- Where the canal turns, a corner box is equipped to assure the smooth water flow at the corner.

- A precast concrete check plate is set at the downstream side of turnout structure on the main irrigation canal to supply water properly to the branch canal.

The required quantities of the irrigation facilities for the designed two blocks are summarized in Table 5-1.

5.3.4 Basic Design of Pump House and Operator Hut

1) Pump house

The pump house is planned as follows, though the definite elevations and dimensions will be determined in the detailed design in the future.

(1) The size of pump house is 13.50 m^2 (5.0 m x 2.7 m) x 2.7 ~ 2.8 m high considering that of existing TIATSP pump house, and size of pumps and engines to be installed as shown in Fig. 5-2.

(2) The pump house is constructed with the brick masonry walls of 25 cm-thickness and the reinforced concrete roof with a hole of 0.9 m x 0.9 m provided for pump installation. The foundation is also made with brick and the floor is of plane concrete. The roof is finished with mortar plastering and is inclined so as to drain rain water.

(3) The brick masonry wall is finished with ruled pointing.

(4) The width of entrance is to be 1.2 m so as to bring the facilities such as engine and pump into the house and the double swinging doors will be installed. To facilitate ventilation and lighting, two windows are

provided and a lattice is fixed for protecting the facilities from robbery.

(5) The pump and engine are installed on an unseparated foundation base.

(6) No lighting facility is provided because the pump is operated for only 12 hours in the daytime. When the night time operation is required, a kerosene lamp can be used.

2) Operator hut

The operator hut is constructed adjacent to the pump house for the operator's rest during the pump operation. Though the exact location and the definite dimensions and elevations will be determined during the detailed design, the preliminary design is made as follows.

(1) The size of the operator hut is 9.72 m^2 (3.6 m x 2.7 m) x 2.7 ~ 2.8 m high as shown in Fig. 5-2.

(2) The operator hut is constructed with 25 cm-thick brick walls and mortar-finished concrete roof and floor as same as the pump house.

(3) The walls are finished with ruled pointing and the floor is finished with mortar.

(4) Two windows are provided to facilitate lighting during the daytime, and no lighting facility is provided because the pump is operated only during the daytime. When the night time operation is required, a kerosene lamp can be used.

(5) The lattice is provided on windows for protecting the operator from robbery.

3) Baffle tank

A pump house is equipped with a baffle tank to still the water discharged from the pump. The preliminary design of the baffle tank is made as stated below.

(1) The tank is constructed with brick masonry.

(2) The baffle tank is composed of the delivery and stilling boxes separated by a brick masonry wall of 25 cm thickness. The width of boxes is determined to be 0.8 m taking into account the diameter of the delivery pipe. The pumped water is received in the delivery box and flows into the stilling box. A V-notch (90°) and a water level gauge are installed to measure the pump discharge. The lengths of the delivery and the stilling boxes are 1.25 m and 1.5 m respectively. A general profile of the baffle tank is shown in Fig. 5-3.

The following equation is applied for discharge calculation.

$$Q = K \cdot H^{5/2}$$

$$K = 1.354 + \frac{0.004}{H} + (0.14 + \frac{0.2}{\sqrt{D}}) (\frac{H}{B} - 0.09)^2$$

where, Q : Discharge (m^3/sec)
H : Overflow depth (m)
K : Coefficient
D : Height from bed of stilling box to vertical angle to the notch (= 0.75 m)
B : Width of box (= 0.80 m)

Q (l/sec)	H (cm)
50	26
40	24
25	21

(2) The V-notch made of 5 mm-thick steel plate is manufactured as shown in Fig. 5-3.

5.3.5 Basic Design of Irrigation Canals and Related Structures

1) Irrigation canals

The main irrigation canals is constructed with one layer-brick masonry because of its cheap construction cost and simple repair and maintenance. The canal section will be same throughout the entire canal length. The following two types of canal will be applied to the development blocks, according to the design discharge of the production wells in each block (Fig. 5-4).

Description	Type-I	Type-II
Size B (m)	0.35	0.35
H (m)	0.42	0.35
Design Discharge (l/sec)	more than 50	45 ~ 30

The hydraulic calculation is made by the Maning formula as follows.

(1) Roughness coefficient : n = 0.014
(2) Allowable velocity : 0.4 ~ 1.0 m/sec
(3) Free board : One third of canal height
(4) Maximum water depth : Type-I 0.28 m
Type-II 0.23 m

In D-7 block, the design discharge is 40 l/sec, however, canal Type-I is applied to gentle slope sections. The principal features of main canals designed are shown in Table 5-2.

The embankment is made by using bulldozers and vibration rollers up to the bottom elevation of the foundation concrete, and after placing the foundation concrete (5 cm thick) the brick masonry canal is made manually. The inside face of canal is finished with mortar plastering. The embankment of both sides of the brick masonry canal will be made by manpower and bulldozer which will gather soils from the fields.

2) Road crossing and cattle pass

In case that the canals cross the existing roads and run across the area where cattles pass frequently, a road crossing or a cattle pass is provided. These structures are of precast concrete slab with soil covering of 20 ~ 30 cm. A road crossing is equipped with a drain pipe so as to drain water on the road. The following types of structure are applied.

Kind of Crossing	Length
Road Crossing (Large)	6 m
Road Crossing (Small)	1 m
Cattle Pass	4 m

The cattle pass is provided every about 400 m along the main canal.

To facilitate manual installation, the width, length and thickness of the slab are unified to be 48 cm, 1 m and 12 cm, respectively. The elevation of the structures will be determined in the detailed design in the future.

3) Turnout

Where the irrigation water is taken into the branch canal from the main canal, an orifice type turnout structure is provided. A precast concrete pipe of 20 cm diameter is installed to connect the turnout and the stilling box installed at the beginning point of the branch canal. To seal an entrance

of the turnout with soil and grass when not used, iron bars are fixed at the entrance. At the downstream side of the main canal, a precast check plate is fixed to stop the water flowing to the downstream reach of the main canal when the water is taken into the branch canal. The size of the turnout structures is shown in Fig. 5-4.

The discharge (Q) to be taken from the main canal is calculated by the following equation.

$$Q = 0.0188 \sqrt{2gH}$$

where, H = water depth of main canal

The elevation of turn out will be determined in the detailed design in the future.

4) Drop

When the canal slope is so steep that the flow velocity therein exceeds the allowable maximum velocity, a drop structure is provided to reduce the velocity. The drop height will be 0.5 m and the length of the stilling box be 1.0 m. Two types of drop will be applied as shown in Fig. 5-5.

5) Division and corner boxes

A division box or a corner box is provided at the place where the main canal is branched off or where the main canal turns at lager than 40°. These boxes are designed so as to have a function of drop structure, where it is necessary. The boxes are constructed with brick masonry of 25 cm-thick wall and 13 cm-thick bottom. Six types of box are applied as shown in Fig. 5-5 according to the canal type and difference of water depth. The elevation of the boxes will be determined in the detailed design in the future.

6) Crossdrain

Where a stream or natural drain crosses the irrigation canal and/or where water stagnation occurs, a crossdrain is provided to let flow pass under irrigation canal.

The crossdrain is constructed with 0.8 m-precast concrete pipes and brick walls at its both ends. To protect the canal embankment from erosion and scouring, gabion mats are provided at the downstream side of the crossdrain.

7) Check plate

A precast check plate is provided at the downstream side of the turnout structure to facilitate water management service. The plate is composed of precast concrete plate and lattice of the iron bars, and two types of plate are applied as shown in Fig. 5-6.

5.4 Equipment and Materials Plan

5.4.1 Adjustment and Repair of Existing Equipment and Materials

According to the inventory survey for the deep tubewell and civil work construction equipment and materials granted under a KR-2 aid, available quantities of such equipment and materials have been reduced year by year because of poor storage in open air, incomplete operation and maintenance, and insufficient adjustment and repairs.

For the construction of eight deep tubewells and nine irrigation units envisaged for two development blocks D-7 and D-15, it is essential not only to grant considerable quantities of new equipment and materials but also to adjust and repair the existing KR-2 ones completely, since the KR-2 ones are utilized as much as possible.

Major adjustment and repair to the KR-2 equipment and materials are itemized below:

(1) Adjustment and repair of three drilling rigs;
(2) Overhaul and repair of mud pumps equipped for the above rigs;
(3) Repair and maintenance of transportation and construction equipment and vehicles;
(4) Reinforcement of the existing Johnson type screens;
(5) Service and repair of submersible pumps for pumping test;
(6) Scraping-off of rust and corrosion from screws of the pump shafts and column pipes, and anti-corrosive measure for them; and
(7) Extension of pump shaft and column pipe of some of the existing vertical turbine pumps (from the original 40 m to 57 m).

5.4.2 Total Quantity of Equipment and Materials Required for Construction

When eight production tubewells and nine irrigation units, excluding a test tubewell in D-7 block and an existing tubewell and its irrigation unit in D-15 block, are constructed, mainly using the equipment and materials granted under the KR-2, during a period of five months and a half as mentioned in the following section 6.5, the equipment and materials listed in Table 5-3 are required as a whole. The materials available in Nepal such as cement, sand, gravel, brick, reinforcement steel, timber, fuel, etc. are not included in the Table 5-3.

5.4.3 Quantity and Features of Equipment and Materials to be Newly Granted

1) Quantity of equipment and materials to be granted

Table 5-3 shows the equipment and materials necessary for the construction of 8 production tubewells and 9 irrigation units in the two (2) blocks of D-7 and D-15. The equipment and materials consist of KR-2 ones provided by HMGN and new ones to be granted by GOJ. Among the equipment and materials to be granted, major ones are summarized below.

(1) Materials and equipment for drilling and finishing

1. Spare parts, tools and consumables for drilling rig (Spare parts of mud pump and drilling tools are essential.)			for 3 rigs
2. Tricone bit	17-1/2"	H type:	3 nos
		MH type:	5 nos
3. Tricone bit	14-3/4"	H type:	3 nos
		MH type:	5 nos
4. Roller cutter type hole opener	14-3/4" → 17-1/2"		4 nos

There is no stock for the above bits and opener. Based on the experience of drilling test tubewells in the basic design study phases-I and II, it is judged to consume each one bit per one deep tubewell on an average for the above items (2) and (3). The reaming from 14-3/4" to 17-1/2" is made using a roller cutter type hole opener after drilling by a 14-3/4"-bit for an installation of pump housing.

5. Submersible motor pump for pumping test to production tubewell (with diesel engine generator): 1 no.

   Submersible pump to be installed in 8" pipe is not available at present, though it is required for pumping tests to production wells. The pump enabling a discharge of 15 l/sec at 70 m head is to be purchased.

6. Column pipes and shafts of vertical turbine pumps: for 4 pump sets

   As majority of shafts and column pipes of the existing vertical turbine pumps are severely rusted or corroded, it is difficult to judge whether those shafts and pipes are usable or not in the implementation stage. Therefore, the shafts and pipes for 4 pump sets are to be procured from Japan. In this context, usability of the existing shafts and column pipes is to be checked in detail and desirable storage method for the future use of them is also to be studied.

7. DC engine welder (6.8 kW, 7.5 kVA): 3 sets

   The existing one (1) set being used at present is severely exhausted and not useful in the near future. Accordingly, three sets are to be newly procured; one each of three drilling sites.

8. 22" conductor pipes (L = 3 m, with screw): 72 m

   Because the existing quantity of 24 m will be thoroughly consumed by TIATSP in drilling tubewells in the near future, a 72 m (24 nos) of the conductor pipe is required.

9. 8" rod based wire-wrapped screen (L = 5.5 m): 28 nos. (154 m)

   The exiting Johnson type screens can not be used for the position deeper than 150 m from the ground, even after they are reinforced up to a lateral compressive strength of 16 kg/cm^2 which is practically maximum reinforcement for the existing screens. The strengthened rod based screens with a lateral compressive strength of 28 kg/cm^2, a slot interval of 1 mm and an opening ratio of more than 20% are to be installed in the position deeper than 150 m of each production tubewell.

10. Centralizer for 8" casing pipes and 17-1/2" boreholes: 18 nos.

    There is no stock. It is necessary to use a centralizer per 3 nos. of 8" casing pipes (18 m) to install the pipes vertically in the center of the drilled hole of 17-1/2".

11. Centralizer for 8" casing pipes and 14-3/4" borehole: 16 nos.

    There is no stock. It is required to use a centralizer per 3 nos. of 8" casing pipes (18 m) to set them vertically in the center of the drilled hole of 14-3/4".

12. 6" delivery pipe with flange and elbow (L = 1.2 m): 10 nos.

    There is no stock. They are to be set at outlet of vertical turbine pumps to be installed in 10 production tubewells.

13. 3 m^3 portable water tank (made of water proof vinyl): 6 nos.

Six (6) tanks are available at present. Since the drilling and construction of irrigation facility are carried out at six sites at the same time, a total of 12 nos., 2 nos. each site, is required.

14. Centrifugal pump with diesel engine for water supply at drilling site: 1 sets

Two (2) sets are available at site. Because three drilling sites require one (1) each, additional one set is to be purchased.

15. Drilling mud and mixture

The following materials are to be brought from Japan, because the Indian products available at site are of poor quality:

	Quantity per production well	Total
- Bentonite	4,000 kg	32 ton
- CMC	500 kg	4 ton
- Barite	300 kg	2.4 ton
- Mud cleaner	300 kg	2.4 ton

16. Lubricating oil for drilling rigs

	Quantity per rig	Total
- Hydraulic oil	450 lit.	1,350 lit
- Gear oil	150 lit.	450 lit

These oils are to be brought from Japan because the Indian products available at site are of poor quality.

(2) Vehicles for transportation

1. 12.5 ton cargo truck equipped with 6 ton crane: 1 unit

   Since there is no large crane truck to hoist and load long pipes, screens and heavy material onto truck, a 10 ton crane truck is required.

2. 1 ton 4WD pick-up truck: 3 units

   The existing 5 pick-up trucks are still useful at present, but extremely deteriorated, so that they can not be used in the future. Three drilling sites require one unit, respectively.

3. Spare parts for existing transportation equipment: required quantity

   There is no stock of spare parts necessary for repairing and adjusting almost all of the existing transportation equipment. Procurement of necessary spare parts including tires are therefore essential.

(3) Construction equipment

Spare parts necessary for operation and maintenance of existing construction equipment: Required quantity

Some spare parts are essential for repairing some of the existing construction equipment at present, and considerable quantity of spare parts for the existing construction equipment will be required during the construction period.

(4) Vehicles for construction supervision

1. 4WD wagon type jeep: 1 unit

Three (3) nos. of wagon type jeep are available at present. They are to be used by the consultant, the drilling contractor and the civil contractor for their management purpose (one each). However, the other one (1) unit is required for the topographic survey and canal survey to be carried out by the consultant and the civil contractor.

2. 4WD jeep: 4 units

Four (4) nos. of 4WD jeep are required to give one (1) to the consultant for construction supervision, one (1) to two (2) mechanical engineers (one for rigs and the other for equipment) for their field work, and two (2) to the civil contractor for their construction sites (three irrigation units are constructed at the same time).

2) Features of additional equipment and materials

The following is main features of the additional equipment and materials to be procured for the construction of eight production wells and irrigation facilities of nine units.

Name of equipment & materials	Outline of the specification

(1) For the construction of the production well

1. Spare parts for 3 units of rig
: for YRD501R

2. Spare parts for 3 units of mud pump
: for mud pumps (type: NAS-7)

Name of equipment & materials	Outline of the specification

3. Tricone bits
   : Size: 17-1/2" and 14-3/4", type: H and MH, with 6-5/8" REG pin thread

4. 22" conductor pipe
   : L = 3 m, thickness: 12 mm, with screw

5. 8" rod based, wire-wrapped screen
   : L = 5.5 m, slot size: 1 mm, opening ratio: 20% or more, collapse strength: 28 k/cm^2 or more, OD: 216 mm or less, ID: 197 mm or more, low carbon steel made with ring type connection in both ends

6. Centralizer
   : Dia.: 17-1/2" ~ 8" and 14-3/4" ~ 8"

7. Hole opener
   : Roller cutter type with a pilot cutter, 14-3/4" → 17-1/2", with 6-5/8 REG: regular type male screw

8. DC engine welder
   : 6.8 kW, 50 Hz - 240 A, for welding of 2.6 to 5 mm, with 4 cycle diesel engine by water cooling, 7.5 kVA, 3,300 r.p.m., cable: 20 m, with accessory

9. Submersible motor pump for pumping test
   : (a) Diesel generator; 43 HP, 400 V ~ 33 kVA, 50 Hz
   (b) Submersible motor; 50 Hz, 3 phases, 2 poles, 400 V ~ 30 kVA, submersible cable 85 m x 2, star-delta starting

Name of equipment & materials	Outline of the specification

(c) Pump; maximum outside dia. 145 mm, capacity 20 l/sec (at pumping head 70 m), discharge pipe ø80 mm ~ 2.75 m x 26 nos., discharge diameter 80 mm

(d) Accessories; control panel, water table detector and controller, outlet pipe ø80 mm ~ 2,75 m x 5 nos., 90° bent pipe, sluice valve and check valve, etc.

10. Centrifugal pump

: Discharge 2.7 m^3/min or more, with an 8 m long suction hose, a foot valve and 6 HP diesel engine

11. Consumable materials for drilling

: (a) Bentonite: KUNIGERU-VI or equivalent
(b) CMC: first class
(c) Barite: first class
(d) Mud cleaner: TRIOFINE or equivalent

(2) Vehicles for transportation and administration of the project

1. 12.5 ton cargo truck equipped with 6 ton crane truck

: Hoisting capacity: 6 ton, loading capacity of cargo truck: 12.5 ton

2. 1 ton pick-up truck

: 4WD, diesel engine type, road clearance: 0.3 m or more

3. Wagon type jeep

: 4WD, for 8 to 9 passengers in 2 rows of rear seat, diesel engine type

4. Jeep : 4WD, diesel engine type

5. The others (spare parts for the existing vehicles)
: Spare parts such as engine parts, tires, etc. applicable to the existing vehicles.

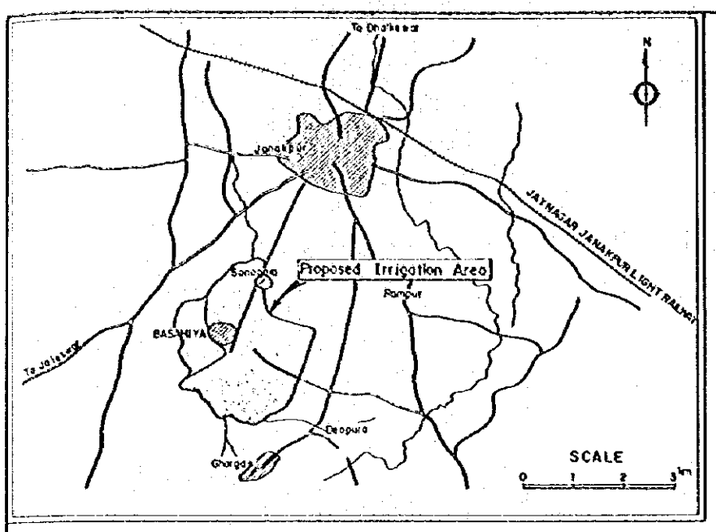
The following is an outline of a drilling equipment required for test boring and long-term groundwater observation well (one well in each block).

