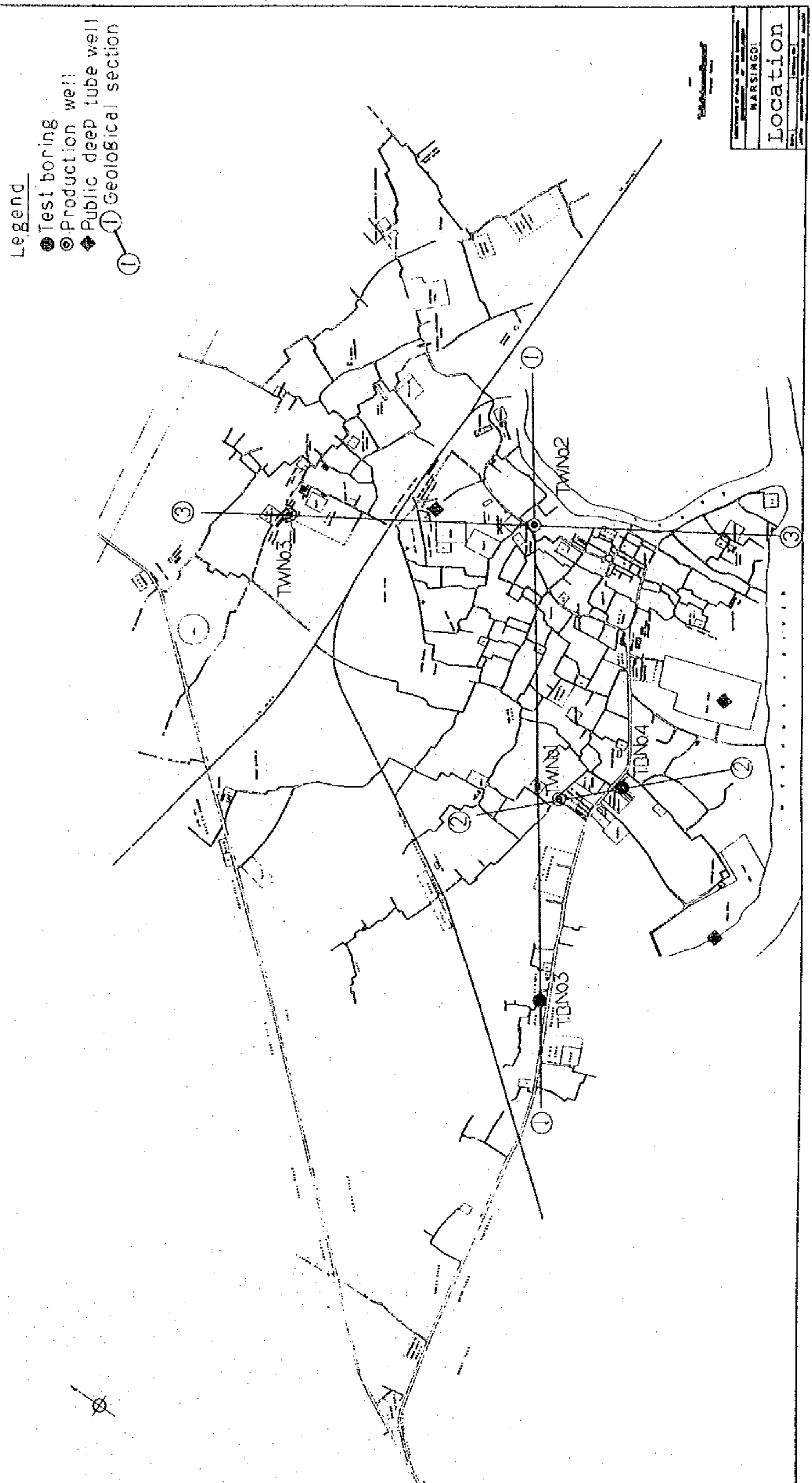
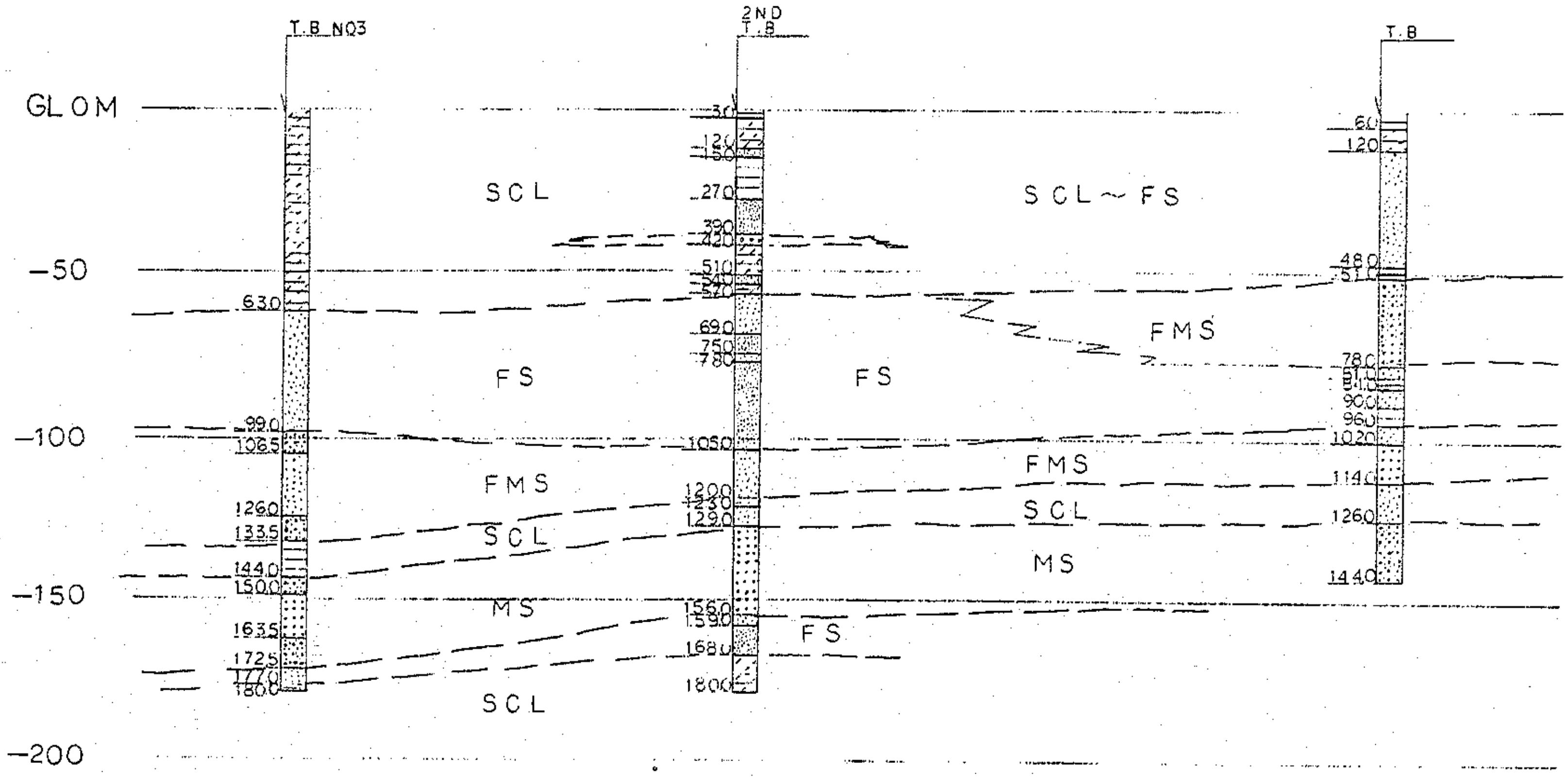
3-10-1 Geological Sections of 7 Towns

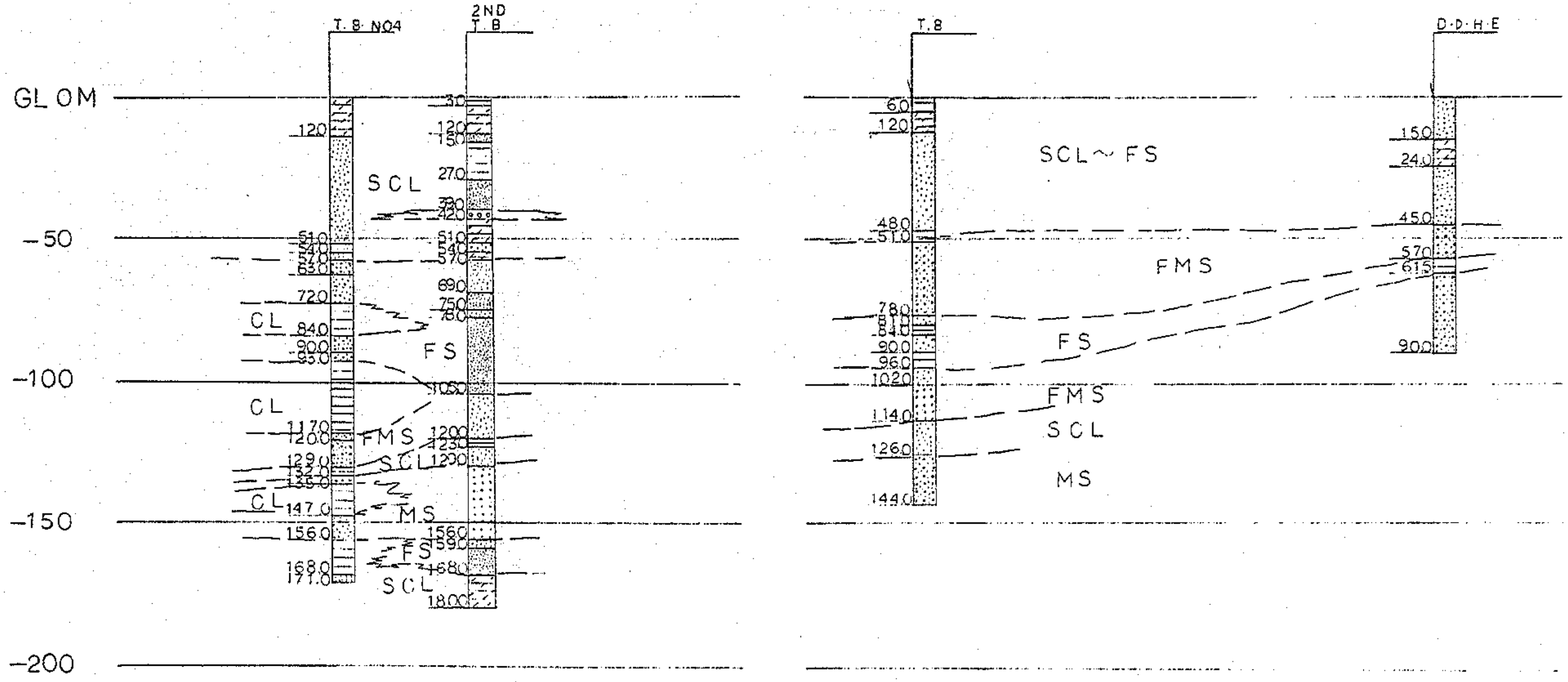
INDEX	
CL	Clay
SCL	Sandy Clay
VFS	Very Fine Sand
FS	Fine Sand
FMS	Fine to Medium Sand
MS	Medium Sand
M&CS	Medium and Coarse Sand
CS	Coarse Sand
G&S	Gravel and Sand

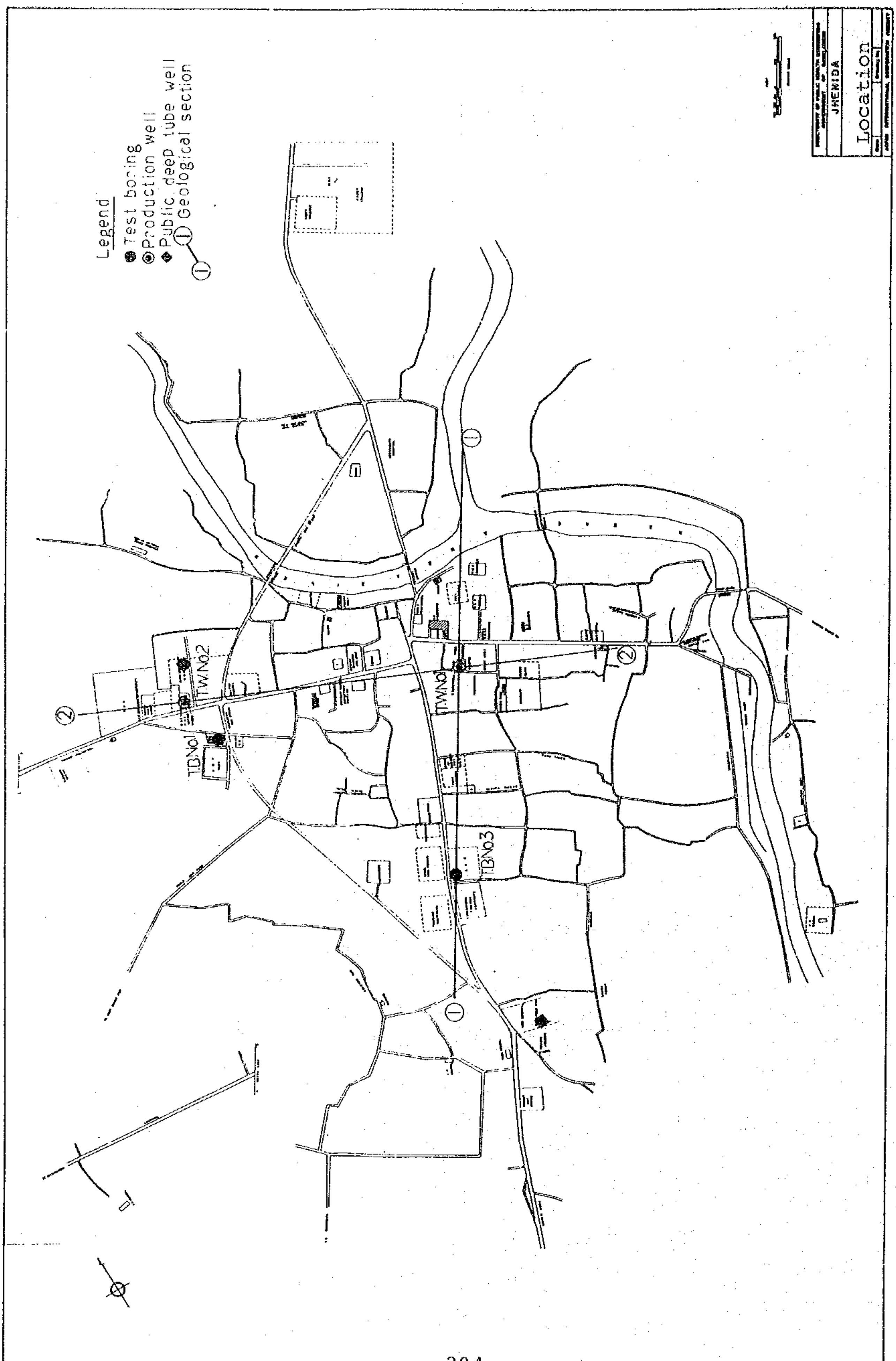

Legend
Test boring
Production well
Public deep tube well
Geological section
NARSINGDI
Location
TWNo1
TWNo2
TWNo3
TBNo3
TBNo4

①-(1) Narsingi

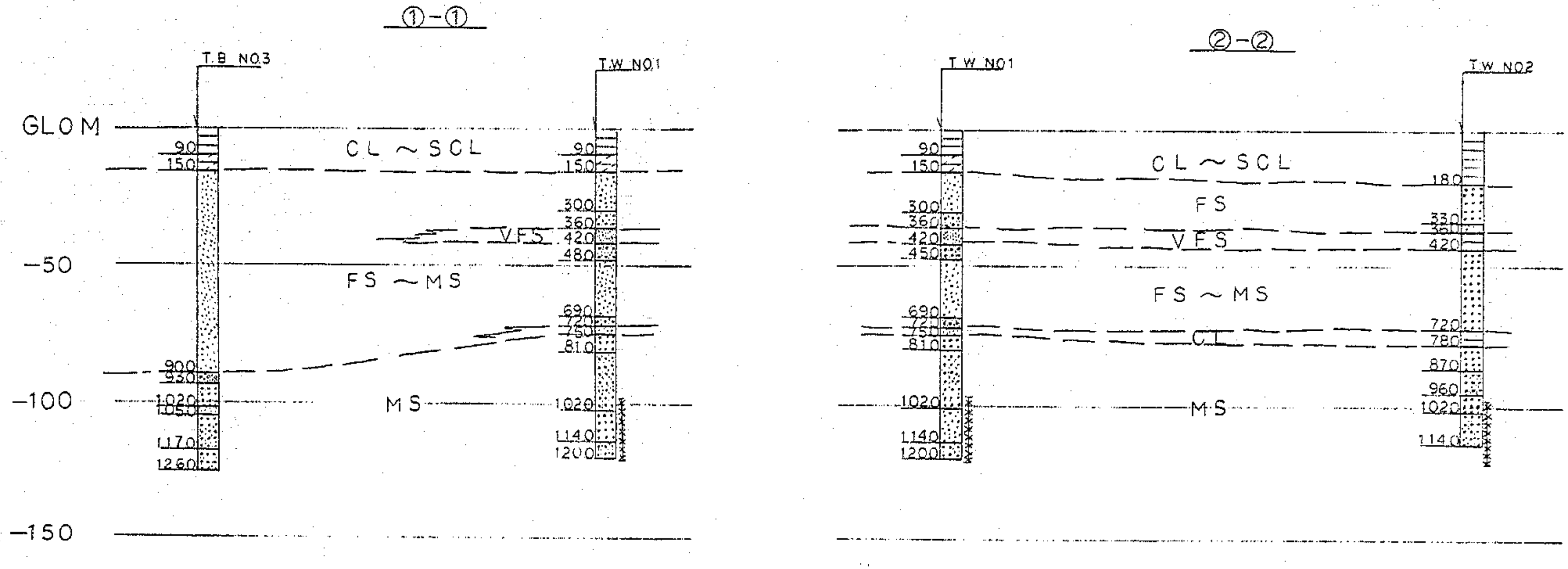

T.B NO3
2ND T.B
T.B
GLOM
-50
-100
-150
-200
SCL
FS
FMS
SCL
MS
SCL
FS
SCL ~ FS
FMS
FMS
SCL
MS
FS

②-② Narsingi ③-③

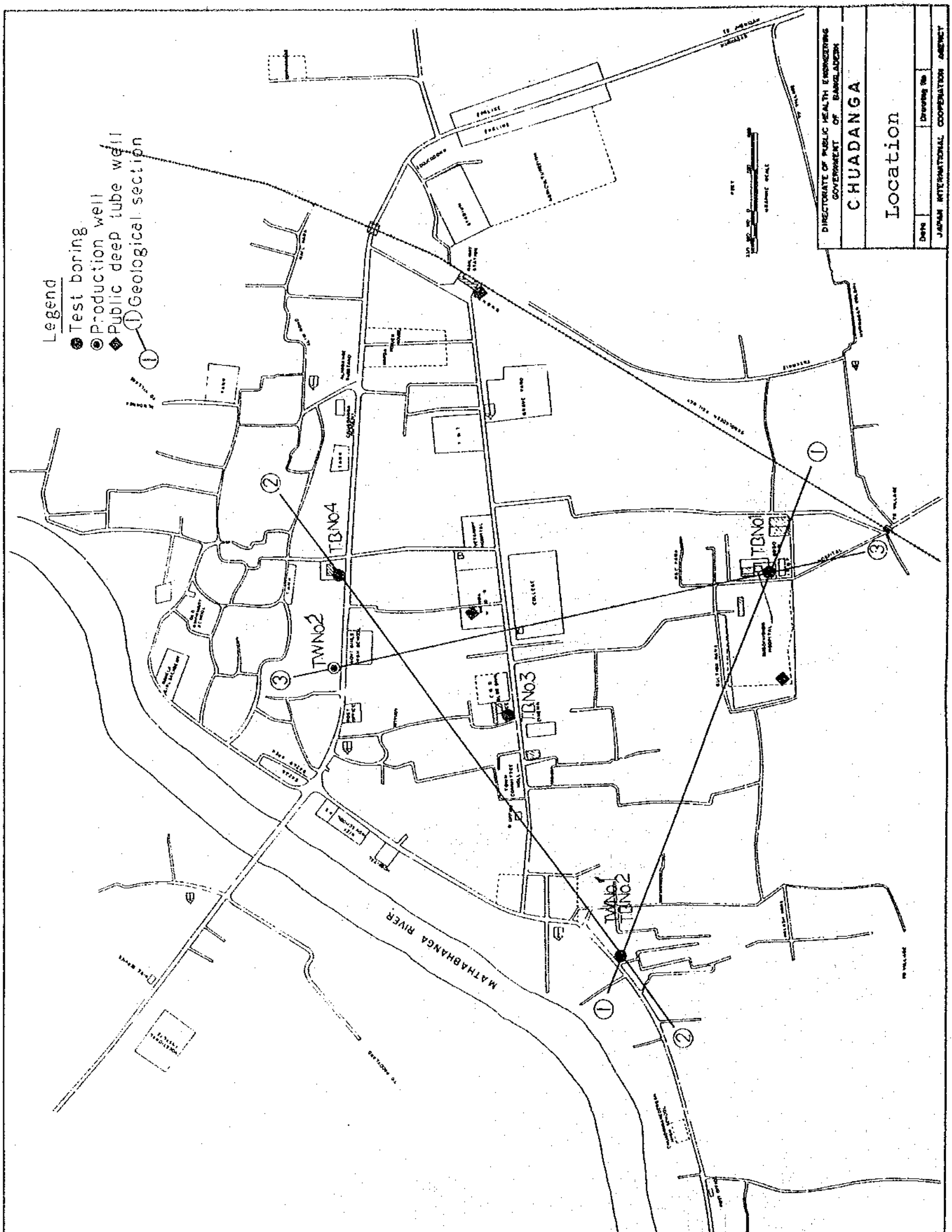



Legend
Test boring
Production well
Public deep tube well
Geological section
T.W.No2
T.W.No1
T.B.No1
T.B.No3
JHENIDA
Location

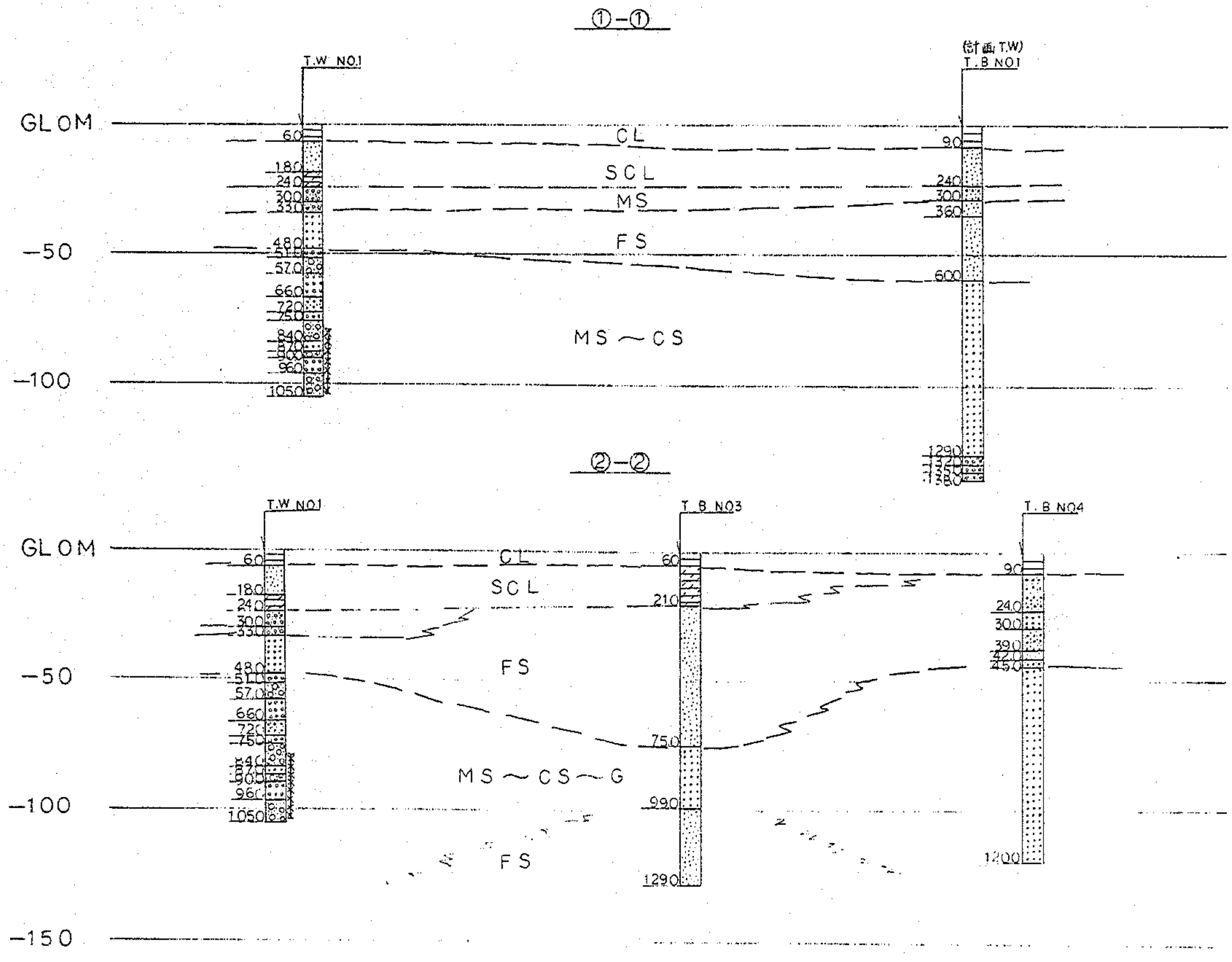
Jenidah



①-①
②-②
T.B NO.3
T.W NO.1
T.W NO.2
GLOM
-50
-100
-150
CL ~ SCL
FS
VFS
FS ~ MS
CL
MS
9.0
15.0
18.0
30.0
33.0
36.0
42.0
45.0
48.0
69.0
72.0
75.0
78.0
81.0
87.0
90.0
93.0
96.0
102.0
105.0
114.0
117.0
120.0
126.0


Legend
Test boring
Production well
Public deep tube well
① Geological section
DIRECTORATE OF PUBLIC HEALTH ENGINEERING
GOVERNMENT OF BANGLADESH
CHUADANGA
Location
JAPAN INTERNATIONAL COOPERATION AGENCY
MATHABHANGA RIVER
T.B.No4
T.W.No2
T.B.No3
T.B.No1
T.W.No1
T.B.No2

