APPENDIX Ⅲ

3-1 Soil Investigation

Table- a   The quantity of the field soil investigation.

Bor.hole No.	Depth (m)	S.P.T. *1 (nos.)	U.S *2 (pieces)	I.P.T*3 (nos.)	Digging Pits	I.D.T*4 (nos.)	D.S. *5 (piece)	Remarks
1	32	32	–	–	–	–	–	for the pumping station
2	10	10	1	1	–	–	1	beside the embankment
3	10	10	1	–	–	–	1	"
4	10	10	2**	–	1	1	–	on the embankment
5	10	10	2**	1	1	1	–	"
Total	72	72	6	2	2	2	2	

*1 S.P.T.: Standard Penetration Test

*2 U.S. : Undisturbed Soil Sampling

　　**:including one sample from the test pit

*3 I.P.T.: In-situ Permiability Test

*4 I.D.T.: In-situ Density Test in the pits

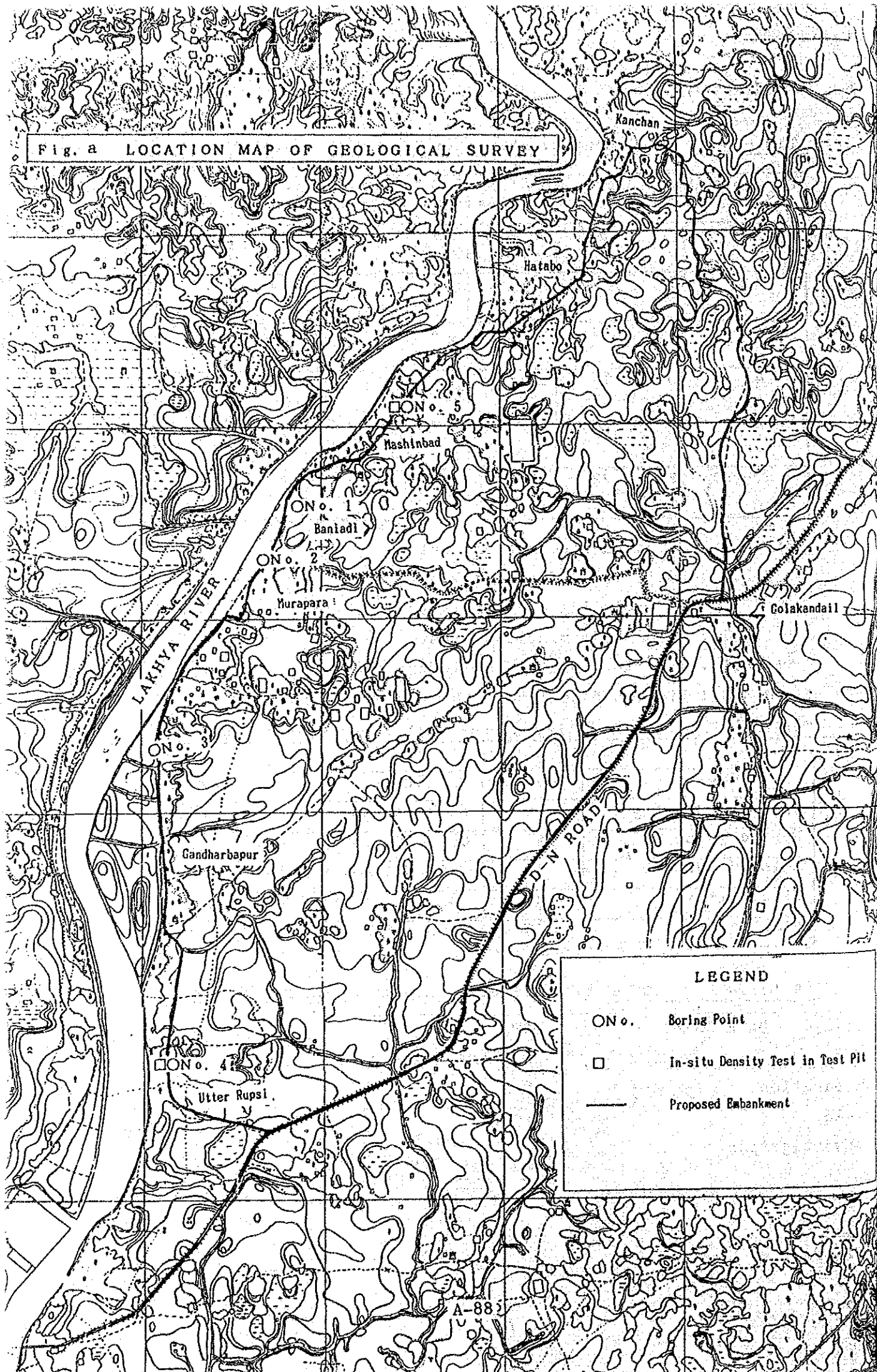*5 D.S. : Disturbed soil sampling for Compaction test

Table - b   The quantity of the soil tests in labolatory

Items	Quant.	Items	Quant.
Specific Gravity	10	Bulk dencity	4
Perticl Size	10	Consoldation	4
Moistur Content	10	Triaxial compression	6
Liquid limit	10	Permiability	2
Plastic limit	10	Compaction	2

Table - c   Time table of soil investigation carried out

Fig. a   LOCATION MAP OF GEOLOGICAL SURVEY

LAKHYA RIVER

Kanchan

Hatabo

○No. 5

Mashinbad

○No. 1

Baniadi

○No. 2

Murapara

Golakandail

○No. 3

D-N ROAD

Gandharbapur

○No. 4

Utter Rupsi

A-88

LEGEND

○No.   Boring Point

□   In-situ Density Test in Test Pit

——   Proposed Embankment

Soiltreat Equipment & Engg.Ltd. 76A, Segun Bagicha, Dhaka	Project :- N-N Irrigation Project Client:- Japan Engineering Consultant Co. Ltd. Site:- Narsinghdi Bore chart of boring no. 1
Method of boring:- Percussion Diameter of boring:- 100 mm Inclination:- Vertical	Date started. 3-10-87 Date completed. 5-10-87 GR.W. Table. 0.5m

reduced elevation	depth mm	thickness mm	strata encountered	log	standard penetration tests blows/30cm 10 20 30 40 50 60 70 80 90	remarks (g.w.т, soil samples vane shear test lbs/sq in.)
	4300	4300	Brown clay with some silt		3 7 9 9	
	7300	3000	Grey clayey silt, trace sand		7 8 8	
	25300	18000	Grey, silt, with clay, trace fine sand		5 5 5 4 5 7 5 3 3 3 4 5 5 5 7 7 5 4	
	32300	7000	Grey fine to medium sand trace clay		16 29 37 35 32 30 29	

drn:-	disturbed sample..... ▨	undisturbed sample..... ▪
checked:-	date:-	scale:- 1: 200	plan no.

Soiltreat Equipment & Engg.,Ltd. 76A, Segun Bagicha. Dhaka	Project :- N-N Irrigation Project Client :- Japan Engineering Consultant Co. Ltd. Site :- Narsing di Bore chart of boring no. 2

Method of boring :-Percussion Diameter of boring :- 100 mm Inclination :-Vertical	Date started. 29-9-87 Date completed, 30-9-87 GRW. Table. 0.63 m on 29-9-87

reduced elevation	depth mm	thickness mm	strata encountered	log	standard penetration tests blows/30cm 10 20 30 40 50 60 70 80 90	remarks (o.w.r, soil samples vane shear test lbs/sq in.
	1300	1300	Brown clayey silt		5	
		3000			13	K = 2.06 x 10⁻⁴ cm/sec
					10	
	4300		Grey clayey silt trace fine sand		15	
		6000			7	
					5	
					9	
					9	
					12	
	10300		Grey clayey silt		11	
						K:coefficient of permiability

drn :-
checked :-   disturbed sample..... ▨   undisturbed sample..... ▬
                                        date :-   scale :-1:7 5   plan no.

Soiltreat Equipment & Engg.Ltd.
76A, Segun Bagicha. Dhaka

Project :- N-N   Irrigation Project
Client:- Japan Engineering Consultant Co. Ltd.
Site:- Narsinghdi
Bore chart of boring no. 3

Method of boring:- Percussion
Diameter of boring :- 100 mm
Inclination:- Vertical

Date started.   1-10-87
Date completed. 1-10-87
GRW.Table.   0.68m

reduced elevation	depth mm	thickness mm	strata encountered	log	standard penetration tests blows/30cm 10 20 30 40 50 60 70 80 90	remarks (a.w.r, soil samples vane shear test lbs/sq in.
		2300			3	
	2300		Brown clay with silt		4	
		3000			7	
					8	
	5300		Grey clayey silt trace fine sand		4	
		5000			13	
					12	
					5	
					6	
	10300		Grey clayey silt		4	

drn:-   disturbed sample.....▨   undisturbed sample.....▬
checked:-   date:-   scale:- 1:75   plan no.

