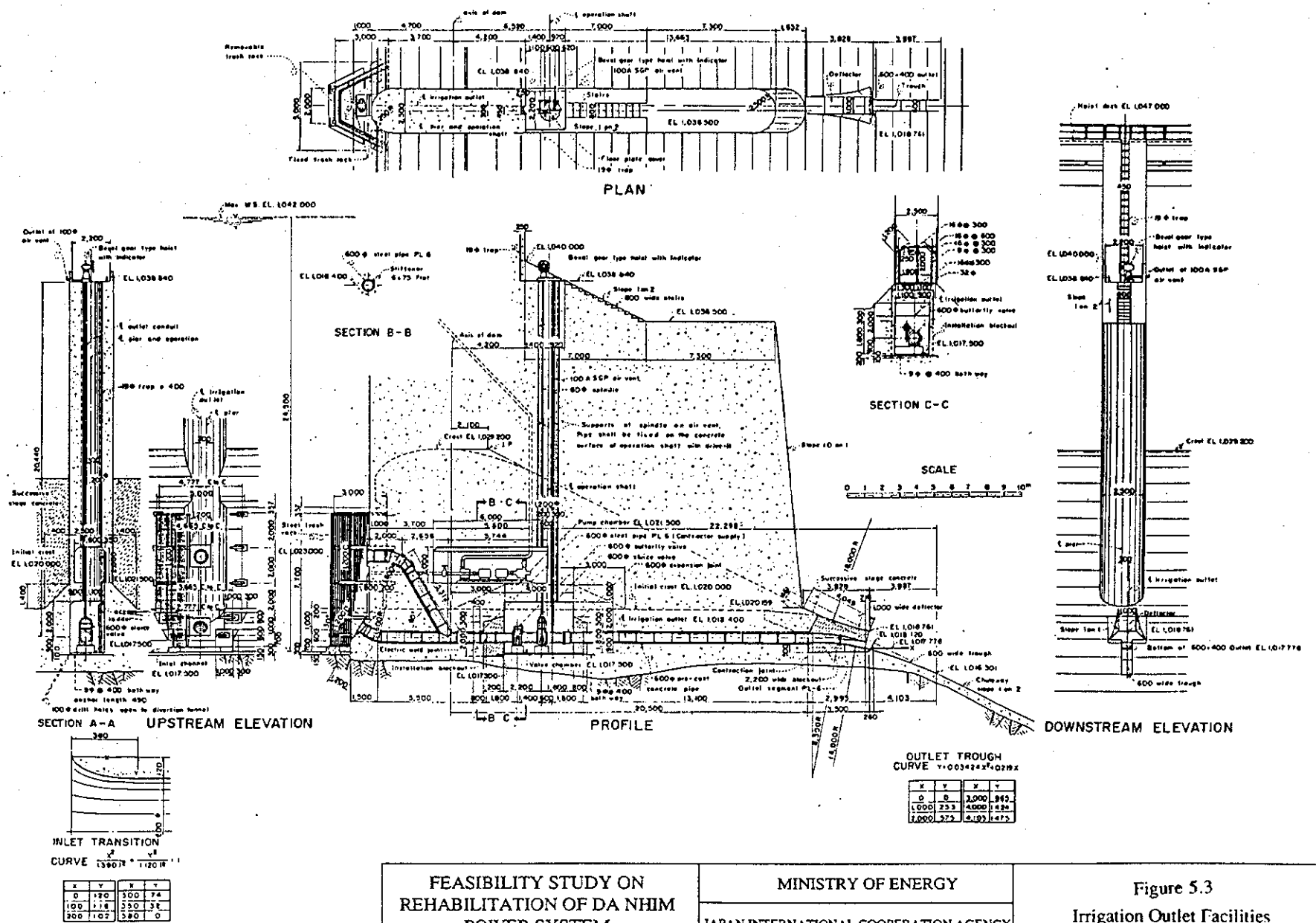
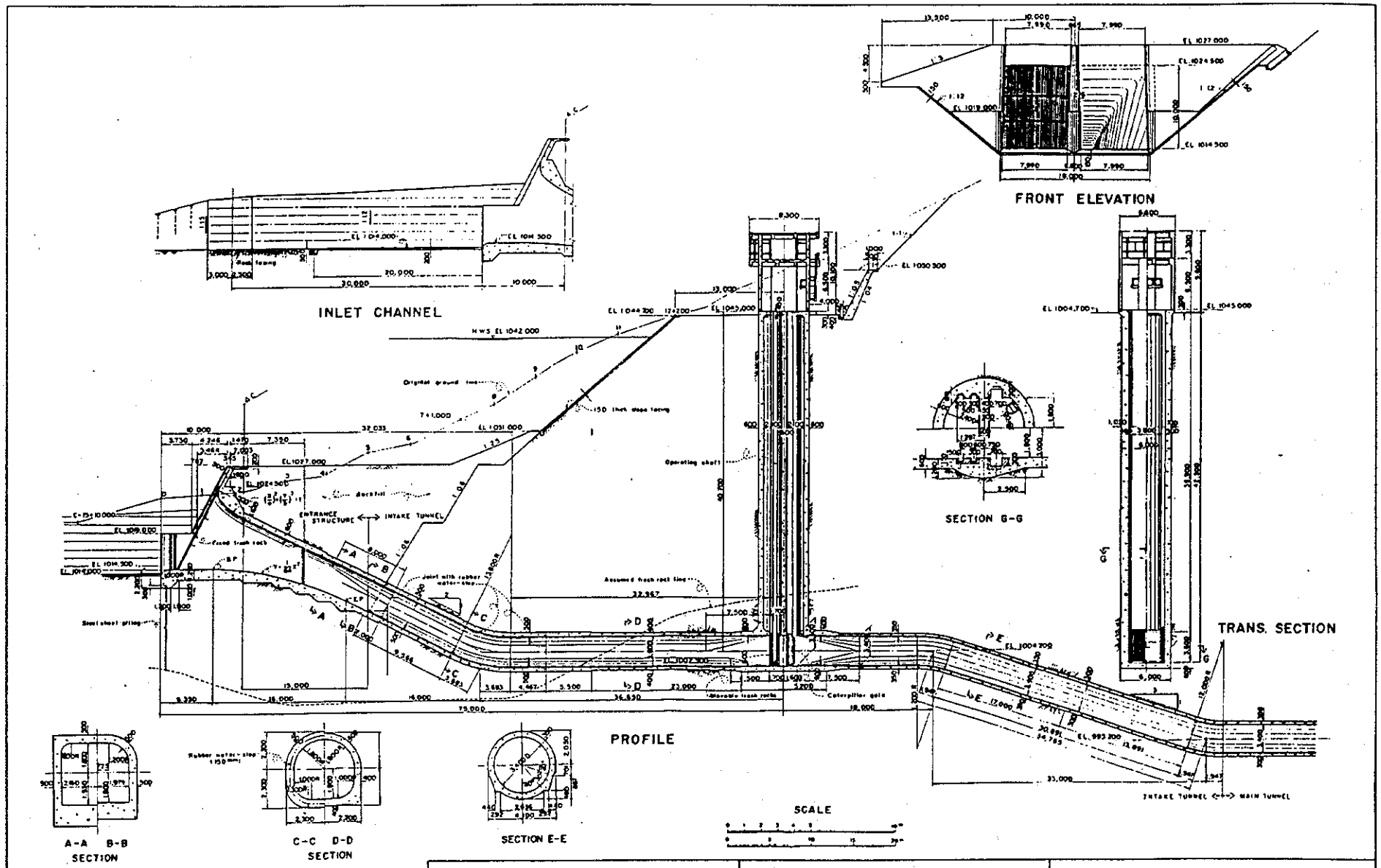
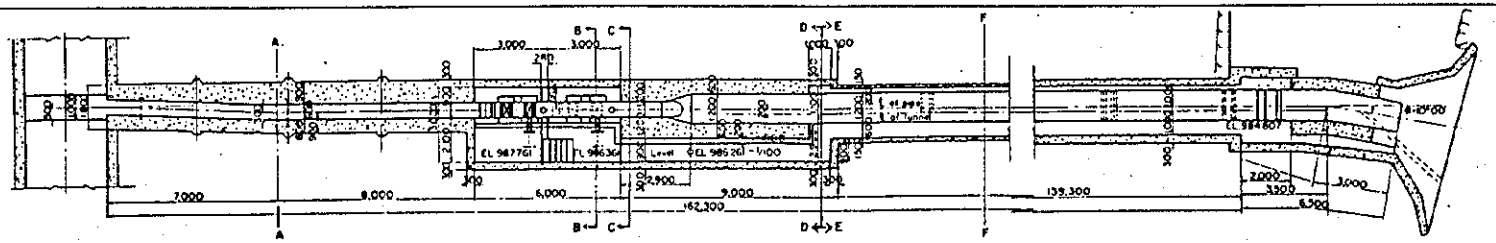


FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY

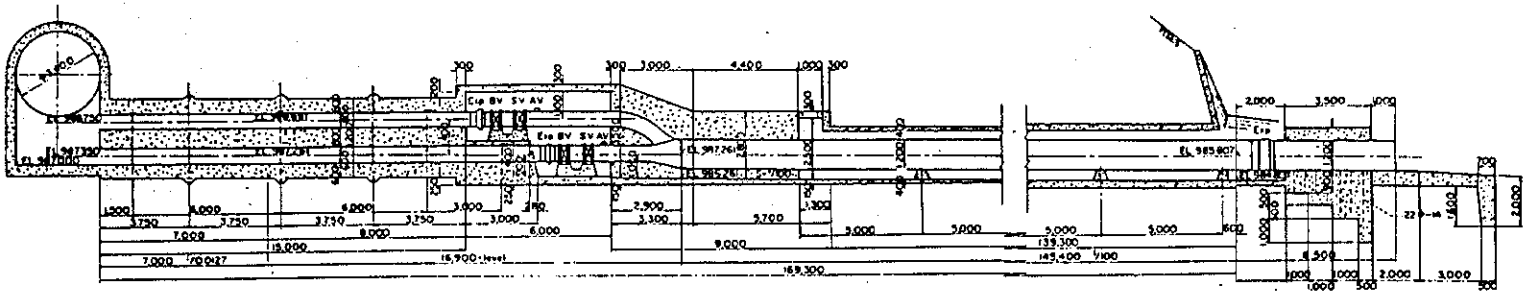
Figure 5.3
Irrigation Outlet Facilities



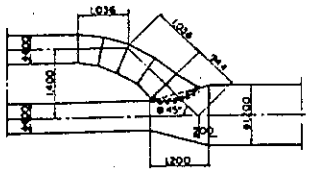
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.4 Intake Gates Facilities



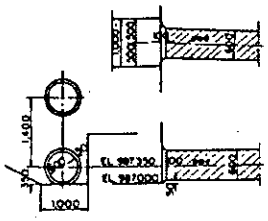
SECTIONAL PLAN



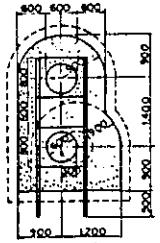
LONGITUDINAL SECTION



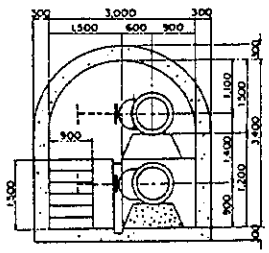
BRANCH



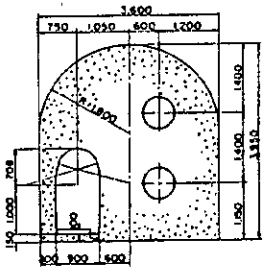
PIPE ENTRANCE



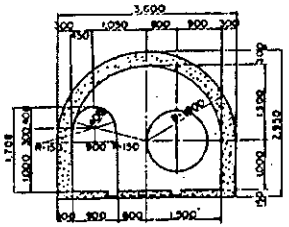
SECTION A – A



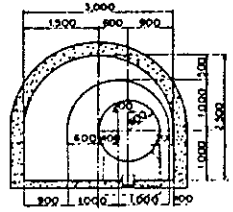
SECTION B – B



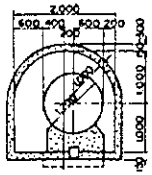
SECTION C – C



SECTION D – D



SECTION E – E



SECTION F – F

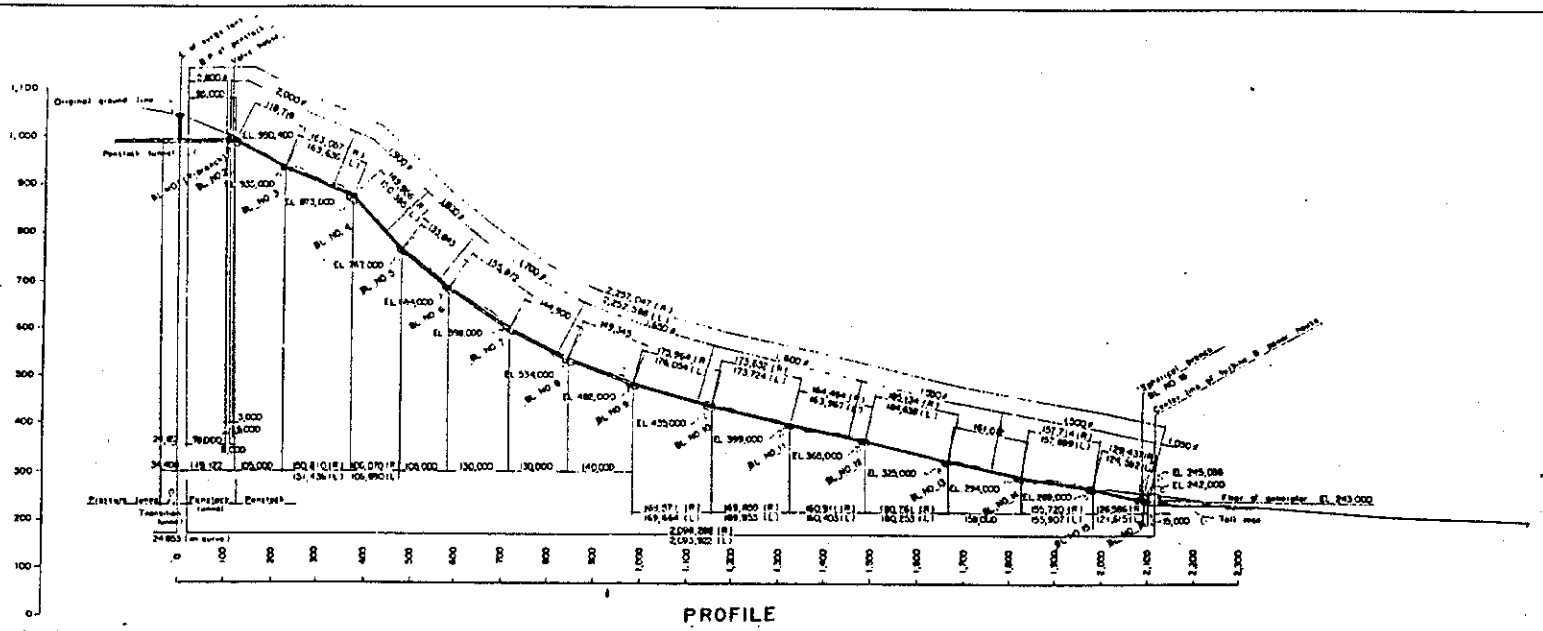
SCALE 1/50

0 10 20m

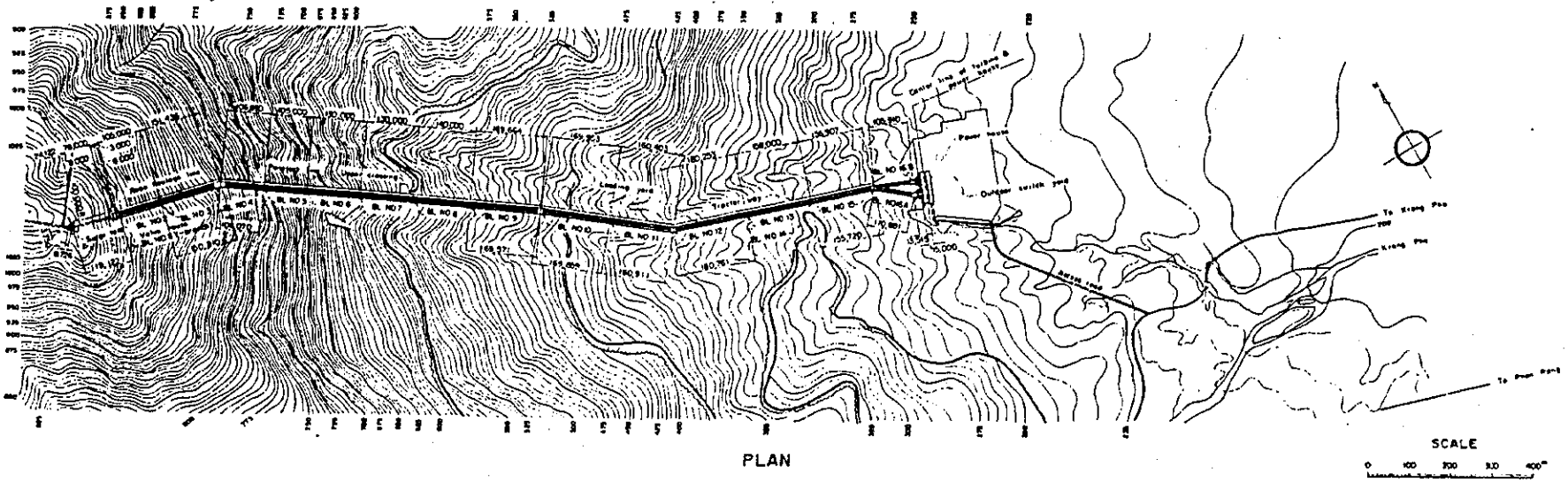
SCALE 1/100

0 10 20 30 40 50m

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.5 Surge Tank and Penstock Tunnel Drain Facilities

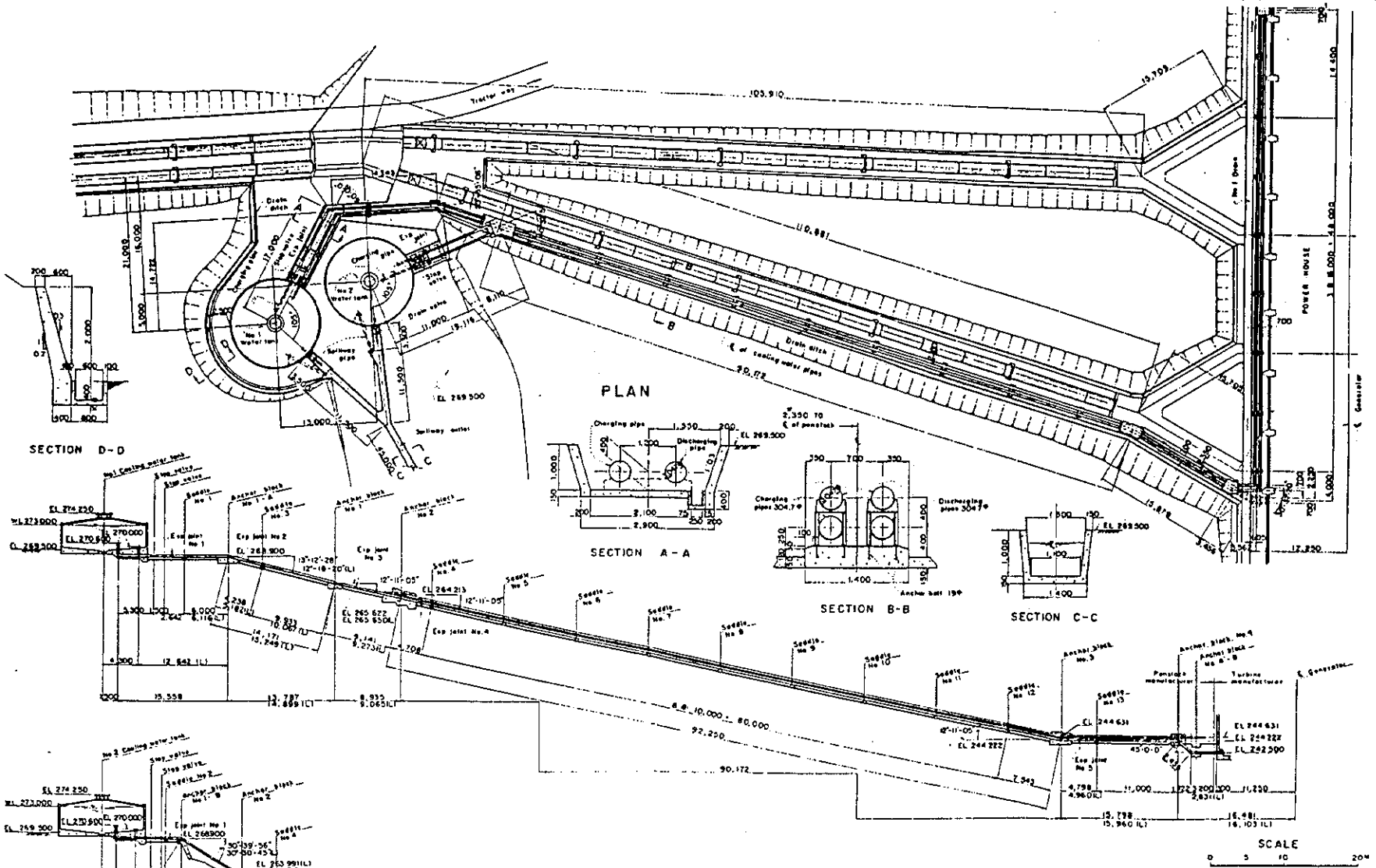


PROFILE

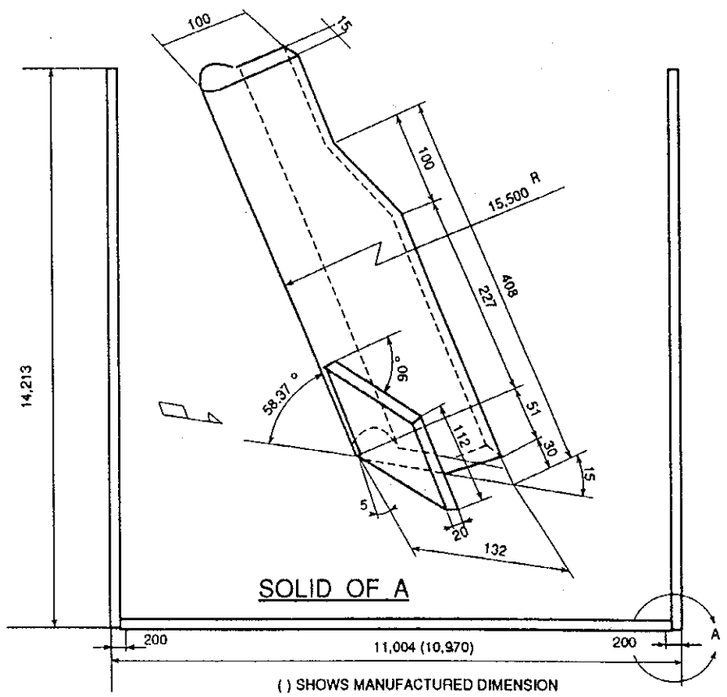


PLAN

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.6 Penstock

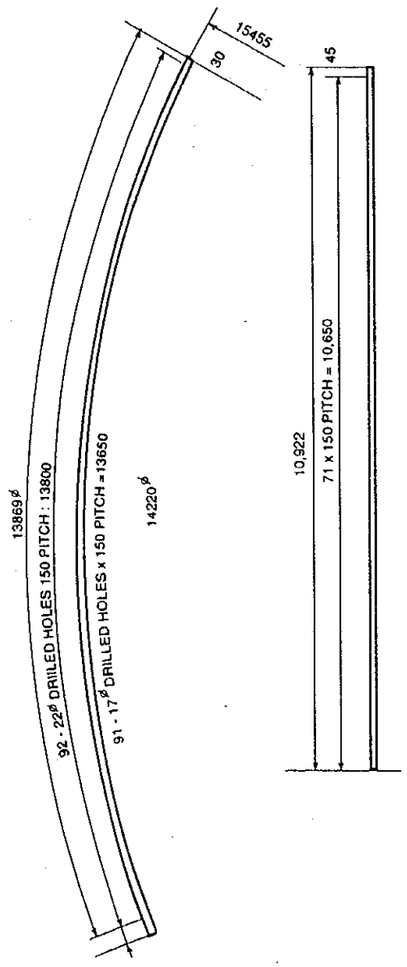


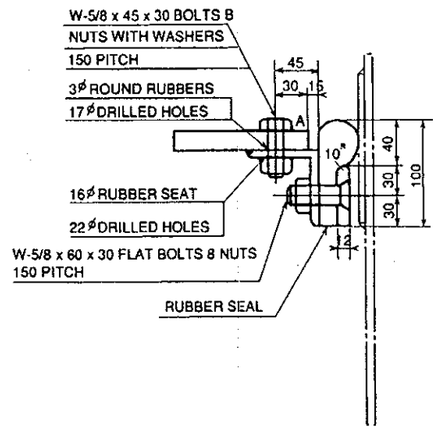
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.7 Cooling Water Pipe



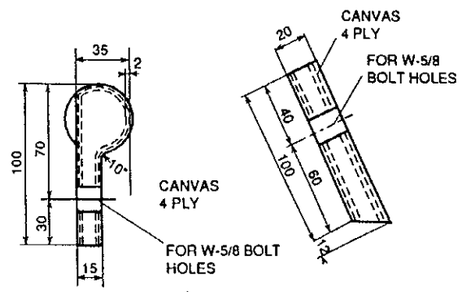
SOLID OF A

( ) SHOWS MANUFACTURED DIMENSION

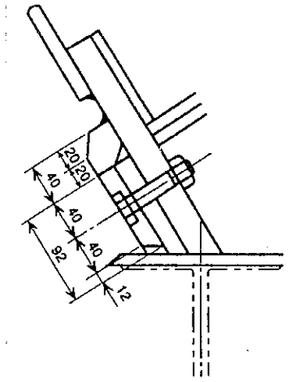




DETAIL OF SIDE WALL SEAL



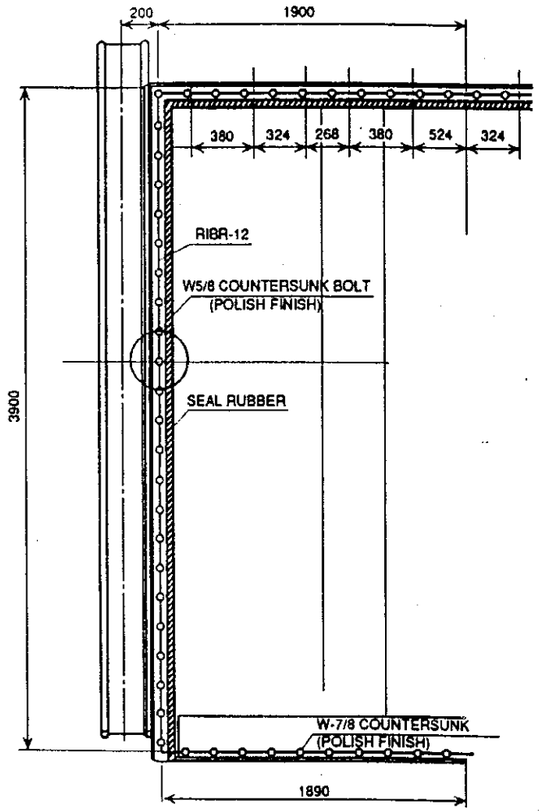
DETAIL OF RUBBER SEAL

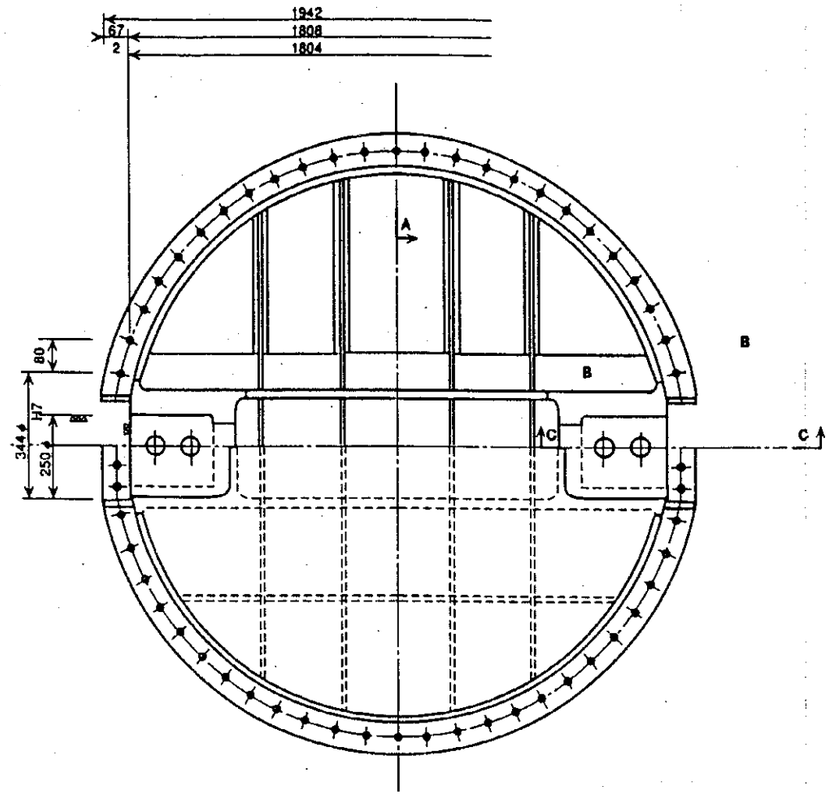


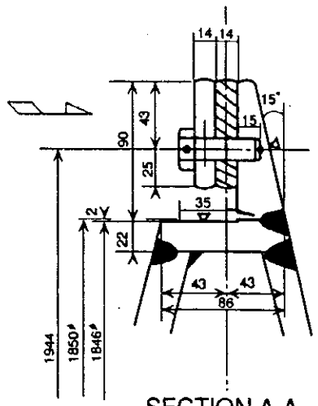
17ϕ DRILLED HOLES

DETAIL OF BOTTOM SEAL

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.8 Spillway Radial Gates and Hoists Detail of Seal

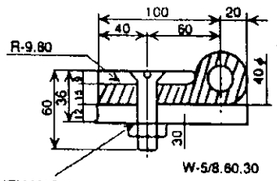


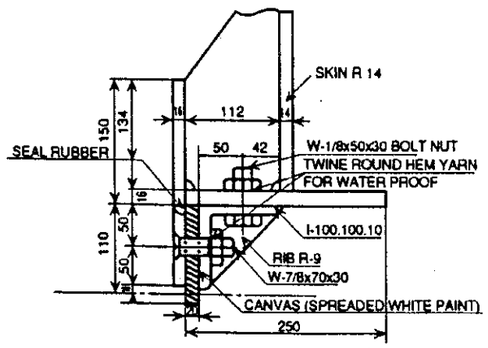


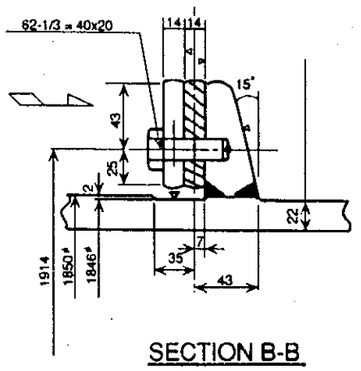


SECTION A-A

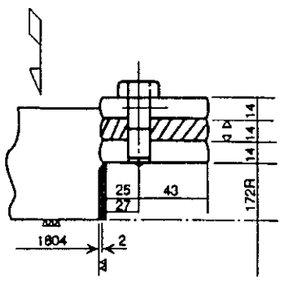
DETAIL OF SIDE AND UPPER RUBBER







SECTION B-B



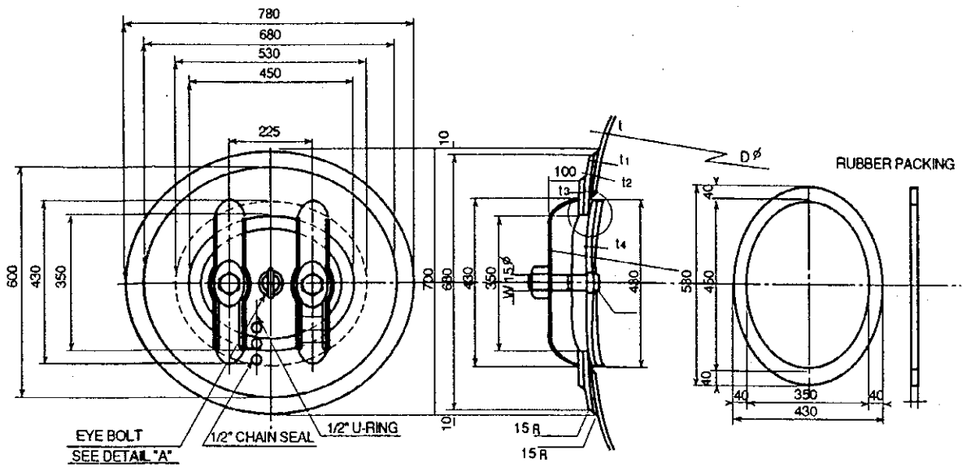
SECTION C-C

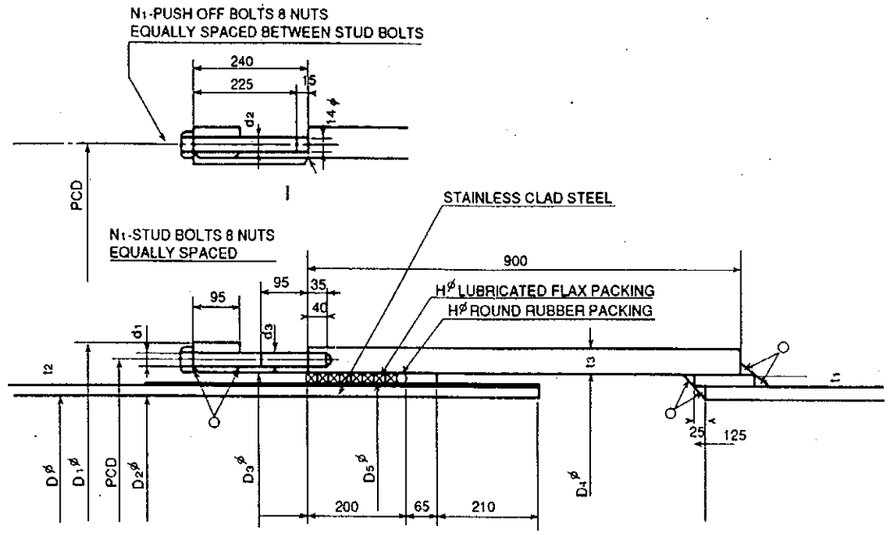
INTAKE CATERPILLAR GATE

BUTTERFLY VALVES

Note: Position of blot holes for seal rubber and clamper shall be adjusted at the site.