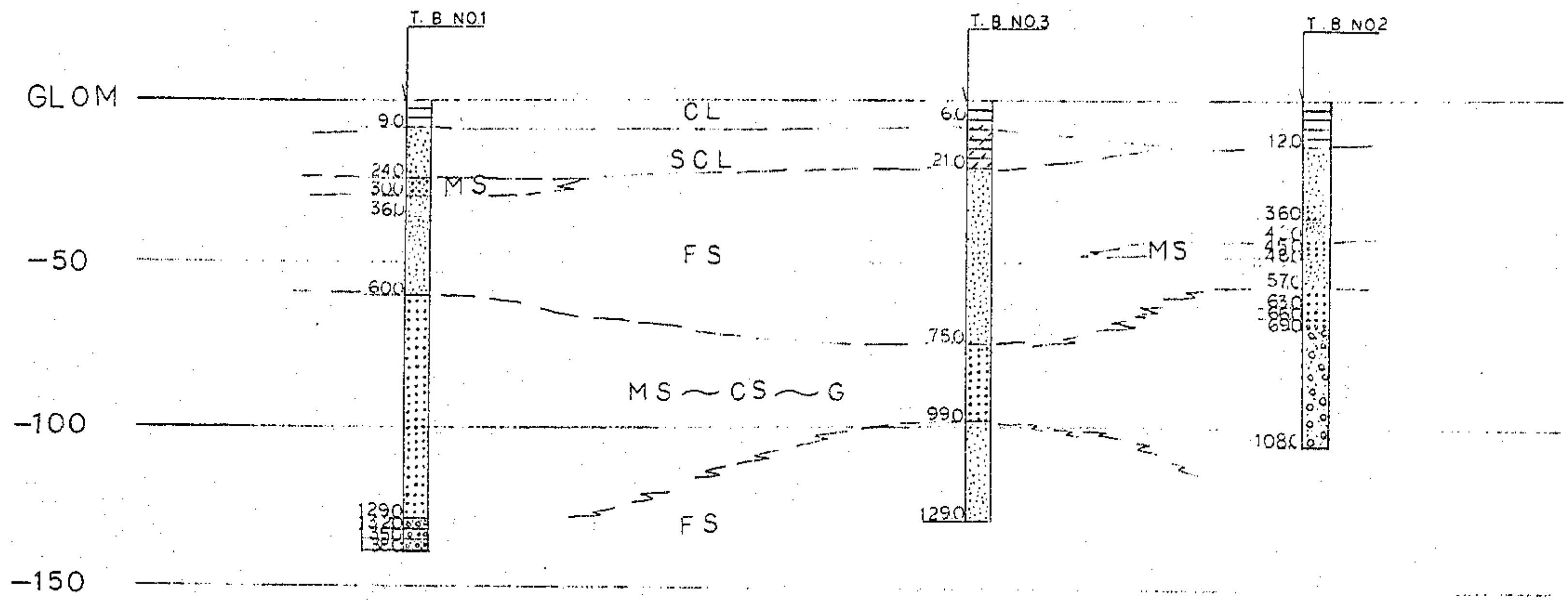
Chuadanga

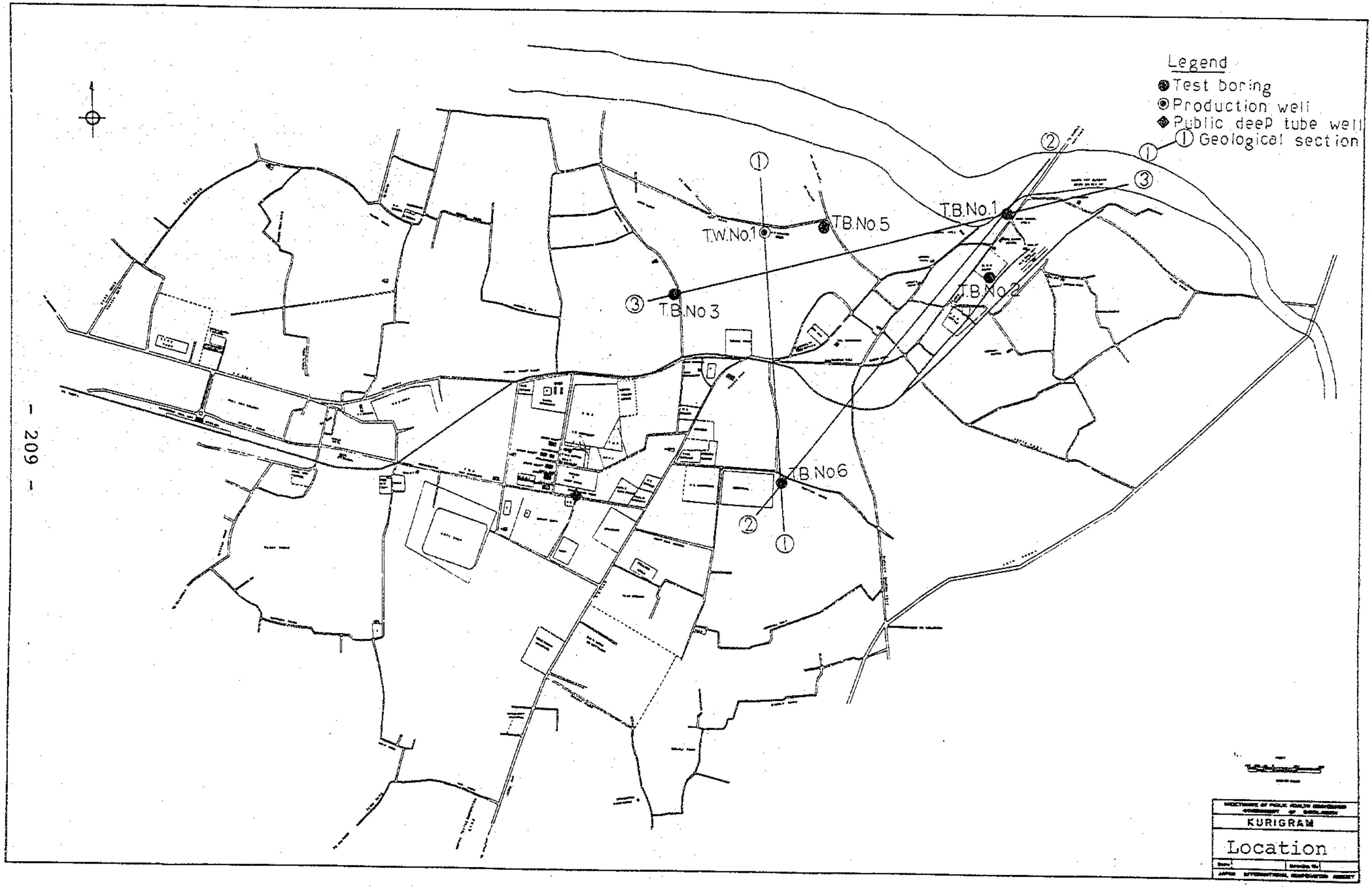


①-①
T.W NO.1
(計画 T.W)
T.B NO.1
GL 0M
-50
-100
CL
SCL
MS
FS
MS ~ CS
②-②
T.W NO.1
T.B NO.3
T.B NO.4
GL 0M
-50
-100
-150
CL
SCL
FS
MS ~ CS ~ G
FS

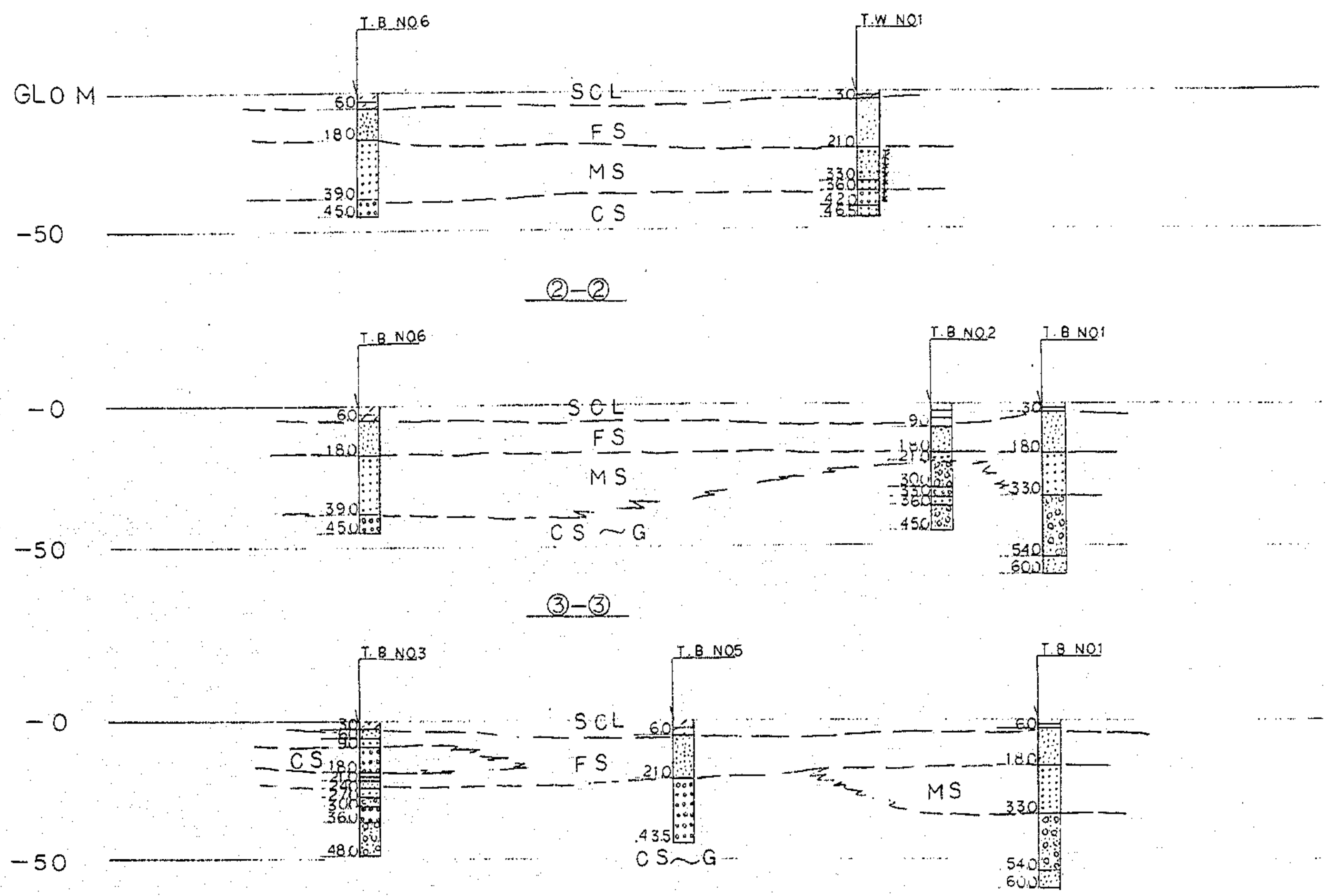
Chuadanga

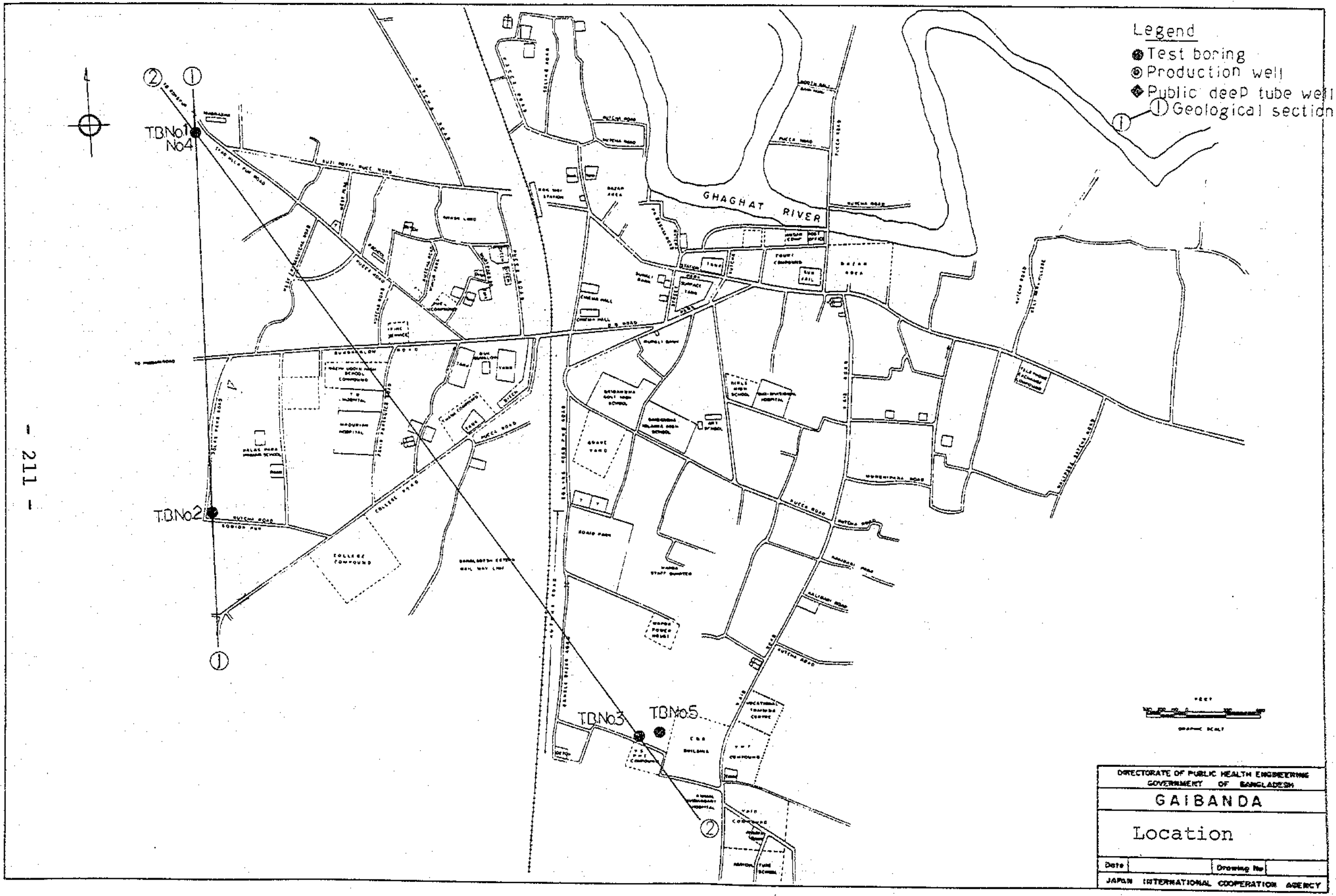
③-③




Legend
Test boring
Production well
Public deep tube well
① Geological section
T.B.No.1
T.B.No.2
T.B.No.3
T.B.No.5
T.B.No.6
T.W.No.1
KURIGRAM
Location

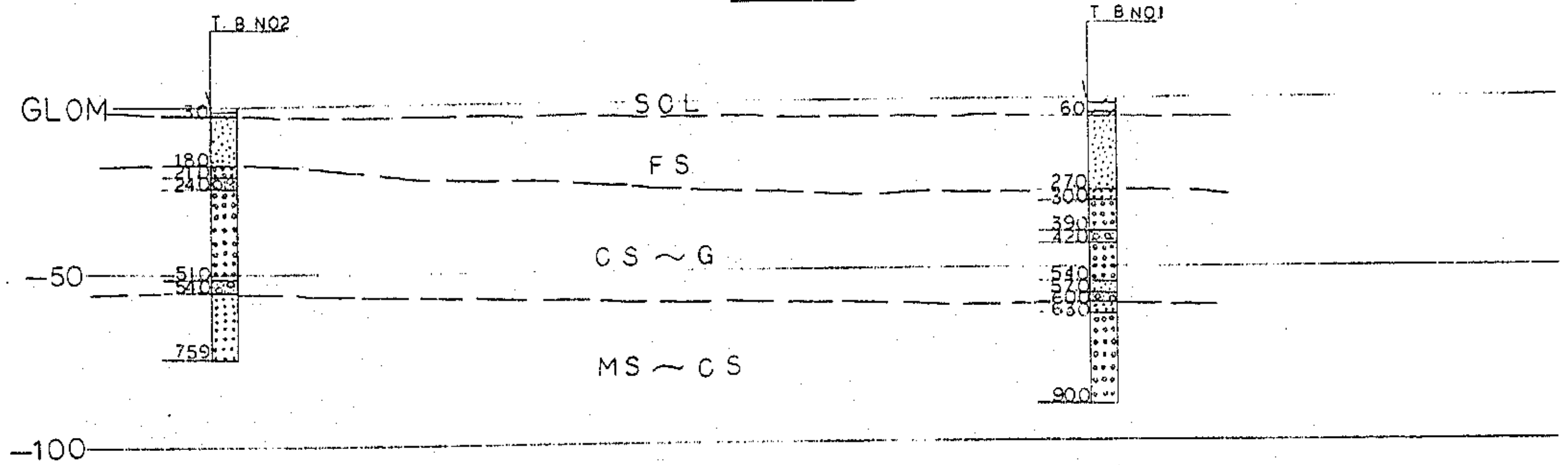
① - ① kurigram


T.B NO6
T.W NO1
GL0 M
-50
SCL
FS
MS
CS
②-②
T.B NO2
T.B NO1
-0
CS ~ G
③-③
T.B NO3
T.B NO5

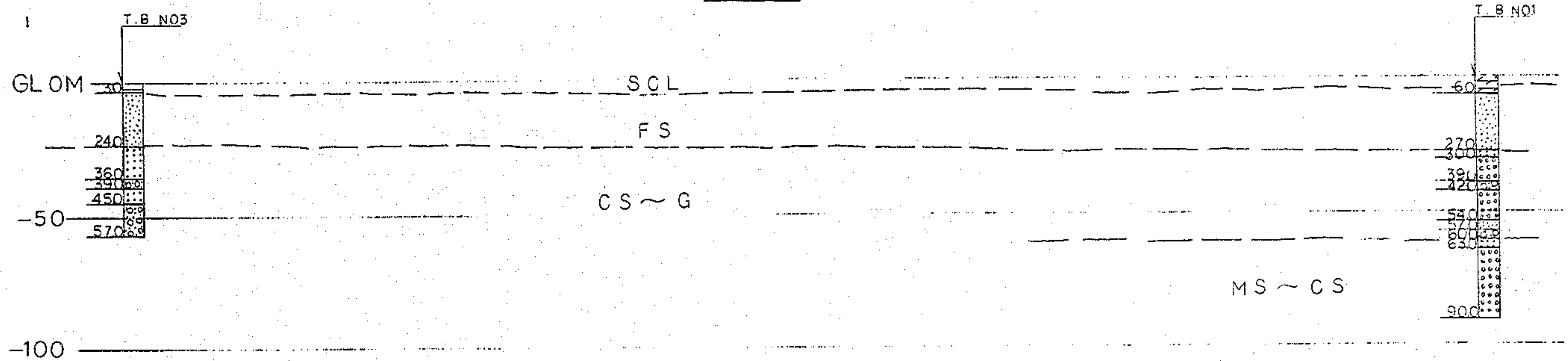

Legend
Test boring
Production well
Public deep tube well
① Geological section
GHAGHAT RIVER
T.B.No1
No4
T.B.No2
T.B.No3
T.B.No5
DIRECTORATE OF PUBLIC HEALTH ENGINEERING
GOVERNMENT OF BANGLADESH
GAIBANDA
Location
Date
Drawing No
JAPAN INTERNATIONAL COOPERATION AGENCY

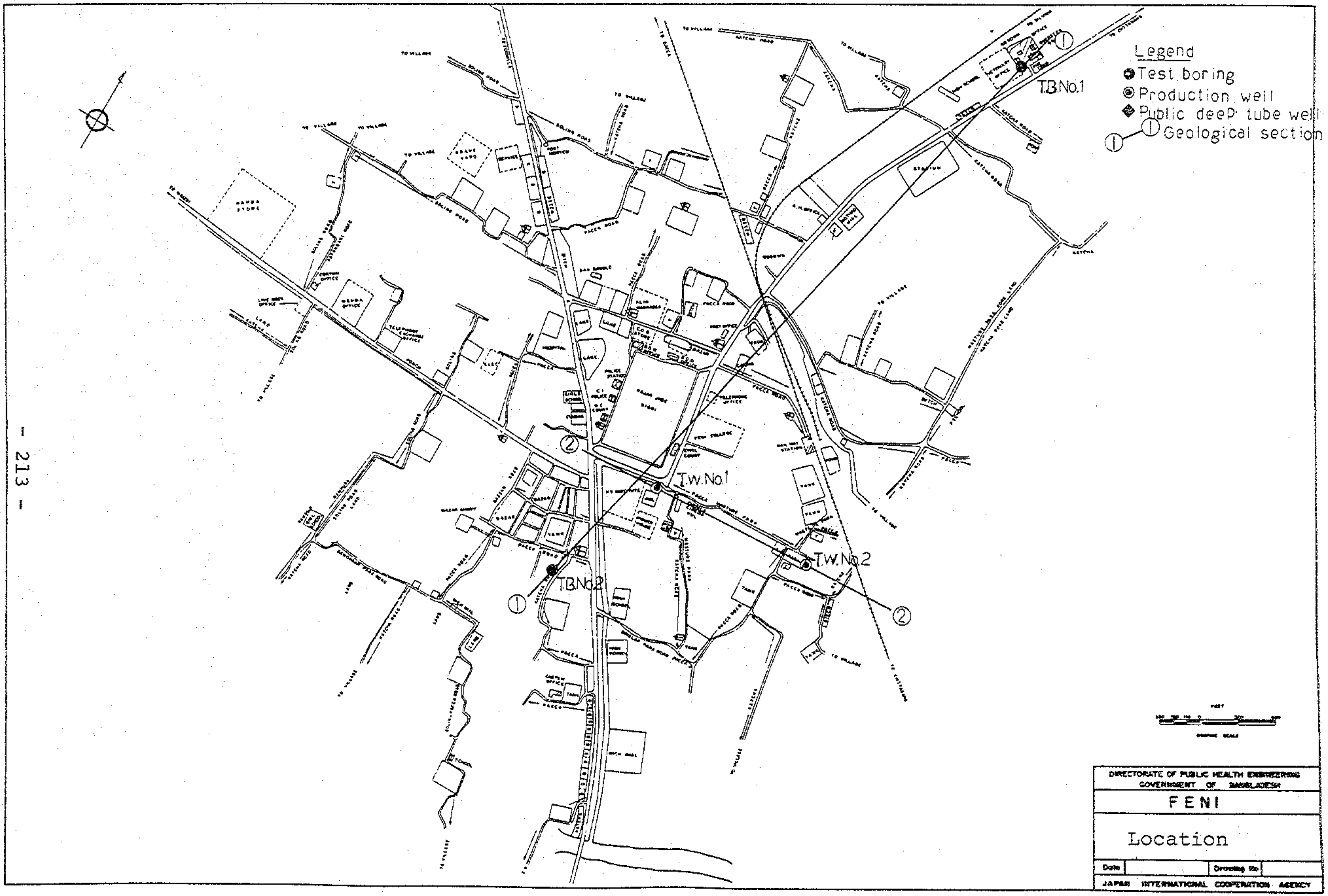
Gaibanda

①-①

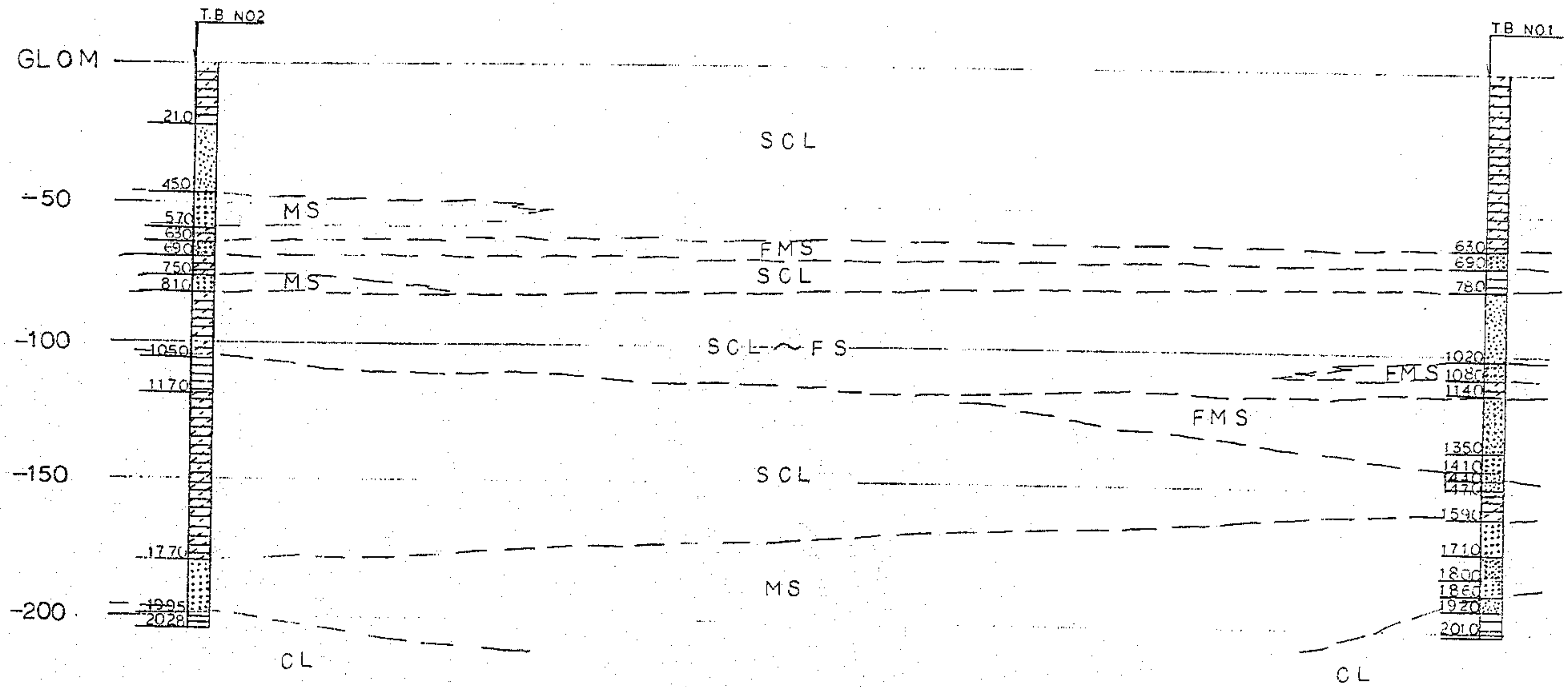


②-②

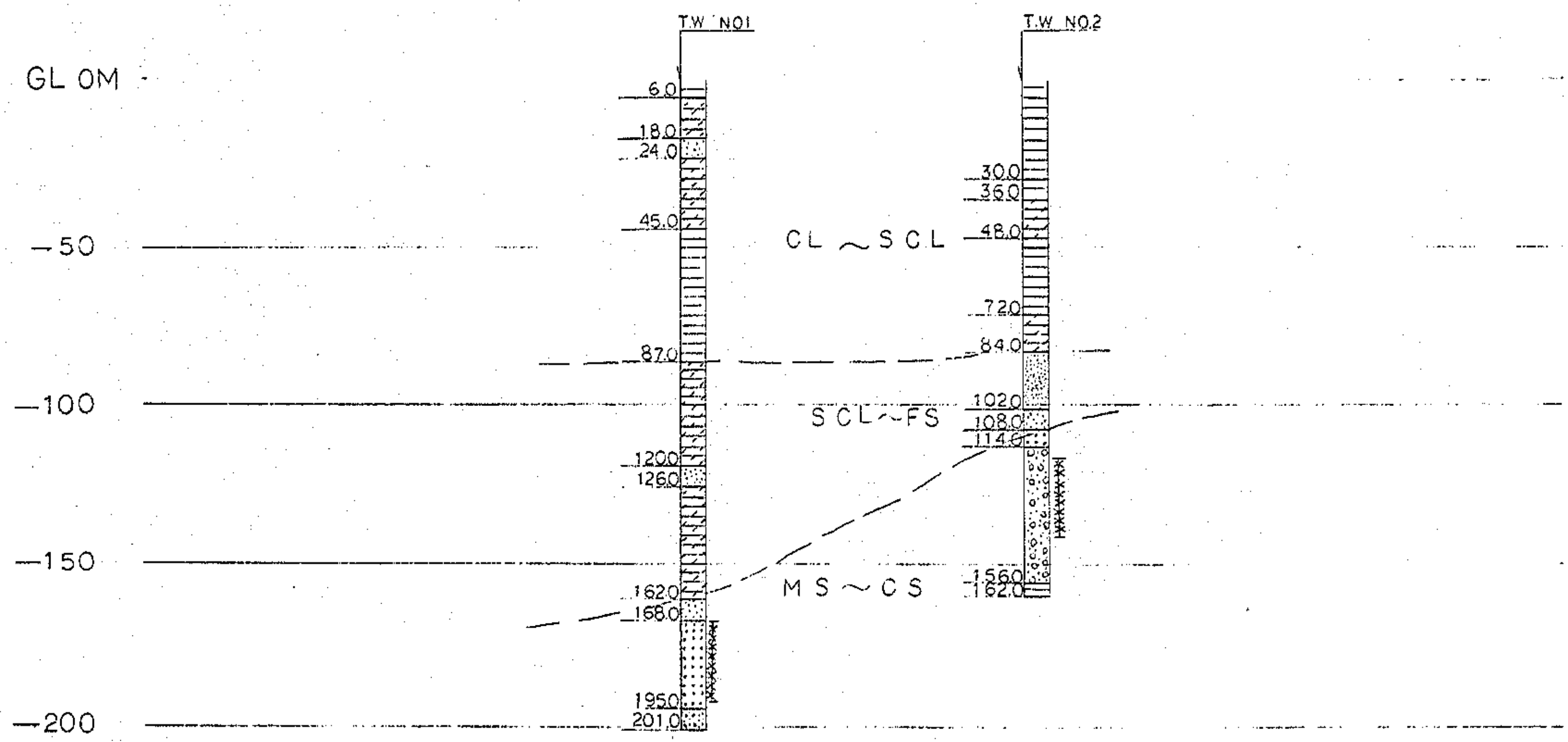



Legend
Test boring
Production well
Public deep tube well
① Geological section
T.B.No.1
T.W.No.1
T.W.No.2
T.B.No.2
DIRECTORATE OF PUBLIC HEALTH ENGINEERING
GOVERNMENT OF BANGLADESH
FENI
Location
Date
Drawing No.
JAPAN INTERNATIONAL COOPERATION AGENCY