A-91

Soiltreat Equipment & Engg. Ltd. 76/A, Segun Bagicha, Dhaka	Project :- N-N Irrigation Project
	Client:- Japan Engineering Consultant Co. Ltd.
	Site:- Narsinghdi
	Bore chart of boring no. 4

Method of boring:- Percussion	Date started. 6-10-87
Diameter of boring:- 100 mm	Date completed. 6-10-87
Inclination:- Vertical	G.R.W. Table. 1.15 m

reduced elevation	depth mm	thickness mm	strata encountered	log	standard penetration tests blows/30cm 10 20 30 40 50 60 70 80 90	remarks (e.w.r. soil samples vane shear test lbs/sq in.)
		4300	Brown clayey silt trace fine sand		3	
					3	
					5	
	4300				7	
		4000	Brown. to grey silt with some fine sand, trace clay		13	K = 1.88 ×10⁻⁴ cm/sec
					12	
					13	
					13	
	8300					
		2000	Grey clayey silt		16	
	10300				21	

drn:-	disturbed sample....▨	undisturbed sample....▥
checked:-	date :-	scale:-1:75
		plan no.

K = 1.88 ×10⁻⁴ cm/sec

Soiltreat Equipment & Engg. Ltd. 76A, Segun Bagicha, Dhaka	Project :- N-N Irrigation Project Client:- Japan Engineering Consultant Co. Ltd. Site:-Narsinghdi Bore chart of boring no. 5

Method of boring:-Percussion Diameter of boring:- 100 mm Inclination:-Vertical	Date started. 2-10-87 Date completed. 2-10-87 GRW.Table. 1.14 m

reduced elevation	depth mm	thickness mm	strata encountered	log	standard penetration tests blows/30cm 10 20 30 40 50 60 70 80 90	remarks (o.w.r, soil samples vane shear test lbs/sq in.
		2300	Brown clayey silt		3 5	
	2300					
		2000			8	K = 2,09 x10^{-4} cm/sec
	4300		Brown to grey silt with trace sand		4 6	
		6000			9 5 3 2	
	10300		Brown silty clay		4	

drn:-   disturbed sample.....▨   undisturbed sample.....▦
checked:-   date:-   scale:-1:75   plan no.

A-93

SOIL TEST RESULTS SUMMARY

B/H No.	Depth(m)	>2mm	2mm-60μm	60-2μm	2μm>	W_L	PI	SG	MC (%)	UW g/cm²	Class. of Soils	M.D.D. (g/cm³)	O.M.C. (%)	e_0	C_c	C_v cm²/d	P_c kg/cm²	q_u kg/cm²	C kg/cm²	φ°	K(cm/sec)
1	4.85~5.30	—	6	57	37	79.40	22.45	2.54	44.86		MC										
1	9.85~10.30	—	10	67	23	82.50	52.98	2.59	44.82		CH										
2	0.85~1.30	—	—	67	33	51.35	25.16	2.70	27.25		CH	1.618	17.90								
2	2.85~3.30	—	4	74	22	40.50	11.91	2.59	35.02		ML										
2	3.40~3.55					-	-	2.61	29	1.82	ML			0.85	0.20	220	0.060		0.545	0	
3	0.85~1.30	—	—	72	28	40.65	22.68	2.66	29.77		CL	1.479	17.50								
3	2.85~3.30	—	5	62	33	37.10	23.29	2.60	29.32		CL										
3	4.40~4.85					-		2.61	38		CL			1.00	0.21	120	0.052		0.408	0	
4(P)	0.50~0.80								43	1.716*	CL								0.300	0	
4	1.85~2.30	—	—	57	43	49.90	34.53	2.65	38.39		CL										
4	2.85~3.30	—	6	54	40	44.50	25.40	2.60	40.89		CL										
4	4.40~4.85							2.60	43	2.00	CL			0.82	0.21	255	0.044		0?	28?	3.15×10⁻⁸
5(P)	0.50~0.80							2.53	29	1.806*	CL								0.460	16	
5	1.85~2.30	—	—	64	36	40.72	26.70	2.63	27.86		CL										
5	2.85~3.30	—	—	91	9	41.80	32.56	2.56	30.11		CL										
5	4.40~4.85							2.58	30	1.90	CL			0.76	0.14	155	0.067		0.306	0	1.20×10⁻⁶
Reference Materials (Baniadi Regulator 1983)																					
H-1	7.60~8.20	—	6	65	29	43	17		42.26	1.89	CL							0.746			
H-2	4.60~5.20	—	3	83	14	42	17	2.682	27.62	1.86	CL			0.72	0.163	259	0.200	1.903			
H-3	6.10~6.70	—	13	77	10	59	29	2.665	42.18	1.75	CH			1.15	0.34	69	0.040	0.285			

Remarks:
SG: Specific Gravity
MC: Natural Moisture Content
UW: Unit Weight
Class: The Unified Soil Classification System
e_0: Initial Void Ratio
C_c: Compression index
C_v: Coeficient of Consolidation
q_u: Unconfined Compression Strength
C: Cohesion
φ: internal friction
*: In-situ density test