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY	Figure 5.9 Intake Caterpillar Gates Butterfly Valves, Detail of Seal
	JAPAN INTERNATIONAL COOPERATION AGENCY	





MAN HOLE NO.	D ø	t	t1	t2	t3	t4	NO. OF REQD	PIPE NO.	MATERIAL OF t-t3	MATERIAL OF t4		
1	2800	11	20	9	9	19	1	(14)	SM41B	SM41B	0°	0°
2	2000	9	22	9	9	19	2	(17)R (17)L	"	"	0°	0°
3	2000	11	20	10	9	10	"	(39)R (39)L	SM50B	60HTS	22° 21'	22° 16'
4	1900	11	24	11	9	23	"	(67)R (67)L	60HTS	"	44° 59'	44° 49'
5	1800	16	25	15	14	29	"	(92)R (92)L	"	"	38° 20'	38° 20'
6	1700	19	26	18	18	33	"	(114)R (114)L	"	"	33° 29'	33° 29'
7	1700	24	25	22	22	37	"	(140)R (140)L	"	"	26° 13'	20° 13'

MAN HOLE NO.	D ø	t	t1	t2	t3	t4	NO. OF REQD	PIPE NO.	MATERIAL OF t-t3	MATERIAL OF t4		
8	1650	26	26	24	24	40	2	(166)R (166)L	60HTS	60HTS	20° 23'	20° 23'
9	1650	30	27	27	27	45	"	(191)R (191)L	"	"	15° 30'	15° 29'
10	1600	30	27	29	28	45	"	(222)R (222)L	"	"	11° 58'	11° 58'
11	1600	32	25	30	30	45	"	(261)R (261)L	"	"	11° 56'	11° 58'
12	1550	33	29	31	31	50	"	(279)R (279)L	"	"	12° 29'	12° 31'
13	1550	35	27	33	33	50	"	(309)R (309)L	"	"	11° 06'	11° 06'
14	1500	35	27	34	33	50	"	(336)R (336)L	"	"	9° 07'	9° 06'
15	1500	39	25	35	35	50	"	(365)R (365)L	"	"	12° 11'	12° 44'
16	1500	38	24	36	36	50	"	(382)R (391)L	"	"	12° 11'	12° 44'

MANHOLES

EXP NO.	D ø	D1 ø	D2 ø	D3 ø	D4 ø	D5 ø	PCD	t1	t2	t3	d1 x N1	d2 x N2	d3	H	MATERIAL OF t1
1	2800	2961	2829	2861	2860	2864	2902	11	13	40	3/4ø x 64	5/8ø x 16	22ø	19	SM41B
3	2000	2157	2025	2057	2056	2060	2098	9	11	40	3/4ø x 44	5/8ø x 11	22ø	19	"
7	1700	1885	1747	1785	1784	1788	1831	20	22	45	7/8ø x 40	3/4ø x 10	25ø	22	"
9	1650	1849	1711	1749	1748	1752	1795	27	29	45	7/8ø x 40	3/4ø x 10	25ø	22	SM50B
11	1600	1815	1671	1715	1714	1718	1761	32	34	45	7/8ø x 40	3/4ø x 10	25ø	25	60HTS
13	1550	1771	1627	1671	1670	1674	1717	35	37	45	7/8ø x 26	3/4ø x 9	25ø	25	"
15	1500	1725	1581	1625	1624	1678	1671	37	39	45	7/8ø x 36	3/4ø x 9	25ø	25	"
16	1500	1729	1585	1629	1628	1632	1675	39	41	45	7/8ø x 36	3/4ø x 9	25ø	25	"

EXP NO.	D ø	D1 ø	D2 ø	D3 ø	D4 ø	D5 ø	PCD	t1	t2	t3	d1 x N1	d2 x N2	d3	MATERIAL OF t1	H
4	2000	2161	2029	2061	2060	2064	2102	11	13	40	3/4ø x 44	5/8ø x 11	22	SM41B	19
5	1900	2061	1929	1961	1960	1964	2002	11	13	"	3/4ø x 44	5/8ø x 11	"	"	"
6	1800	1979	1841	1879	1878	1882	1920	17	19	"	3/4ø x 44	5/8ø x 11	"	"	22
8	1700	1895	1757	1795	1794	1798	1841	25	27	45	7/8ø x 40	3/4ø x 10	25	SM50B	"
10	1650	1861	1717	1761	1760	1764	1812	30	32	50	7/8ø x 40	3/4ø x 10	"	"	25
12	1600	1819	1675	1719	1718	1722	1765	34	36	45	7/8ø x 40	3/4ø x 10	"	60HTS	"
14	1550	1775	1621	1675	1674	1678	1721	37	39	"	7/8ø x 36	3/4ø x 9	"	"	"

EXPANTION JOINTS

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.10 Manholes and Expansion Joints Detail of Seal

(I) Spillway radial gates and intake caterpillar gate

Property	Limits
Tensil strength	210 kgf/cm2 minimum
Ultimate elongation	450 % minimum
Specific gravity	1.1 to 1.3
Durometer hardness (Shore, Type A)	more than 60
Water absorption (70o C for 48 hours)	5 % by weight (max.)

(II) Butterfly valves with air valves and expansion joints

Property	Limits
Tensil strength	150 kgf/cm2 minimum
Ultimate elongation	300 % minimum
Specific gravity	1.1 to 1.3
Durometer hardness (Shore, Type A)	more than 55
Water absorption (70o C for 48 hours)	5 % by weight (max.)

(III) Manhole of penstocks

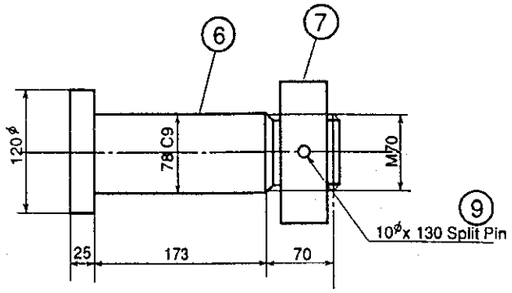
For No. 1 to No.7 manhole

Property	Limits
Tensil strength	150 kgf/cm2 minimum
Ultimate elongation	300 % minimum
Specific gravity	1.1 to 1.3
Durometer hardness (Shore, Type A)	more than 60
Water absorption (70o C for 48 hours)	5 % by weight (max.)

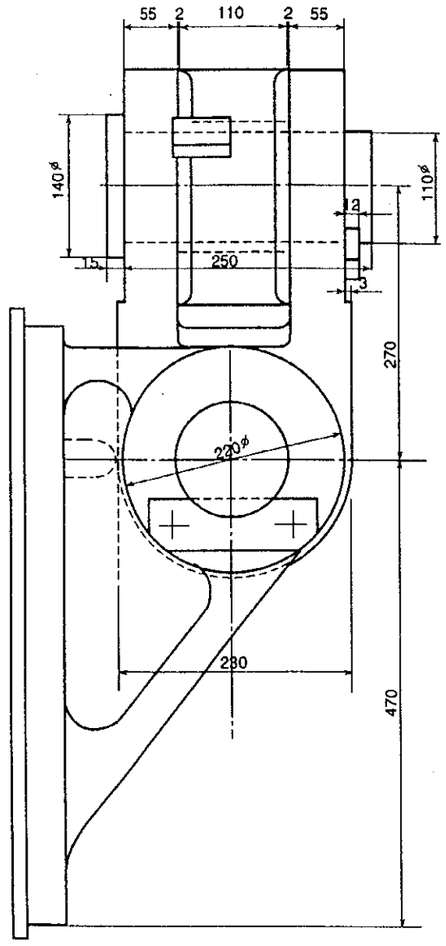
For No. 8 to no.16 manhole

Property	Limits
Tensil strength	200 kgf/cm2 minimum
Ultimate elongation	400 % minimum
Specific gravity	1.1 to 1.3
Durometer hardness (Shore, Type A)	more than 60
Water absorption (70o C for 48 hours)	5 % by weight (max.)

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.11 Specification of Seal Rubbers

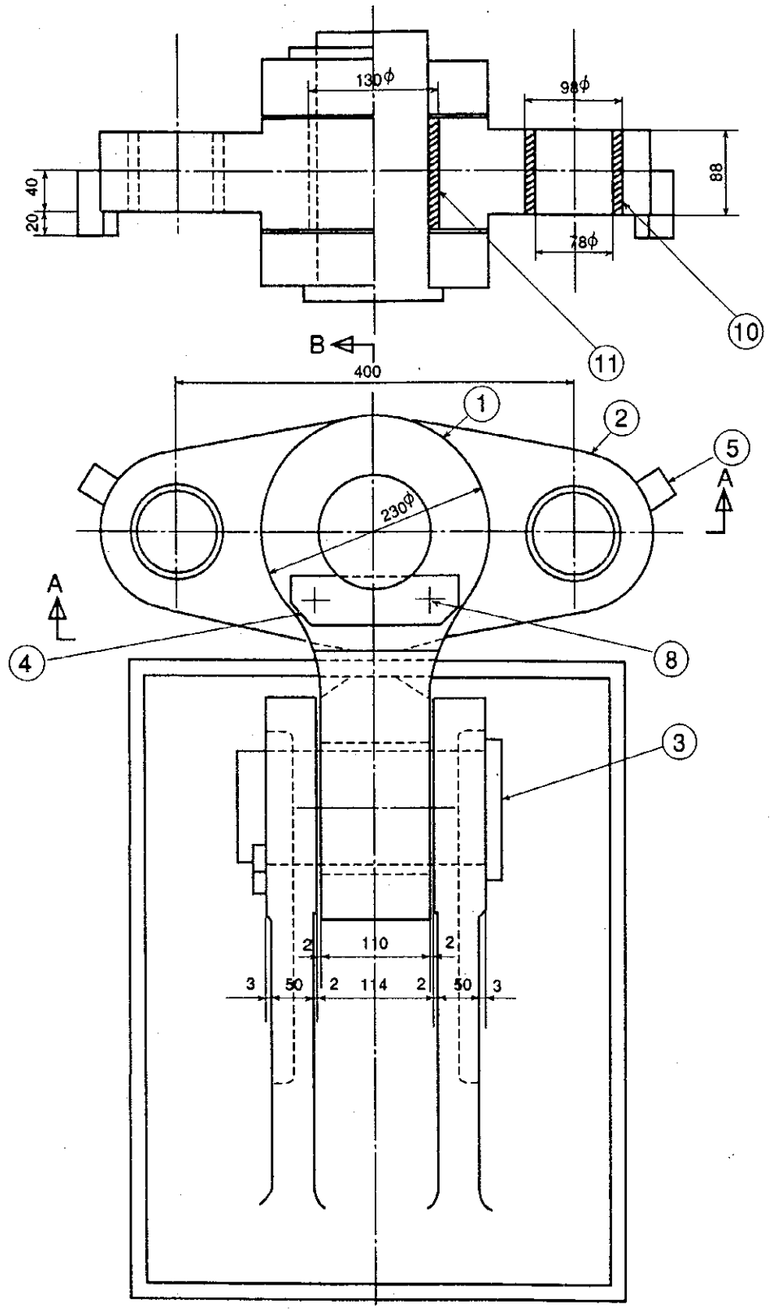


DETAIL OF ROPE PIN



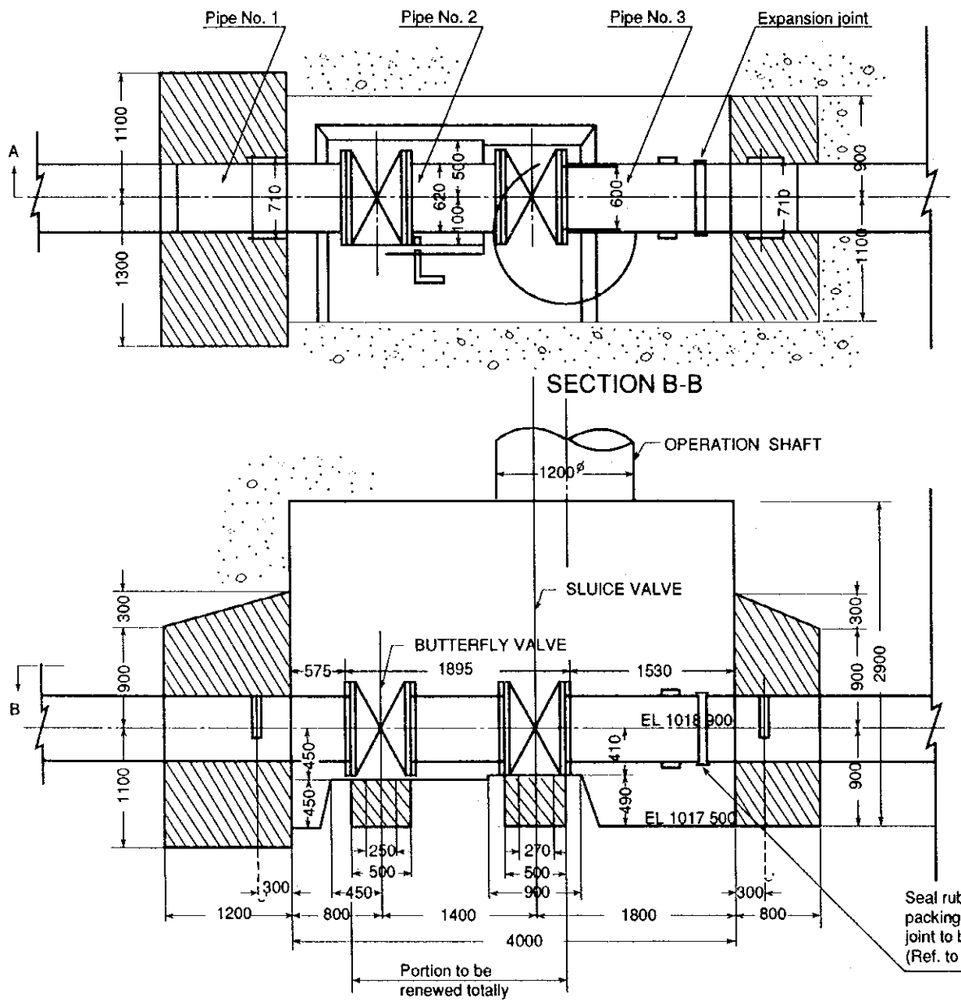
SECTION B-B

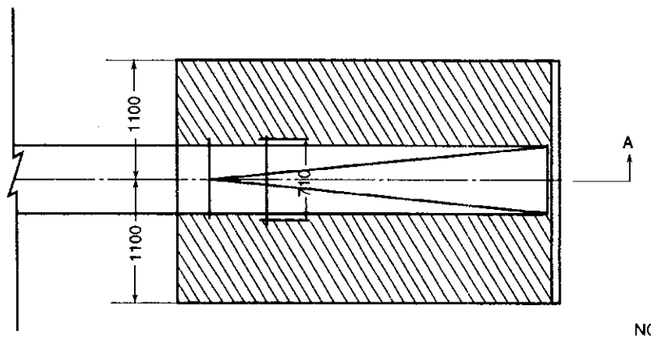
SECTION A-A



	Parts	Material	Q'ty	
①	Rocker	SF540A	2x4	
②	Balance Lever	"	2x4	
③	Pin	SUS304	2x4	
④	Key Plate	SS400	2x4	
⑤	Stopper	"	4x4	
⑥	Rope Pin	SUS304	4x4	
⑦	Nut	SUS	4x4	
⑧	Bolt(w3/4x30x25)	S45C	4x4	
⑨	Split Pin	SUS	4x4	
⑩	Bush	Oilless	4x4	
⑪	"	"	4x4	
⑫	Set Screw	Bs	16x4	

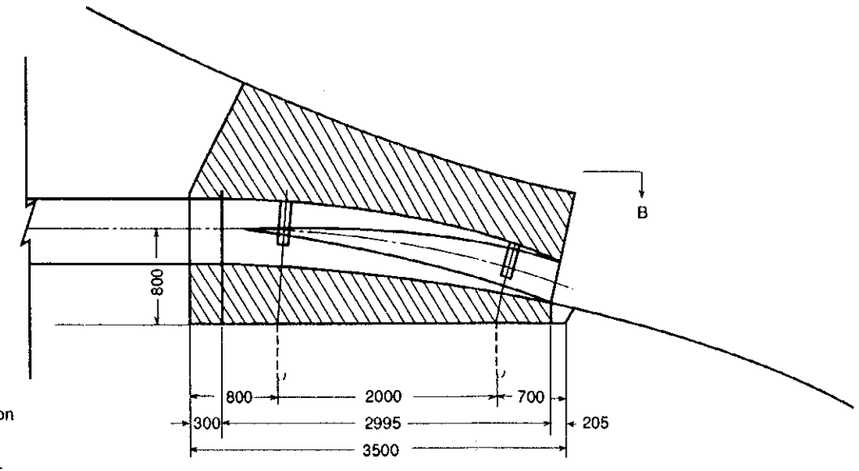
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.12 Spillway Radial Gates and Hoists Wire Rope Hangers



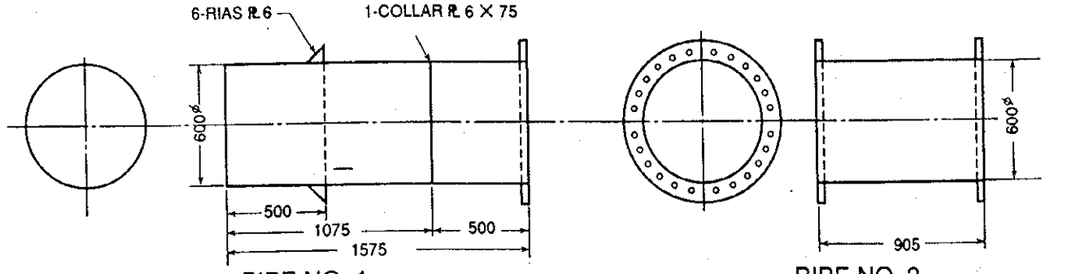


NOTES:

1. ▨ SHOWS SECONDARY CONCRETE.
2. TYPE OF FLANGE FOR IRRIGATION VALVES SHOWS IN FIGURE 5.14

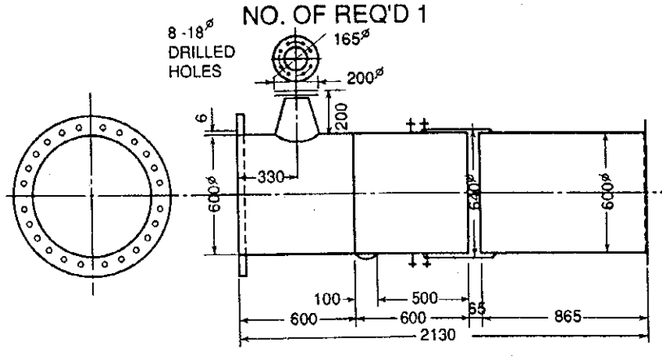


FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.13 Irrigation Outlet Facilities Outlet Valves

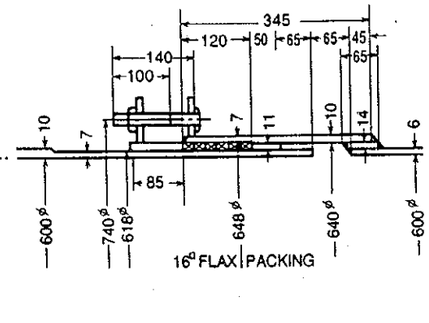


PIPE NO. 1
SS 41
NO. OF REQ'D 1

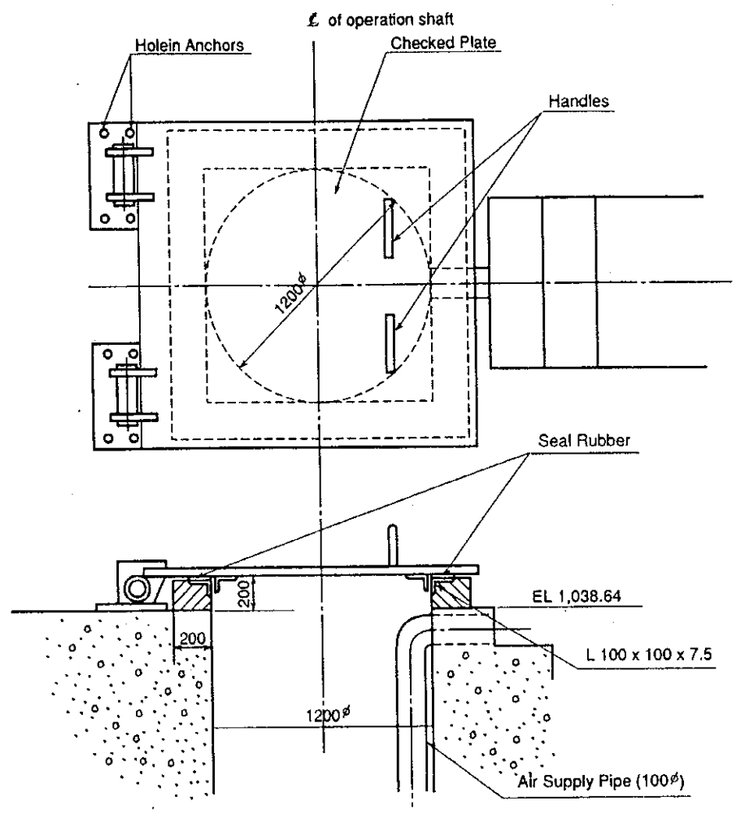
PIPE NO. 2
SS41
NO. OF REQ'D 1



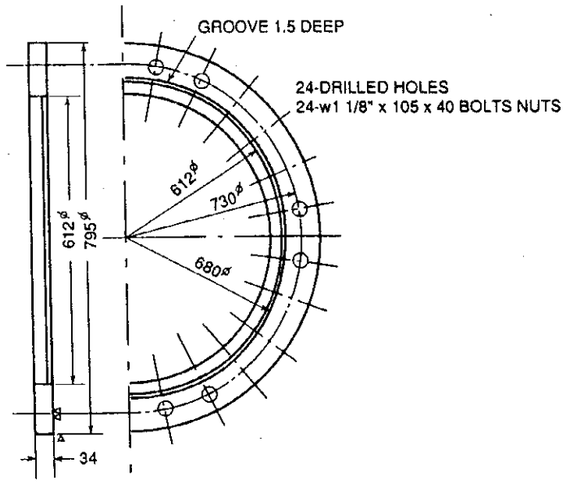
PIPE NO. 3
SS 41
NO. OF REQ'D 1



DETAIL A

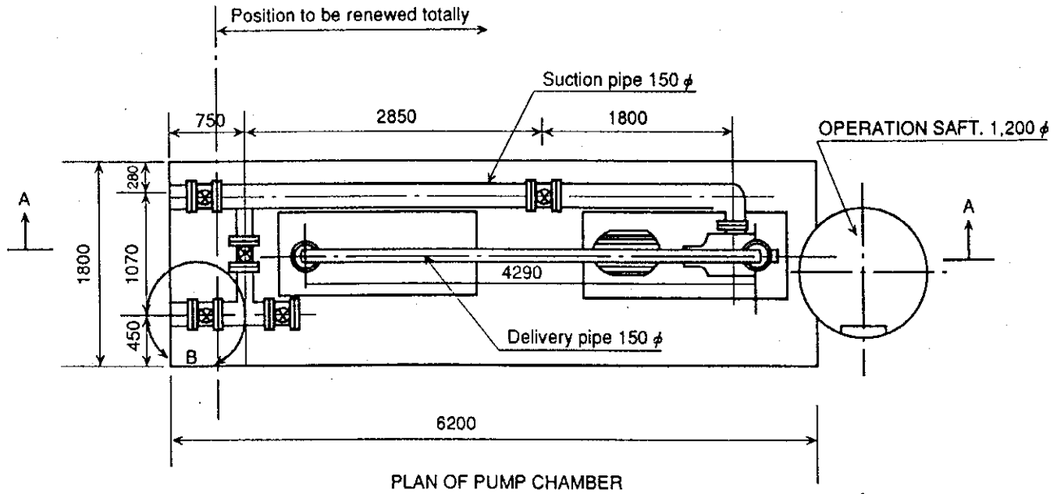


DETAIL OF MANHOLE

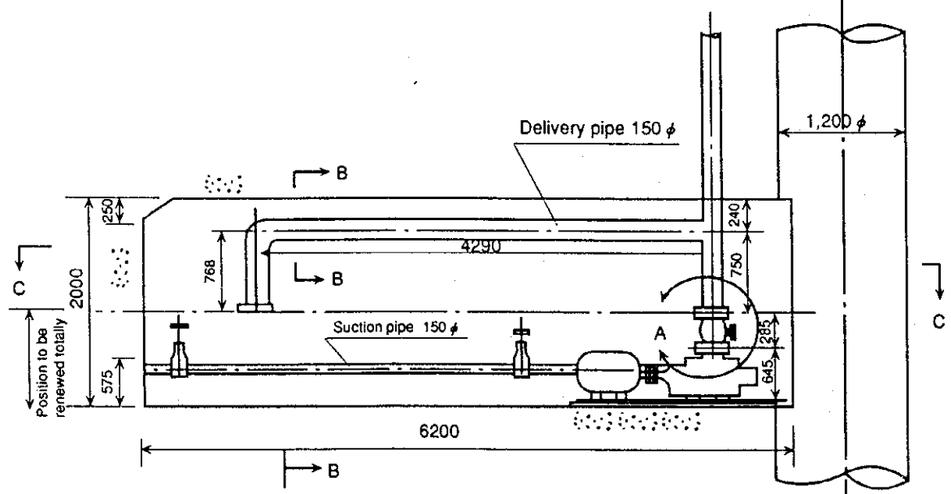


FLANGE
SS41
NO. OF REQ'D 4

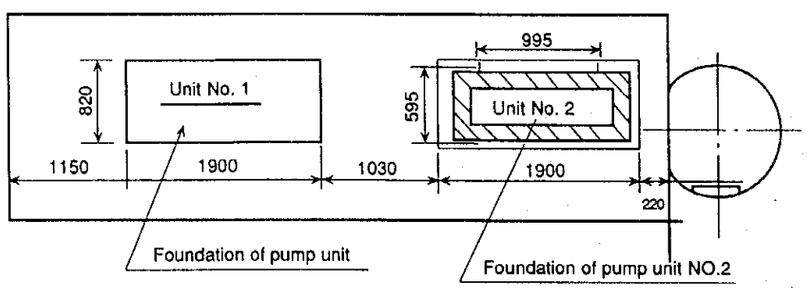
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.14 Irrigation Outlet Facilities Outlet Conduit and Manhole