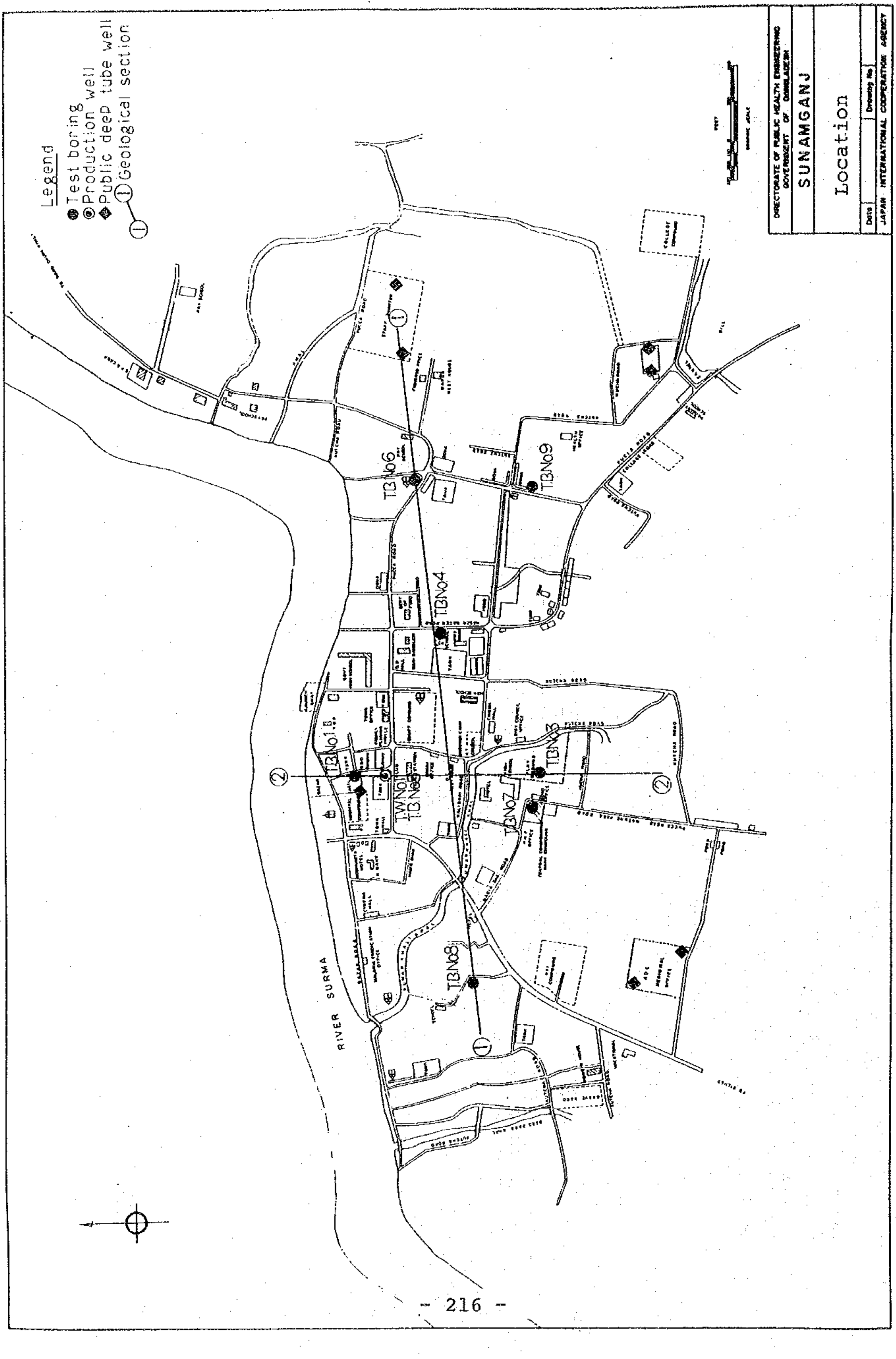
①-① Feni


T.B NO2
T.B NO1
GLOM
-50
-100
-150
-200
21.0
450
570
630
690
750
810
1050
1170
1770
1995
2028
630
690
780
1020
1080
1140
1350
1410
1470
1590
1710
1800
1860
1920
2010
SCL
MS
FMS
SCL
MS
SCL～FS
FMS
FMS
SCL
MS
CL
CL

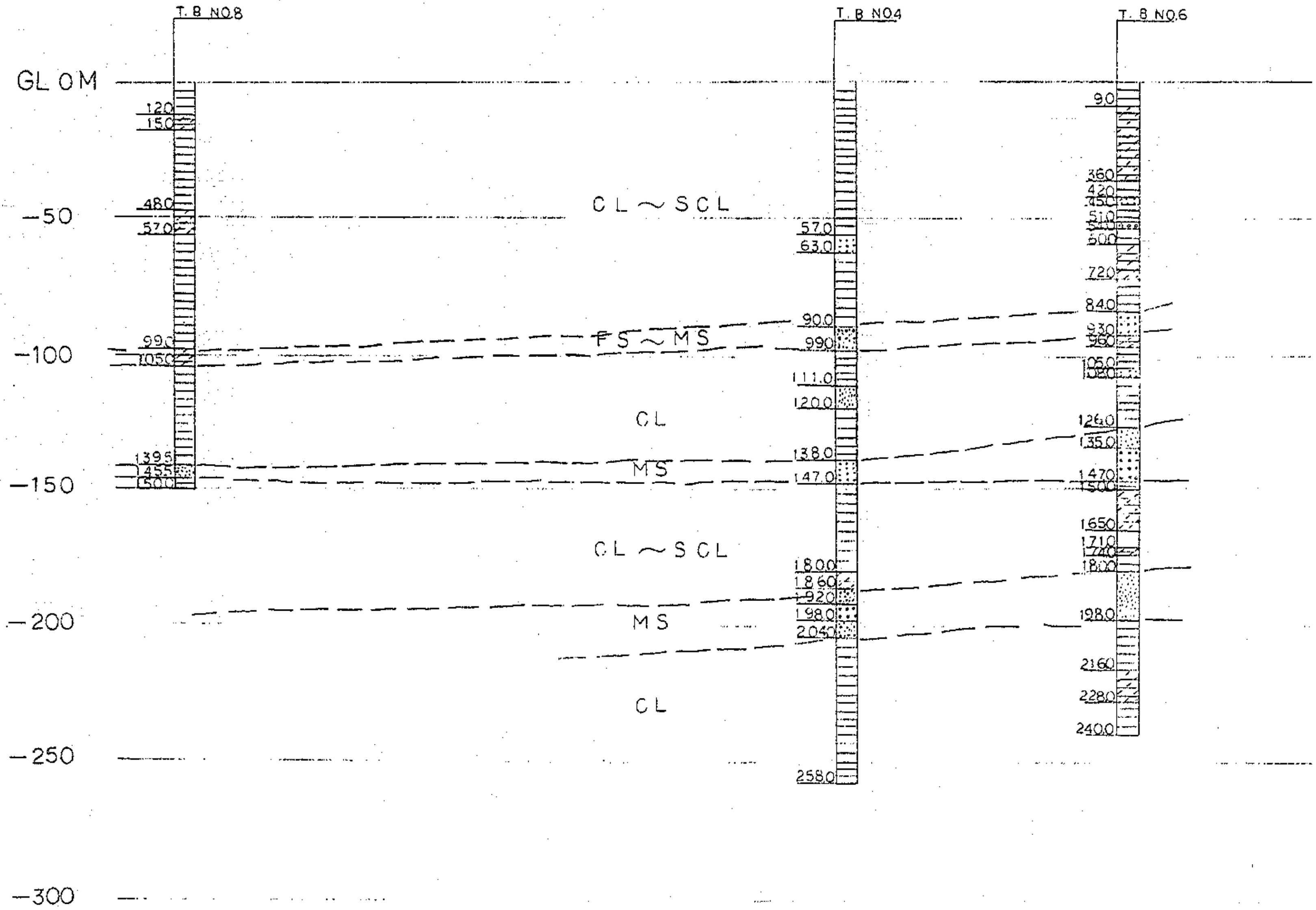
②-② Feni



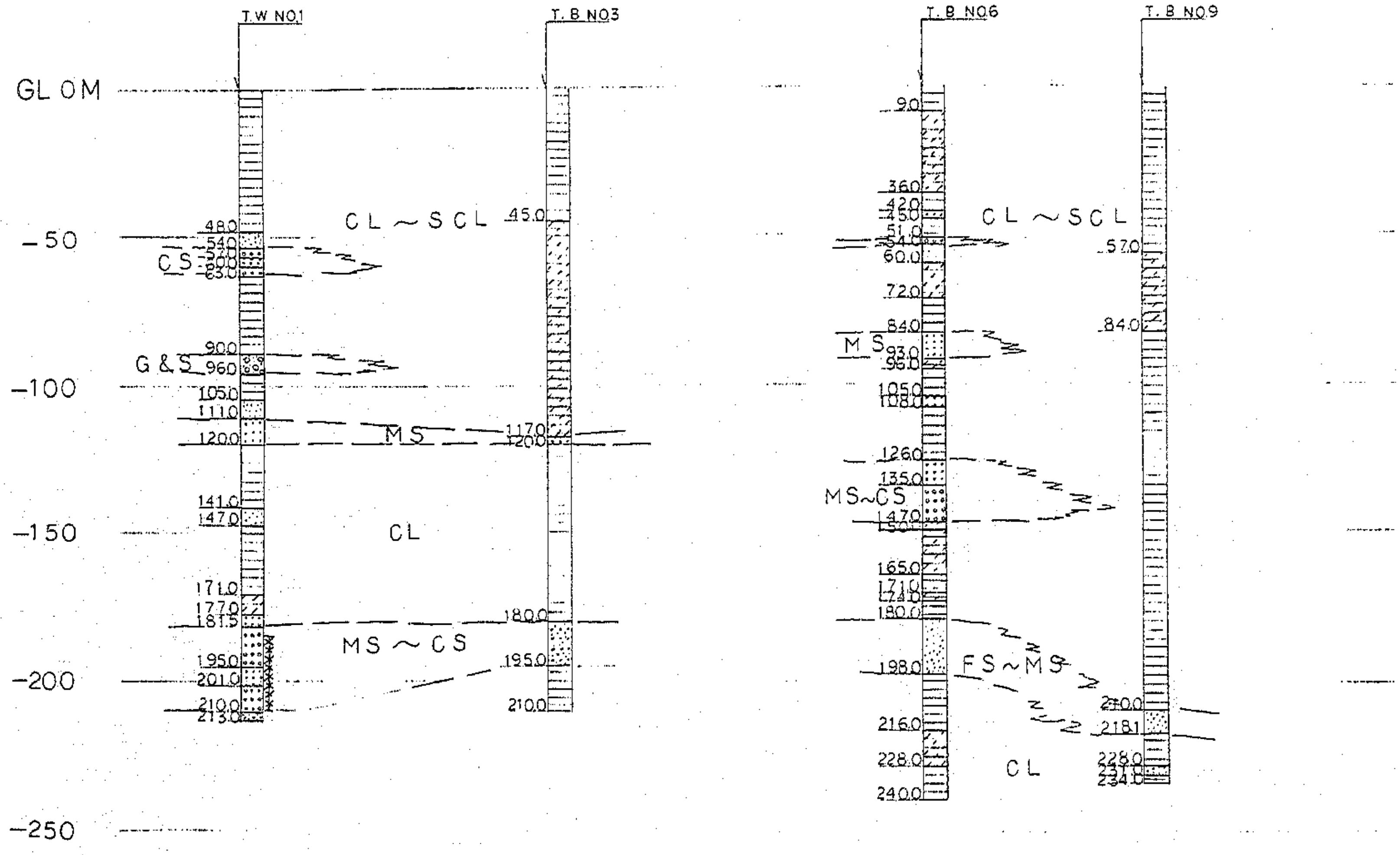
GL 0M
-50
-100
-150
-200
T.W NO1
T.W NO2
6.0
18.0
24.0
45.0
87.0
120.0
126.0
162.0
168.0
195.0
201.0
30.0
36.0
48.0
72.0
84.0
102.0
108.0
114.0
156.0
162.0
CL ～ SCL
SCL～FS
MS ～ CS


Legend
Test boring
Production well
Public deep tube well
Geological section
DIRECTORATE OF PUBLIC HEALTH ENGINEERING
GOVERNMENT OF BANGLADESH
SUNAMGANJ
Location
JAPAN INTERNATIONAL COOPERATION AGENCY
RIVER SURMA
T.B.No.6
T.B.No.9
T.B.No.4
T.B.No.1.B
T.W.No.1
T.B.No.3
T.B.No.7
T.B.No.8