Name of equipment & materials	Outline of the specification
Core boring machine : Drilling capacity: 250 m or more in wireline method, HQ size	
Pipes	
- Rod	HQ size or more
- Casing for drilling	PW (12 m), HW (90 m)
- Bit	Diamond bits for PW, HW and HQ Metal crown bits for PW, HW and HQ
- Casing for well	To be applicable in the hole of HQ size, percolated steel pipe with thread
- Long-term water level monitoring recorder	Automatic recorder for 3 month period

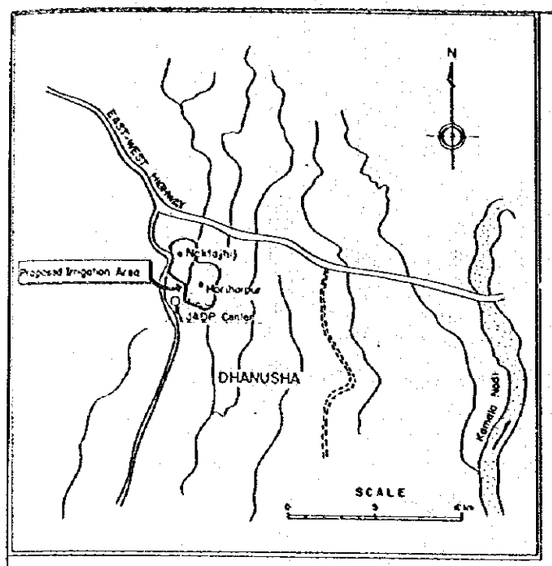
5.5 Basic Design Drawings

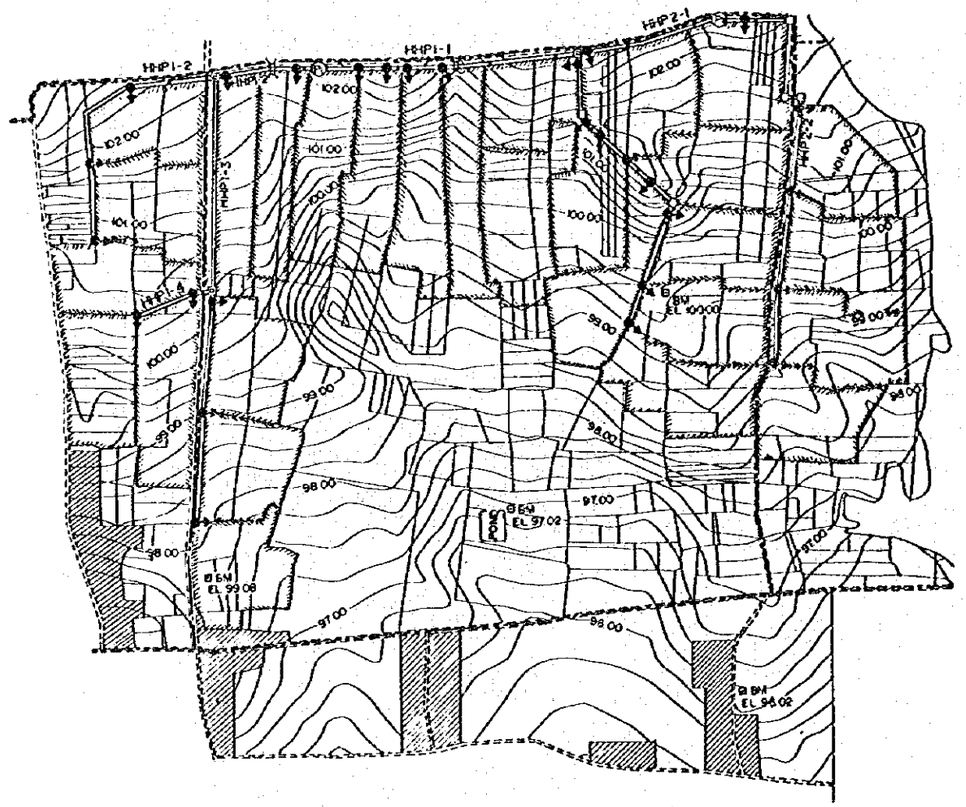
The layout and structure of the irrigation facilities in D-7 and D-15 blocks are shown in the basic design drawings attached herewith. The list of drawings is as follows:

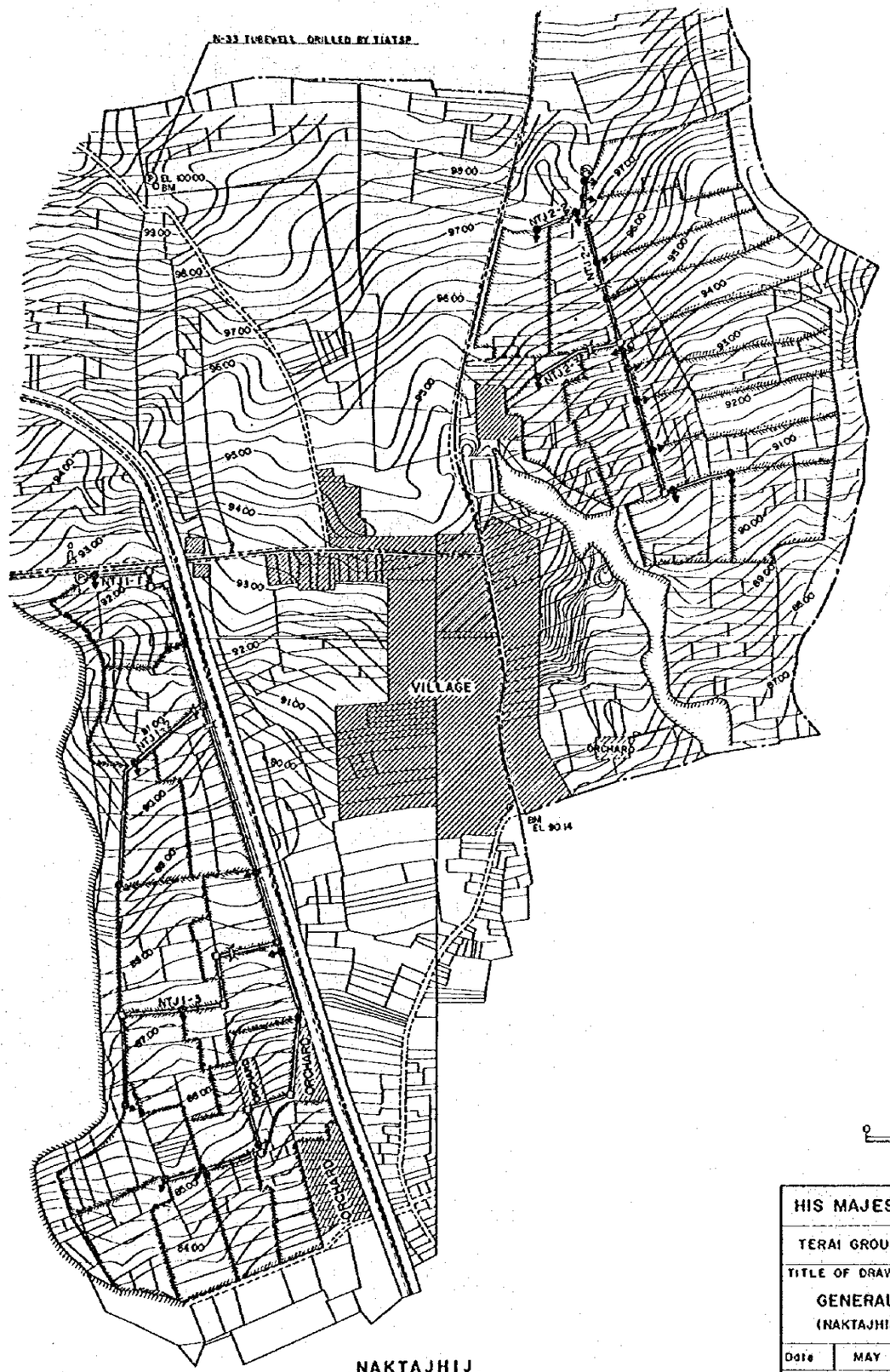
Dwg. No.	Title
0001	GENERAL LAYOUT OF BLOCK D-7
0002	GENERAL LAYOUT OF BLOCK D-15
1001	PUMP HOUSE AND OPERATOR HUT
1002	BAFFLE TANK
1003	TURNOUT, DROP AND PRECAST CHECK PLATE
1004	CROSS DRAIN, DIVISION BOX AND CORNER BOX
1005	CROSS DRAIN ON BSY 1-1
1006	CATTLE PASS, ROAD CROSSING AND TYPICAL CANAL SECTION
2001	PROFILE OF BSY 1-1, 1-2, 2-1 AND BSY 2-2 (BLOCK D-7)
2002	PROFILE OF BSY 3-1, 3-2, 4-1, 4-2 AND BSY 5-1 (BLOCK D-7)
2003	PROFILE OF BSY 5-2, 5-3 (BLOCK D-7)
2004	PROFILE OF HHP 1-1, 1-2, 1-3, 1-4, 2-1 AND HHP 2-2 (BLOCK D-15)
2005	PROFILE OF NTJ 1-1, 1-2, 1-3, 2-1, 2-2 AND NTJ 2-3 (BLOCK D-15)
3001	INSTALLATION OF VERTICAL TURBINE PUMP AND ENGINE (45 l/sec TYPE)
3002	INSTALLATION OF VERTICAL TURBINE PUMP AND ENGINE (60 l/sec TYPE)



HIS MAJESTY'S GOVERNMENT OF NEPAL			
TERAI GROUNDWATER DEVELOPMENT PROJECT			
TITLE OF DRAWING GENERAL LAYOUT OF D-7 BLOCK (BASAHIYA PANCHAYAT)			
Date	MAY 1988	Drawing No.	0001
JAPAN INTERNATIONAL COOPERATION AGENCY			







LEGEND

- Pumping Station
- Main Canal
- Corner Box
- Division Box
- Turnout
- Drop
- Road Crossing
- Cattle Pass, Small Pass
- BM Temporary Bench Mark
- Village Road, Farm Road
- Ward Boundary
- Command Area by Turnout
- Irrigation Area
- POND Pond
- Village & Orchard

SCALE
0 100 200 300 400m

HIS MAJESTY'S GOVERNMENT OF NEPAL

TERAI GROUNDWATER DEVELOPMENT PROJECT

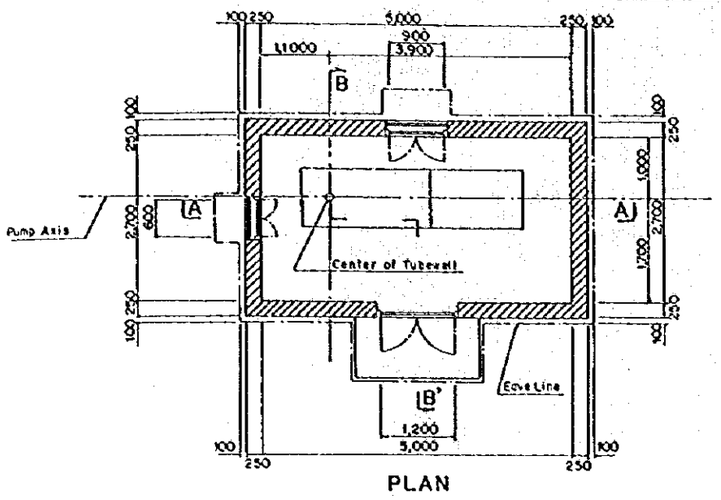
TITLE OF DRAWING

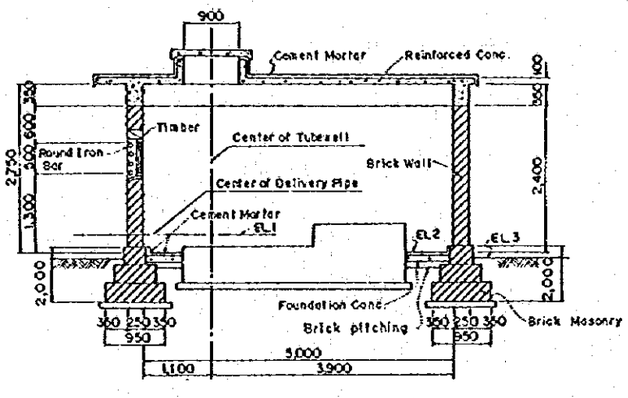
GENERAL LAYOUT OF D-15 BLOCK
(NAKTAJHIJ AND HARIHARPUR PANCHAYAT)

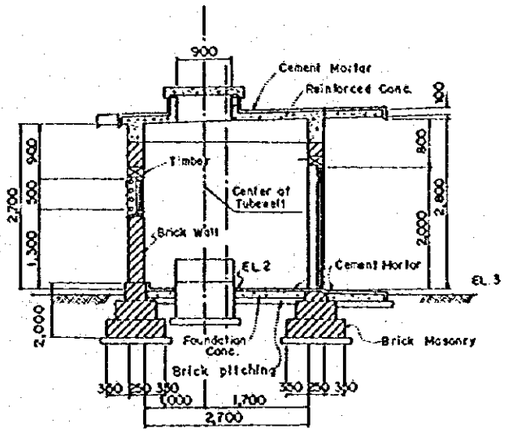
Date	MAY 1988	Drawing No.	0002

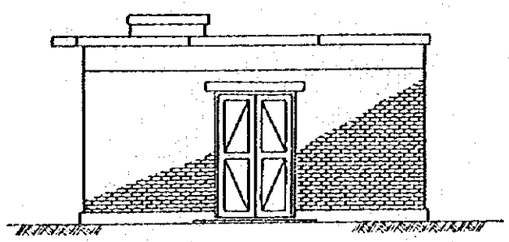
JAPAN INTERNATIONAL COOPERATION AGENCY.

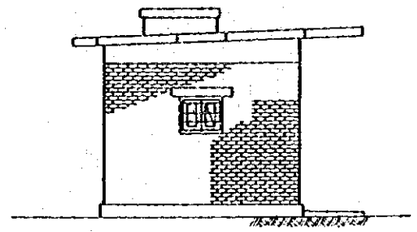
PUMP HOUSE



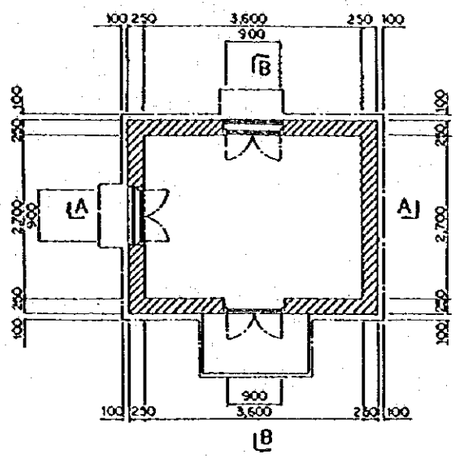


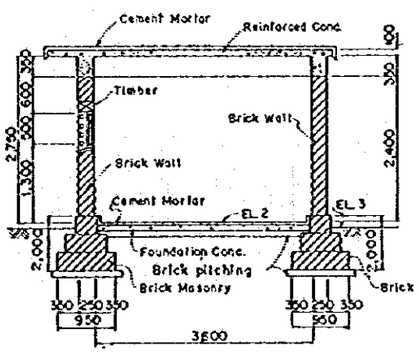


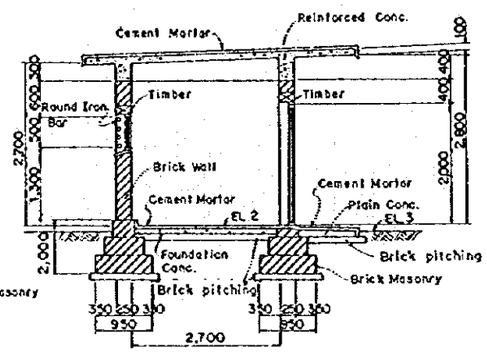


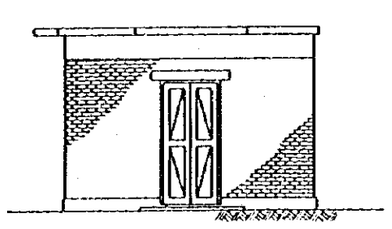


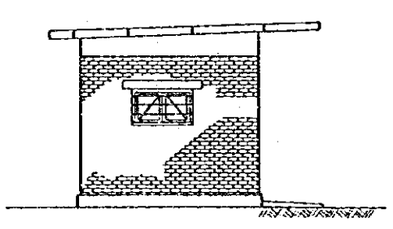
OPERATOR HUT





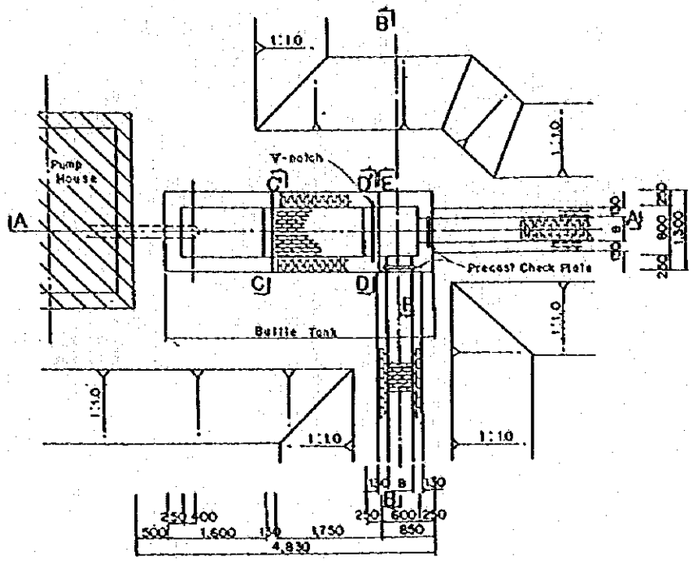




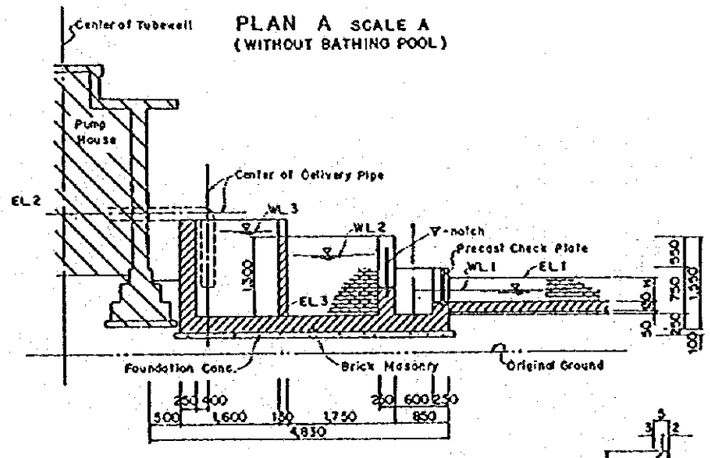


SCALE 0 1 2 3(m)

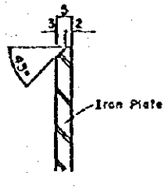
HIS MAJESTY'S GOVERNMENT OF NEPAL			
TERAI GROUNDWATER DEVELOPMENT PROJECT			
TITLE OF DRAWING: PUMP HOUSE AND OPERATOR HUT			
Date	MAY 1988	Drawing No.	1001
JAPAN INTERNATIONAL COOPERATION AGENCY			