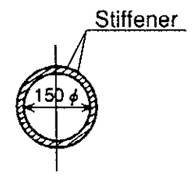
PLAN OF PUMP CHAMBER



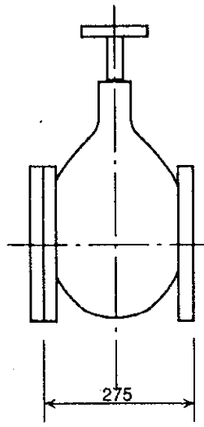
SECTION A-A

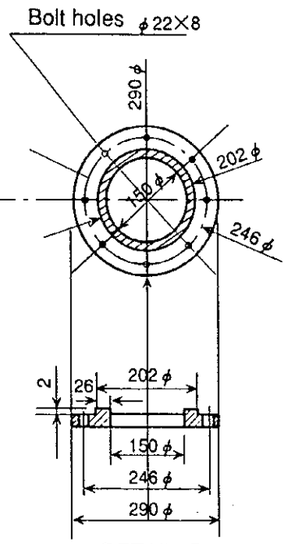


SECTION C-C

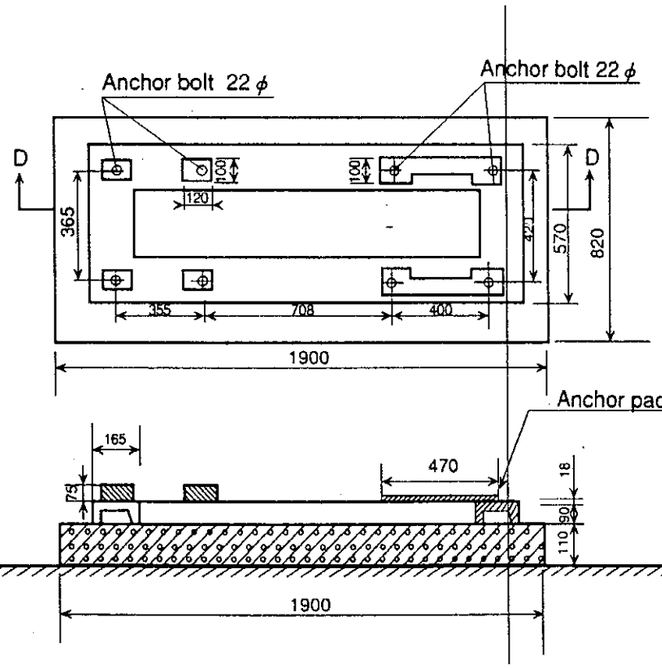


SECTION B-B



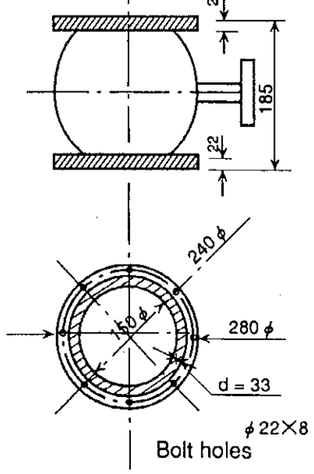


DETAIL B



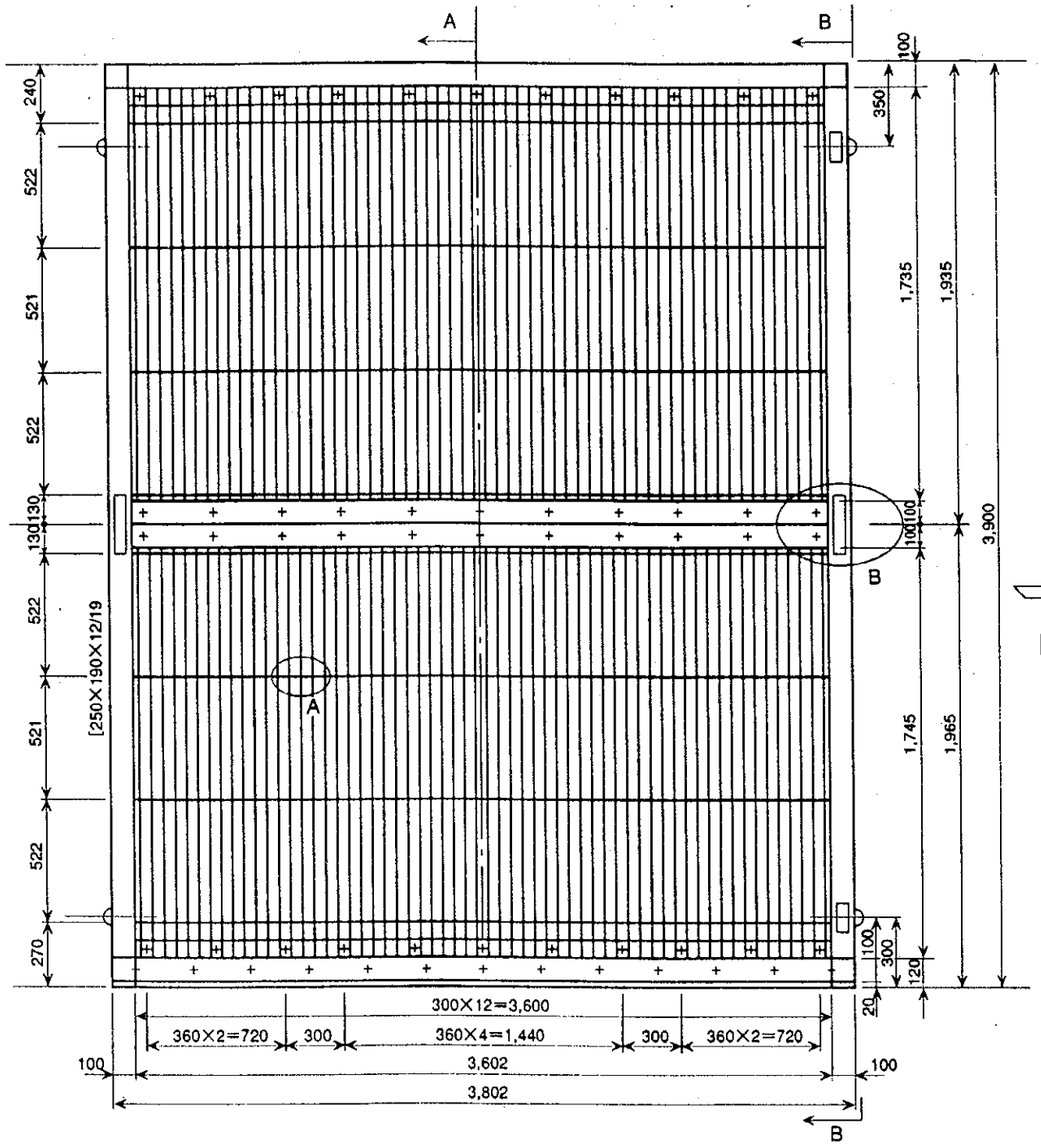
SECTION D-D

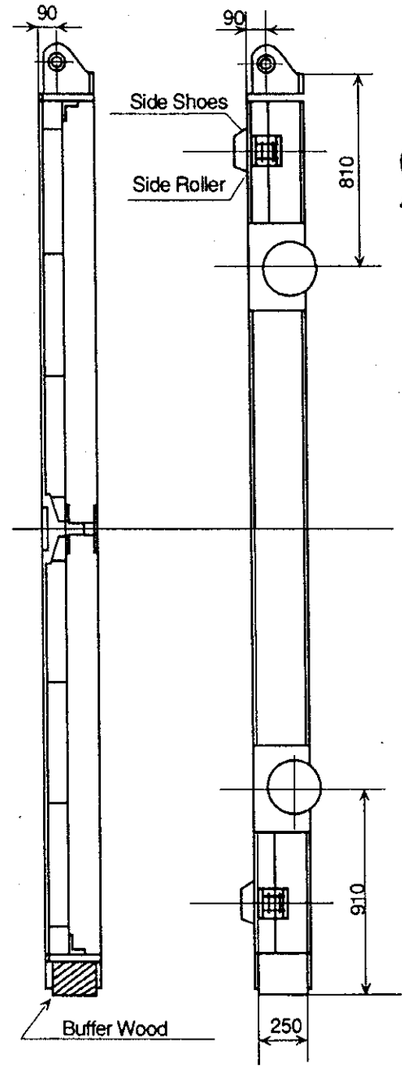
FOUNDATION OF PUMP UNIT



DETAIL A

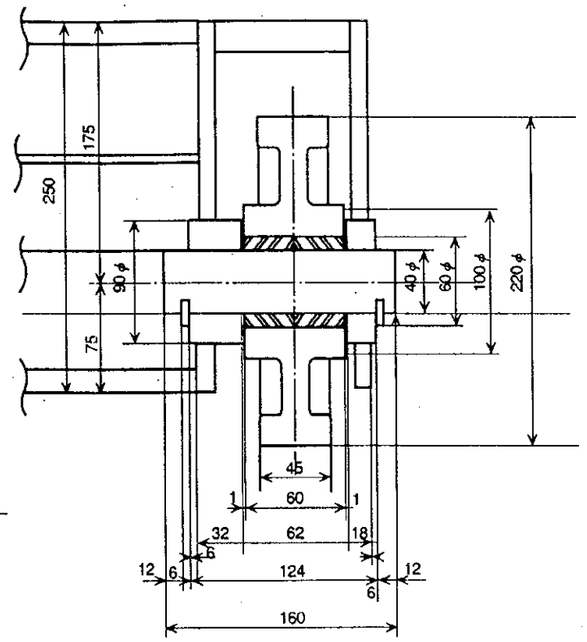
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.15 Irrigation Outlet Facilities Water Supply Pump



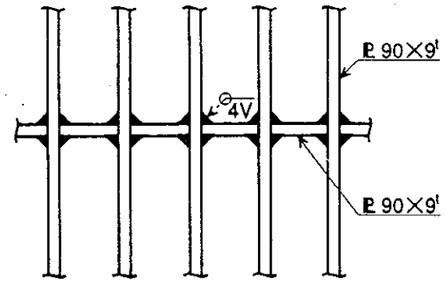


SECTION A - A

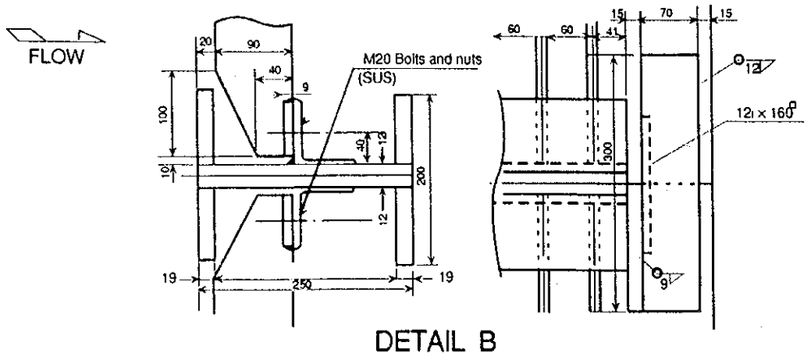
SECTION B - B



DETAIL OF ROLLER PARTS

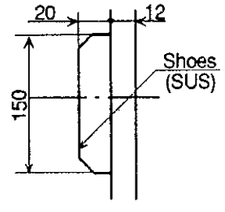


DETAIL A



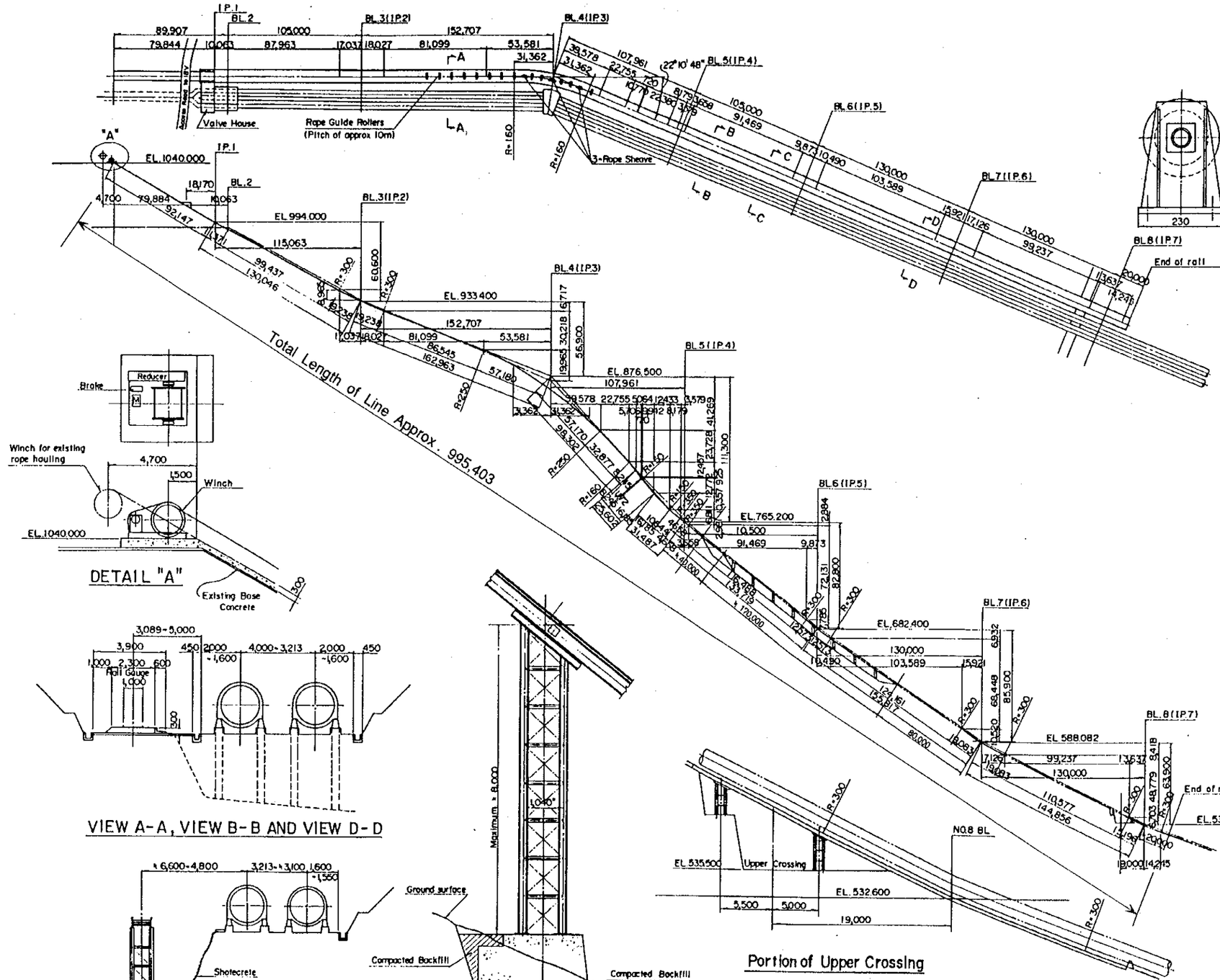
DETAIL B

NOTE : SUS : Stainless steel



DETAIL OF SHOES

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.16 Movable Trah Racks Upstream Trash Rack Panel

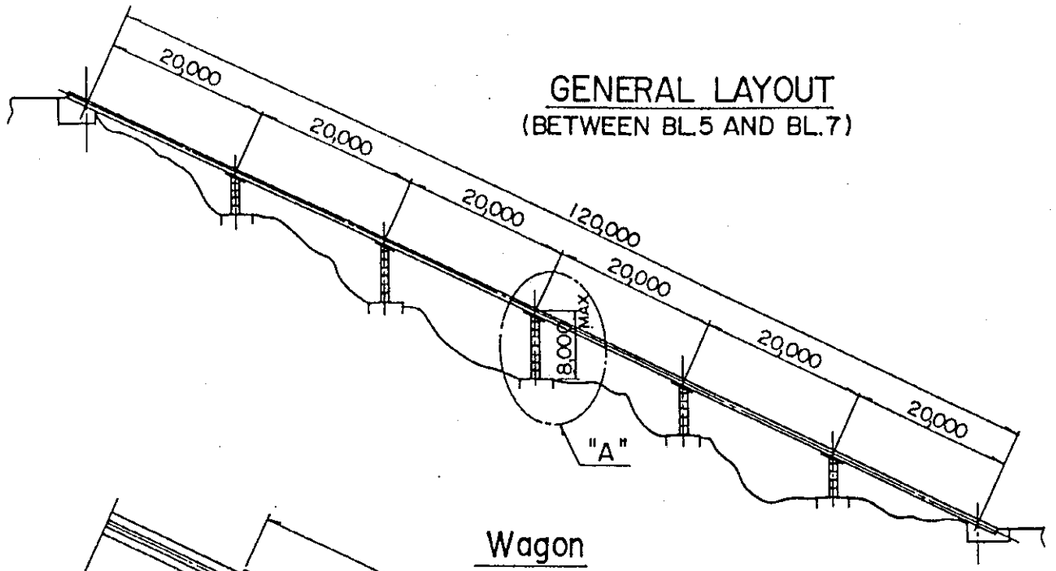


Notes :

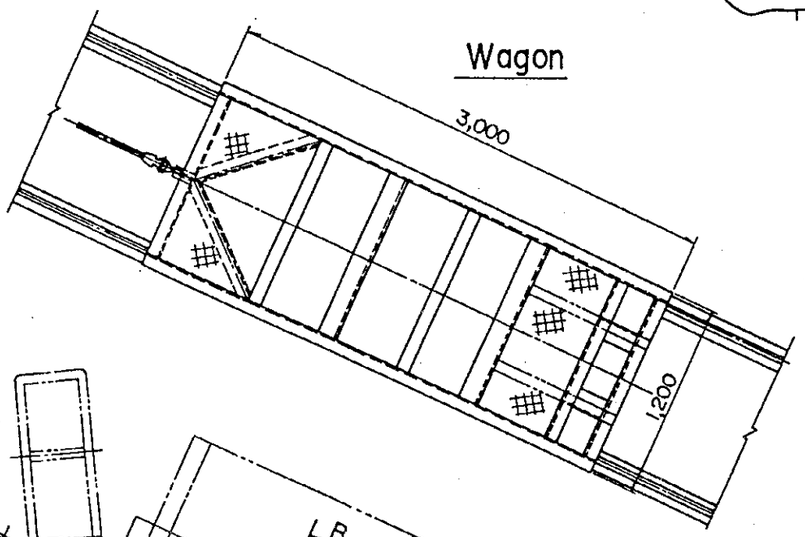
1. All the structures shall be designed on condition that the maximum loading capacity of the wagon shall be 1 ton.
2. All the dimensions indicated in the drawing will be decided finally by the detailed survey and design at the implementation stage.

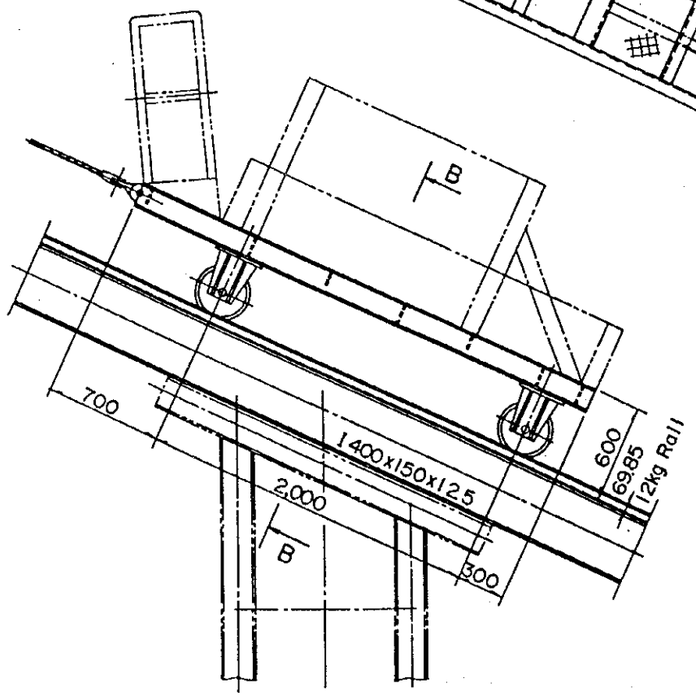
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.17 Penstock Rope Haulage (1/2)

GENERAL LAYOUT
(BETWEEN BL.5 AND BL.7)

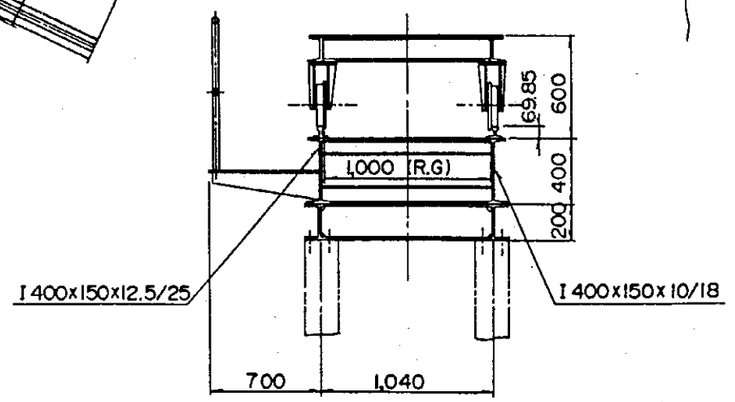


Wagon

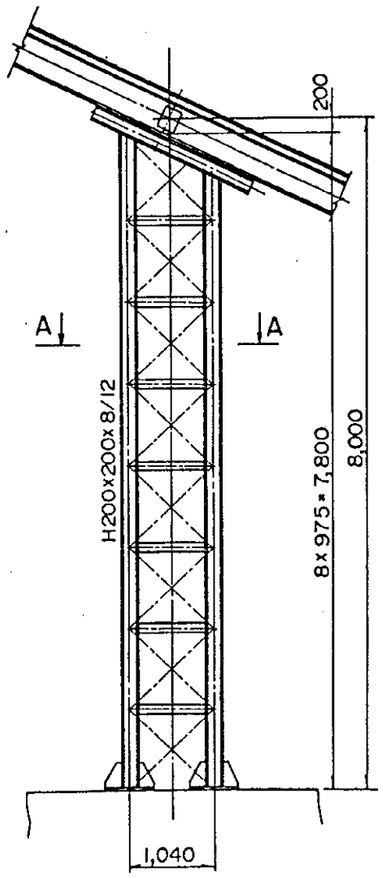




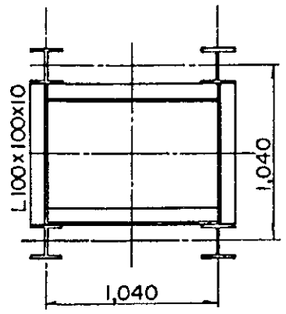
VIEW B-B



DETAIL "A"



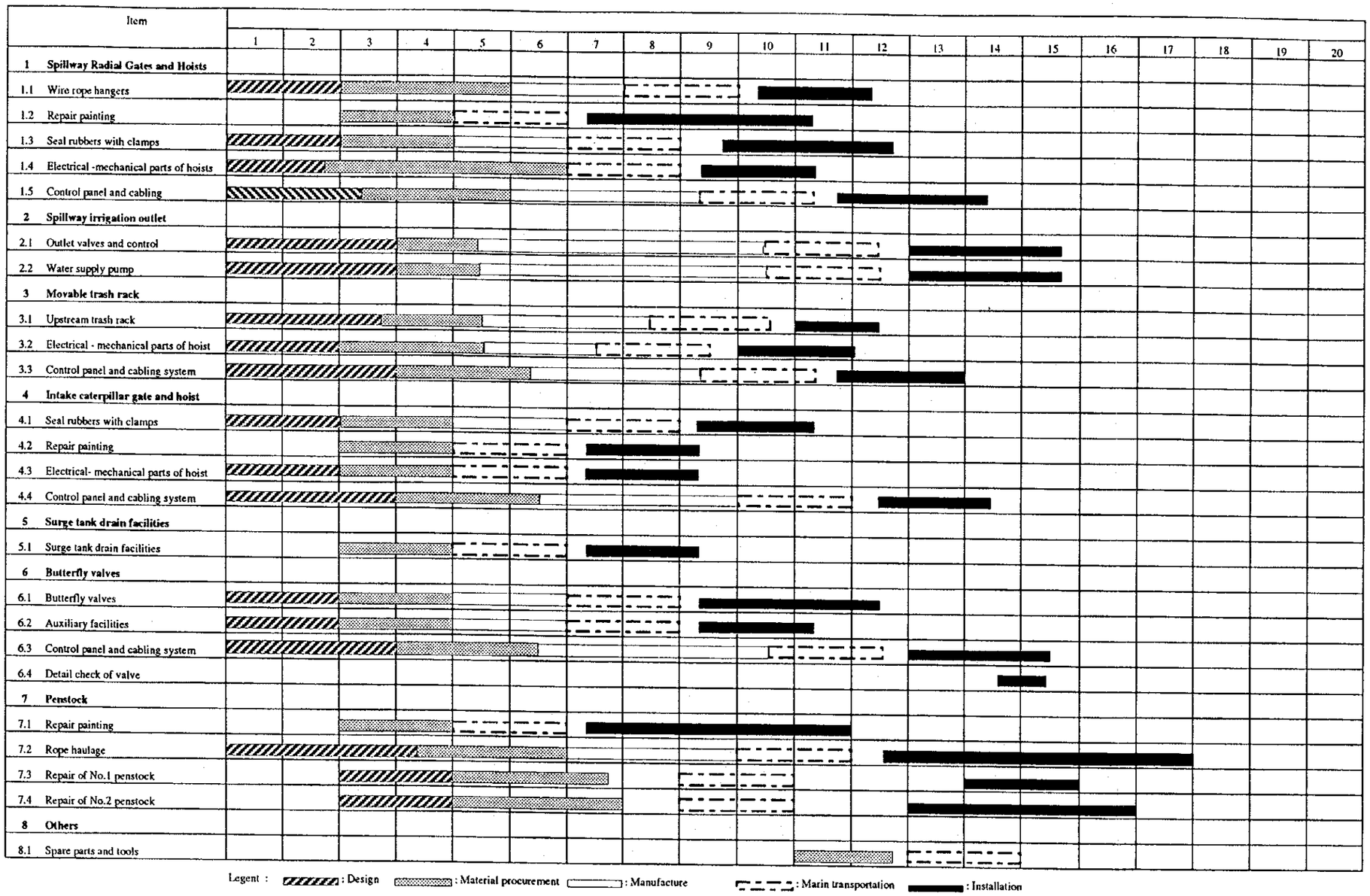
VIEW A-A



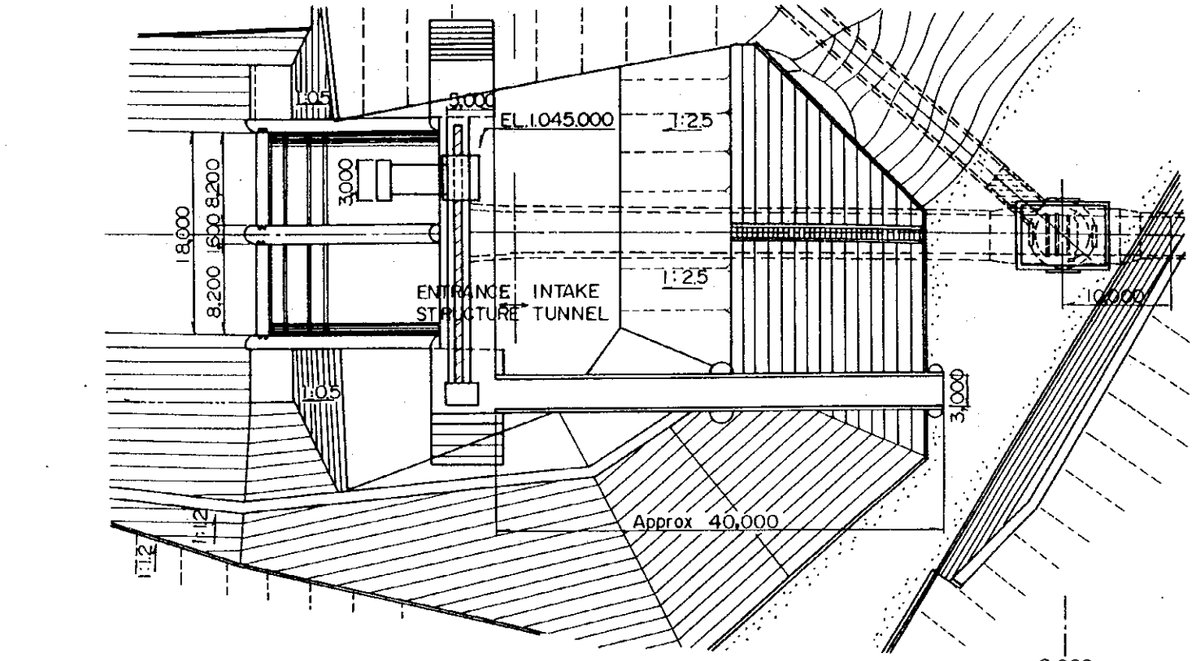
Notes :

1. All the structures shall be designed on condition that the maximum loading capacity of the wagon shall be 1 ton.
2. The parts shown as ----- shall be of removable type.
3. All the dimensions indicated in the drawing will be decided finally by the detailed survey and design at the implementation stage.

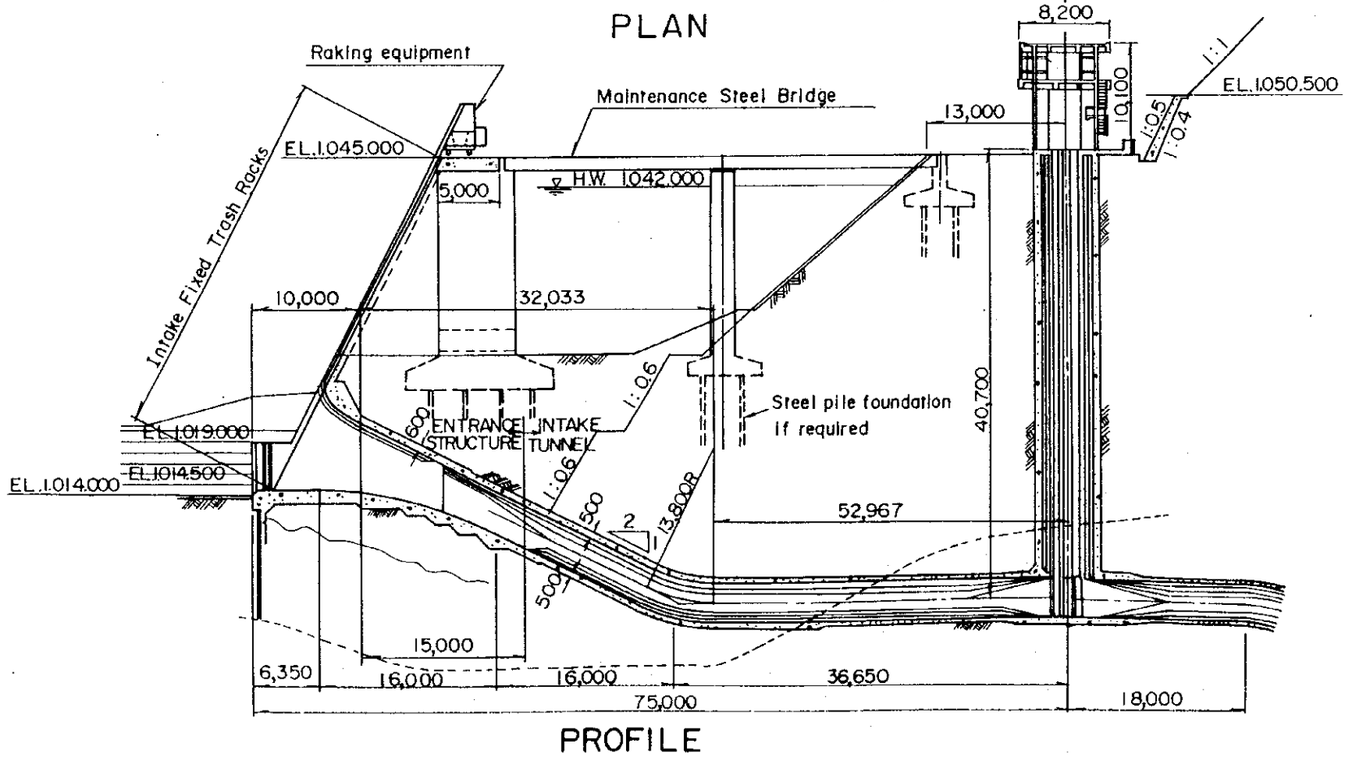
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.17 Penstock Rope Haulage (2/2)



FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.18 Implementation Schedule



PLAN



PROFILE

Note :

The bar pitch of the intake trash rack shall be changed to 60mm from 100mm.

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 5.19 Design Modification of Intake Structure

CHAPTER 6

DAM AND CIVIL STRUCTURES

CHAPTER 6 DAM AND CIVIL STRUCTURES

6.1 Approach, Results and Analysis of the Study

6.1.1 Field Investigation Works Carried out

The main features of the civil structures provided under the Da Nhim Hydroelectric Project are shown in Table 6.1. The overall alignment of those structures is given in Figure 6.1.

The field investigation for the dam and it's appurtenant structures inclusive of waterway was carried out for about one (1) month from the middle of July to the middle of August 1994 in order to clarify their present condition and to work out the necessary rehabilitation plan therefor. The investigation works carried out for the purpose comprise:

- Investigation on reservoir sedimentation ; Cross section survey of the reservoir with the echo sounder and sampling of sediment in the reservoir as well as sieving analysis thereon

- Visual inspection at field ; Civil structures such as dam, spillway, waterway (intake, penstock line, powerhouse and tailrace), except for those and their parts submerged during the field investigation

- Topographic survey ; Cross section survey of dam and leveling along dam crest at the nearby locations of spillway

- Inspection by diving in water of the reservoir ; Intake structure at the lowest portion of intake shaft where movable trash racks/intake gate are set, and in front of fixed trash rack, and approach channel of spillway and upstream toe of Dam near spillway right wall

- Collection/analysis of data and information related to civil structures ; Records on dam measuring apparatus including seepage through the dam and water surface in

dam body, and inspection records of headrace tunnel and penstock line

- Collection of data and information on the 1993 flood ; Data on the flood damages in the downstream areas of the dam site, which were caused by the flood in December 1993 (the 1993 flood)

The above field works were executed in collaboration with the counterpart personnel dispatched by the PC-2. The reservoir water level was constant at around EL. 1025 throughout the field investigation period, which is about 17 m lower than the reservoir high water level of El. 1042 m.

6.1.2 Present Condition of Sediment Deposit in the Reservoir

(1) Reservoir cross section survey

Of the field investigation works performed in the present Study, an emphasis was placed on the reservoir cross section survey conducted mainly with a set of echo sounder brought from Japan, which aimed to clarify the present condition of the sediment deposit in the reservoir. The Study Team and counterpart personnel made the best efforts to complete the field survey works within the specified period, which were hampered from time to time by the worse weather condition that a strong wind hit the small boat running along the survey line in the reservoir.

Figures 6.2 and 6.3 show the locations of the survey lines along which the cross section survey was done in the present Study. The survey results are compiled in Annex to this Chapter 6.