①-① Sunamganj



②-② Sunamganj



3-10-2 Hydraulic Calculation Results for Pipe Line Networks

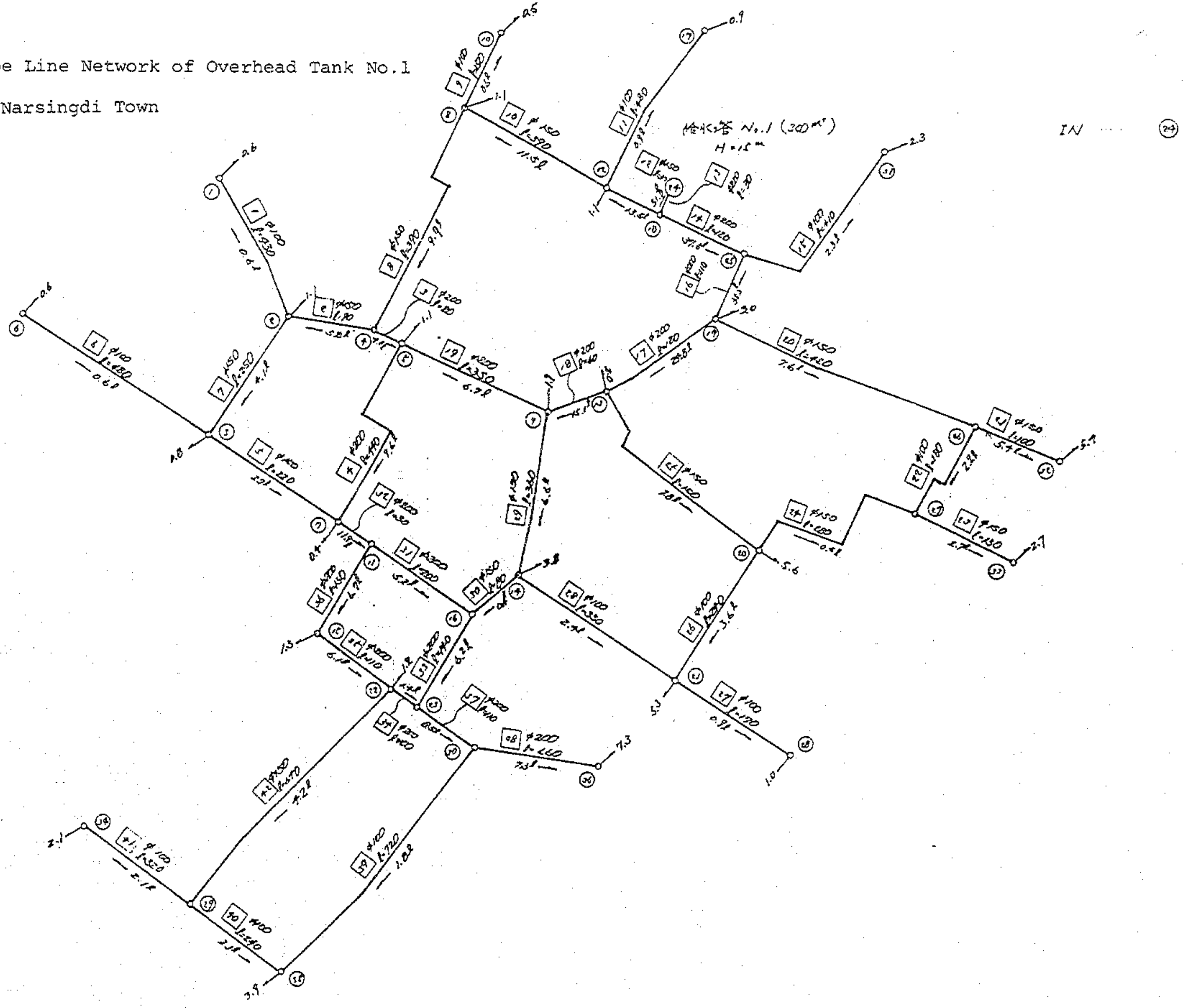


Fig. 3-10-2-1 Pipe Line Network of Overhead Tank No.1 of Narsingdi Town

Fig. 3-10-2-2 Pipe Line Network of Overhead Tank No.2 of Narsingdi Town

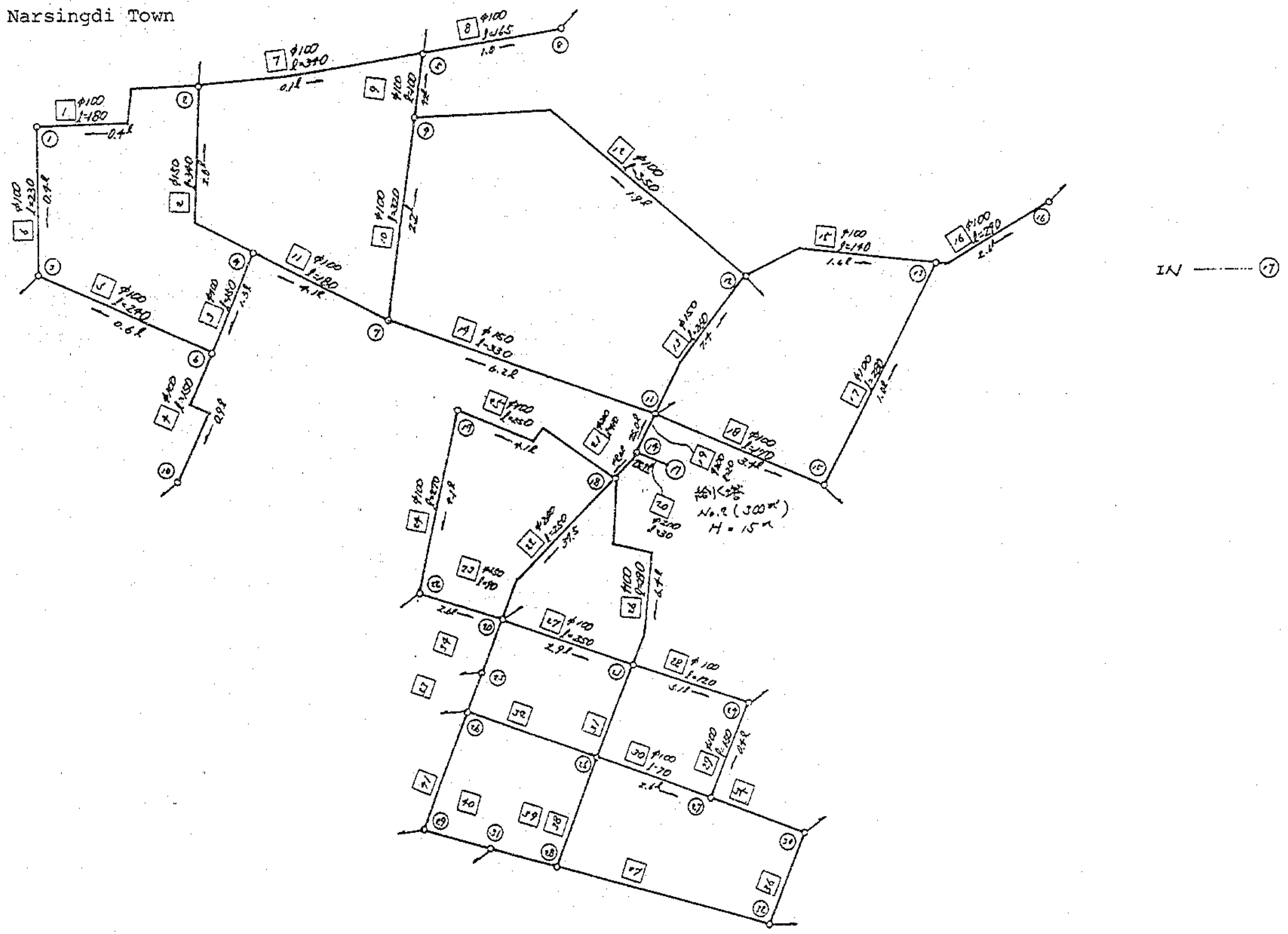


Fig. 3-10-2-3 Pipe Line Network of Overhead Tank No.3 of Narsingdi Town

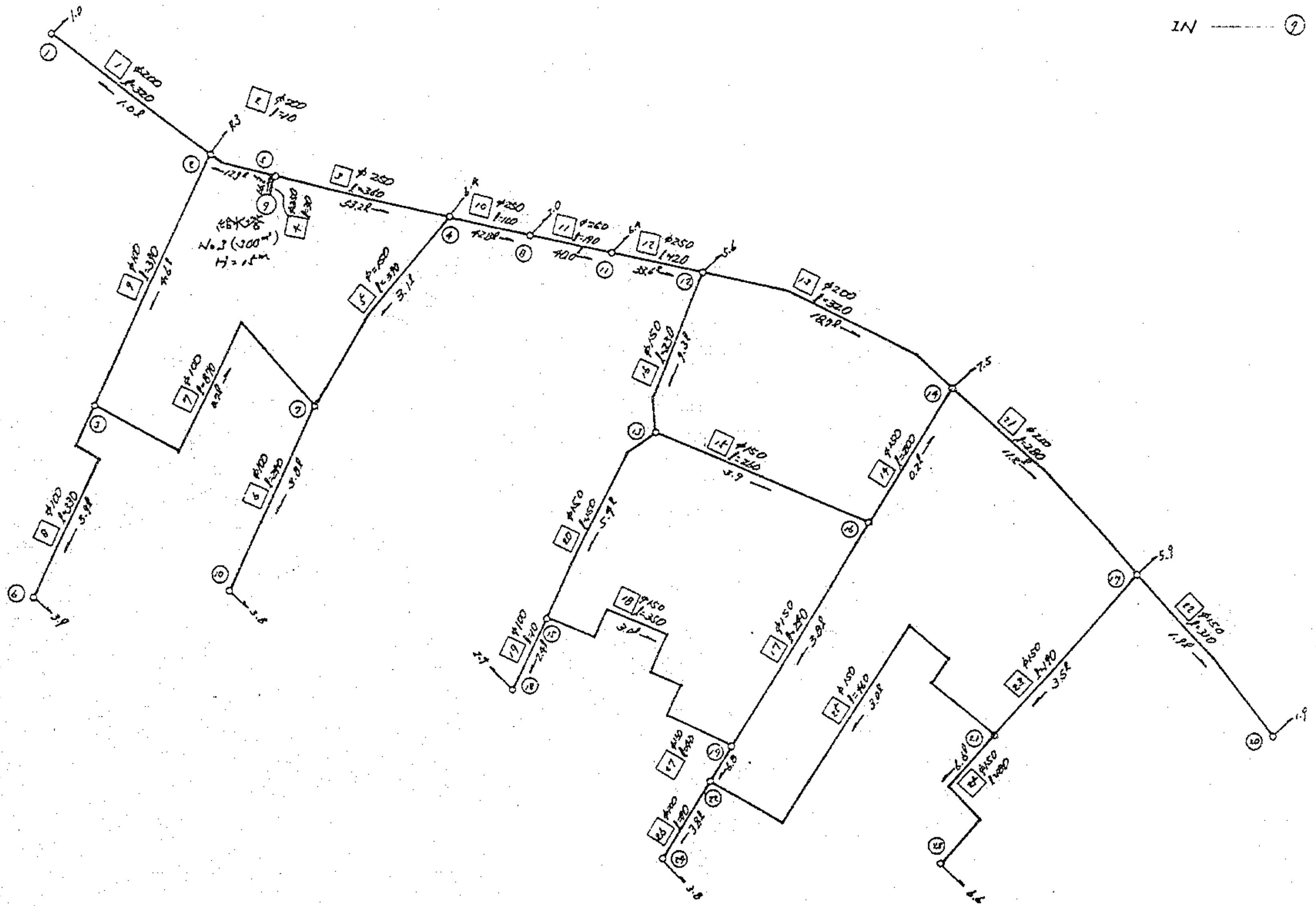


Fig. 3-10-2-4 Pipe Line Network of Overhead Tank No.4 of Narsingdi Town

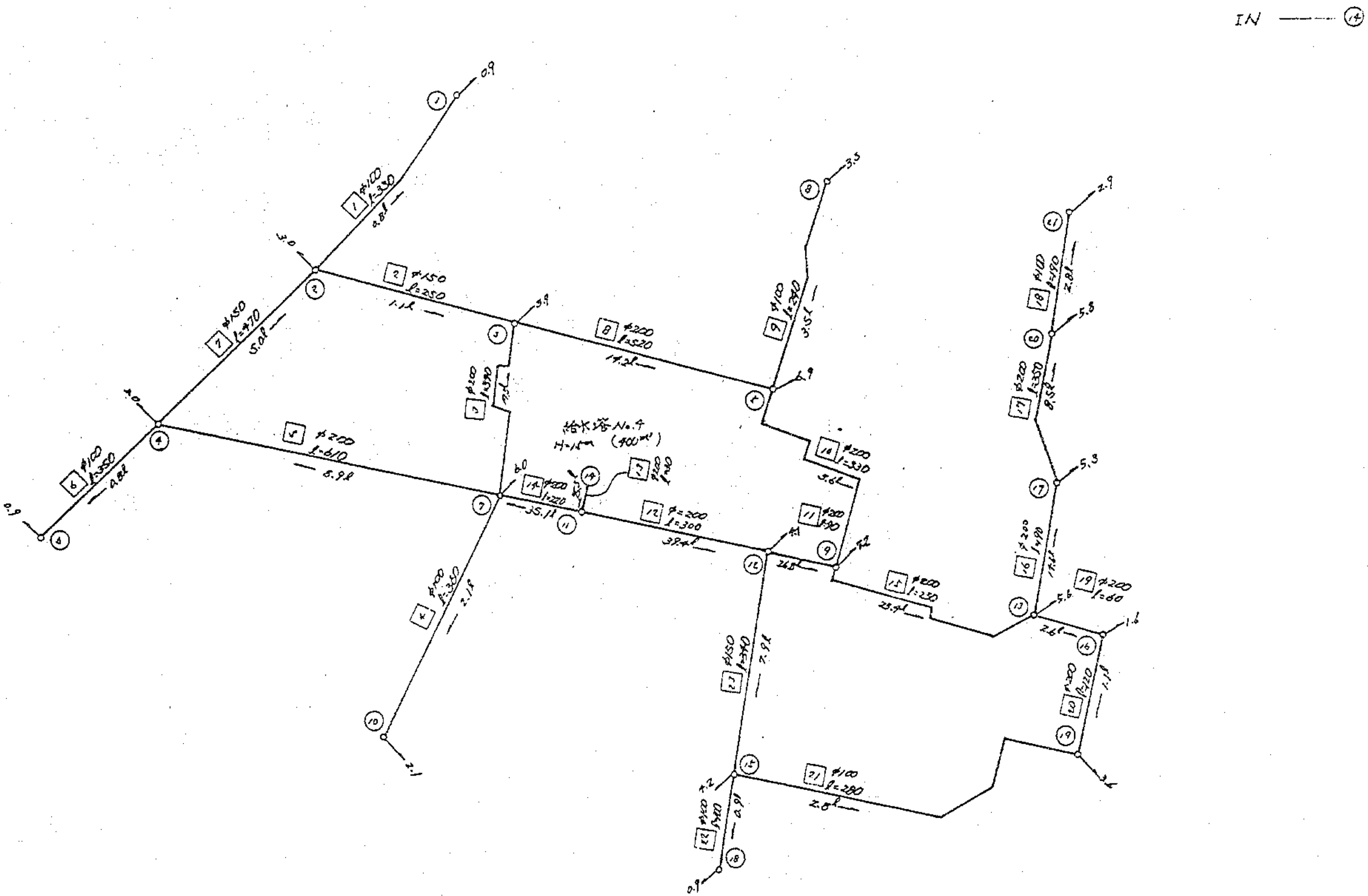
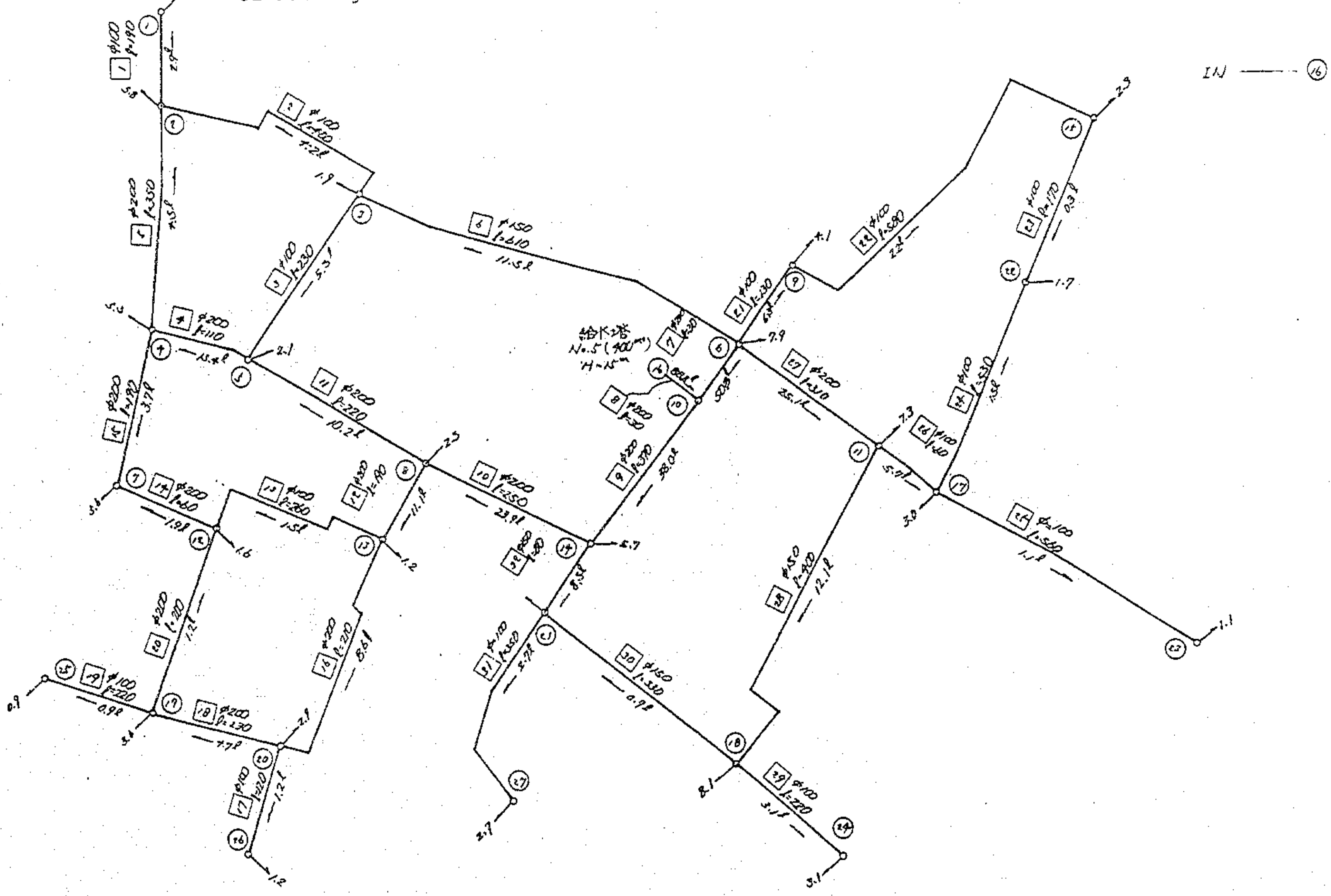


Fig. 3-10-2-5 Pipe Line Network of Overhead Tank No.5

of Narsingdi Town



****N-SINGDI-1

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0006	-0.061	-0.077	0.100	430.000	110	-0.0143
2	2 -- 4	-0.0059	-0.121	-0.334	0.150	90.000	110	-0.1355
3	4 -- 5	0.0041	0.003	0.131	0.200	20.000	110	0.0172
4	5 -- 7	0.0098	0.375	0.312	0.200	440.000	110	0.0854
5	3 -- 7	0.0028	0.075	0.159	0.150	220.000	110	0.0344
6	3 -- 6	0.0006	0.069	0.077	0.100	490.000	110	0.0143
7	2 -- 3	0.0042	0.181	0.238	0.150	250.000	110	0.0726
8	4 -- 8	-0.0101	-1.426	-0.570	0.150	390.000	110	-0.3657
9	8 -- 10	0.0005	0.015	0.064	0.100	150.000	110	0.0101
10	8 -- 12	-0.0117	-1.873	-0.661	0.150	390.000	110	-0.4804
11	12 -- 17	0.0009	0.144	0.115	0.100	480.000	110	0.0300
12	12 -- 18	-0.0137	-0.193	-0.774	0.150	30.000	110	-0.6438
13	18 -- 24	-0.0526	-0.576	-1.675	0.200	30.000	110	-1.9210
14	18 -- 25	0.0385	1.295	1.227	0.200	120.000	110	1.0799
15	25 -- 31	0.0023	0.700	0.293	0.100	410.000	110	0.1707
16	19 -- 25	-0.0360	-1.046	-1.146	0.200	110.000	110	-0.9514
17	13 -- 19	-0.0252	-0.887	-0.803	0.200	180.000	110	-0.4930
18	9 -- 13	-0.0153	-0.117	-0.488	0.200	60.000	110	-0.1957
19	5 -- 9	-0.0067	-0.149	-0.214	0.200	350.000	110	-0.0426
20	19 -- 26	0.0077	0.941	0.438	0.150	420.000	110	0.2241
21	26 -- 32	0.0054	0.115	0.306	0.150	100.000	110	0.1151
22	26 -- 27	0.0023	0.303	0.291	0.100	180.000	110	0.1689
23	27 -- 33	0.0027	0.041	0.153	0.150	130.000	110	0.0318
24	20 -- 27	-0.0003	-0.001	-0.018	0.150	280.000	110	-0.0006
25	13 -- 20	0.0080	0.359	0.454	0.150	150.000	110	0.2396
26	20 -- 21	0.0035	0.893	0.446	0.100	240.000	110	0.3723
27	21 -- 28	0.0007	0.034	0.093	0.100	170.000	110	0.0202
28	14 -- 21	0.0022	0.519	0.280	0.100	330.000	110	0.1574
29	9 -- 14	0.0067	0.616	0.379	0.150	360.000	110	0.1712
30	14 -- 16	0.0007	0.002	0.042	0.150	80.000	110	0.0029
31	11 -- 16	0.0053	0.054	0.168	0.200	200.000	110	0.0271
32	7 -- 11	0.0123	0.039	0.393	0.200	30.000	110	0.1310
33	16 -- 23	0.0064	0.055	0.205	0.200	140.000	110	0.0394
34	22 -- 23	0.0012	0.001	0.038	0.200	100.000	110	0.0017
35	15 -- 22	0.0062	0.039	0.196	0.200	110.000	110	0.0363
36	11 -- 15	0.0069	0.067	0.221	0.200	150.000	110	0.0452
37	23 -- 30	0.0086	0.074	0.275	0.200	110.000	110	0.0675
38	30 -- 36	0.0073	0.327	0.232	0.200	660.000	110	0.0496
39	30 -- 35	0.0018	0.747	0.224	0.100	720.000	110	0.1039
40	29 -- 35	0.0021	0.358	0.273	0.100	240.000	110	0.1496

****N-SINGDI-1

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	10.747	0.0006	0.6	10.747	0.000	1
2	10.808	0.0011	1.1	10.808	0.000	2
3	10.627	0.0008	0.8	10.627	0.000	3
4	10.930			10.930	0.000	4
5	10.927	0.0011	1.1	10.927	0.000	5
6	10.557	0.0006	0.6	10.557	0.000	6
7	10.551	0.0004	0.4	10.551	0.000	7
8	12.356	0.0011	1.1	12.356	0.000	8
9	11.076	0.0019	1.9	11.076	0.000	9
10	12.341	0.0005	0.5	12.341	0.000	10
11	10.512			10.512	0.000	11
12	14.230	0.0011	1.1	14.230	0.000	12
13	11.193	0.0020	2.0	11.193	0.000	13
14	10.460	0.0038	3.8	10.460	0.000	14
15	10.444	0.0013	1.3	10.444	0.000	15
16	10.457			10.457	0.000	16
17	14.086	0.0009	0.9	14.086	0.000	17
18	14.423			14.423	0.000	18
19	12.081	0.0030	3.0	12.081	0.000	19
20	10.834	0.0056	5.6	10.834	0.000	20
21	9.940	0.0053	5.3	9.940	0.000	21
22	10.404	0.0012	1.2	10.404	0.000	22
23	10.402			10.402	0.000	23
24	15.000			15.000	0.000	24
25	13.127			13.127	0.000	25
26	11.140			11.140	0.000	26
27	10.836			10.836	0.000	27
28	9.906	0.0010	1.0	9.906	0.000	28
29	9.939			9.939	0.000	29
30	10.328			10.328	0.000	30
31	12.427	0.0023	2.3	12.427	0.000	31
32	11.025	0.0054	5.4	11.025	0.000	32
33	10.794	0.0027	2.7	10.794	0.000	33
34	9.478	0.0021	2.1	9.478	0.000	34
35	9.580	0.0039	3.9	9.580	0.000	35
36	10.001	0.0073	7.3	10.001	0.000	36

****N-SINGDI-2

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0002	-0.004	-0.031	0.100	180.000	110	-0.0026
2	2 -- 4	-0.0037	-0.191	-0.207	0.150	340.000	110	-0.0562
3	4 -- 6	0.0017	0.149	0.219	0.100	150.000	110	0.0994
4	6 -- 10	0.0010	0.052	0.125	0.100	150.000	110	0.0351
5	3 -- 6	-0.0008	-0.052	-0.097	0.100	240.000	110	-0.0219
6	1 -- 3	0.0002	0.006	0.031	0.100	230.000	110	0.0026
7	2 -- 5	0.0011	0.154	0.143	0.100	340.000	110	0.0455
8	5 -- 8	0.0010	0.062	0.127	0.100	170.000	110	0.0365
9	5 -- 9	-0.0032	-0.308	-0.403	0.100	100.000	110	-0.3081
10	7 -- 9	0.0015	0.243	0.189	0.100	320.000	110	0.0761
11	4 -- 7	-0.0054	-0.206	-0.305	0.150	180.000	110	-0.1145
12	9 -- 12	-0.0017	-0.328	-0.212	0.100	350.000	110	-0.0939
13	11 -- 12	0.0072	0.506	0.406	0.150	260.000	110	0.1948
14	7 -- 11	-0.0069	-0.591	-0.388	0.150	330.000	110	-0.1793
15	12 -- 13	0.0017	0.137	0.218	0.100	140.000	110	0.0985
16	13 -- 16	0.0026	0.621	0.331	0.100	290.000	110	0.2143
17	13 -- 15	-0.0009	-0.082	-0.113	0.100	280.000	110	-0.0295
18	11 -- 15	0.0033	0.561	0.418	0.100	170.000	110	0.3304
19	11 -- 14	-0.0254	-0.099	-0.809	0.200	20.000	110	-0.4988
20	14 -- 17	-0.0734	-1.066	-2.335	0.200	30.000	110	-3.5551
21	14 -- 18	0.0480	1.786	1.529	0.200	110.000	110	1.6238
22	18 -- 20	0.0376	2.580	1.198	0.200	250.000	110	1.0323
23	20 -- 22	-0.0026	-0.026	-0.145	0.150	90.000	110	-0.0291
24	19 -- 22	0.0041	1.326	0.518	0.100	270.000	110	0.4913
25	18 -- 19	0.0041	1.228	0.518	0.100	250.000	110	0.4913
26	18 -- 21	0.0064	3.277	0.813	0.100	290.000	110	1.1302
27	20 -- 21	0.0030	0.696	0.382	0.100	250.000	110	0.2787
28	21 -- 24	0.0051	0.901	0.652	0.100	120.000	110	0.7515
29	24 -- 27	0.0004	0.010	0.053	0.100	150.000	110	0.0073
30	25 -- 27	0.0026	0.146	0.327	0.100	70.000	110	0.2099
31	21 -- 25	0.0043	0.765	0.549	0.100	140.000	110	0.5471
32	25 -- 26	-0.0010	-0.108	-0.127	0.100	300.000	110	-0.0362
33	23 -- 26	0.0211	0.282	0.671	0.200	80.000	110	0.3536
34	20 -- 23	0.0264	1.071	0.840	0.200	200.000	110	0.5355
35	27 -- 30	0.0030	0.388	0.381	0.100	140.000	110	0.2778
36	30 -- 32	-0.0008	-0.036	-0.103	0.100	150.000	110	-0.0246
37	28 -- 32	0.0074	0.085	0.234	0.200	170.000	110	0.0503
38	25 -- 28	0.0028	0.413	0.354	0.100	170.000	110	0.2432
39	28 -- 31	-0.0036	-0.018	-0.115	0.200	140.000	110	-0.0134
40	29 -- 31	0.0092	0.098	0.293	0.200	130.000	110	0.0761

****N-SINGDI-2

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	12.840			12.840	0.000	1
2	12.845	0.0023	2.3	12.845	0.000	2
3	12.834	0.0010	1.0	12.834	0.000	3
4	13.036			13.036	0.000	4
5	12.690	0.0033	3.3	12.690	0.000	5
6	12.886			12.886	0.000	6
7	13.242			13.242	0.000	7
8	12.628	0.0010	1.0	12.628	0.000	8
9	12.998			12.998	0.000	9
10	12.834	0.0010	1.0	12.834	0.000	10
11	13.833	0.0081	8.1	13.833	0.000	11
12	13.327	0.0038	3.8	13.327	0.000	12
13	13.189			13.189	0.000	13
14	13.933			13.933	0.000	14
15	13.271	0.0024	2.4	13.271	0.000	15
16	12.567	0.0026	2.6	12.567	0.000	16
17	15.000			15.000 → 17.000	0.000	17
18	12.147			12.147	0.000	18
19	10.919			10.919	0.000	19
20	9.566	0.0108	10.8	9.566	0.000	20
21	8.869			8.869	0.000	21
22	9.592	0.0015	1.5	9.592	0.000	22
23	8.495	0.0053	5.3	8.495	0.000	23
24	7.967	0.0047	4.7	7.967	0.000	24
25	8.103			8.103	0.000	25
26	8.212	0.0045	4.5	8.212	0.000	26
27	7.956			7.956	0.000	27
28	7.690			7.690	0.000	28
29	7.807	0.0064	6.4	7.807	0.000	29
30	7.567	0.0038	3.8	7.567	0.000	30
31	7.709	0.0056	5.6	7.709	0.000	31
32	7.604	0.0075	7.5	7.604	0.000	32

Therefore, the height of overhead tank is 17.0m.

****N-SINGDI-3

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0010	-0.003	-0.032	0.200	320.000	110	-0.0012
2	2 -- 5	-0.0128	-0.014	-0.407	0.200	10.000	110	-0.1401
3	4 -- 5	-0.0515	-2.239	-1.048	0.250	360.000	110	-0.6220
4	5 -- 9	-0.0643	-0.281	-1.309	0.250	30.000	110	-0.9383
5	4 -- 7	0.0033	0.181	0.187	0.150	390.000	110	0.0464
6	7 -- 10	0.0038	1.038	0.484	0.100	240.000	110	0.4327
7	3 -- 7	0.0005	0.102	0.069	0.100	870.000	110	0.0118
8	3 -- 6	0.0039	1.498	0.497	0.100	330.000	110	0.4540
9	2 -- 3	0.0045	2.303	0.572	0.100	390.000	110	0.5907
10	4 -- 8	0.0409	0.405	0.833	0.250	100.000	110	0.4059
11	8 -- 11	0.0379	0.670	0.772	0.250	190.000	110	0.3529
12	11 -- 12	0.0315	0.300	0.642	0.250	120.000	110	0.2505
13	12 -- 14	0.0173	0.781	0.550	0.200	320.000	110	0.2441
14	14 -- 16	-0.0003	-0.001	-0.018	0.150	200.000	110	-0.0006
15	13 -- 16	0.0037	0.149	0.210	0.150	260.000	110	0.0577
16	12 -- 13	0.0086	0.630	0.488	0.150	230.000	110	0.2740
17	16 -- 19	0.0034	0.117	0.192	0.150	240.000	110	0.0489
18	15 -- 19	0.0028	0.122	0.161	0.150	350.000	110	0.0351
19	15 -- 18	0.0024	0.018	0.306	0.100	10.000	110	0.1847
20	13 -- 15	0.0049	0.144	0.278	0.150	150.000	110	0.0964
21	14 -- 17	0.0101	0.252	0.321	0.200	280.000	110	0.0902
22	17 -- 20	0.0019	0.051	0.108	0.150	310.000	110	0.0166
23	17 -- 21	0.0031	0.078	0.176	0.150	190.000	110	0.0415
24	21 -- 23	0.0066	0.300	0.373	0.150	180.000	110	0.1669
25	21 -- 22	-0.0027	-0.149	-0.154	0.150	460.000	110	-0.0325
26	22 -- 24	0.0038	0.302	0.484	0.100	70.000	110	0.4327
27	19 -- 22	0.0065	0.065	0.370	0.150	40.000	110	0.1636

****N-SINGDI-3

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	14.700	0.0010	1.0	14.700	0.000	1
2	14.704	0.0073	7.3	14.704	0.000	2
3	12.400			12.400	0.000	3
4	12.479	0.0064	6.4	12.479	0.000	4
5	14.718			14.718	0.000	5
6	10.902	0.0039	3.9	10.902	0.000	6
7	12.298			12.298	0.000	7
8	12.073	0.0020	2.0	12.073	0.000	8
9	15.000			15.000	0.000	9
10	11.260	0.0038	3.8	11.260	0.000	10
11	11.402	0.0064	6.4	11.402	0.000	11
12	11.102	0.0056	5.6	11.102	0.000	12
13	10.472			10.472	0.000	13
14	10.321	0.0075	7.5	10.321	0.000	14
15	10.327			10.327	0.000	15
16	10.322			10.322	0.000	16
17	10.068	0.0059	5.9	10.068	0.000	17
18	10.309	0.0024	2.4	10.309	0.000	18
19	10.204			10.204	0.000	19
20	10.016	0.0019	1.9	10.016	0.000	20
21	9.989			9.989	0.000	21
22	10.139			10.139	0.000	22
23	9.689	0.0066	6.6	9.689	0.000	23
24	9.836	0.0038	3.8	9.836	0.000	24

****N-SINGDI-4

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0008	-0.087	-0.107	0.100	330.000	110	-0.0264
2	2 -- 3	0.0006	0.004	0.034	0.150	250.000	110	0.0020
3	3 -- 7	-0.0160	-0.785	-0.510	0.200	370.000	110	-0.2124
4	7 -- 10	0.0021	0.515	0.266	0.100	360.000	110	0.1431
5	4 -- 7	-0.0084	-0.390	-0.267	0.200	610.000	110	-0.0641
6	4 -- 6	0.0009	0.104	0.114	0.100	350.000	110	0.0300
7	2 -- 4	-0.0045	-0.390	-0.256	0.150	470.000	110	-0.0830
8	3 -- 5	0.0124	0.689	0.395	0.200	520.000	110	0.1327
9	5 -- 8	0.0035	0.885	0.444	0.100	240.000	110	0.3688
10	5 -- 9	0.0024	0.021	0.078	0.200	330.000	110	0.0066
11	9 -- 12	-0.0247	-0.425	-0.786	0.200	90.000	110	-0.4728
12	11 -- 12	0.0361	2.868	1.149	0.200	300.000	110	0.9561
13	11 -- 14	-0.0702	-0.983	-2.236	0.200	30.000	110	-3.2797
14	7 -- 11	-0.0331	-1.796	-1.055	0.200	220.000	110	-0.8166
15	9 -- 13	0.0206	0.776	0.655	0.200	230.000	110	0.3376
16	13 -- 17	0.0132	0.282	0.421	0.200	190.000	110	0.1488
17	17 -- 20	0.0087	0.238	0.276	0.200	350.000	110	0.0682
18	20 -- 21	0.0029	0.494	0.368	0.100	190.000	110	0.2605
19	13 -- 16	0.0027	0.004	0.087	0.200	60.000	110	0.0080
20	16 -- 19	0.0012	0.002	0.038	0.200	120.000	110	0.0017
21	15 -- 19	0.0023	0.514	0.299	0.100	290.000	110	0.1774
22	15 -- 18	0.0009	0.027	0.109	0.100	100.000	110	0.0272
23	12 -- 15	0.0074	0.694	0.416	0.150	340.000	110	0.2042

****N-SINGDI-4

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	11.351	0.0009	0.9	11.351	0.000	1
2	11.438	0.0030	3.0	11.438	0.000	2
3	11.433	0.0039	3.9	11.433	0.000	3
4	11.828	0.0030	3.0	11.828	0.000	4
5	10.743	0.0069	6.9	10.743	0.000	5
6	11.723	0.0009	0.9	11.723	0.000	6
7	12.219	0.0060	6.0	12.219	0.000	7
8	9.858	0.0035	3.5	9.858	0.000	8
9	10.722	0.0072	7.2	10.722	0.000	9
10	11.704	0.0021	2.1	11.704	0.000	10
11	14.016			14.016	0.000	11
12	11.147	0.0041	4.1	11.147	0.000	12
13	9.945	0.0056	5.6	9.945	0.000	13
14	15.000			15.000	0.000	14
15	10.453	0.0042	4.2	10.453	0.000	15
16	9.940	0.0016	1.6	9.940	0.000	16
17	9.663	0.0053	5.3	9.663	0.000	17
18	10.426	0.0009	0.9	10.426	0.000	18
19	9.938	0.0036	3.6	9.938	0.000	19
20	9.424	0.0058	5.8	9.424	0.000	20
21	8.929	0.0029	2.9	8.929	0.000	21

****N-SINGDI-5

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0029	-0.498	-0.369	0.100	190.000	110	-0.2623
2	2 -- 3	-0.0042	-2.095	-0.536	0.100	400.000	110	-0.5238
3	3 -- 5	0.0053	1.855	0.677	0.100	230.000	110	0.8067
4	4 -- 5	-0.0135	-0.169	-0.429	0.200	110.000	110	-0.1541
5	2 -- 4	-0.0045	-0.070	-0.143	0.200	350.000	110	-0.0201
6	3 -- 6	-0.0114	-2.816	-0.647	0.150	610.000	110	-0.4617
7	6 -- 10	-0.0507	-0.538	-1.614	0.200	30.000	110	-1.7949
8	10 -- 16	-0.0887	-1.517	-2.825	0.200	30.000	110	-5.0579
9	10 -- 14	0.0380	3.895	1.210	0.200	370.000	110	1.0528
10	8 -- 14	-0.0239	-1.110	-0.760	0.200	250.000	110	-0.4443
11	5 -- 8	-0.0103	-0.204	-0.326	0.200	220.000	110	-0.0929
12	8 -- 13	0.0111	0.204	0.354	0.200	190.000	110	0.1079
13	12 -- 13	-0.0015	-0.193	-0.187	0.100	260.000	110	-0.0743
14	7 -- 12	-0.0019	-0.002	-0.061	0.200	60.000	110	-0.0042
15	4 -- 7	0.0037	0.026	0.117	0.200	190.000	110	0.0140
16	13 -- 20	0.0086	0.140	0.273	0.200	210.000	110	0.0669
17	20 -- 26	0.0012	0.061	0.153	0.100	120.000	110	0.0512
18	19 -- 20	-0.0046	-0.049	-0.148	0.200	230.000	110	-0.0214
19	19 -- 25	0.0009	0.066	0.115	0.100	220.000	110	0.0300
20	12 -- 19	-0.0011	-0.003	-0.036	0.200	200.000	110	-0.0016
21	6 -- 9	0.0064	1.467	0.812	0.100	130.000	110	1.1292
22	9 -- 15	0.0023	0.975	0.290	0.100	580.000	110	0.1681
23	15 -- 22	0.0000	-0.000	-0.006	0.100	170.000	110	-0.0001
24	17 -- 22	0.0015	0.409	0.191	0.100	530.000	110	0.0772
25	17 -- 23	0.0011	0.243	0.140	0.100	560.000	110	0.0436
26	11 -- 17	0.0056	0.531	0.713	0.100	60.000	110	0.8866
27	6 -- 11	0.0250	1.501	0.796	0.200	310.000	110	0.4844
28	11 -- 18	0.0121	2.055	0.685	0.150	400.000	110	0.5138
29	18 -- 24	0.0031	0.652	0.395	0.100	220.000	110	0.2968
30	18 -- 21	0.0009	0.014	0.052	0.150	330.000	110	0.0043
31	21 -- 27	0.0027	0.804	0.344	0.100	350.000	110	0.2298
32	14 -- 21	0.0085	0.214	0.482	0.150	80.000	110	0.2679

****N-SINGDI-5

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	7.533	0.0029	2.9	7.533	0.000	1
2	8.032	0.0058	5.8	8.032	0.000	2
3	10.127	0.0019	1.9	10.127	0.000	3
4	8.102	0.0053	5.3	8.102	0.000	4
5	8.272	0.0021	2.1	8.272	0.000	5
6	12.944	0.0079	7.9	12.944	0.000	6
7	8.076	0.0056	5.6	8.076	0.000	7
8	8.476	0.0025	2.5	8.476	0.000	8
9	11.476	0.0041	4.1	11.476	0.000	9
10	13.482			13.482	0.000	10
11	11.442	0.0073	7.3	11.442	0.000	11
12	8.078	0.0016	1.6	8.078	0.000	12
13	8.271	0.0012	1.2	8.271	0.000	13
14	9.587	0.0057	5.7	9.587	0.000	14
15	10.500	0.0023	2.3	10.500	0.000	15
16	15.000			15.000→17.000	0.000	16
17	10.910	0.0030	3.0	10.910	0.000	17
18	9.387	0.0081	8.1	9.387	0.000	18
19	8.081	0.0036	3.6	8.081	0.000	19
20	8.131	0.0029	2.9	8.131	0.000	20
21	9.373	0.0068	6.8	9.373	0.000	21
22	10.501	0.0017	1.7	10.501	0.000	22
23	10.666	0.0011	1.1	10.666	0.000	23
24	8.734	0.0031	3.1	8.734	0.000	24
25	8.015	0.0009	0.9	8.015	0.000	25
26	8.069	0.0012	1.2	8.069	0.000	26
27	8.568	0.0027	2.7	8.568	0.000	27

Therefore, the height of overhead tank is 17.0 m.