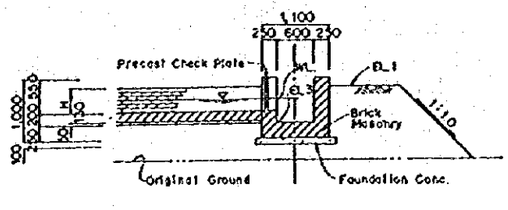
PLAN A SCALE A
(WITHOUT BATHING POOL)



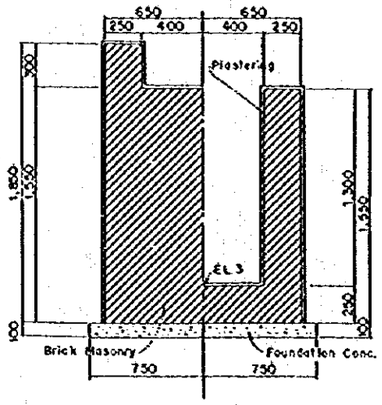
SECTION A-A
SCALE A



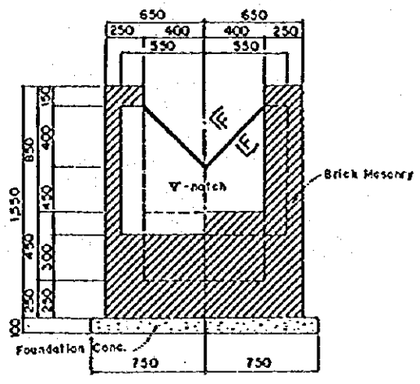
SECTION F-F SCALE C
(V-NOTCH)



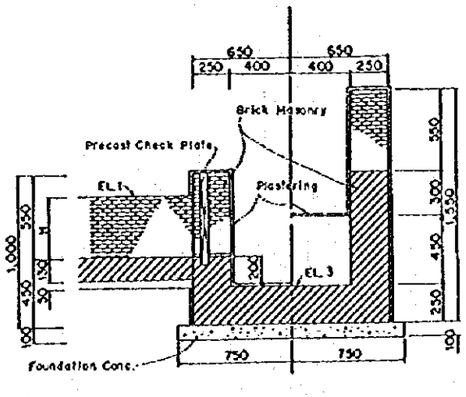
SECTION B-B
SCALE A



SECTION C-C'
SCALE B



SECTION D-D
SCALE B

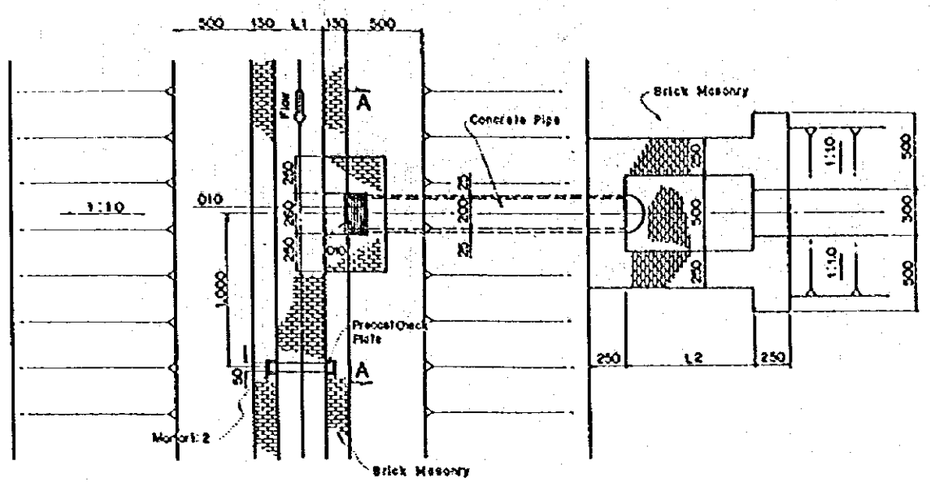


SECTION E-E'
SCALE B

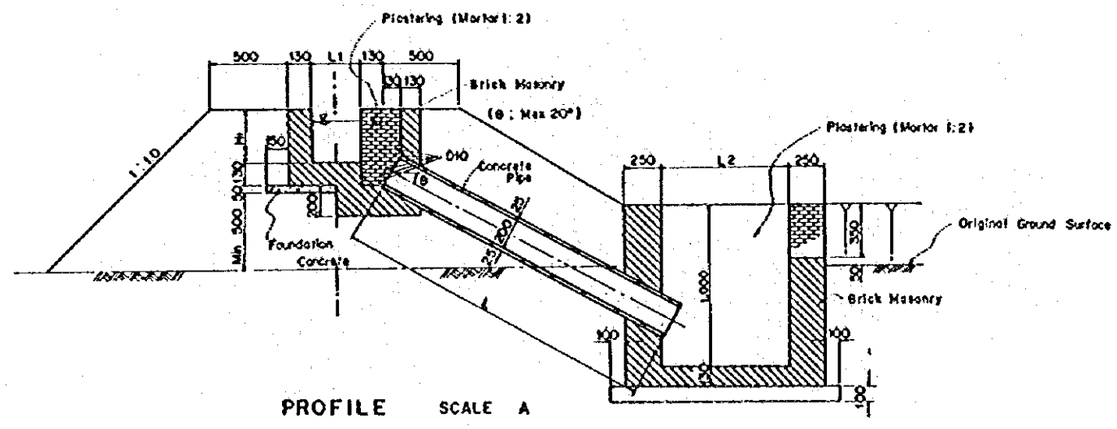
SCALE C 0 10 20 30 40 50 (m)
SCALE B 0 0.5 1.0 (m)
SCALE A 0 1 2 3 (m)

HIS MAJESTY'S GOVERNMENT OF NEPAL			
TERAI GROUNDWATER DEVELOPMENT PROJECT			
TITLE OF DRAWING: BAFFLE TANK			
Date	MAY 1988	Drawing No.	1002
JAPAN INTERNATIONAL COOPERATION AGENCY			

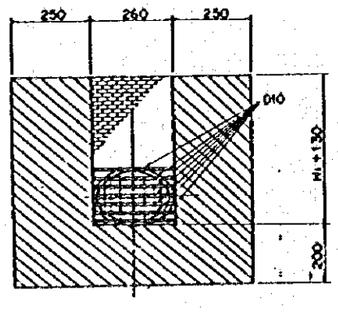
TURNOUT



PLAN SCALE A



PROFILE SCALE A

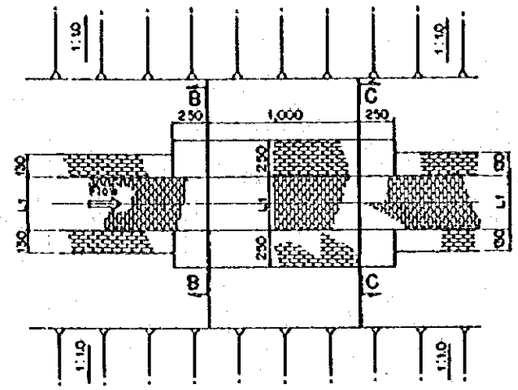


SECTION A-A SCALE B

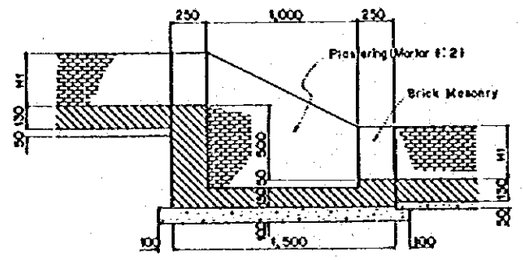
DIMENSION TABLE FOR TURNOUT
Unit : mm

Type	Canal Type	L1	L2	L	H1
I	I	350	1,000	2,500	420
II	I	350	1,000	5,000	420
III	II	350	750	2,500	350
IV	II	350	750	5,000	350

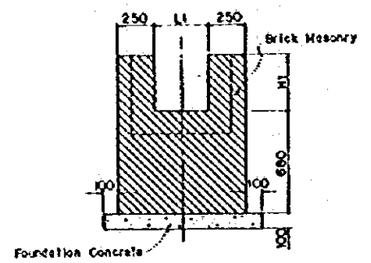
DROP



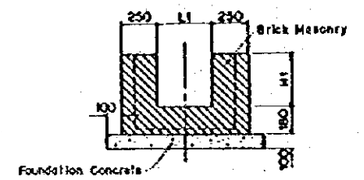
PLAN SCALE A



PROFILE SCALE A

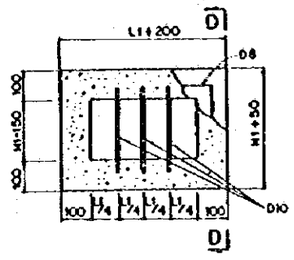


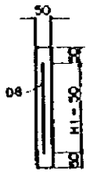
SECTION B-B SCALE A



SECTION C-C SCALE A

PRECAST CHECK PLATE SCALE B





SECTION D-D

DIMENSION FOR CANAL
Unit : mm.

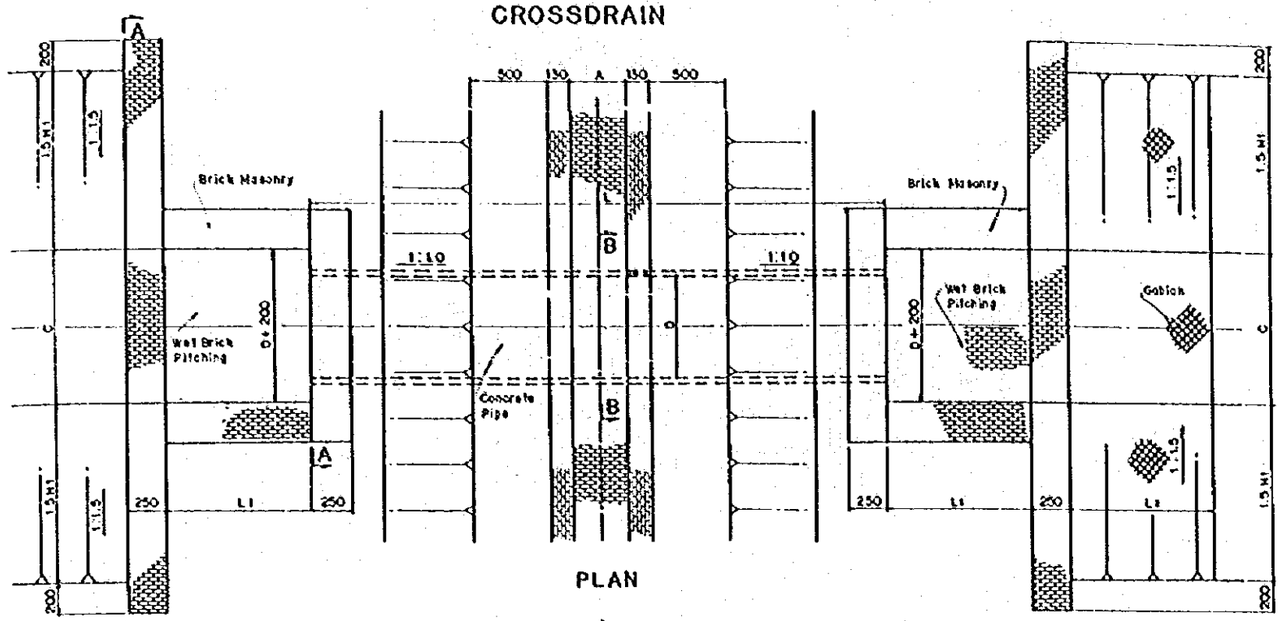
Canal Type	H1	L1
I	420	350
II	350	350

SCALE A
0 0.5 1.0 (m)

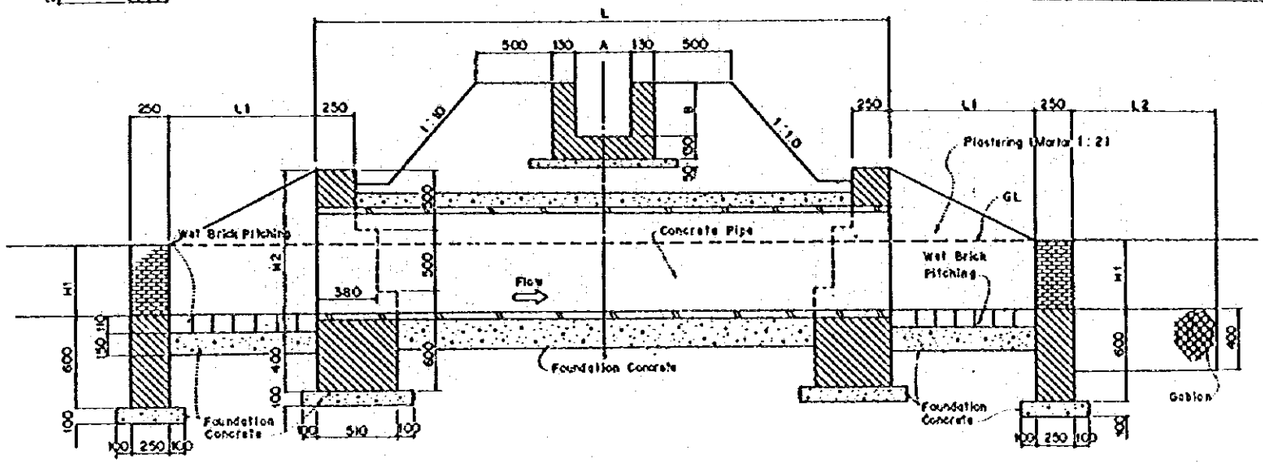
SCALE B
0 0.5 (m)

HIS MAJESTY'S GOVERNMENT OF NEPAL	
TERAI GROUNDWATER DEVELOPMENT PROJECT	
TITLE OF DRAWING	
TURNOUT, DROP AND PRECAST CHECK PLATE	
Date	MAY 1988
Drawing No.	1003
JAPAN INTERNATIONAL COOPERATION AGENCY	

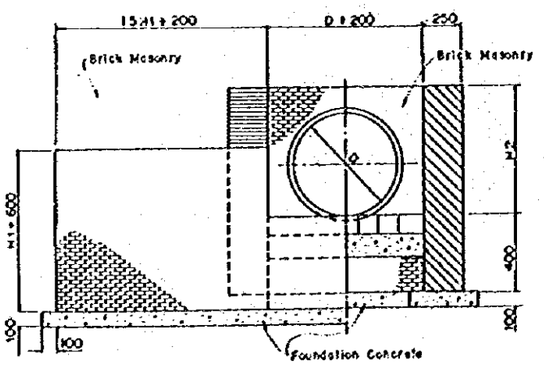
CROSSDRAIN



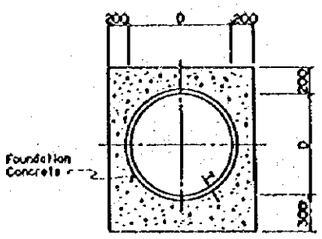
PLAN



PROFILE



SECTION A-A



SECTION B-B

DIMENSION TABLE FOR CROSSDRAIN

Unit : mm

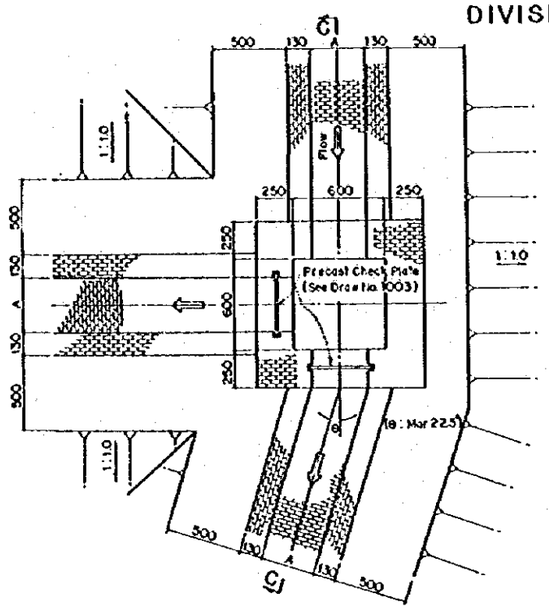
H1	H2	L1	L2	D	T	C
440	1,200	3,000	5,000	800	45	1,000

DIMENSION TABLE FOR DIVISION BOX AND CORNER BOX

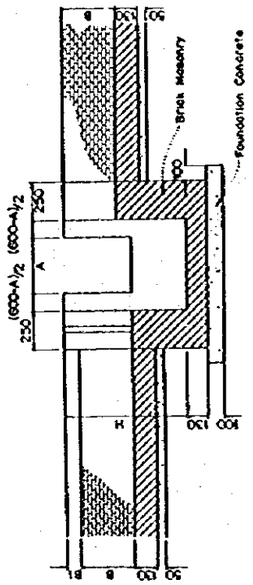
Unit : mm

Type	Canal Type	A	B	B1	H
I - I	I	350	420	0	620
I - II	I	350	420	0 ~ 250	870
I - III	I	350	420	260 ~ 500	1,120
II - I	II	350	350	0	480
II - II	II	350	350	0 ~ 250	730
II - III	II	350	350	260 ~ 500	980