A-94

3-2 Surveying

LOCATION MAP
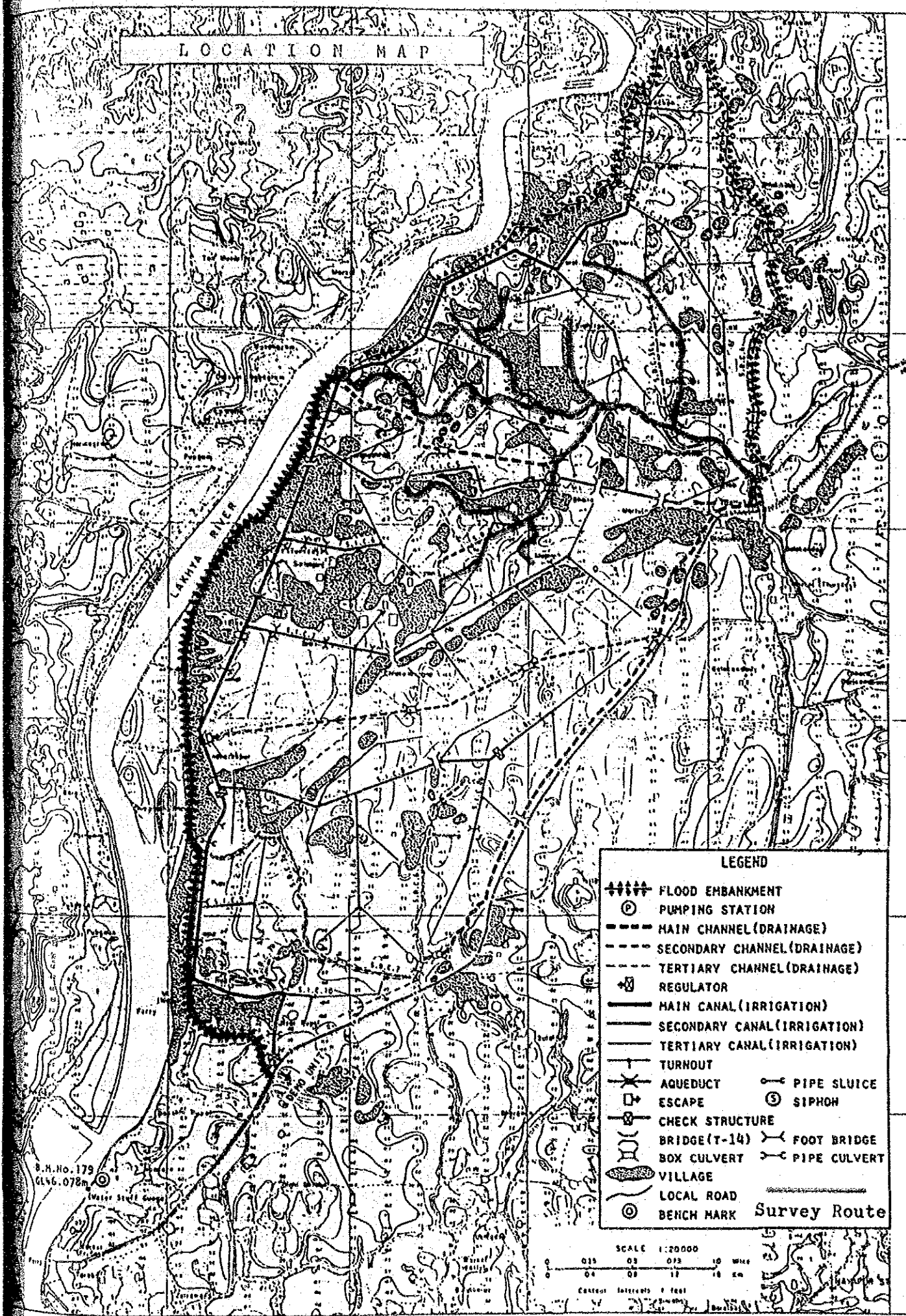
LEGEND

┿┿┿┿	FLOOD EMBANKMENT
℗	PUMPING STATION
▬ ▬ ▬	MAIN CHANNEL (DRAINAGE)
─ ─ ─	SECONDARY CHANNEL (DRAINAGE)
- - -	TERTIARY CHANNEL (DRAINAGE)
⊠	REGULATOR
───	MAIN CANAL (IRRIGATION)
───	SECONDARY CANAL (IRRIGATION)
───	TERTIARY CANAL (IRRIGATION)
┬	TURNOUT
✕	AQUEDUCT
☐►	ESCAPE
⊠	CHECK STRUCTURE
)(	BRIDGE (T-14)
	BOX CULVERT
▰	VILLAGE
	LOCAL ROAD
◎	BENCH MARK

PIPE SLUICE

Ⓢ SIPHON

)—(FOOT BRIDGE

>—< PIPE CULVERT

Survey Route

B.H.No.179
GL46.078m ◎

SCALE 1:20000

Contour Intervals 1 feet

A-97
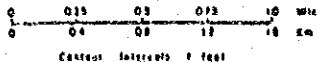
1. Objective of the Survey

Objective of this survey work is to decide the location of
the facilities to be constructed in the first stage of the
Project implementation in order that the land for the
constraction of the facilities will be acquired by the
Government of Bangladesh prior to the commencement of the work.

2. Scope of Surveying

The scope of surveying is as follows:

Facilities	Surveyed Section
Flood embankment	From beginning of Rupsi road to proposed Pumping station
Main drainage channel	Baniadi Khal from Lakhya river to D-N road
Secondary and tertiary drainage channel	Branch channels of the MDC of said section
Pumping station	Baniadi

Item of Survey

Traverse Surveying

Establishment of Bench Marks

Route Alignment

Centering Survey

Logitudinal and cross Sectional Survey

Topographical Survey

A-99

3. Contents and Results of Surveying

3.1 Traverse Survey /Horizontal control

Closed traverse surveying has been done along Rupsi road ,
Bulta - Murapara road and D - N road, provided that
the allowable closure error is 1/5000.
The results of the surveying are given in Table 1.

3.2 Establishment of Bench Marks

Twenty five (25) Bench Marks (B.Ms) have been established
along the flood embankment including the D-N road.
The leveling has been carried out on the basis of the P.W.D.
B.M. No.179 (19.94ft=6.078m) at Tarabo, under the condition
of the allowable error of 20mmsquare root per Km.
The results of survey are shown in Table 1.

3.3 Route Alignment

Final route of the flood embankment and the drainage channels
said in section 2 have been located at the site through detailed
reconnaissance survey on the basis of the basic design (see Fig.1).
Since a part of the main drainage channel route desided in the
basic design has been modified in accordace with the site
reconnaissance , names of the secondary and tertiary channels
have been changed as follwos;

New Name	Old Name
SDC.1	SDC.2
SDC.2	TDC.2
SDC.3	SDC.1
SDC.4	SDC.3

New Name	Old Name
TDC.1-1	TDC.2-3
TDC.1-2	TDC.2-2
TDC.3-1	TDC.1-1
TDC.3-2	TDC.1-3
TDC.3-3	TDC.1-2
TDC.4-1	TDC.3-1
TDC.4-2	TDC.3-2

3.4 Centering Servey and Logitudinal and Cross Section

Centering survey with fixed traverse survey and logitu

cross sectional leveling have been done as shown below

a . Flood Embankment :

Section   :   from D-N road (Rupsi)
                            to proposed pumping station

Survey length   :   7.3 Km

Station interval :   25 m

Survey width   :   50 m

b . Main drainage channel

Section   :   from Lakhya river
                         to D-N road

Survey length   :   5.7 Km

Station interval :   50 m

Survey width   :   30 m

c . Secondary drainage channel

SDC.1	L=1.03 Km
SDC.2	L=0.94 Km
SDC.3	L=1.41 Km
SDC.4	L=1.41 Km
Total length	: 4.79 Km
Interval	: 50 m
Width	: 20 m

d . Tertiary drainage channel

TDC.1-1	L=0.41 Km
TDC.1-2	L=0.48 Km
TDC.3-1	L=0.76 Km
TDC.3-2	L=1.51 Km
TDC.3-3	L=1.24 Km
TDC.4-1	L=0.60 Km
TDC.4-2	L=0.40 Km
Total length	: 5.40 Km
Interval	: 50 m
Width	: 20 m

The coordinates of I.Ps of above routes are shown in Table 2.

3.5 Topographical Survey

Topographical Survey by using Plane Table has been done as shown in the following;

a . Flood embankment   :   7.30 Km x 50 m = 36.5 ha

b . Main drainage channel   5.62 Km x 30 m = 16.9 ha

c . Secondary drainage channel   4.79 Km x 20 m = 9.6   ha

d . Tertiary drainage channel   5.40 Km x 20 m = 10.8 ha

e . Pumping station   150   m x 180 m = 2.7 ha

                                   Total   76.5 ha

3.6 Drawing

The results of surveying have been summarized in the following drawings .

a . Longitudinal Section , Scale Hor. 1:500

                                   Ver. 1:100

b . Cross Section ,   Scale   1:100

c . Topographical Maps   Scale   1:500

4. Persons engaged, Syrvey Instrument used and Progress of the Surveying

4.1 Persons engaged

Leader	Tsuneo Amano
Survey Surpervisor	Kunihiko Okada
Surveyor	Yoshiaki Inoue
Surveyors	8 partties from Bangladesh Survey Organisation LTd (Local Private Firm)

4.2 Survey Instruments

Theodolite Electric Distance Metre(EDM)from Japan	2 sets
Auto level	1 set
Tilting level	4 sets
Plane table	4 sets

4.3 Progress of the Surveying

The actual progress of the survey work is summarized in Table 3.

5. Checking the T.B.M of Demonstration Unit

There are two types of Bench Marks are being used in
Bangladesh. One of them is S.O.B. (Survey of Bangladesh) and
the another one is P.W.D. (Public Works Department) and
difference of which is 1.508 ft (0.45m). BWDB is using the
B.M. of P.W.D for all of its construction works. The elevation
of the T.B.M. (Temporary Bench Mark) at the intake site of
pumping station for Demonstration Unit which is said to be
+ 21.33 ft (+6.5m) was checked from P.W.D. B.M. No. 179
(19.94 ft = 6.078m) located near Demra Observation Station.

It was found that the elevation of the T.B.M. of Demonstration
Unit is 6.965m P.W.D. as shown below:

```
                              I   0.891
            *----------------------------------------*
 B.M.No.179                 II  -0.897                 TBM.D
 6.078 m                    III -0.873                  6.965 m

                         AVERAGE 0.887 m
```

ROUTE	DIF.HEIGH	ADJUSTMENT	REMARK
I	0.891	-0.004	BY OKADA
II	-0.897	-0.01	BY OKADA
III	-0.873	0.014	BY INOUE
AVERAGE	0.887		

TBM.D height is as follows:

6.078 m + 0.887 = 6.965 m

The difference the Datums of S.O.B. and P.W.D is as follows;

(Difference between S.O.B. and P.W.D Datum)

```
                (DATUM)
S.O.B      ---------------------┐
                (DATUM)         ├─ 1.508 ft (0.45m)
P.W.D.     ---------------------┘
```

