 10 x 3100	48.7	1	48.7
		100 x 100 x 10 x 2100	33.0	1	33.0
4	Guide frame	150 x 150 x 10 x 3100	73.0	1	73.0
		150 x 150 x 10 x 2100	49.5	1	49.5
Total (2)					623.0 (kg)
			x 1.2 =		0.8 (ton)
			x 3 =		2.4 (ton)

Total weight of intake trash racks (1) + (2) 7.8 (ton)

Table 5.3.3 (5): DIMENSIONS, QUANTITIES AND WEIGHTS OF MEMBERS (River Outlet Bulkhead Gate)

(1) Bulkhead Gate Leaf

	Item	Size (mm)	Unit Weight (kg)	Q'ty	Weight (kg)
1	Main horizontal beam	380x100x13x16.5x2000	124.0	4	496.0
2	Skin plate	1700 x 2000 x 18	480.4	1	480.4
3	Vertical beam	380 x 6 x 1700	30.4	2	60.9
4	Side beam	380x100x13x16.5x1700	105.4	2	210.8

Total (1) 1248.1 (kg)

x 1.2 = 1.5 (ton)

(2) Bulkhead Gate Guide Frame

	Item	Size (mm)	Unit Weight (kg)	Q'ty	Weight (kg)
1	Track frame	200x100x5.5x8x4750	101.2	2	202.4
2	Sealing frame	180x75x7x10.5x1900	40.7	2	81.3
3	Side sealing frame	150 x 150 x 8 x 1500	28.3	2	56.5
4	Side guide frame	150x75x6.5x10x2700	50.2	2	100.4
5	Rail plate	100 x 8 x 4750	29.8	2	59.7
6	Sealing plate	100 x 8 x 1500	9.4	4	37.7
7	Auxiliary material for gate operation		–	–	2000.0

Total (2) 2538.0 (kg)

x 1.2 = 3.1 (ton)

Total weight of river outlet inlet bulkhead gate (1) + (2) 4.6 (ton)

Table 5.3.3 (6): DIMENSIONS, QUANTITIES AND WEIGHTS OF MEMBERS (River Outlet Trash Tacks)

	Item	Size (mm)	Unit Weight (kg)	Q'ty	Weight (kg)
1	Screen bar	100 x 12 x 2600	24.5	25	612.3
		100 x 12 x 2500	23.6	100	2355.0
2	Top beam	200 x 200 x 8 x 2600	121.9	4	487.8
3	Post	200 x 200 x 8 x 3200	150.1	4	600.3
4	Tie bolt	Dia 20 x 2600	6.4	40	256.3
5	Guide frame	80 x 10 x 2600	16.3	8	130.6
6	Guide frame	100 x 150 x 10 x 2500	49.1	4	196.3

Total 4638.6 (kg)

Total weight of river outlet trash racks x 1.2 = 5.6 (ton)

Table 5.3.3 (7): DIMENSIONS, QUANTITIES AND WEIGHTS OF MEMBERS (River Outlet Conduit and Valves)

(1) River Outlet Conduit

	Item	Size (mm)	Unit Weight (kg/m)	Q'ty (m)	Weight (kg)
1	Steel conduit	1500 dia x 10 tickness	372.4	51.8	19289.8
2	Steel conduit	1000 dia x 8 tickness	198.9	5.5	1093.8

Total (1) 20383.6 (kg)
x 1.2 = 24.5 (ton)

(2) River Outlet Valves

	Item	Size (mm)	Unit Weight (ton)	Q'ty	Weight (ton)
1	Discharge valve	1000 dia	7.0	1	7.0
2	Guard valve	1000 dia	12.0	1	12.0

Total (2) 19.0 (ton)
x 1.2 = 22.8 (ton)

Total weight of river outlet facilities (1) + (2) 47.3 (ton)

Table 5.3.3 (8): DIMENSIONS, QUANTITIES AND WEIGHTS OF MEMBERS (Water Supply Facilities)

(1) Water Supply Conduit & River Outlet Conduit

	Item	Size (mm)	Unit Weight (kg/m)	Q'ty (m)	Weight (kg)
1	Steel conduit	1500 dia x 10 tickness	372.4	206.2	76789.3
2	Steel conduit	400 dia x 6 tickness	60.1	4.0	240.3

Total (1) 77029.6 (kg)
x 1.2 = 92.5 (ton)

(2) Water Supply Valves

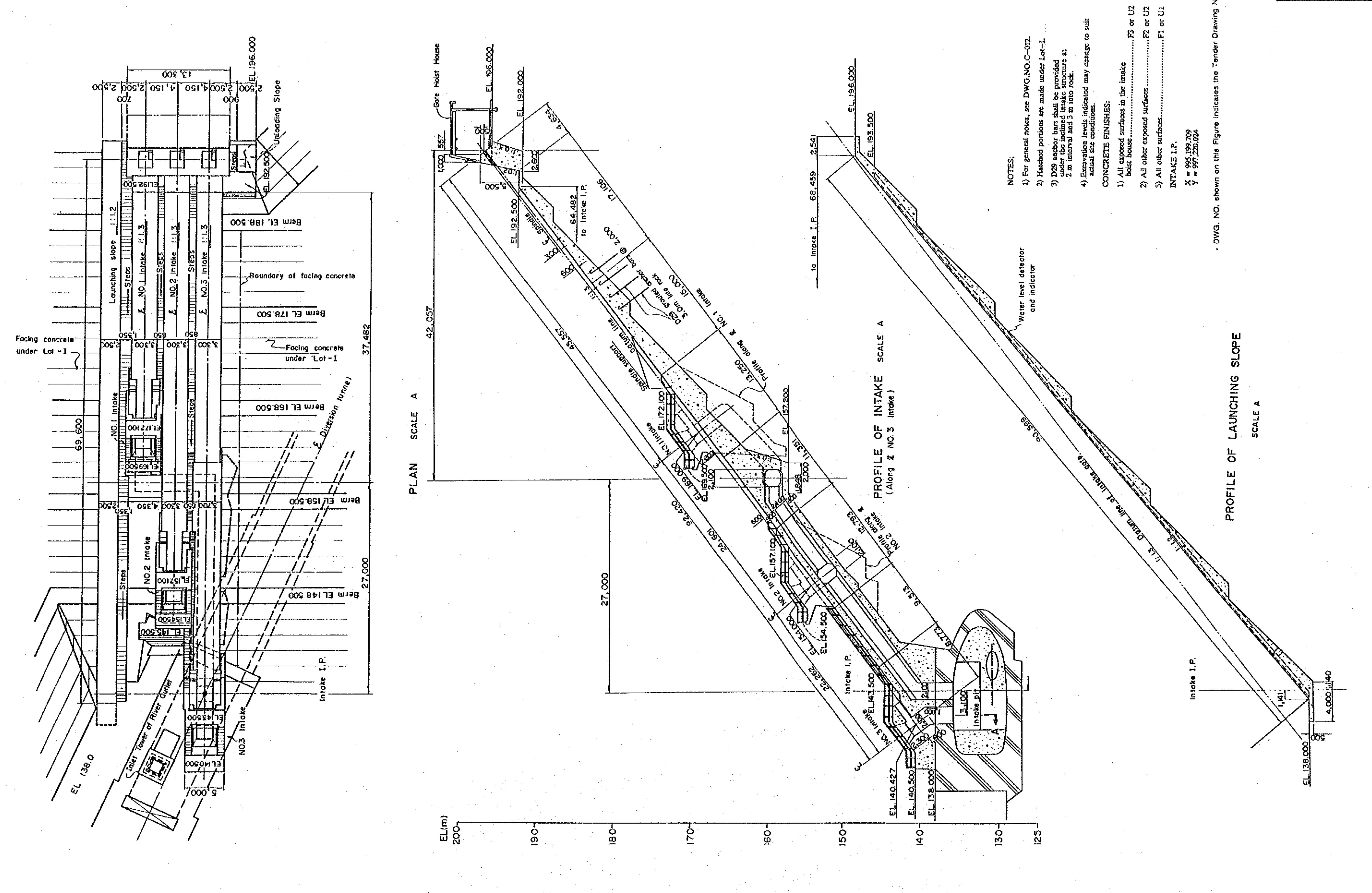
	Item	Size (mm)	Unit Weight (ton)	Q'ty	Weight (ton)
1	Discharge valve	400 dia	1.5	1	1.5
2	Guard valve	400 dia	2.5	1	2.5

Total (2) 4.0 (ton)
x 1.2 = 4.8 (ton)

Total weight of water supply facilities (1) + (2) 97.3 (ton)

FIGURES

Fig 5.1.1



INTAKE AND RIVER OUTLET
PLAN & PROFILE

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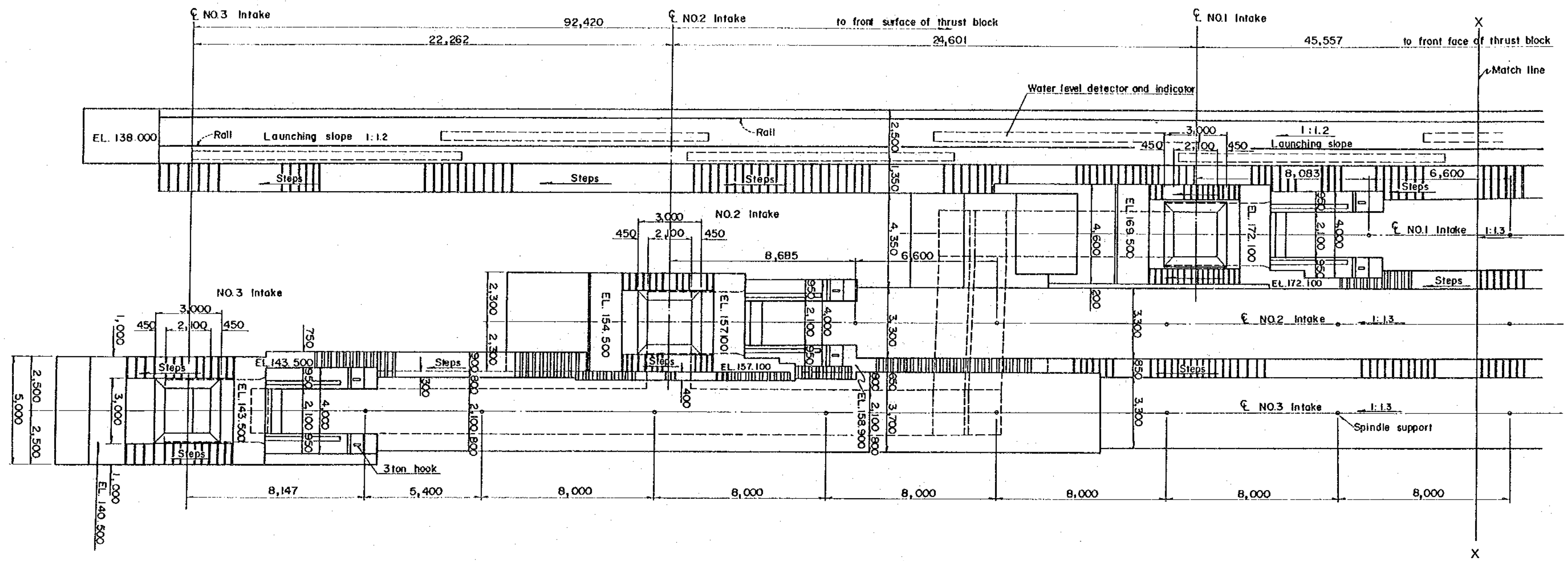
Fig 5.1.2



SLANT PLAN SCALE A

SCALE A 0 5 10m

INTAKE AND RIVER OUTLET
INTAKE,
SLANT PLAN (1)

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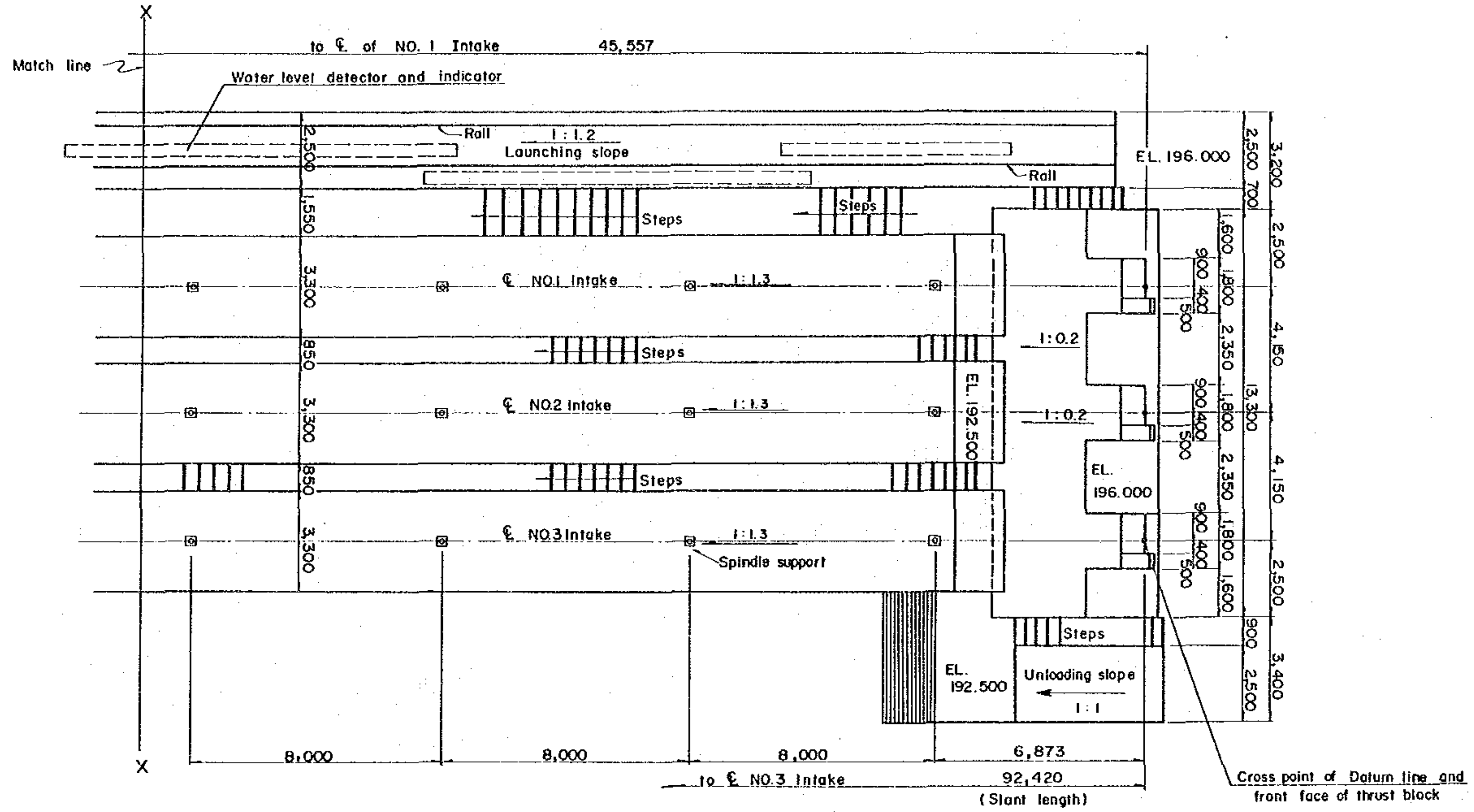

SLANT PLAN SCALE A

SCALE A 0 5 10m

INTAKE AND RIVER OUTLET
INTAKE,
SLANT PLAN (2)