Fig. 3-10-2-6 Pipe Line Network of Overhead Tank No.1 of Jenidah Town

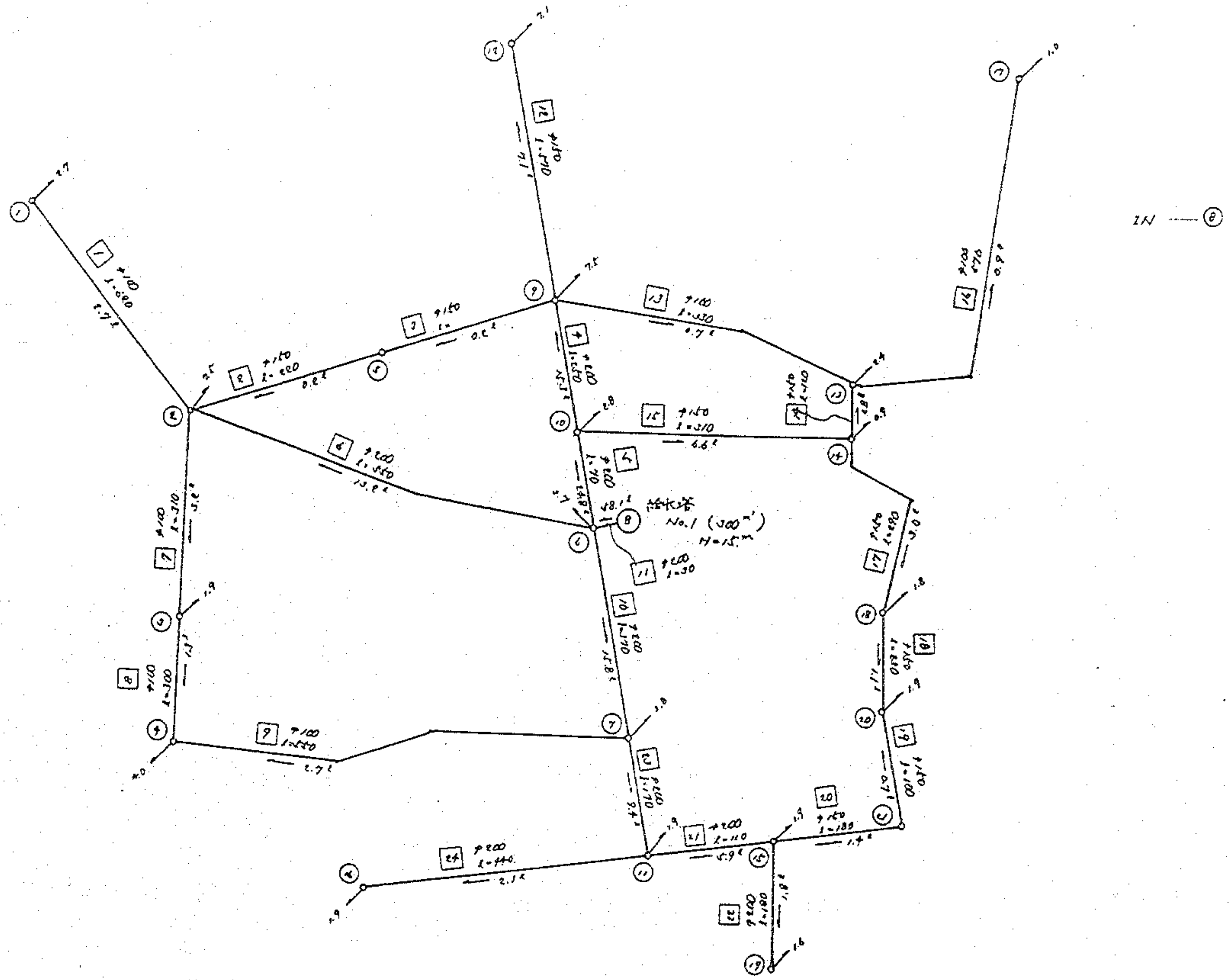


Fig. 3-10-2-7 Pipe Line Network of Overhead Tank No.2 of Jenidah Town

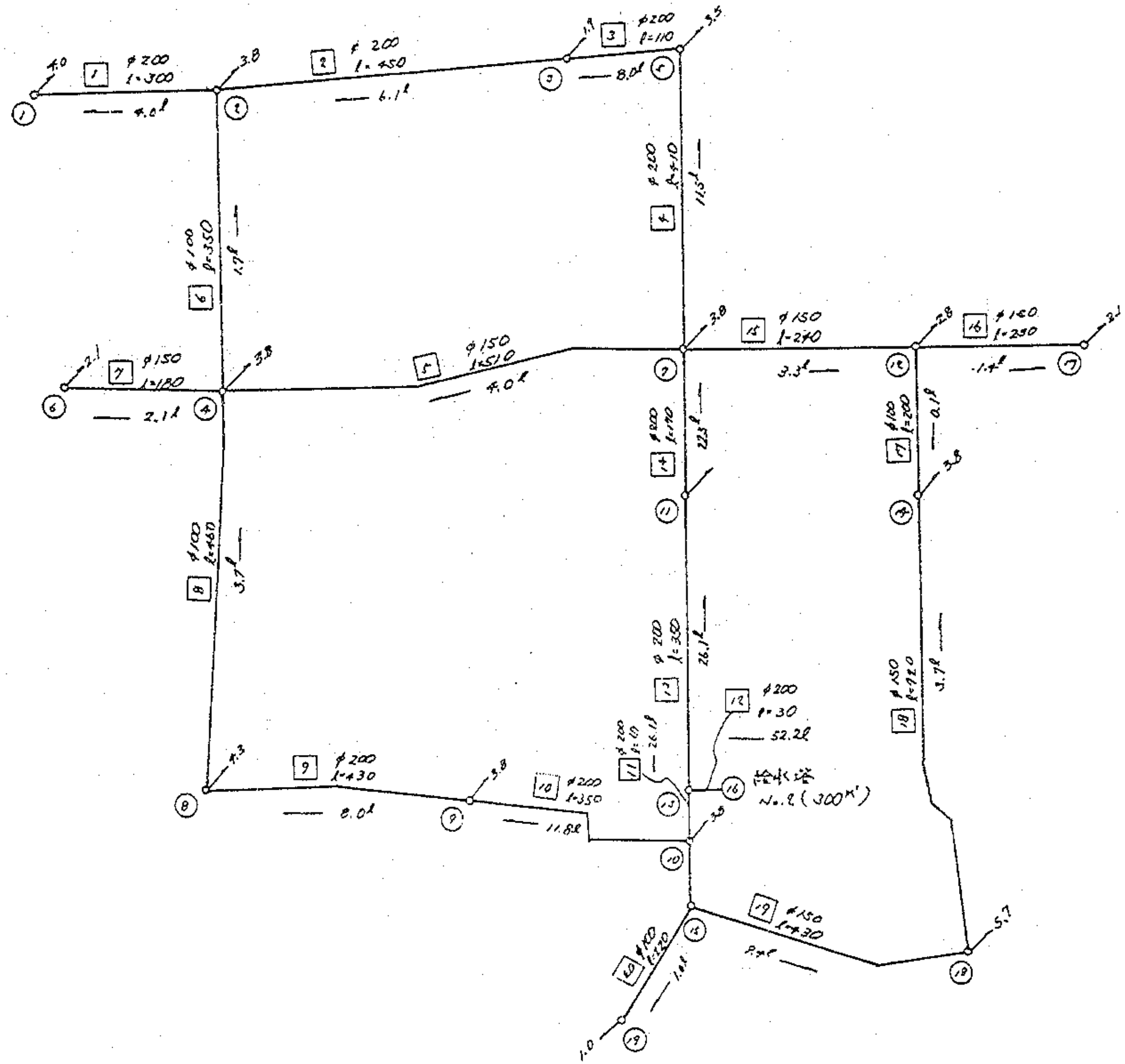
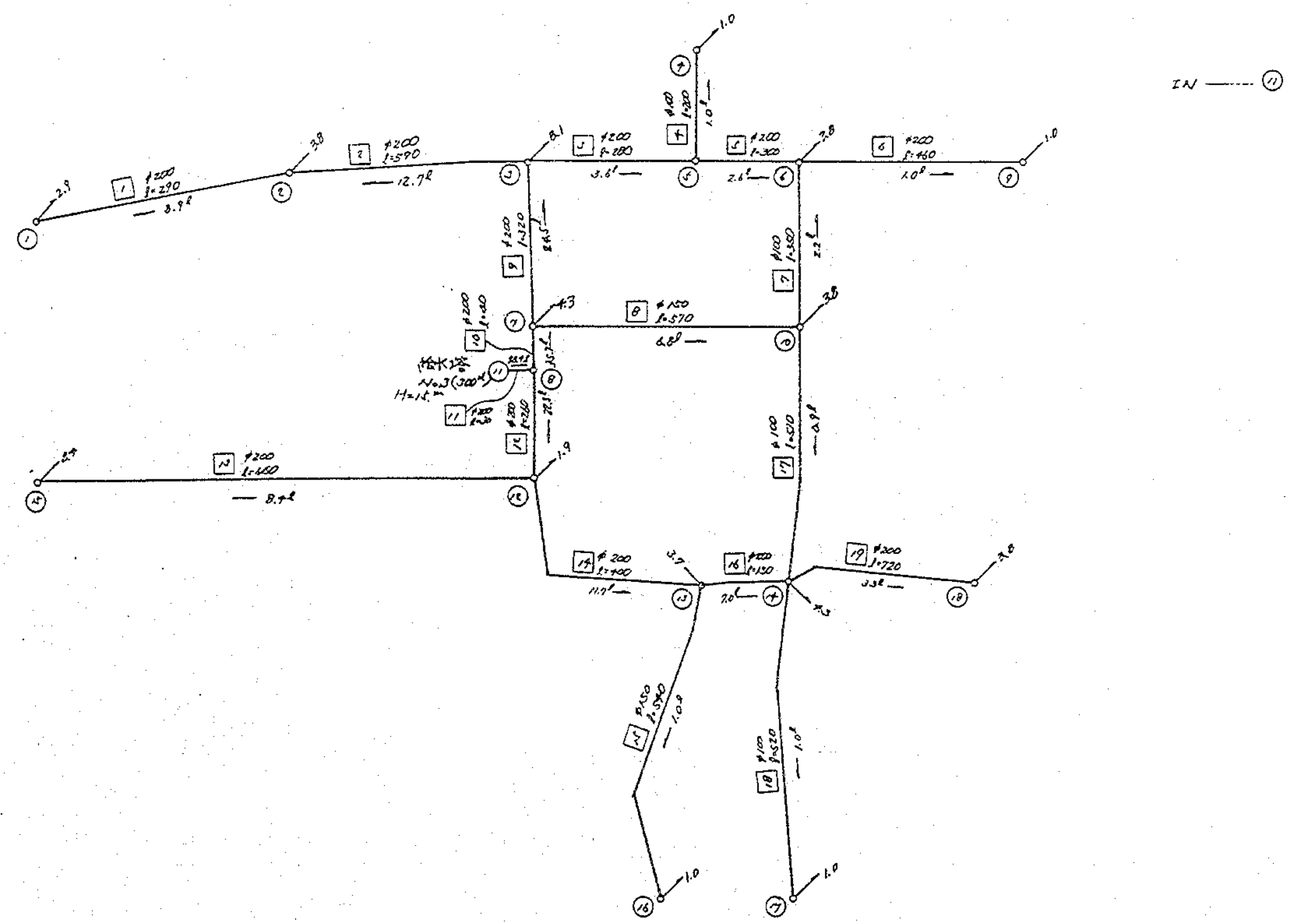


Fig. 3-10-2-8 Pipe Line Network of Overhead Tank No.3 of Jenidah Town



****JENIDAH-1

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0027	-1.424	-0.344	0.100	620.000	110	-0.2298
2	2 -- 5	-0.0011	-0.013	-0.064	0.150	220.000	110	-0.0063
3	5 -- 9	-0.0011	-0.020	-0.064	0.150	320.000	110	-0.0063
4	9 -- 10	-0.0138	-0.404	-0.440	0.200	250.000	110	-0.1619
5	6 -- 10	0.0136	0.110	0.434	0.200	70.000	110	0.1576
6	2 -- 6	-0.0107	-0.549	-0.339	0.200	550.000	110	-0.0999
7	2 -- 3	0.0016	0.265	0.202	0.100	310.000	110	0.0856
8	3 -- 4	-0.0003	-0.012	-0.040	0.100	300.000	110	-0.0043
9	4 -- 7	-0.0043	-3.011	-0.549	0.100	550.000	110	-0.5475
10	6 -- 7	-0.0280	-2.209	-0.891	0.200	370.000	110	-0.5971
11	6 -- 8	0.0000	0.000	0.000	0.200	30.000	110	0.0000
12	9 -- 12	0.0071	1.089	0.402	0.150	570.000	110	0.1911
13	9 -- 13	-0.0019	-0.391	-0.241	0.100	330.000	110	-0.1187
14	13 -- 14	-0.0053	-0.132	-0.299	0.150	120.000	110	-0.1108
15	10 -- 14	-0.0030	-0.119	-0.170	0.150	310.000	110	-0.0387
16	13 -- 17	0.0010	0.208	0.127	0.100	570.000	110	0.0365
17	14 -- 18	-0.0092	-0.892	-0.520	0.150	290.000	110	-0.3078
18	18 -- 20	-0.0112	-1.016	-0.632	0.150	230.000	110	-0.4418
19	20 -- 21	-0.0129	-0.580	-0.732	0.150	100.000	110	-0.5802
20	15 -- 21	0.0131	1.073	0.743	0.150	180.000	110	0.5964
21	11 -- 15	0.0171	0.263	0.545	0.200	110.000	110	0.2400
22	15 -- 19	0.0016	0.005	0.051	0.200	180.000	110	0.0030
23	7 -- 11	-0.0361	-1.626	-1.149	0.200	170.000	110	-0.9569
24	11 -- 16	0.0019	0.017	0.060	0.200	440.000	110	0.0041

****JENIDAH-1

PointNo.	EnergyHeight (M)	Turnout Discharge (M3/S)	Turnout Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	9.190	0.0027	2.7	9.190	0.000	1
2	10.614	0.0075	7.5	10.614	0.000	2
3	10.349	0.0019	1.9	10.349	0.000	3
4	10.362	0.0040	4.0	10.362	0.000	4
5	10.628			10.628	0.000	5
6	11.163	0.0037	3.7	11.163	0.000	6
7	13.373	0.0038	3.8	13.373	0.000	7
8	11.163			11.163	0.000	8
9	10.648	0.0075	7.5	10.648	0.000	9
10	11.053	0.0028	2.8	11.053	0.000	10
11	15.000	0.0019	1.9	15.000	0.000	11
12	9.559	0.0071	7.1	9.559	0.000	12
13	11.040	0.0024	2.4	11.040	0.000	13
14	11.173	0.0009	0.9	11.173	0.000	14
15	14.736	0.0019	1.9	14.736	0.000	15
16	14.982	0.0019	1.9	14.982	0.000	16
17	10.832	0.0010	1.0	10.832	0.000	17
18	12.066	0.0018	1.8	12.066	0.000	18
19	14.730	0.0016	1.6	14.730	0.000	19
20	13.082	0.0019	1.9	13.082	0.000	20
21	13.662			13.662	0.000	21

****JENIDAH-2

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0040	-0.048	-0.127	0.200	300.000	110	-0.0163
2	2 -- 3	-0.0061	-0.158	-0.193	0.200	450.000	110	-0.0351
3	3 -- 5	-0.0080	-0.064	-0.253	0.200	110.000	110	-0.0582
4	5 -- 7	-0.0115	-0.468	-0.365	0.200	410.000	110	-0.1143
5	4 -- 7	-0.0040	-0.334	-0.226	0.150	510.000	110	-0.0656
6	2 -- 4	-0.0017	-0.355	-0.221	0.100	350.000	110	-0.1017
7	4 -- 6	0.0021	0.036	0.119	0.150	180.000	110	0.0200
8	4 -- 8	-0.0037	-1.848	-0.465	0.100	460.000	110	-0.4019
9	8 -- 9	-0.0080	-0.249	-0.253	0.200	430.000	110	-0.0581
10	9 -- 10	-0.0118	-0.419	-0.374	0.200	350.000	110	-0.1199
11	10 -- 13	-0.0259	-0.309	-0.824	0.200	60.000	110	-0.5163
12	13 -- 16	-0.0520	-0.563	-1.654	0.200	30.000	110	-1.8771
13	11 -- 13	-0.0261	-1.829	-0.829	0.200	350.000	110	-0.5227
14	7 -- 11	-0.0223	-0.663	-0.708	0.200	170.000	110	-0.3903
15	7 -- 12	0.0033	0.112	0.188	0.150	240.000	110	0.0467
16	12 -- 17	0.0014	0.021	0.080	0.150	230.000	110	0.0095
17	12 -- 14	0.0001	0.000	0.012	0.100	200.000	110	0.0005
18	14 -- 18	-0.0037	-0.411	-0.209	0.150	720.000	110	-0.0572
19	15 -- 18	0.0094	1.382	0.532	0.150	430.000	110	0.3216
20	15 -- 19	0.0010	0.080	0.127	0.100	220.000	110	0.0365
21	10 -- 15	0.0104	0.501	0.587	0.150	130.000	110	0.3860

****JENIDAH-2

PointNo.	EnergyHeight (M)	Turnout Discharge (M3/S)	(L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	11.204	0.0040	4.0	11.204	0.000	1
2	11.253	0.0038	3.8	11.253	0.000	2
3	11.411	0.0019	1.9	11.411	0.000	3
4	11.609	0.0038	3.8	11.609	0.000	4
5	11.475	0.0035	3.5	11.475	0.000	5
6	11.573	0.0021	2.1	11.573	0.000	6
7	11.943	0.0038	3.8	11.943	0.000	7
8	13.457	0.0043	4.3	13.457	0.000	8
9	13.707	0.0038	3.8	13.707	0.000	9
10	14.127	0.0038	3.8	14.127	0.000	10
11	12.607	0.0038	3.8	12.607	0.000	11
12	11.831	0.0028	2.8	11.831	0.000	12
13	14.436			14.436	0.000	13
14	11.830	0.0038	3.8	11.830	0.000	14
15	13.625			13.625	0.000	15
16	15.000			15.000	0.000	16
17	11.809	0.0021	2.1	11.809	0.000	17
18	12.242	0.0057	5.7	12.242	0.000	18
19	13.545	0.0010	1.0	13.545	0.000	19

****JENIDAH-3

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	0.0039	0.044	0.123	0.200	290.000	110	0.0152
2	1 -- 3	-0.0127	-0.831	-0.405	0.200	600.000	110	-0.1385
3	3 -- 5	0.0034	0.033	0.108	0.200	280.000	110	0.0120
4	4 -- 5	-0.0010	-0.073	-0.128	0.100	200.000	110	-0.0369
5	5 -- 6	0.0027	0.022	0.085	0.200	300.000	110	0.0077
6	6 -- 9	0.0010	0.005	0.031	0.200	460.000	110	0.0012
7	6 -- 10	-0.0022	-0.541	-0.278	0.100	350.000	110	-0.1548
8	7 -- 10	0.0069	1.026	0.389	0.150	570.000	110	0.1801
9	3 -- 7	-0.0247	-1.511	-0.785	0.200	320.000	110	-0.4724
10	7 -- 8	-0.0362	-0.384	-1.152	0.200	40.000	110	-0.9609
11	8 -- 11	-0.0593	-0.718	-1.887	0.200	30.000	110	-2.3957
12	8 -- 12	0.0225	1.034	0.716	0.200	260.000	110	0.3980
13	12 -- 15	0.0083	0.414	0.264	0.200	660.000	110	0.0628
14	12 -- 13	0.0117	0.471	0.371	0.200	400.000	110	0.1179
15	13 -- 16	0.0010	0.028	0.058	0.150	540.000	110	0.0053
16	13 -- 14	0.0073	0.074	0.233	0.200	150.000	110	0.0498
17	10 -- 14	0.0010	0.170	0.121	0.100	510.000	110	0.0333
18	14 -- 17	0.0010	0.186	0.126	0.100	520.000	110	0.0358
19	14 -- 18	0.0034	0.084	0.107	0.200	720.000	110	0.0118

****JENIDAH-3

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	11.553	0.0089	8.9	11.553	0.000	1
2	11.509	0.0038	3.8	11.509	0.000	2
3	12.385	0.0081	8.1	12.385	0.000	3
4	12.277	0.0010	1.0	12.277	0.000	4
5	12.351			12.351	0.000	5
6	12.328	0.0038	3.8	12.328	0.000	6
7	13.896	0.0043	4.3	13.896	0.000	7
8	14.281			14.281	0.000	8
9	12.323	0.0010	1.0	12.323	0.000	9
10	12.870	0.0038	3.8	12.870	0.000	10
11	15.000			15.000	0.000	11
12	13.246	0.0019	1.9	13.246	0.000	12
13	12.774	0.0037	3.7	12.774	0.000	13
14	12.700	0.0043	4.3	12.700	0.000	14
15	12.832	0.0084	8.4	12.832	0.000	15
16	12.746	0.0010	1.0	12.746	0.000	16
17	12.514	0.0010	1.0	12.514	0.000	17
18	12.615	0.0038	3.8	11.615	1.000	18