The coverting equation of elevation will be

P.W.D = S.O.B + 1.5 ft (0.45 m).
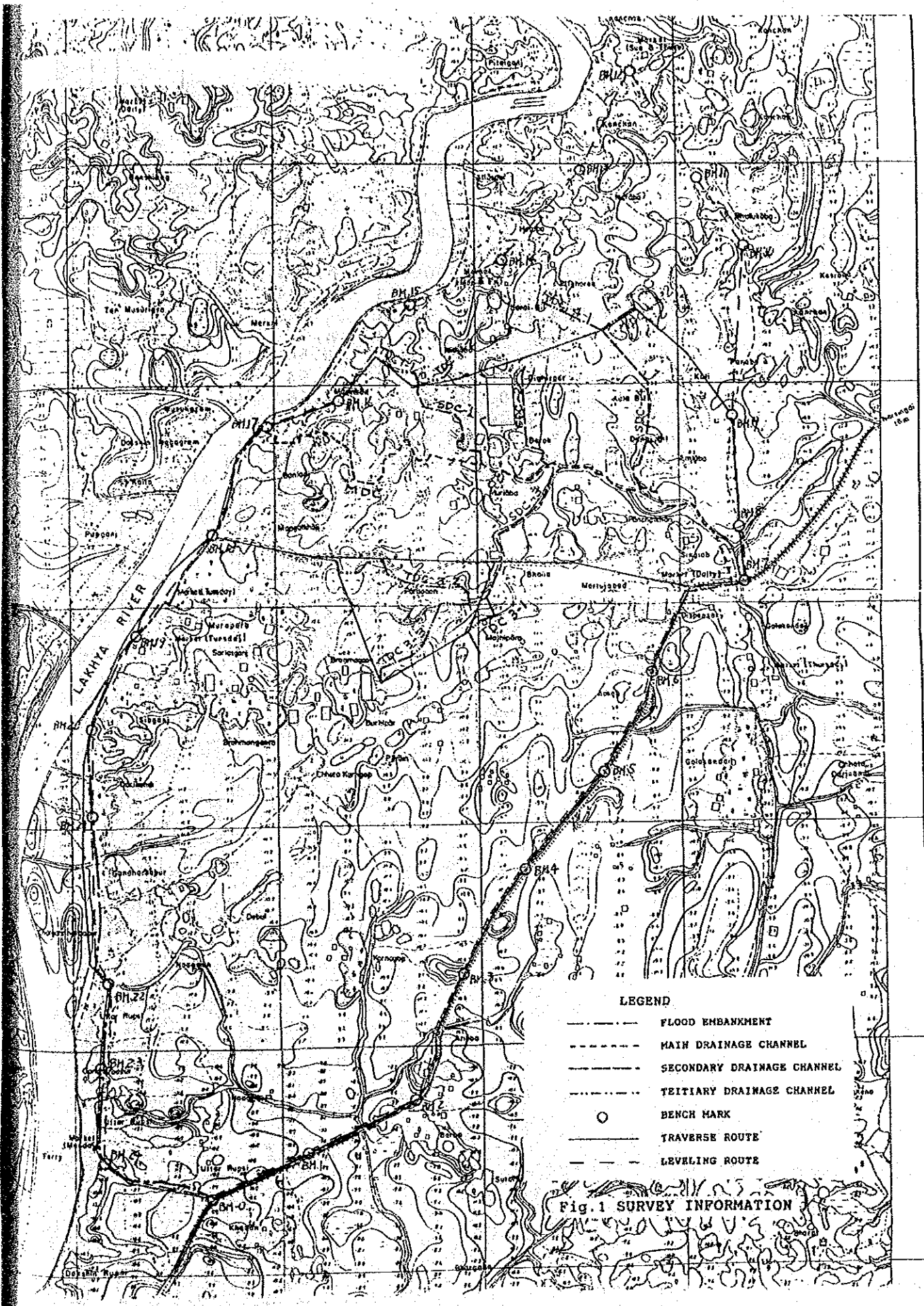
LEGEND

———————— FLOOD EMBANKMENT
– – – – – MAIN DRAINAGE CHANNEL
–·–·–·– SECONDARY DRAINAGE CHANNEL
–··–··– TERTIARY DRAINAGE CHANNEL
○ BENCH MARK
———————— TRAVERSE ROUTE
–·–·– LEVELING ROUTE

Fig.1 SURVEY INFORMATION

A-107

Table. 1   FINAL RESULT OF BENCH MARKS

NAME	X(NORTH)	Y(EAST)	(Z)HEIGHT	REMARK
B.M.0	500000	500000	6.763	
B.M.1	500349.522	500772.824	6.984	
B.M.2	500801.529	501658.633	6.545	
B.M.3	501787.600	502132.674	6.462	
B.M.4	502643.847	502661.139	6.507	
B.M.5	503437.787	503367.889	6.940	
B.M.6	504288.111	503756.428	6.668	
B.M.7	505012.246	504492.984	8.717	
B.M.8	505458.157	504436.420	5.906	
B.M.9	506412.026	504394.007	5.784	
B.M.10			6.732	
B.M.11			6.731	
B.M.12			6.279	
B.M.13			6.000	
B.M.14			6.189	
B.M.15			7.427	
B.M.16	506661.963	501099.899	6.174	
B.M.17	506200.876	500309.703	7.487	
B.M.18	505448.910	500012.837	6.283	
B.M.19	504589.770	499385.301	6.548	
B.M.20	503962.892	499119.105	7.178	
B.M.21	503473.455	499081.265	6.997	
B.M.22	501732.178	499277.261	5.335	
B.M.23	501089.923	499111.234	6.623	
B.M.24	500314.339	499094.202	7.390	

DESCRIPTION OF B.Ms

B.M.No.	Road Name	Kind of Mark
O	D — N	CONCRETE

Location

Sketch

RICE FIELD

POND

POND

B.M. No.	Road Name	Kind of Mark
1	D — N	CONCRETE

Location

Sketch

PERMANE-NT BUIDIND

POND

POND

B.M No.	Road Name	Kind of Mark
2	D — N	CONCRETE

Location

Sketch

POND

B.M. No.	Road Name	Kind of Mark
3	D — N	CONCRETE

Location

Sketch

POND

PERMANENT BUIDIND

LOCATION MAP FOR BENCH MARKS

LEGEND

┼┼┼┼	FLOOD EMBANKMENT
	PUMPING STATION
	MAIN CHANNEL(DRAINAGE)
	SECONDARY CHANNEL(DRAINAGE)
	TERTIARY CHANNEL(DRAINAGE)
	REGULATOR
	MAIN CANAL(IRRIGATION)
	SECONDARY CANAL(IRRIGATION)
	TERTIARY CANAL(IRRIGATION)
	TURNOUT
	AQUEDUCT
	ESCAPE
	CHECK STRUCTURE
	BRIDGE(1-1N)
	BOX CULVERT
	VILLAGE
	LOCAL ROAD
	BENCH MARK
	PIPE SLUICE
	SIPHON
	FOOT BRIDGE
	PIPE CULVERT
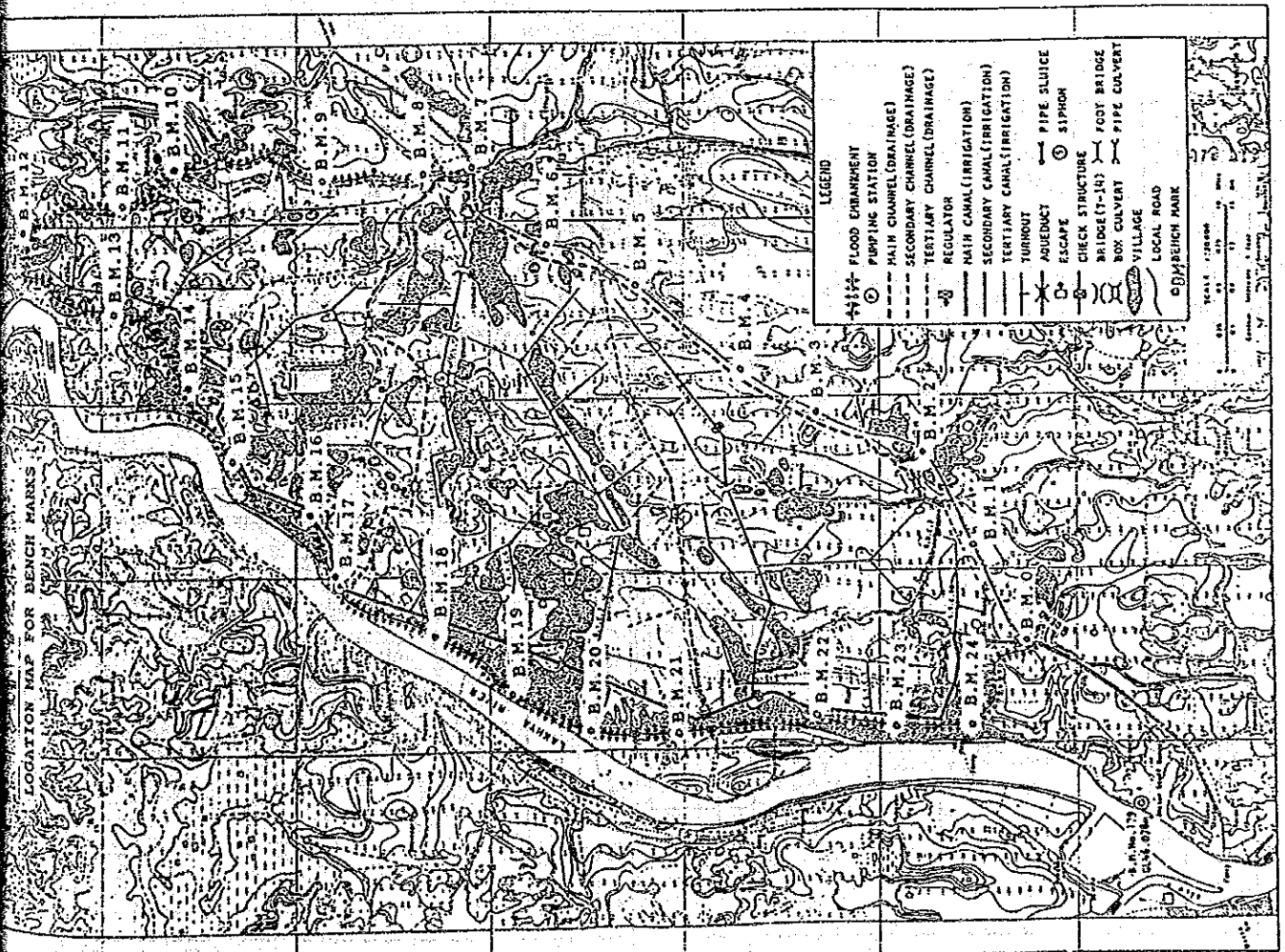
DESCRIPTION OF B.Ms