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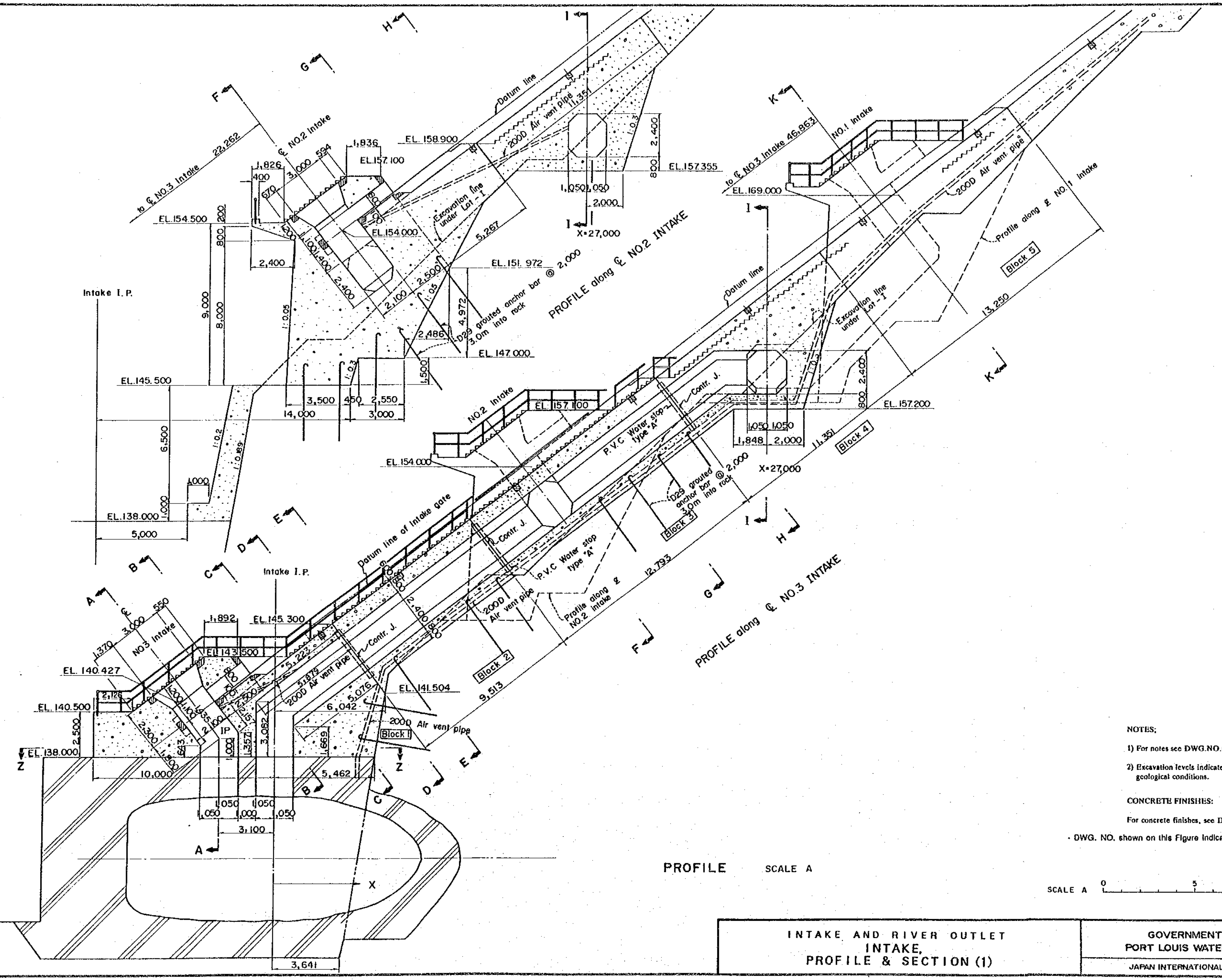
Fig 5.1.4



NOTES;

1) For notes see DWG.NO.C–101.

2) Excavation levels indicated may change to suit actual geological conditions.

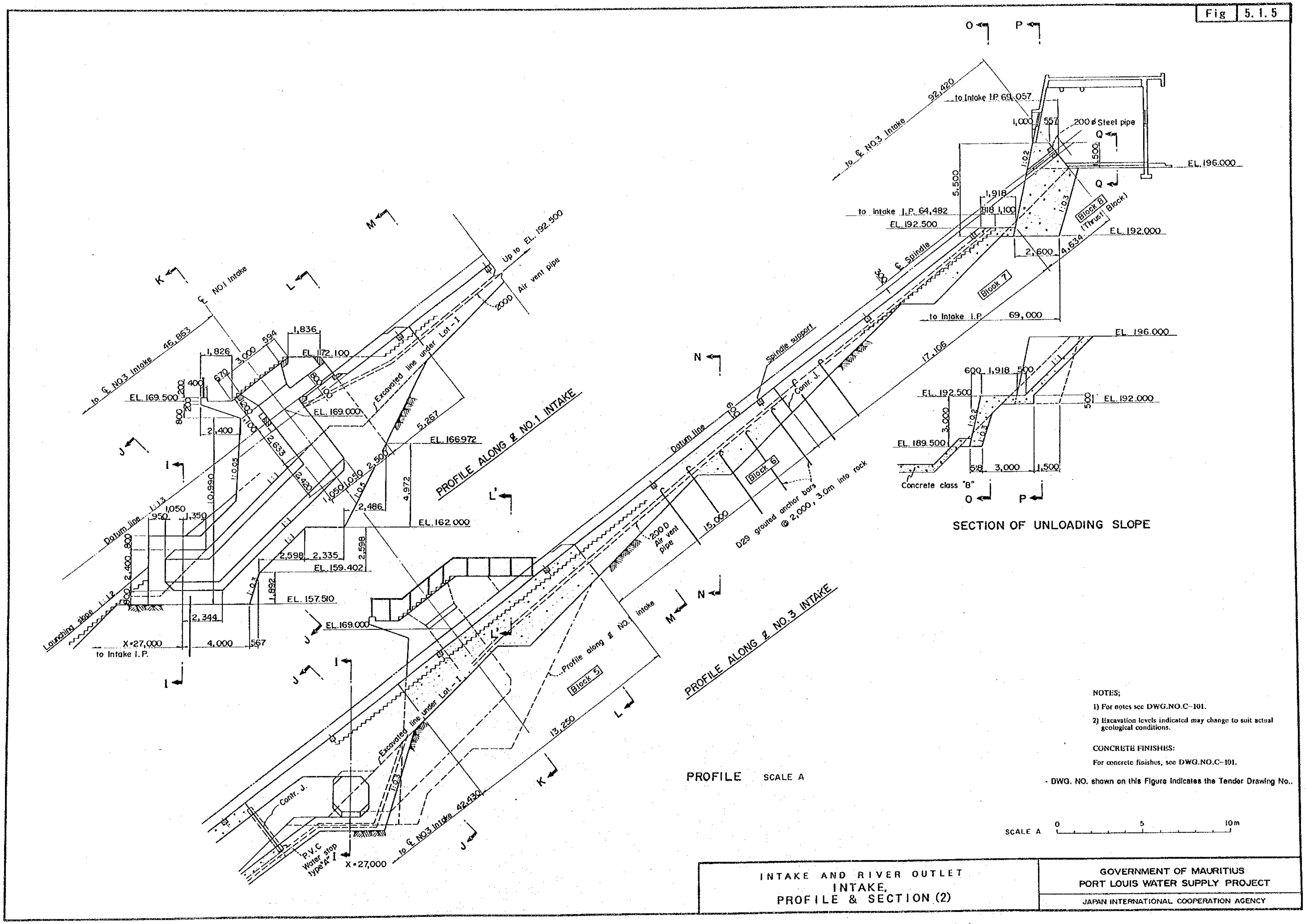
CONCRETE FINISHES:

For concrete finishes, see DWG.NO.C–101.

· DWG. NO. shown on this Figure indicates the Tender Drawing No..

SCALE A 0 5 10 m

INTAKE AND RIVER OUTLET INTAKE, PROFILE & SECTION (1)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY



NOTES;

1) For notes see DWG.NO.C-101.

2) Excavation levels indicated may change to suit actual geological conditions.

CONCRETE FINISHES:

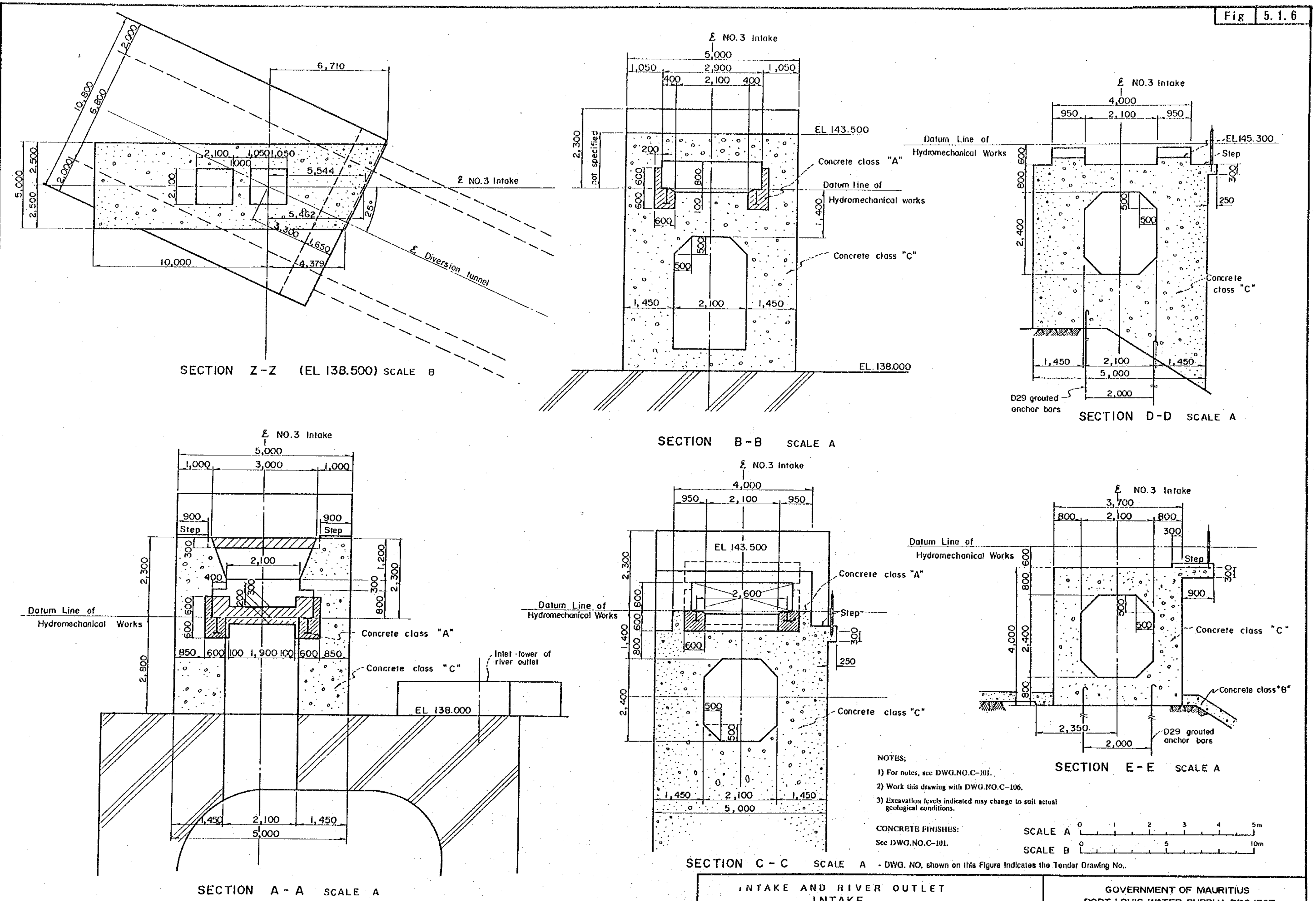
For concrete finishes, see DWG.NO.C-101.

- DWG. NO. shown on this Figure Indicates the Tender Drawing No..

INTAKE AND RIVER OUTLET
INTAKE,
PROFILE & SECTION (2)

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

Fig 5.1.6



NOTES;

1) For notes, see DWG.NO.C-101.

2) Work this drawing with DWG.NO.C-106.

3) Excavation levels indicated may change to suit actual geological conditions.

CONCRETE FINISHES:

See DWG.NO.C-101.

SCALE A 0 1 2 3 4 5m

SCALE B 0 5 10m

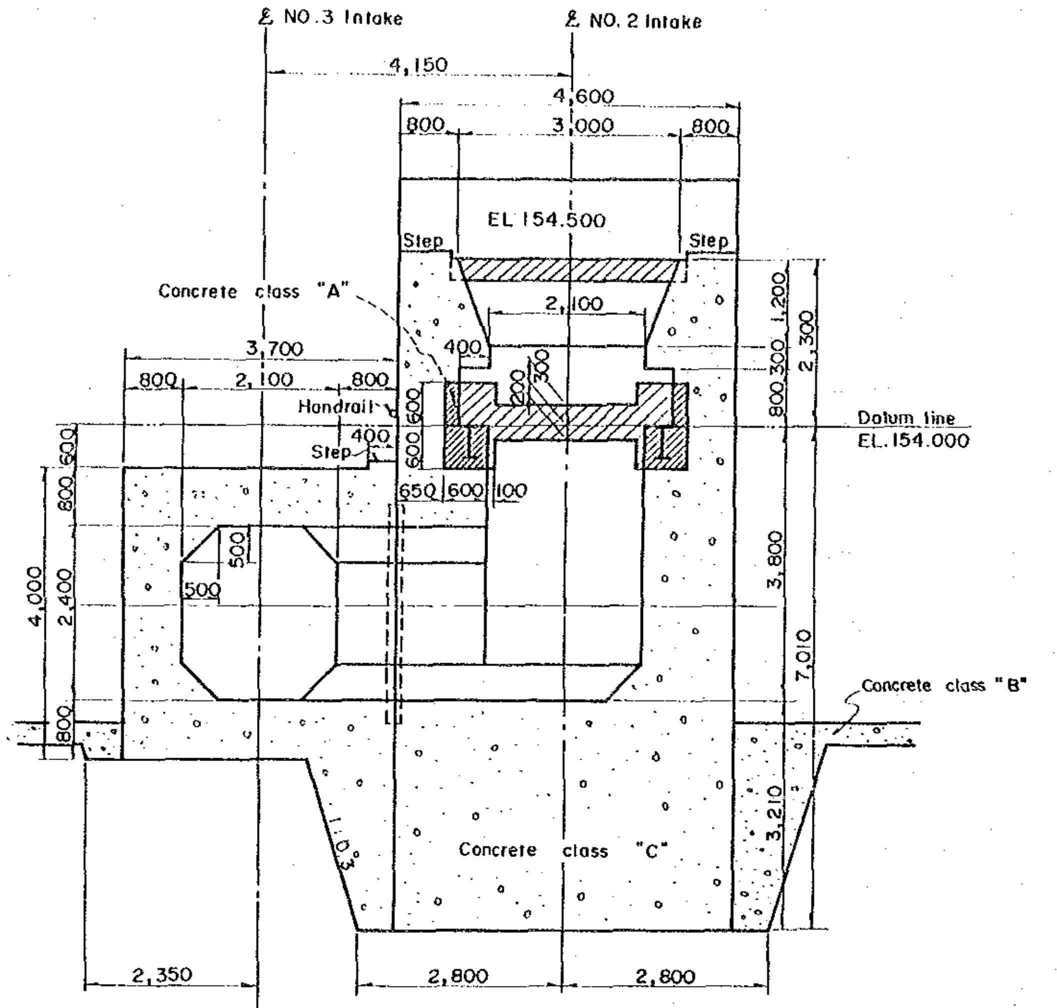
- DWG. NO. shown on this Figure indicates the Tender Drawing No..