In 1973, the river cross section survey was performed along the upstream survey lines of the reservoir, namely D1, D2 and D3 on the Da Nhim River and at K1 and K2 on the Krong Klet River, whose locations are shown in Figure 6.2. Of these upstream survey lines where trees and grasses grow densely, the survey staff could not find the line-D1 during the field survey. Since the reservoir water level was as low as around EL. 1025 m during the field survey, unfortunately, the boat was not available so as to proceed to the survey lines on the upstream two tributaries due to the shallow water depth. Consequently, the cross section survey in the upstream

reaches was done by leveling at D1 and D2 on the Da Nhim River and at K1 and K2 on the Krong Klet River.

For the purpose of utilizing permanently the survey lines in checking the condition of the reservoir sedimentation from now on, the concrete-made base points were installed on the both banks of each survey line as shown in Figure 6.4. From now on, it is recommended to periodically monitor the change of the reservoir bottom along these survey lines applying the modernized reservoir survey system.

(2) Preliminary estimate of the reservoir storage volumes

Figure 6.5 shows the reservoir storage curve which was constructed in the design stage by means of planimetering the topographic maps made available at that time. In principle, the reservoir cross sections surveyed in the present Study should be compared with those worked out based on the original topographic maps used to construct the reservoir storage curve in the design stage in order to assess the present condition of sediment deposit in the reservoir for the following reasons:

- Although in the present survey the ground control survey for determining the coordinates of the base points was carried out with a portable global positioning system (GPS) equipment, it is associated with a certain range of error in the measurement of their coordinates.

- The number of the survey lines, especially in the upper reaches of the reservoir as seen in Figure 6.2, is insufficient for estimating the reservoir capacity at higher elevations with the same accuracy as that derived through the planimetering on the topographic maps in the design stage. In case of the circular-shaped reservoir like the Dran dam, moreover, it is possible to more accurately estimate the reservoir capacity by the planimetering rather than by calculating areas of cross sections, as long as the detailed topographic maps are available.

Unfortunately, however, the Study Team could not find a complete set of the topographic maps which were used to construct the original reservoir storage capacity curve in the design stage, which is shown in Figure 6.5, but a topographic map covering a small area between the dam site and intake is available at present. On the basis of the topographic map as well as the present and previous reservoir cross section data, a comparison is made to assess the long term change of the space corresponding to the effective storage volume as shown below:

Comparison of Sectional Areas Corresponding to the Effective Storage Volume between EL. 1042 m and EL. 1018 m

(Unit : m2)

Year	No. of Survey Line				
	No.1	K2	D2	D3	I (Intake)
1964*	32,037				56,867
1973**		3,971	1,849	2,648	
1993***			1,809		
1994	32,825	3,608		2,553	55,908
- Area decreased	-789	364	40	94	959
- Ratio of decrease (%)	-2.5	0.4	0.0	0.2	-1.7
(Period in years)	(30)	(21)	(20)	(21)	(30)

Notes

1. Location of the survey lines - No. 1, K2, D2, D3 and I are shown in Figure 6.2.
2. * ; estimated based on the topographic map available at present.
3. ** ; estimated based on the cross section survey performed in the course of preparing the Report, "Observation and Study on the Dran Dam and Reservoir of Da Nhim Hydroelectric Project, June 1973".
4. *** ; estimated based on the cross section survey conducted by the PC - 2 in 1993.
5. The data above in 1994 are estimated based on the present reservoir cross section survey.

The above comparison implies that there is little change in a space of the reservoir corresponding to the effective storage capacity, both in downstream and upstream portions of the reservoir.

In the present Study, the reservoir storage capacities left as of August 1994 were preliminarily calculated based on the results of the reservoir cross section survey as shown in Table 6.2. The calculated storage capacities were compared with those proposed originally in the design stage as summarized below:

Comparison of Reservoir Storage Capacities Planned Originally and Estimated Preliminarily Based on the Present Survey

(Unit : Million m3)

No.	Item	Planned Volume (1)	Present Volume (2)	Difference =(1)-(2)
1.	Silt sedimentation space (below EL. 1014.5 m)	2.0	1.0	1.0
2.	Dead storage capacity (below EL. 1018 m (LWL))	9.0	7.5	1.5
3.	Gross storage capacity (below EL. 1042 m (HWL))	165.0	146.3(152.3)	18.7(12.7)
4.	Effective storage capacity (between EL. 1018 m and EL 1042 m)	156.0	138.8(144.8)	17.2(11.2)

Note

The values in parentheses above show the gross and effective storage volumes in case that the calculation is made applying an additional section between the survey lines K1 and K2 on the Krong Klet River as explained in Table 6.2.

From the table above, the following points are noted in connection with the reservoir storage capacity:

i) The present silt sedimentation space below EL. 1014.5 m is derived to be about 50 % of the originally secured one (2 million m^3) in about 30 years after completion of the Dran dam in 1964. Since the silt sedimentation space constitutes a strip shape in the downstream portion of the reservoir, the estimated value is considered to be in a reliable range.

ii) Concerning the effective storage capacity, the preliminary estimate reveals that it has reduced by about 7 to 11 % from the originally planned capacity. However, the sectional areas corresponding to the effective storage capacity have not been varied to the same extent over a long term as aforesaid. Thus, it is difficult to simply compare the present effective volume with original one. Repeatedly, this is a reason why the present volume one is calculated based on the limited number of the reservoir cross sections, while the originally planned one was estimated in detail based on areas enclosed at the contour line at some intervals on topographic maps as mentioned above.

From the above examination on the reservoir storage capacity, it is considered that the reservoir sedimentation is not in the critical condition yet. On the other hand, it is advisable that the reservoir survey be carried out in the next study stage taking into account the following matters:

- To install additional survey lines other than those done in the present Study in order to enable to estimate the effective storage volume with more accuracy.

- To perform the ground control survey using the regular GPS equipment which can allow the accurate measurement of the coordinates as compared with the portable one.

- To measure the location (or coordinates) of the boat at a short interval, which is running in the reservoir for the reservoir cross section survey. For the purpose, it is advisable to use the modernized reservoir survey system, in which the location of the boat in the reservoir is automatically measured by the regular GPS equipment put in the boat.

(3) Particle size distribution of bed load materials of the reservoir

During the field investigation period, the bed load materials of the reservoir were sampled from the following locations, which are depicted in Figure 6.6:

Sample No.	Location of Sampling
1	In front of fixed trash rack of intake structure
2	In spillway channel adjacent to the right wall and toe of dam embankment
3	In spillway channel adjacent to the right wall and near the overflow crest
4	On the survey line - K2 on the Krong Klet River (upper tributary)
5	On the survey line - D3 on the Da Nhim River (upper tributary)

The sieving analysis for the sampled materials above was carried out in the laboratory of the Southern Institute of Water Resources Research (SIWRR) in Ho Chi Minh city. The results of the sieving analysis are shown in Figure 6.7 and Table 6.3, from which the following characteristics are understandable concerning the particle size of bed load materials in the reservoir:

i) The bed load materials sampled on the upper tributaries flowing into the reservoir show the rather finer particle size as compared with those sampled at the intake structure and spillway sites located on the left banks of the reservoir. Thus, the sediment materials supplied from the upper reaches into the reservoir are of the comparatively fine particles.

ii) It appears that a considerable amount of the bed loads at the spillway and intake structure sites are being supplied from the land slides which take place along the left bank of the reservoir.

6.1.3 Records of Measurement on the Dran dam

After completion of the Dran dam in 1964, the detailed investigation for checking the dam situation was performed to prepare a report titled as " Report on Observation and Study on the Dran Dam and Reservoir of Da Nhim Hydroelectric Project, June 1973". The Report states that the dam, spillway and intake structures are as a whole in satisfactory condition based on the results of the field investigation including core drilling in the dam body.

In the present Study, the condition of the Dran dam was assessed based on the latest measurement records on the dam as discussed hereinafter.

(1) Seepage through the dam

The seepage of the dam has been measured at the original 26 relief wells, sewer pipes as well as the smaller size of 14 supplemental wells constructed by the Da Nhim P/S office after completion of the Dran dam, and drain ditches collecting outflow from these wells. However, of the 14 supplemental wells, only 5 ones are working properly at present. The location of the original 26 relief wells is shown in Figure 6.8.

Figure 6.9 illustrates the relation between the reservoir water level and the total seepage through the dam which were measured between November 1980 and July 1994. As seen in the Figure, the total seepage volumes are mostly less than 80 litres/sec, excepting one record which seems to include rain water drained from the downstream area of the dam, according to the weather condition at the time of the measurement which is stated in the recording sheet provided by the Da Nhim P/S office. In addition, the total seepage volumes through the dam are wholly less than 180 litres/sec, which was estimated in the original design of the dam on the condition that the reservoir water level is eqall to the high water level (HWL : EL.

1,042 m). Thus, there seem to be no issues concerning the total seepage volume through the dam.

Figure 6.10 and Table 6.4 show the distribution of seepage volumes measured at the 26 original relief wells at the time of the reservoir water level of more than or close to the HWL, exhibiting that the considerably higher rates are observed at the relief well No. 9, No. 11 and No. 12. In particular, the seepage volume which is close to the design volume per one relief well (180 litres/26 = 6.9 litres), was measured at relief well No. 9 at time of the reservoir water level higher than the HWL (EL. 1042.0 m) by around 50 cm. On the other hand, the long-term seepage records on the relief well No. 9 and other dam measurement records reveal:

- The high leakage has taken place for more than these ten (10) years when the reservoir water level exceeds the HWL, and no abnormal phenomenon on the dam has been experienced up to date,
- No significant settlement of the dam crest around the relief well No. 9 occurred to date.
- The seepage volume becomes low as well as other relief wells when the reservoir water level becomes low.

Judging from the above facts, it appears that the higher seepage at the relief well No. 9 under the reservoir water level higher than the HWL results from concentration of seepage from the surrounding dam embankment sections because of clogging of filter zones for the nearby relief wells such as No. 8 and 10. Moreover, it is judged that the aforesaid situation has already been normalized in terms of distribution of the seepage along an axis of the Dran dam.

(2) Settlement of the dam crest

To investigate the settlement at the contact portion of dam and spillway on which the conceivable issue in relation to occurrence of muddy flow is discussed in the following Subsection 6.1.4, the cross section survey of the dam at a point of IP-63.3 as well as the leveling along the dam crest in the contact portion were carried out during the field investigation. The data on the dam crest elevations are tabulated in Table 6.5 together with those surveyed in 1972, 1992 and 1993 and the dam cross section at the point is depicted in Figure 6.11. As seen in the Table, the comparison of the dam crest elevations in 1972, 1992 and 1993 clarifies that no significant settlement of the dam body has occurred as a whole for these 20 years.

In the present topographic survey, the dam crest elevation was measured to be EL. 1045.3 m at the aforesaid point (IP-63.3) where the dam cross section survey was performed in August 1994 as shown in Figure 6.11. While, those at the neighboring locations about 2 m to 3 m distant from the point are measured at about EL. 1045.5 m, which is almost equal to the designed dam crest elevation. It is recommendable to perform, from now on, the leveling survey along the dam crest adjacent to the contact portion of dam and spillway with accuracy so as to monitor the settlement of the dam crest.

(3) Water surface in the dam body

The water levels in the dam body, which were measured in December 1992 and 1993 at the time of the reservoir water level higher than the HWL of EL. 1042 m, are shown in Figure 6.12. The higher water levels in the dam body were observed at the holes dug close to the both abutments of the dam (Section No. IP-38 and S12) where the dam is founded on the elevated original ground. At the Section No. IP-38 located close to the contact portion of dam and spillway, the original elevated ground in the left abutment constitutes a part of the dam body. Although it appears that this is not serious phenomenon, more detailed geotechnical investigation including core drilling thereat should be performed in relation to the occurrence of muddy flow in the contact place of dam and spillway, which is discussed in the succeeding Subsection 6.1.4.

6.1.4 Main Defects and Issues Identified Concerning Civil Structures

The present conditions of the civil structures, which are clarified through the field investigation, are summarized in Tables 6.6 to 6.9 by each component of the civil structures. The main defects and issues on the civil structures, which require or might require some degree of rehabilitation works sooner or later, are discussed below:

(1) Dam : Occurrence of muddy flow along spillway channel on the condition of spillout of discharge through spillway at the reservoir water level higher than the HWL

In the rainy season of 1978, as explained in Table 6.6, the muddy flow came out from drain pipes installed on concrete stair beside the downstream spillway right wall where there is a contact surface of the dam embankment and sloped concrete surface of spillway right wall. At that time, about 10 m long crack took place on surface of downstream embankment slope of dam, which ran from the spillway right wall in parallel with the dam axis and the land slide occurred in the downstream

embankment slope near the spillway right wall as shown in Figure 6.13. In addition, it was found that the upper portion of downstream cut-off concrete wall in the dam embankment was cracked. During the field investigation, it is reported that the deteriorated portion of the dam embankment had completely been repaired by the Da Nhim P/S office by means of filling the qualified soil materials with man-power after removal of the deteriorated embankment materials. Likewise, the Da Nhim P/S office undertook the rehabilitation works to strengthen the downstream cut-off wall by cement grouting.

Afterward, no such phenomenon in the dam embankment surface occurred up to date. On the other hand, it is reported by the staff of the Da Nhim P/S office that the muddy flow occurred at water edge on upstream dam slope (about 5 m distant from the spillway right wall) and flowed down along the most right portion of spillway channel especially since 1991, when the flood discharge of more than 500 m^3/sec is released downstream of dam through opening the spillway gates. The Study Team could not encounter such a phenomenon during the field investigation due to the rather low reservoir water level as aforesaid. As a result of the field investigation, it appears that this phenomenon has taken place by either Cause-A or Cause-B, which are explained below:

Cause-A : Hydraulic phenomenon caused by the current inside the reservoir on the condition of opening of the spillway gates, which wounds up the sediment deposited along the left bank side of the reservoir

At present, the permanent access road connecting the dam and intake on the left bank side of the reservoir is under rehabilitation so as to stabilize the land slope from the road surface to the reservoir surface. As a result of the inspection, it is considered that the land slides which occurred along the access road led to deposits of sediment along the left bank side of the reservoir. There is a possibility that the current inside the reservoir flows down to the left bank side to wound up the sediment upward and that the muddy flow discharges downstream along the spillway. In reality, fresh rocks are exposed over the left bank projecting into the reservoir which is located about 200 m upstream of the dam. This seems to exhibit that the reservoir current collides with the left bank, when the spillway gates are opened on the condition of the reservoir water level over the HWL.

Cause-B : Leakage and/or outflow of the dam embankment materials at the nearby location of spillway

It was confirmed through the field investigation that the 20 cm thick slab concrete on the upstream embankment slope adjacent to the spillway right wall is stable as a whole without any large-scale depressed portions. In addition, the inspection of the embankment portion after removal of the slab concrete, which was conducted by the Da Nhim P/S staff in the past, also revealed that there was no deterioration on the surface portion of the dam embankment. Thus, it seems that the possibility this has caused the muddy flow is relatively low as a result of the visual inspection. However, there is a very little possibility that the water passage route is formed in the dam body or the foundation in the contact portion of dam and spillway as long as the issues that took place in the contact portion show.

To clarify the cause of occurrence of the muddy flow, the additional study including the hydraulic and geotechnical investigations are required to be performed in the subsequent detailed design stage for the rehabilitation works proposed under the present Study, or in a separate study as discussed in the succeeding Section 6.5. On the basis of the results of the aforesaid additional investigation, the necessity of the rehabilitation works, as well as the degree thereof, should finally be determined.

On the other hand, it has to be noted that the geotechnical investigations including core drilling for investigating the situation of dam embankment materials in the contact portion must not be performed during the high reservoir water level so as not to cause any unexpected defects on the dam embankment. Thus, it is strongly advisable that the core drilling be performed by skilled boring experts under the supervision of senior geologist and dam engineer.

(2) Spillway : River bank erosion in the downstream portion of spillway

The present condition of spillway is summarized in Table 6.7. The main issues on the spillway are identified through the visual inspection as well as hearing to the Da Nhim P/S staff as follows:

i) Occurrence of cracks in concrete of overflow weir
ii) Clogging of drain holes in the valve chamber of irrigation outlet provided inside the spillway pier (The irrigation outlet facilities are proposed to be

repaired under the urgent rehabilitation plan, although the valve Chamber is now completely submerged due to intrusion of rain water).

iii) River bank erosion in the downstream portion of spillway

Concerning iii) above, the riprap rocks provided behind the most downstream part of spillway walls are missing due to the past large-scale spill-out discharge from spillway, being aggravated severely by the 1993 flood with the maximum peak discharge of about 1,600 m^3/sec. Besides, the river bank erosion was seen on the both abutments just downstream of spillway. In particular, it appears that land slide occurred along the land slope of the left bank. It is considered that the river bed in the downstream reach of spillway has been raised up as a result of these bank erosion and land slides.

(3) Waterway - Intake structure : Partial loss of concrete in guide frame of movable trash racks and cracks in concrete of partition wall in intake shaft

As a result of inspection of the inside portion of intake structure by diving during the field investigation, the following defects in concrete of intake structure were found out:

i) Partial loss of concrete inside of guide frames for movable trash racks, and
ii) Occurrence of cracks in concrete of partition wall in intake shaft
iii) Land slides in the downstream and upstream banks of inlet channel

Concerning iii) above, as described in Table 6.8, the sediment of above 250 m^3 which was deposited above EL. 1018 m was removed by man-power in 1992. The river cross sections along a centerline of the river channel, which were surveyed in 1992, are illustrated in Figure 6.14. Figure 6.15 shows the approximate locations where the land slide occurs in the upstream and downstream banks of intake.

(4) Waterway - Headrace tunnel : High water leakage from the surrounding rock zones of tunnel under the dewatered condition

Figure 6.16 shows the results of inspection on the headrace tunnel, which was conducted by the Da Nhim P/S staff in March 1992. As seen in the Figure, there are two major portions where a notably high water leakage in the headrace tunnel took

place under the dewatered condition therein. These locations in headrace tunnel are listed below:

i) About 330 m long section between approximately 1,050 m and 1,380 m downward of the intake gate where the decomposed granite zone lies, and
ii) About 140 m long section between approximately 640 m and 780 m upward of the surge tank.

On the other hand, no issues on the headrace tunnel were reported in terms of the practical power generation. From the practical viewpoint, hence, these high leakage portions of headrace tunnel would not require the urgent rehabilitation works, since no adverse phenomenon take place in the surrounding mountainous areas along the route of headrace tunnel and its neighboring civil structures and it is foreseen that the present condition would not interrupt the ordinary power generation for some time.

(5) Waterway - Penstock line : Drainage of rain water and erosion of foundation in the steep-sloped portion

During the field investigation, the Study Team inspected visually the penstock line and collected the inspection records from the Da Nhim P/S office. As a result, no major problems on the civil structures related to the penstock line were found out except for the steepest portion from Anchor Block No. 3 to Anchor Block No. 7.

Of about 2,200 m long surface-type penstock line, the upper portion of about 620 m in length between Anchor Block No. 3 and No. 8 has slopes of 22 to 45 degrees to a horizontal line. The steep-sloped portion of penstock line was destroyed two times up to date. The major problems identified through the field investigation are as follows:

i) There is a portion between Anchor Block No. 5 and No. 6 that the concrete slab under the penstock pipe is missing. This would affect adversely the penstock line in terms of the stability of the civil structures including saddle piers.

ii) According to the information from the Da Nhim P/S office, the steep-sloped portion requires the regular rehabilitation works for its foundation every year, which is eroded by rapid water flow flushing down along the depressed section in the rainy season. In addition, the side slope at and around Anchor Block No. 4 is not stable, being covered by unstable rocks and stones.

It is recommended that the works for improving the present drainage system along the penstock line be provided in the framework of the urgent rehabilitation works.

Concerning the valve house, it is proposed that louvers are to be provided on the existing concrete walls so as to facilitate the supply of air required for operation of air valve installed inside the air valve.

(6) Waterway - Powerhouse : Repair of cracked concrete walls of powerhouse

It was confirmed through the visual inspection that a lot of hair and deep cracks were found to take place in the downstream side wall of powerhouse. Although it seems that these cracks have been gradually enlarged due to the large vibration of the existing generating units, there were very less cracks in the upstream side wall as compared with those in the downstream one. Moreover, no cracks were found on concrete piers and beams of the powerhouse. Judging from the present situation, therefore, there seems to be no possibility that these cracks will soon lead to the significant defects of powerhouse. However, the rehabilitation works which comprise V-cut of the cracked portions and filling of mortal and plastic materials therein should be performed in parallel with the rehabilitation works of the generating equipment. Thus, it is determined that the rehabilitation works of the cracked concrete walls of be executed within the framework of the urgent rehabilitation works.

6.1.5 Necessity of Flood Mitigation Measures and FFWS

The 1993 flood with a peak discharge of about 1,600 m3/sec caused large-scale flood damages to private houses, cultivated lands, infra-structures such as school, governmental office, transmission line, factory, and road bridges in the downstream area as summarized in Table 6.10. Of the seven (7) bridges destroyed by the 1993 flood, the farest one was located about 25 km downstream of the Dran dam. The total amount of the flood damage is officially reported to be US$ 1.2 millions, while it is estimated by the office of the Communist Party of the Don Duong Province at about US$ 3.7 millions.

According to the Design Report on the Da Nhim Hydroelectric Project which was prepared by Nippon Koei Co., Ltd. in March 1962, it rained 307 mm at Dalat on May 4, 1932 so that the flood of 2,500 m^3/sec was observed at the Dran dam site on the date. As far as the hydrological data observed so far are concerned, the flood is ranked as the historical maximum one at the Dran dam site. The report states that about 100 houses

were washed away by the 1932 flood, 150 persons being lost. It is envisaged that the downstream area of the dam site was sparsely settled with lesser land uses in comparison with the present condition. In reality, the population of the Dong Duong Province has increased from about 40 thousand in 1980 to about 66 thousand in 1993 at an annual increase rate of 3.9 %. Hence, it would be natural to conceive that the larger flood damages would occur in the downstream reach, in the event of the same scale flood as the 1932 flood. Moreover, it is forecast that the downstream areas would suffer from the tremendous flood damages, provided that the design flood of 4,500 m^3/sec or critical flood of 5,500 m^3/sec shown in Table 6.1 would occur in the upper catchment.

To avoid the occurrence of the large-scale flood damages in the downstream areas in future, the following actions are recommended to be taken soon:

i) Establishment and implementation of comprehensive flood mitigation plan for the downstream reach, which comprises the enlargement of flow area by dredging and excavation of river channel and banks, construction of flood dikes and new bridges, etc., and

ii) Establishment of the flood forecasting and warning system (FFWS) for the downstream areas of the dam in order to enable the optimum operation of spillway gates for the unusual flood in the upper basin as well as to timely evacuate the people living in the downstream flooding areas (The FFWS is discussed in more detail in the succeeding Chapter 5).

6.1.6 Necessity of Basin Conservation Program

The reservoir cross section survey conducted during the field investigation revealed that the sediment deposited in the reservoir is not in the critical condition yet. On the other hand, it is reported that recently there are activities in the upstream reaches of the dam site, which include mining and development of new cultivated areas on sloped mountainous areas by burning out the forest. If the development of the upstream areas will be continued from now on, the sediment transport into the reservoir will be accelerated in near future. Therefore, some range of countermeasures are required to be planned to conserve the catchment in order maintain the function of the reservoir in relation to the sediment deposit therein.

6.2 Overall Rehabilitation Plan for Civil Structures

As discussed in the foregoing Section 6.1, some degree of rehabilitation works are required to be executed for each component of the civil structures, although the necessity of urgent rehabilitation differs from structure by structure. Concerning the occurrence of muddy flow in the reservoir when the comparatively large discharge is spilled out through opening the spillway gates, it is considered that the detailed field investigations to clarify the cause are required to be performed before commencement of the rehabilitation works. Besides, the flood control plan as well as the FFWS for the downstream areas of dam need to be established to mitigate the flood damages in the downstream towns and communities in the event of a large-scale flood. Likewise, the further study on the basin conservation of the catchment should be carried out at an earlier stage in order to avoid augmentation of the sediment transport into the reservoir.

Taking into the aforesaid aspects, the rehabilitation plan for the civil works are classified into the following three types taking into account their natures:

i) Urgent rehabilitation plan proposed under the prsent Study
ii) Long term rehabilitation plan proposed under the present Study
iii) Rehabilitation plan which requires the additional basic study and field investigations in order to determine the necessity of the further rehabilitation works as well as the scope thereof, which are expected to be carried out in the stage of the subsequent detailed design after completion of the present Study, or in a separate study

6.3 Urgent Rehabilitation Plan

6.3.1 General

The urgent rehabilitation works include the civil works which require the urgent rehabilitation due to severe deterioration and defects in all or some part of the existing civil structures, or those which should be rehabilitated together with the rehabilitation of the generating equipment and metal works although they deem not require the urgent rehabilitation for the time being. These include:

(1) Spillway
- V-cut and filling mortal in cracked portion of overflow weir
- Provision of drain holes for valve chamber of irrigation outlet by core drilling

(2) Intake structure
- Concrete placement in the deteriorated portions of guide frame for movable trash racks
- V-cut and filling of mortal in cracked portions of partition wall of intake shaft

(3) Penstock line
- Compacted backfill with sand and gravel materials as well as placement of concrete slab in the section between Anchor Block No. 5 and No. 6,
- Check boring in the foundation between Anchor Block No. 2 and upper crossing point, and grouting with low pressure in the deteriorated foundation portion if any,
- Construction of new drainage channel to mitigate the drainage congestion in the section between Anchor Block No. 2 and upper crossing point
- Slope protection works between Anchor Block No. 3 and upper crossing
- Provision of louvers in concrete walls of valve house after revoval of existing windows

(4) Powerhouse
- V-cut and filling of mortal and/or other plastic materials in cracked portions of downstream wall and other cracked concrete portions

6.3.2 Basic Design of Urgent Rehabilitation Plan

The quantities of the proposed urgent rehabilitation works for the civil structures are summarized in Table 6.11.

(1) Urgent rehabilitation works for spillway

The repair works for the cracked portion of the overflow weir concrete need to be carried out during the dry season when the reservoir water level becomes considerably lower than the crest level of EL. 1029.20 m taking into account the necessary period for curing.

Concerning the drain holes for valve chamber of irrigation outlet, two holes are planned to be drilled from the surface of slab concrete of the shuteway as shown in Figure 6.17.

(2) Urgent rehabilitation works for concrete in guide frame portion for movable trash racks and cracks of concrete in partition wall of intake shaft

Concerning the repair of the guide frame portion, the following two (2) construction methods are applicable:

Method-1 : Chipping and concrete placement in the deteriorated portion after making the working area dry for the necessary period by setting the stoplogs in front of the fixed trash racks

Method-2 : Welding a steel plate to cover the deteoriated portion, and filling of mortal therein on the under-water condition

The above two construction methods are explained hereunder. On the other hand, the repair works for the cracked concrete of partition wall need the dry condition therein.

a. Method-1: Concrete placement under the dry condition

Since the repair works need to be carried on in the very confined small area at the bottom of intake shaft, it is most important to ensure the safety during execution of the repair works. Therefore, it is essential to make the working area dry by installing two sets of stop logs in front of fixed trash racks, after the reservoir water level be lowered to less than the low water level (LWL) of El. 1018 m. The top elevation of the stoplog slots are set at EL. 1019 m.

The time required for the repair works of the guide frame portion is estimated to be about 10 days at least as broken down below:

-	Chipping/anchoring	: 1 day
-	Form work	: 1 day
-	Placement of concrete (with high-	
-	early strength cement)	: 1 day
-	Curing	: 5 days
-	Removal of forms	: 1 day
-	Others	: 1 day
	Total	10 days

It is considered that it would be necessary to keep the reservoir water level less than EL. 1,019 m for about two (2) weeks taking into account some allowance for the

work period. On the other hand, the irrigation outlet facility provided in one of the spillway piers is a sole one which is capable of draining out the reservoir water after the stoplogs are set, but it has not worked at all at over these 20 years because of submergence of the valve house in the spillway pier. There are two inlets of the irrigation outlets, of which a center of the lower inlet portion is set at EL. 1,019 m. Hence, it is not possible to sufficiently discharge downstream the inflow into the reservoir on the condition of closure of the stoplogs due to the small drainage capacity, even though the repair works are executed in the driest period after the complete rehabilitation of the irrigation outlet facilities.

From the above, the repair works will have to be conducted during the driest period when the inflow discharge becomes the smallest. As seen in the records of long term mean monthly inflow into the reservoir which are shown in Table 6.12, the inflow discharge usually becomes minimum in March and April throughout a year and in some years the mean monthly inflow in these months comes less than 5 m^3/sec. Generally speaking, therefore, the repair works should be commenced in the end of March. Assuming that the repair works are continued on the condition of the mean inflow discharge of 5 m^3/sec after the reservoir water level be lowered to EL. 1016.5 m, the time the reservoir water level rises to the top elevation of stoplog slot (EL. 1019 m) is calculated by the following equation:

$$T=V/(5.0 \times 24 \times 3600)$$

Where, T : Time in days, that can be secured for the repair works
V : Reservoir storage volume between EL. 1016.5 m and EL. 1019 m

From the reservoir storage capacity curve shown in Figure 6.15, the value of "V" above is obtained to be about 6.5 million m^3 so that the time available for the repair works ("T") comes to 15 days. This reveals that the repair works can be conducted during such a dry period when the inflow discharge is less than 5 m^3/sec. Judging from the long-term inflow records, in general, the inflow discharges of less than 5 m^3/sec in the month March and April take place on the condition that the mean inflows in December of the previous year and January at the next month were less than 20 and 10 m^3/sec, respectively. Thus, it would be necessary to monitor the inflow discharge to determine whether the repair works should be conducted in the coming dry period. If the severe flooding took place in December of the previous year, it is hopeless to conduct the repair works in March and April of the next year. In this case, the repair works should be postponed to the successive year's dry period when the aforesaid hydrologic condition is likely to take place.

In order to conduct the repair works, the following preparatory works will be required to be carried out:

- To make concrete beams and place them on top of the existing concrete walls of the inlet portion as shown in Figure 6.18, taking into account the reduction of reservoir storage capacity below EL. 1019 m which results from the sediment deposit as explained in the foregoing Subsection 6.1.2,
- To make two sets of stoplogs with a height of 5.3 m, which can stop intrusion of the reservoir water up to an elevation of EL. 1019.3 m in front of inlet portion of intake structure,
- To repair the stair in the intake shaft and install the construction equipment inside the bottom portion of the intake shaft, and
- To keep open the irrigation outlet valve installed in a pier of spillway in order to flow down some of the natural inflow into the reservoir, if it is repaired before the commencement of the repair works.

b. Method-2: Placement of under-water concrete

In case of the alternative method, most of the repair works will be executed by the skilled divers under the water. Figure 6.19 shows the proposed rehabilitation works, which are going to be done in the following sequences:

- Welding of three steel plates to cover the deteriorated portion
- Carrying mortal put in bags, and filling it in the portion

(3) Urgent rehabilitation works for penstock line

The proposed rehabilitation works for the penstock line comprise mainly placement of slab concrete under penstock in the section between Anchor Block No. 5 and No. 6, and provision of new drainage channel along the penstock line in order to improve the drainage congestion above the upper crossing of penstock line and access road. The typical sections of the slab concrete and new drainage channel are illustrated in Figure 6.20.

The louvers to be newly installed in the concrete walls of the valve house instead of existing windows are depicted in Figure 6.21.

(4) Urgent rehabilitation works for powerhouse

All the cracks in concrete of walls in the powerhouse are proposed to be repaired through the V-cut of the cracked portions and filling with mortar and/or plastic materials to be brought from Japan.

6.4 Long-Term Rehabilitation Plan

The long-term rehabilitation plan for the civil works comprises the following works:

(1) Spillway : - Slope protection works of the river banks downstream of spillway

(2) Intake : - Slope protection works for land slopes upstream and downstream of the intake structure
- Construction of coffer dam in front of the fixed trash racks in order to enlarge the silt sedimentation space of the reservoir as shown in Figure 6.22, which will require the under-water construction work for placement of concrete by means of providing cable crane crossing the inlet channel

(3) Headrace tunnel : - Repair of the water leakage portion by grouting/shotcrete, especially the two (2) major water leakage portions inspected by the Da Nhim P/S Office as discussed in the foregoing Subsection 6.1.4

6.5 Additional Study on Rehabilitation of Civil Structures and Flood Control Plan

It is recommended that the detailed study which covers a broad range of scope of works is to be carried out in a separate study at the earliest stage after the completion of the present Study, or in the course of the detailed design of the rehabilitation works proposed under the present Study. It is expected that the additional rehabilitation plan on the civil structures will be formulated through the additional study.