DIVISION BOX

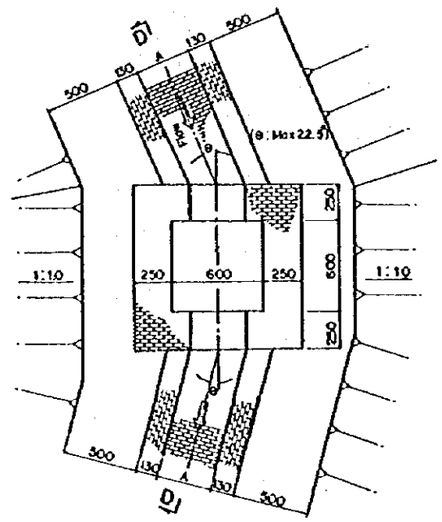


PLAN

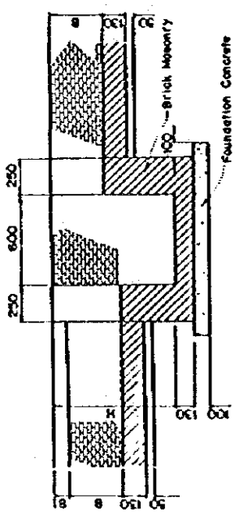


SECTION C-C

CORNER BOX



PLAN

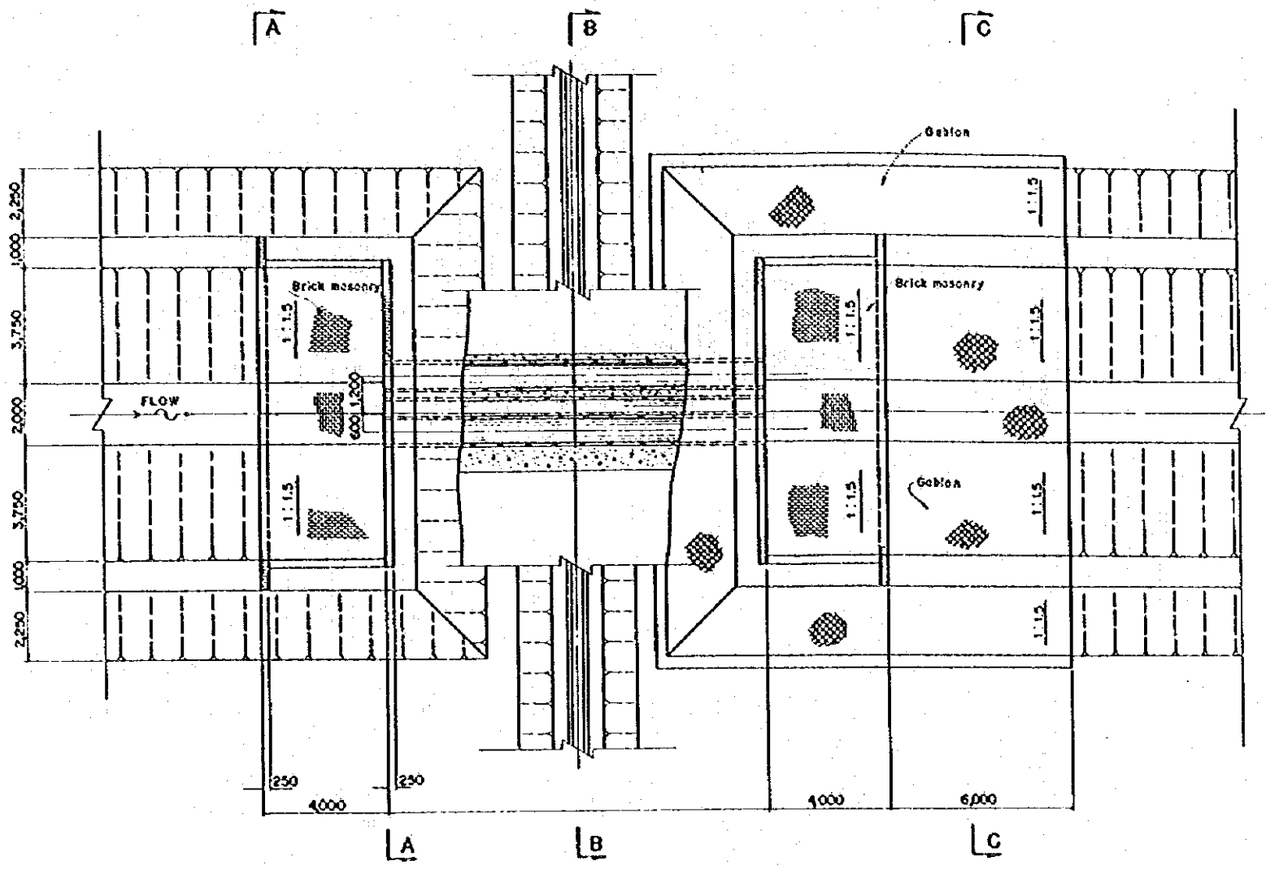


SECTION D-D

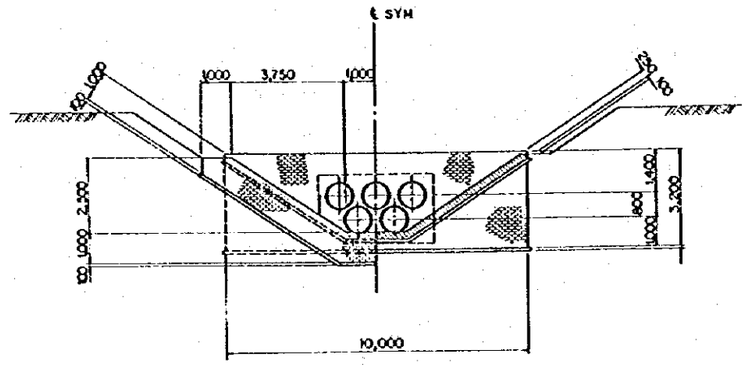
SCALE

0 0.5 1.0(m)

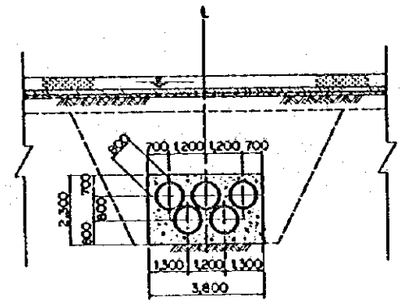
HIS MAJESTY'S GOVERNMENT OF NEPAL	
TERAI GROUNDWATER DEVELOPMENT PROJECT	
TITLE OF DRAWING	
CROSSDRAIN, DIVISION BOX AND CORNER BOX	
Date: MAY 1988	Drawing No: 1004
JAPAN INTERNATIONAL COOPERATION AGENCY	



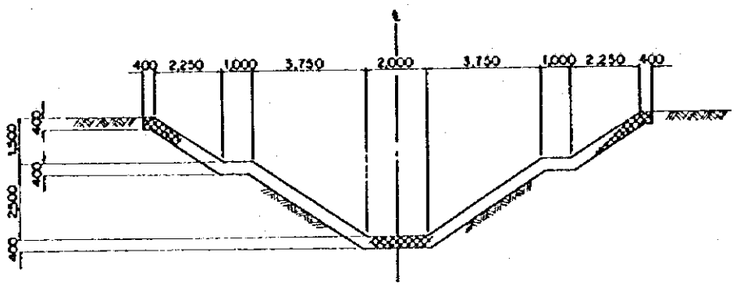
PLAN



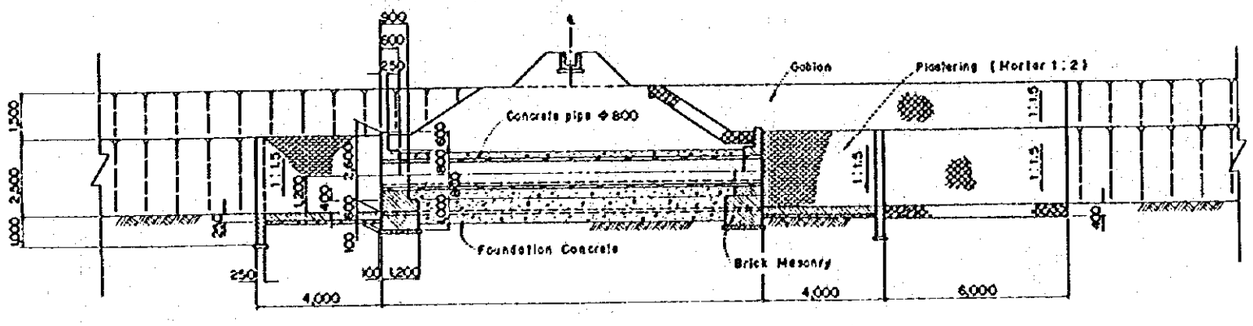
SECTION A-A



SECTION B-B



SECTION C-C

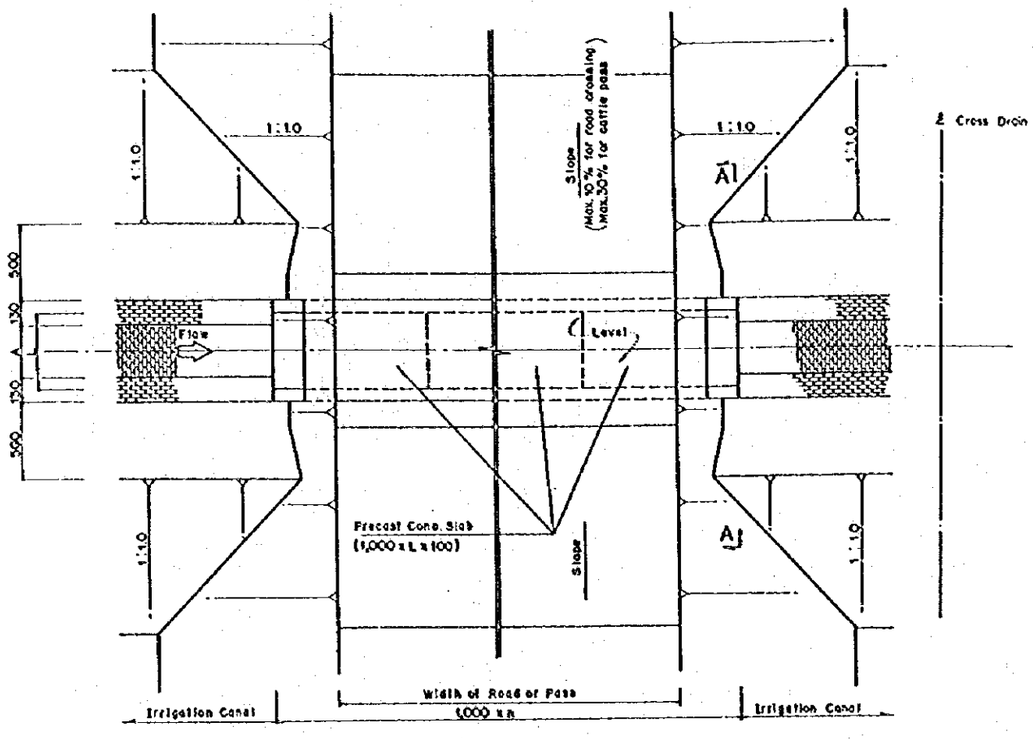


PROFILE

SCALE 0 5 10m

HIS MAJESTY'S GOVERNMENT OF NEPAL			
TERAI GROUNDWATER DEVELOPMENT PROJECT			
TITLE OF DRAWING: CROSS DRAIN ON BSY 1-1			
Date	MAY 1988	Drawing No.	1005
JAPAN INTERNATIONAL COOPERATION AGENCY			

CATTLE PASS AND ROAD CROSSING



PLAN

DIMENSION FOR CANAL

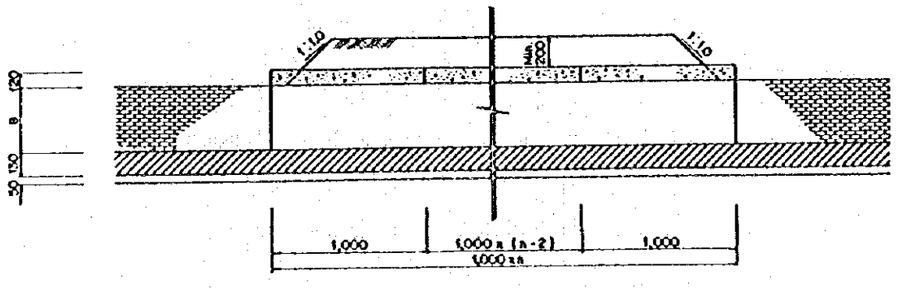
Unit : mm

Canal Type	A	B
I	350	420
II	350	350

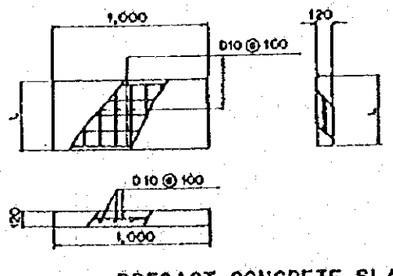
PRECAST CONCRETE SLAB

Unit : mm

Type	Canal Type	L
I	I , II	480

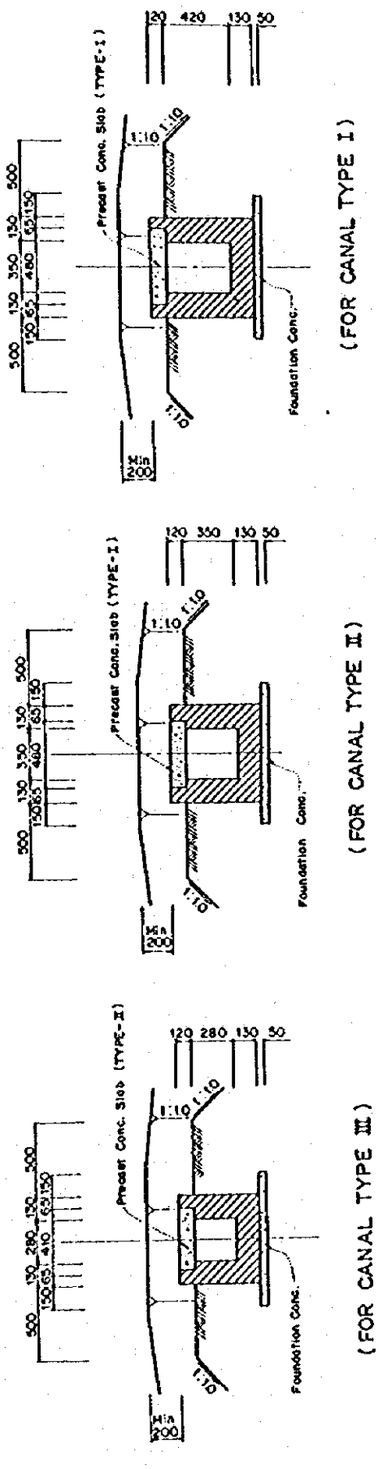


PROFILE



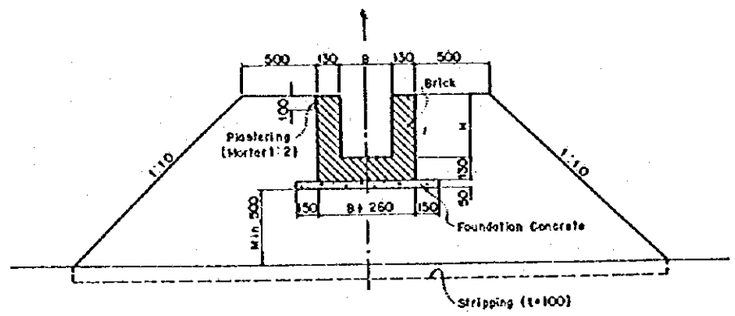
PRECAST CONCRETE SLAB

Crossing	Required No.
Farm Road	6 nos (6m)
Cattle Pass	4 nos. (4m)
Small Pass	1 no. (1m)



SECTION A-A

TYPICAL CANAL SECTION



DIMENSION TABLE

Unit : mm

Canal Type	B	H
I	350	420
II	350	350

Note : Cross Drain structure will be provided to one side of the road crossing structure. (Ref : DWG. NO. 1004)

SCALE

0 1 2(m)

HIS MAJESTY'S GOVERNMENT OF NEPAL

TERAI GROUNDWATER DEVELOPMENT PROJECT

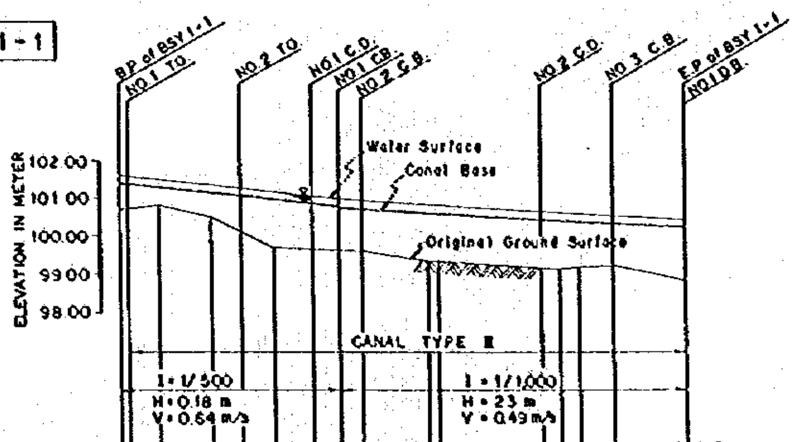
TITLE OF DRAWING

CATTLE PASS AND ROAD CROSSING AND TYPICAL CANAL SECTION

Date	MAY 1988	Drawing No.	1006

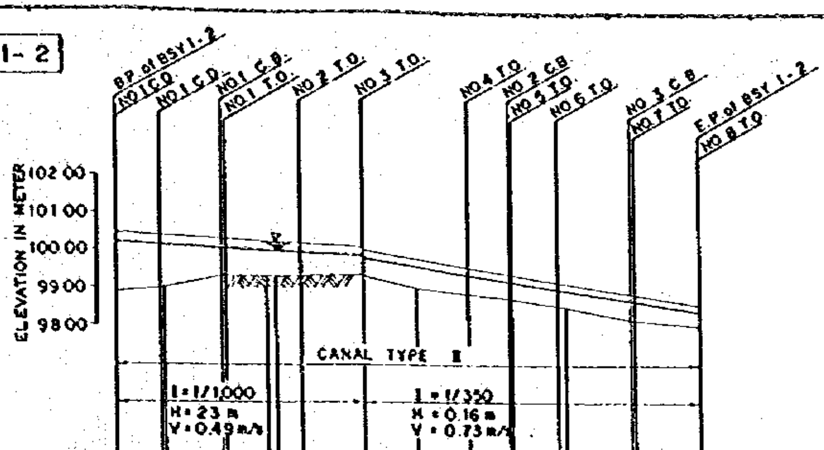
JAPAN INTERNATIONAL COOPERATION AGENCY

BSY 1-1



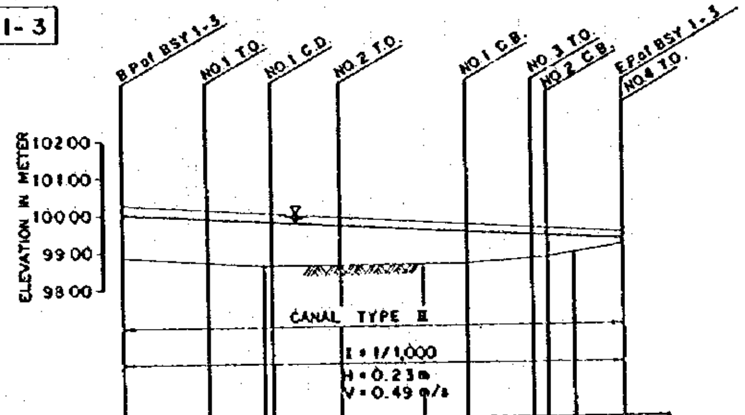
CANAL BASE ELEVATION	101.42, 101.40, .38, 101.29, 101.16, 101.08, .06, 100.98, 100.81, 100.74, 100.71, .69, 100.60, 100.59, 100.43, 100.40, 100.33, .33, 100.24
WATER SURFACE ELEVATION	101.60, 101.58, .56, 101.47, 101.34, 101.26, .24, 101.16, 100.99, 100.97, 100.94, .92, 100.83, 100.82, 100.66, 100.63, 100.58, .56, 100.47
GROUND SURFACE ELEVATION	100.75, 100.75, 100.80, 100.50, 100.10, 99.70, 99.70, 99.65, 99.60, 99.35, 99.35, 99.20, 99.15, 99.20, 99.25, 98.85
REDUCED DISTANCE	0, 10, 51, 119, 157, 200, 247, 283, 312, 400, 412, 550, 572, 600, 645, 738
DISTANCE	0, 10, 41, 68, 38, 90, 126, 29, 100, 138, 22, 73, 93
STATION	B.P. +10, I.P. 1, I.P. 2, I.P. 3, NO. 1, + 47, I.P. 4, I.P. 5, NO. 2, I.P. 6, + 150, I.P. 7, NO. 3, I.P. 8, E.P.
HORIZONTAL CURVE	IA=14-30-00, IA=42-00-00, IA=40-00-00, IA=68-00-00, IA=61-30-00, IA=11-30-00, IA=37-30-00, IA=73-30-00