INTAKE AND RIVER OUTLET
INTAKE,
PROFILE & SECTION (3)

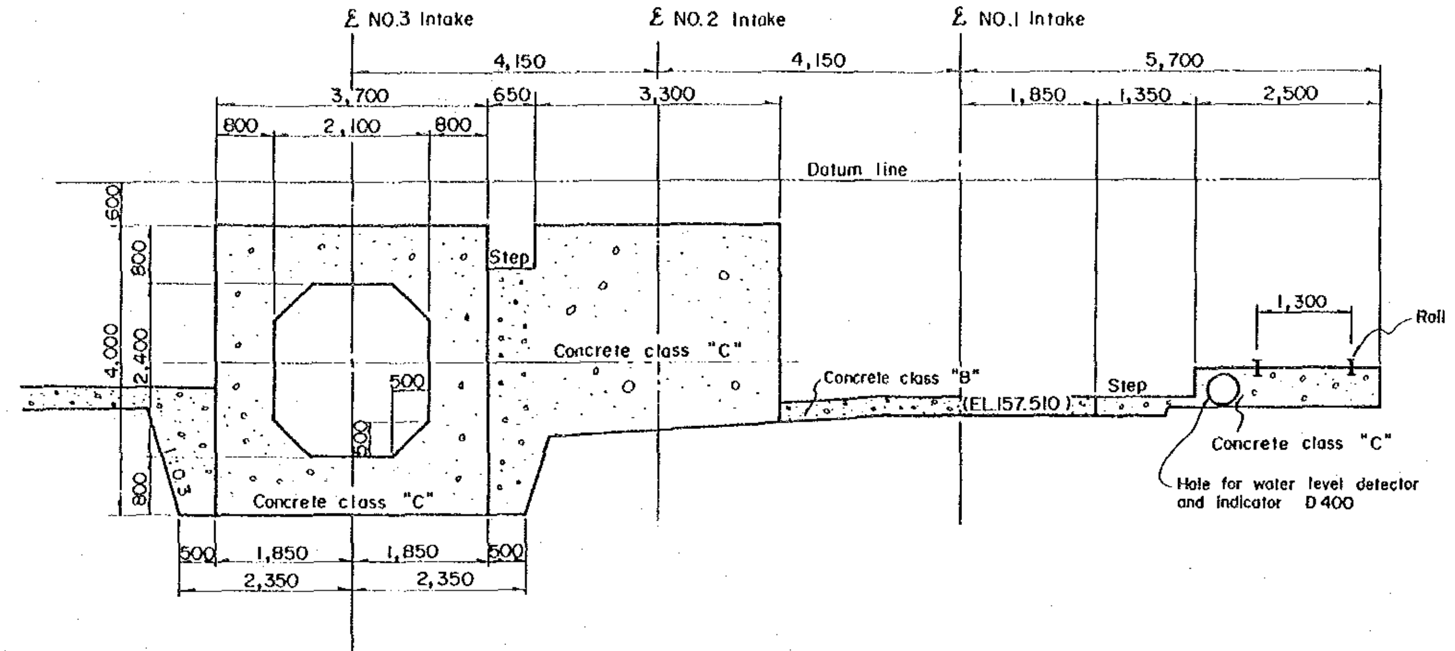
GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

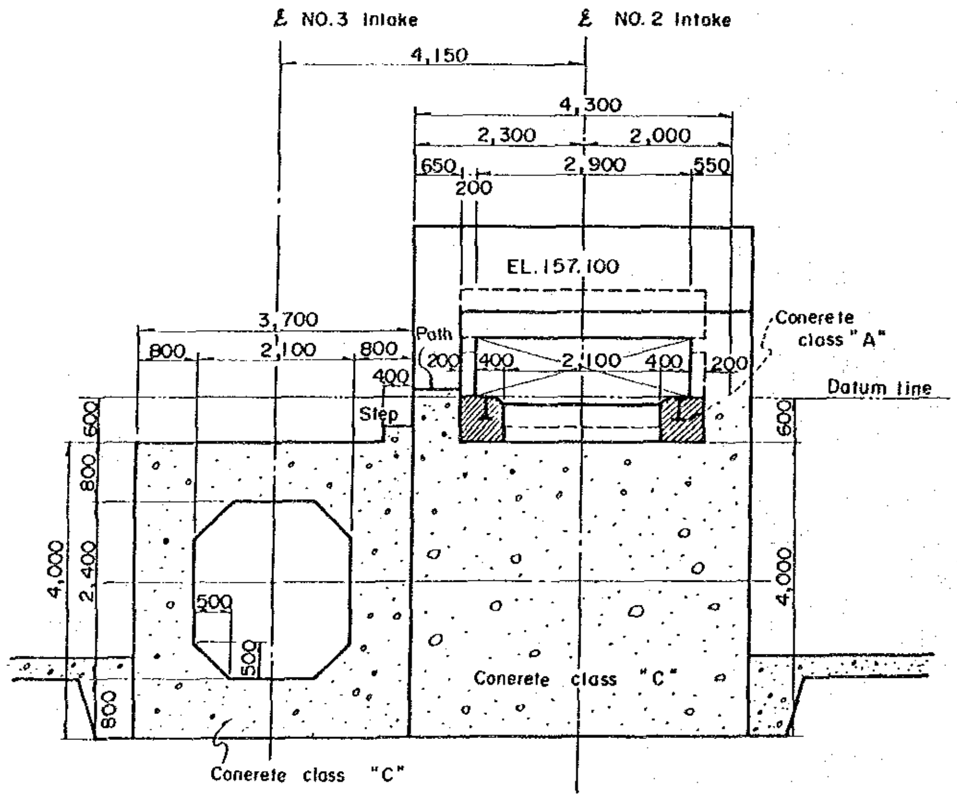
Fig 5.1.7



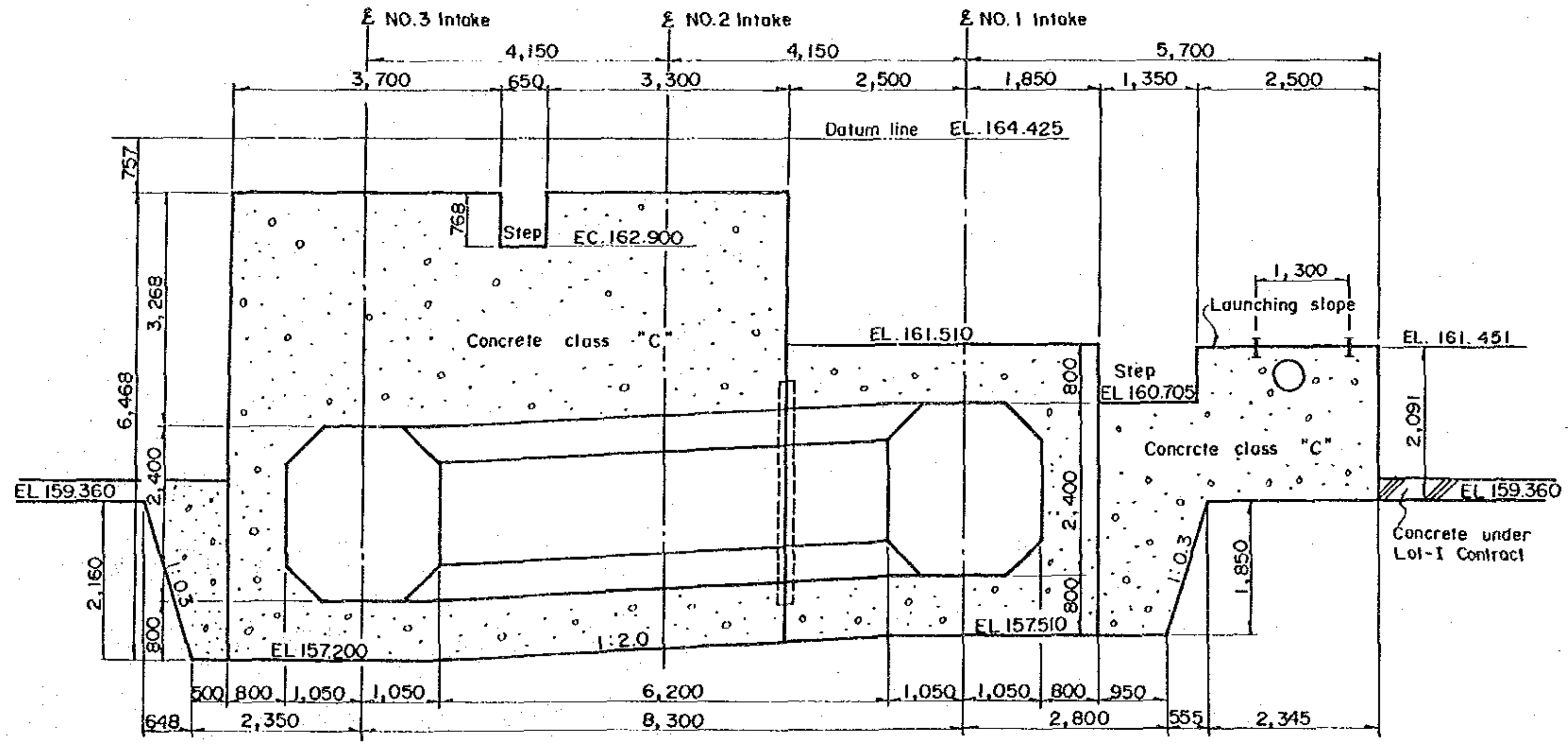
SECTION F-F SCALE A



SECTION H-H SCALE A



SECTION G-G SCALE A



SECTION I-I (X = 27.0, Vertical) SCALE A

NOTES;

1) For notes, see DWG.NO.C-101.

2) D29 grouted anchor bars are not shown. See notes in DWG.NO.C-101

3) Work this drawing with DWG.NO.C-106.

4) Excavation levels indicated may change to suit actual geological conditions.

CONCRETE FINISHES:

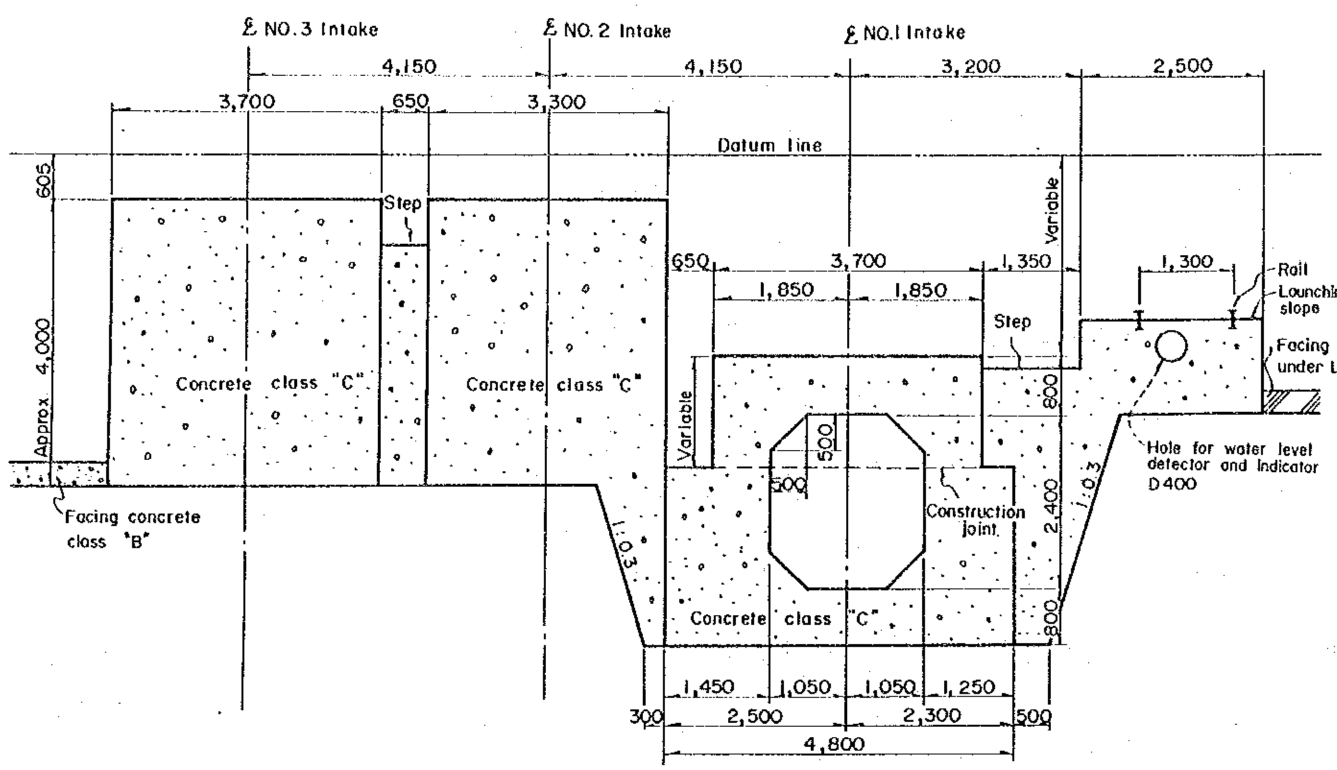
See DWG.NO.C-101.

- DWG. NO. shown on this Figure indicates the Tender Drawing No..