The future study will also include the field investigations required to verify the necessity of the regular rehabilitation works for the contact portion dam and spillway. The subsequent study will comprise the following:

(1) Field Investigations and analyses to clarify the cause of occurrence of muddy flow in the reservoir during release of a large-scale flood discharge from spillway, and preparation of rehabilitation plan if any defects are found out in the dam body

1.a Field investigations and hydraulic study to clarify the hydraulic phenomenon in the reservoir, which include;

- Observation of the hydraulic phenomenon at field and confirmation of flow direction of the reservoir water when the spillway gates are opened (usually, the large-scale floods requiring opening the gates take place in November to December),
- Sampling of sediment materials contained in the muddy flow and laboratory tests of those sediment materials with respect their engineering properties such as dry density, particle size, etc., and
- Hydraulic model test utilizing a man-made model of the reservoir, which is to be scaled down in proportion to the actual one, if required.

1.b Geotechnical investigation at the contact portion of dam and spillway right wall

- Drilling of four (4) boreholes with standard penetration test (SPT) in dam body and original ground left unremoved at a time of construction of dam foundation, and installation of piezometer in each of the boreholes to observe the pore water pressure
- Laboratory tests of soil materials sampled from the boreholes with respect their engineering properties such as dry density, particle size, etc., and comparison of those embankment materials and the aforesaid sediment materials concerning the engineering properties, and
- Preparation of urgent rehabilitation plan if any defects are found out in the dam body at the contact portion

(2) Study on conservation of the upper Da Nhim river basin of the Dran dam

2.a Reservoir cross section survey applying the modernized reservoir survey system explained in the foregoing Subsection 6.1.2

2.b Clarification of the present land use in the upper Da Nhim river basin, placing an emphasis mainly on the areas of shifting cultivation, through interpretation of available satellite imageries as well as air reconnaissance using a helicopter

2.c Establishment of the long-term basin conservation program in consideration of the present condition therein

(3) Feasibility study on the flood mitigation in the downstream area of the Dran dam site;

3.a Meteo-hydrological investigation for estimating the probable floods for the downstream reach, including the estimate of the probable maximum flood (PMF) at the Dran dam site

3.b Topographic survey

- River cross section survey for about 30 km long reach downstream of the Dran dam site
- Aero-photo mapping for the purpose of producing topographic maps at a scale of 1: 5,000 for downstream area of about 100 km^2, which covers the Dong Duong town area

3.c Hydraulic analysis for estimating a carrying capacity of the downstream reach based on the river cross sections surveyed and clarifying the inundation areas in the event of the respective probable floods under the present condition

3.d Flood damage survey along the downstream reach, especially placing the importance on collection of the detailed data on flood damages to infra-structures, cultivated lands, other properties, etc. by the 1993 flood

3.e Socio-economic and environmental survey, which comprise collection of the related data and the assessment based thereon in terms of the socio-economic and environmental conditions in the study area

3.f Supplemental study on installation of the regular flood forecasting and warning system (FFWS)

3.g Geotechnical investigation including core drilling and laboratory tests of soil materials at the proposed and/or relocated structure sites in order to obtain the geological data on the foundation of those structures and the soil mechanical properties on the embankment mterials, which are required for the desigh of those structures.

3.h Preliminary design of flood control facilities and their related ones such as flood dike, regulator, culvert, bridge, etc.

3.i Preparation of flood control plan inclusive of both structural and non-structural measures (i.e. FFWS) for the downstream area of the Dran dam site. The structural measures be set up by combining such measures as widening of the river and dredging of the river bed, provision of flood dikes, etc.

3.j Economic analysis on the flood control plan

6.6 Recommendation of Operation and Maintenance of Civil Structures

With regard to the civil structures, the Da Nhim P/S office have made the best efforts to operate and maintain them in the proper condition up to date. Therefore, it is hoped that the periodical inspection and measurement is to be continued from now on.

On the other hand, it is recommended that the following matters are kept in mind in relation to the operation and maintenance of the existing civil structures:

(1) Operation of spillway gates

The reservoir water should not be raised up intentionally over the normal high water level (EL. 1042 m) at the rising time of flood, unless the regular flood forecasting system to properly operate the spillway gates are introduced. For the time being, it is recommended that the discharge equivalent to the inflow should always be released downstream through spillway during the flood in order to avoid instantaneous augmentation of spill-out discharge to the downstream reach.

(2) Opportunity of repair of intake structure

In case the repair works are conducted on the dry condition, it would difficult to repair the defected concrete portions in the intake structure, unless the reservoir water level will become less than EL. 1016.5 m under the condition of small inflow therein during the period of the rehabilitation works. In case there is no chance for repairing them during the proposed rehabilitation period due to the unfavorable hydrologic conditions, it is hoped that the rehabilitation works are to be completed in the subsequent dry period when the reservoir area be blessed with the favorable conditions.

Otherwise, the reapir works may be conducted on the under-water condition in accordance with the Method-2 mentioned in the foregoing Subsection 6.3.2.

(3) Monitoring of settlement of dam crest in the contract portion of dam and spillway

It is essential to perform periodically the levelling survey along the dam crest between the spillway right wall and IP to monitor the settlement in the contact portion until the commencement of the additional field investigation on the civil structures.

(4) Reservoir cross section survey

It is recommended to monitor the condition of sediment deposit in the reservoir at an interval of five (5) years, applying the modernized reservoir survey system explained in the foregoing Subsection 6.1.1, after the introduction thereof in the subsequent study stage.

Table 6.1 PRINCIPAL FEATURES OF THE DA NHIM HYDROELECTRIC PROJECT

No./ Component	Principal Features		
1. Reservoir	- Storage capacity	Gross storage capacity	: 165 million m3
		Effective storage capacity	: 150 million m3
	- Reservoir area at HWL		9.7 km2
	- High water level (HWL)		EL. 1042 m
	- Low water level (LWL)		EL. 1018 m
	- Drawdown		24 m
	- Design flood		4,500 m3/sec
	- Critical flood		5,500 m3/sec
2. Dran dam	- Type	Homogeneous type rolled earth embankment, provided with foundation drains, toe rockfill, slope protection of rock riprap and sod facing, cut-off curtain of steel sheet piling into foundation, and upstream impervious blanketing	
	- Height	Maximum : 38 m, Average : 34 m	
	- Length	At the crest	1,460 m
	- Width	At the crest	6 m
		Average width at the base	180 m
	- Slope	Upstream - 1:2.5 to 1:3, Downstream - 1:1.8 to 1:2	
	- Embankment volume		3.6 million m3
3. Spillway	- Type	Overflow type, with upturned bucket	
	- Dimension	Width : 51.5 m, Length : 142 m	
	- Cate	Four taintor gates, each having a dimension of 11.0 m x 13.6 m	
4. Intake	- Type	Bell mouth type concrete structure with gate operating shaft.	
	- Inlet dimension	Width :18 m, Height : 10 m	
	- Tunnel dimension	Typical section : 3.6 meters square to 3.4 meters round, Length : 100 m	
	- Shaft dimension	Inside diameter : 4.8 m, Height : 49 m	
	- Gate	One caterpillar gate with a dimension of 3.6 m square.	
	- Trashrack	Two fixed trash racks, each having a dimension of 8 m x 11.25 m	
		Two movable trash racks, each having a dimension of 3.6 m square.	
5. Headrace tunnel	- Type	Circular shape, pressure tunnel	
	- Diameter	Diameter : 3.4 m, Length : 4,930 m	
6. Surge tank	- Type	Chamber surge tank	
	- Riser dimension	Inside diameter : 4.0 m, Height : 47.6 m	
	- Upper chamber dimension	Circular tank, inside diameter : 8 m	
	- Lower chamber dimension	Two circular tunnels, Inside diameter : 3.4 m, Length : 15 m each	
7. Penstock tunnel and valve house	- Type/dimension of tunnel	Horse shoe-shape tunnel, Diameter : 4 m, Length : 87 m	
	- Penstock pipe	One lane of steel pipe, Diameter : 2.8 m	
	- Dimension of valve house	Width : 6 m, Length : 10 m, Height : 8 m	
	- Valve	Two butterfly valves, Diameter : 2 m	
8. Penstock line	- Type	Welded steel pipe	
	- No. of lane	Two lanes	
	- Length for each lane		2,300 m
	- Inside diameter		2.0 to 1.0 m
9. Powerhouse	- Type of powerhouse	Above-ground type, reinforced concrete building with steel roof girder.	
	- Dimension of powerhouse	Width : 27.8 m, Length : 93.2 m, Height : 17.0 m	
	- Maximum discharge		26.4 m3/sec
	- Maximum gross head		799.00 m
	- Maximum net head for maximum discharge		741.00 m
	- Rated maximum power output		160,000 KW
	- Turbine	Four 42,000 KW horizontal Pelton turbines.	
	- Generator	Four 45,000 KVA horizontal generators.	
10. Tailrace	- Type	Twin-box shape conduit and rectangular open channel	
	- Dimension		
	Box conduit (on each water passage)	Width : 8 m, Height : 5.3 m, Length : 46 m	
	Open channel	Width : 3.5 m, Height : 2.0 m, Length : 132 m	

Tabe 6.2 **PRELIMINARY ESTIMATE OF REMAINING RESERVOIR STORAGE CAPACITIES BASED ON RESERVOIR CROSS SECTIONS SURVEYED**

No. of Survey Line	Distance (m)	(1) Silt Sedimentation Capacity (below EL.1,014.5 m) Area (m2)	(1) Capacity (x 1000 m3)	(2) Dead Storage Capacity (below LWL : EL1,018 m) Area (m2)	(2) Capacity (x 1000 m3)	(3) Gross Storage Capacity (below HWL : EL 1,042.0 m) Case-1 No. of Survey Line	Case-1 Distance (m)	Case-1 Area (m2)	Case-1 Capacity (x 1000 m3)	Case-2 No. of Survey Line	Case-2 Distance (m)	Case-2 Area (m2)	Case-2 Capacity (x 1000 m3)
1) Axis of Dam	0	0		0		1) Axis of Dam	0	0		1) Axis of Dam	0	0	
2) Bottom of Dam	100	861	43	4,807	240	2) Bottom of Dam	100	37,632	1,882	2) Bottom of Dam	100	37,632	1,882
3) No.1	100	861	86	4,807	481	3) No.1	100	37,632	3,763	3) No.1	100	37,632	3,763
4) No.2	800	574	574	4,723	3,812	4) No.2	800	50,428	35,224	4) No.2	800	50,428	35,224
5) No.3	1,000	21	297	756	2,739	5) No.3	1,000	39,505	44,967	5) No.3	1,000	39,505	44,967
6) No.4	500	0	5	0	189	6) No.4	500	20,519	15,006	6) No.4	500	20,519	15,006
7) K2	1,250	0	0	0	0	7) K2	1,250	3,608	15,079	7) K2	1,250	3,608	15,079
8) K1	2,380	0	0	0	0	8) K1	2,380	3,311	8,234	(K1+1,190 m)	1,190	8,512	7,211
(K1 + 2,000 m)	2,000	0	0	0	0	(K1 + 2,000 m)	2,000	0	3,311	8) K1	1,190	3,311	7,035
Subtotal-1			1,006		7,461	Subtotal-1			127,466	(K1 + 2,000 m)	2,000	0	3,311
										Subtotal-1			133,478
9) No.5	0	0		0		9) No.5	0	9,108		9) No.5	0	9,108	
10) D3	2,700	0	0	0	0	10) D3	2,700	2,553	15,743	10) D3	2,700	2,553	15,743
11) D2	770	0	0	0	0	11) D2	770	1,849	1,695	11) D2	770	1,849	1,695
(D2 + 1,500 m)	1,500	0	0	0	0	(D2 + 1,500 m)	1,500	0	1,387	12) (D2 + 1,500 m)	1,500	0	1,387
Subtotal-2			0		0	Subtotal-2			18,824	Subtotal-2			18,824
Total (Subtotal-1 + Subtotal-2)			1,006		7,461	Total (Subtotal-1 + Subtotal-2)			146,290	Total (Subtotal-1 + Subtotal-2)			152,302

Note

The gross storage capacity is calculated based on the river cross sections surveyed in the Case-1 above, while in the Case-2 the new cross section (K1 + 1,190 m) located between the survey lines K1 and K2 on the Krong Klet River, which is configulated with reference to the available topographic maps as well as these neighbouring two cross sections, are applied to estimate the remaining gross storage volume.

Table 6.3 PARTICLE SIZE DISTRIBUTION CURVE OF BED LOAD MATERIALS IN RESERVOIR

Sieve ParticleSize (mm)	Location of Sampling				
	No.1 (Intake site) Finer(%)	No.2 (Spillway site) Finer(%)	No.3 (Spillway site) Finer(%)	No.4 (Survey Line-K2) Finer(%)	No.5 (Survey Line-D3) Finer(%)
50.80	77.7				
19.20	66.1	75.12	76.43		
2.00	65.6	61.31	36.29	99.96	96.95
1.00	62.3	53.80	30.07	99.25	94.25
0.84	58.3	46.65	26.29	97.84	92.26
0.42	43.6	20.22	16.61	78.85	82.34
0.25	33.9	5.10	12.31	48.65	70.38
0.13	5.7	0.30	3.85	14.94	44.67

Notes:

1. The sieving analysis was carried out by the Southern Institute of Water Resources Research in July and August 1994
2. The locations of sampling of the bed load materials are shown in Figure II-4.6.

Table 6.4 SEEPAGE VOLUME MEASURED AT EACH OF 26 RELIEF WELLS

No.	Date of Measurement	Reservoir Water Level (El. m)	Seepage Volume at each of 26 Relief Wells (litre/sec) (No of Relief Well)																									
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
1	23th Dec. "83	1,042.405	0.67	1.67	0.43	1.00	1.43	1.00	0.36	0.57	6.66	1.00	5.00	2.00	0.15	0.13	0.05	1.35	0.25	0.16	2.00	0.92	1.25	0.50	1.10	0.67	0.55	0.31
			Total seepage from 26 Relief wells : Qw= 31.18																									
2	12th Dec. "84	1,042.540	0.53	1.10	0.25	0.38	0.19	0.48	0.43	0.42	6.67	0.62	6.67	2.50	0.16	0.15	0.06	1.43	0.22	0.13	1.67	0.26	1.00	0.43	0.91	0.59	0.50	0.17
			Total seepage from 26 Relief wells : Qw= 27.92																									
3	5th Dec. "86	1,042.450	1.10	2.00	1.67	1.10	0.71	0.83	0.40	0.55	6.67	0.83	5.00	2.50	0.24	0.33	0.08	1.25	0.25	0.15	2.00	1.00	1.43	0.55	1.10	0.50	0.50	0.22
			Total seepage from 26 gauging wells : Qw= 32.96																									
4	24th Nov. "88	1,042.452	0.83	1.67	0.50	0.83	0.67	0.83	0.30	0.45	6.67	0.71	4.00	3.33	0.25	0.21	0.10	1.25	0.26	0.12	1.67	1.00	1.25	0.50	1.25	0.59	0.32	0.25
			Total seepage from 26 RElief wells : Qw= 29.81																									
5	21th Nov. "89	1,042.380	0.50	1.67	0.27	0.34	0.14	0.40	0.22	0.33	5.00	0.45	2.50	2.00	0.14	0.09	0.08	0.91	0.19	0.09	1.67	0.77	1.00	0.40	1.62	0.40	0.38	0.13
			Total seepage from 26 Relief wells : Qw= 21.69																									
6	15th Nov. "90	1,041.800	0.55	2.00	0.36	0.67	0.34	0.71	0.25	0.40	5.00	0.67	3.33	2.50	0.16	0.14	0.00	0.91	0.18	0.00	1.43	0.62	1.25	0.45	0.83	0.29	0.29	0.00
			Total seepage from 26 Relief wells : Qw= 23.33																									
7	28th Nov. "90	1,042.525	0.67	1.67	0.27	0.50	0.48	0.53	0.23	0.36	5.00	0.21	3.33	2.50	0.14	0.14	0.09	0.91	0.13	0.08	1.67	1.43	0.53	0.42	0.62	0.38	0.40	0.13
			Total seepage from 26 Relief wells : Qw= 22.82																									
8	20th Nov. "92	1,042.530	0.62	2.00	0.28	0.53	0.30	0.67	0.26	0.36	5.00	0.83	4.00	2.50	0.16	0.11	0.00	0.77	0.18	0.08	1.43	0.77	0.91	0.36	0.67	0.33	0.36	0.00
			Total seepage from 26 Relief wells : Qw= 23.48																									
9	31th Dec. "93	1,042.538	0.34	1.67	0.25	0.29	0.19	0.37	0.17	0.34	6.67	0.43	2.50	2.00	0.14	0.08	0.00	0.62	0.13	0.07	1.43	0.62	0.83	0.36	0.45	0.29	0.28	0.00
			Total seepage from 26 Relief wells : Qw= 20.52																									
10	21th Mar. "81	1,034.590	0.00	0.30	0.09	0.00	0.00	0.13	0.15	0.15	3.33	0.30	1.67	1.43	0.07	0.06	0.00	0.48	0.05	0.05	0.83	0.43	0.34	0.19	0.31	0.25	0.25	0.00
			Total seepage from 26 Relief wells : Qw= 10.86																									
11	20th Apr. "93	1,034.115	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.15	3.33	0.21	1.67	1.10	0.00	0.00	0.00	0.29	0.00	0.00	0.77	0.36	0.11	0.14	0.22	0.20	0.20	0.00
			Total seepage from 26 Relief wells : Qw= 8.84																									
12	14th Mar. "94	1,035.030	0.00	0.71	0.00	0.00	0.00	0.16	0.13	0.25	3.33	0.25	2.00	1.25	0.00	0.00	0.00	0.45	0.00	0.00	0.77	0.40	0.20	0.25	0.22	0.20	0.19	0.00
			Total seepage from 26 Relief wells : Qw= 10.76																									
13	2th May "81	1,028.780	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	1.67	0.14	1.10	0.77	0.00	0.00	0.00	0.28	0.00	0.00	0.50	0.20	0.00	0.09	0.00	0.15	0.15	0.00
			Total seepage from 26 Relief wells : Qw= 5.12																									
14	29th Jul. "94	1,025.190	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.05	0.59	0.09	0.00	0.00	0.00	0.24	0.00	0.00	0.29	0.13	0.00	0.00	0.00	0.11	0.10	0.00
			Total seepage from 26 Relief wells : Qw= 1.66																									

Table 6.5 SURVEY DATA ON SETTLEMENT OF DAM CREST

(1) Comparison of Dam Crest Elevations Surveyed in 1972, 1992 and 1993

Station No.	Cumulated Distance from I.P. (m)	Dam Crest Elevation on 20 Dec. 1972 (El. m) (at both edges of dam crest)		Dam Crest Elevation (El. m) (at center of dam crest)		Difference in Dam Crest Elevation (m)	
		Upstream side	Downstream side	Dec. 1992	Dec. 1993	1992 and 1993	1972 and 1993
	(1)	(2a)	(2b)	(3)	(4)	=(4) - (3)	=(4) - (2a+2b)/2
Right Abut.	71.3	1,045.35	-	-	-	-	-
R.A. + 50 m	21.3	1,045.45	1,045.45	-	-	-	-
I.P.	0.0	1,045.64	1,045.69	1,045.61	1,045.60	0.00	-0.06
I.P. + 28.7 m	28.7	1,045.82	1,045.87	-	-	-	-
I.P. + 78.7 m	78.7	1,045.99	1,046.00	-	-	-	-
S1	100.0	1,046.06	1,046.07	1,046.02	1,046.02	0.00	-0.05
S2	200.0	1,046.10	1,046.14	1,046.11	1,046.10	0.00	-0.02
S3	300.0	1,046.07	1,046.10	1,046.02	1,046.02	0.00	-0.07
S4	400.0	1,046.12	1,046.12	1,045.99	1,045.99	0.00	-0.13
S5	500.0	1,046.07	1,046.14	1,046.02	1,046.02	0.00	-0.08
S6	600.0	1,046.07	1,046.13	1,046.03	1,046.03	0.00	-0.07
S7	700.0	1,046.06	1,046.15	1,046.02	1,046.03	0.01	-0.08
S8	800.0	1,046.07	1,046.11	1,046.02	1,046.02	0.00	-0.07
S9	900.0	1,046.05	1,046.11	1,046.01	1,046.02	0.01	-0.06
S10	1,000.0	1,046.10	1,046.10	1,046.03	1,046.04	0.00	-0.06
S11	1,100.0	1,046.05	1,046.09	1,046.06	1,046.06	0.00	-0.01
S12	1,200.0	1,045.89	1,045.98	1,045.90	1,045.90	0.00	-0.04
S13	1,300.0	1,045.64	1,045.74	1,045.69	1,045.69	-0.01	-0.01
TBM		1,045.63		1,045.63	1,045.63		

(2) Elevations at Center of Dam Crest in the neighbourhood of the Right Abutment (Surveyed in August 1994)

Station No.	Cumulated Distance from I.P. (m)	Dam Crest Elevation Surveyed on Aug. 1994 (at center of dam crest) : (El. m)
Right Abut. (R.A.)	71.3	1,045.44
R.A. + 5 m	66.3	1,045.45
R.A. + 8 m (IP - 63.3 m)	63.3	1,045.30
R.A. + 10 m	61.3	1,045.48
R.A. + 15 m	56.3	1,045.53
R.A. + 20 m	51.3	1,045.54
R.A. + 25 m	46.3	1,045.60
R.A. + 30 m	41.3	1,045.59
R.A. + 35 m	36.3	1,045.48
R.A. + 40 m	31.3	1,045.48
R.A. + 45 m	26.3	1,045.61
R.A. + 50 m	21.3	1,045.64

Table 6.6 CHECK SHEET ON CONDITION OF CIVIL STRUCTURE - DAM

I. Present condition confirmed through the visual inspection	(1) Dam crest	No settlement was seen on the dam crest. Some of curbs provided on the dam crest were damaged, but no urgent rehabilitation works are necessary therefor since these shall not cause any serious condition in future.
	(2) Downstream embankment surface of dam	The downstream embankment surface of the dam was stable as a whole, being covered by grass. However, the portion behind the spillway walls at the downstream end was considerably eroded due to the 1993 flood when about 1,600 m3/sec was spilled out downstream.
	(3) Upstream embankment surface of dam (above EL. 1,025 m)	The riprap rocks placed on the dam surface were stable and no eroded portions were found.
	(4) 20 cm thick concrete slab placed on the upstream dam surface in the contact portion of dam and spillway	In the construction joints, some gaps with several centimeters in height were found out.
	(5) Dam measuring apparatus	On July 29, the Study Team participated in the measurement of seepage and water surface in the dam body, which was periodically carried out by the dam site staff of the Da Nhim P/S Office. On the other hand, the pore pressure meters installed in the dam body were not working.
II. Seepage volume through the dam (based on the measurement records)		The recorded total seepage volumes through the dam are less than the designed value. While, the seepage volume at the original relief wells No. 9 and No. 11 exhibits the considerably high rate as compared with those at other relief wells, especially at the time of the reservoir water level higher than HWL (El. 1042 m).
III. Issues encountered after completion of the Project	(1) Leakage of water in the contact portion of dam and spillway right wall in 1978 and occurrence of muddy flow after 1991	The following were reported by the staff of the Da Nhim P/S office in relation to the issues of dam body in the contract portion of dam and spillway: " In 1978, land slide as well as about 10 m long crack took place on the downstream slope surface of the dam embankment located adjacent to the spillway right wall. Besides, a lot of muddy water came out from a pipe installed on the concrete stair, which is located beside the downstream spillway right wall. To deal with the situation, the cracked portion of the dam surface was repaired through of filling the suitable materials after removal of the deteriorated ones. As well, the upper portion of the downstream concrete cut-off wall was strengthened with cement grout. Afterwards, such a phenomenan has not occurred up to date although some amount of water came out through the pipe when the reservoir water level becomes higher than HWL (El. 1,042 m). After 1991, on the other hand, the muddy water has flowed down along the right side channel of spillway when the flood of more than 400 m3/sec is spilled out during the peak rainy season."
	(2) Erosion of dam embankment surface by white ants	In the past, a depression in the dam surface which amounted to about 1.5 m3 in volume took place because of erosion by white ants. The depressed portion was repaired and the works for exterminating the white ants from the embankment surface were executed by the Da Nhim P/S Office.
IV. Additional study and investigation required for the dam	Hydraulic and geotechnical investigations to verify the cause of occurrence of muddy flow mentioned in III(1) above, and setting up the urgent rehabilitation plan for the dam if it is clarified that the muddy flow takes place due to the derioration of dam body in the contact portion of the dam and spillway .	

Table 6.7 CHECK SHEET ON CONDITION OF CIVIL STRUCTURE - SPILLWAY

I. Present condition confirmed through the visual inspection	(1) Spillway right wall upstream of spillway gate	No significant damages and defects were found.
	(2) Overflow weir portion	No significant damages and defects were found, but there are cracks in concrete surface of the overflow weir.
	(3) Spillway right wall downstream of spillway gate	No significant damages and defects were found.
	(4) Downstream river stretch of spillway	It appeared that the river bed had rised, presumably due to deposits of soils which fell down from the both banks in the downstream river channel of spillway. As a result of the visual inspection, the flow capacity of the Da Nhim river has diminished to a considerable extent. Hence, in an event of the flood of more than 2,000 m3/sec, the large-scale flood damage would occur in the downstream towns, since the downstream area is utilized intensively for residential and agricultural purposes.
II. Sediment deposits in front of spillway (based on cross section survey of the reservoir by ecoh sounder)		As a result of the reservoir cross section survey, no significant sediment take place in the reservoir adjacent to the spillway inlet portion.
III. Issures encountered after completion of the Project	(1) Flood damages in the downstream area of the dam	In December 1993, the water level at the No.3 Construction Bridge rised up to 1 m above the neaby road surface when about 1,600 m3/sec was spilled out downstream. Consequently, the bridge was washed away. In addition, the flood caused the damages to infrastructures, agricultural damages , etc. in the downstream area.
	(2) Erosion of the river banks around the downstream end of the spillway walls	Downstream of the spillway walls, the both banks were considerably eroded, mainly due to the 1993 flood. In particular, the large-scale bank erosion was seen on the left bank side.
	(3) Submergence of Value house of irrigation outlet	The value house of irrigation outlet provided in a pier of spillway has been completely submerged due to intrusion of rain water.
IV. Additional study and investigation required	(1) Preparation of flood mitigation plan for the downstream ares of the dam The flood mitigation plan for the downstream areas of the dam needs to be established by combining such measures as dredging the river bed, widening the river channel, provision of flood dikes and reconstruction of the river-related structures including road bridges in order to enhance the flow capacity of the downsream reach.	
	(2) Preparation of computer system for the flood forecasting and warning system The additional study will be required to set up the cpmuter program for forecasting the flood to arrive at the dam site as well as for determining the optimum spillway gate operation based on the rainfall and water level data observed by the Meteo-Hydrological Data Acquisition System, which is proposed to be installed under the Study.	
V. Proposed Urgent Rehabilitation Works	(1) Repair of creacked portions of the overflow weir concrete (2) Provision of drain holes in value house of irrigation outlet	
VI. Long Term Rehabilitation Works	(1) Slope prtection works of the banks downstream of spillway, including construction of concrete retaining wall as well as excavation of slope to make it more gentle will be conducted.	

Table 6.8 CHECK SHEET ON CONDITION OF CIVIL STRUCTURE - INTAKE STRUCTURE

I. Present condition confirmed through the visual inspection	(1) Land slide along the access road connecting the dam and intake structure	It was seen that the land slide took place on the access road connection the left abutment of dam and intake stucture, which seemed to result from the 1993 flood. The local contractor is now conducting the slope protection works for the slopes of the access road.
	(2) 15 cm thick slope facing concrete in front of the hoist chamber (between El. 1025 and El. 1042 m)	A part of the slope facing concrete was found to be depressed to about 15 cm in depth near the construction joint. Except for the portion, no damage was found on the slope facing concrete.
	(3) Land slides along slopes of the both sides in the inlet channel in front of the fixed trash rack	Of the downstream slope of the inlet channel, some portions higher than a berm collapsed. It appeared that this was caused by the land slide in the portion behind the downstream side slope. However, this is not in the serious situation.
II. Present condition clarified through the diving survey	(1) Sediment deposits in front of the fixed trash rack	It was found through the diving survey that the sediment deposit in front of the fixed trash rack is insignificant. But, it clarified that there were a lot of drift woods in front of the fixed trash rack.
	(2) Missing of concrete in guide frame of movable trash rack	It was found that a part of the guide frame concrete was missing. Concerning the ordinary power generation, on the other hand, it can work for some time without any problem, since the steel-made guide frame was left therein.
	(3) Cracks in the lowest portion of concrete of partition wall inside the intake shaft	Several cracks in the lowest portion of patirion wall were found.
III. Sediment deposits in the reservoir along the centerline of the inlet channel (based on the results of the reservoir cross section survey by the ecoh sounder)		It was found through the survey out that the sediment deposit in the reservoir is not significant as a whole.
IV. Issues encountered after completion of the Project	(1) Operation of the power plants on the condition that the stoplogs are set in front of the fixed trash racks	According to the staff of the Da Nhim P/S office, the power generation has been gone on for more than these 10 years as the stoplogs in front of the fixed trash racks was drpped to the elevation of El. 1017 m, in order to avoid the intrusion of drift woods into the headrace tunnel.
	(2) Removal of sediment deposited in the inlet channel	In the dry season of 1992 when the reservoir water level lowered to around El. 1018 m, about 250 m3 of sediment deposited above the reservoir water level was removed with the man-power.
V. Proposed urgent rehabilitation works for intake structure	(1) Concrete placement in the guide frame for the movable trash racks (II (2) above) (2) Repair of the cracked portions in the partition wall of the intake shaft (II (3) above) (It is recommended that the above rehabilitation works should be in principle conducted when the reservoir water level is to be lowered to less than El. 1,016.5 m)	
VI. Long term rehabilitation works	(1) Slope rehabilitation works against land slide in the down- and upstream banks of the intake structure (2) Construction of coffer dam in front of the fixed trash rack in order to enlarge the sediment deposit space of the reservoir.	

Table 6.9 CHECK LIST ON CONDITION OF CIVIL STRUCTURE - OTHER WATERWAY STRUCTURES

(1) Headrace Tunnel and Surge Tank

I. Issues identified after completion of the Project	(1) Headrace tunnel	The inspection was made by the staff of the Da Nhim P/S ofice throughout the headrace tunnel in March 1992. As a result of the inspection, it was found that there were two water leakage portions in the headrace tunnel.
	(2) Surge tank	Concerning the surge tank, no issues were found.
II. Long term rehabilitation works for headrace tunnel	(1) Rehabilitation works for the aforesaid two portions of the headrace tunnel by grouting/lining of tunnel with concrete in order to reduce the water leakage from the surrounding zones of tunnel.	

(2) Penstock Line

I. Present condition confirmed through the visual inspection	(1) Missing of slab concrete between Anchor Block No. 5 nad No.6	There was a section in between Anchor Block No. 5 and No. 6 that the slab concrete under the penstock pipe is missing.
	(2) Unstable side slope around Anchor Block No. 4	In the section of penstock line around Anchor Block No. 4, the excavated slopes were not stabilized, being covered with unstable rocks and stones.
	(3) Condition of penstock line between Anchor Block No. 8 and Anchor Block No. 15	No significant damages and defects were found.
II. Issues encountered after completion of the Project	(1) Drainage conjestion in the upper penstock line of the upper crossing	According to the staff of the Da Nhim P/S office, the upper section of penstock line suffered the drainage problems in the rainy season, requiring the rehabilitation works after the rainy season every year.
III. Proposed urgent rehabilitation works for penstock line	(1) Placement of slab concrete under the penstock pipe (I (1) above) (2) Slope protection works around Anchor Block No.4 ((2) above) (3) Drainage improvement in the upper section of penstock line (II (1) above) (4) Provision of louvers on concrete walls of the value house to facilitate air supply for air valve instead of existing windows	

(3) Powerhouse

I. Present condition confirmed through the visual inspection	(1) Cracks in concrete of walls	A lot of cracks were found in the wall concrete of powerhouse, especially in the downstream side wall.
II Proposed urgent rehabilitation works for powerhouse	(1) Repair of the cracks in concrete walls of powerhouse.	