B.M.No.	Road Name	Kind of Mark
4	D — N	CONCRETE
Location		

Sketch

P. B

P. B

B.M.No.	Road Name	Kind of Mark
5	D — N	CONCRETE
Location		

Sketch

BM.5

12.0

27.6

3.8

B.M.No.	Road Name	Kind of Mark
6	D — N	CONCRETE
Location		

Sketch

BM.6

brige

POND

B.M.No.	Road Name	Kind of Mark
7	D — N	CONCRETE
Location		

Sketch

brige

POND

BM.7

DESCRIPTION OF B.Ms

B.M.No.	Road Name	Kind of Mark
8		CONCRETE
Location		

Sketch

brige

POND

POND

BM.8

B.M No.	Road Name	Kind of Mark
9		CONCRETE
Location		

Sketch

BM.9

45.0

B.M No.	Road Name	Kind of Mark
10		CONCRETE
Location		

Sketch

brige

BM.10

POND

B.M No.	Road Name	Kind of Mark
11		CONCRETE
Location		

Sketch

DESCRIPTION OF B.Ms.

B.M.No.	Road Name	Kind of Mark	B.M.No.	Road Name	Kind of Mark
16		CONCRETE			
Location			Location		
Sketch			Sketch		

Sketch for BM 16 — FACTORY, ELECTRIC TOWER, DITCH, 20.0M

B.M. No.	Road Name	Kind of Mark	B.M. No.	Road Name	Kind of Mark
Location			Location		
Sketch			Sketch		

DESCRIPTION OF B.Ms.

B.M.No.	Road Name	Kind of Mark	B.M.No.	Road Name	Kind of Mark
12		CONCRETE	13		CONCRETE
Location			Location		
Sketch			Sketch		

Sketch for BM 12 — box culvert, gate, BM12

Sketch for BM 13 — BM13

B.M. No.	Road Name	Kind of Mark	B.M. No.	Road Name	Kind of Mark
14		CONCRETE	15		CONCRETE
Location			Location		
Sketch			Sketch		

Sketch for BM 14 — BM14, POND

Sketch for BM 15 — BM15, RIVER

DESCRIPTION OF B.Ms

B.M.No.	Road Name	Kind of Mark
21		CONCRETE
Location		
Sketch		

B.M No.	Road Name	Kind of Mark
22		CONCRETE
Location		
Sketch		

B.M No.	Road Name	Kind of Mark
23		CONCRETE
Location		
Sketch		

B.M No.	Road Name	Kind of Mark
24		COCRETE
Location		
Sketch		

DESCRIPTION OF B.Ms

B.M.No.	Road Name	Kind of Mark
17		CONCRETE
Location		
Sketch		

B.M.No.	Road Name	Kind of Mark
18		CONCRETE
Location		
Sketch		

B.M No.	Road Name	Kind of Mark
19		CONCRETE
Location		
Sketch		

B.M No.	Road Name	Kind of Mark
20		CONCRETE
Location		
Sketch		

Table. 2-1   LIST OF COORDINATE   (FLOOD ENBANKMENT)

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
B.P.	500016.941	500022.364	NAIL	
IP-1	500037.336	499985.929	CONCRETE	
IP-2	500078.574	499853.579	CONCRETE	
IP-3	500114.336	499696.053	CONCRETE	
IP-4	500146.868	499604.466	CONCRETE	
IP-5	500154.534	499545.574	CONCRETE	
IP-6	500155.070	499343.832	CONCRETE	
IP-7	500160.458	499279.010	CONCRETE	
IP-8	500173.256	499246.022	CONCRETE	
IP-9	500264.168	499134.385	CONCRETE	
IP-10	500322.274	499089.673	CONCRETE	
IP-11	500454.405	499100.496	CONCRETE	
IP-12	500518.961	499103.421	CONCRETE	
IP-13	500582.451	499099.773	CONCRETE	
IP-14	500722.426	499102.551	CONCRETE	
IP-15	500850.161	499128.529	CONCRETE	
IP-16	500889.840	499128.220	CONCRETE	
IP-17	501089.984	499111.317	CONCRETE	
IP-18	501160.720	499111.891	CONCRETE	
IP-19	501276.552	499125.385	CONCRETE	
IP-20	501611.453	499249.156	CONCRETE	
IP-21	501734.990	499288.992	CONCRETE	
IP-22	501940.840	499089.344	CONCRETE	
IP-23	501993.973	499095.165	CONCRETE	
IP-24	502044.389	499107.389	CONCRETE	
IP-25	502169.116	499119.852	CONCRETE	
IP-26	502253.698	499129.275	CONCRETE	
IP-27	502359.825	499133.088	CONCRETE	
IP-23	502471.844	499127.812	CONCRETE	
IP-29	502575.166	499117.477	CONCRETE	
IP-30	502666.861	499103.954	CONCRETE	
IP-31	502758.523	499102.265	CONCRETE	
IP-32	502830.298	499109.140	CONCRETE	
IP-33	502859.152	499106.200	CONCRETE	
IP-34	503115.434	499098.836	CONCRETE	
IP-35	503247.626	499089.617	CONCRETE	
IP-36	503469.008	499080.726	CONCRETE	
IP-37	503540.390	499080.784	CONCRETE	
IP-38	503598.022	499072.869	CONCRETE	
IP-39	503747.025	499082.147	CONCRETE	
IP-40	503897.913	499104.272	CONCRETE	
IP-41	503956.872	499120.116	CONCRETE	

Table. 2-2   LIST OF COORDINATE   (FLOOD ENBANKMENT)

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
IP-42	504232.072	499204.016	CONCRETE	
IP-43	504338.345	499258.930	NAIL	
IP-44	504452.790	499311.892	NAIL	
IP-45	504518.402	499348.074	NAIL	
IP-46	504606.958	499398.656	CONCRETE	
IP-47	504675.050	499449.026	NAIL	
IP-48	504742.994	499493.238	NAIL	
IP-49	504787.451	499555.733	NAIL	
IP-50	504823.017	499584.865	NAIL	
IP-51	504843.512	499608.246	CONCRETE	
IP-52	504926.173	499635.296	NAIL	
IP-53	504952.288	499671.742	NAIL	
IP-54	504947.905	499680.955	NAIL	
IP-55	505020.614	499729.345	NAIL	
IP-56	505025.644	499738.520	NAIL	
IP-57	505063.715	499766.061	NAIL	
IP-58	505092.466	499785.190	NAIL	
IP-59	505145.804	499816.328	NAIL	
IP-60	505166.625	499837.379	NAIL	
IP-61	505192.684	499848.294	NAIL	
IP-62	505215.809	499862.500	CONCRETE	
IP-63	505250.722	499916.572	NAIL	
IP-64	505297.515	499923.528	CONCRETE	
IP-65	505400.335	499981.911	CONCRETE	
IP-66	505423.575	500017.182	NAIL	
IP-67	505478.437	500015.868	CONCRETE	
IP-68	505532.526	500048.941	NAIL	
IP-69	505607.414	500072.412	NAIL	
IP-70	505641.264	500090.199	NAIL	
IP-71	505784.887	500136.437	NAIL	
IP-72	505863.233	500153.040	NAIL	
IP-73	506108.002	500231.497	CONCRETE	
IP-74(EP)	506150.146	500271.158	NAIL	