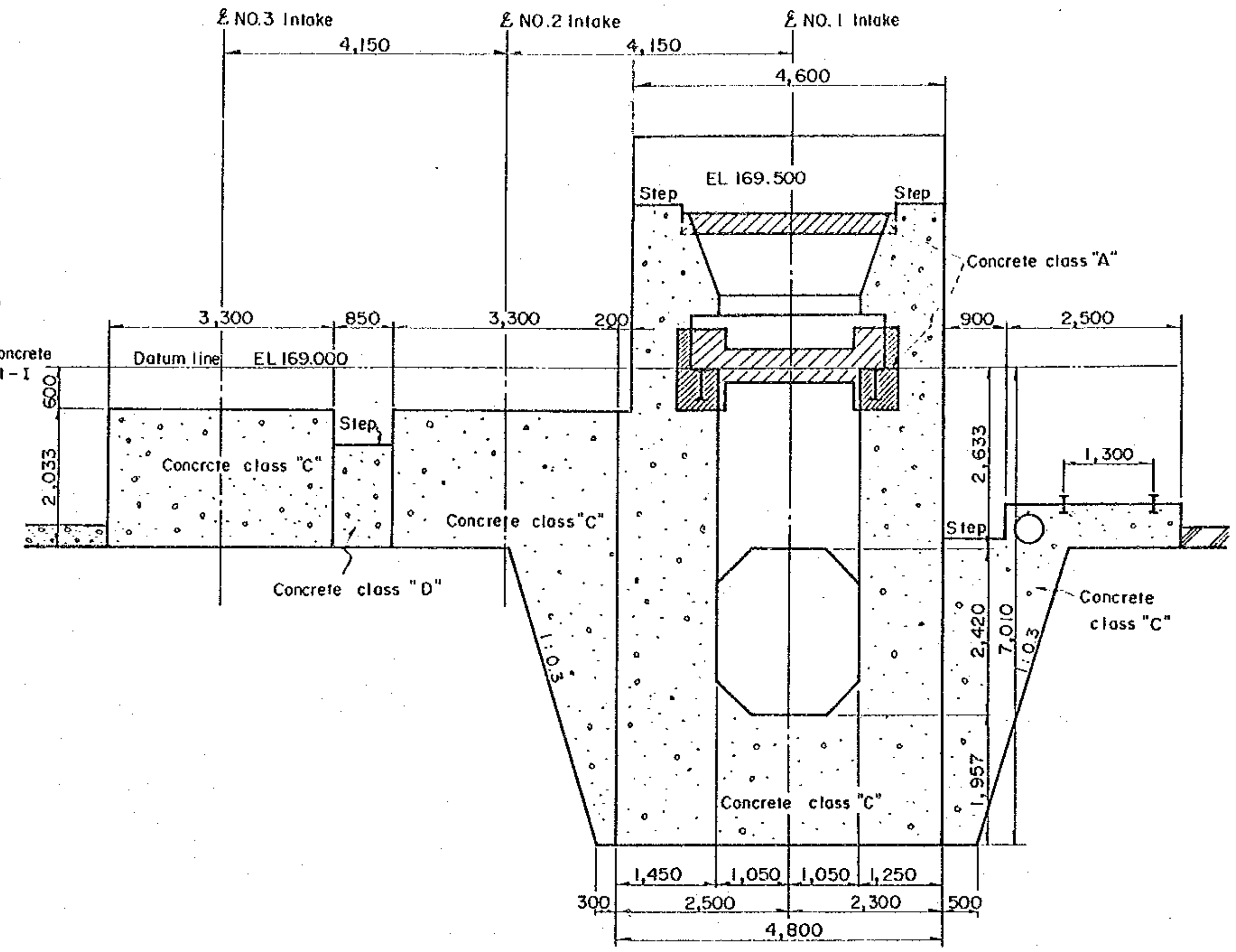
SCALE A 0 1 2 3 4 5m

INTAKE AND RIVER OUTLET INTAKE, PROFILE & SECTION (4)	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

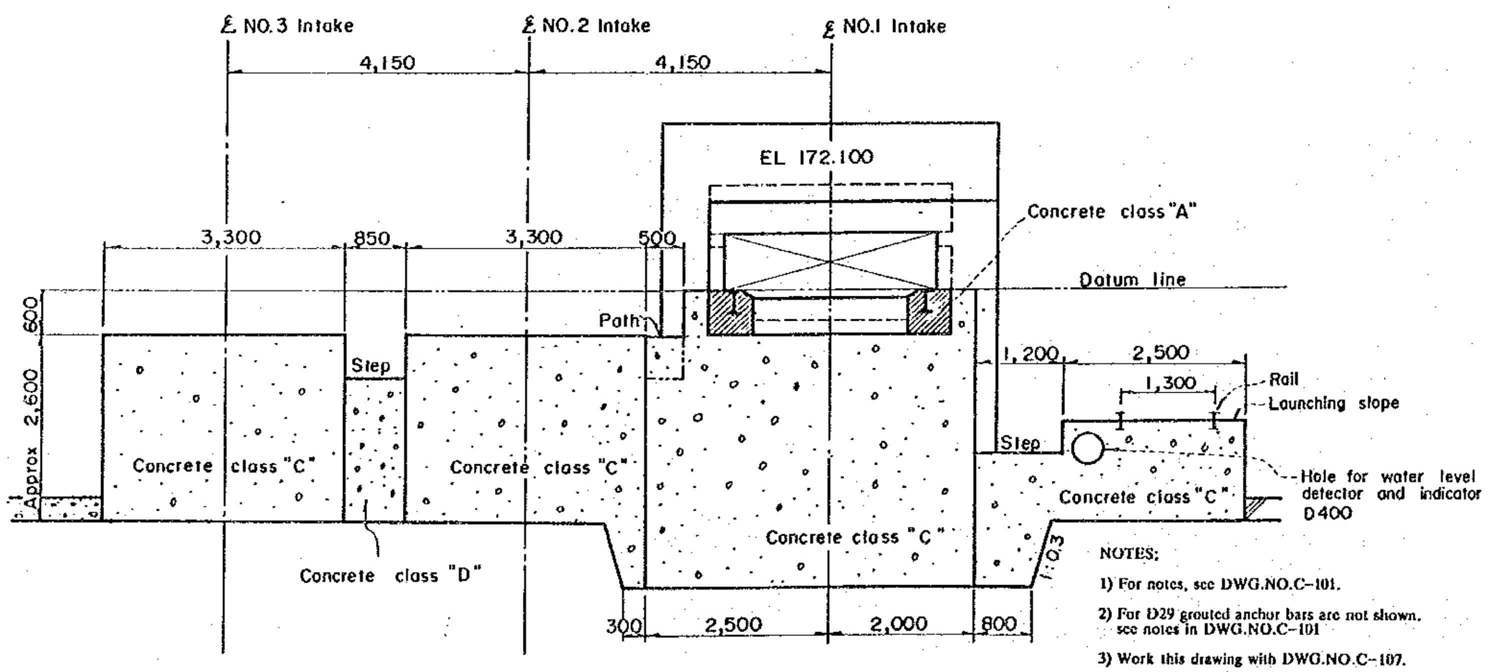
Fig 5.1.8



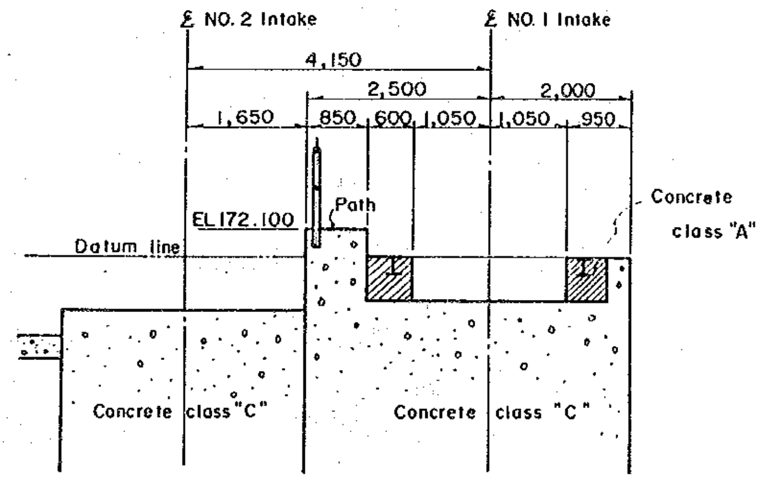
SECTION J - J SCALE A



SECTION K - K SCALE A



SECTION L - L SCALE A



SECTION L'-L' (Vertical) SCALE A

SCALE A 0 1 2 3 4 5m

NOTES:

1) For notes, see DWG.NO.C-101.

2) For D29 grouted anchor bars are not shown, see notes in DWG.NO.C-101

3) Work this drawing with DWG.NO.C-107.

4) Water level detector and indicator to be installed shall be proposed by the contractor for approval.

5) Excavation levels indicated may change to suit actual geological conditions.

- DWG. NO. shown on this Figure indicates the Tender Drawing No..

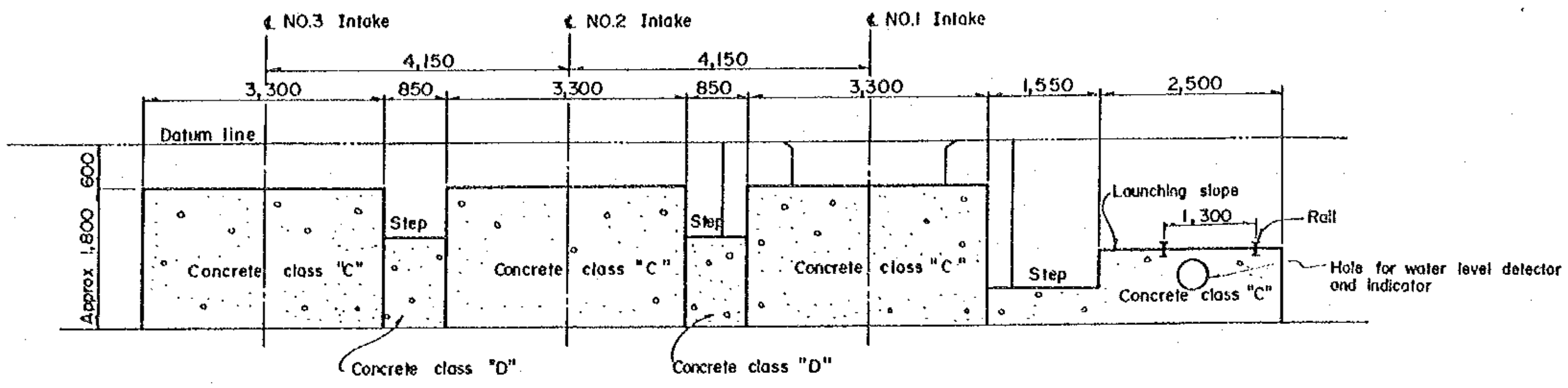
CONCRETE FINISHES:

See DWG.NO.C-101.

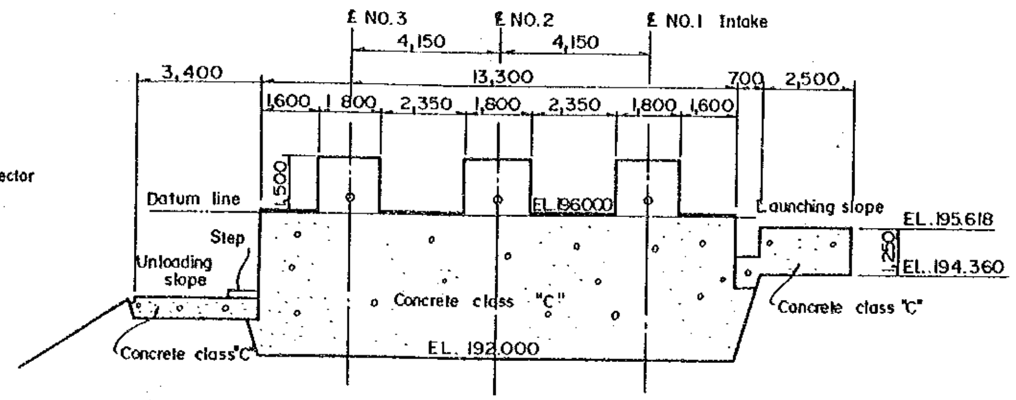
INTAKE AND RIVER OUTLET
INTAKE,
PROFILE & SECTION (5)

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

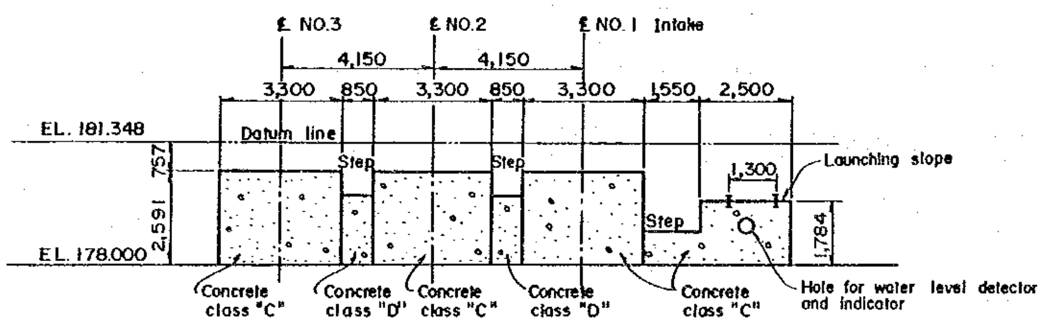
Fig. 5.1.9



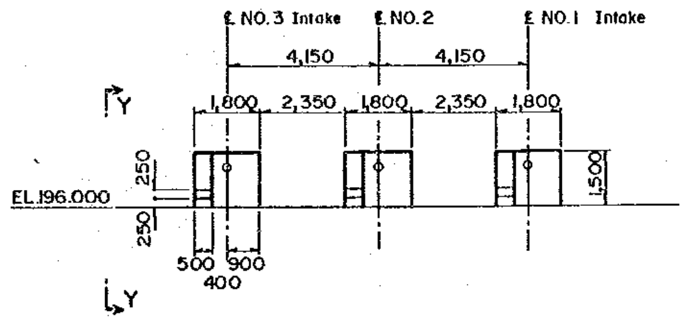
SECTION M – M SCALE A



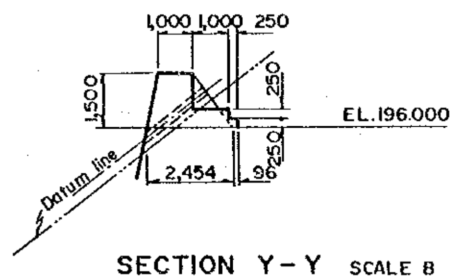
SECTION P–P (X=68,000) SCALE B



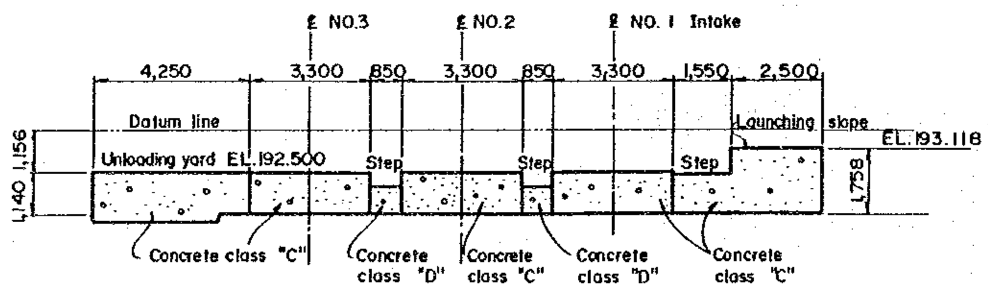
SECTION N–N (X=49,000) SCALE B



SECTION Q – Q SCALE B



SECTION Y – Y SCALE B



SECTION O–O (X=65,000) SCALE B

NOTES;

1) For notes, see DWG.NO.C-101.

2) D29 grouted anchor bars are not shown. See notes in DWG.NO.C-101

3) Work this drawing with DWG.NO.C-107.

CONCRETE FINISHES:

See DWG.NO.C-101.

- DWG. NO. shown on this Figure indicates the Tender Drawing No..