Table 6.10 FLOOD DAMAGE RECORDS IN DON DUONG PROVINCE BY THE 1993 FLOOD

(1) Population Increase in the Don Duong Province

(Unit : x 1000 persons)

Year	1980	1993
Population	40	66

Notes :

1. The annual average increase rate of population increase in the Don Duong Province is estimated at about 3.9 %.
2. In the Don Duong Province, population of farmers occupies about 80% of the total population.

(2) Records on Flood Damages by the1993 Flood

Item	Situation of damage
1) Private house	: 50 houses were destoroyed.
2) Cultivated land for vesitable	: 3,000 ha was flooded.
3) Cultivated land for sugar	: 1,040 ha was flooded.
4) Cultivated land for industrial trees	: 3,040 ha was flooded.
5) Cultivated land for fruit	: 300 ha was flooded.
6) School	: 3 schools were destoroyed.
7) Governmental office	: 1 office was destoroyed.
8) Factory	: 2 factories were destoroyed.
9) Transmission line	: 30 km long transmission lines in total were destoroyed.
10) Bridge (steel-made)	: 7 bridges were destoroyed (the farest one was located about 25 km downstream of the Dran dam)

Notes :

1. Data source : The Communist Party office in the Don Duong Province
2. The damage by the1993 flood was the most serious of those by the past floods.
3. The total flood damage is officilly reported to be US$1.2 millions, while it is estimated by the office of the Communist Party of the Don Duong Province at about US$ 3.7 millions.

Table 6.11 PROPOSED URGENT REHABILITATION WORKS FOR CIVIL STRUCTURES

No.	Work Item	Unit	Quantity
C1	Preparatory works	L.S.	-
C2	Spillway		
	C2-1) Repair of cracked portion in concrete of the overflow weir portions	L.S	-
	C2-2) Drilling of bore holes of 10 cm diameter for drainage of valve house of irrigation outlet	m	40
C3	Intake structure		
	C3-1) Manufacturing and installing new stoplogs	m2	80
	C3-2) Manufacturing and installing concrete beams behind the stoplogs at the inlet portion (Provisional works)	m3	2
	C3-3) Concrete placement of guide frame portion of movable trash racks including chipping at the deteriorated portion	m3	1
	C3-4) Repair of cracked portions in partiiton wall of intake shaft including V-cut	L.S.	-
C4	Penstock line		
	C4-1) Excavation for diversion channel and along penstock line	m3	650
	C4-2) Excavation for foundation of roap haulage tower	m3	270
	C4-3) Compacted backfill for foundauion of roap haulage tower	m3	50
	C4-4) Placement of slab concrete under penstock pipe	m3	40
	C4-5) Concrete placement in foundation and base concrete of roap haulage	m3	780
	C4-6) Slope protection works around Anchor Block 4	m2	250
	C4-7) Slope protection works around roap haulage tower	m2	1,300
	C4-8) Concrete placement for drainage channel	m3	300
	C4-9) Check boring (3 m deep per 1 piece)	Nos.	24
	C4-10) Low pressure grout	L.S.	-
	C4-11) Removal of existing windows and installtion of new louvers (1 m x 1 m) on concrete walls of valve house	L.S.	-
C5	Powerhouse		
	C5-1) Repair of cracks in concrete wall of powerhouse	L.S.	-

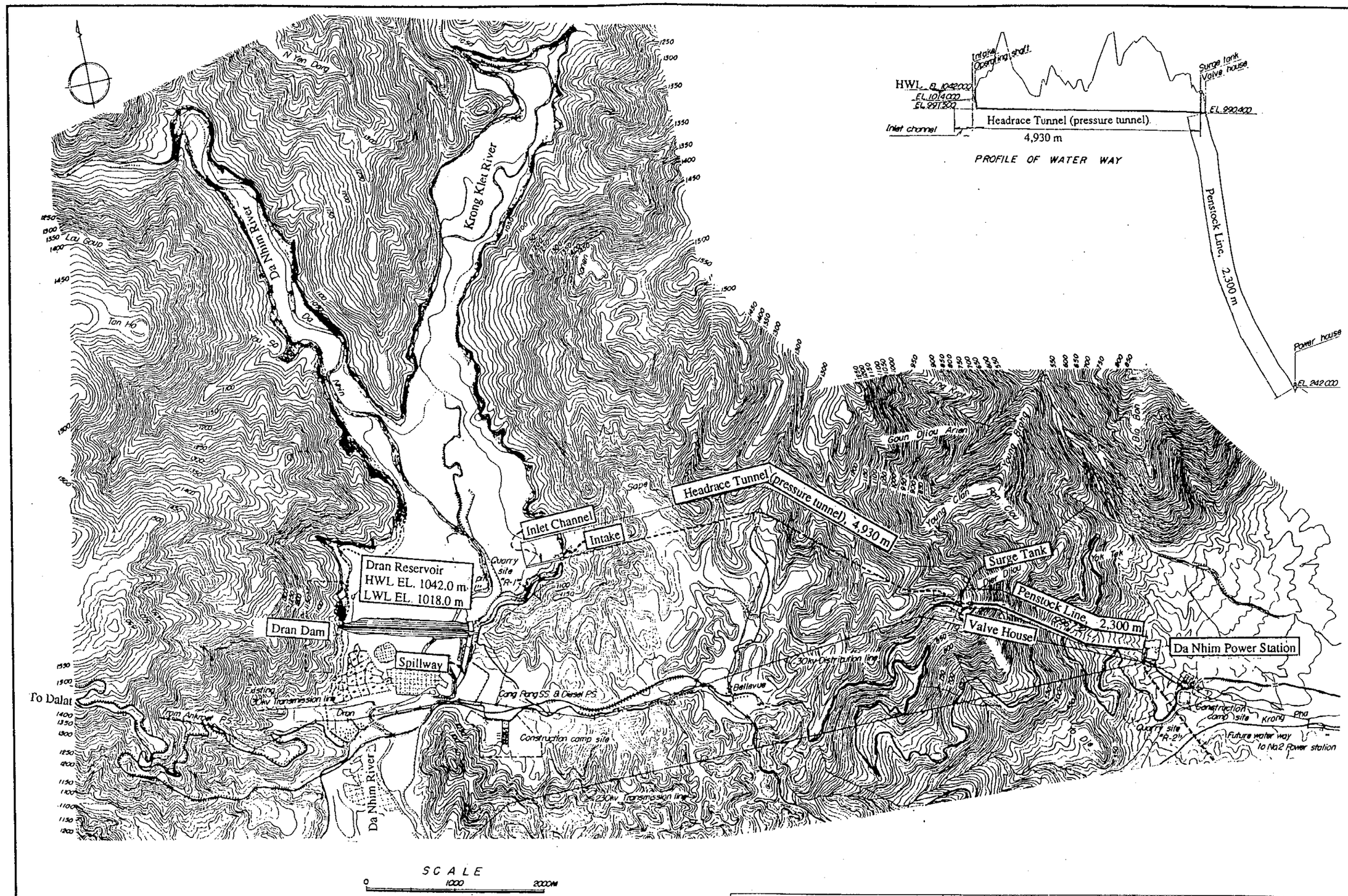
Table 6.12 LONG TERM MEAN MONTHLY INFLOW INTO RESERVOIR

(Unit : m3/sec)

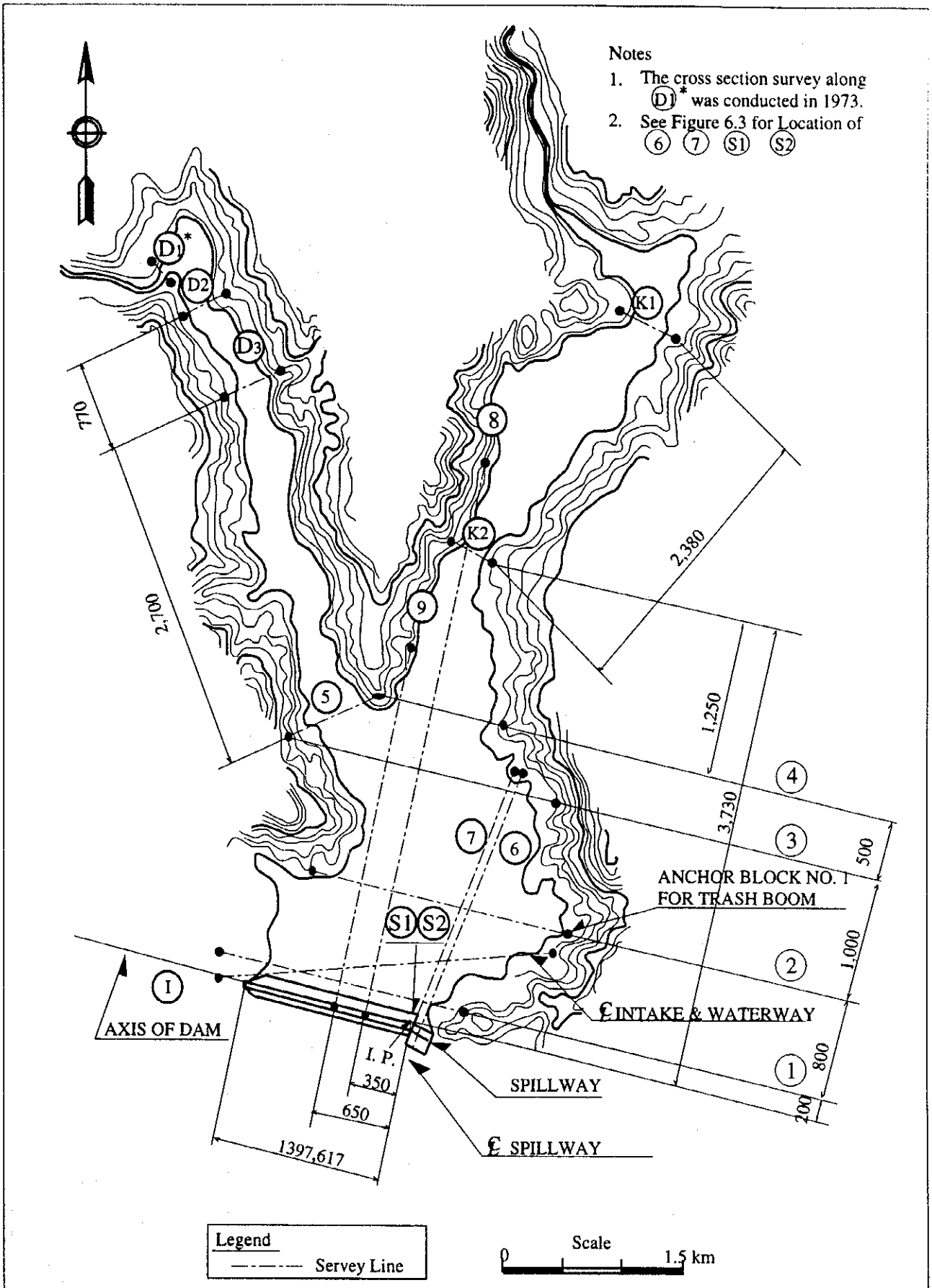
Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Max.	Min.	Ave.
1934	15.00	8.16	7.33	7.07	13.12	20.91	15.79	18.37	17.98	40.63	25.28	17.08	40.63	7.07	17.29
1935	10.48	6.51	5.20	5.02	15.71	22.84	22.63	15.07	32.15	34.44	37.36	16.29	37.36	5.02	18.68
1936	14.00	6.83	4.84	5.76	9.48	11.88	7.56	11.53	44.59	47.56	33.65	16.17	47.56	4.84	17.81
1937	11.31	6.63	5.74	6.71	11.12	12.54	19.22	13.70	19.55	80.62	35.75	16.97	80.62	5.74	20.11
1938	9.57	7.81	7.38	15.70	23.64	7.38	15.36	25.74	29.25	102.79	33.58	25.64	102.79	7.38	25.51
1939	16.51	11.37	10.30	14.78	20.36	18.55	15.00	16.92	23.03	24.04	88.66	69.75	88.66	10.30	27.47
1940	18.95	7.88	8.49	8.18	12.35	20.20	21.29	21.08	44.32	27.35	44.93	28.40	44.93	7.88	21.95
1941	11.81	9.36	8.06	15.60	16.74	12.24	6.39	9.00	22.31	34.08	26.16	14.45	34.08	6.39	15.53
1942	9.48	5.32	3.75	5.86	15.59	26.31	15.71	21.25	41.56	140.23	179.83	22.25	179.83	3.75	40.64
1943	11.06	9.90	9.18	9.34	13.83	8.97	8.76	8.68	26.56	69.75	87.77	62.89	87.77	8.68	27.30
1944	27.13	8.66	6.24	7.12	13.54	12.64	9.98	8.08	21.68	20.82	12.83	46.65	46.65	6.24	16.35
1945	11.74	10.34	7.22	7.41	12.32	13.24	20.82	19.86	-	-	-	-	-	-	-
1949	7.47	6.50	6.05	5.06	5.81	8.31	17.07	17.49	28.21	33.50	39.82	41.09	41.09	5.06	18.10
1950	24.36	12.31	9.00	7.73	17.18	18.19	25.67	10.93	39.26	32.86	36.02	18.30	39.26	7.73	21.01
1951	9.31	5.55	5.03	10.96	20.29	16.39	24.50	22.89	40.31	41.05	44.65	50.39	50.39	5.03	24.39
1952	17.52	9.96	5.58	3.92	21.68	19.30	9.28	12.85	24.60	136.10	49.65	29.32	136.10	3.92	28.46
1953	22.33	14.61	9.21	10.77	23.17	38.14	47.88	49.59	52.54	41.15	53.36	34.70	53.36	9.21	33.21
1954	19.13	11.03	7.60	10.32	11.62	25.46	30.58	49.68	64.89	60.71	25.60	53.39	64.89	7.60	30.99
1955	27.59	11.83	6.81	7.32	16.99	16.30	18.88	34.01	46.25	38.91	86.51	24.45	86.51	6.81	28.00
1956	13.72	8.43	5.10	9.45	31.86	28.62	20.12	20.42	25.26	25.55	31.52	39.05	39.05	5.10	21.64
1957	14.28	9.15	6.95	9.47	13.14	11.46	13.64	15.54	33.10	38.20	15.37	12.91	38.20	6.95	16.14
1958	8.98	6.48	4.56	4.00	8.16	9.39	11.19	23.52	17.35	33.27	25.29	10.02	33.27	4.00	13.57
1959	6.52	4.59	3.70	4.45	9.65	15.20	12.56	10.95	16.24	66.76	48.00	30.00	66.76	3.70	19.15
1960	15.00	6.83	6.81	7.02	16.11	11.38	19.38	13.65	21.43	45.62	45.16	20.91	45.62	6.81	19.15
1961	11.27	7.94	5.20	11.11	9.65	12.85	11.32	9.87	8.94	24.19	13.95	8.12	24.19	5.20	11.22
1962	9.16	5.78	4.18	6.14	7.03	10.50	25.85	34.82	27.45	169.21	68.44	38.65	169.21	4.18	34.23
1963	9.81	8.84	8.08	8.03	9.96	11.18	9.75	35.69	47.88	76.03	25.59	16.28	76.03	8.03	22.36
1964	8.71	8.54	4.75	3.79	10.57	20.50	22.00	11.05	15.13	24.35	58.37	105.39	105.39	3.79	24.52
1965	11.82	8.70	6.66	11.36	22.21	11.68	9.66	16.10	34.83	28.64	26.18	66.30	66.30	6.66	21.28
1966	8.50	7.29	7.71	11.87	25.77	20.81	21.83	19.35	30.67	22.47	23.26	36.55	36.55	7.29	19.75
1967	40.62	11.99	7.67	11.17	13.79	8.65	7.65	7.83	16.81	31.05	25.68	22.35	40.62	7.65	17.16
1968	8.40	6.00	4.60	4.50	11.50	27.40	11.20	7.70	20.20	84.60	27.90	11.80	84.60	4.50	18.87
1969	10.90	6.40	3.90	10.50	15.90	12.90	24.00	26.60	33.10	44.10	37.10	20.10	44.10	3.90	20.54
1970	8.80	4.10	2.10	4.30	10.00	17.00	24.10	27.10	30.90	48.10	39.20	19.30	48.10	2.10	19.67
1971	9.00	3.90	3.70	3.36	9.37	13.95	19.10	25.16	57.77	49.96	71.16	57.29	71.16	3.36	27.06
1972	16.29	8.89	7.43	14.22	22.64	36.36	28.67	25.05	30.39	40.35	39.42	65.02	65.02	7.43	27.97
1973	25.21	12.26	9.39	11.48	22.36	22.22	21.84	30.08	42.90	48.38	130.39	32.26	130.39	9.39	34.05
1974	11.40	5.38	6.93	14.74	25.92	15.38	24.45	34.86	32.77	52.03	71.06	79.69	79.69	5.38	31.40
1975	37.33	15.07	12.84	-	39.84	34.45	29.86	18.24	39.79	65.93	50.68	40.10	-	-	-
1976	22.11	17.95	16.08	16.27	29.51	27.28	26.31	37.58	42.62	58.10	37.95	17.39	58.10	16.08	29.14
1977	9.93	6.54	4.90	4.46	5.48	11.80	12.74	11.69	42.34	19.10	35.75	9.72	42.34	4.46	14.50
1978	8.18	5.06	4.09	5.35	11.73	9.81	13.35	13.34	21.72	39.72	37.69	15.83	39.72	4.09	15.54
1979	8.00	5.33	4.91	7.76	9.89	17.93	21.95	22.40	21.15	31.58	52.79	21.19	52.79	4.91	18.78
1980	9.69	6.78	4.37	4.62	15.18	38.19	15.23	28.48	29.59	49.98	43.87	20.59	49.98	4.37	22.22
1981	10.78	8.72	4.84	4.72	10.62	14.51	13.85	14.33	22.85	48.82	66.88	60.54	66.88	4.72	23.53
1982	13.56	8.50	9.45	13.91	16.23	22.10	13.14	10.32	27.53	20.51	17.92	11.03	27.53	8.50	15.35
1983	7.50	5.43	4.71	5.35	9.44	15.14	17.63	38.27	42.16	73.50	30.30	17.07	73.50	4.71	22.33
1984	10.70	7.53	5.02	7.84	19.51	20.92	31.23	19.85	24.45	49.25	28.88	23.71	49.25	5.02	20.82
1985	10.73	7.84	5.53	18.07	20.36	11.02	16.43	9.88	17.71	43.38	24.56	24.61	43.38	5.53	17.59
1986	10.18	7.33	5.58	4.38	4.95	8.62	12.60	15.90	31.27	45.53	30.73	44.71	45.53	4.38	18.57
1987	12.18	7.99	6.49	6.96	10.21	11.51	10.08	15.16	27.61	19.30	36.69	16.03	36.69	6.49	15.01
1988	9.19	6.84	4.87	6.29	5.50	8.80	27.49	15.03	43.88	38.02	39.98	16.97	43.88	4.87	18.57
1989	12.49	7.35	8.51	10.56	23.81	28.90	32.91	18.12	29.64	33.46	20.84	10.93	33.46	7.35	19.87
1990	6.99	4.88	5.11	11.70	10.15	26.49	16.50	23.94	28.25	29.51	60.36	20.53	60.36	4.88	20.37
1991	10.06	6.84	5.88	6.18	6.82	6.12	8.11	7.67	30.78	35.55	13.22	8.17	35.55	5.88	12.14
1992	5.80	4.06	3.31	16.77	22.15	41.51	24.95	22.05	15.05	48.50	32.21	14.84	48.50	3.31	20.97
1993	9.37	6.40	7.38	6.12	9.40	22.57	15.74	9.99	21.61	59.45	37.98	76.19	76.19	6.12	23.67
1994	17.11	9.88	7.27										17.11	7.27	-
Ave.	13.53	8.08	6.44	8.47	15.28	17.98	18.43	19.90	30.21	48.57	43.22	30.71	59.09	5.81	21.46

Note : In the year enclosed thus ☐ , the mean monthly inflow into the reservoir became less than some 5 m3/sec or less for the two consecutive months.

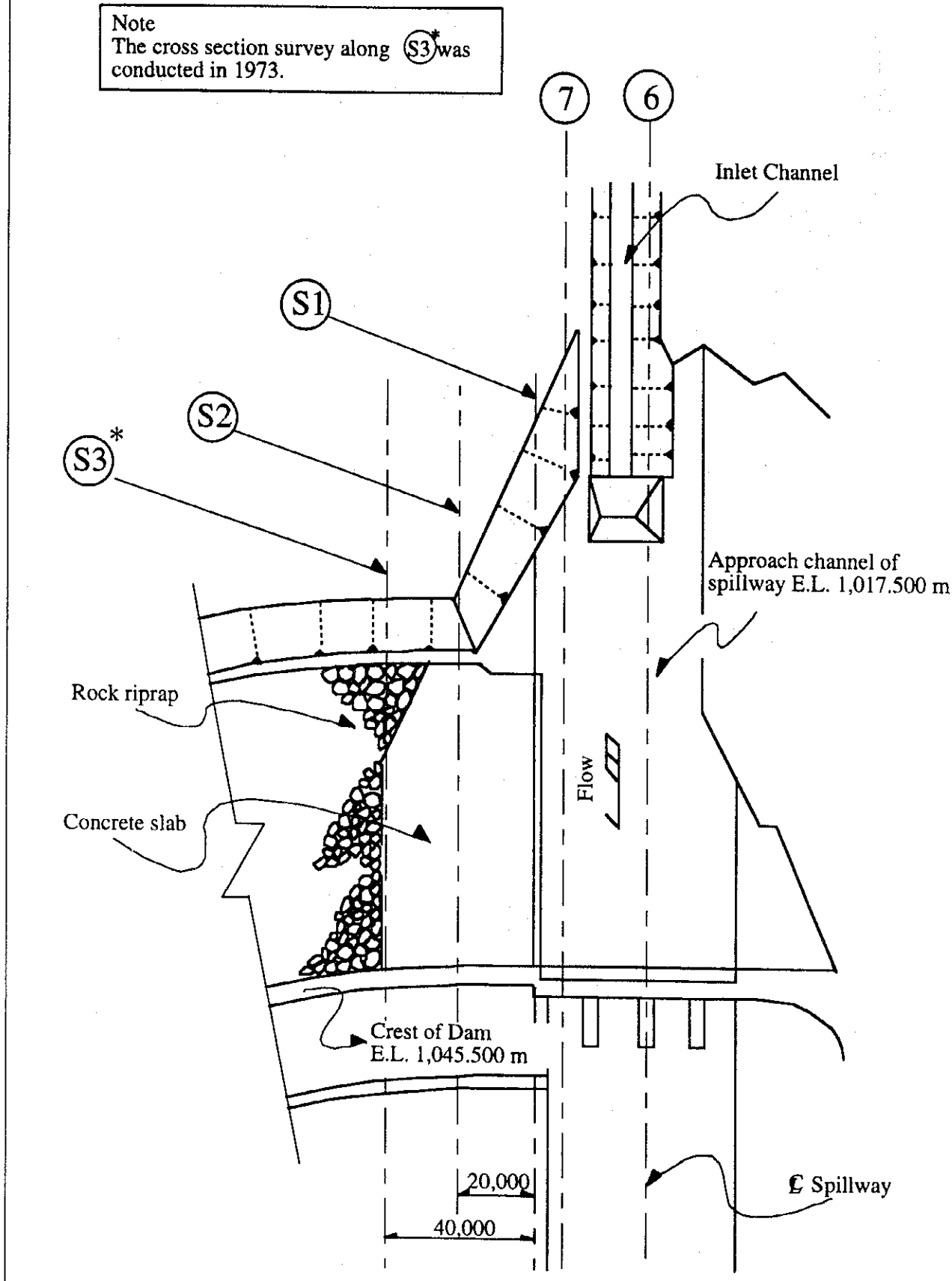
Data source : Power Company No.2 (PC-2)



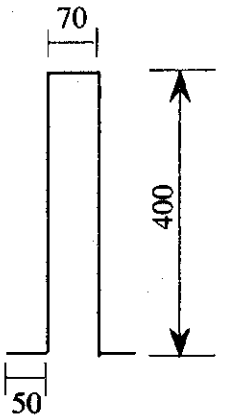
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.1 General Location of the Da Nhim Hydroelectric Project



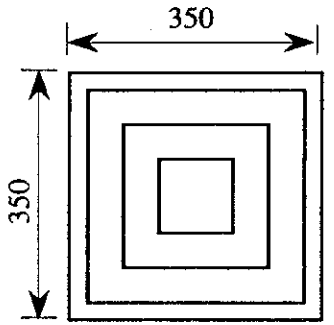
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.2 Location of Reservoir Cross Section Survey



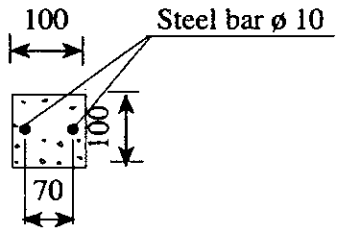
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.3 Location of Reservoir Cross Section Survey in and around Spillway



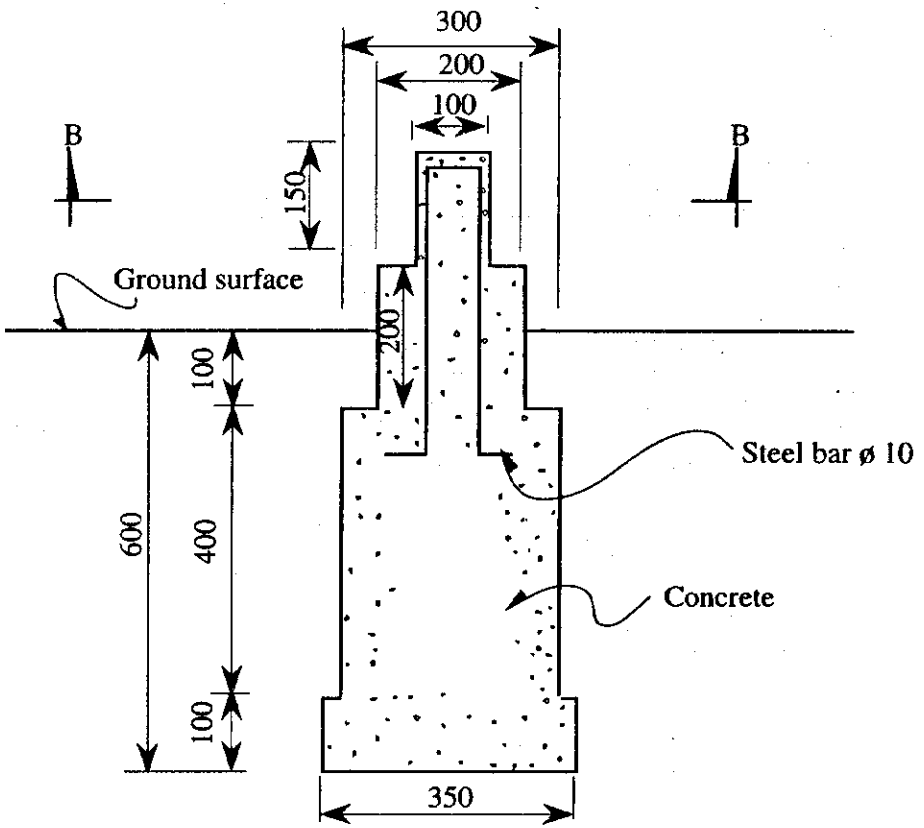
STEEL BAR ARRANGEMENT



SECTIONAL PLAN OF BASE POINT

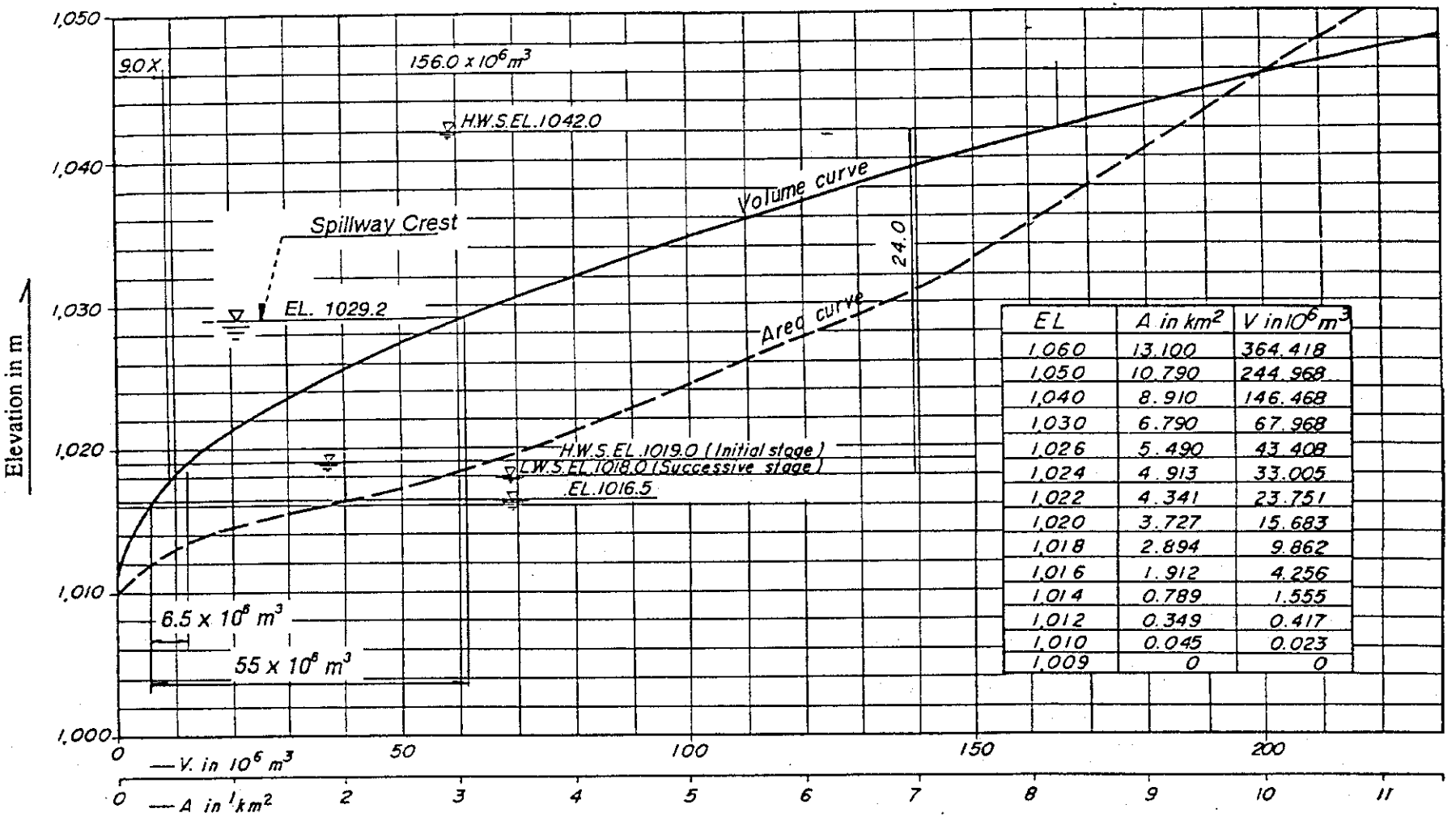


SECTION B - B



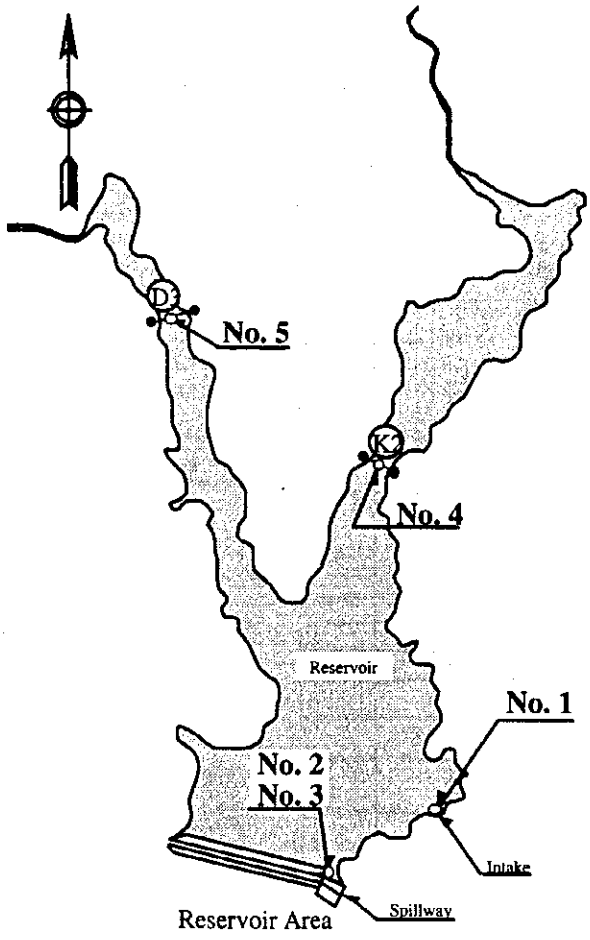
TYPICAL SECTION OF BASE POINT

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.4 Structure of Base Point Installed on Survey Line of Reservoir Cross Section