BSY 1-2



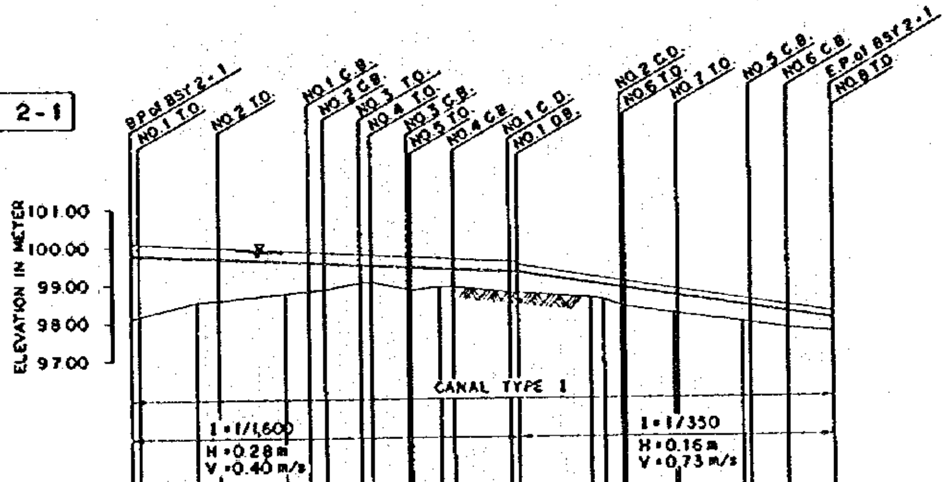
CANAL BASE ELEVATION	100.22, 100.16, 100.15, 100.09, 100.03, 100.03, 99.97, 99.96, 99.94, .92, 99.84, .82, 99.60, 99.41, .39, 99.24, .22, 99.21, 99.19, 98.97, .95, 98.71, .69, 98.67, .65, 98.40
WATER SURFACE ELEVATION	100.45, 100.39, 100.38, 100.31, .29, 100.26, 100.20, 100.19, 100.17, .15, 100.07, 99.98, 99.76, 99.57, .55, 99.40, .38, 99.37, 99.35, 99.13, .11, 98.87, .85, 98.83, .81, 98.56
GROUND SURFACE ELEVATION	98.85, 99.00, 99.00, 99.30, 99.30, 99.30, 99.30, 99.30, 99.35, 99.00, 98.80, 98.70, 98.70, 98.60, 98.50, 98.15, 98.15, 98.00
REDUCED DISTANCE	0, 60, 65, 137, 142, 200, 210, 245, 323, 400, 468, 519, 521, 589, 600, 682, 690, 778
DISTANCE	0, 60, 5, 72, 5, 58, 35, 78, 145, 51, 2, 68, 93, 8, 88
STATION	B.P., + 60, I.P. 1, I.P. 2, + 77, NO. 1, I.P. 3, + 45, + 123, NO. 2, + 68, I.P. 4, + 121, + 189, NO. 3, I.P. 5, + 90, E.P.
HORIZONTAL CURVE	IA=27-30-00, IA=82-30-00, IA=7-30-00, IA=79-30-00, IA=79-30-00

BSY 1-3



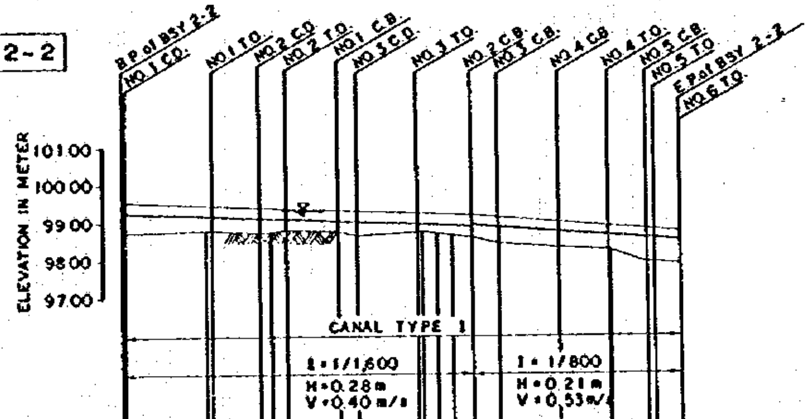
CANAL BASE ELEVATION	100.02, 99.90, .88, 99.81, 99.80, 99.70, .68, 99.58, 99.52, .50, 99.42, .40, 99.38, .36, 99.25
WATER SURFACE ELEVATION	100.25, 100.13, .11, 100.04, 100.03, 99.93, .91, 99.81, 99.75, .73, 99.65, .63, 99.61, .59, 99.48
GROUND SURFACE ELEVATION	98.85, 98.60, 98.60, 98.60, 98.60, 98.60, 98.60, 98.75, 98.75, 98.85, 99.10
REDUCED DISTANCE	0, 116, 187, 200, 300, 400, 460, 543, 565, 600, 668
DISTANCE	0, 116, 71, 13, 100, 100, 60, 83, 105, 35, 68
STATION	B.P., + 116, I.P. 1, NO. 1, + 100, NO. 2, I.P. 2, + 143, I.P. 3, NO. 3, E.P.
HORIZONTAL CURVE	IA=30-00-00, IA=61-00-00, IA=85-30-00

BSY 2-1



CANAL BASE ELEVATION	99.79, 99.78, 99.76, 99.72, 99.69, .67, 99.60, [illegible], 98.94, 98.88, 98.85, 98.65, .63, 98.34, .32, 98.18, .16, 98.00
WATER SURFACE ELEVATION	100.07, 100.06, .04, 100.00, 99.97, .95, 99.88, [illegible], 99.10, 99.04, 99.01, 98.81, .79, 98.50, .48, 98.34, .32, 98.16
GROUND SURFACE ELEVATION	98.10, 98.15, 98.55, 98.60, 98.75, 98.85, 98.85, 99.03, 99.03, 98.85, 98.85, 98.90, 98.90, 98.75, 98.75, 98.60, 98.55, 98.40, 98.35, 98.20, 98.15, 97.93, 97.90, 97.75, 97.65
REDUCED DISTANCE	0, 12, 83, 115, 200, 231, 252, 296, 311, 356, 361, 400, 419, 499, 504, 600, 619, 643, 647, 710, 715, 800, 809, 859, 922
DISTANCE	0, 12, 71, 30, 87, 31, 21, 44, 15, 45, 5, 58, 80, 5, 115, 24, 4, 63, 5, 94, 50, 63
STATION	B.P. + 12, I.P. 1, + 115, NO. 1, I.P. 2, I.P. 3, + 96, + 111, I.P. 4, + 261, NO. 2, I.P. 5, + 99, I.P. 6, NO. 3, I.P. 7, + 43, + 47, I.P. 8, + 115, NO. 4, I.P. 9, I.P. 10, E.P.
HORIZONTAL CURVE	IA=10-00-00, IA=65-30-00, IA=86-00-00, IA=73-00-00, IA=93-00-00, IA=56-00-00, IA=29-30-00, IA=28-30-00, IA=64-00-00, IA=87-30-00

BSY 2-2



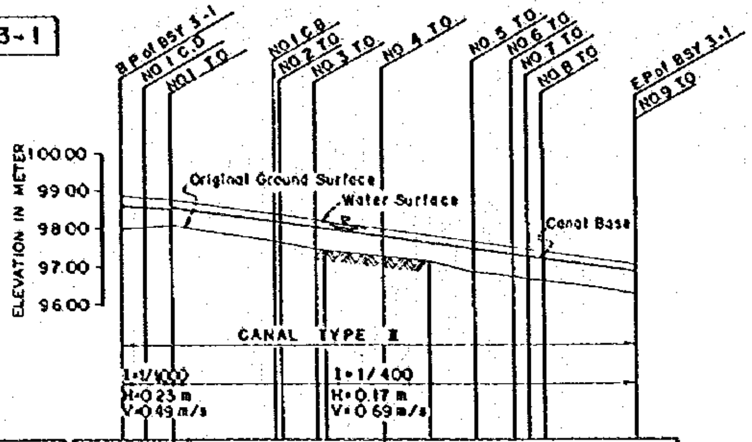
CANAL BASE ELEVATION	99.27, 99.26, 99.24, 99.19, .17, 99.13, 99.11, .09, 99.04, .02, 99.01, 98.96, .94, 98.90, 98.89, 98.88, .86, 98.78, .76, 98.74, .72, 98.63, 98.60, 98.56
WATER SURFACE ELEVATION	99.55, 99.54, 99.52, 99.47, .45, 99.41, 99.39, .37, 99.32, .30, 99.29, 99.24, .22, 99.18, 99.10, 99.09, .07, 98.99, .97, 98.95, .93, 98.86, 98.84, 98.81, 98.77
GROUND SURFACE ELEVATION	98.75, 98.75, 98.80, 98.80, 98.75, 98.75, 98.80, 98.75, 98.65, 98.75, 98.75, 98.70, 98.65, 98.60, 98.45, 98.35, 98.25, 98.23, 97.90, 97.90, 97.90
REDUCED DISTANCE	0, 5, 113, 118, 183, 200, 221, 291, 315, 393, 400, 438, 456, 466, 502, 582, 599, 600, 651, 659, 694
DISTANCE	0, 5, 108, 5, 67, 36, 70, 24, 78, 7, 18, 28, 36, 80, 17, 52, 8, 35
STATION	B.P. + 5, I.P. 1, + 118, + 185, NO. 1, + 21, I.P. 2, + 115, + 193, NO. 2, I.P. 3, I.P. 4, I.P. 5, I.P. 6, I.P. 7, + 193, NO. 3, I.P. 8, + 59, E.P.
HORIZONTAL CURVE	IA=31-30-00, IA=73-30-00, IA=11-30-00, IA=17-30-00, IA=45-30-00, IA=33-00-00, IA=63-00-00, IA=49-00-00

NOTE :
1. DESIGN DISCHARGE Q = 0.040 m^3/sec
2. ABBREVIATION
   - CB : CORNER BOX
   - TO : TURNOUT
   - DB : DIVISION BOX
   - CD : CROSS DRAIN

0 100 200 300m
HORIZONTAL SCALE

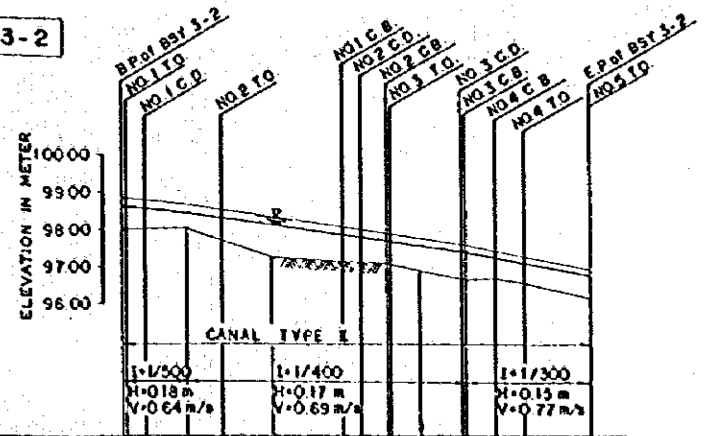
HIS MAJESTY'S GOVERNMENT OF NEPAL			
TERAI GROUNDWATER DEVELOPMENT PROJECT			
TITLE OF DRAWING: PROFILE OF BSY 1-1, 1-2, 2-1, 2-2 (DEVELOPMENT BLOCK D-7)			
Date	MAY 1988	Drawing No.	2001
JAPAN INTERNATIONAL COOPERATION AGENCY			

BSY 3-1



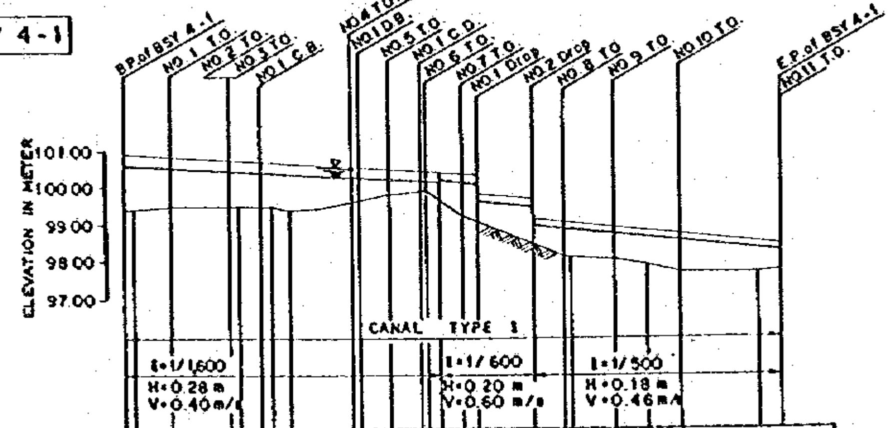
Item	Values
CANAL BASE ELEVATION	98.62 98.59 98.55 98.59 98.26 .24 98.22 .20 98.09 .07 97.85 .83 97.53 .51 97.38 .35 97.33 .29 97.24 .22 96.92
WATER SURFACE ELEVATION	98.85 98.82 98.78 .76 98.43 .41 98.39 .37 98.26 .24 98.02 .00 97.70 .68 97.55 .53 97.50 .47 97.41 .39 97.09
GROUND SURFACE ELEVATION	98.00 98.05 98.10 97.65 97.65 97.50 97.45 97.25 97.15 96.90 96.75 96.70 96.65 96.30
REDUCED DISTANCE	0 30 65 200 208 253 265 338 400 458 511 531 553 671
DISTANCE	0 30 35 135 8 47 12 73 120 53 20 22 118
STATION	B.P. +30 +65 I.P.1 (NO.1) +8 +53 I.P.2 +138 NO.2 I.P.3 +111 I.P.4 +153 E.P.
HORIZONTAL CURVE	IA=60-00-00 IA=22-00-00 IA=13-30-00 IA=10-00-00

BSY 3-2



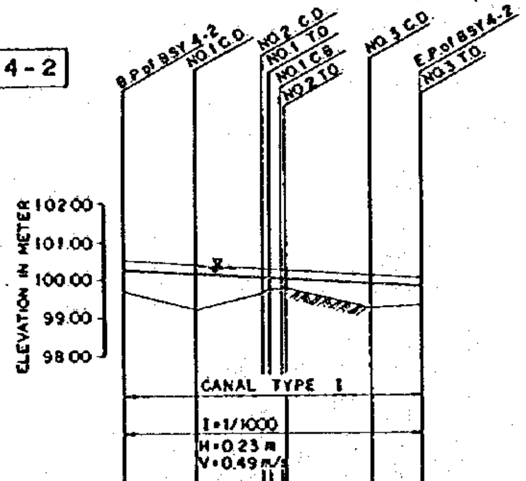
Item	Values
CANAL BASE ELEVATION	98.62 .59 98.57 98.43 .42 98.30 .28 98.11 97.87 .85 97.77 .75 97.69 .67 97.59 97.57 97.42 .41 97.38 .36 97.12 .10 96.82
WATER SURFACE ELEVATION	98.80 .77 98.75 98.61 .59 98.47 .45 98.28 98.04 .02 97.96 .94 97.86 .84 97.74 97.66 97.49 .47 97.44 .41 97.27 .25 96.97
GROUND SURFACE ELEVATION	98.00 98.00 98.00 98.00 97.65 97.25 97.15 97.15 97.10 97.05 96.90 96.70 96.65 96.70 96.60 96.20
REDUCED DISTANCE	0 5 30 85 132 200 297 322 355 360 400 453 458 498 538 623
DISTANCE	0 5 25 80 47 165 25 33 5 93 5 40 40 85
STATION	B.P. +5 +30 I.P.1 +132 NO.1 I.P.2 +122 I.P.3 +160 NO.2 +53 I.P.4 I.P.5 +138 E.P.
HORIZONTAL CURVE	IA=19-30-00 IA=81-00-00 IA=90-00-00 IA=90-00-00 IA=90-00-00

BSY 4-1



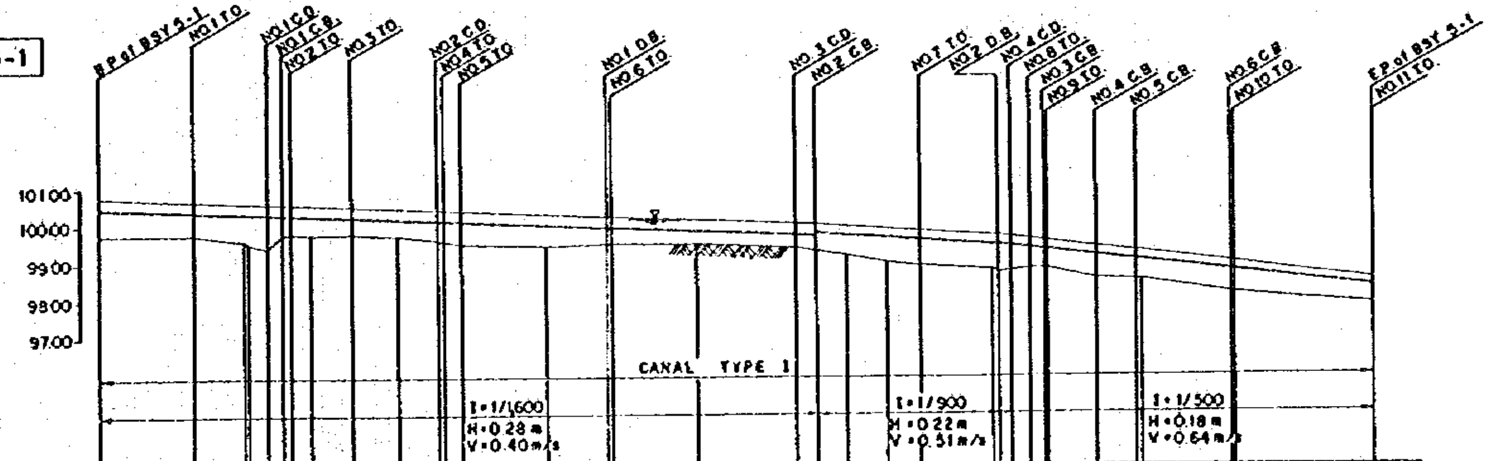
Item	Values
CANAL BASE ELEVATION	100.58 100.54 .52 100.47 .45 100.42 .40 100.38 100.31 .29 100.27 .25 100.23 .20 100.18 .15 100.13 99.63 99.50 99.00 98.92 .90 98.77 .75 98.66 98.57 .55 98.42 98.28
WATER SURFACE ELEVATION	100.86 100.82 .80 100.75 .73 100.70 .68 100.66 100.64 .62 100.57 .55 100.53 .51 100.48 .45 100.38 .35 99.85 99.70 99.18 99.10 .09 98.95 .93 98.84 98.75 .73 98.60 98.46
GROUND SURFACE ELEVATION	99.40 99.40 99.50 99.50 99.50 99.50 99.50 99.40 99.65 99.70 99.85 99.90 99.95 99.70 99.25 99.10 98.50 98.15 99.10 98.05 97.90 97.70 97.70 97.75
REDUCED DISTANCE	0 13 63 143 156 183 200 225 308 317 358 400 408 425 456 475 550 591 600 658 703 748 800 881
DISTANCE	0 13 50 80 13 27 42 83 9 41 42 8 17 31 19 75 41 67 45 45 133
STATION	B.P. I.P.1 I.P.2 +143 I.P.3 I.P.4 NO.1 I.P.5 +108 +117 +158 NO.2 I.P.6 +25 +56 +75 +150 I.P.7 NO.3 I.P.8 I.P.9 +148 NO.4 E.P.
HORIZONTAL CURVE	IA=24-30-00 IA=25-30-00 IA=13-30-00 IA=5-30-00 IA=4-30-00 IA=10-30-00 IA=48-00-00 IA=4-30-00 IA=4-00-00