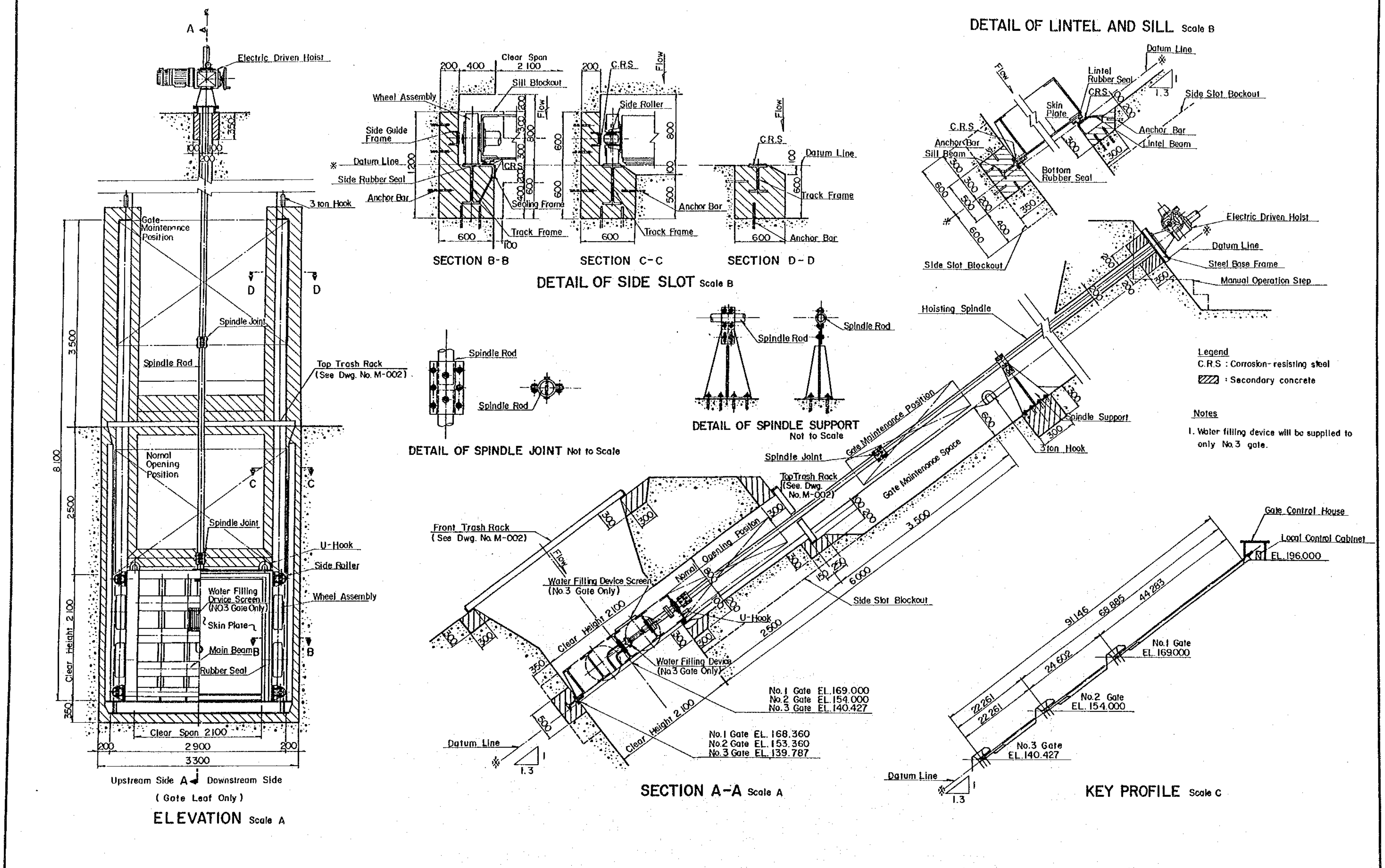
SCALE A 0 1 2 3 4 5m

SCALE B 0 5 10m

INTAKE AND RIVER OUTLET
INTAKE,
PROFILE & SECTION (6)

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

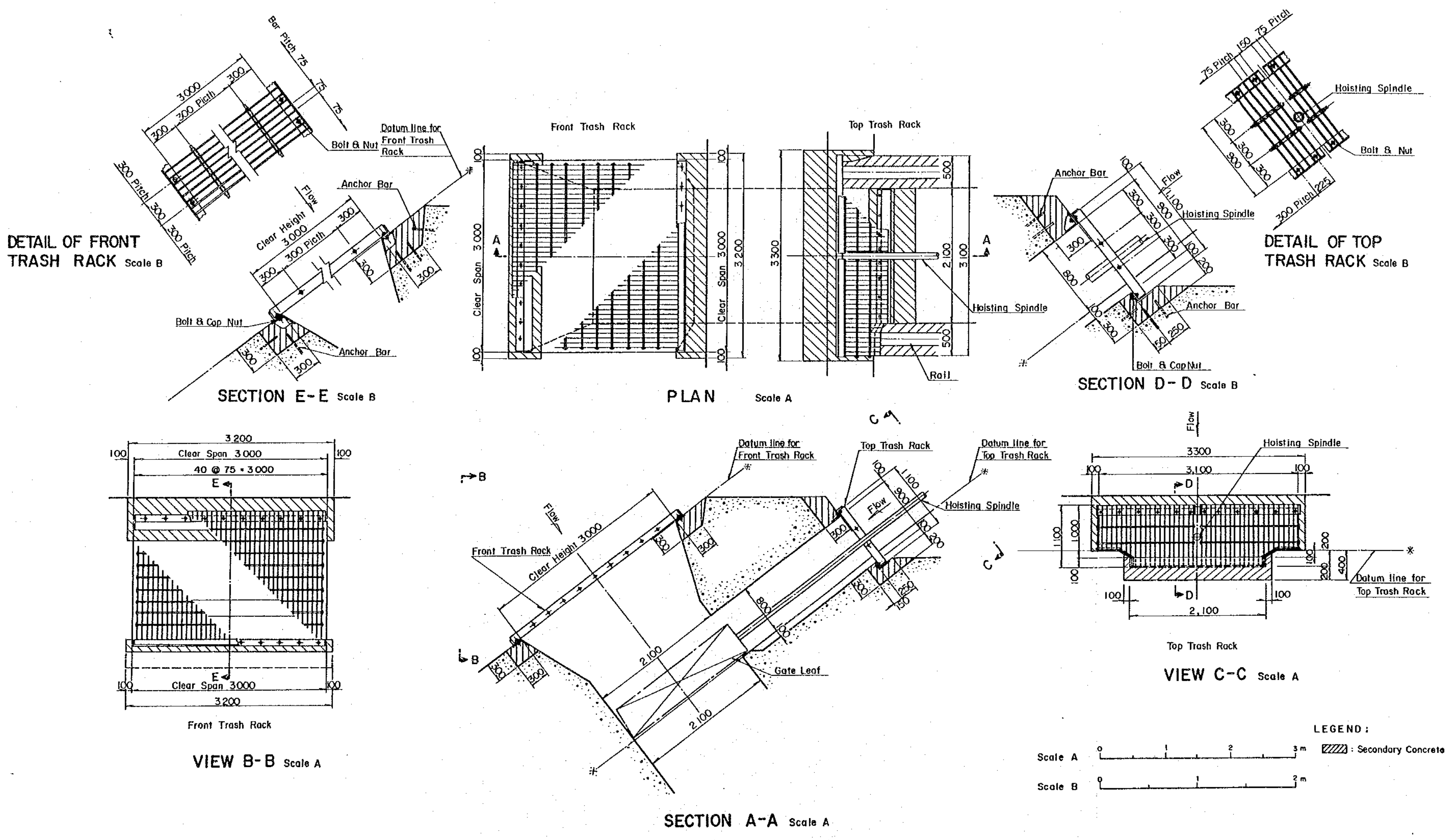
Fig. 5.1.10



HYDROMECHANICAL WORKS
WATER SUPPLY FACILITIES,
INTAKE GATES AND HOIST

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

Fig. 5.1.11



HYDROMECHANICAL WORKS
WATER SUPPLY FACILITIES,
INTAKE TRASH RACKS

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

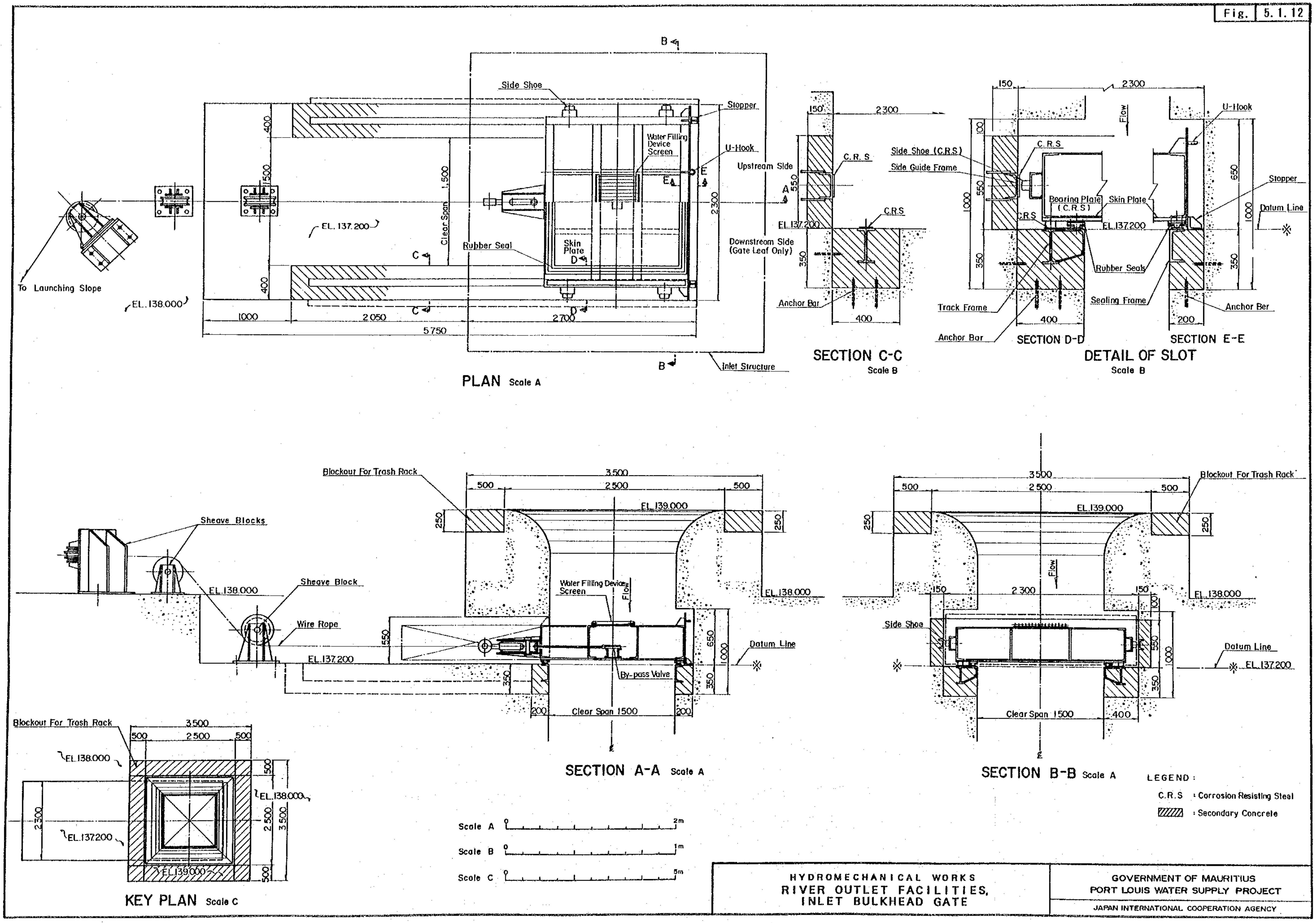
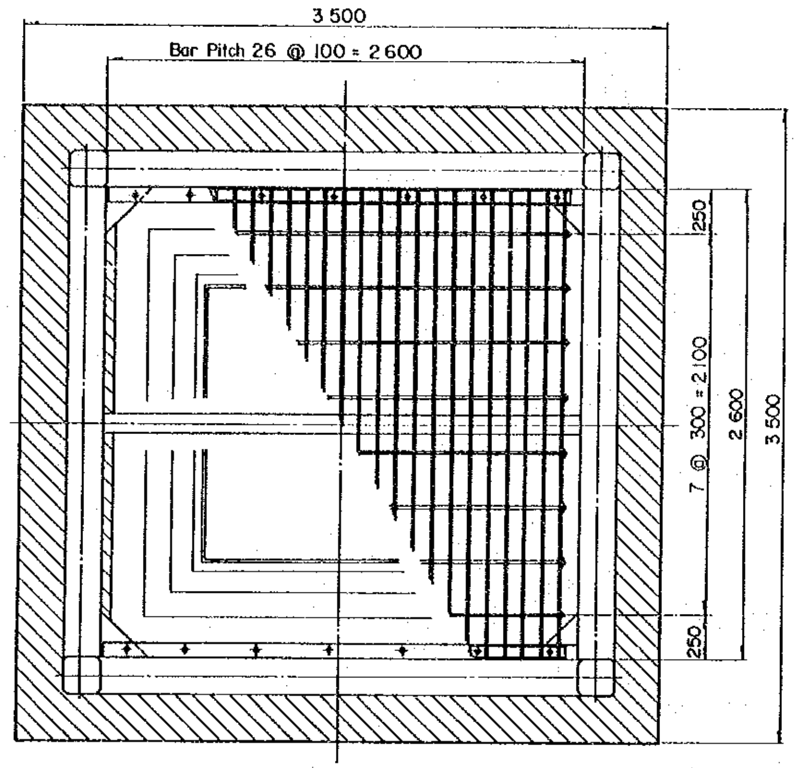
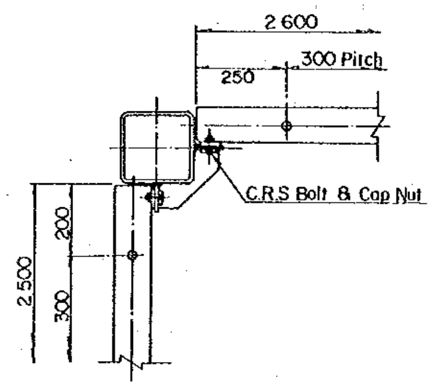


Fig. 5.1.12
PLAN Scale A
SECTION C-C Scale B
DETAIL OF SLOT Scale B
SECTION D-D
SECTION E-E
SECTION A-A Scale A
SECTION B-B Scale A
KEY PLAN Scale C
Side Shoe
Stopper
Water Filling Device Screen
U-Hook
Upstream Side
Downstream Side (Gate Leaf Only)
Rubber Seal
Skin Plate
Clear Span
To Launching Slope
Inlet Structure
EL. 137.200
EL. 138.000
EL. 139.000
C.R.S
Anchor Bar
Side Shoe (C.R.S)
Side Guide Frame
Bearing Plate (C.R.S)
Rubber Seals
Track Frame
Sealing Frame
Datum Line
Blockout For Trash Rack
Sheave Blocks
Sheave Block
Wire Rope
By-pass Valve
Clear Span 1500
Flow
LEGEND:
C.R.S : Corrosion Resisting Steel
: Secondary Concrete
Scale A
Scale B
Scale C
HYDROMECHANICAL WORKS
RIVER OUTLET FACILITIES, INLET BULKHEAD GATE
GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