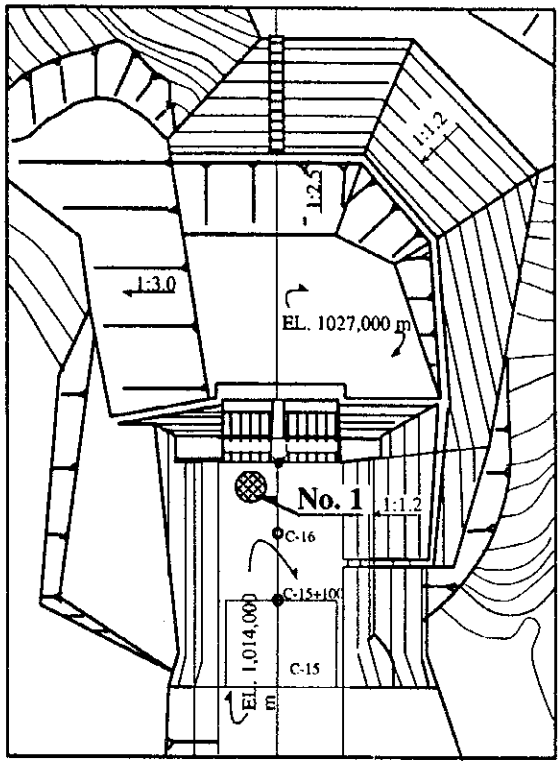


EL	A in km²	V in 10⁶ m³
1,060	13.100	364.418
1,050	10.790	244.968
1,040	8.910	146.468
1,030	6.790	67.968
1,026	5.490	43.408
1,024	4.913	33.005
1,022	4.341	23.751
1,020	3.727	15.683
1,018	2.894	9.862
1,016	1.912	4.256
1,014	0.789	1.555
1,012	0.349	0.417
1,010	0.045	0.023
1,009	0	0

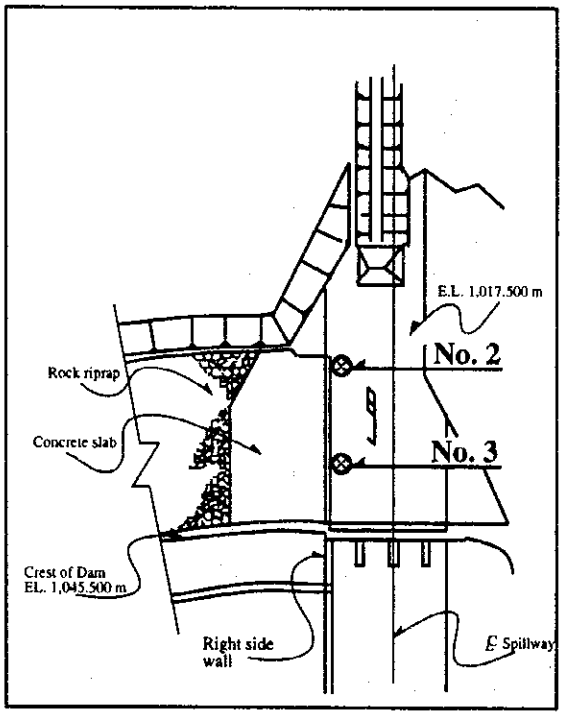
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.5 Original Reservoir Capacity Curve in the Design Sage of the Project



Reservoir Area

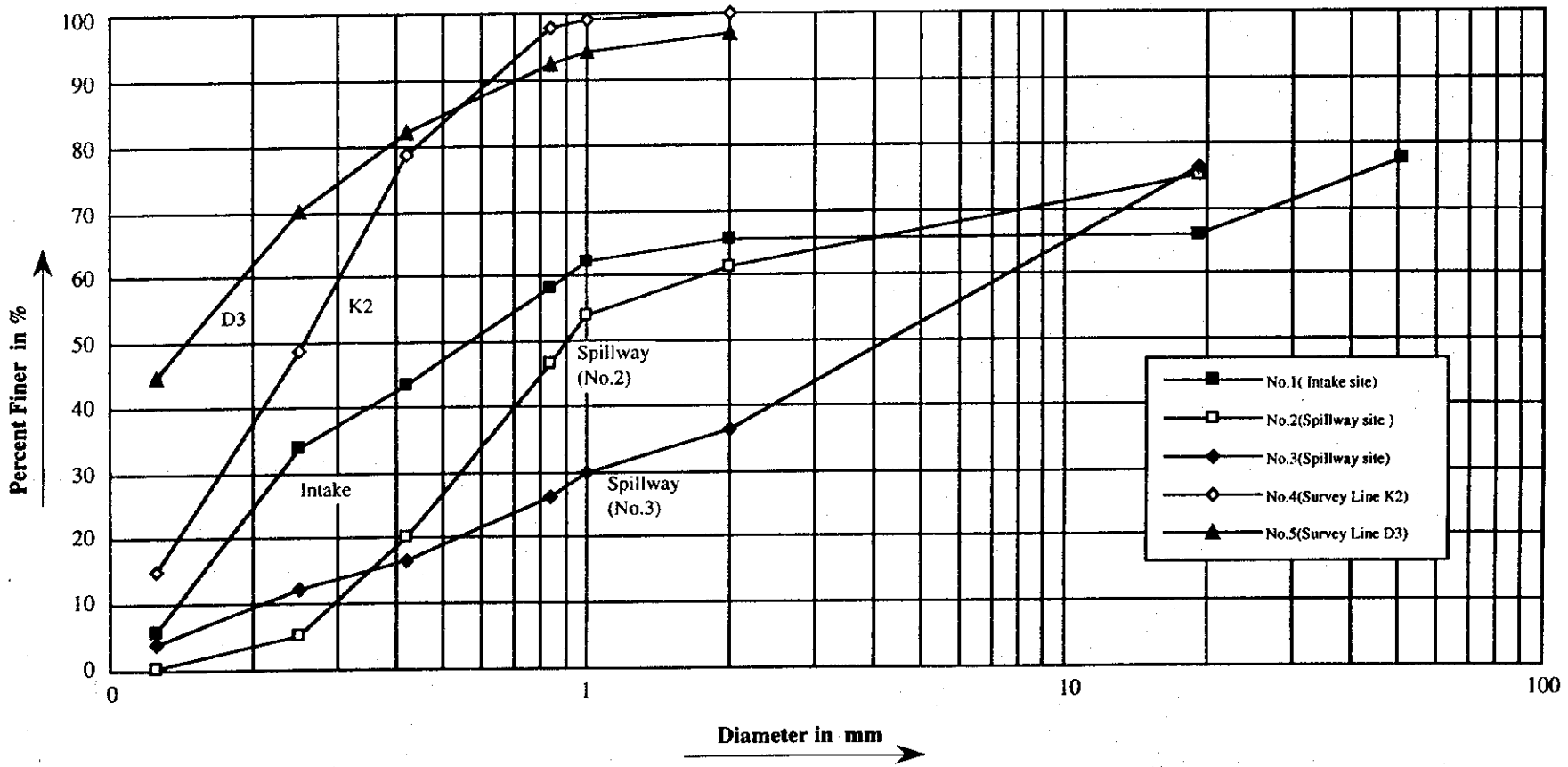


Plan of Intake



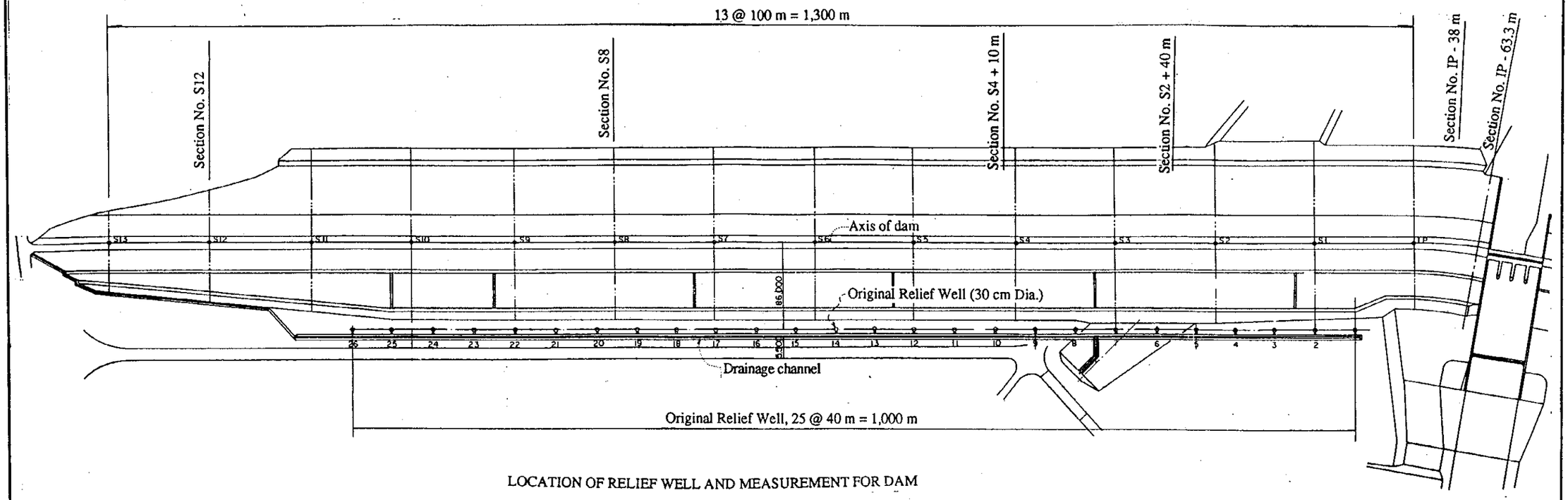
Plan of Spillway

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.6 Location of Sampling of Bed Load Materials in the Reservoir

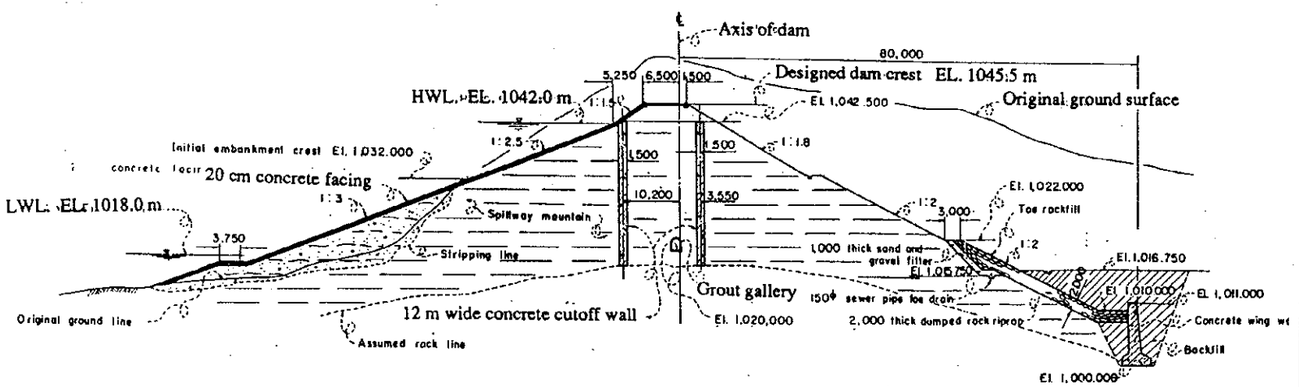


Note: See Figure 6.6 for location of sampling

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.7 Particle Size Distribution Curve of Sediment Material Sampled from Reservoir Bottom



LOCATION OF RELIEF WELL AND MEASUREMENT FOR DAM

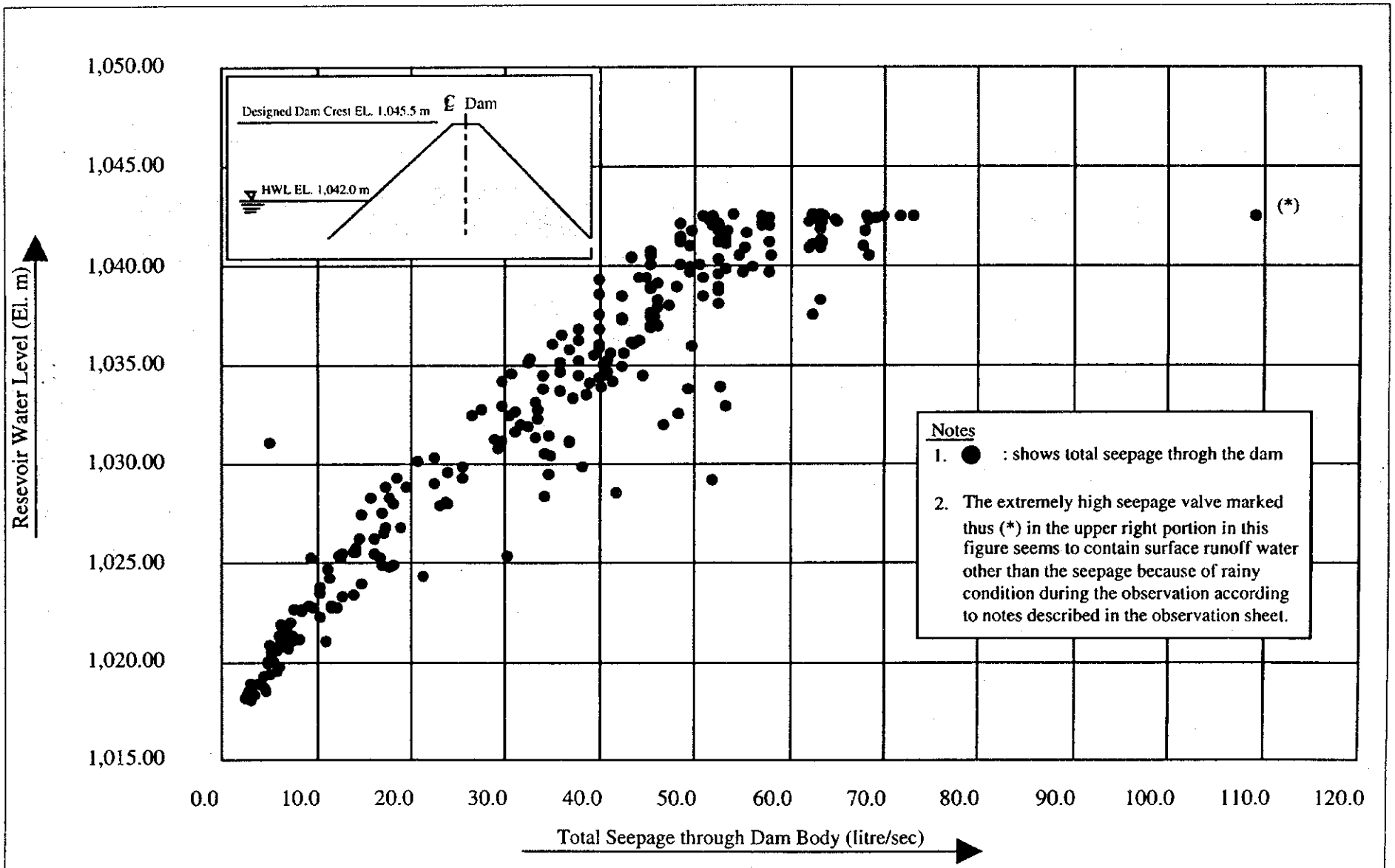


SECTION OF DAM EMBANKMENT AT NEARBY LOCATION OF SPILLWAY

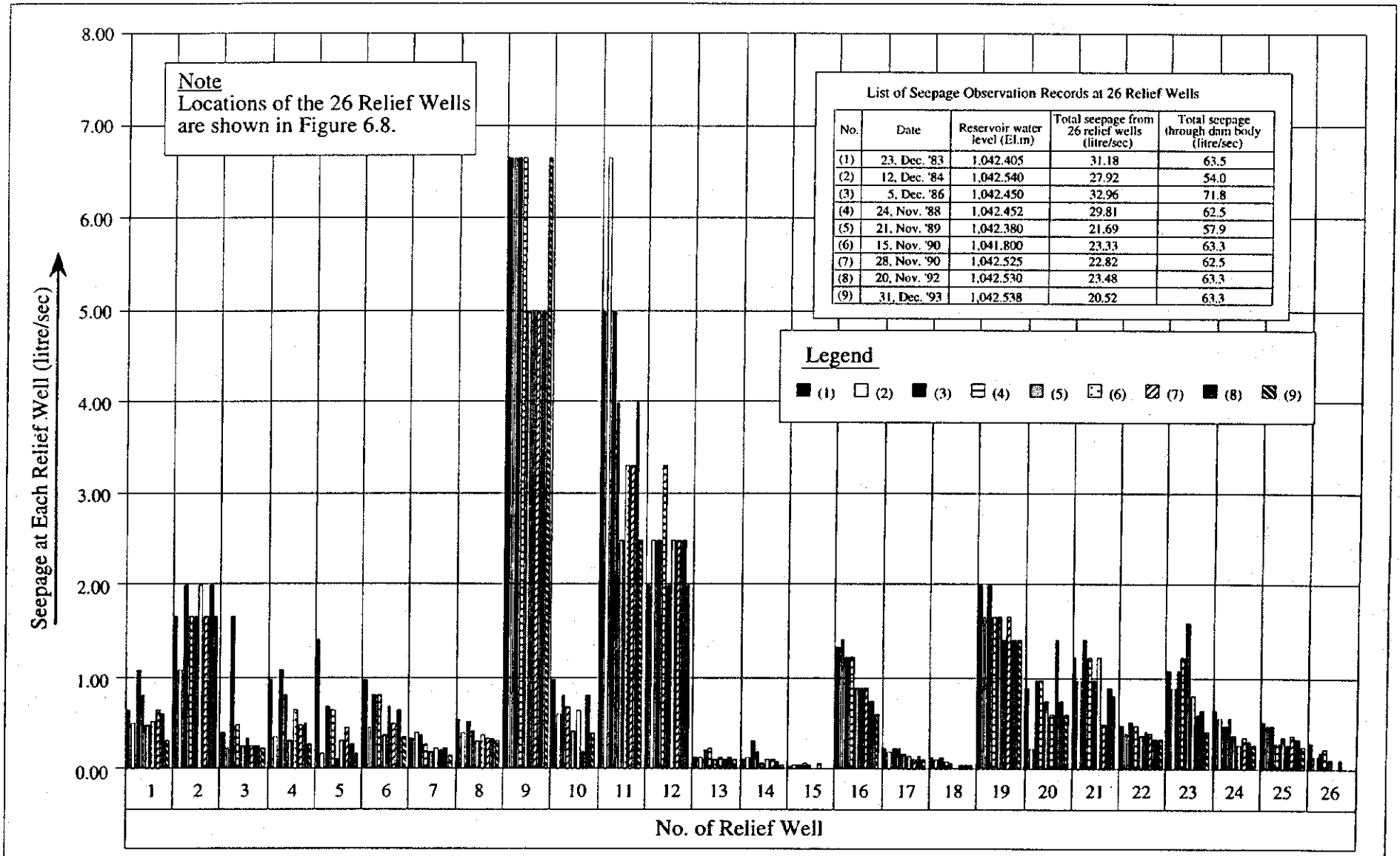
LOCATION OF MEASUREMENT

No.	Item of Measurement	Location of Measurement	Fig./Table Refered
1	Seepage	26 Original Relief Wells, 4 Supplemental ones, Drain channels	Fig.4.9, Fig.4.10
2	Water Surface Elevation in Dam Body	IP-38 m, S2+40 m, S4+10 m, S8, S12	Fig.4.12
3	Settlement (Dam Crest Elevation)	IP, S1 to S12	Table 4.5
4	- do -	IP-63.3 m (done in Aug. 1994)	Fig.4.11

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.8 Location of Measurement and Survey for Dam

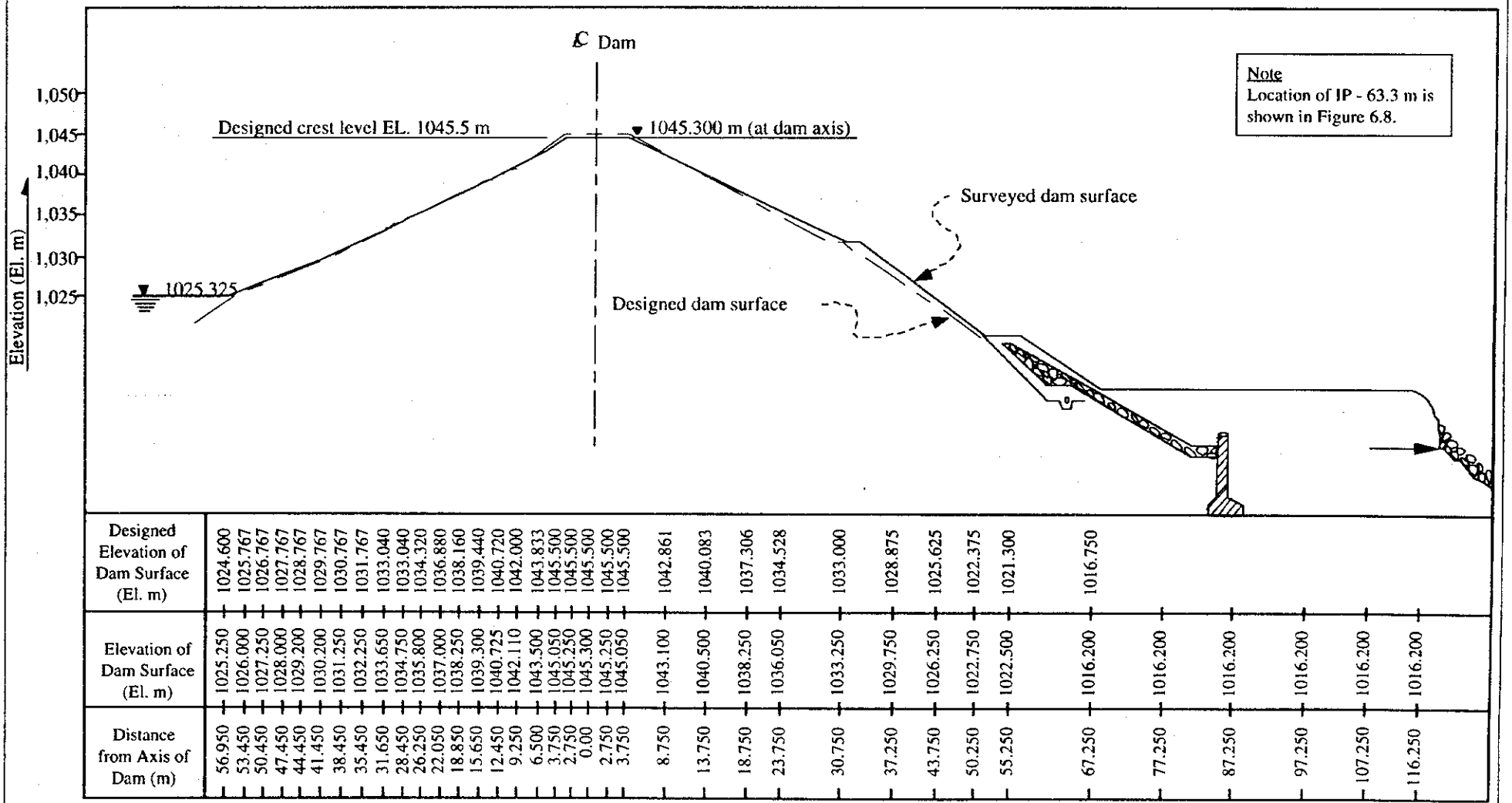


FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.9 Relation between Reservoir Water Level and Total Seepage through Dam

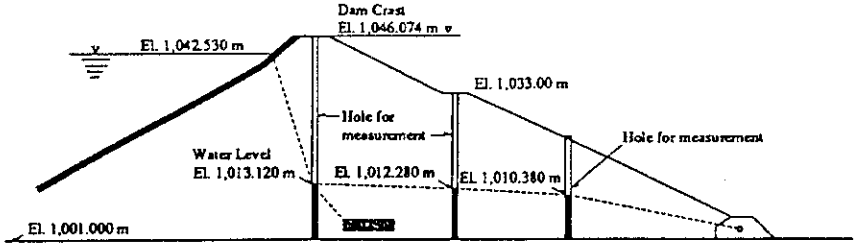


No.	Date	Reservoir water level (El.m)	Total seepage from 26 relief wells (litre/sec)	Total seepage through dam body (litre/sec)
(1)	23, Dec. '83	1,042.405	31.18	63.5
(2)	12, Dec. '84	1,042.540	27.92	54.0
(3)	5, Dec. '86	1,042.450	32.96	71.8
(4)	24, Nov. '88	1,042.452	29.81	62.5
(5)	21, Nov. '89	1,042.380	21.69	57.9
(6)	15, Nov. '90	1,041.800	23.33	63.3
(7)	28, Nov. '90	1,042.525	22.82	62.5
(8)	20, Nov. '92	1,042.530	23.48	63.3
(9)	31, Dec. '93	1,042.538	20.52	63.3

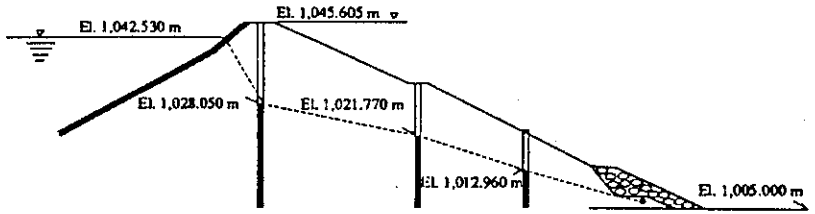
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.10 Seepage Volume at Each of Original 26 Relief Wells



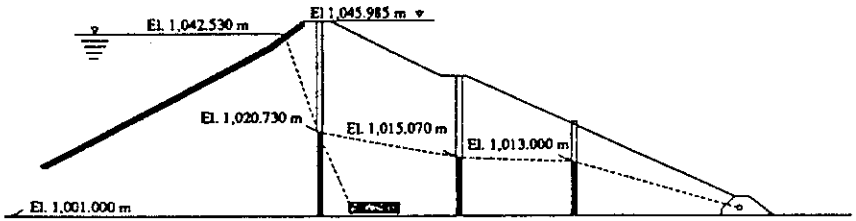
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.11 Cross Section of Dam at IP - 63.3 m (Surveyed on August 5, 1994)



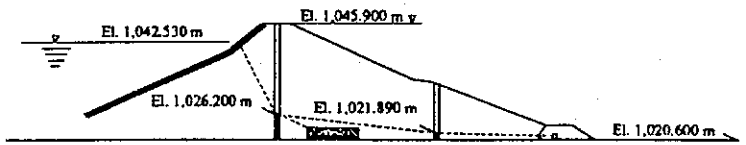
Section No. S 2 + 40 m



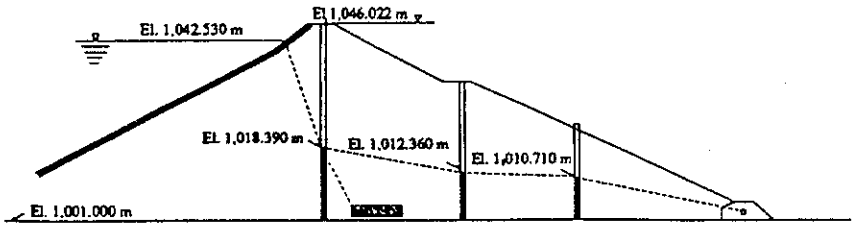
Section No. IP– 38 m



Section No. S 4 + 10 m



Section No. S 12

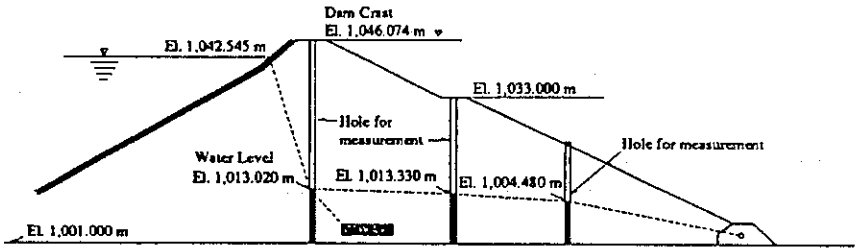


Section No. S 8

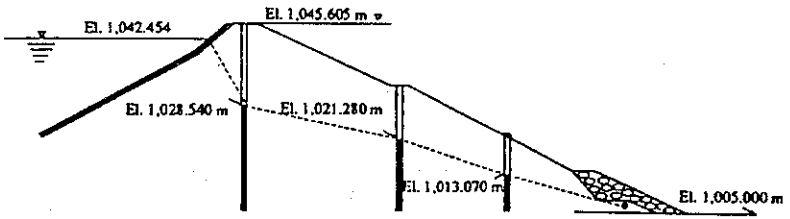
Note

Locations of the Dam Sections are shown in Figure 6.8.