BSY 4-2



Item	Values
CANAL BASE ELEVATION	100.27 100.17 100.08 .07 100.03 .01 100.00 99.99 99.89 99.82
WATER SURFACE ELEVATION	100.50 100.40 100.29 .28 100.24 .23 100.22 100.12 100.05
GROUND SURFACE ELEVATION	99.70 99.20 99.65 99.70 99.75 99.75 99.25 99.30
REDUCED DISTANCE	0 95 180 190 200 210 318 385
DISTANCE	0 95 85 10 10 10 108 67
STATION	B.P. +95 +180 +190 I.P.1 +10 +118 E.P.
HORIZONTAL CURVE	IA=95-00-00

BSY 5-1



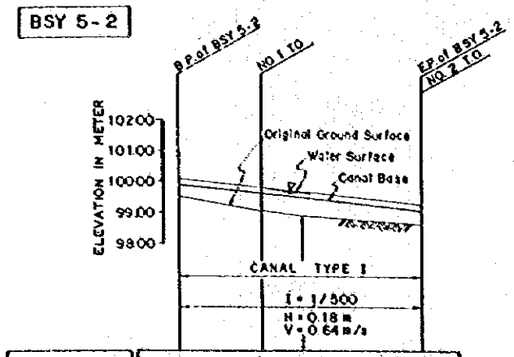
Item	Values
CANAL BASE ELEVATION	100.49 100.41 .39 100.35 100.33 100.32 .29 .27 100.22 .20 100.16 100.13 .11 .10 100.09 .07 100.00 99.95 .93 99.92 .90 99.83 99.75 .73 .71 99.73 99.67 99.62 .60 99.48 99.50 99.41 .38 .36 99.33 .31 99.17 .15 99.05 .03 98.78 .76 .75 98.74 98.35
WATER SURFACE ELEVATION	100.77 100.69 .67 100.63 100.61 100.62 .59 .57 100.50 .48 100.44 100.41 100.40 .37 100.37 .35 100.28 100.23 .21 100.20 .18 100.11 100.03 100.01 99.99 99.95 99.89 99.84 .82 99.70 99.68 99.59 .57 99.54 .52 99.50 99.35 99.33 99.23 .21 98.96 .94 98.93 .91 98.53
GROUND SURFACE ELEVATION	99.75 99.75 99.60 99.50 99.40 99.75 99.75 99.75 99.75 99.70 99.60 99.55 99.50 99.45 99.50 99.50 99.50 99.40 99.30 99.20 99.00 98.90 98.80 98.75 98.75 98.80 98.80 98.80 98.55 98.50 98.50 98.15 98.15 97.85
REDUCED DISTANCE	0 125 195 207 217 247 255 282 337 400 454 461 486 600 679 686 800 931 960 1,000 1,055 1,102 1,200 1,207 1,225 1,250 1,268 1,273 1,341 1,393 1,400 1,518 1,523 1,711
DISTANCE	0 125 70 22 10 30 8 27 55 63 54 7 25 114 79 7 114 131 29 40 55 47 103 18 25 18 5 68 52 125 5 188
STATION	B.P. +125 I.P.1 NO.1 +17 I.P.2 +55 I.P.3 +137 NO.2 +54 +61 I.P.4 NO.3 I.P.5 +86 NO.4 +131 I.P.6 NO.5 I.P.7 +102 NO.6 I.P.8 +50 +59 I.P.9 +73 I.P.10 I.P.11 NO.7 I.P.12 +123 E.P.
HORIZONTAL CURVE	IA=33-30-00 IA=38-30-00 IA=12-30-00 IA=18-30-00 IA=81-30-00 IA=64-00-00 IA=90-30-00 IA=53-00-00 IA=38-30-00 IA=70-30-00 IA=90-00-00 IA=88-00-00

NOTE :
1. DESIGN DISCHARGE Q=0.040 m³/sec
2. ABBREVIATION
   - CB : CORNER BOX
   - TO : TURNOUT
   - DB : DIVISION BOX
   - CD : CROSS DRAIN

0 100 200 300m
HORIZONTAL SCALE

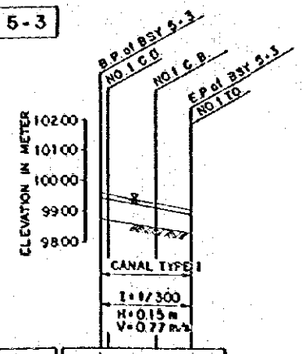
HIS MAJESTY'S GOVERNMENT OF NEPAL			
TERAI GROUNDWATER DEVELOPMENT PROJECT			
TITLE OF DRAWING: PROFILE OF BSY 3-1, 3-2, 4-1, 4-2, 5-1 (DEVELOPMENT BLOCK D-7)			
Date	MAY 1988	Drawing No.	2002
JAPAN INTERNATIONAL COOPERATION AGENCY			

BSY 5-2



CANAL BASE ELEVATION	99.93	99.86 .64	99.51	99.13
WATER SURFACE ELEVATION	100.11	99.84 .82	99.69	99.31
GROUND SURFACE ELEVATION	99.50	99.05	98.90	98.65
REDUCED DISTANCE	0	133	200	390
DISTANCE	0	133	67	190
STATION	B.P.	+133	NO.1	E.P.
HORIZONTAL CURVE				

BSY 5-3



CANAL BASE ELEVATION	99.46	99.16 .14	98.96
WATER SURFACE ELEVATION	99.61	99.51 .29	99.11
GROUND SURFACE ELEVATION	98.70 98.70	98.50	98.35
REDUCED DISTANCE	00	90	145
DISTANCE	00	80	55
STATION	B.P. +10	T.P.1	E.P.
HORIZONTAL CURVE		IA=90-00-00	

NOTE :
1. DESIGN DISCHAGE Q=0.040 m³/sec
2. ABBREVIATION
   CB : CORNER BOX
   TO : TURNOUT
   DB : DIVISION BOX
   CO : CROSS DRAIN

0 100 200 300m
HORIZONTAL SCALE

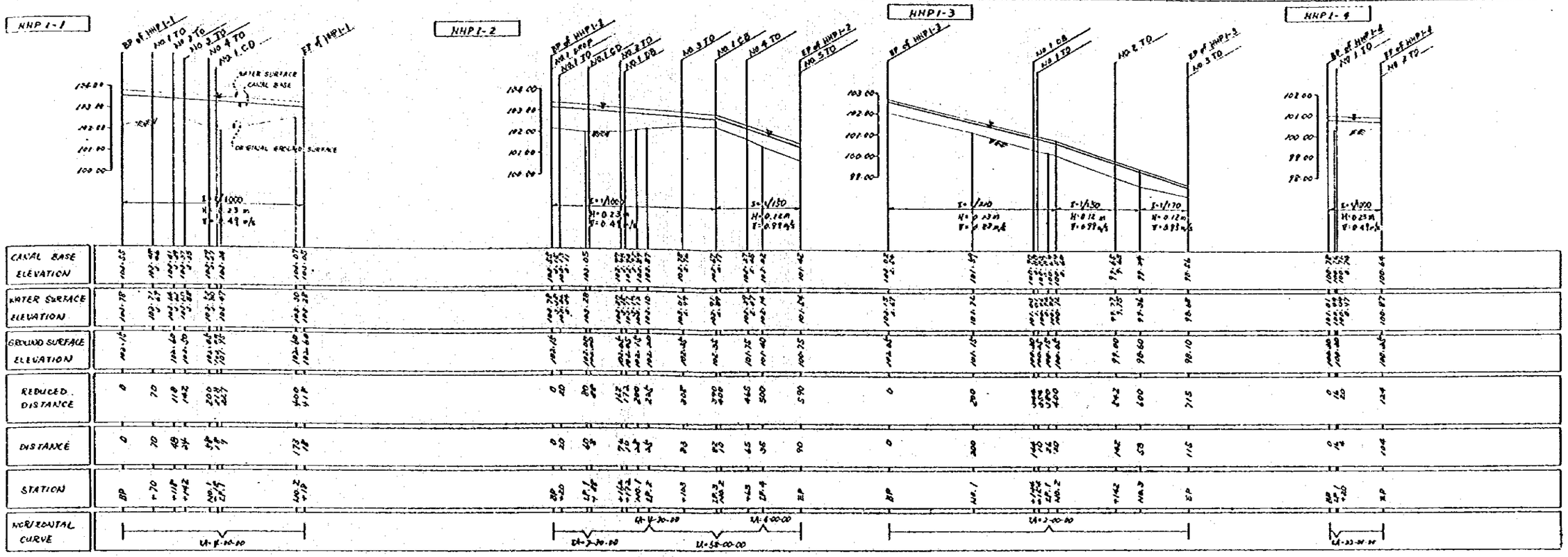
HIS MAJESTY'S GOVERNMENT OF NEPAL

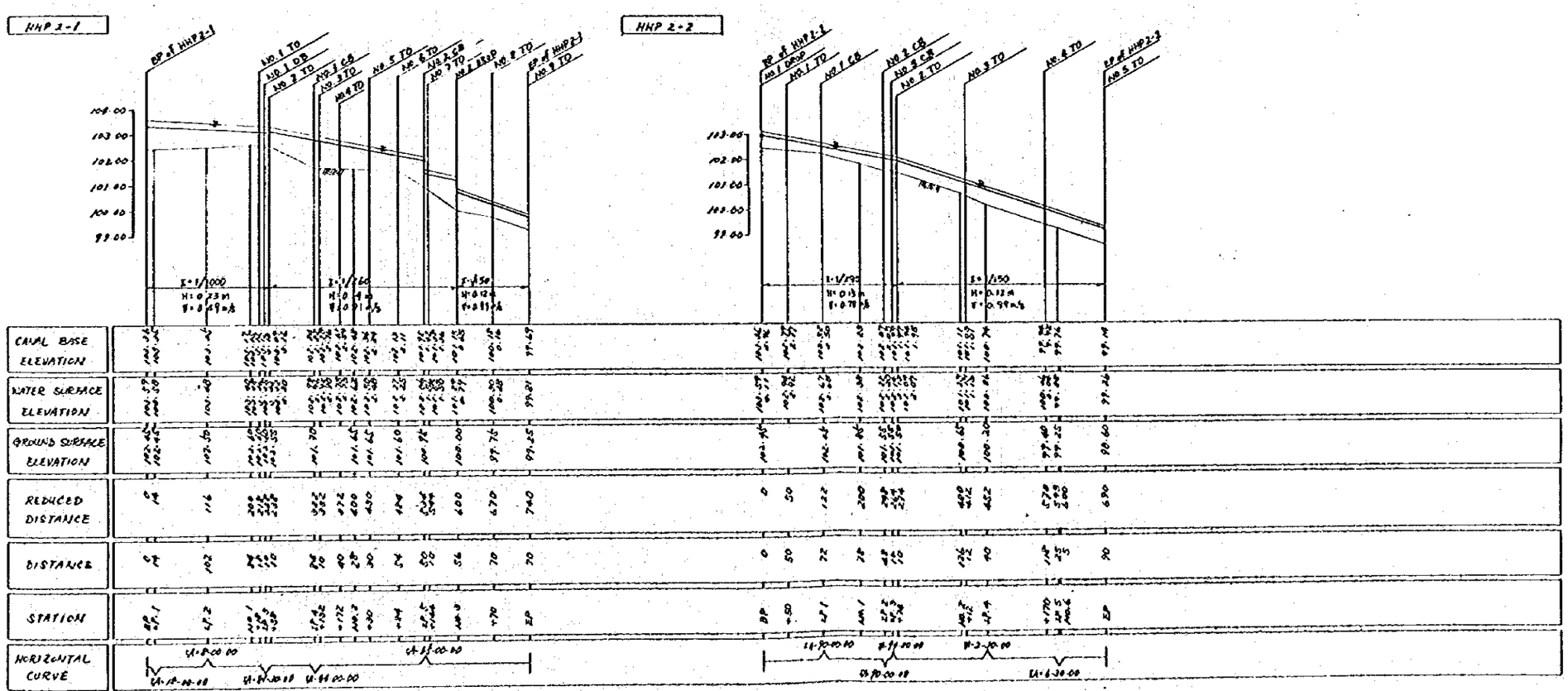
TERAI GROUNDWATER DEVELOPMENT PROJECT

TITLE OF DRAWING
PROFILE OF BSY 5-2, 5-3
(DEVELOPMENT BLOCK D-7)

Date	MAY 1988	Drawing No.	2003

JAPAN INTERNATIONAL COOPERATION AGENCY





NOTE:
1. DESIGN DISCHARGE Q = 0.060 m³/sec
2. ABBREVIATION
   CB : CORNER BOX
   TO : TURNOUT
   DB : DIVISION BOX
   CD : CROSS DRAIN
3. CANAL TYPE : K

0 100 200 300m
HORIZONTAL SCALE

HIS MAJESTY'S GOVERNMENT OF NEPAL

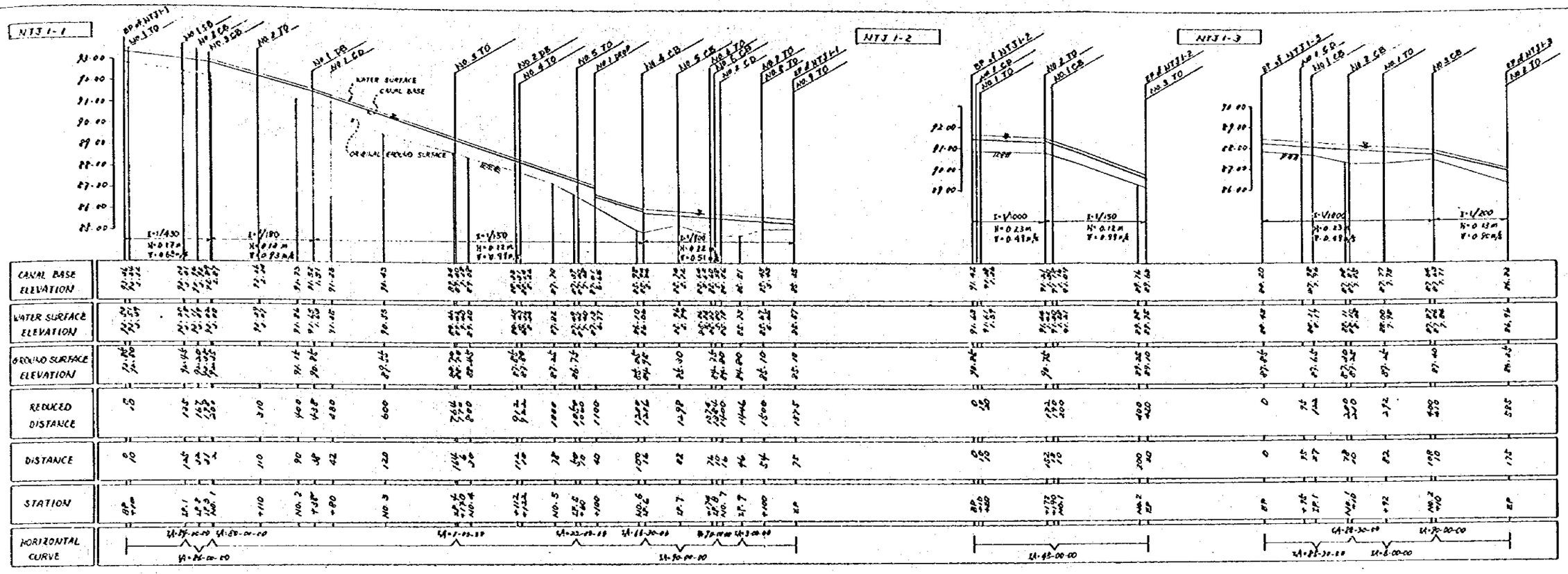
TERAI GROUNDWATER DEVELOPMENT PROJECT

TITLE OF DRAWING

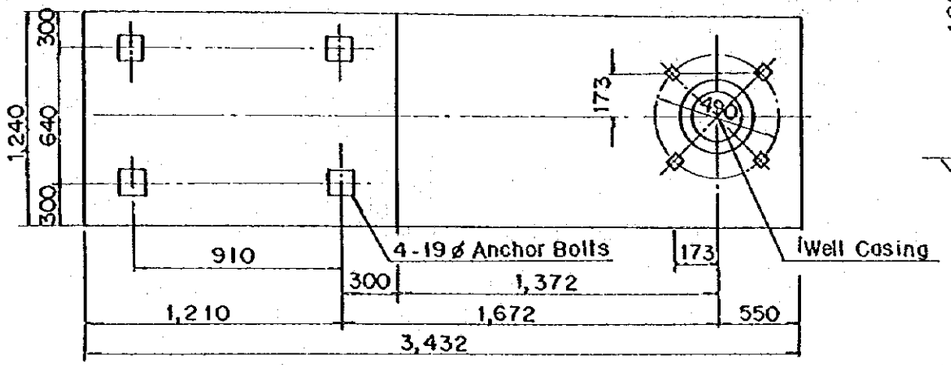
PROFILE OF NHP1-1, 1-2, 1-3, 1-4, 2-1 AND NHP2-2 (BLOCK D-15)