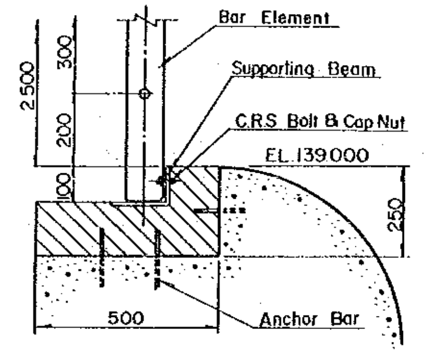
Fig. 5.1.13



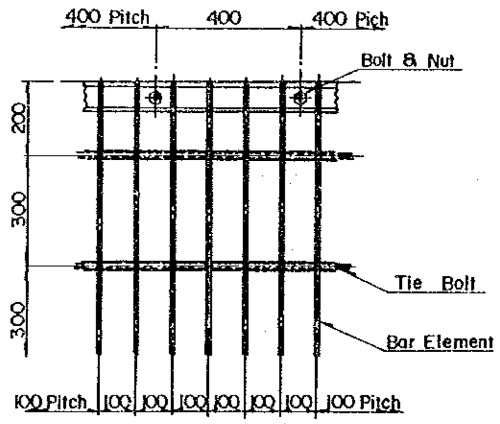
PLAN Scale A



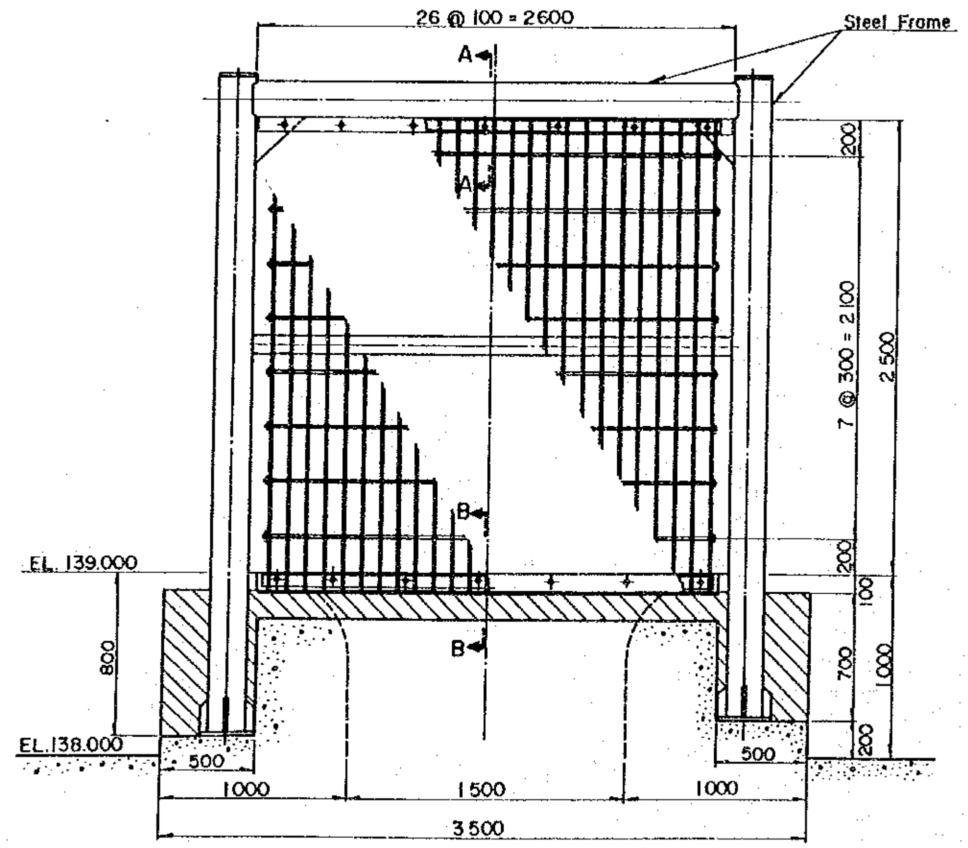
SECTION A-A Scale B



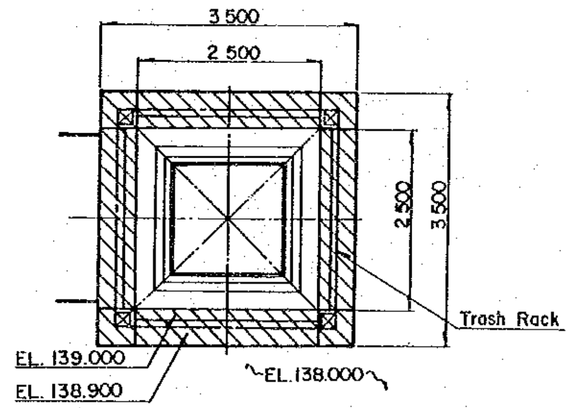
SECTION B-B Scale B



DETAIL OF TRASH RACK Scale B

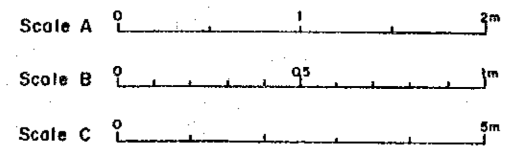


ELEVATON Scale A

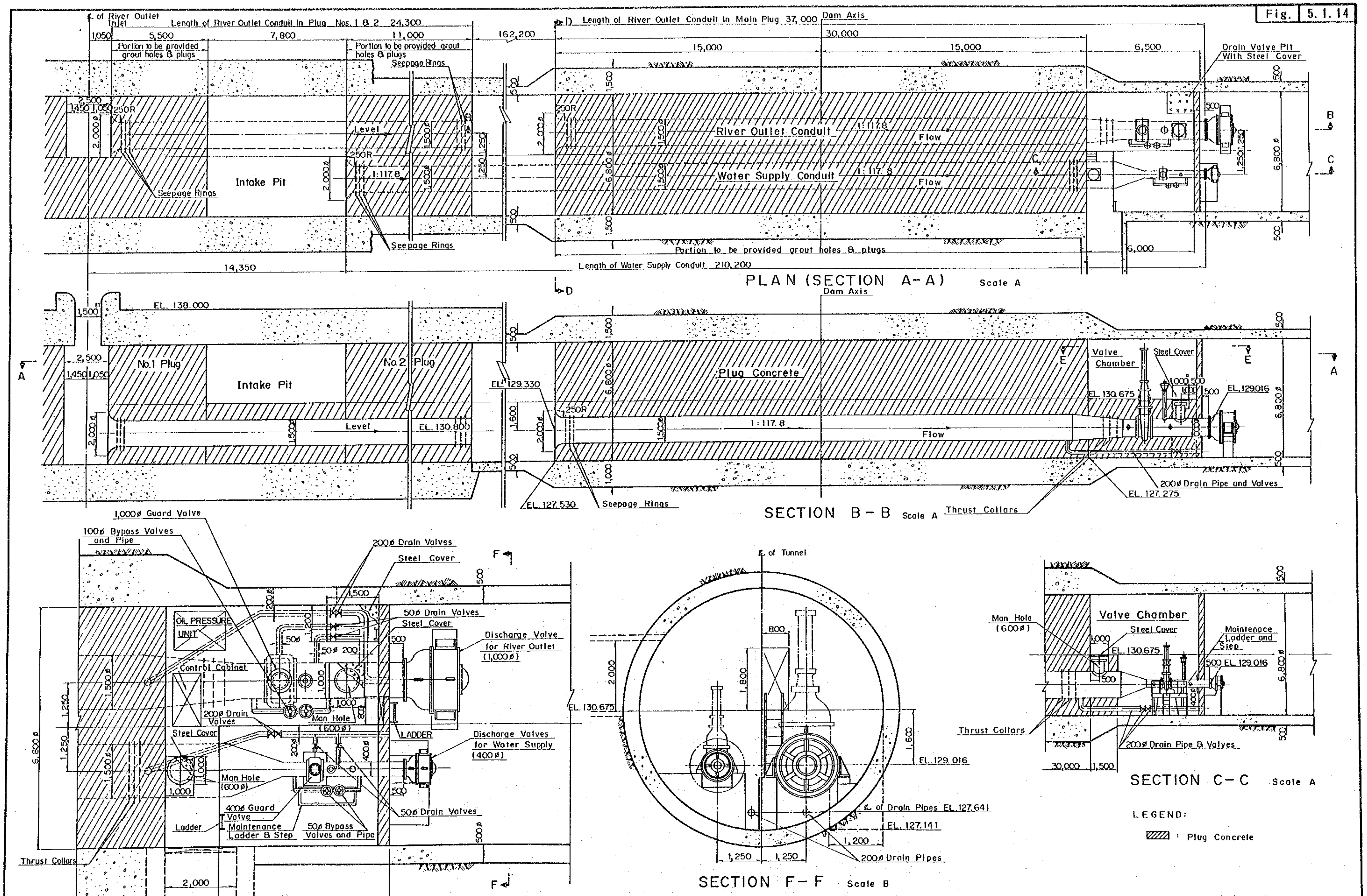


KEY PLAN Scale C

Note:
C.R.S; Corrosion Resisting Steel
▨ : Secondary Concrete

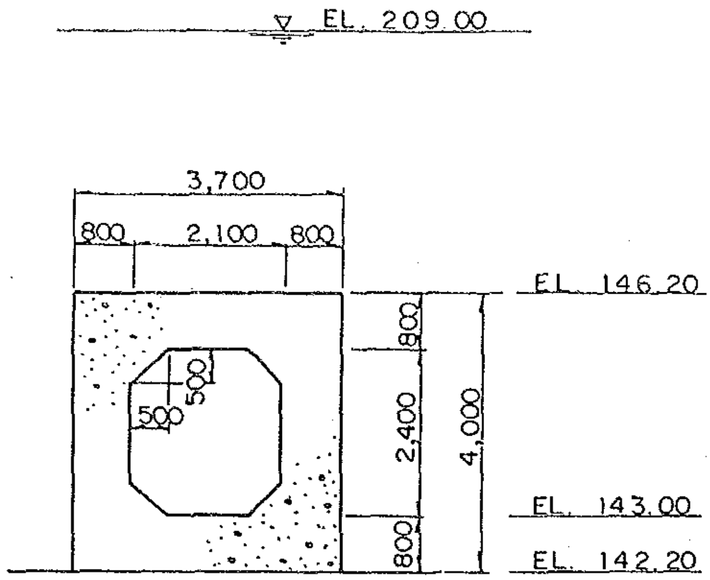


HYDROMECHANICAL WORKS RIVER OUTLET FACILITIES, TRASH RACKS	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT JAPAN INTERNATIONAL COOPERATION AGENCY

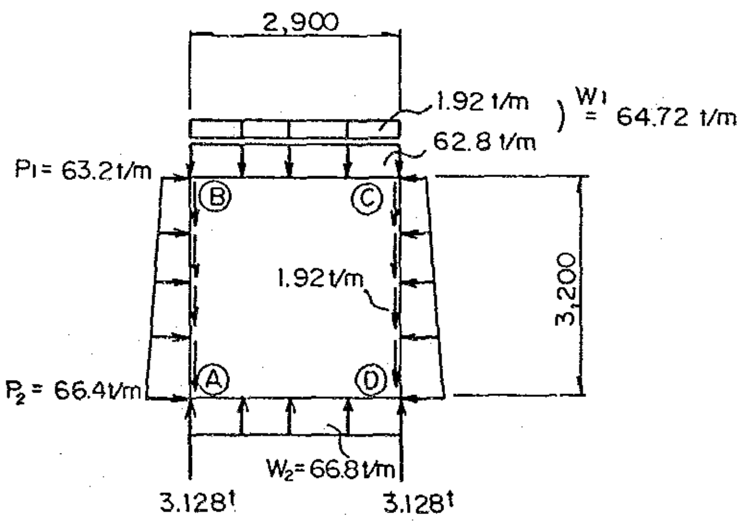


HYDROMECHANICAL WORKS
WATER SUPPLY AND RIVER OUTLET FACILITIES, DISCHARGE VALVES AND GUARD VALVES

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



Section of Inclined Shaft

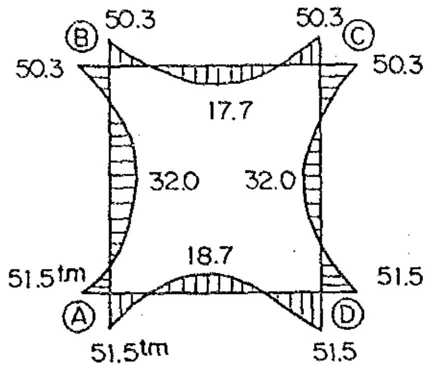


Frame Structure and Loading

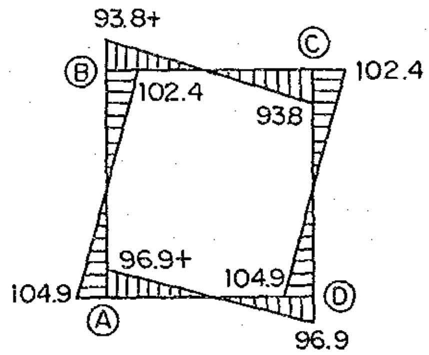
Remark Sectional area of member : $A = 0.8\ m^2$

Moment of inertia of area : $I = bh^3/12 = 0.04$

SECTION , FRAME STRUCTURE AND LOADING CONPITION	GOVERNMENT OF MAURITIUS PORT LOUIS WATER SUPPLY PROJECT
	JAPAN INTERNATIONAL COOPERATION AGENCY