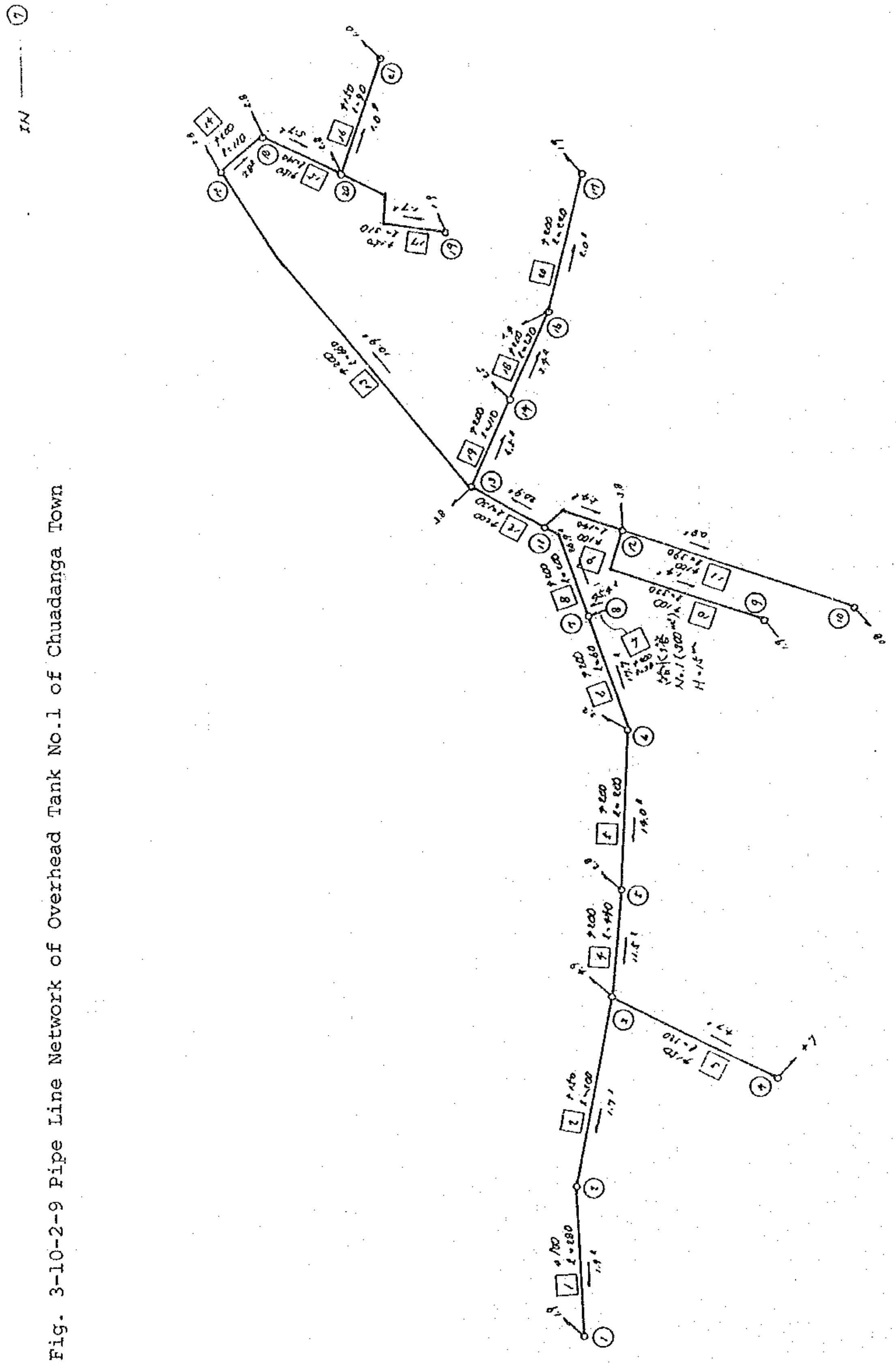


Fig. 3-10-2-9 Pipe Line Network of Overhead Tank No.1 of Chuadanga Town

Fig. 3-10-2-10 Pipe Line Network of Overhead Tank No.2 of Chuadanga Town

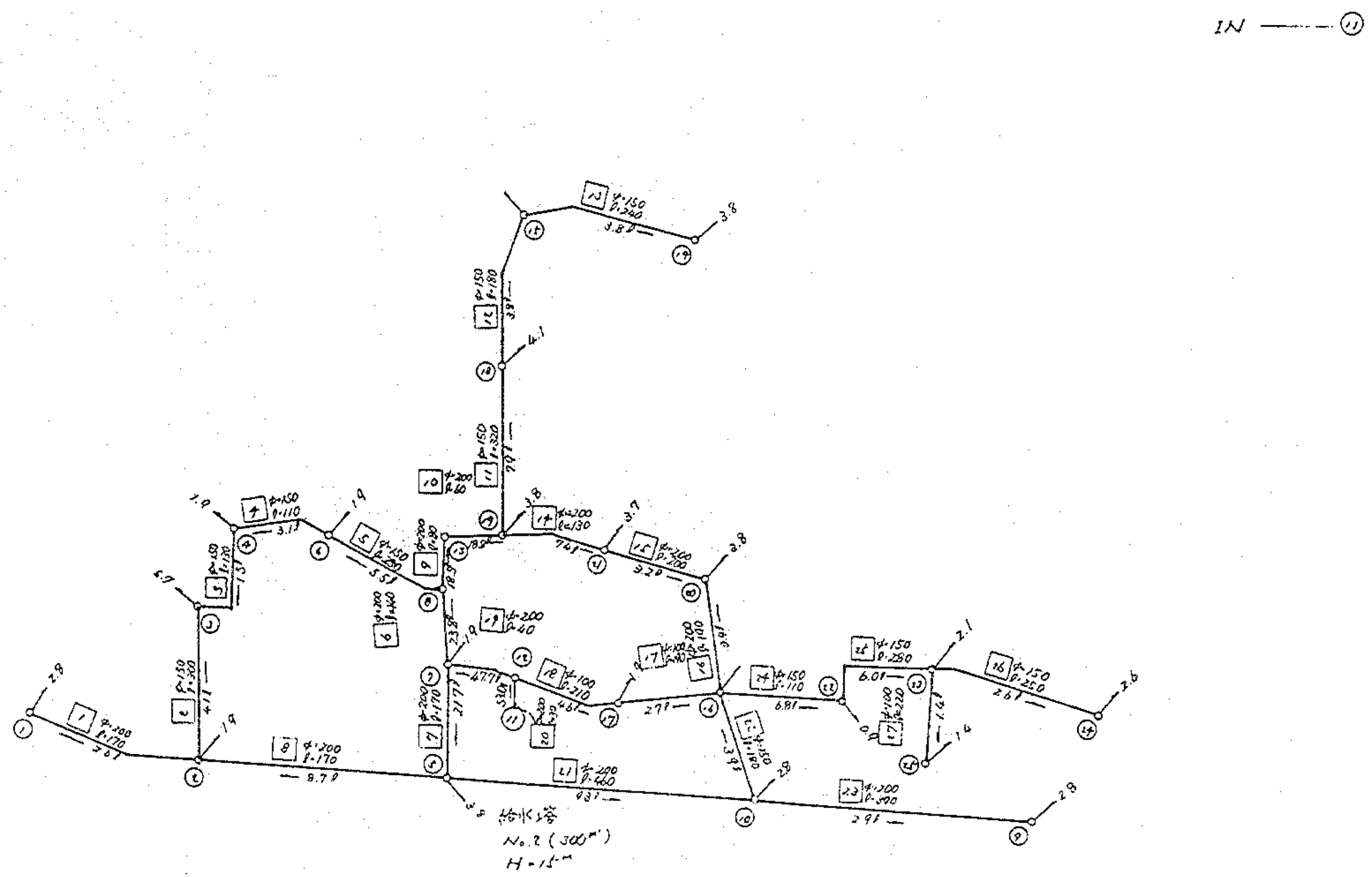
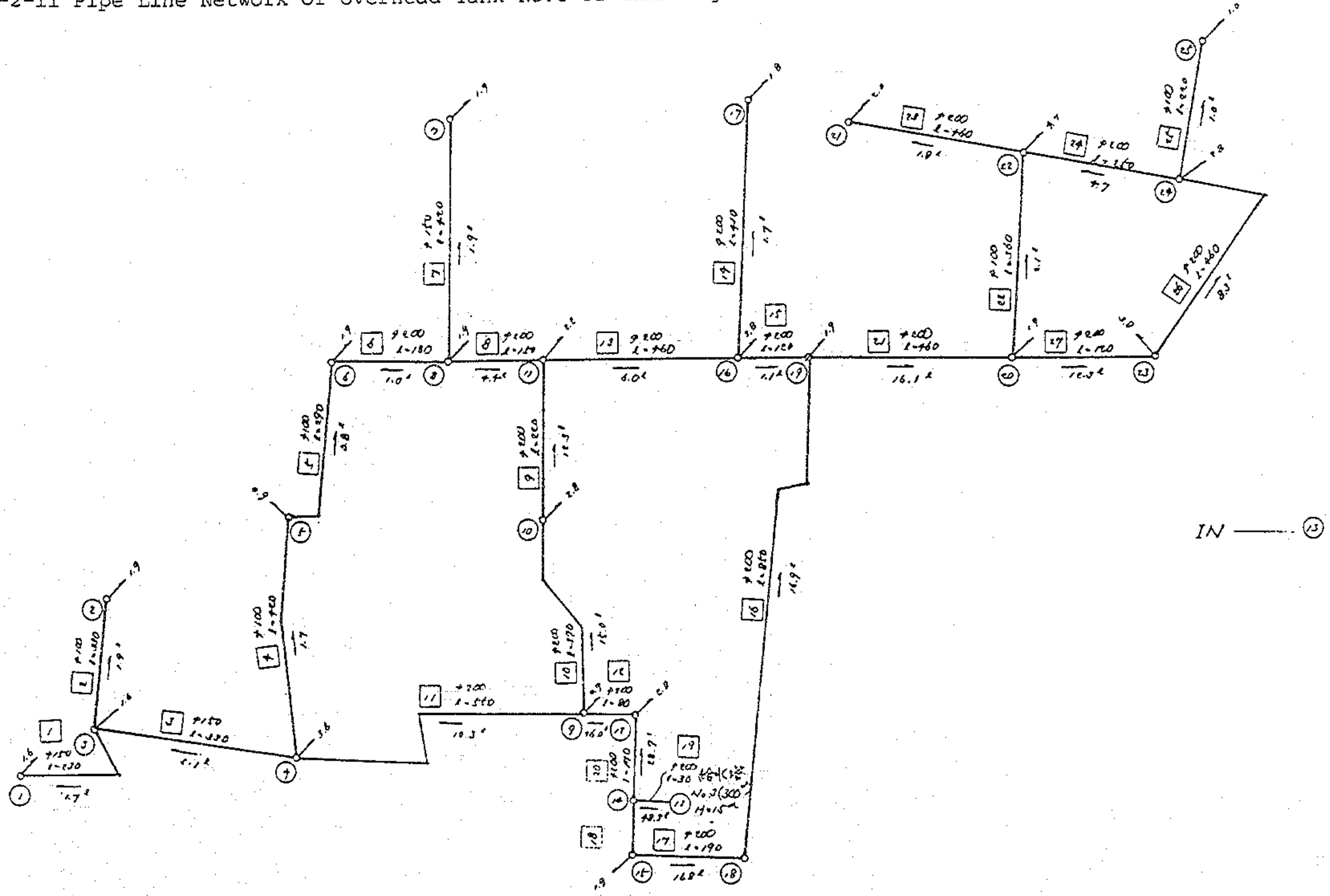


Fig. 3-10-2-11 Pipe Line Network of Overhead Tank No.3 of Chuadanga Town



****CHUADANGA-1

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0019	-0.339	-0.243	0.100	280.000	110	-0.1212
2	2 -- 3	-0.0017	-0.039	-0.095	0.150	300.000	110	-0.0133
3	3 -- 4	0.0047	0.285	0.266	0.150	320.000	110	0.0893
4	3 -- 5	-0.0115	-0.505	-0.366	0.200	440.000	110	-0.1149
5	5 -- 6	-0.0140	-0.332	-0.447	0.200	200.000	110	-0.1665
6	6 -- 8	-0.0177	-0.152	-0.563	0.200	60.000	110	-0.2548
7	7 -- 8	0.0454	0.439	1.446	0.200	30.000	110	1.4635
8	8 -- 11	0.0269	1.112	0.857	0.200	200.000	110	0.5561
9	11 -- 12	0.0054	1.169	0.690	0.100	140.000	110	0.8356
10	9 -- 12	-0.0014	-0.238	-0.184	0.100	330.000	110	-0.0724
11	10 -- 12	-0.0008	-0.094	-0.102	0.100	390.000	110	-0.0242
12	11 -- 13	0.0209	0.450	0.664	0.200	130.000	110	0.3462
13	13 -- 15	0.0109	0.681	0.345	0.200	660.000	110	0.1033
14	15 -- 18	0.0078	0.061	0.249	0.200	110.000	110	0.0562
15	18 -- 20	0.0057	0.179	0.324	0.150	140.000	110	0.1282
16	20 -- 21	0.0010	0.004	0.054	0.150	90.000	110	0.0046
17	19 -- 20	-0.0017	-0.041	-0.095	0.150	310.000	110	-0.0133
18	14 -- 16	0.0034	0.027	0.108	0.200	230.000	110	0.0121
19	13 -- 14	0.0065	0.043	0.207	0.200	110.000	110	0.0399
20	16 -- 17	0.0020	0.009	0.063	0.200	220.000	110	0.0045

****CHUADANGA-1

PointNo.	EnergyHeight (M)	Turnout Discharge (M3/S)	Turnout Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	13.190	0.0019	1.9	13.190	0.000	1
2	13.529			13.529	0.000	2
3	13.569	0.0049	4.9	13.569	0.000	3
4	13.283	0.0047	4.7	13.283	0.000	4
5	14.075	0.0028	2.8	14.075	0.000	5
6	14.408	0.0032	3.2	14.408	0.000	6
7	15.000			15.000	0.000	7
8	14.560			14.560	0.000	8
9	12.040	0.0019	1.9	12.040	0.000	9
10	12.184	0.0008	0.8	12.184	0.000	10
11	13.448			13.448	0.000	11
12	12.278	0.0038	3.8	12.278	0.000	12
13	12.998	0.0038	3.8	12.998	0.000	13
14	12.954	0.0025	2.5	12.954	0.000	14
15	12.317	0.0038	3.8	12.317	0.000	15
16	12.926	0.0019	1.9	12.926	0.000	16
17	12.917	0.0019	1.9	12.917	0.000	17
18	12.255	0.0028	2.8	12.255	0.000	18
19	12.034	0.0019	1.9	12.034	0.000	19
20	12.075	0.0028	2.8	12.075	0.000	20
21	12.071	0.0010	1.0	12.071	0.000	21

****CHUADANGA-2

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0026	-0.012	-0.082	0.200	170.000	110	-0.0072
2	2 -- 3	0.0041	0.202	0.229	0.150	300.000	110	0.0676
3	3 -- 4	-0.0015	-0.014	-0.085	0.150	130.000	110	-0.0108
4	4 -- 6	-0.0031	-0.046	-0.177	0.150	110.000	110	-0.0420
5	6 -- 8	-0.0055	-0.270	-0.309	0.150	230.000	110	-0.1178
6	7 -- 8	0.0238	0.621	0.759	0.200	140.000	110	0.4438
7	5 -- 7	-0.0217	-0.632	-0.690	0.200	170.000	110	-0.3723
8	2 -- 5	-0.0087	-0.116	-0.277	0.200	170.000	110	-0.0686
9	8 -- 13	0.0185	0.222	0.589	0.200	80.000	110	0.2778
10	13 -- 19	0.0188	0.171	0.598	0.200	60.000	110	0.2855
11	18 -- 19	-0.0079	-0.742	-0.446	0.150	320.000	110	-0.2320
12	15 -- 18	-0.0038	-0.107	-0.214	0.150	180.000	110	-0.0598
13	14 -- 15	-0.0038	-0.140	-0.212	0.150	240.000	110	-0.0587
14	19 -- 21	0.0074	0.065	0.234	0.200	130.000	110	0.0502
15	20 -- 21	-0.0032	-0.021	-0.102	0.200	200.000	110	-0.0107
16	16 -- 20	0.0004	0.000	0.011	0.200	190.000	110	0.0002
17	16 -- 17	-0.0027	-0.443	-0.347	0.100	190.000	110	-0.2336
18	12 -- 17	0.0046	1.298	0.587	0.100	210.000	110	0.6181
19	7 -- 12	-0.0477	-0.640	-1.518	0.200	40.000	110	-1.6019
20	11 -- 12	0.0530	0.585	1.689	0.200	30.000	110	1.9507
21	5 -- 10	0.0093	0.354	0.295	0.200	460.000	110	0.0771
22	10 -- 16	0.0039	0.113	0.221	0.150	180.000	110	0.0631
23	9 -- 10	-0.0029	-0.035	-0.093	0.200	390.000	110	-0.0090
24	16 -- 22	0.0068	0.194	0.385	0.150	110.000	110	0.1766
25	22 -- 23	0.0060	0.396	0.342	0.150	280.000	110	0.1416
26	23 -- 24	0.0026	0.075	0.149	0.150	250.000	110	0.0303
27	23 -- 25	0.0014	0.152	0.180	0.100	220.000	110	0.0694

****CHUADANGA-2

PointNo.	EnergyHeight (M)	Turnout Discharge (M3/S)	(L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	13.012	0.0028	2.8	13.012	0.000	1
2	13.024	0.0019	1.9	13.024	0.000	2
3	12.821	0.0057	5.7	12.821	0.000	3
4	12.835	0.0019	1.9	12.835	0.000	4
5	13.141	0.0038	3.8	13.141	0.000	5
6	12.881	0.0019	1.9	12.881	0.000	6
7	13.774	0.0019	1.9	13.774	0.000	7
8	13.152			13.152	0.000	8
9	12.751	0.0028	2.8	12.751	0.000	9
10	12.786	0.0028	2.8	12.786	0.000	10
11	15.000			15.000	0.000	11
12	14.414			14.414	0.000	12
13	12.930			12.930	0.000	13
14	11.768	0.0038	3.8	11.768	0.000	14
15	11.909			11.909	0.000	15
16	12.672			12.672	0.000	16
17	13.116	0.0019	1.9	13.116	0.000	17
18	12.016	0.0041	4.1	12.016	0.000	18
19	12.759	0.0038	3.8	12.759	0.000	19
20	12.672	0.0038	3.8	12.672	0.000	20
21	12.693	0.0037	3.7	12.693	0.000	21
22	12.478	0.0009	0.9	12.478	0.000	22
23	12.082	0.0021	2.1	12.082	0.000	23
24	12.006	0.0026	2.6	12.006	0.000	24
25	11.929	0.0014	1.4	11.929	0.000	25

****CHUADANGA-3

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 3	-0.0017	-0.030	-0.095	0.150	230.000	110	-0.0132
2	2 -- 3	-0.0019	-0.395	-0.242	0.100	330.000	110	-0.1199
3	3 -- 4	-0.0051	-0.338	-0.287	0.150	330.000	110	-0.1027
4	4 -- 5	0.0017	0.418	0.219	0.100	420.000	110	0.0996
5	5 -- 6	0.0008	0.074	0.106	0.100	290.000	110	0.0258
6	6 -- 8	-0.0010	-0.002	-0.033	0.200	180.000	110	-0.0013
7	7 -- 8	-0.0019	-0.071	-0.109	0.150	420.000	110	-0.0170
8	8 -- 11	-0.0044	-0.028	-0.139	0.200	150.000	110	-0.0191
9	10 -- 11	0.0123	0.284	0.390	0.200	220.000	110	0.1293
10	9 -- 10	0.0150	0.691	0.476	0.200	370.000	110	0.1869
11	4 -- 9	-0.0103	-0.514	-0.327	0.200	550.000	110	-0.0935
12	9 -- 12	-0.0260	-0.416	-0.828	0.200	80.000	110	-0.5208
13	11 -- 16	0.0060	0.156	0.189	0.200	460.000	110	0.0340
14	16 -- 17	0.0017	0.012	0.053	0.200	410.000	110	0.0032
15	16 -- 19	0.0011	0.001	0.035	0.200	120.000	110	0.0015
16	18 -- 19	0.0169	1.998	0.539	0.200	850.000	110	0.2351
17	15 -- 18	0.0168	0.438	0.533	0.200	190.000	110	0.2309
18	14 -- 15	0.0190	0.174	0.604	0.200	60.000	110	0.2908
19	13 -- 14	0.0483	0.492	1.539	0.200	30.000	110	1.6425
20	12 -- 14	-0.0287	-1.060	-0.913	0.200	170.000	110	-0.6241
21	19 -- 20	0.0161	0.991	0.514	0.200	460.000	110	0.2155
22	20 -- 22	0.0021	0.503	0.263	0.100	360.000	110	0.1399
23	21 -- 22	-0.0018	-0.017	-0.058	0.200	460.000	110	-0.0038
24	22 -- 24	-0.0047	-0.055	-0.151	0.200	250.000	110	-0.0222
25	24 -- 25	0.0010	0.081	0.128	0.100	220.000	110	0.0370
26	23 -- 24	0.0083	0.290	0.265	0.200	460.000	110	0.0632
27	20 -- 23	0.0123	0.157	0.393	0.200	120.000	110	0.1311

****CHUADANGA-3

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M).	No.
1	12.146	0.0016	1.6	12.146	0.000	1
2	11.780	0.0019	1.9	11.780	0.000	2
3	12.176	0.0016	1.6	12.176	0.000	3
4	12.515	0.0036	3.6	12.515	0.000	4
5	12.097	0.0009	0.9	12.097	0.000	5
6	12.022	0.0019	1.9	12.022	0.000	6
7	11.953	0.0019	1.9	11.953	0.000	7
8	12.024	0.0019	1.9	12.024	0.000	8
9	13.029	0.0009	0.9	13.029	0.000	9
10	12.337	0.0028	2.8	12.337	0.000	10
11	12.053	0.0022	2.2	12.053	0.000	11
12	13.446	0.0028	2.8	13.446	0.000	12
13	15.000			15.000	0.000	13
14	14.507			14.507	0.000	14
15	14.332	0.0019	1.9	14.332	0.000	15
16	11.897	0.0038	3.8	11.897	0.000	16
17	11.884	0.0018	1.8	11.884	0.000	17
18	13.894			13.894	0.000	18
19	11.895	0.0019	1.9	11.895	0.000	19
20	10.904	0.0019	1.9	10.904	0.000	20
21	10.383	0.0020	2.0	10.383	0.000	21
22	10.400	0.0047	4.7	10.400	0.000	22
23	10.747	0.0038	3.8	10.747	0.000	23
24	10.456	0.0028	2.8	10.456	0.000	24
25	10.374	0.0010	1.0	10.374	0.000	25

Fig. 3-10-2-12 Pipe Line Network of Overhead Tank No.1 of Gaibandha Town

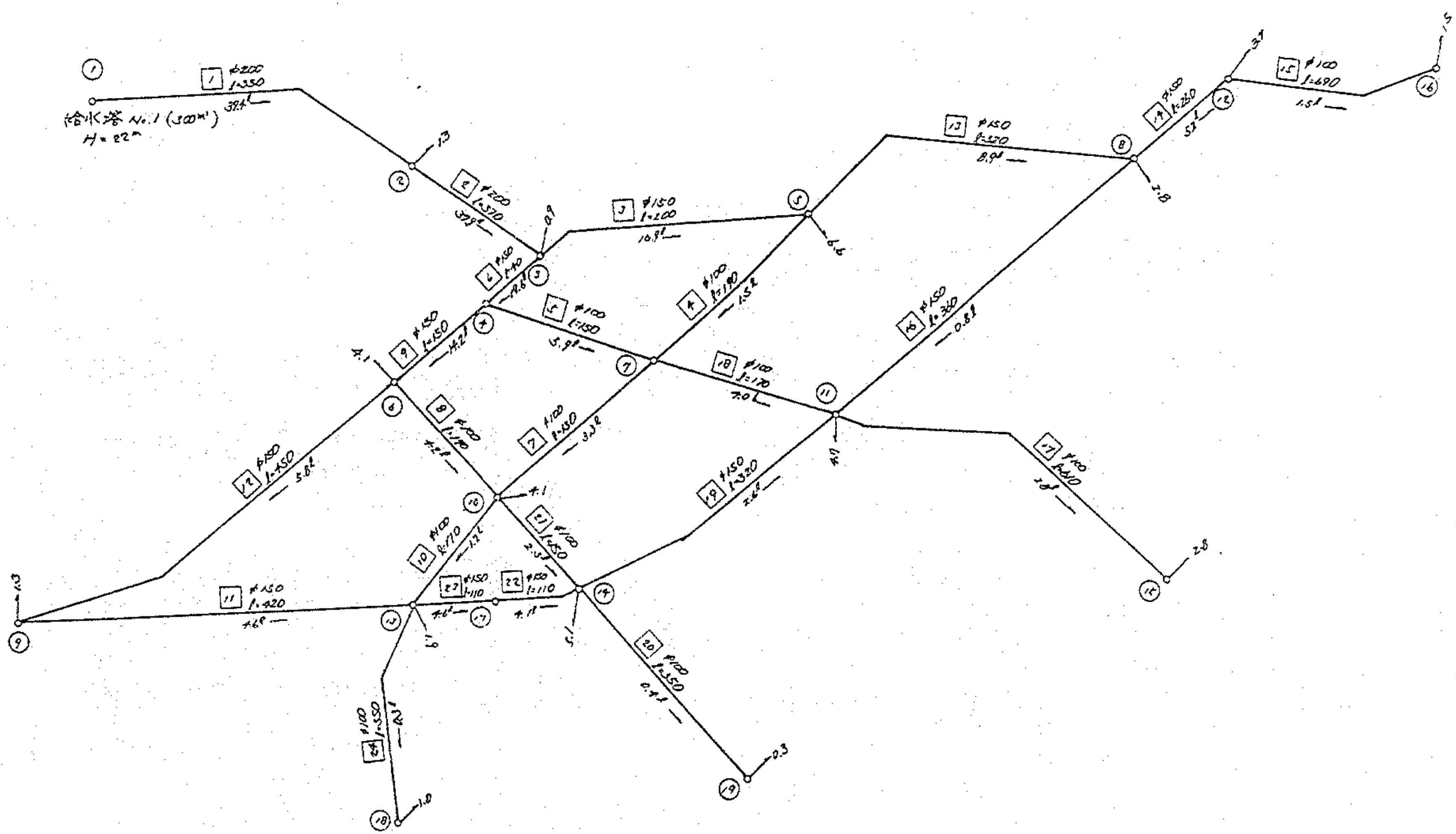
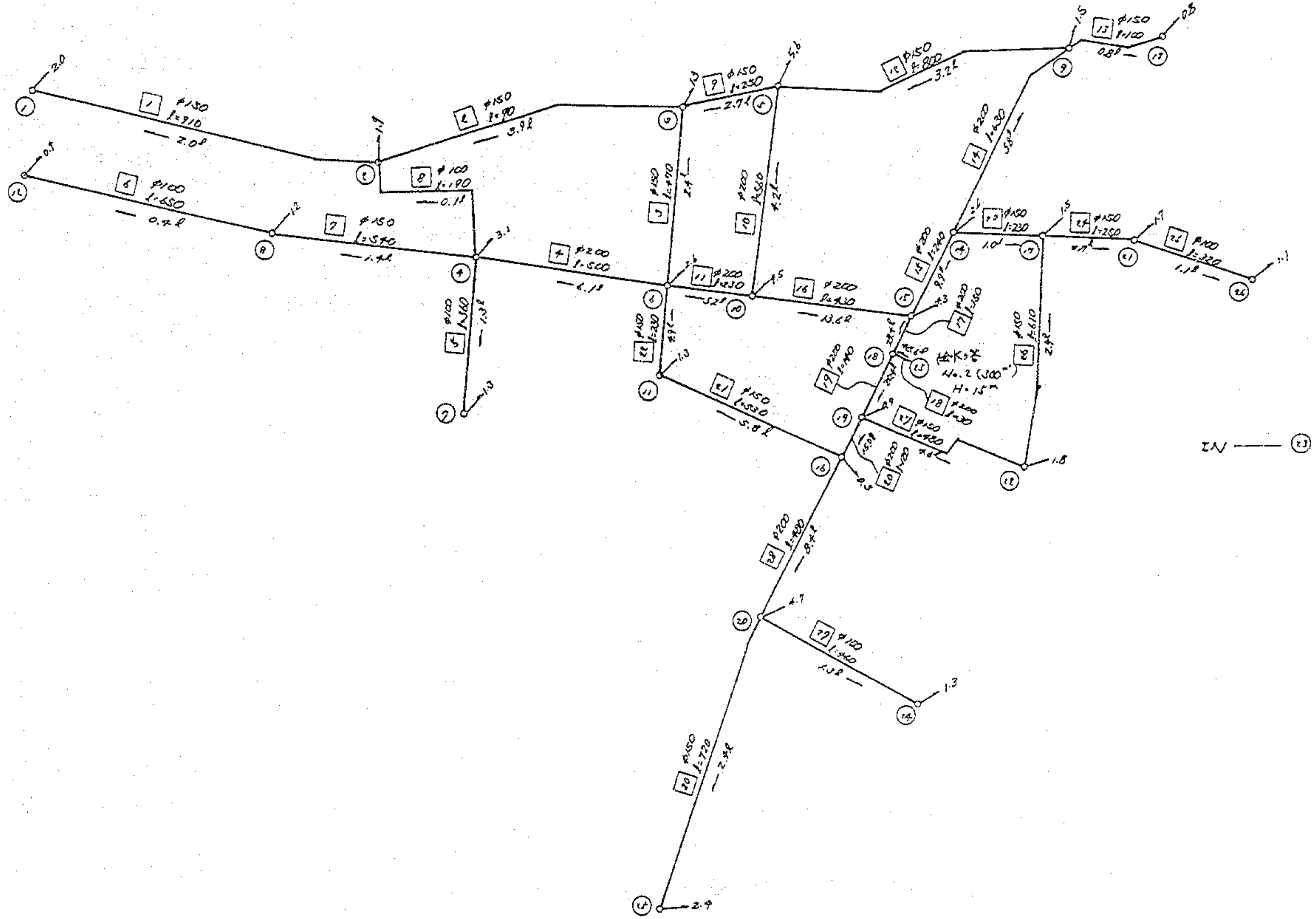


Fig. 3-10-2-13 Pipe Line Network of Overhead Tank No.2 of Gaibandha Town



****KURIGRAM-1

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	0.0404	4.128	1.287	0.200	350.000	110	1.1796
2	2 -- 3	0.0391	4.108	1.246	0.200	370.000	110	1.1104
3	3 -- 5	0.0173	1.992	0.980	0.150	200.000	110	0.9960
4	5 -- 7	0.0015	0.154	0.196	0.100	190.000	110	0.0813
5	4 -- 7	0.0061	1.581	0.783	0.100	150.000	110	1.0541
6	3 -- 4	0.0209	0.565	1.184	0.150	40.000	110	1.4130
7	7 -- 10	0.0036	0.500	0.454	0.100	130.000	110	0.3853
8	6 -- 10	0.0044	0.969	0.562	0.100	170.000	110	0.5702
9	4 -- 6	0.0148	1.112	0.836	0.150	150.000	110	0.7418
10	10 -- 13	0.0015	0.124	0.185	0.100	170.000	110	0.0731
11	9 -- 13	0.0050	0.412	0.281	0.150	420.000	110	0.0983
12	6 -- 9	0.0063	0.680	0.354	0.150	450.000	110	0.1513
13	5 -- 8	0.0092	0.983	0.519	0.150	320.000	110	0.3072
14	8 -- 12	0.0052	0.279	0.294	0.150	260.000	110	0.1073
15	12 -- 16	0.0015	0.533	0.191	0.100	690.000	110	0.0774
16	8 -- 11	0.0012	0.024	0.066	0.150	360.000	110	0.0068
17	11 -- 15	0.0028	1.499	0.357	0.100	610.000	110	0.2458
18	7 -- 11	0.0041	0.853	0.524	0.100	170.000	110	0.5020
19	11 -- 14	-0.0022	-0.070	-0.125	0.150	320.000	110	-0.0219
20	14 -- 19	-0.0006	-0.053	-0.079	0.100	350.000	110	-0.0152
21	10 -- 14	0.0024	0.282	0.309	0.100	150.000	110	0.1883
22	14 -- 17	-0.0042	-0.079	-0.237	0.150	110.000	110	-0.0719
23	13 -- 17	0.0042	0.079	0.237	0.150	110.000	110	0.0719
24	13 -- 18	0.0008	0.120	0.097	0.100	550.000	110	0.0220

****KURIGRAM-1

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	20.000			20.000 → 22.000	0.000	1
2	15.871	0.0013	1.3	15.871	0.000	2
3	11.762	0.0009	0.9	11.762	0.000	3
4	11.197			11.197	0.000	4
5	9.770	0.0066	6.6	9.770	0.000	5
6	10.084	0.0041	4.1	10.084	0.000	6
7	9.616			9.616	0.000	7
8	8.787	0.0028	2.8	8.787	0.000	8
9	9.404	0.0013	1.3	9.404	0.000	9
10	9.115	0.0041	4.1	9.115	0.000	10
11	8.763	0.0047	4.7	8.763	0.000	11
12	8.508	0.0037	3.7	8.508	0.000	12
13	8.991	0.0019	1.9	8.991	0.000	13
14	8.833	0.0051	5.1	8.833	0.000	14
15	7.263	0.0028	2.8	7.263	0.000	15
16	7.974	0.0015	1.5	7.974	0.000	16
17	8.912			8.912	0.000	17
18	8.870	0.0010	1.0	8.870	0.000	18
19	8.886	0.0003	0.3	8.886	0.000	19

Therefore, the height of overhead tank is 22.0 m.