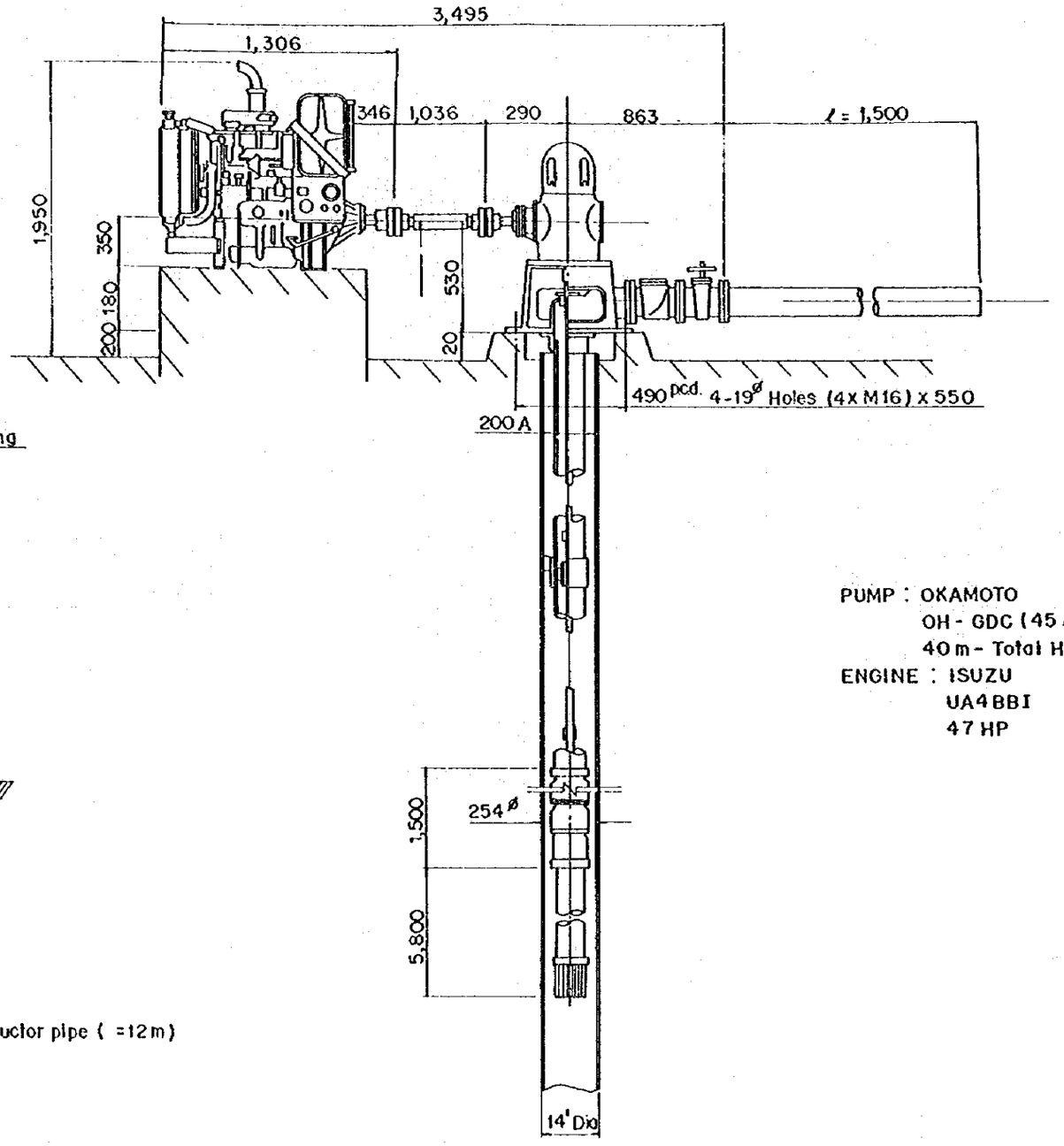
Date	MAY 1988	Drawing No.	2004

JAPAN INTERNATIONAL COOPERATION AGENCY

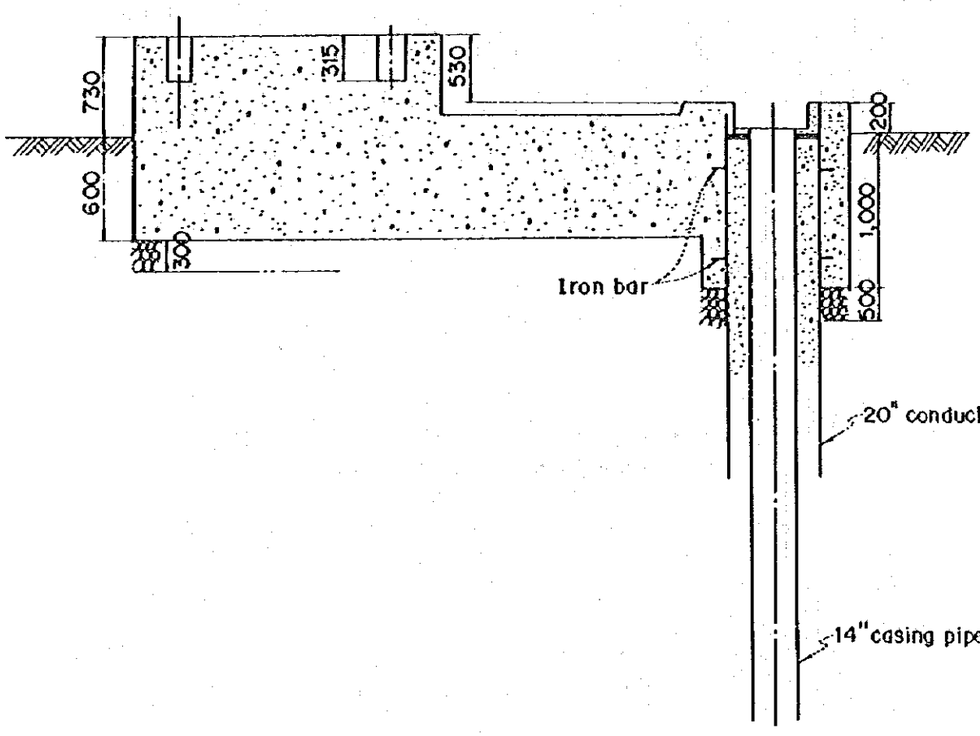

NTJ 1-1
NTJ 1-2
NTJ 1-3
CANAL BASE ELEVATION
WATER SURFACE ELEVATION
GROUND SURFACE ELEVATION
REDUCED DISTANCE
DISTANCE
STATION
HORIZONTAL CURVE
NTJ 2-1
NTJ 2-2
NTJ 2-3
NOTE :
1. DESIGN DISCHARGE Q = 6.000 m³/sec
2 ABBREVIATION
CB : CORNER BOX
TO : TURNOUT
DB : DIVISION BOX
CD : CROSS DRAIN
3 CANAL TYPE : RC
0 100 200 300m
HORIZONTAL SCALE
HIS MAJESTY'S GOVERNMENT OF NEPAL
TERAI GROUNDWATER DEVELOPMENT PROJECT
TITLE OF DRAWING
PROFILE OF NTJ1-1, 1-2, 1-3, 2-1, 2-2 AND NTJ2-3 (BLOCK D-15)
Date MAY 1988
Drawing No. 2005
JAPAN INTERNATIONAL COOPERATION AGENCY

FOUNDATION OF PUMP UNIT





PUMP : OKAMOTO
OH - GDC (45 ℓ/sec)
40 m - Total Head
ENGINE : ISUZU
UA4BBI
47 HP



(After the Operation manual of Pump maker)

HIS MAJESTY'S GOVERNMENT OF NEPAL

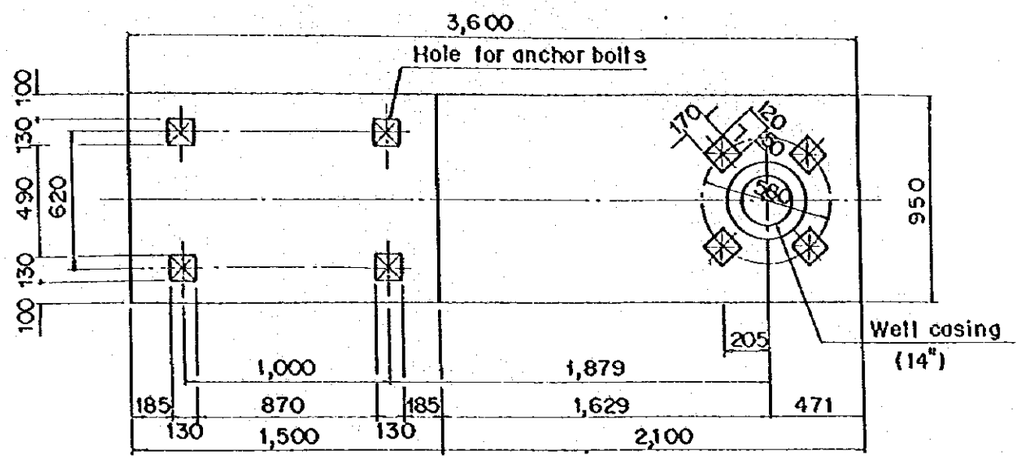
TERAI GROUNDWATER DEVELOPMENT PROJECT

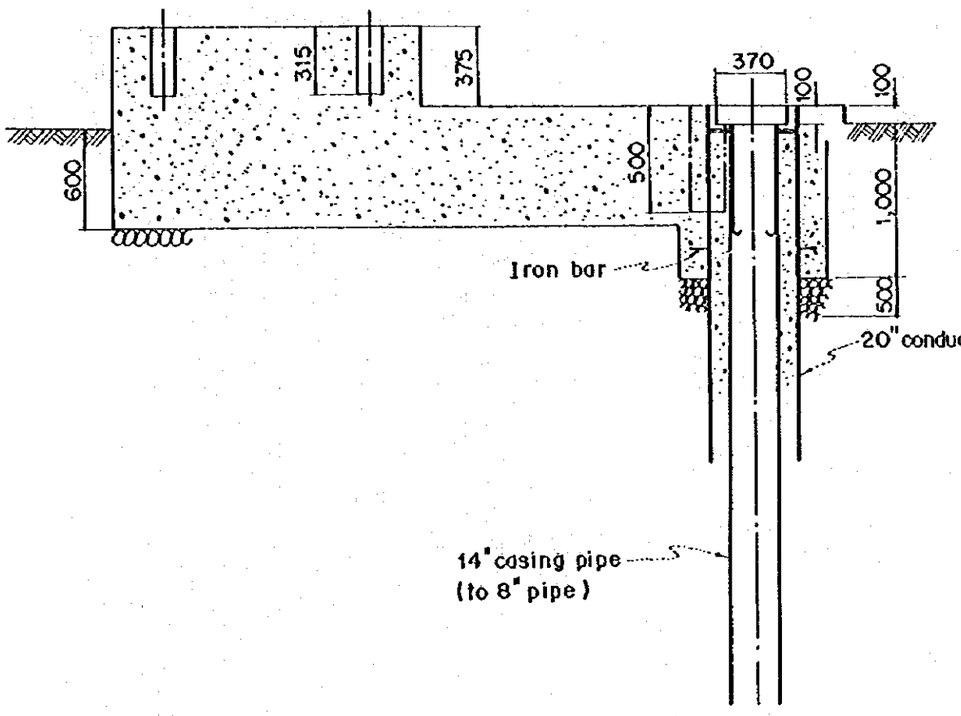
TITLE OF DRAWING
INSTALLATION OF VERTCAL TURBINE PUMP AND ENGINE (45 l/sec TYPE)

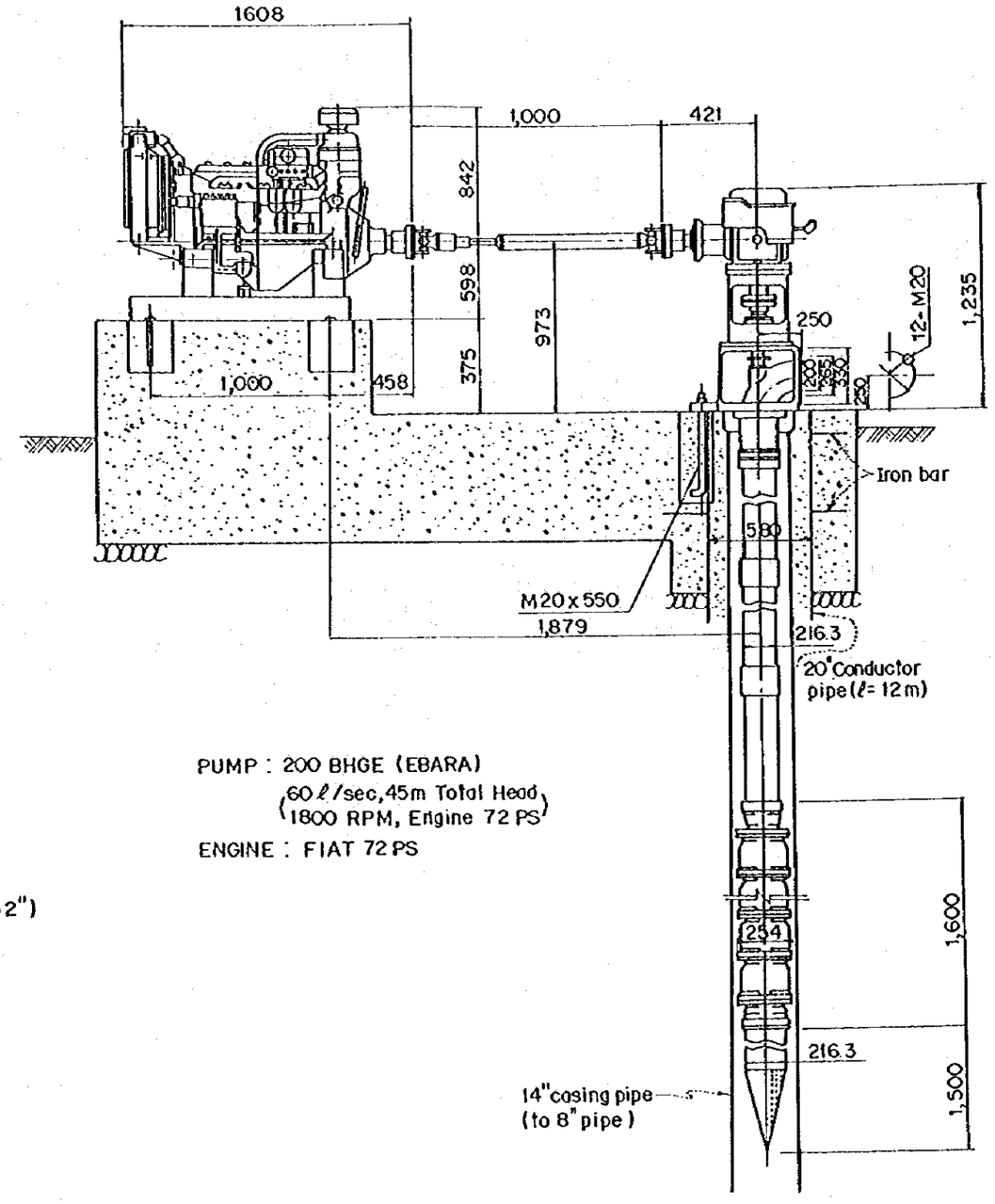
Date	MAY 1988	Drawing No.	3001

JAPAN INTERNATIONAL COOPERATION AGENCY

FOUNDATION OF PUMP UNIT







PUMP : 200 BHGE (EBARA)
(60 ℓ/sec, 45m Total Head
1800 RPM, Engine 72 PS)

ENGINE : FIAT 72 PS

(After the Operation manual of Pump maker)

HIS MAJESTY'S GOVERNMENT OF NEPAL

TERAI GROUNDWATER DEVELOPMENT PROJECT

TITLE OF DRAWING
INSTALLATION OF VERTICAL TURBINE PUMP AND ENGINE (60 l/sec TYPE)

Date	MAY 1988	Drawing No.	3002

JAPAN INTERNATIONAL COOPERATION AGENCY

CHAPTER 6. IMPLEMENTATION PLAN

CHAPTER 6. IMPLEMENTATION PLAN

6.1 Organization of Project Execution

1) Overall Organization

The Terai Groundwater Development Project is incorporated in the groundwater development program to be implemented by TIATSP under the administrative control by the Department of Agriculture in the Ministry of Agriculture. Therefore, the Ministry of Agriculture is the sole governmental body responsible for the implementation of the Project, and TIATSP is an executing agency of the Project. TIATSP is controlled by the TIATSP Board because the system is already applied. In such organization, the Minister of Agriculture has the sole responsibility for the implementation of the Project, though the actual responsible person is the Secretary of the Ministry of Agriculture who is fully assisted by two Joint Secretaries and one Director General of the Department of Agriculture.

The Ministry of Agriculture will be authorized to execute the following works throughout the implementation of the project.

(1) Superintendent of all construction works,
(2) Execution of contracts for consulting services and for construction,
(3) Approval of design,
(4) Tendering and evaluation of tenders,
(5) Approval of all payments,
(6) Administration of all contracts,
(7) Acceptance of completed works, and
(8) Liaison and coordination with other government agencies.

The organization of the Ministry of Agriculture and that of the Department of Agriculture are shown on Fig. 6-1 and Fig. 6-2 respectively.

In accordance with a grant aid system of the Japanese Government, construction works of the Project will be carried out by a Japanese contractor, who will be awarded through tender procedure, and the construction supervision will be rendered by a Japanese consulting firm engaged in both the basic design study and the detailed design. The equipment and materials to be newly granted by the Japanese Government will be shipped by a Japanese supplier selected through tender procedure.

The overall organization chart for the implementation of the Project is shown in Fig. 6-3.

2) Organization of TIATSP

The present TIATSP organization (refer to Fig. 3-9) is insufficient for the execution, operation and maintenance of the Project, therefore, the organization has to be reinforced by recruitment of capable staff as follows.

Division	Number of Increment			
	Assistant Engineer	Overseer	Technician	Total
Workshop Division	0	0	1	1
Agriculture Extension & Training Division	0	1	0	1
O & M Division (newly established)	1	1	0	2
Total	1	2	1	4

3) Control of drilling and construction equipment and materials

Prior to the onset of construction works, the KR-2 drilling and construction equipment and materials required for construction have to be transferred from TIATSP to the contractor and controlled by the contractor as well as those newly granted throughout the construction period for the sake of smooth construction works. In this connection, the contractor has to build his own compound including office, motor pool and stores by his expense.

6.2 Scope of the Work

The scope of the Project to be undertaken by the Japan's Grant Aid is outlined as follows:

(1) To construct eight production wells in D-7 and D-15 blocks, because a test tubewell drilled in D-7 block under the Phase-II and a deep tubewell drilled by TIATSP in D-15 block are to be used as production wells;

(2) To construct the irrigation facilities such as pump house, operator hut, main canal and the related structures in nine irrigation units of D-7 and D-15 blocks, since those in the other unit are under construction by TIATSP; and

(3) To newly grant necessary equipment and materials to those provided under the KR-2, for the construction mentioned above.

On the other hand, the following services have to be undertaken by HMGN:

(1) To furnish data, reports, maps and drawings necessary for the detailed design;

(2) To ensure tax exemption, custom clearance at the port of disembarkation for the additional drilling and construction equipment and materials, vehicles, tools, spare pats and consumables;

(3) To issue visa, traffic certificate and other necessary certificates for the Japanese persons concerned;

(4) To ensure tax exemption for the Japanese persons engaged in the Project;

(5) To provide Japanese contractors and consultant, free of charge, with the materials and equipments granted by the KR-2 and required by them;

(6) To ensure payment of contract to the consultant and contractors;

(7) To secure land acquisition and compensation required for the construction of temporary access roads and irrigation facilities;

(8) To construct branch canals and their related structures (by farmers); and

(9) Operation and maintenance for the completed facilities.

6.3 Detailed Design, Construction Work and Construction Supervision

6.3.1 Detailed Design

Immediately after the conclusion of the Exchange Note, a Japanese consulting firm will contract with MOA of HMGN to start detailed design work. The detailed design work will be conducted in Nepal and in Japan. The following works will be included:

1) Field investigation;

- To discuss with HMGN about the scope of detailed design work

- To confirm the result of basic design and to examine the necessity of change about the detailed design

- To survey situation of construction in Nepal required for detailed design, cost estimate and construction planning

2) Detailed design and preparation of tender documents;

- Preparation of detailed design drawing and tender drawing
- Preparation of tender documents
- Cost estimate

6.3.2 Construction Plan

1) Basic idea

The construction work will be made in the dry season, taking into consideration the work volume, the term required, maximum period allowed in the Japan's Grant Aid system, meteorology in the project area, etc. The construction work will start in February and last till June.

The drilling work of production wells has to be started first and is followed by construction of irrigation facilities after confirmation of the yield of the production tubewell by pumping test.

2) Construction plan

At the beginning of construction work, a construction plan is carefully made by a consultant to enable a rationalized construction work. The construction plan is made taking present situation, scale of construction, kind and quantity of

construction machinery, and labor management, etc. into consideration.