Moment Diagram

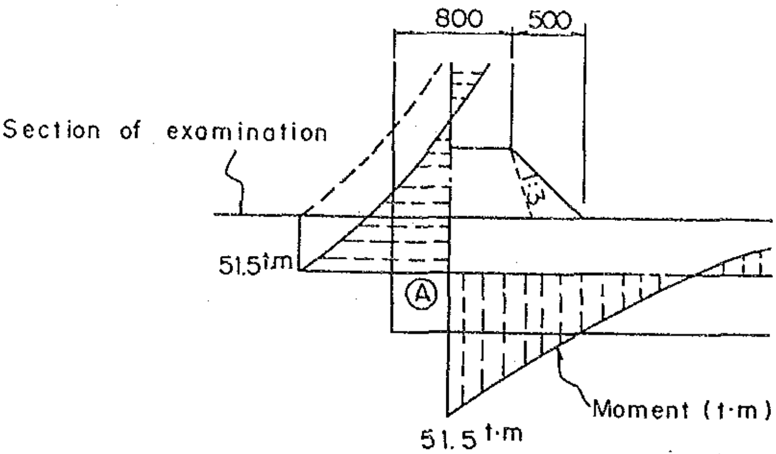


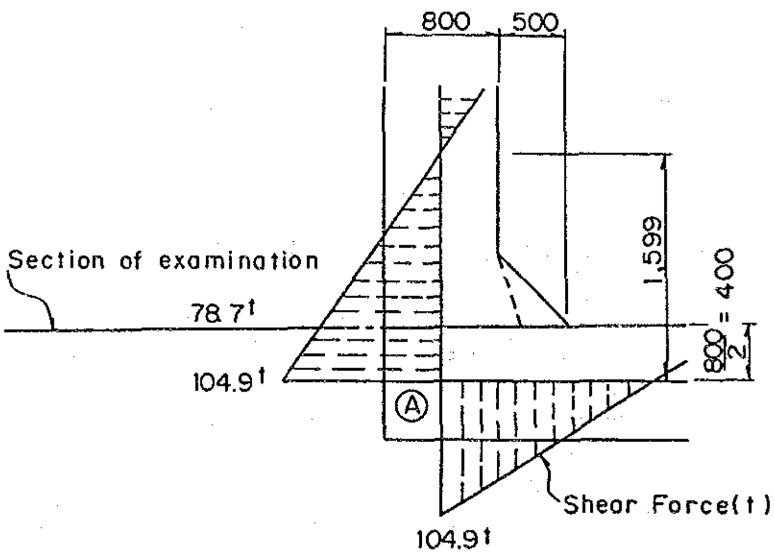
Shear Diagram

MOMENT AND SHEAR DIAGRAMS

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY



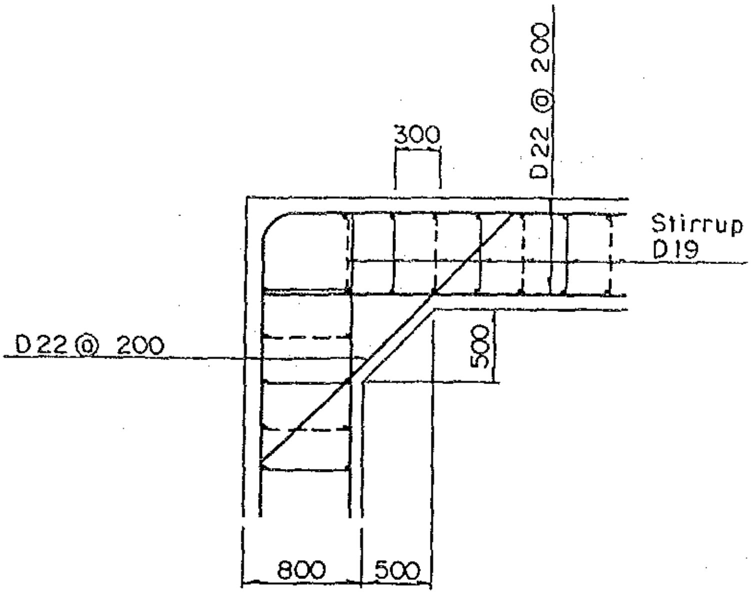


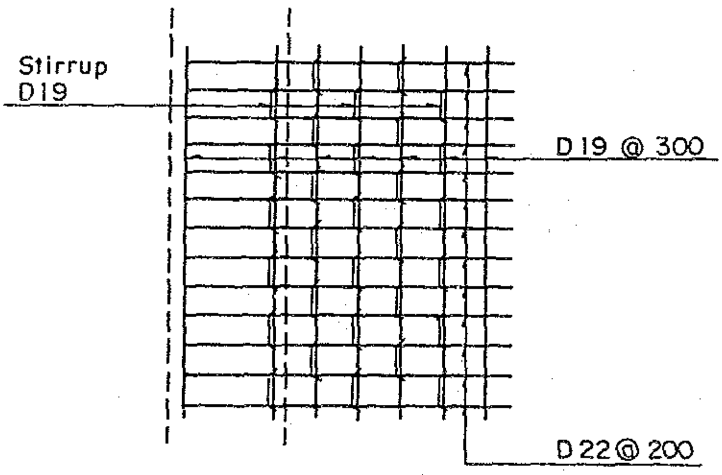
SECTION FOR STRESS ANALYSIS

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 5.2.4



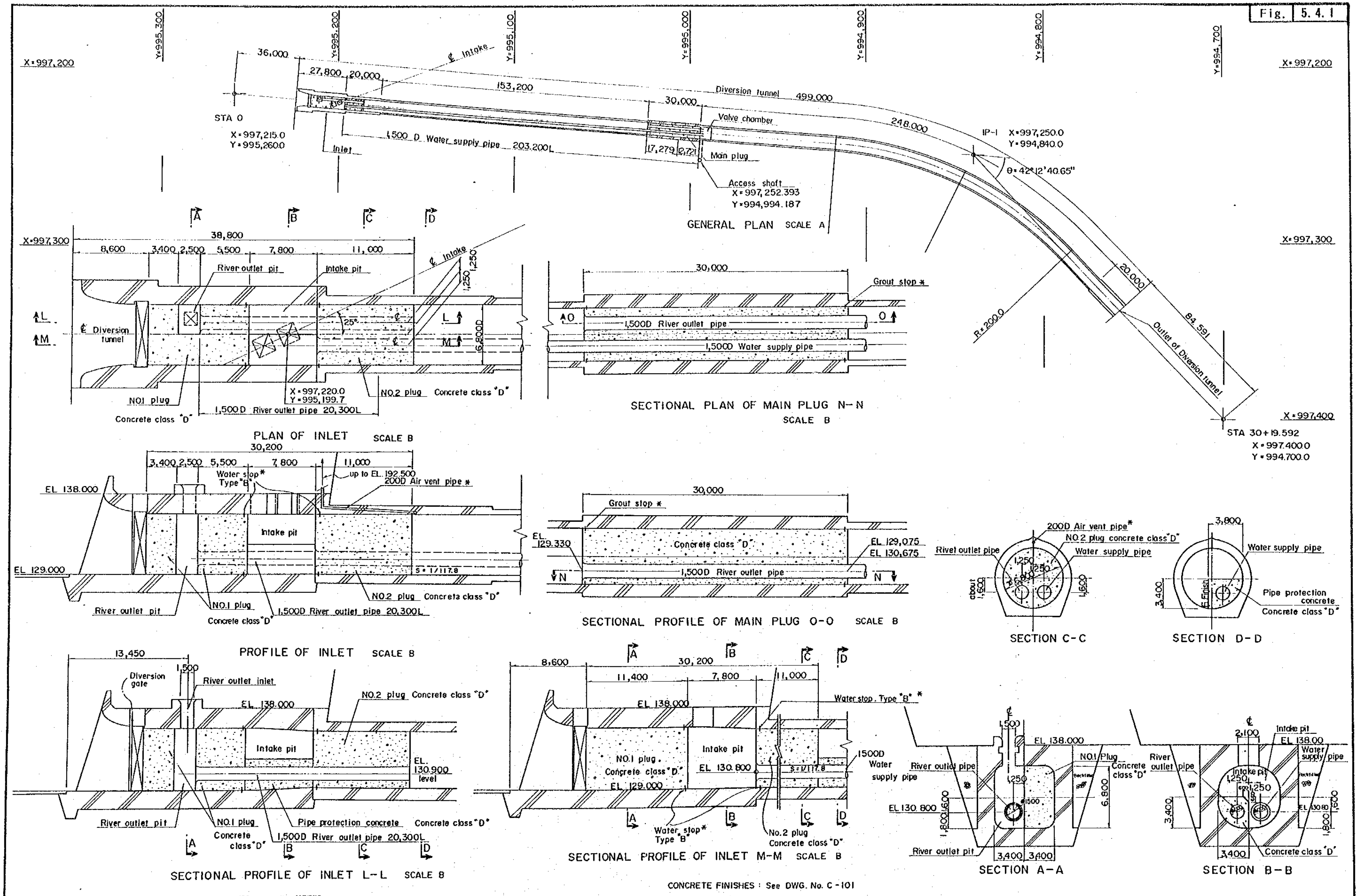


REINFORCEMENT BAR ARRANGEMENT

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 5.4.1



SCALE A 0 50 100m

SCALE B 0 10 20m

SCALE C 0

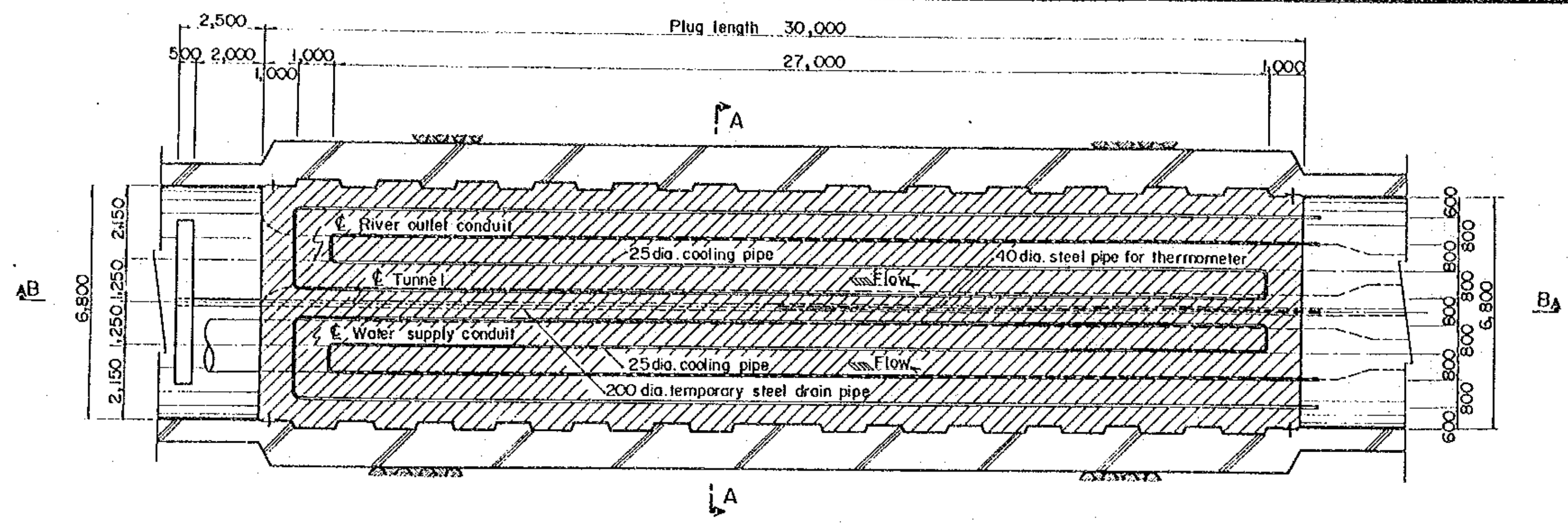
NOTES;

1) Hatched concrete structure shall be made under Lot-I.
2) Grout stop, water stop and air vent pipe with * shall be installed under Lot-I.
3) Arrangement of cooling pipe and grout pipe shall be refered to relevant drawing(s).
4) Diversion gate shall be manufactured under Lot-I and shall be installed under Lot-II.

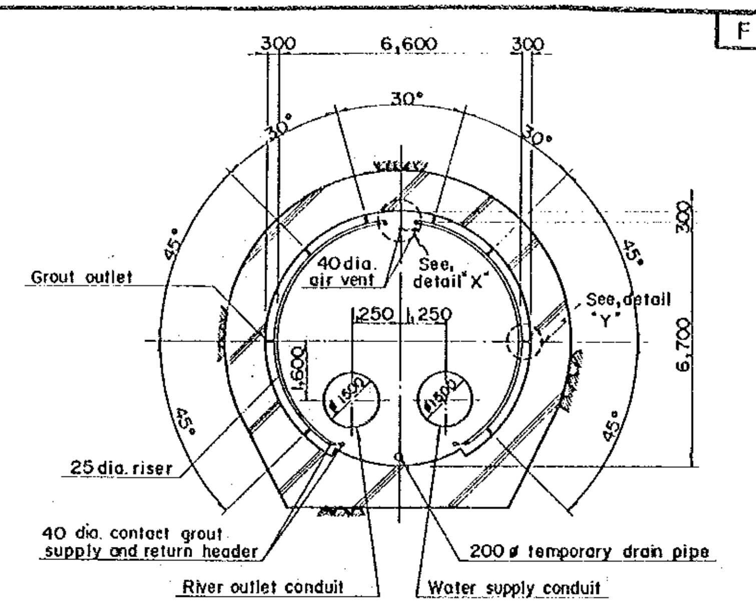
INTAKE AND RIVER OUTLET
STRUCTURAL DETAIL IN TUNNEL

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

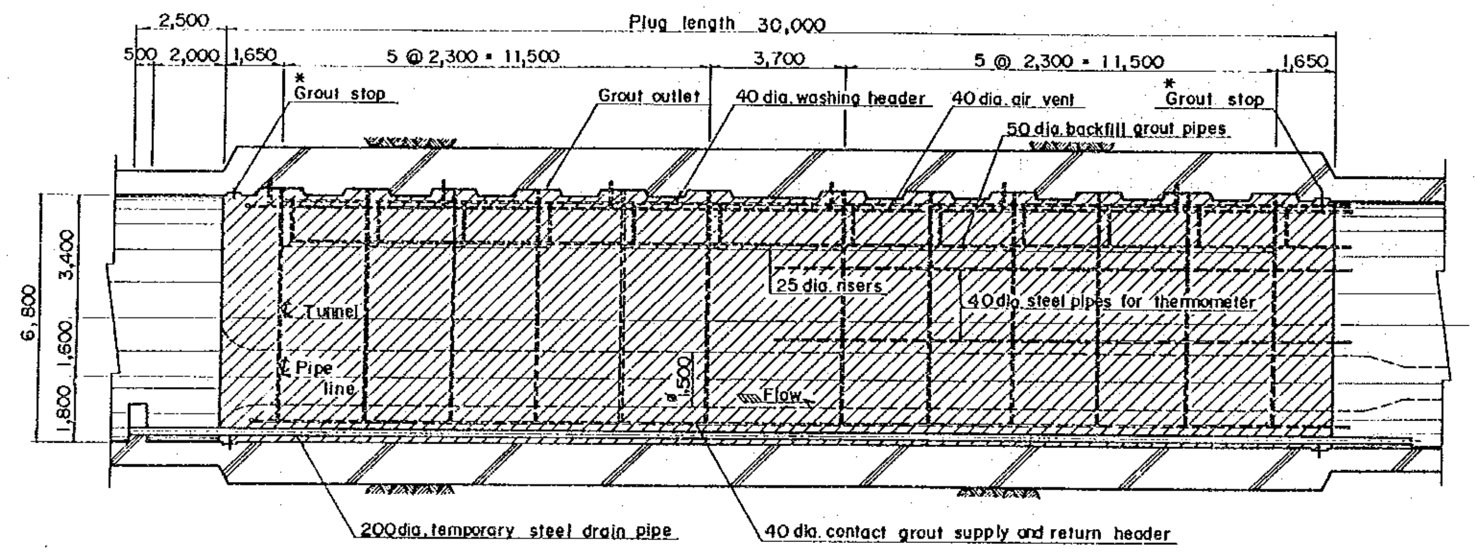
Fig. 5.4.2



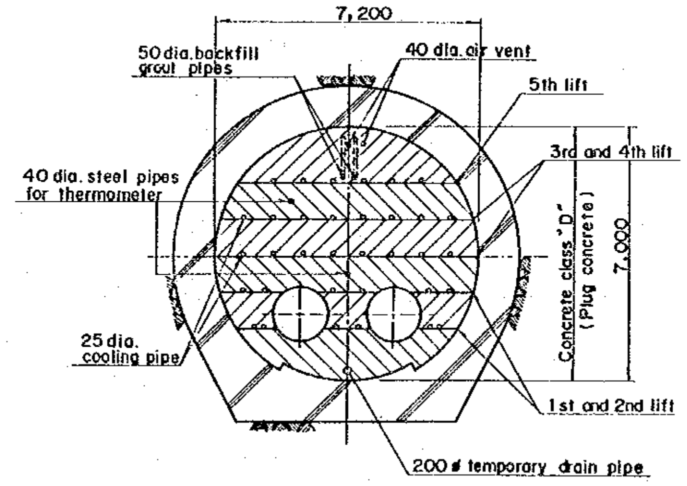
SECTION PLAN SCALE A



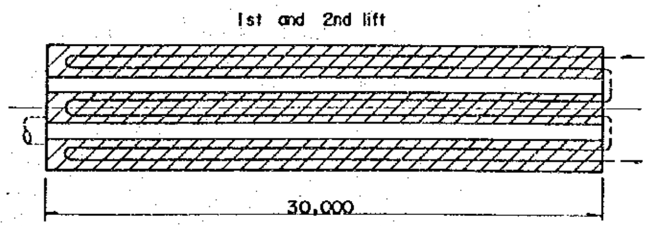
SECTION A – A SCALE A

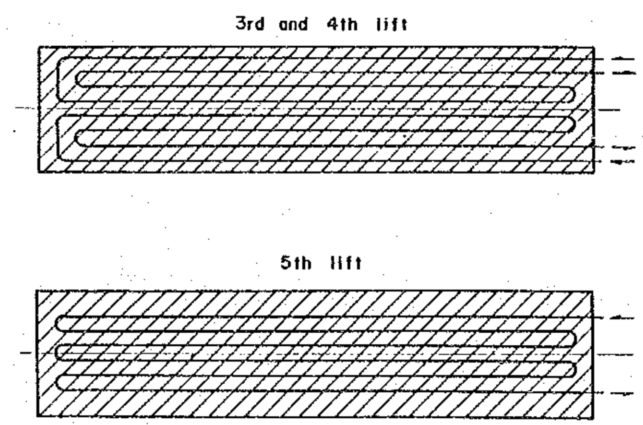


SECTION B – B SCALE A



SECTION A – A SCALE A





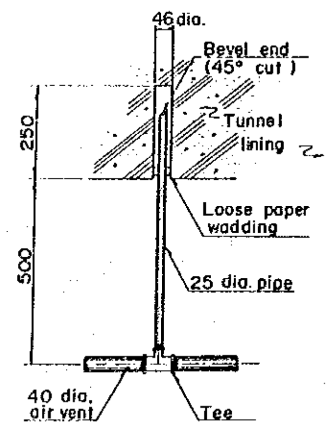
TYPICAL ARRANGEMENT OF COOLING PIPE

NOTES:

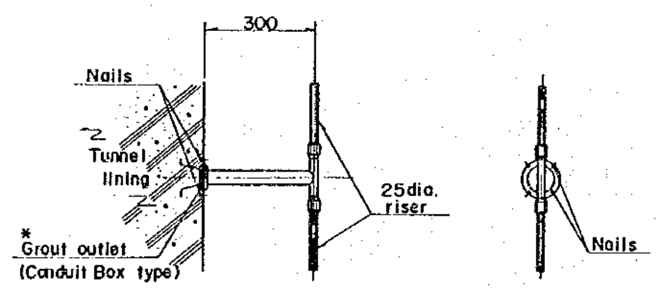
1) The marked * shall be done under Lot–1.