****KURIGRAM-2

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0023	-0.223	-0.133	0.150	910.000	110	-0.0245
2	2 -- 3	-0.0041	-0.060	-0.229	0.150	90.000	110	-0.0677
3	3 -- 6	-0.0022	-0.104	-0.126	0.150	470.000	110	-0.0222
4	4 -- 6	-0.0059	-0.168	-0.189	0.200	500.000	110	-0.0337
5	4 -- 7	0.0013	0.212	0.165	0.100	360.000	110	0.0591
6	8 -- 12	0.0004	0.045	0.052	0.100	650.000	110	0.0071
7	4 -- 8	0.0014	0.051	0.080	0.150	540.000	110	0.0095
8	2 -- 4	0.0002	0.003	0.025	0.100	190.000	110	0.0018
9	3 -- 5	-0.0024	-0.063	-0.135	0.150	250.000	110	-0.0253
10	5 -- 10	-0.0043	-0.102	-0.136	0.200	560.000	110	-0.0184
11	6 -- 10	-0.0052	-0.061	-0.167	0.200	230.000	110	-0.0269
12	5 -- 9	-0.0034	-0.396	-0.194	0.150	800.000	110	-0.0495
13	9 -- 13	0.0008	0.003	0.043	0.150	100.000	110	0.0031
14	9 -- 14	-0.0058	-0.203	-0.184	0.200	630.000	110	-0.0323
15	14 -- 15	-0.0098	-0.203	-0.311	0.200	240.000	110	-0.0849
16	10 -- 15	-0.0139	-0.700	-0.442	0.200	430.000	110	-0.1630
17	15 -- 18	-0.0277	-0.877	-0.881	0.200	150.000	110	-0.5852
18	18 -- 23	-0.0493	-0.510	-1.569	0.200	30.000	110	-1.7023
19	18 -- 19	0.0207	0.476	0.658	0.200	140.000	110	0.3407
20	16 -- 19	-0.0152	-0.231	-0.484	0.200	120.000	110	-0.1928
21	11 -- 16	-0.0059	-0.712	-0.332	0.150	530.000	110	-0.1344
22	6 -- 11	-0.0049	-0.220	-0.277	0.150	230.000	110	-0.0957
23	14 -- 17	0.0013	0.016	0.072	0.150	210.000	110	0.0079
24	17 -- 21	0.0028	0.084	0.157	0.150	250.000	110	0.0337
25	21 -- 26	0.0011	0.135	0.138	0.100	320.000	110	0.0424
26	17 -- 22	-0.0028	-0.214	-0.161	0.150	610.000	110	-0.0352
27	19 -- 22	0.0046	0.406	0.259	0.150	480.000	110	0.0846
28	16 -- 20	0.0085	0.316	0.271	0.200	480.000	110	0.0659
29	20 -- 24	0.0013	0.267	0.164	0.100	460.000	110	0.0582
30	20 -- 25	0.0025	0.193	0.139	0.150	720.000	110	0.0269

****KURIGRAM-2

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	12.460	0.0020	2.0	12.460	0.000	1
2	12.683	0.0019	1.9	12.683	0.000	2
3	12.744	0.0013	1.3	12.744	0.000	3
4	12.680	0.0031	3.1	12.680	0.000	4
5	12.807	0.0056	5.6	12.807	0.000	5
6	12.848	0.0026	2.6	12.848	0.000	6
7	12.467	0.0013	1.3	12.467	0.000	7
8	12.628	0.0012	1.2	12.628	0.000	8
9	13.204	0.0015	1.5	13.204	0.000	9
10	12.910	0.0045	4.5	12.910	0.000	10
11	13.068	0.0013	1.3	13.068	0.000	11
12	12.582	0.0004	0.4	12.582	0.000	12
13	13.201	0.0008	0.8	13.201	0.000	13
14	13.407	0.0026	2.6	13.407	0.000	14
15	13.611	0.0043	4.3	13.611	0.000	15
16	13.781	0.0009	0.9	13.781	0.000	16
17	13.391	0.0015	1.5	13.391	0.000	17
18	14.489			14.489	0.000	18
19	14.012	0.0009	0.9	14.012	0.000	19
20	13.464	0.0047	4.7	13.464	0.000	20
21	13.306	0.0017	1.7	13.306	0.000	21
22	13.606	0.0018	1.8	13.606	0.000	22
23	15.000			15.000	0.000	23
24	13.196	0.0013	1.3	13.196	0.000	24
25	13.271	0.0024	2.4	13.271	0.000	25
26	13.171	0.0011	1.1	13.171	0.000	26

Fig. 3-10-2-14 Pipe Line Network of Overhead Tank No.1 of Kurigram Town

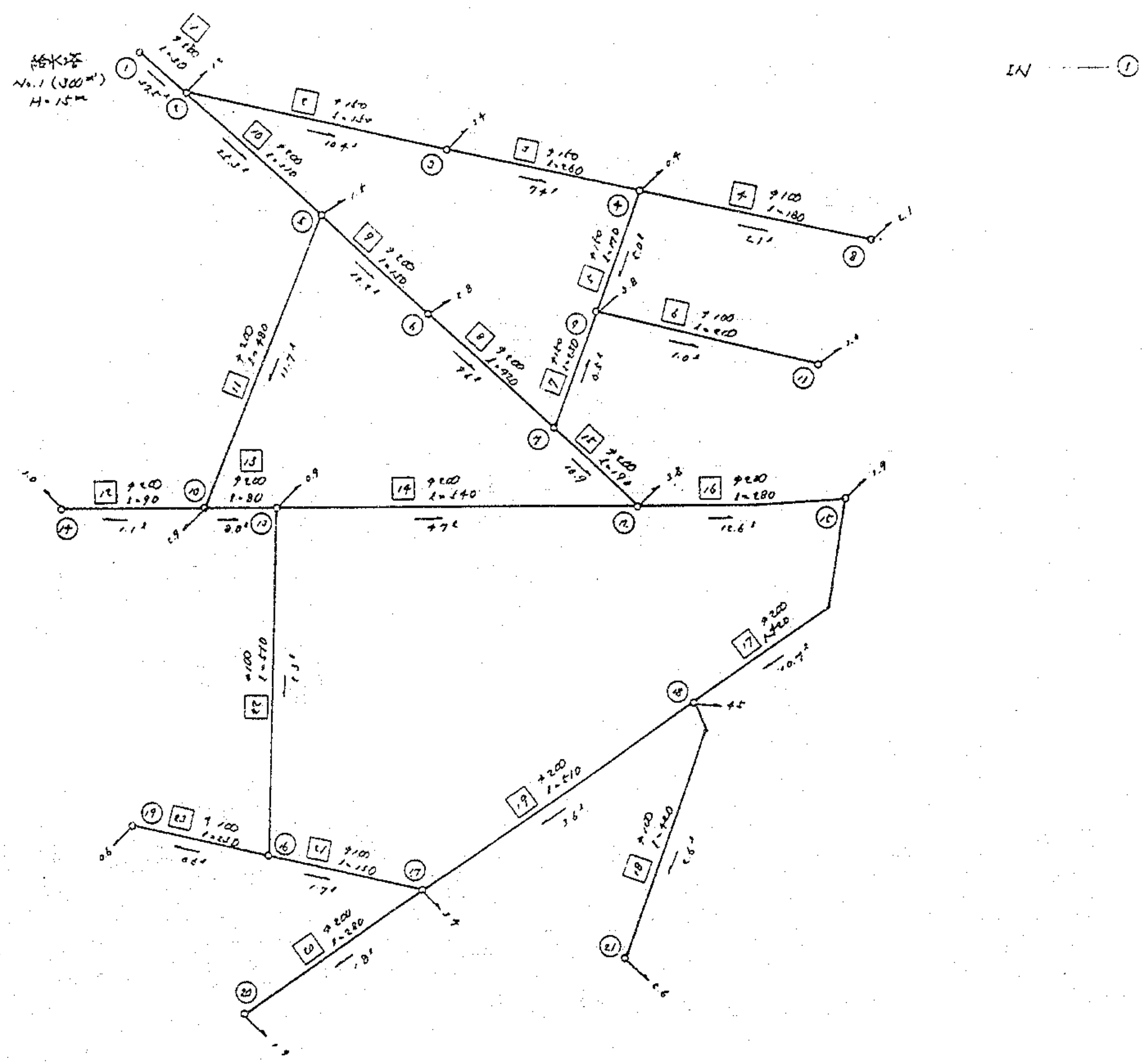
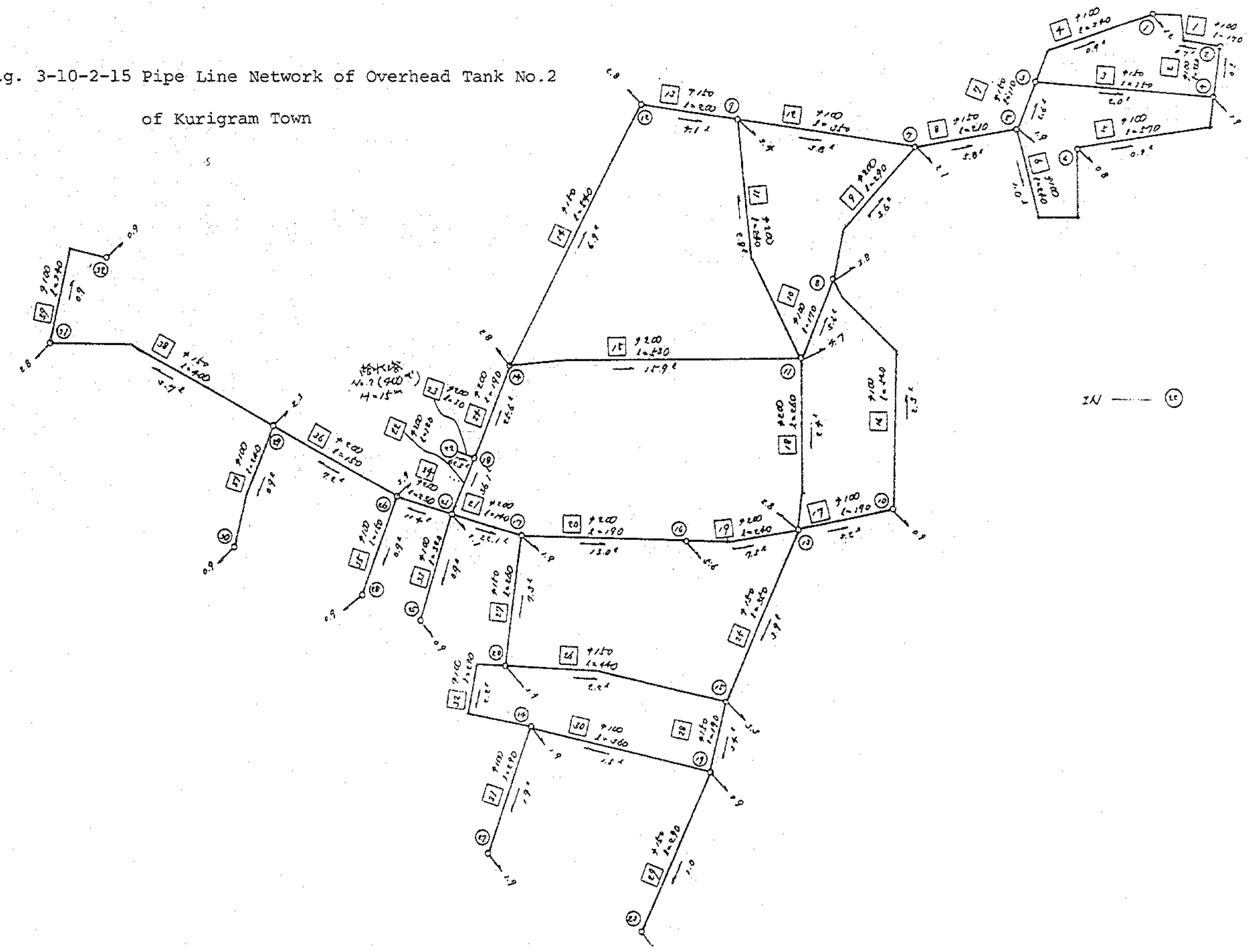


Fig. 3-10-2-15 Pipe Line Network of Overhead Tank No.2

of Kurigram Town



****GAIBANDA-1

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	0.0375	0.307	1.193	0.200	30.000	110	1.0245
2	2 -- 3	0.0104	1.363	0.590	0.150	350.000	110	0.3897
3	3 -- 4	0.0074	0.534	0.418	0.150	260.000	110	0.2057
4	4 -- 8	0.0021	0.257	0.266	0.100	180.000	110	0.1431
5	4 -- 9	0.0050	0.172	0.285	0.150	170.000	110	0.1014
6	9 -- 11	0.0010	0.073	0.128	0.100	200.000	110	0.0369
7	7 -- 9	-0.0005	-0.003	-0.029	0.150	230.000	110	-0.0014
8	6 -- 7	0.0096	0.342	0.304	0.200	420.000	110	0.0817
9	5 -- 6	0.0122	0.193	0.390	0.200	150.000	110	0.1291
10	2 -- 5	0.0253	1.537	0.806	0.200	310.000	110	0.4960
11	5 -- 10	0.0117	0.569	0.372	0.200	480.000	110	0.1186
12	10 -- 14	0.0011	0.001	0.035	0.200	90.000	110	0.0015
13	10 -- 13	0.0080	0.047	0.255	0.200	80.000	110	0.0588
14	12 -- 13	-0.0047	-0.118	-0.149	0.200	540.000	110	-0.0219
15	7 -- 12	0.0109	0.197	0.347	0.200	190.000	110	0.1041
16	12 -- 15	0.0126	0.378	0.400	0.200	280.000	110	0.1353
17	15 -- 18	0.0107	0.422	0.340	0.200	420.000	110	0.1005
18	18 -- 21	0.0026	0.896	0.330	0.100	420.000	110	0.2135
19	17 -- 18	-0.0036	-0.069	-0.116	0.200	510.000	110	-0.0136
20	17 -- 20	0.0018	0.010	0.058	0.200	280.000	110	0.0038
21	16 -- 17	0.0017	0.127	0.217	0.100	130.000	110	0.0983
22	13 -- 16	0.0023	0.860	0.291	0.100	510.000	110	0.1687
23	16 -- 19	0.0006	0.033	0.078	0.100	230.000	110	0.0147

****GAIBANDA-1

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	15.000			15.000	0.000	1
2	14.692	0.0012	1.2	14.692	0.000	2
3	13.328	0.0034	3.4	13.328	0.000	3
4	12.794	0.0004	0.4	12.794	0.000	4
5	13.155	0.0015	1.5	13.155	0.000	5
6	12.961	0.0028	2.8	12.961	0.000	6
7	12.618			12.618	0.000	7
8	12.536	0.0021	2.1	12.536	0.000	8
9	12.621	0.0038	3.8	12.621	0.000	9
10	12.585	0.0029	2.9	12.585	0.000	10
11	12.547	0.0010	1.0	12.547	0.000	11
12	12.420	0.0038	3.8	12.420	0.000	12
13	12.538	0.0009	0.9	12.538	0.000	13
14	12.584	0.0010	1.0	12.584	0.000	14
15	12.041	0.0019	1.9	12.041	0.000	15
16	11.677			11.677	0.000	16
17	11.550	0.0034	3.4	11.550	0.000	17
18	11.619	0.0045	4.5	11.619	0.000	18
19	11.644	0.0006	0.6	11.644	0.000	19
20	11.539	0.0019	1.9	11.539	0.000	20
21	10.722	0.0026	2.6	10.722	0.000	21

****GAIBANDA-1

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0007	-0.031	-0.089	0.100	170.000	110	-0.0187
2	2 -- 4	-0.0002	-0.005	-0.031	0.100	220.000	110	-0.0026
3	3 -- 4	0.0020	0.064	0.114	0.150	350.000	110	0.0185
4	1 -- 3	-0.0009	-0.102	-0.115	0.100	340.000	110	-0.0301
5	4 -- 6	-0.0002	-0.008	-0.023	0.100	570.000	110	-0.0015
6	5 -- 6	0.0010	0.088	0.128	0.100	240.000	110	0.0369
7	3 -- 5	-0.0026	-0.032	-0.146	0.150	110.000	110	-0.0294
8	5 -- 7	-0.0058	-0.277	-0.329	0.150	210.000	110	-0.1321
9	7 -- 8	-0.0036	-0.039	-0.115	0.200	290.000	110	-0.0136
10	8 -- 11	-0.0056	-1.488	-0.708	0.100	170.000	110	-0.8758
11	9 -- 11	-0.0028	-0.019	-0.088	0.200	240.000	110	-0.0082
12	7 -- 9	-0.0038	-1.508	-0.483	0.100	350.000	110	-0.4310
13	9 -- 12	-0.0041	-0.138	-0.233	0.150	200.000	110	-0.0694
14	12 -- 14	-0.0069	-0.987	-0.392	0.150	540.000	110	-0.1829
15	11 -- 14	-0.0159	-1.106	-0.505	0.200	530.000	110	-0.2088
16	8 -- 10	-0.0023	-0.881	-0.292	0.100	520.000	110	-0.1696
17	10 -- 13	-0.0032	-0.591	-0.405	0.100	190.000	110	-0.3111
18	11 -- 13	0.0024	0.015	0.075	0.200	260.000	110	0.0061
19	13 -- 16	-0.0073	-0.120	-0.234	0.200	240.000	110	-0.0501
20	16 -- 17	-0.0130	-0.275	-0.415	0.200	190.000	110	-0.1450
21	17 -- 21	-0.0221	-0.540	-0.704	0.200	140.000	110	-0.3862
22	18 -- 21	0.0361	1.149	1.150	0.200	120.000	110	0.9581
23	18 -- 22	-0.0625	-0.793	-1.990	0.200	30.000	110	-2.6452
24	14 -- 18	-0.0256	-0.963	-0.816	0.200	190.000	110	-0.5070
25	13 -- 15	0.0039	0.217	0.219	0.150	350.000	110	0.0623
26	15 -- 20	-0.0022	-0.093	-0.123	0.150	440.000	110	-0.0212
27	17 -- 20	0.0073	0.520	0.412	0.150	260.000	110	0.2001
28	15 -- 19	0.0034	0.090	0.190	0.150	190.000	110	0.0478
29	19 -- 23	0.0010	0.014	0.057	0.150	290.000	110	0.0051
30	19 -- 24	0.0015	0.262	0.185	0.100	360.000	110	0.0729
31	24 -- 27	0.0019	0.344	0.241	0.100	290.000	110	0.1188
32	20 -- 24	0.0022	0.446	0.282	0.100	280.000	110	0.1595
33	21 -- 25	0.0009	0.096	0.115	0.100	320.000	110	0.0301
34	21 -- 26	0.0114	0.262	0.364	0.200	230.000	110	0.1139
35	26 -- 28	0.0009	0.049	0.121	0.100	150.000	110	0.0332
36	26 -- 29	0.0072	0.071	0.228	0.200	150.000	110	0.0480
37	29 -- 30	0.0009	0.073	0.116	0.100	240.000	110	0.0307
38	29 -- 31	0.0037	0.226	0.208	0.150	400.000	110	0.0567
39	31 -- 32	0.0009	0.102	0.115	0.100	340.000	110	0.0300

****GAIBANDA-1

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	10.195	0.0012	1.2	10.195	0.000	1
2	10.227			10.227	0.000	2
3	10.298			10.298	0.000	3
4	10.233	0.0019	1.9	10.233	0.000	4
5	10.330	0.0019	1.9	10.330	0.000	5
6	10.242	0.0008	0.8	10.242	0.000	6
7	10.608	0.0021	2.1	10.608	0.000	7
8	10.647	0.0038	3.8	10.647	0.000	8
9	12.116	0.0034	3.4	12.116	0.000	9
10	11.529	0.0009	0.9	11.529	0.000	10
11	12.136	0.0047	4.7	12.136	0.000	11
12	12.255	0.0028	2.8	12.255	0.000	12
13	12.120	0.0028	2.8	12.120	0.000	13
14	13.243	0.0028	2.8	13.243	0.000	14
15	11.902	0.0033	3.3	11.902	0.000	15
16	12.240	0.0056	5.6	12.240	0.000	16
17	12.516	0.0019	1.9	12.516	0.000	17
18	14.206			14.206	0.000	18
19	11.811	0.0009	0.9	11.811	0.000	19
20	11.995	0.0034	3.4	11.995	0.000	20
21	13.056	0.0021	2.1	13.056	0.000	21
22	15.000			15.000	0.000	22
23	11.796	0.0011	1.1	11.796	0.000	23
24	11.549	0.0019	1.9	11.549	0.000	24
25	12.960	0.0009	0.9	12.960	0.000	25
26	12.794	0.0039	3.9	12.794	0.000	26
27	11.204	0.0019	1.9	11.204	0.000	27
28	12.744	0.0009	0.9	12.744	0.000	28
29	12.722	0.0023	2.3	12.722	0.000	29
30	12.649	0.0009	0.9	12.649	0.000	30
31	12.496	0.0028	2.8	12.496	0.000	31
32	12.394	0.0009	0.9	12.394	0.000	32