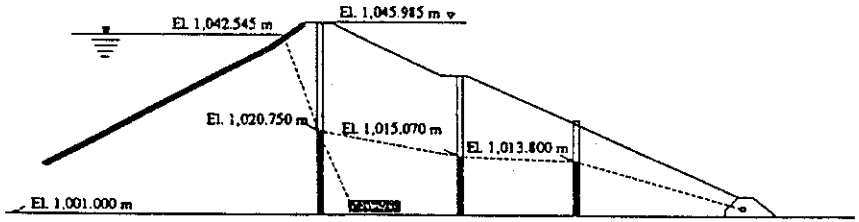
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.12 (1) Water Surface in Dam Body (Measured on December 1992, Reservoir Water Level: El. 1,042.530 m)



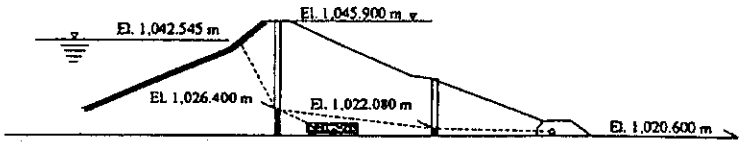
Section No. S 2 + 40 m



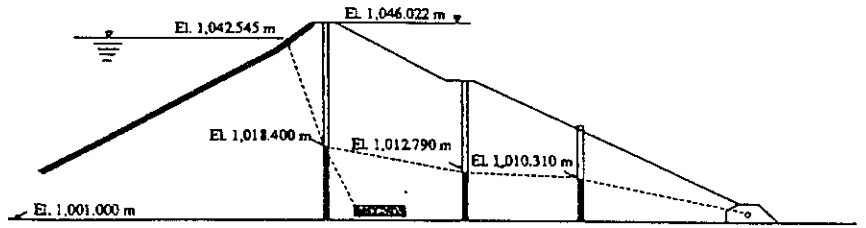
Section No. IP- 38 m



Section No. S 4 + 10 m



Section No. S 12

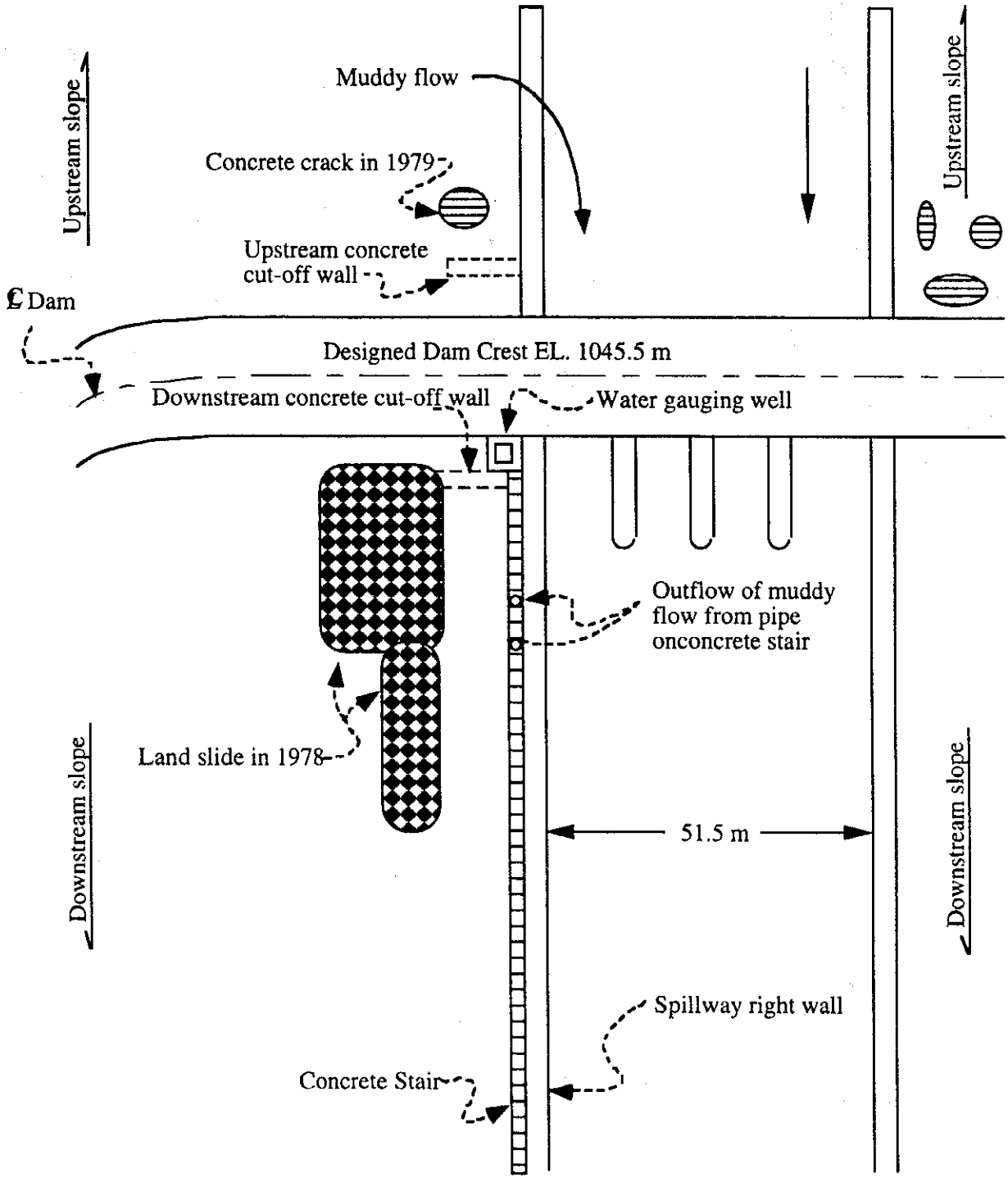


Section No. S 8

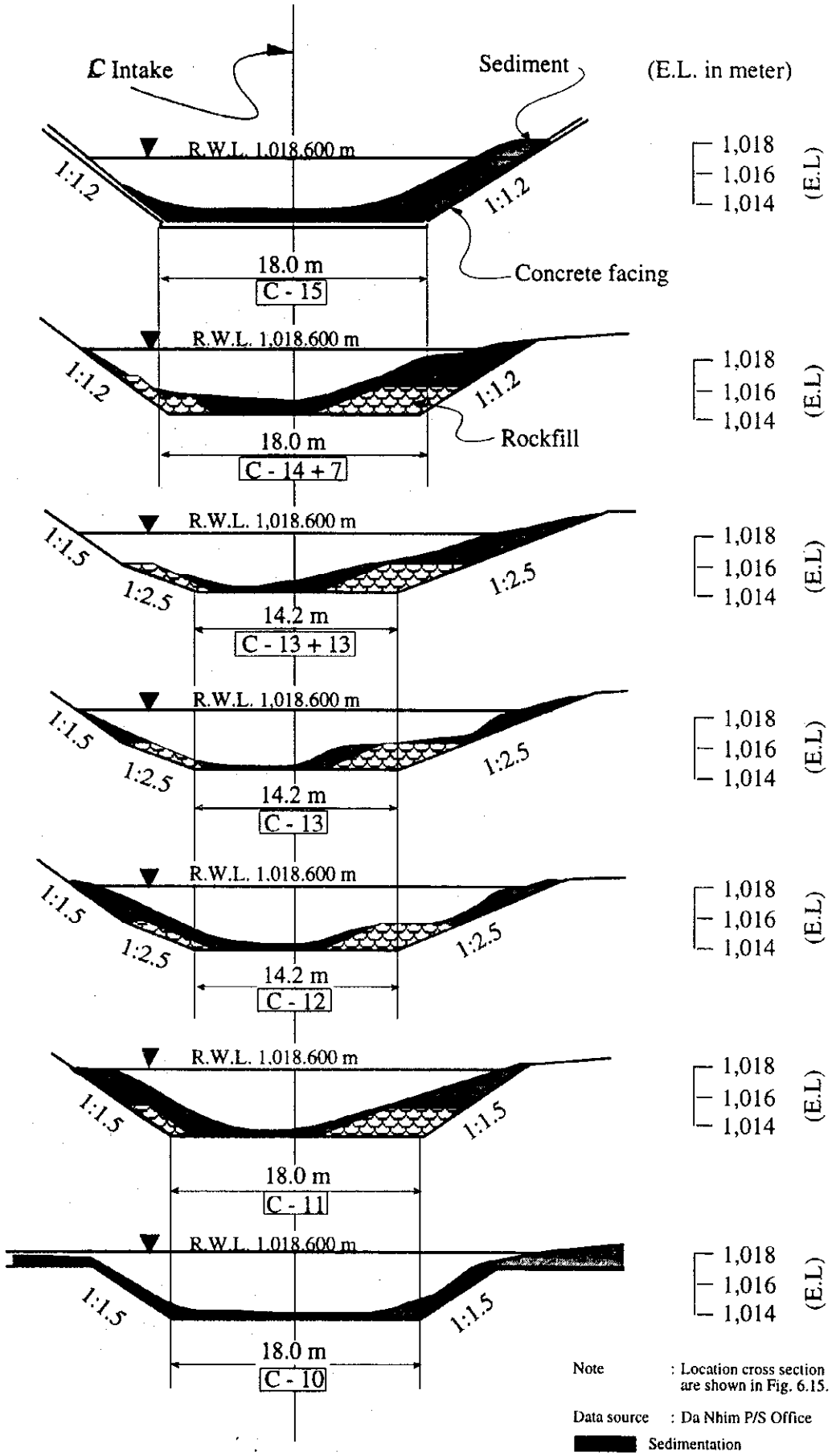
Note

Locations of the Dam Sections are shown in Figure 6.8.

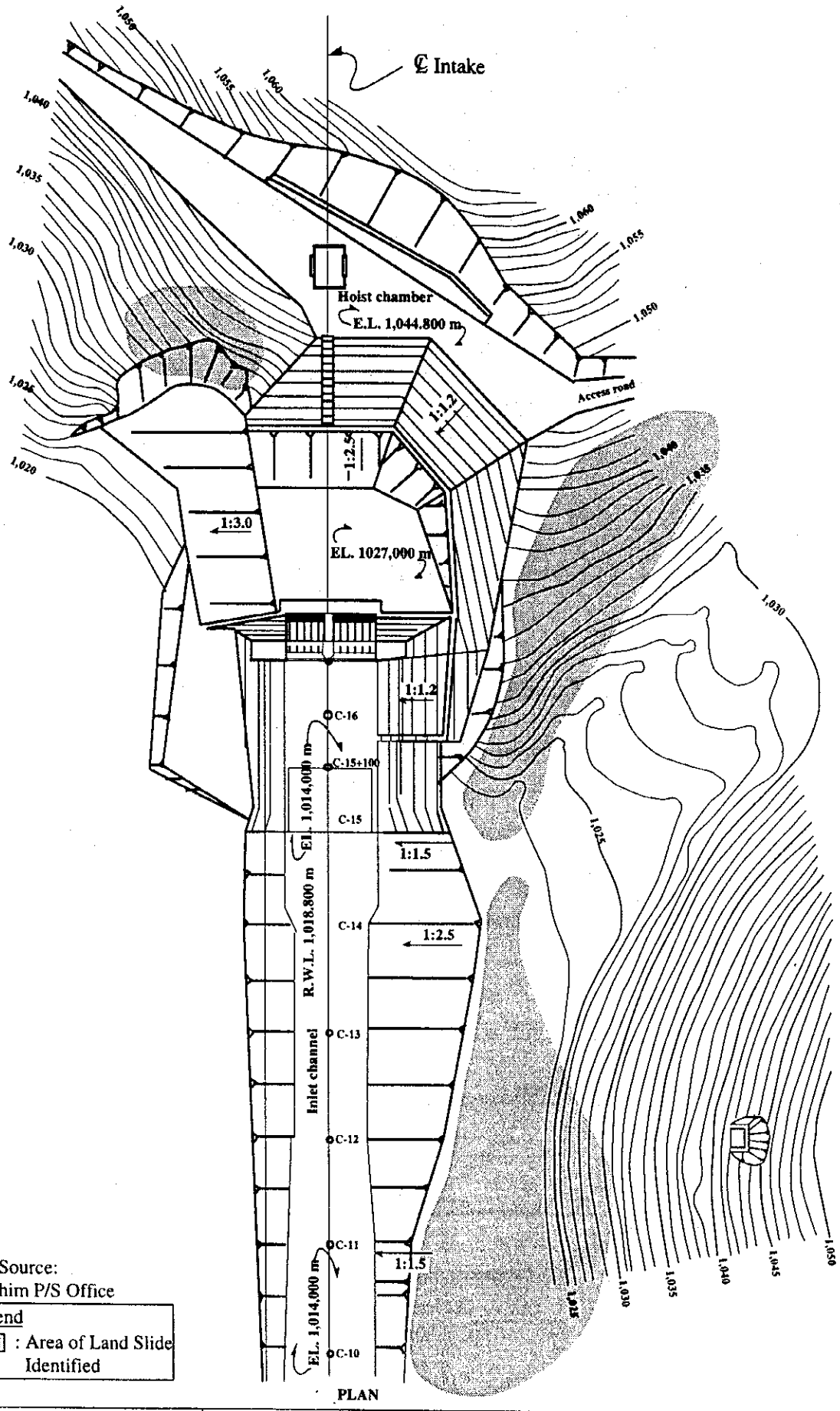
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.12 (2) Water Surface in Dam Body (Measured on December 1992, Reservoir Water Level: El. 1,042.530 m)



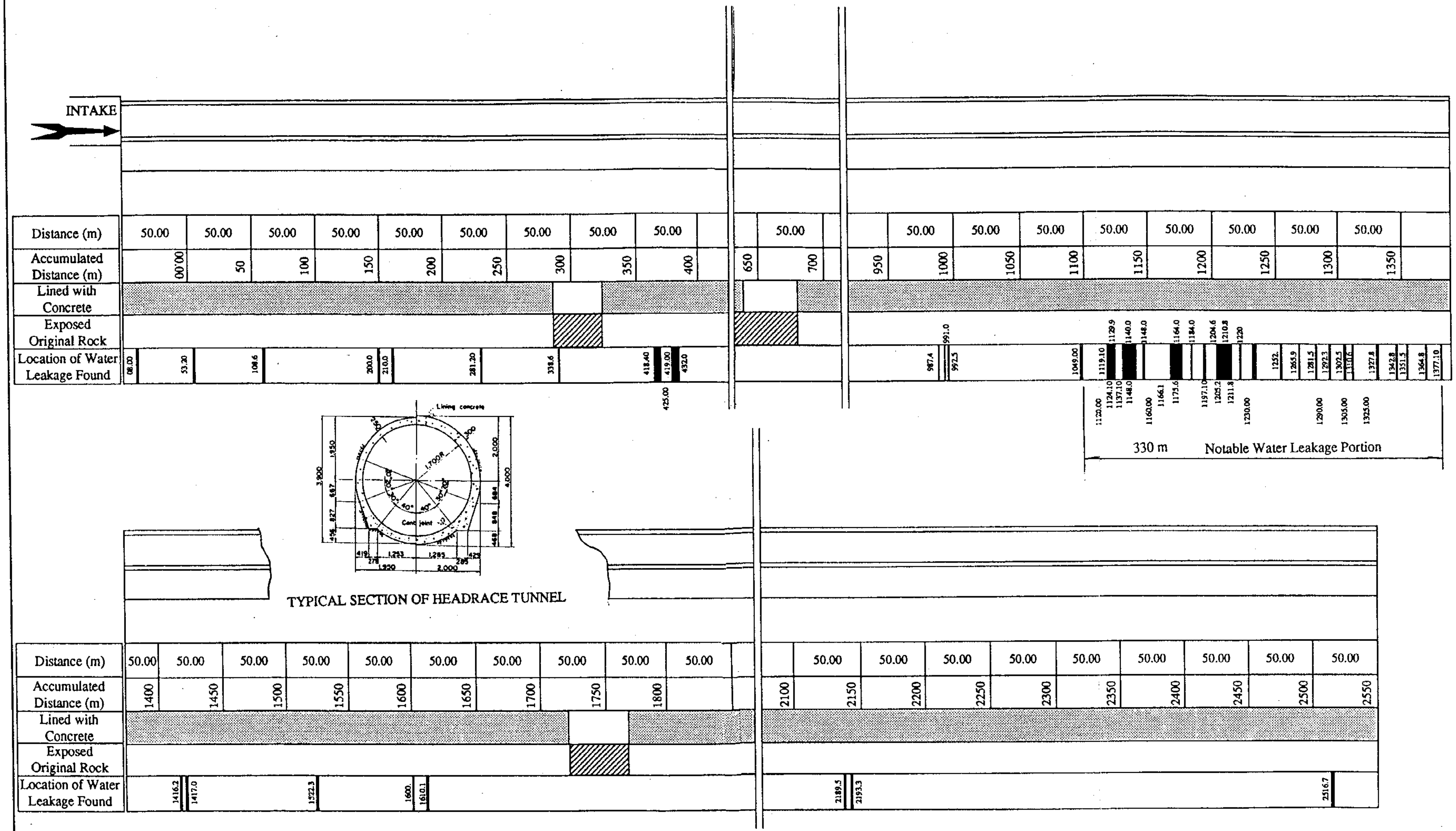
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.13 Schematic Location Map of Occurrence of Past Issues in Contract Portion and Spillway Right Wall



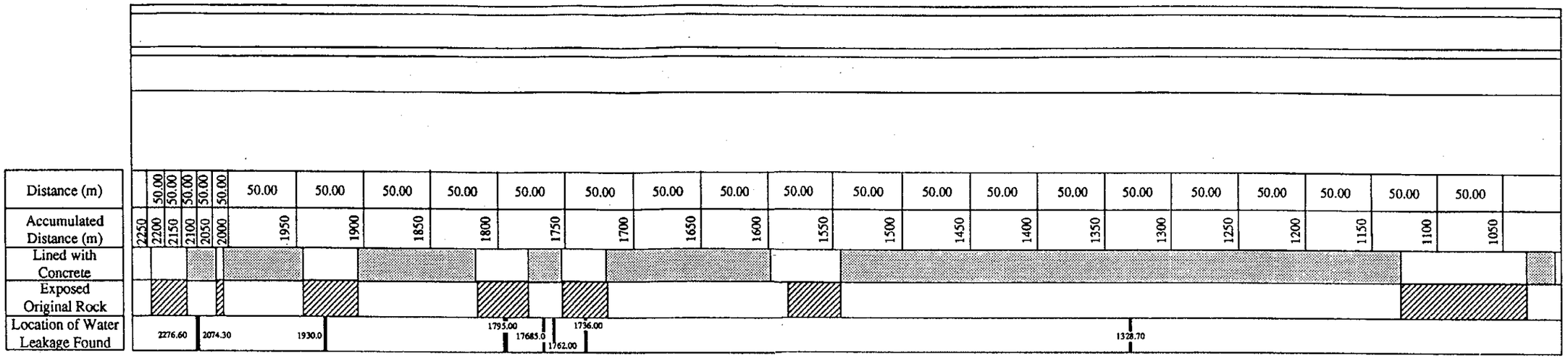
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.14 Cross Section along Inlet Channel Surveyed in 1992

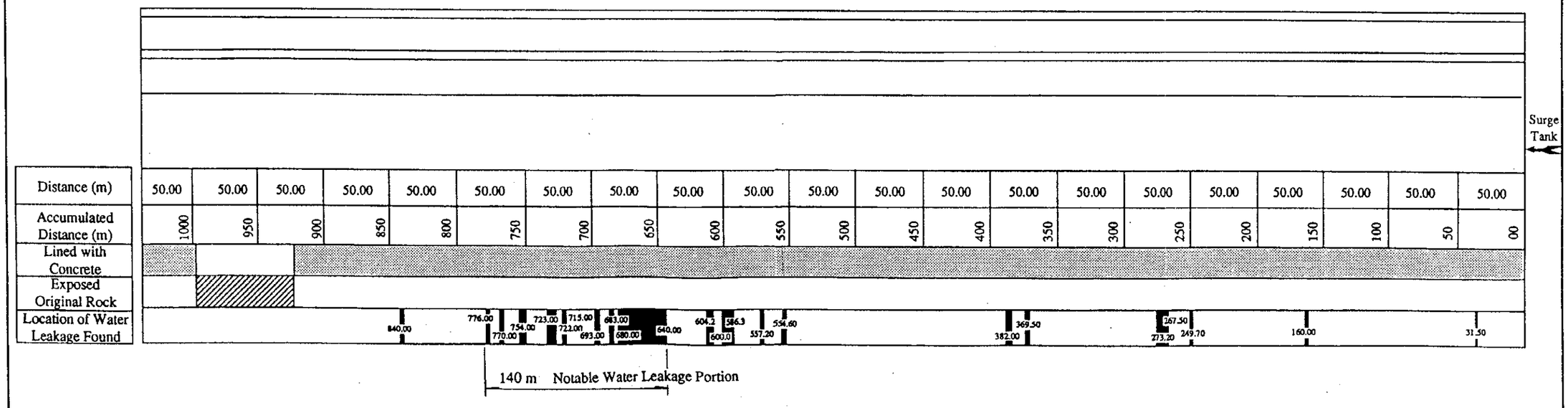


FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.15 Location of Land Slide Occurring around Inlet Channel of Intake Structure

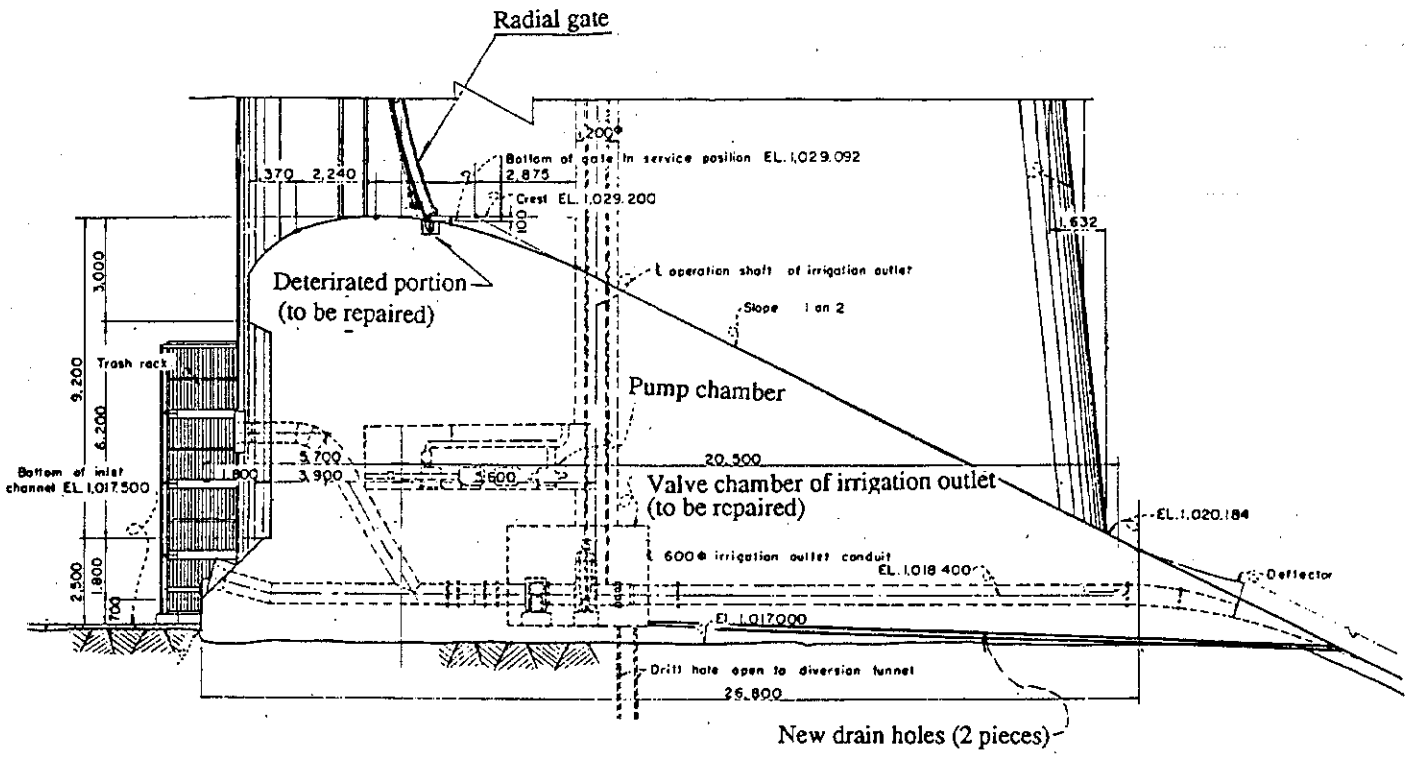


FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.16 (1) Water Leakage in Headrace Tunnel, Inspected in March 1992 (between Intake and 2,550 m Downward of Intake)



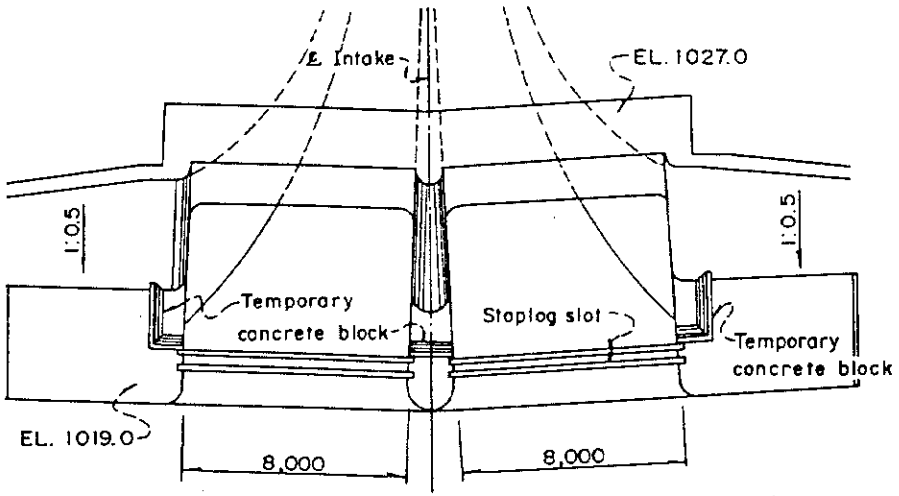


FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.16 (2) Water Leakage in Headrace Tunnel, Inspected in March 1992 (between Surge Tank and 2,250 m Upward of Surge Tank)

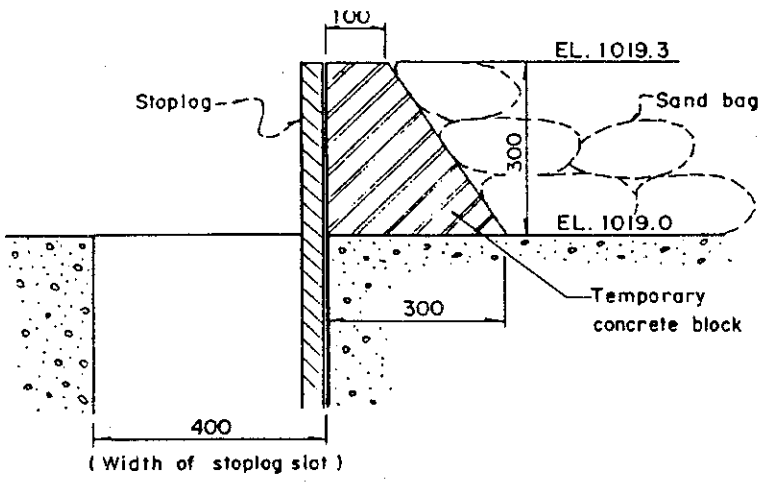


TYPICAL SECTION OF OVERFLOW WEIR PORTION OF SPILLWAY

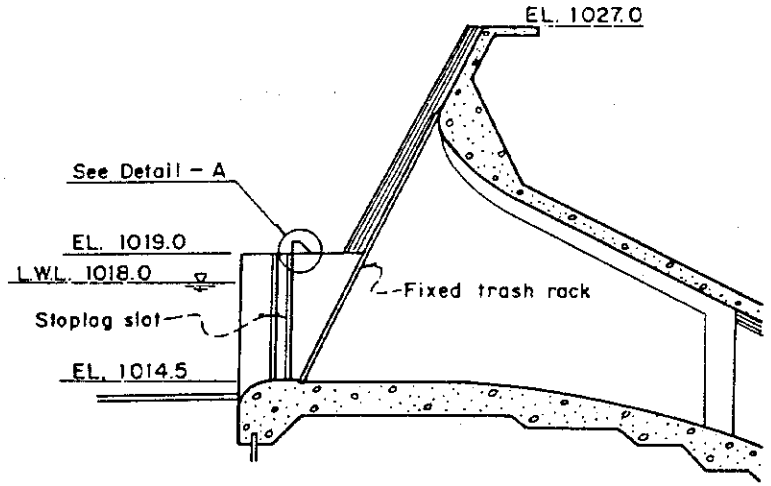
FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.17 Urgent Rehabilitation Works for Spillway



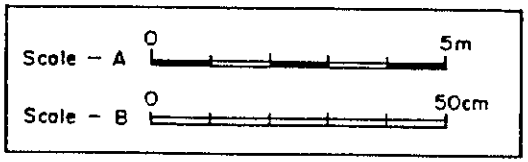
PLAN Scale - A



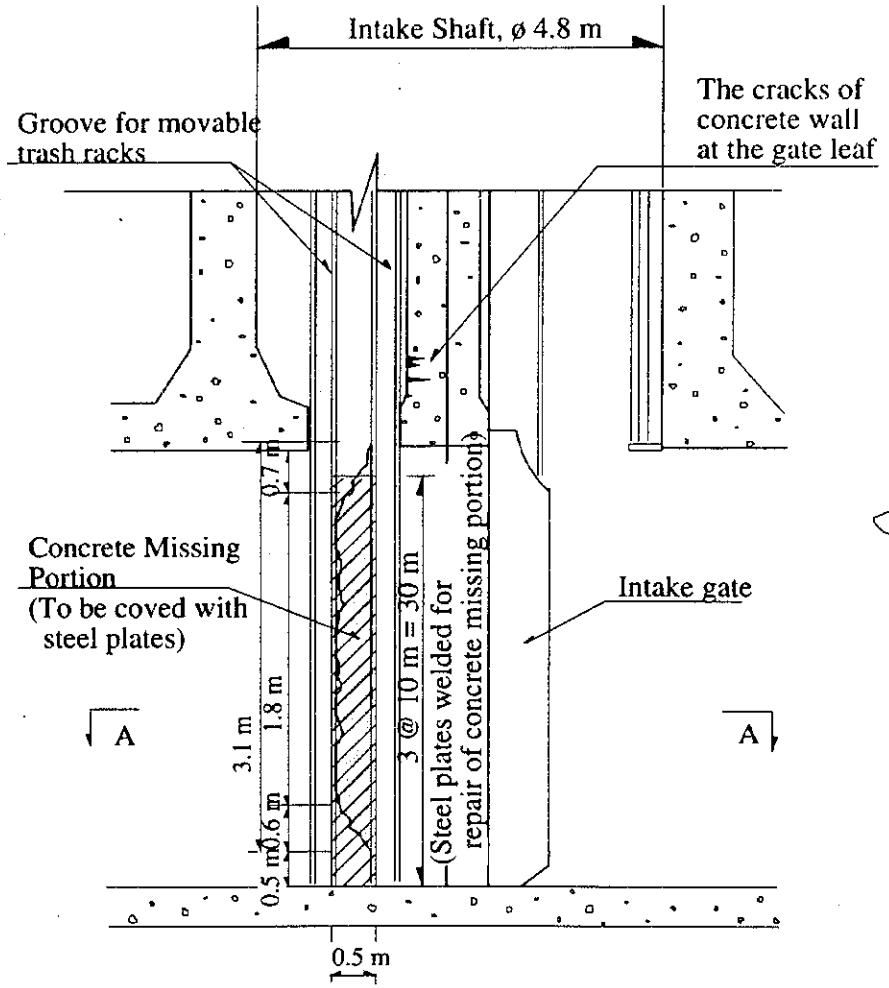
DETAILE- A Scale - B



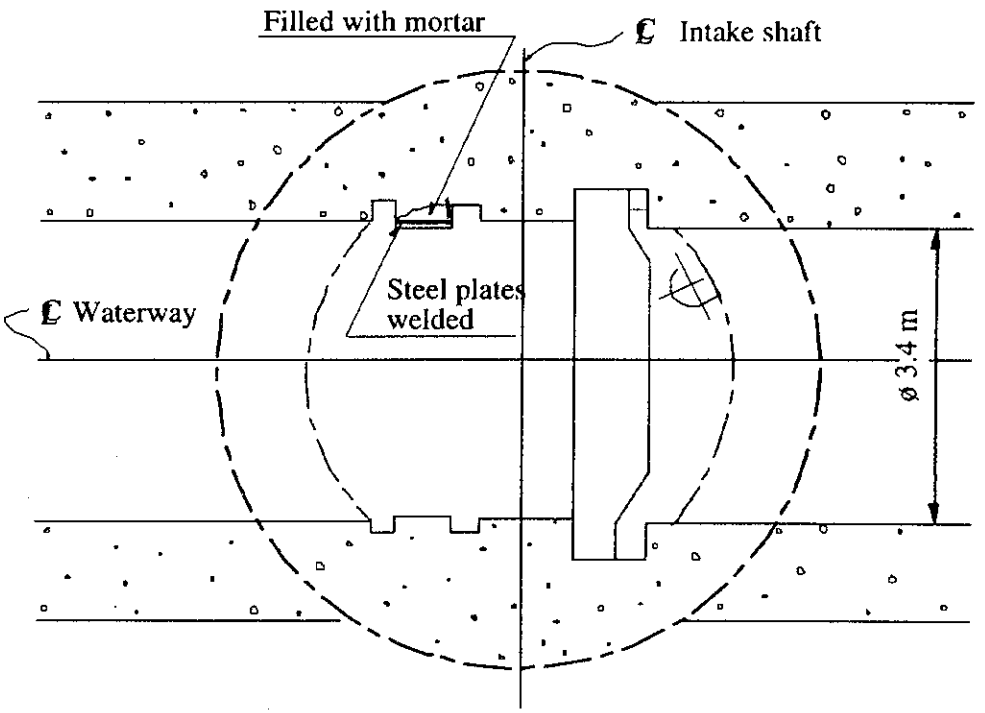
PROFILE Scale - A



FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.18 Provisional Works for Repair of Guide Frame



PROFILE OF GUIDE FRAME PORTION FOR MOVABLE TRASH RACKS AND INTAKE GATE



SECTION A - A

FEASIBILITY STUDY ON REHABILITATION OF DA NHIM POWER SYSTEM	MINISTRY OF ENERGY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 6.19 Alternative Method for Repair of Guide Frame for Movable Trash Racks