The construction plan which specifies construction method, construction procedure, time schedule, construction facilities, etc. will be made for the following construction works:

- Temporary works
- Drilling works
- Earthworks
- Brick works
- Concrete works
- Control of materials and equipment
- Construction schedule
- Labor management

6.3.3 Construction Method

1) Access road and temporary road

The East-West Highway and its branch road from Dhalkewar will be used for transportation of materials. The roads in the project area have to be improved for construction work. Some of temporary roads will have to be constructed for some of drilling sites to transport drilling rig and construction equipment and materials. In this case, a present farm land has to be used for the temporary road.

2) Drilling works

Drilling works will be conducted by using the equipment and materials granted by the KR-2 and newly granted by the Japanese Government. The drilling works have to be carried out during the period from February to May since the ground surface has to dry up for transportation of the rig. The drilling and development works have to be made according to the methods described in 3) hereinafter.

3) Drilling and development methods

Based on the results of the test tubewells in the Phase-II the drilling and development methods of production wells are determined as follows.

(1) Consumable materials for tubewell drilling such as bentonite, CMC and barite, etc. are to be procured in Japan, because those available in local market are poor in quality.

(2) Both screens have to be used: one is made by reinforcing the present Johnson type screen and the other is a strengthened rod base type to be procured newly. The applicable depth of each screen is as follows.

Depth	Screen to be applied	Collapse strength
0 - 50m	Present screen	4.6 kg/cm^2
50 - 100m	Present screen reinforced	9.2 kg/cm^2
100 - 150m	Present screen reinforced	16 kg/cm^2
more than 150m	Rod based wire-wrapped screen of 1 mm-slots (to be procured newly)	28 kg/cm^2

(3) Centralizer has to be attached to the pipes at an interval of 15 m to 30 m.

(4) Diameter of gravels to be packed is strictly in the range of 1.7 mm to 6 mm. Before starting gravel packing, the density of mud water in the drilled hole has to be decreased for a smooth installation of the casing and screen. In the gravel packing work, jetting and mud cleaner have to be applied in order to avoid a plugging and lifting of screen and to promote smooth sinking of gravel.

(5) The casing string has to be hung by casing bands until the pump test is completed. The conductor pipe has to be recovered in principle. After completion of the

recovery work, the top of casing string has to be fixed by cementing.

(6) Mud water has to be drawn by bailing and water circulation have to be done.

(7) Injection of the water with mud cleaner and cleaning screen by jetting nozzle have to be done.

(8) Cleaning of tubewell bottom has to be done by using bailer.

(9) In case that the development work was judged to be imperfect from the results of preliminary pumping, the above items from (6) to (8) have to be repeated. Air lifting has to be, if required, carefully conducted from the top position to lowest position of the screen step by step.

3) Earth works

The embankment of irrigation canal has tobe constructed by using bulldozer and vibrating roller up to the height of a base concrete of the canal after stripping top soil.

The embankment of higher portion than the base concrete has to be built by manpower after constructing flume with brick masonry.

4) Brick work

Irrigation canal and its related structures, pump house and operator hut will be constructed by brick masonry.

5) Concrete works

Concrete works are required for a base concrete of canal, roof and foundation of pump house and operator hut, precast structures, etc. All concrete works other than precast structures are carried out in site. All materials such as cement, sand, gravel, reinforcement steel, etc. are procured in Nepal. Precast concrete pipe products are also procured in Nepal.

6.3.4 Supervision of Construction

After signing of the contract for the construction the consultant will visit Nepal to conduct the mobilization necessary for the construction. The consultant will stay in Nepal to manage the construction works and to coordinate between the contractor and the authorities concerned.

A careful attention will be paid to natural condition, customs, traditions and capability of workers to aim at smooth construction and completion of the work within the given period.

The construction program will be scheduled taking into account the workmanship of local workers and the period required for delivery of materials and equipment procured in Japan.

The main activities in the construction supervision will be classified into as follows:

1) Assistance and advice on contract of construction work

The services are given to prequalification of tenderers, tendering, evaluation of tenders and drafting contract.

2) Examination and approval of shop drawings

Check, examine and approve shop drawings, samples, specifications, etc. submitted by the contractor.

3) Inspection of construction work

Examine construction program, control construction progress, and inspect and approve field work.

4) Approval of payments

Approve payment claimed by the contractor based on the progress of the work.

5) Reporting

Prepare regular progress reports on all aspects concerning the construction for the information to the concerned authorities of HMGN and GOJ.

6) Handing over of the work completed

Hand over the work completed to HMGN after examining the work and confirming fulfillment of all contractual obligations.

6.4 Procurement of Equipment and Materials

6.4.1 Procurement Plan

1) Equipment and materials to be newly granted

The equipment and materials mentioned in the previous section 5.4.3 will be delivered by a Japanese supplier selected through tendering. It will take about 4 months to procure in Japan and to deliver the equipment and materials to the site. Accordingly, a supplier has to be selected by late in September so that the drilling works can be commenced early in February of the next year.

2) Materials to be procured in Nepal

Cement, sand, gravel, timber, reinforcement steel, steel plate, etc. are to be procured in Nepal. Bricks and precast concrete pipes are also to be procured in Nepal.

However, Bentonite, Barite, CMC and mud cleaner have to be procured in Japan because those available in Nepal are poor in quality. Gear oil, hydraulic oil and grease are also to be procured in Japan.

6.4.2 Transportation Plan

The equipment and materials procured in Japan are imported through India, excluding the goods to be carried by air. The equipment and materials shipped from Japan are unloaded at Calcutta and transported via Laxual in Indian border to Birganj. The commodities to be imported to Nepal via India are not difficult for the custom clearance at Calcutta, provided that the documents are complete.

The Calcutta-Birganj-Janakpur road is paved with asphalt, and thereby makes transport of equipment and materials easy. The precision instruments, spare pats of equipment, consumables, etc. shall be packed in a sealed wooden case and others are packed in an open worked wooden case. Construction equipment and vehicles are to be transported by trailer and self-propelling, respectively.

It will take 35 days for sea transport between Japan and Calcutta and take another 10 days for offshore waiting. The custom clearance at Calcutta and Birganj and the inland transport between Calcutta and site nearby Janakpur will be conducted by Nepalese or Indian agents. It will take about 5 days for custom clearance and unloading at Calcutta, about 5 days for inland transport in India and Nepal and 5 days for custom clearance at Birganj. Therefore, it is estimated to be

two months to deliver the equipment and materials from Japan to the site.

6.4.3 Control of Equipment and Materials

The contractor will have to receive all of necessary KR-2 equipment and materials from TIATSP prior to the onset of the construction work and have to be liable for control of them as well as equipment and materials newly granted by GOJ and/or purchased by the contractor.

6.5 Implementation Program

Immediately after the conclusion of the Exchange Note, the consulting firm will contract with HMGN for engineering services. The detailed design works will take two months and a half, tendering works such as prequalification, tendering, evaluation and contract will take three months. The contractor will take one month for preparatory works. The construction works will therefore be started at the sixth and a half month after the conclusion of the exchange note.

Drilling work of eight (8) production tubewells requires three months and a half, by using three rigs. Civil works in nine (9) irrigation units, which are undertaken one month later from the drilling work, require three months and a half. Besides, another one month is required for the final service of the rigs, construction equipment and vehicles provided by TIATSP, HMGN before returning them to TIATSP. Total construction period is therefore set to be six months and a half, including one month for the preparatory works by the contractor.

To meet the construction schedule, the equipment and materials to be newly granted by GOJ will be procured in Japan and shipped by the supplier selected through tendering to the site before onset of the drilling work, and it will take four

months and a half, including a half month for selection of the supplier.

A tentative implementation schedule including all the activities discussed above is illustrated in Fig. 6-4.

CHAPTER 7.

OPERATION AND MAINTENANCE

CHAPTER 7. OPERATION AND MAINTENANCE

7.1 Organization and Maintenance of Facilities

TIATSP will be liable for the operation and maintenance of the constructed facilities. TIATSP will increase four staffs as mentioned in Section 6.1 to carry out the operation and maintenance works. An annual operation and maintenance cost is estimated as follows:

	Unit	Q'ty	Unit cost (Rs.)	Amount (Rs.)
1. Personal expenditure				
- Salary for staffs	man-month	48	1,225	58,800
- Wage for workers	man-day	860	30	25,800
2. Materials of canal rehabilitation	L.S.			60,000
3. Materials of pump repair	L.S.			210,000
4. Refreshment of well	L.S.			34,300
5. Pump operation cost				
- D-7 block	hour-nos.	6,000	59.7	358,200
- D-15 block	hour-nos.	6,000	64.1	384,600
Total				1,131,700

The annual operation and maintenance cost mentioned above will be charged for beneficiaries. The operation and maintenance cost will be Rs.2,830/ha.

However, until the beneficiaries will stock sufficient amount of farming income by the deep tubewell irrigation envisaged, the operation and maintenance cost will have to be subsidized by HMGN in the following manner:

First year	:	100% subsidized by HMGN
Second year	:	70% by HMGN, 30% by beneficiaries
Third year	:	30% by HMGN, 70% by beneficiaries
From fourth year	:	100% shared by beneficiaries

During the initial year, TIATSP will organize a Water Users' Group in each irrigation unit (an irrigable area by one pump) and then collect a 100% of operation and maintenance cost from the Water Users' Group after the fourth year. An agricultural extension and training division of TIATSP is responsible for establishing the Water Users' Groups, and an operation and maintenance division for collecting the water charge.

7.2 Construction of On-farm Facilities

In the Project the Japanese Government will construct pump houses, operator huts, main canals and their related structures (including turnouts for branch canals) and HMGN will construct the on-farm facilities such as branch canals.

The rotation irrigation with one week cycle will be employed, therefore, the number of branch canals branching off from main canal will be 14 and the irrigable area by one branch canal will be 2.9 ha. An average farm size is about 1 ha, so 2 or 3 farmers are irrigated by one branch canal.

In order to secure equitable and even distribution of irrigation water, it is essential to organize the water users' groups and to construct the on-farm facilities within one year after completion of the main irrigation facilities. TIATSP's guidance and supervision are indispensable for successful construction of the on-farm facilities and establishment of the water users' groups.

7.3 Education and Training for Farmers

The organized water users' groups will be responsible for construction of branch canals, operation and maintenance of them and water management. For the purpose of successful implementation of the above, it is essential to instruct farmers the irrigation farming and the rotation irrigation method and to convince them of those merits and the necessity of the water users' group. Also it is necessary to train the farmers to let them master the technique and skill for the above. Therefore, TIATSP has to be responsible for such instruction and training of farmers.

The construction division in TIATSP will guide and supervise farmers on construction of branch canals, the extension and training division will do guidance and supervision on irrigation farming and organization of the water users' groups, the irrigation division will do instruction and training for rotation irrigation and water management, and the O & M division will do guidance and supervision for maintenance of branch canals. A systematic technical cooperation is required so as to promote such activities because the TIATSP's staff don't have sufficient technique and experience at present.

CHAPTER 8.

EVALUATION OF THE PROJECT

CHAPTER 8. EVALUATION OF THE PROJECT

By implementing the Project, that is, deep tubewell irrigation development in the two blocks of D-7 and D-15, direct effects such as expansion of irrigable farm lands, increase of cropping intensity and diversification of crops by perennial irrigation, increase of crop unit yields and agricultural production, and improvement to farmers' incomes and living standards resulting from the said effects are anticipated, in addition to such indirect effects as improvements to the living environment, increase of farmers' mutual cooperation, upgrading of deep tubewell development technique, etc.

Such direct effects can be summarized as follows.

1) Expansion of irrigable farm lands

In both blocks arable land of 400 ha (200 ha in D-7 and 200 ha in D-15) will be provided with perennial irrigation.

2) Increase of cropping intensity and diversification of crops

It is expected to increase cropping intensity from the present 160% (640 ha in area) to 210% (840 ha in area) and diversify crops because the perennial irrigation will enable cultivation of early season paddy, expansion of the cropping area of wheat and cultivation of more beneficial vegetables such as potatoes, tomatoes, etc.

3) Increase of crop unit yields and agricultural production

At present, rainy season paddy (about 360 ha), wheat (about 240 ha), mustard (about 30 ha), vegetables (about 10 ha), etc. are cultivated in both blocks. However, the unit yield level is very low because of both rainfed culture and extensive farming practices.

By implementing the Project, irrigation facilities and perennial irrigation are provided which will enable improvement of farming practices such as introduction of high yielding varieties, increase of fertilizer application, etc. Thus, it is expected that the crop unit yields will greatly increase as follows.

	Present yield (ton/ha)	Anticipated yield (ton/ha)	Anticipated increment (ton/ha)
Paddy	2.0	4.0	2.0
Wheat	1.8	2.5	0.7
Mustard	0.5	0.8	0.3
Vegetables (Potato, etc.)	6.0	12.0	6.0
Tomato	-	12.0	12.0

With the increase of crop unit yields, the increase of cropping intensity, the diversification of crops, etc. as mentioned above, agricultural production in the project area (400 ha) is expected to be greatly increased as follows.

	Present yield (ton/ha)	Anticipated yield (ton/ha)	Anticipated increment (ton/ha)
Paddy	720	1,760	1,040
Wheat	430	700	270
Mustard	15	48	33
Vegetables (Potato, etc.)	60	480	420
Tomato	-	240	240

Therefore, the Project will contribute to increasing agricultural production on which the present national development plan places top priority, though a marketing route for the increased production, particularly vegetables and

tomatoes will have to be secured for Kathmandu, Birganj, Biratnagar, etc.

4) Increase of farm income and improvement of farmers' living standards

By the increment in agricultural production, the agricultural gross income of average farmers with a land holding of 1.0 ha in the project area will increase about 2.7 times, i.e. from Rs. 9,710 to Rs. 26,170, and will contribute to improvement of their living standards. The operation and maintenance cost of the constructed facilities including tubewells, pumps and irrigation facilities, which is estimated at about Rs.2,830/ha/year in case of annual pump running of 1,200 hours, will be covered by the increment in farmer's gross income.

In addition to the direct effects as mentioned above, the following indirect effects may also be expected:

1) Improvement in living environment

Since domestic water will be easily taken from both the baffle tank of a pump house and from irrigation canals, the farmers' living environment, particularly in health and sanitation, in the project area will be significantly improved.

2) Increase of mutual cooperation between farmers

Because construction of the branch earth canals and water management of the rotation irrigation will involve educating farmers in technical guidance and supervision from TIATSP, the organization of farmers' cooperatives such as water users' groups, etc. will naturally be promoted. In addition, farmers' participation in the construction of irrigation facilities will increase their mutual cooperation since the pump and irrigation facilities

constructed must be operated and maintained by benefiting farmers themselves. It is expected that the water charge for operation and maintenance of the facilities will be paid by all the beneficiaries.

3) Upgrading of deep tubewell development technique

Japanese technology introduced to the hydrogeological investigation for selection of tubewell drilling points, tubewell drilling and development, pumping tests, etc. will contribute to upgrading deep tubewell development technique in Nepal. In particular, the following technical improvements are expected:

(1) Selection of deep tubewell drilling points by comprehensive analysis of the geological logs of test tubewells and electric sounding in each development block;

(2) Tubewell drilling at a diameter and depth appropriate to the hydrogeological structures;

(3) Gravel packing to prevent the inflow of silt, fine sand, etc., and tubewell cleaning by jetting and mud cleaner; and

(4) Confirmation of tubewell yield and discharge by both step drawdown test and continuous pumping test.

CHAPTER 9.

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 9. CONCLUSIONS AND RECOMMENDATIONS

The hydrogeological conditions such as piezometric levels, prospective pump discharge, etc. in the Terai plain in Janakpur zone vary significantly from block to block and from place to place. It is therefore too risky to construct production tubewells in the proposed development blocks without first confirming the pump discharge by drilling a test well in each block. It is therefore not possible to implement an overall plan for the Terai groundwater development project, for construction of 115 production tubewells and associated irrigation facilities in 23 development blocks during a period of 4 years, as worked out in the basic design study Phase-I on the basis of probable pump discharge in the various blocks estimated from available data on existing deep tubewells.

It is, nevertheless, possible to implement development of D-7 and D-15 blocks at any time because a pump discharge of more than 40 l/sec has been confirmed by a test well and a pumping tests on existing tubewells, and a basic design for the irrigation facilities has been worked out. However, in implementing the development it is necessary to prepare the detailed design of the production tubewells and the associated irrigation facilities and to provide a considerable quantity of new equipment and materials for the drilling and construction equipment and materials granted under a KR-2 aid of GOJ.

In D-7 and D-15 blocks eight (8) production tubewells and irrigation facilities of nine (9) irrigation units will have to be newly constructed, since a test tubewell drilled in D-7 block under the Phase-II study and an existing deep tubewell drilled by TIATSP in D-15 block are converted to production tubewells, and the latter's irrigation facilities are under construction by TIATSP.

It is anticipated that operation and maintenance of the constructed irrigation facilities including pumps will be

undertaken by HMGN which has expressed to GOJ its capability to operate and maintain the irrigation facilities including the organizing of water users' groups by benefiting farmers and collecting the necessary water charges from the water users' groups. The operation and maintenance costs of the pump and irrigation facilities will be recoverable as water charges paid by benefiting farmers whose agricultural income will be substantially increased by irrigation.

Regarding M-4 and S-1 blocks, it is essential to shift the development areas southwards from the original sites and to prepare designs for the irrigation facilities based on new topographic surveys before implementing the development. Furthermore, whether S-1 block is to be developed or not should be judged from the results of a test well to be drilled in the new area. S-7 block should be abandoned since no promising aquifer was observed in drilling the test well under the Phase-II study.

If deep tubewell irrigation development is to be promoted in many of the proposed blocks in the future, it will be essential to forecast yearly and seasonal variations of groundwater over the whole project area, namely the Terai plain in Janakpur zone, and therefore to establish a comprehensive long term groundwater level observation well network.

When development of blocks D-7 and D-15 is implemented with general grant aid cooperation from GOJ, the cooperation of HMGN will be vital, particularly in the following:

(1) Providing a Japanese contractor, free of charge, with the drilling and construction equipment and materials required by him out of those granted under the KR-2 aid;

(2) Acceptance of production tubewells constructed by the Japanese contractor and issuance of the necessary

completion certificates to him, unless the wells are dry;

(3) Provision of construction sites and access roads as required by the Japanese contractor, including land acquisition and compensation, if required;

(4) Construction of branch earth canals from main canals constructed under the Japanese grant aid; and

(5) Operation and maintenance of the constructed facilities by organizing water users' groups and collecting water charges from the users' groups.

TABLES

Table 2-1 Production and Area of Major Crops

(Production : 1,000ton)
(Area : 1,000ha)

			1981/82	1982/83	1983/84	1984/85
1.	Paddy	Production	2,560	1,832	2,757	2,709
		Area	1,297	1,264	1,334	1,377
2.	Maize	Production	752	718	761	820
		Area	475	510	504	579
3.	Wheat	Production	526	656	634	534
		Area	400	483	472	452
4.	Millet	Production	122	121	115	124
		Area	122	129	124	134
5.	Barley	Production	23	21	22	24
		Area	27	24	25	28
6.	Potato	Production	320	373	383	420
		Area	52	59	59	66
7.	Sugarcane	Production	590	616	509	408
		Area	25	25	23	17
8.	Oil seed	Production	79	69	73	84
		Area	114	110	110	128
9.	Tobacco	Production	5	6	7	6
		Area	7	8	9	9

Source: Statistical Pocket Book, Nepal, 1986