Table. 2-3   LIST OF COORDINATE (M.D.C.1   )

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
IIP-74	506150.14	500271.15	BAMBOO PEG	
MDC.IP-1	506129.14	500381.39	BAMBOO PEG	
MDC.IP-2	506109.65	500432.45	BAMBOO PEG	
MDC.IP-3	506057.46	500425.84	BAMBOO PEG	
MDC.IP-3A	506047.93	500524.02	BAMBOO PEG	
MDC.IP-3B	506056.26	500599.00	BAMBOO PEG	
MDC.IP-4	506046.56	500640.61	BAMBOO PEG	
MDC.IP-5	506095.43	500645.92	BAMBOO PEG	
MDC.IP-6	506132.74	500739.37	BAMBOO PEG	
MDC.IP-7	506138.24	500799.77	BAMBOO PEG	
MDC.IP-8	506120.85	500900.10	BAMBOO PEG	
MDC.IP-9	506054.99	500997.92	BAMBOO PEG	
MDC.IP-10	506013.48	501040.38	BAMBOO PEG	
MDC.IP-11	505845.95	501055.93	BAMBOO PEG	
MDC.IP-12	505793.09	501054.36	BAMBOO PEG	
MDC.IP-13	505772.88	501098.22	BAMBOO PEG	
MDC.IP-14	505753.19	501220.79	BAMBOO PEG	
MDC.IP-15	505775.69	501226.75	BAMBOO PEG	
MDC.IP-16	505766.06	501290.03	BAMBOO PEG	
MDC.IP-17	505838.56	501339.11	BAMBOO PEG	
MDC.IP-18	505937.41	501358.50	BAMBOO PEG	
MDC.IP-19	505991.79	501415.53	BAMBOO PEG	
MDC.IP-20	505983.70	501481.86	BAMBOO PEG	
MDC.IP-21	506021.32	501483.40	BAMBOO PEG	
MDC.IP-22	506016.00	501596.97	BAMBOO PEG	
MDC.IP-23	506127.66	501687.54	BAMBOO PEG	
MDCIP-23A	506041.45	501733.49	BAMBOO PEG	
MDC.IP-24	505990.53	501741.69	BAMBOO PEG	
MDC.IP-25	505998.15	501809.51	BAMBOO PEG	
MDC.IP-26	506046.72	501817.66	BAMBOO PEG	
MDC.IP-27	506027.85	501983.04	BAMBOO PEG	
MDC.IP-28	506041.12	501984.94	BAMBOO PEG	
MDC.IP-29	506009.47	502180.45	BAMBOO PEG	
MDC.IP-30	506021.28	502290.97	BAMBOO PEG	
MDC.IP-31	505971.10	502345.99	BAMBOO PEG	
MDC.IP-32	505950.36	502457.68	BAMBOO PEG	
MDC.IP-33	505918.37	502515.66	BAMBOO PEG	
MDC.IP-34	505852.69	502673.15	BAMBOO PEG	
MDC.IP-35	505911.01	502721.61	BAMBOO PEG	
MDC.IP-36	506026.83	502893.92	BAMBOO PEG	
MDC.IP-37	505963.54	502939.74	BAMBOO PEG	
MDC.IP-38	505973.17	502962.36	BAMBOO PEG	
MDC.IP-39	505971.12	503235.06	BAMBOO PEG	
MDC.IP-40	505923.80	503248.99	BAMBOO PEG	
MDC.IP-41	505931.07	503321.92	BAMBOO PEG	
MDC.IP-42	505844.87	503370.94	BAMBOO PEG	
MDC.IP-43	505797.57	503438.83	BAMBOO PEG	
MDC.IP-44	505793.77	503758.66	BAMBOO PEG	
MDC.IP-45	505660.79	503785.81	BAMBOO PEG	
MDC.IP-46	505646.93	503842.43	BAMBOO PEG	
MDC.IP-47	505699.12	504054.50	BAMBOO PEG	
MDC.IP-48	505480.16	504154.79	BAMBOO PEG	
MDC.IP-49	505482.81	504198.08	BAMBOO PEG	
MDC.IP-50	505365.00	504287.71	BAMBOO PEG	
E.P.IP-51	504996.02	504382.32	BAMBOO PEG	

Table. 2-4   LIST OF COORDINATE   (S.D.C.1   )

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
SDC.NO-0	506016.32	502290.55	CONCRETE	
SDC.IP-1	506100.66	502245.71	BAMBOO PEG	
SDC.IP-2	506098.21	502135.79	BAMBOO PEG	
SDC.IP-3	506163.43	502055.45	BAMBOO PEG	
SDC.IP-4	506207.25	502055.75	BAMBOO PEG	
SDC.IP-5	506236.19	502101.15	BAMBOO PEG	
SDC.IP-6	506381.27	502087.25	BAMBOO PEG	
SDC.IP-7	506442.32	502057.60	BAMBOO PEG	
SDC.IP-8	506495.82	501954.36	BAMBOO PEG	
SDC.IP-9	506504.57	501860.57	BAMBOO PEG	
SDC.IP-10	506621.74	501782.37	BAMBOO PEG	
SDC.IP-11	506683.86	501777.09	CONCRETE	

LIST OF COORDINATE   (S.D.C.2   )

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
SDC.2IP-0	506011.12	502871.27	CONCRETE	
SDC.2IP-1	506021.06	502829.42	BAMBOO PEG	
SDC.2IP-2	506091.63	502833.77	BAMBOO PEG	
SDC.2IP-3	506160.60	502653.52	BAMBOO PEG	
SDC.2IP-4	506739.61	502580.34	BAMBOO PEG	
SDC.2IP-5	506787.92	502592.56	CONCRETE	

LIST OF COORDINATE   (S.D.C.3   )

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
SDC.3NO-0	505949.32	502941.68	BAMBOO PEG	
SDC.3IP-1	505831.65	502847.35	BAMBOO PEG	
SDC.3IP-2	505692.57	502799.65	BAMBOO PEG	
SDC.3IP-3	505600.80	502716.14	BAMBOO PEG	
SDC.3IP-4	505551.21	502635.44	BAMBOO PEG	
SDC.3IP-5	505492.30	502579.85	BAMBOO PEG	
SDC.3IP-6	505424.71	502461.40	BAMBOO PEG	
SDC.3IP-7	505380.90	502478.87	BAMBOO PEG	
SDC.3IP-8	505291.29	502486.37	BAMBOO PEG	
SDC.3IP-9	505277.13	502499.61	BAMBOO PEG	
SDC3IP-10	505194.00	502483.61	BAMBOO PEG	
SDC3IP-11	505075.60	502461.39	BAMBOO PEG	
SDC3IP-12	505024.19	502418.49	BAMBOO PEG	
SDC3IP-13	504910.41	502398.82	BAMBOO PEG	
SDC3IP-14	504869.20	502279.96	BAMBOO PEG	

Table. 2-5   LIST OF COORDINATE (S.D.C.4   )

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
SDC.4NO-0	505802.35	503604.37	BAMBOO PEG	
SDC.4IP-1	505907.11	503570.63	BAMBOO PEG	
SDC.4IP-2	505936.62	503548.47	BAMBOO PEG	
SDC.4IP-3	506032.98	503520.05	BAMBOO PEG	
SDC.4IP-4	506060.82	503552.50	BAMBOO PEG	
SDC.4IP-5	506218.05	503641.02	BAMBOO PEG	
SDC.4IP-6	506380.67	503645.43	BAMBOO PEG	
SDC.4IP-7	506688.31	503643.76	BAMBOO PEG	
SDC.4IP-8	507066.45	503362.45	CONCRETE	

LIST OF COORDINATE (TDC 1-1   )

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
TDC1IP-1	506799.57	501756.81	BAMBOO PEG	
TDC1IP-2	506837.18	501598.34	BAMBOO PEG	
TDC1IP-3	506902.39	501490.45	CONCRETE	

LIST OF COORDINATE (T.D.C. 1-2)

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
TDC2IP-1	506771.72	501961.71	BAMBOO PEG	
TDC2IP-2	506852.39	502008.33	BAMBOO PEG	
TDC2IP-3	507034.31	501967.50	CONCRETE	

LIST OF COORDINATE (T.D.C. 3-1)

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
TDC.3NO.0	504911.30	502396.09	CONCRETE	
TDC.3IP-1	504783.83	502457.68	BAMBOO PEG	
TDC.3IP-2	504714.47	502308.85	BAMBOO PEG	
TDC.3IP-3	504582.91	502153.96	BAMBOO PEG	
TDC.3IP-4	504368.64	502279.74	CONCRETE	