2) Tunnel lining concrete for the diversion tunnel shall be done under Lot–I.

3) As for operation of contact grouting, see Technical Specification, clause T3.7.



DETAIL "X" SCALE B



DETAIL "Y" SCALE B

SCALE A 0 10 m

SCALE B 0 1 m

INTAKE AND RIVER OUTLET
DETAIL OF PLUG

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

CHAPTER VI CONSTRUCTION SCHEDULE

6.1 Pre-construction Program

The pre-construction activities for Lot II works comprise prequalification of contractors, tendering, evaluation and award of contract. The detailed design, preparation of tender documents and financial arrangement will be completed by the end of the first year, considering the implementation of Lot I works.

The selection of consultant for the construction supervision will also be made before starting the Lot I international tendering.

The implementation schedule for Lot II works is planned to be established according to the time of river diversion after the completion of diversion tunnel work (Lot I).

The tendering time which comprises of the advertisement of tender and prequalification, tendering, tender evaluation, approval and contract awarding are expected as shown in Fig. 6.1, Implementation Schedule (Lot II) for the Port Louis Water Supply Project.

6.2 Construction Period and Target Date

The construction period required for implementation of the Lot II works is planned to be 34 months. As for the overall construction works including Lot I, Lot II and Lot III works, the whole period is to be 47 months. The construction works are scheduled to be commenced at the beginning of January in the fourth year and be completed by the end of October in the sixth year.

The following target dates of the major works are required to ensure the good sequence of the Lot II works. The Lot II works are planned to commence two months before the completion of the Lot I works.

a. Award of contract : January 1, 4th year
b. River diversion : March 1, 4th year
c. Cofferdam, completed : August 31, 4th year
d. Main dam, completed : March 31, 6th year
e. Spillway except bridge, completed : March 31, 6th year
f. Intake, completed : September 30, 5th year

g. Intake trush racks, intake gates, river outlet trush rack and bulkhead, completed : March 31, 6th year
h. Diversion gate and bulkhead gate closures : April 1, 6th year
i. Dam impounding : April 1, 6th year
j. River outlet including river outlet facilities, completed : September 30, 6th year
k. Completion date of Lot II works : October 31, 6th year

6.3 Construction Schedule

The construction schedule of the Lot II works is shown in Fig. 6.2 by bar chart. The land acquisition and compensation for the Project will be settled by the CWA prior to the commencement of Lot II works.

The Lot II construction works will be performed to follow the Lot II works including preparatory works and diversion tunnel work. The river diversion through the diversion tunnel provided by Lot I works is planned to be carried out on March 1 in the fourth year, two months after the commencement of Lot II works.

The work schedule for the major items are summarized by year as follows:

(1) Fourth year (the first year in Lot II)

(a) Award of contract, Lot II
(b) Mobilization and construction of site facilities
(c) Temporary access road
(d) River diversion
(e) Excavation and embankment of the cofferdam
(f) Provision of the deep well
(g) Excavation, plug concrete, gallery concrete, embankment and grouting works of the main dam
(h) Preparation of the borrow area and the quarry site
(i) Excavation and concrete works of the inspection tunnel
(j) Excavation and concrete works of the No. 1 grout tunnel
(k) Excavation of the spillway

(2) Fifth year (the second year in Lot II)

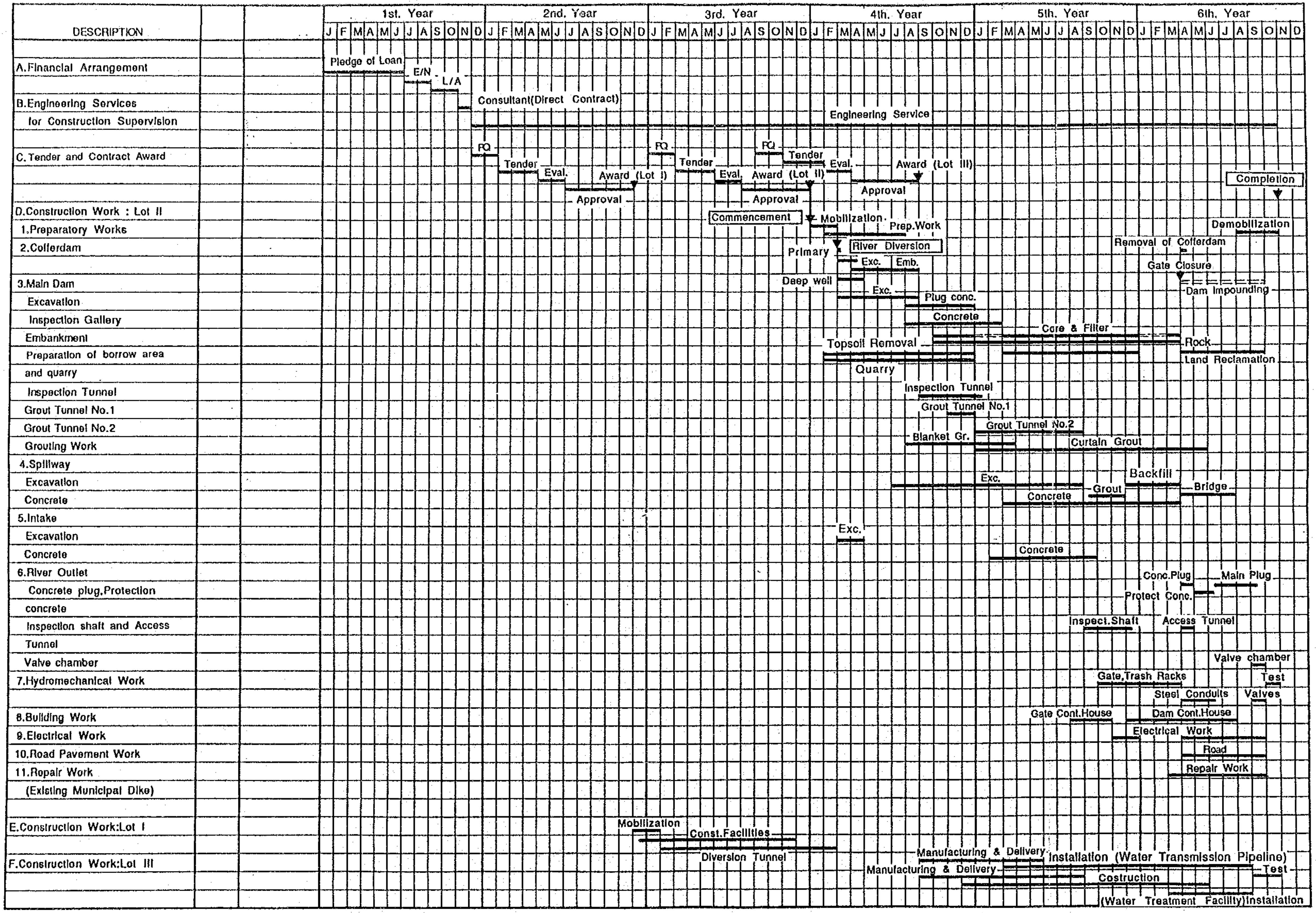
(a) Embankment and grouting works of the main dam
(b) Excavation and concrete works of the No. 2 grout tunnel
(c) Excavation, grout, concrete and slope protection works of the spillway
(d) Excavation and concrete works of the intake
(e) Excavation and concrete works of the inspection shaft
(f) Installation of the intake trush racks and the intake gates
(g) Building works of the hoist house

(3) Sixth year (the third year in Lot II)

(a) Embankment and grouting works for the main dam
(b) Concrete works of the spillway
(c) Installation of the intake trush racks, the intake gates, the diversion gate, the river outlet trush rack and the bulkhead gate
(d) Gates closure and dam impounding
(e) Spillway bridge
(f) River outlet works including the No. 1 and No. 2 plugs concrete, main plug concrete, pipe protection concrete, drain holes and valve chamber
(g) Excavation and concrete works of the access tunnel to the valve chamber
(h) Installation of the river outlet facilities in parallel with the river outlet works
(i) Land reclamation of the borrow area
(j) Building works of the dam control house
(k) Road pavement work at the dam site
(l) Repair work at the existing municipal dike
(m) Test for the hydromechanical work
(n) Demobilization

FIGURES

Fig. 6.1



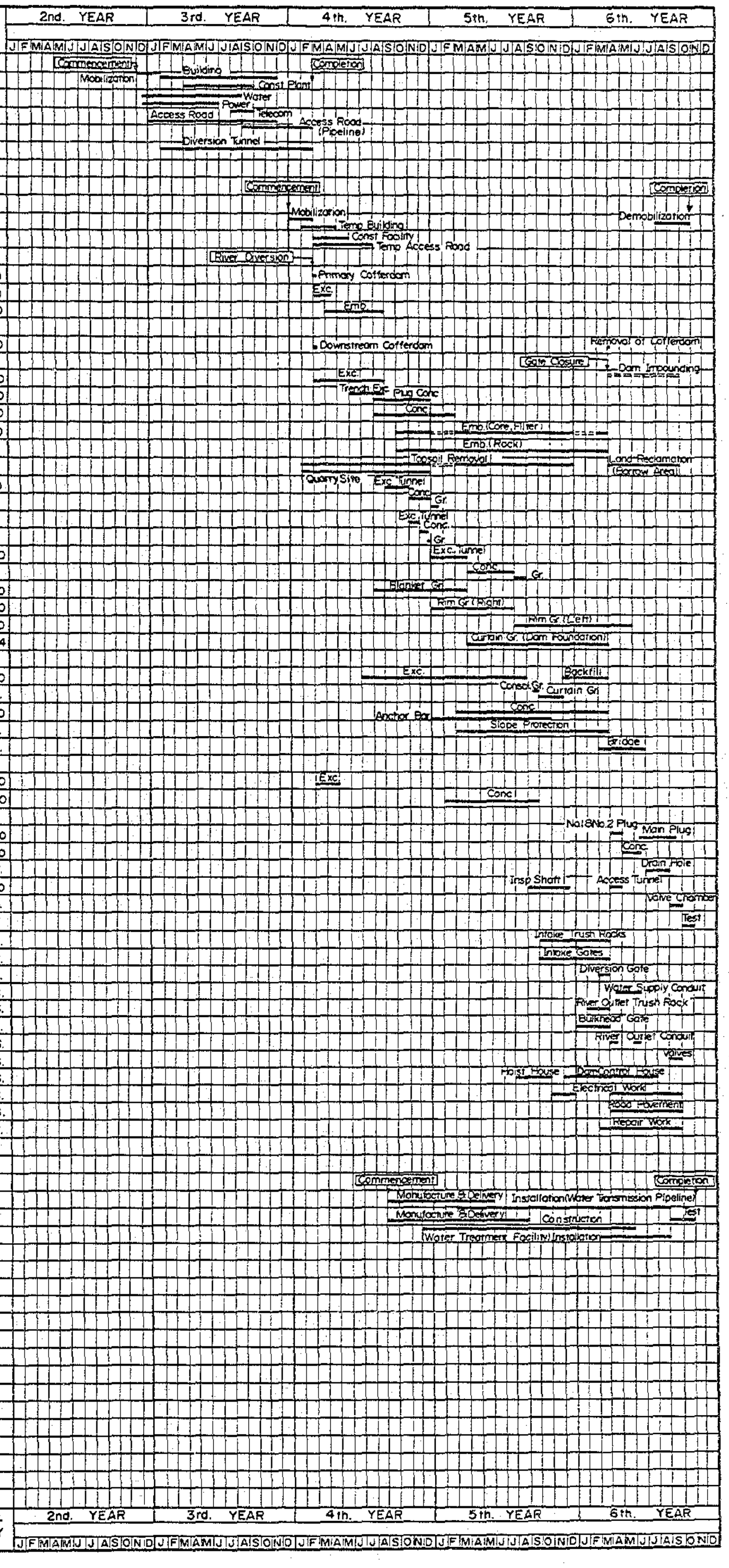
IMPLEMENTATION SCHEDULE (LOT II) FOR THE PORT LOUIS WATER SUPPLY PROJECT

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 6.2

DESCRIPTION	UNIT	QUANTITY
Lot I : Preparatory Works and Diversion Tunnel		
Lot II : Dam and Related Facilities, and Repair Work of the Existing Municipal Dike		
1. Preparatory Works		L.S.
2. Cofferdam		
Primary cofferdam (Upstream)	m³	6,400
Main cofferdam, Excavation	m³	48,810
Embankment	m³	166,300
Downstream cofferdam	m³	4,200
3. Main Dam		
Excavation	m³	404,000
Gallery trench excavation Plug concrete	m³	19,520
Inspection gallery	m	230
Embankment	m³	1,381,400
Preparation of borrow area, quarry site, etc.		L.S.
Inspection tunnel	m	150
Grout tunnel, NO.1 (Right abutment)		-
Grout tunnel, NO.2 (Left abutment)	m	430
Grouting work, Blanket grout	m	3,820
Rim grout (Right bank)	m	2,420
Rim grout (Left bank)	m	8,680
Dam foundation	m	12,654
4. Spillway		
Excavation	m³	824,490
Grouting work, consolidation & curtain		L.S.
Concrete	m³	46,060
Slope protection	m²	L.S.
Spillway bridge	m	L.S.
5. Intake		
Excavation	m³	900
Concrete	m³	3,420
6. River Outlet		
Plug concrete	m³	1,900
Protection concrete	m³	1,500
Drain hole		L.S.
Inspection shaft & Access tunnel	m³	260
Valve chamber		L.S.
7. Hydromechanical Work		
Intake trush racks		L.S.
Intake gates		L.S.
Diversion gate closure		L.S.
Water supply conduit		L.S.
River outlet trush rack		L.S.
Bulkhead gate		L.S.
River outlet conduit		L.S.
River outlet facilities		L.S.
8. Building Work		L.S.
9. Electrical Work		L.S.
10. Road Pavement Work		L.S.
11. Repair Work at the Existing Municipal Dike		L.S.
Lot III : Intake at the Existing Municipal Dike, Water Transmission Pipeline and Treatment Facilities		



GENERAL
CONSTRUCTION TIME SCHEDULE

GOVERNMENT OF MAURITIUS
PORT LOUIS WATER SUPPLY PROJECT
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