Table. 2-6   LIST OF COORDINATE   (T.D.C. 3-2)

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
TDC.4NO.0	504866.82	502214.67	CONCRETE	
TDC.4IP-1	504935.22	502198.35	BAMBOO PEG	
TDC.4IP-2	505017.19	502125.51	BAMBOO PEG	
TDC.4IP-3	504993.89	502015.70	BAMBOO PEG	
TDC.4IP-4	504995.5	501805.75	BAMBOO PEG	
TDC.4IP-5	505020.48	501713	BAMBOO PEG	
TDC.4IP-6	505126.17	501544.68	BAMBOO PEG	
TDC.4IP-7	505236.17	501474.54	BAMBOO PEG	
TDC.4IP-8	505191.54	501339.48	BAMBOO PEG	
TDC.4IP-9	505101.95	501266.06	BAMBOO PEG	
TDC4IP-10	505060.38	501121.36	BAMBOO PEG	
TDC4IP-11	505165.55	501104.57	CONCRETE	

LIST OF COORDINATE   (T.D.C. 3-3)

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
TDC.5NO.0	504848.39	502167.73	BAMBOO PEG	
TDC.5IP-1	504853.24	501935.88	BAMBOO PEG	
TDC.5IP-2	504554.97	501795.88	BAMBOO PEG	
TDC.5IP-3	504475.35	501645.90	BAMBOO PEG	
TDC.5IP-4	504417.9	501403.60	BAMBOO PEG	
TDC.5IP-5	504276.97	501446.87	CONCRETE	

LIST OF COORDINATE   (T.D.C. 4-1)

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
TDC.6IP-1	507349.86	502834.63	CONCRETE	

LIST OF COORDINATE   (T.D.C. 4-2)

NAME	X(NORTH)	Y(EAST)	MATERIAL	REMARK
TDC.7IP-1	507188.71	503646.76	BAMBOO PEG	
TDC.7IP-2	507280.13	503649.35	CONCRETE	

Table.3 PROGRESS OF THE SURVEYING

ITEM		PARTY	JAN	FEB			MAR		Notes
			25	1	10	20	1	10	
1. TRAVERSING	JAPANESE	1		10 — 19					
2. LEVELING	"	1	29 — 9						
3. ROUTE ALIGNMENT	"	1	28 31 3 — 7 / F·E MDC SDC		11 — 18 / MDC SDC.TDC				
4. CENTERING	LOCAL	2	31 — 6 / F·E						
5. LONGITUDINAL AND CROSS SECTION	"	2	1 — 11 / F·E	11 — 17 / MDC	21 24 — 27 / SDC TDC F·E				
6. TOPOGRAPHIC	"	4	1 — 11 / F·E	11 — 16 / MDC	23 25 — 2 / SDC TDC P F·E				
7. MAPPING	"				22 — 6				

F·E -- FLOOD EMBANKMENT
P -- PUMP STATION

Japan Engineering Consultants Co., Ltd

APPENDIX IV

Inspection Report on

Damaged Flood Embankment of

Demonstration Unit of

N-N Irrigation Project

INSPECTION REPORT

ON

DAMAGED FLOOD EMBANKMENT

OF

DEMONSTRATION UNIT OF N-N IRRIGATION PROJECT

1. Introduction

The flood-embankment of the N-N Irrigation Project
Demonstration Unit constructed under the Japanese Grant
Assistance which has 1,000 ha of irrigable area, has been
breached on August 14th, 1987 by the flooding set off by
repeated heavy monsoon rains since early last July.

In response to the request of the Japanese Embassy in Dhaka,
the JICA basic desig study team who has been sent to
Bangladesh for preparation of the basic design of the N-N
Irrigation Project (Block A-1) has inspected the said damaged
flood-embankment on September 24th, 1987.

This paper is a summary of results of the inspection and the
proposed measures to meet the situation.

2.1. Breached portion

Location : 4.3 km from the pumping station. (Marked as (A)
given in Annex-1, attached hereto) According to the
topographic map, it seems to be a place where a tributary of
the Tatkir Khal had been flowing.

1

Length of breaching : 73.2 m long.

Depth of scouring: About 9.3 m deep from G.L. (See Annex-2)

Cause of breaching: It is judged that the direct cause of breaching is piping failure due to the rat holes barrowed into the embankment.

2.2 Very dengerous portion about to be breached

Location : 5.7 km from the pumping station (Marked as (B) given in Annex-1)

Length of the portion : About 15 m

Situation : The embankment has been settled through a hight of about 1.2 m and the innerside of the embankment has almost been eroded and washed away. If (A) portion has not been broken down, this portion must have been breached.

2.3. Seriously damaged portion

Location : From 6.5 km point from pumping station to Golakandail Village.

Length : 1.9 km long

Situation : Serious slope failure along the entire length of the portion was witnessed. The cross-section of the embankment above the flood water level seemed to be half of its original size and the top width of the embankment has

2

been reduced to be less than one meter.

Somewhere in this portion may be broken down by flood waterin the next wet season if any rehabilitation work is not done even if the reconstruction of embankment at (A) portion is done in this dry season.

Cause of damage :

(1) The phreatic line became somewhat horizontal due to the presence of rat holes inside the embankment and the honeycomb made by rat holes made the embankment extremely weak. As a result of these, the downsream slope of the embankment was failed. Such failure can be found along the entire length of the embankment.

(2) The flow of rain water into the honeycomb rat holes caused the slope failure.

(3) The wave action of flood water scooped out the earth and also caused slips.

(4) The maintenance work/resectioning in this portion has never been done since its construction. Therefore, the deterioration of the embankment in this portion had been propagating before the flooding. (A part of other portion, 3.4 km, of the embankment had been resectioned by Food for Works programme.

2.4 Other dengerous portion

There were several places which had temporary repairs as emergency measures to prevent the failure of embankment

3

before the breaching of portion (A).

Moreover, serious deterioration was observed in the 50 percent length of hundreds meters back and forth of portion (A) and of point 6.4 km.

2.5 Rat holes

There are huge number of rat holes exist along the whole length of the embankment. Serious places have more than ten holes per squre meter. The size of the holes ranges from 5 cm to 10 cm in diameter. The rat holes are concentrated on the innerside shoulder and slope of embankment because of the absence of flood water and availability of food throughout the year. As a result, the innerside slope is more deteriorated than the outerside.

2.6 Material of embankment

According to eye observation, the materials of the embankment along the whole length are mainly consists of uniformed grain size silt.

The permiability coefficient of the soil material can be reduced to be less than 10^{-4} cm/sec under the condition of sufficient compaction. The strength of the soil material is, however, difficult to increase.

Sand boiling occured at many places, which was observed by BWDB staff, might be caused by the existance of uniformed grain size silt in the embankment foundation.

4

2.7 Team's synthetic viewpoint

The rehabilitation of the damage in the Demonestration Unit should be devided into two stages; one is temporary repairs as an emergency measure for the cultivation in the next wet season and another one is a full scale rehabilitation work in order to assure flood control extending over a long period of time.

3. Measure/Rehabilitation Plan

According to the results of only field inspection under the flood condition, it can be proposed that the following rehabilitation programme should be taken immediately.

3.1 Temporary repairs

In order to cultivate under flood control in the next wet season (1988), following rehabilitation works should be done during this dry season.

(1) To reconstruct embankment in (A) portion with a measure work for prevention of piping in the deep scoured place.

(2) To resection the embankment in (B) and (C) portions and the other dangerous places.

The rehabilitation work needs a constructio period of 5 or 6 months and the project cost of approximately a hundred million yen as shown in Annex-3.

5

And further detailes investigation is needed for the implementation of the work.
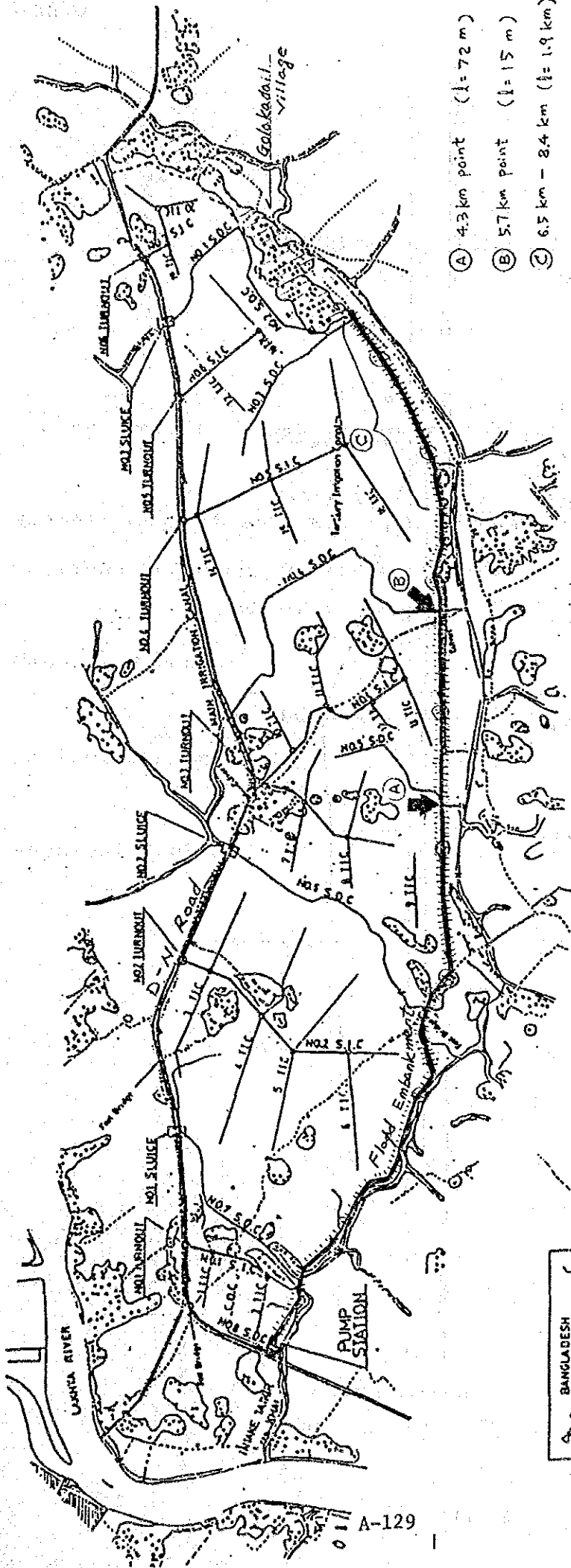
3.2 Full scale rehabilitation

A detailed survey should be carried out within this dry season and a full scale rehabilitation works should be implemented from next dry season (1988/89).

If the full scale rehabilitation works are not possible to be implemented to the above schedule, the temporary repairs should not be done in this dry season.
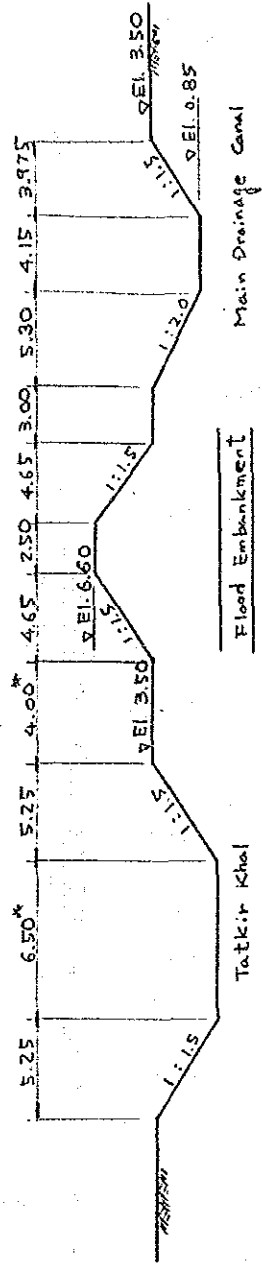
October 5th, 1987

T. AMANO
Irrigation and Drainage Planning
JICA Basic Design Study Team
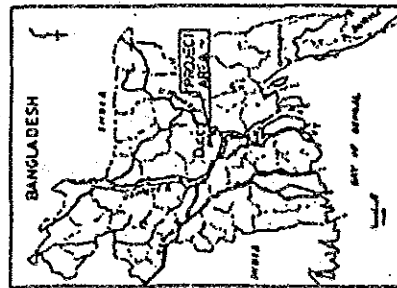for N-N Irrigation Project
(Block A-1)

PLAN

LAKHYA RIVER

Golokadail Village

NO.1 SLUICE
NO.1 TURNOUT
NO.1 SLUICE
NO.2 TURNOUT
NO.1 TURNOUT
NO.2 SLUICE
NO.2 TURNOUT
NO.1 SLUICE
NO.1 TURNOUT

D-N Road

PUMP STATION

MAIN IRRIGATION CANAL

Flood Embankment

Tertiary Irrigation Canal

(A) 4.3 km point (ℓ = 72 m)
(B) 5.7 km point (ℓ = 15 m)
(C) 6.5 km – 8.4 km (ℓ = 1.9 km)

A-129

BANGLADESH
PROJECT AREA
BAY OF BENGAL

SCALE

STANDARD CROSS SECTION OF FLOOD EMBANKMENT

∇ El. 3.50
∇ El. 0.85
∇ El. 6.60
∇ El. 3.50
∇ El. 3.975

Main Drainage Canal
Flood Embankment
Tatkir Khal

5.25   5.25   6.50   5.25   4.00   4.65   5.25   4.65   4.00   3.00   5.30   4.15   3.975

1:1.5   1:1.5   1:1.1   1:1.5   1:2.0   1:1.5

LONGITUDINAL SECTION OF BREACHED PORTION

SCALE = 1/500

Top of Embankment

G.L.

El. 7.13

+0.0
+10.8
+14.8
+20.0
+30.0
+40.0
+50.0
+60.0
+70.0
+80.0
+84.0

El. +7.10
El. +7.10
El. +4.11
El. +2.14
El. — 0.31
El. — 1.11
El. — 3.31
El. — 3.11
El. — 2.31
El. +4.11
El. +7.26

El. 7.26

W.L. 5.13

El. +10
+5
0
-5
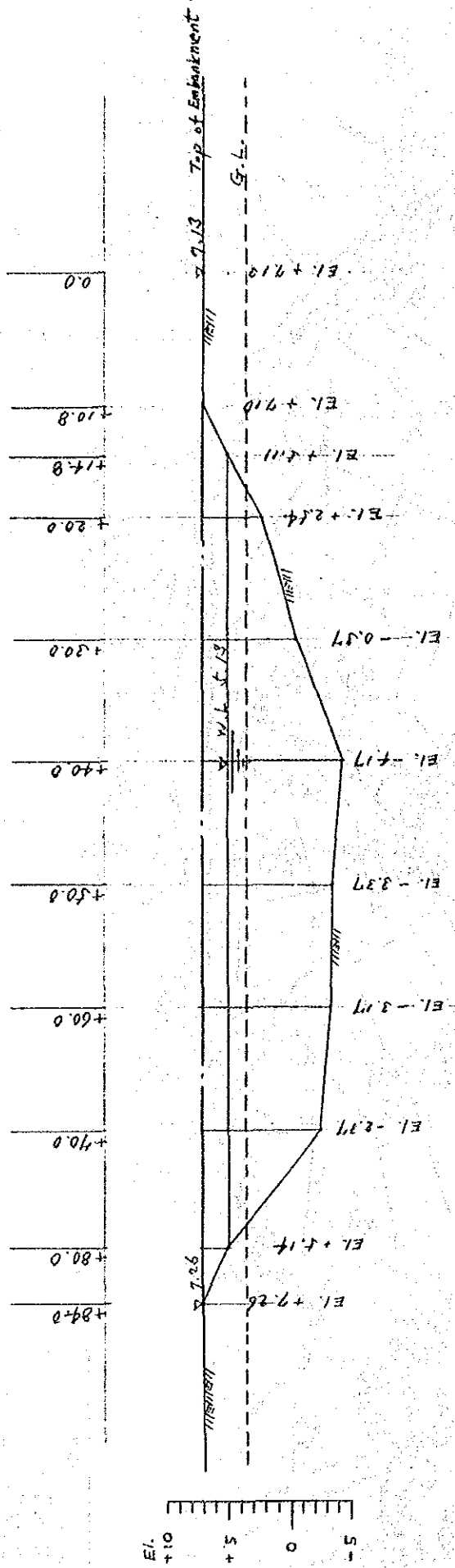
※ The elevation is on the basis of the
B.M. at the pumping station.

Surveyed on 22-09-1987

.A-130

Rough Cost Estimate for Temporary Repairs

(million yen)

1. Reconstruction of embankment in (A) portion   50.4

2. Resectioning of embankment in (B) and (C)

    portions and other dangerous places   24.6

3. General Expense   7.0

4. Engineering Services   15.0

5. Physical Contigencies   8.0

                            Total : 105.0

              (Total 105.0 million yen)

JICA