Fig. 3-10-2-16 Pipe Line Network of Overhead Tank No.1

of Feni Town

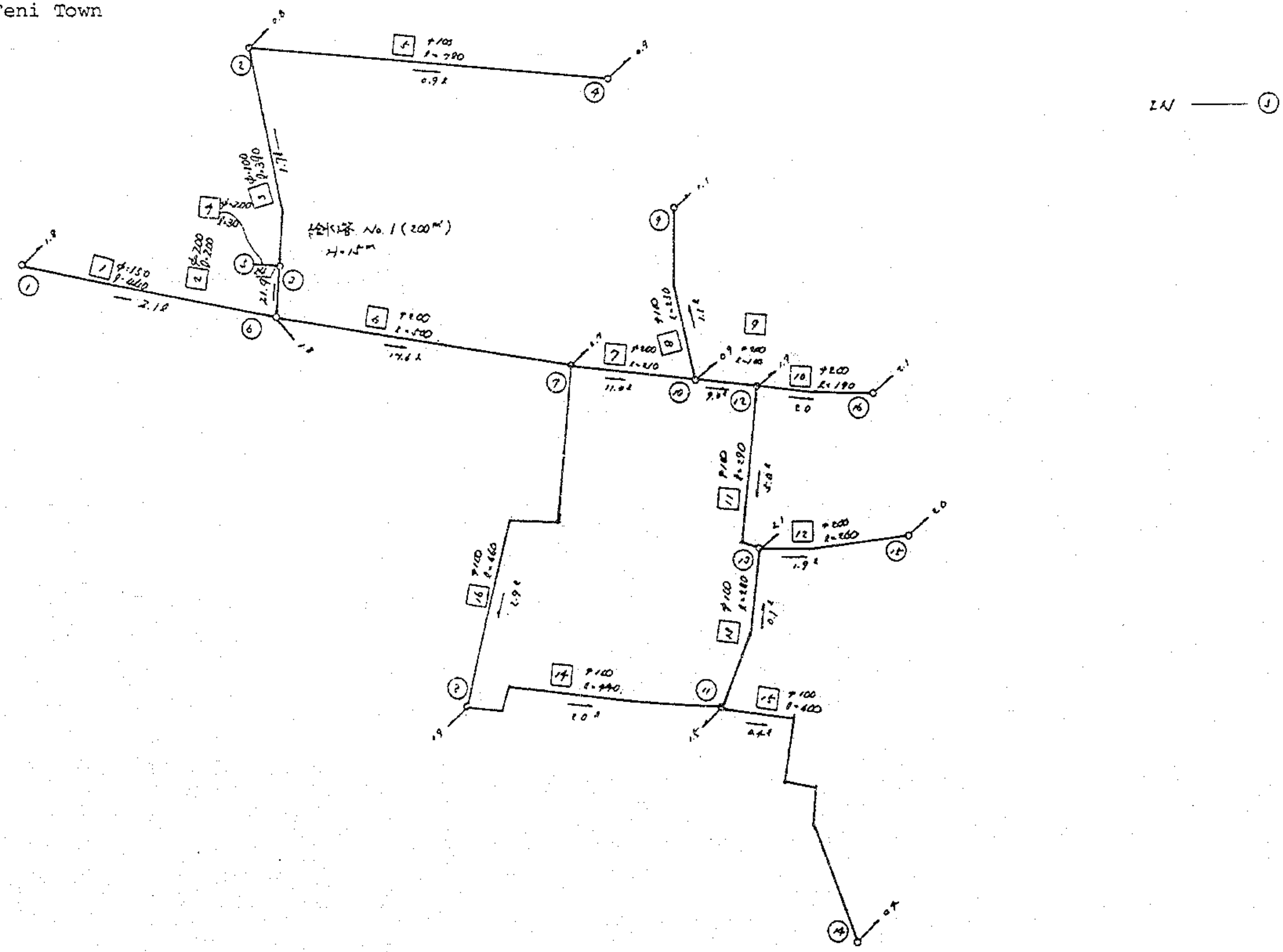


Fig. 3-10-2-17 Pipe Line Network of Overhead Tank No.2 of Feni Town

ΣN — 24

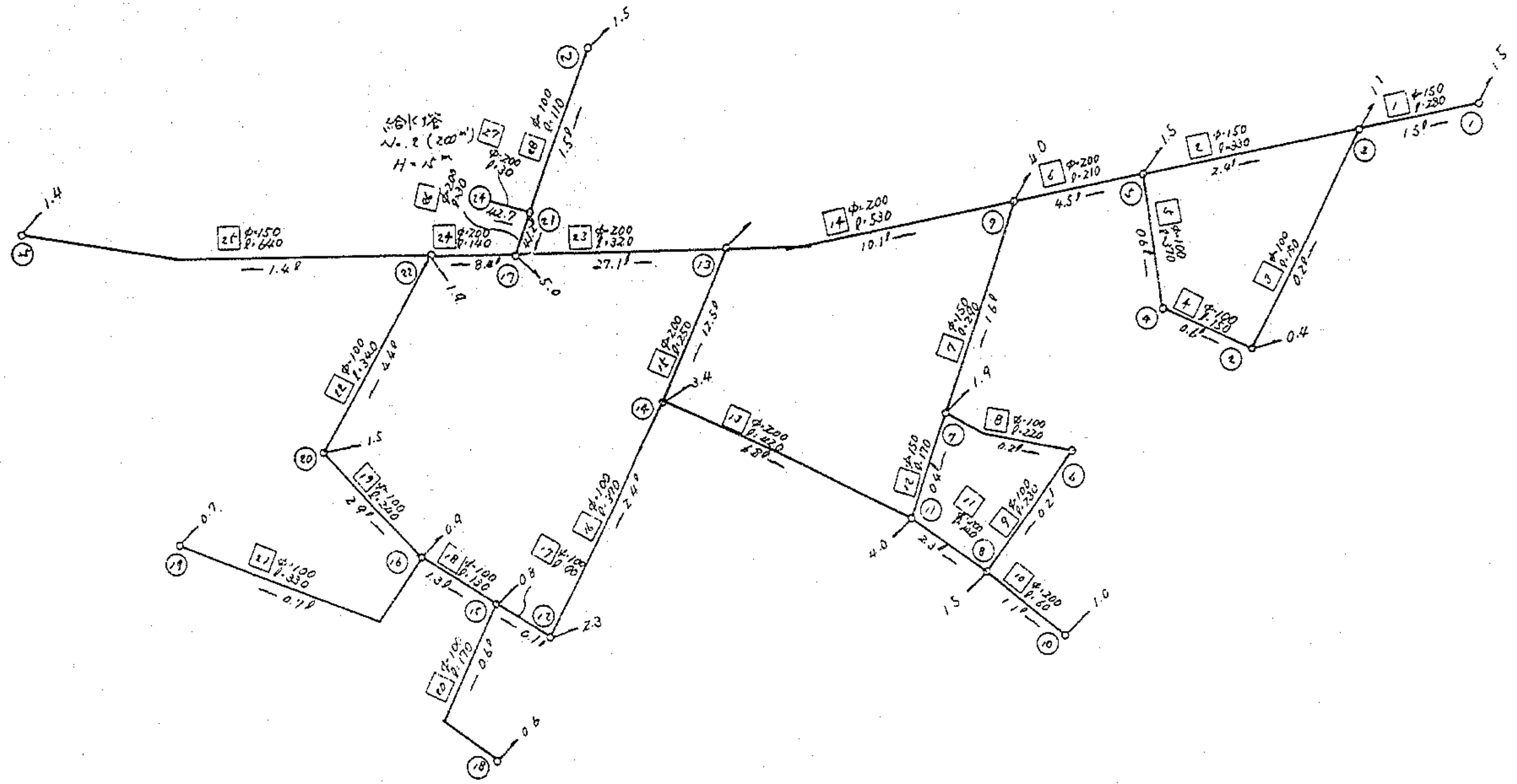
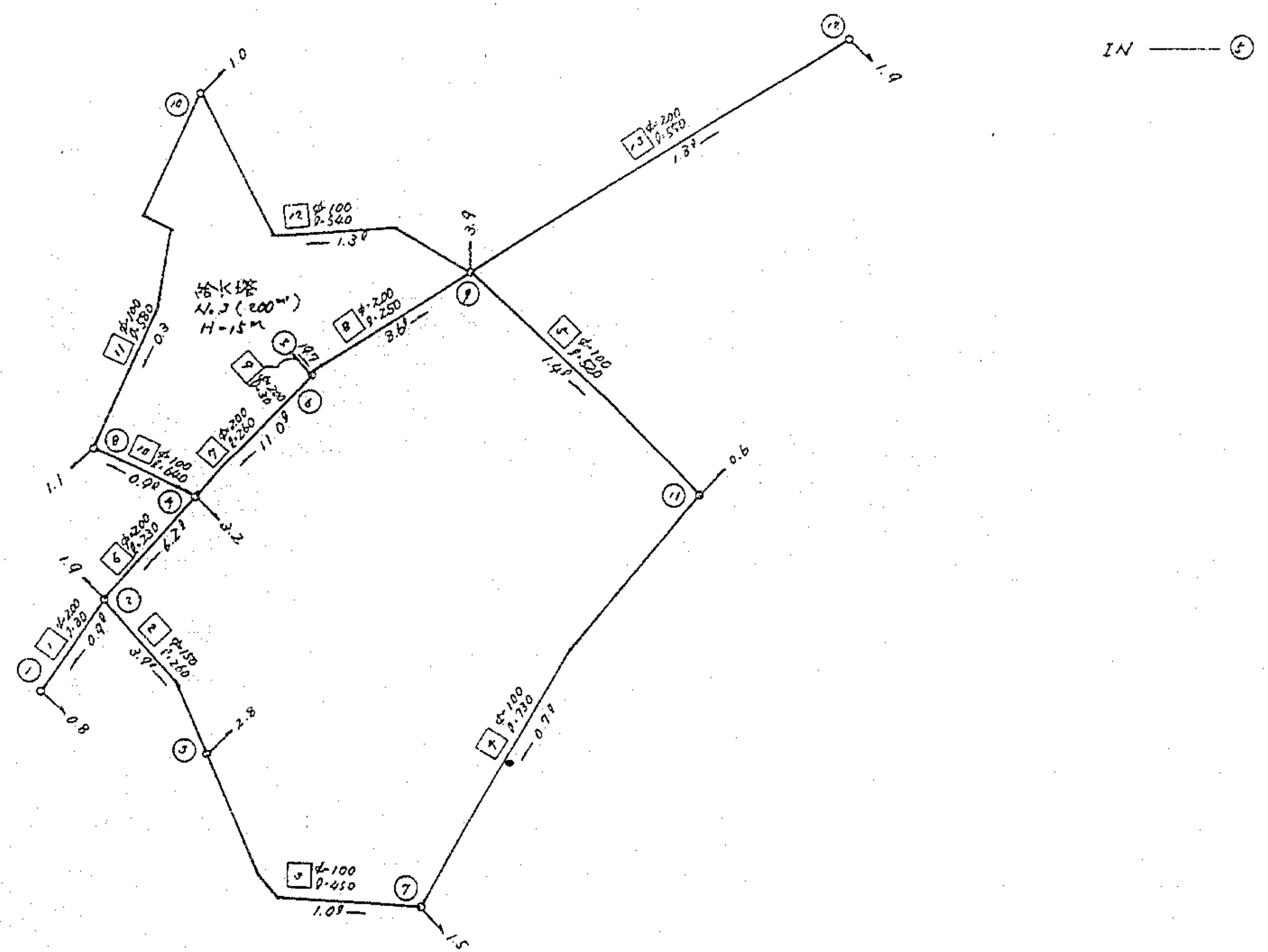


Fig. 3-10-2-18 Pipe Line Network of Overhead Tank No.3 of Feni Town



****FENI-1

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 6	-0.0021	-0.089	-0.120	0.150	440.000	110	-0.0202
2	3 -- 6	0.0219	0.756	0.697	0.200	200.000	110	0.3784
3	2 -- 3	-0.0017	-0.377	-0.216	0.100	390.000	110	-0.0968
4	3 -- 5	-0.0241	-0.136	-0.769	0.200	30.000	110	-0.4541
5	2 -- 4	0.0009	0.233	0.114	0.100	780.000	110	0.0299
6	6 -- 7	0.0176	1.258	0.559	0.200	500.000	110	0.2517
7	7 -- 10	0.0110	0.220	0.349	0.200	210.000	110	0.1051
8	9 -- 10	-0.0011	-0.100	-0.140	0.100	230.000	110	-0.0436
9	10 -- 12	0.0090	0.073	0.287	0.200	100.000	110	0.0734
10	12 -- 16	0.0020	0.008	0.064	0.200	190.000	110	0.0046
11	12 -- 13	0.0050	2.052	0.631	0.100	290.000	110	0.7076
12	13 -- 15	0.0019	0.010	0.061	0.200	260.000	110	0.0042
13	11 -- 13	0.0001	0.002	0.016	0.100	280.000	110	0.0008
14	8 -- 11	0.0020	0.587	0.256	0.100	440.000	110	0.1335
15	11 -- 14	0.0004	0.042	0.052	0.100	600.000	110	0.0071
16	7 -- 8	0.0029	1.756	0.372	0.100	660.000	110	0.2661

****FENI-1

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	14.017	0.0018	1.8	14.017	0.000	1
2	14.486	0.0008	0.8	14.486	0.000	2
3	14.863			14.863	0.000	3
4	14.252	0.0009	0.9	14.252	0.000	4
5	15.000			15.000	0.000	5
6	14.106	0.0018	1.8	14.106	0.000	6
7	12.848	0.0037	3.7	12.848	0.000	7
8	11.091	0.0009	0.9	11.091	0.000	8
9	12.527	0.0011	1.1	12.527	0.000	9
10	12.627	0.0009	0.9	12.627	0.000	10
11	10.504	0.0015	1.5	10.504	0.000	11
12	12.554	0.0019	1.9	12.554	0.000	12
13	10.502	0.0031	3.1	10.502	0.000	13
14	10.461	0.0004	0.4	10.461	0.000	14
15	10.491	0.0020	2.0	10.491	0.000	15
16	12.545	0.0021	2.1	12.545	0.000	16

****FENI-2

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 3	-0.0015	-0.030	-0.085	0.150	280.000	110	-0.0107
2	3 -- 5	-0.0024	-0.082	-0.134	0.150	330.000	110	-0.0251
3	2 -- 3	0.0002	0.003	0.029	0.100	150.000	110	0.0023
4	2 -- 4	-0.0006	-0.022	-0.080	0.100	150.000	110	-0.0153
5	4 -- 5	-0.0006	-0.056	-0.080	0.100	370.000	110	-0.0153
6	5 -- 9	-0.0045	-0.042	-0.143	0.200	210.000	110	-0.0202
7	7 -- 9	-0.0016	-0.036	-0.093	0.150	290.000	110	-0.0126
8	6 -- 7	-0.0002	-0.003	-0.022	0.100	220.000	110	-0.0014
9	6 -- 8	0.0002	0.003	0.022	0.100	230.000	110	0.0014
10	8 -- 10	0.0011	0.000	0.034	0.200	60.000	110	0.0014
11	8 -- 11	-0.0023	-0.008	-0.074	0.200	140.000	110	-0.0060
12	7 -- 11	-0.0004	-0.001	-0.025	0.150	170.000	110	-0.0011
13	11 -- 14	-0.0068	-0.180	-0.215	0.200	420.000	110	-0.0430
14	9 -- 13	-0.0101	-0.482	-0.323	0.200	530.000	110	-0.0910
15	13 -- 14	0.0125	0.336	0.398	0.200	250.000	110	0.1345
16	12 -- 14	-0.0024	-0.658	-0.300	0.100	370.000	110	-0.1781
17	12 -- 15	0.0001	0.000	0.011	0.100	90.000	110	0.0004
18	15 -- 16	-0.0013	-0.082	-0.172	0.100	130.000	110	-0.0634
19	16 -- 20	-0.0029	-0.648	-0.375	0.100	240.000	110	-0.2703
20	15 -- 18	0.0006	0.024	0.076	0.100	170.000	110	0.0142
21	16 -- 19	0.0007	0.062	0.089	0.100	330.000	110	0.0189
22	20 -- 22	-0.0044	-1.968	-0.566	0.100	340.000	110	-0.5790
23	13 -- 17	-0.0271	-1.793	-0.861	0.200	320.000	110	-0.5605
24	17 -- 22	0.0084	0.089	0.267	0.200	140.000	110	0.0639
25	22 -- 25	0.0014	0.060	0.079	0.150	640.000	110	0.0095
26	17 -- 21	-0.0412	-0.366	-1.312	0.200	30.000	110	-1.2225
27	21 -- 24	-0.0427	-0.391	-1.360	0.200	30.000	110	-1.3062
28	21 -- 23	0.0015	0.085	0.191	0.100	110.000	110	0.0774

****FENI-2

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	11.809	0.0015	1.5	11.809	0.000	1
2	11.843	0.0004	0.4	11.843	0.000	2
3	11.839	0.0011	1.1	11.839	0.000	3
4	11.866			11.866	0.000	4
5	11.922	0.0015	1.5	11.922	0.000	5
6	11.925			11.925	0.000	6
7	11.928	0.0019	1.9	11.928	0.000	7
8	11.922	0.0015	1.5	11.922	0.000	8
9	11.965	0.0040	4.0	11.965	0.000	9
10	11.921	0.0010	1.0	11.921	0.000	10
11	11.930	0.0040	4.0	11.930	0.000	11
12	11.452	0.0023	2.3	11.452	0.000	12
13	12.447	0.0044	4.4	12.447	0.000	13
14	12.111	0.0034	3.4	12.111	0.000	14
15	11.452	0.0008	0.8	11.452	0.000	15
16	11.534	0.0009	0.9	11.534	0.000	16
17	14.241	0.0050	5.0	14.241	0.000	17
18	11.428	0.0006	0.6	11.428	0.000	18
19	11.472	0.0007	0.7	11.472	0.000	19
20	12.183	0.0015	1.5	12.183	0.000	20
21	14.608			14.608	0.000	21
22	14.151	0.0019	1.9	14.151	0.000	22
23	14.523	0.0015	1.5	14.523	0.000	23
24	15.000			15.000	0.000	24
25	14.091	0.0014	1.4	14.091	0.000	25

****FENI-3

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0009	-0.000	-0.028	0.200	80.000	110	-0.0010
2	2 -- 3	0.0039	0.166	0.223	0.150	260.000	110	0.0640
3	3 -- 7	0.0010	0.152	0.122	0.100	450.000	110	0.0339
4	7 -- 11	-0.0007	-0.145	-0.092	0.100	730.000	110	-0.0200
5	9 -- 11	0.0014	0.364	0.181	0.100	520.000	110	0.0700
6	2 -- 4	-0.0062	-0.083	-0.197	0.200	230.000	110	-0.0364
7	4 -- 6	-0.0110	-0.274	-0.350	0.200	260.000	110	-0.1055
8	6 -- 9	0.0086	0.167	0.273	0.200	250.000	110	0.0669
9	5 -- 6	0.0197	0.093	0.626	0.200	30.000	110	0.3106
10	4 -- 8	0.0009	0.210	0.120	0.100	640.000	110	0.0329
11	8 -- 10	-0.0003	-0.017	-0.033	0.100	580.000	110	-0.0030
12	9 -- 10	0.0013	0.300	0.160	0.100	540.000	110	0.0557
13	9 -- 12	0.0018	0.020	0.058	0.200	550.000	110	0.0037

****FENI-3

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	14.547	0.0008	0.8	14.547	0.000	1
2	14.548	0.0019	1.9	14.548	0.000	2
3	14.382	0.0028	2.8	14.382	0.000	3
4	14.632	0.0032	3.2	14.632	0.000	4
5	15.000			15.000	0.000	5
6	14.906			14.906	0.000	6
7	14.229	0.0015	1.5	14.229	0.000	7
8	14.421	0.0011	1.1	14.421	0.000	8
9	14.739	0.0039	3.9	14.739	0.000	9
10	14.439	0.0010	1.0	14.439	0.000	10
11	14.375	0.0006	0.6	14.375	0.000	11
12	14.719	0.0019	1.9	14.719	0.000	12

Fig. 3-10-2-20 Pipe Line Network of Overhead Tank No.2 of Sunamganj Town

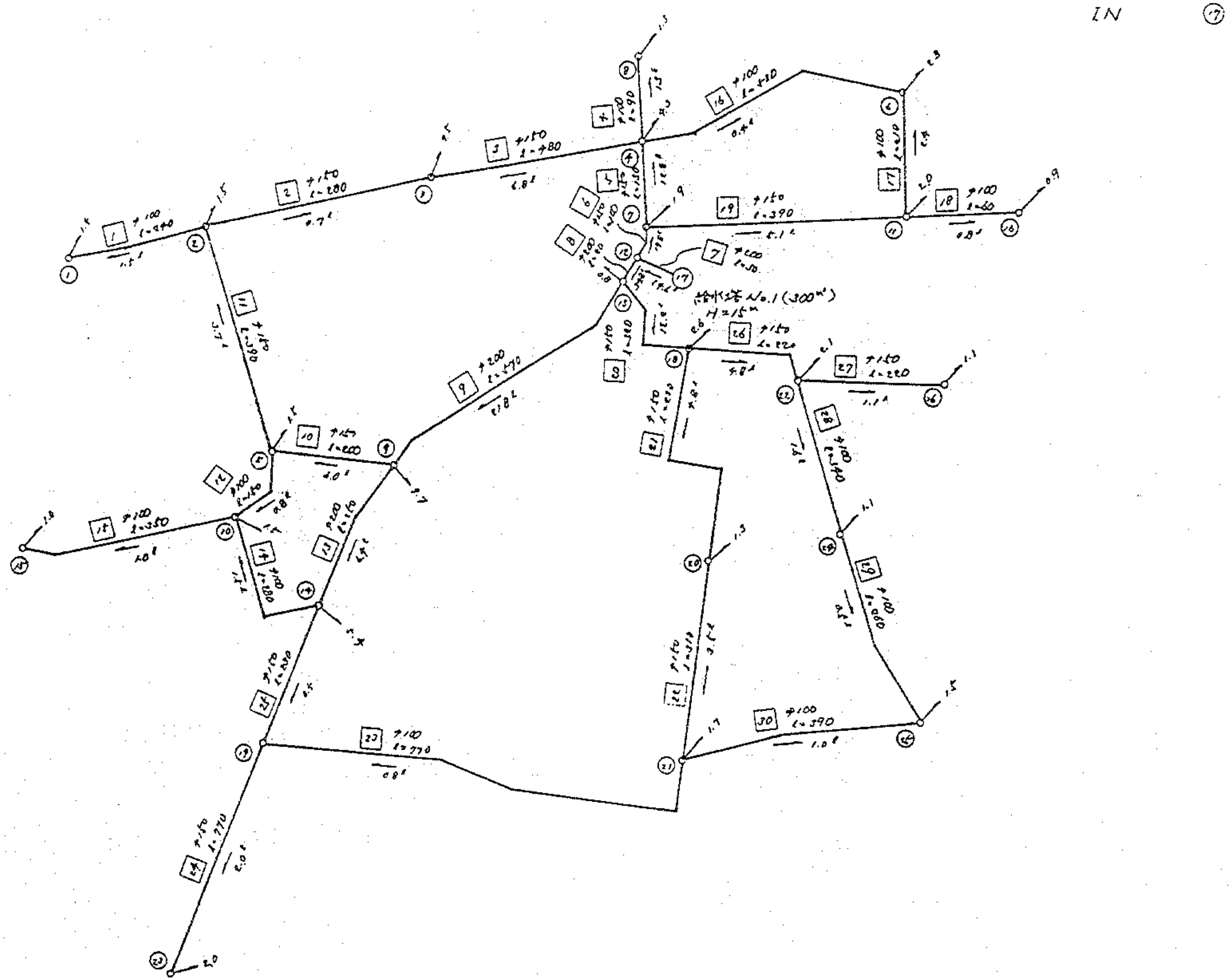
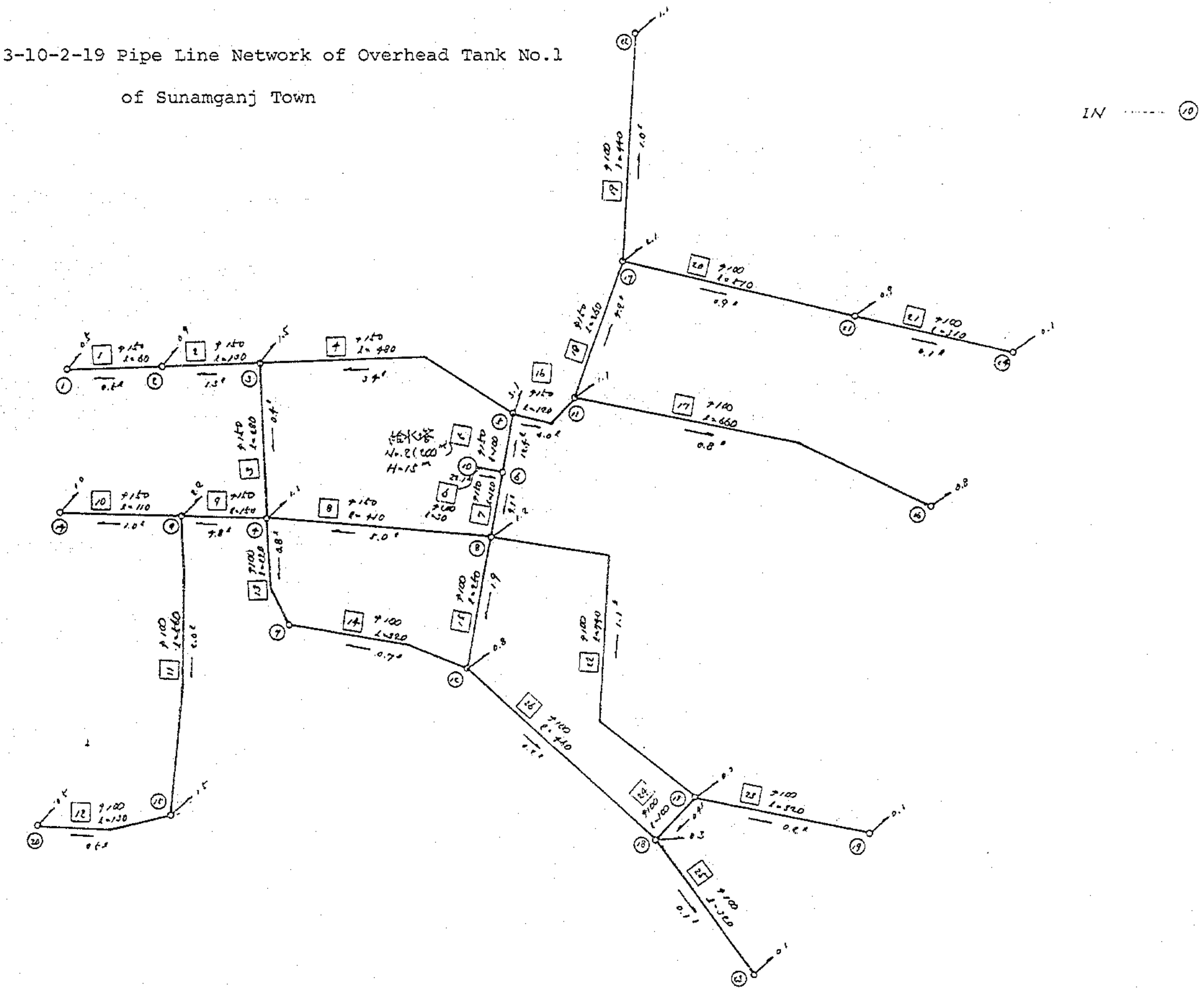


Fig. 3-10-2-19 Pipe Line Network of Overhead Tank No.1

of Sunamganj Town



****S-GANJ-2

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0005	-0.000	-0.030	0.150	60.000	110	-0.0015
2	2 -- 3	-0.0013	-0.011	-0.076	0.150	130.000	110	-0.0088
3	3 -- 4	0.0004	0.003	0.025	0.150	280.000	110	0.0011
4	3 -- 5	-0.0034	-0.231	-0.191	0.150	480.000	110	-0.0482
5	5 -- 6	-0.0124	-0.540	-0.704	0.150	100.000	110	-0.5402
6	6 -- 10	-0.0221	-0.115	-0.702	0.200	30.000	110	-0.3840
7	6 -- 8	0.0091	0.361	0.513	0.150	120.000	110	0.3009
8	4 -- 8	-0.0050	-0.413	-0.285	0.150	410.000	110	-0.1009
9	4 -- 9	0.0048	0.136	0.270	0.150	150.000	110	0.0912
10	9 -- 14	0.0010	0.005	0.055	0.150	110.000	110	0.0048
11	9 -- 15	0.0020	0.708	0.249	0.100	560.000	110	0.1266
12	15 -- 20	0.0005	0.012	0.061	0.100	130.000	110	0.0094
13	4 -- 7	-0.0008	-0.051	-0.100	0.100	220.000	110	-0.0235
14	7 -- 12	-0.0007	-0.063	-0.092	0.100	320.000	110	-0.0199
15	8 -- 12	0.0019	0.298	0.241	0.100	250.000	110	0.1193
16	5 -- 11	0.0060	0.170	0.342	0.150	120.000	110	0.1419
17	11 -- 16	0.0008	0.160	0.102	0.100	660.000	110	0.0243
18	11 -- 17	0.0042	0.185	0.236	0.150	260.000	110	0.0715
19	17 -- 22	0.0010	0.165	0.129	0.100	440.000	110	0.0377
20	17 -- 21	0.0009	0.161	0.118	0.100	510.000	110	0.0316
21	21 -- 24	0.0001	0.001	0.013	0.100	310.000	110	0.0005
22	8 -- 13	0.0011	0.300	0.135	0.100	740.000	110	0.0406
23	13 -- 19	0.0002	0.008	0.032	0.100	320.000	110	0.0028
24	13 -- 18	0.0004	0.005	0.045	0.100	100.000	110	0.0054
25	18 -- 23	0.0001	0.001	0.013	0.100	320.000	110	0.0005
26	12 -- 18	0.0002	0.007	0.023	0.100	460.000	110	0.0016

****S-GANJ-2

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	14.101	0.0005	0.5	14.101	0.000	1
2	14.101	0.0009	0.9	14.101	0.000	2
3	14.113	0.0015	1.5	14.113	0.000	3
4	14.110	0.0011	1.1	14.110	0.000	4
5	14.344	0.0031	3.1	14.344	0.000	5
6	14.884			14.884	0.000	6
7	14.161			14.161	0.000	7
8	14.523	0.0012	1.2	14.523	0.000	8
9	13.973	0.0022	2.2	13.973	0.000	9
10	15.000			15.000	0.000	10
11	14.174	0.0011	1.1	14.174	0.000	11
12	14.225	0.0008	0.8	14.225	0.000	12
13	14.223	0.0003	0.3	14.223	0.000	13
14	13.968	0.0010	1.0	13.968	0.000	14
15	13.264	0.0015	1.5	13.264	0.000	15
16	14.013	0.0008	0.8	14.013	0.000	16
17	13.988	0.0021	2.1	13.988	0.000	17
18	14.218	0.0003	0.3	14.218	0.000	18
19	14.214	0.0001	0.1	14.214	0.000	19
20	13.252	0.0005	0.5	13.252	0.000	20
21	13.827	0.0009	0.9	13.827	0.000	21
22	13.822	0.0011	1.1	13.822	0.000	22
23	14.216	0.0001	0.1	14.216	0.000	23
24	13.825	0.0001	0.1	13.825	0.000	24

****S-GANJ-1

Line No.	Point No.	Discharge (M3/S)	Loss (M)	Velocity (M/S)	Pipe Dia. (M)	PipeLength (M)	C	i=h/L(%) (%)
1	1 -- 2	-0.0015	-0.185	-0.191	0.100	240.000	110	-0.0774
2	2 -- 3	0.0007	0.008	0.042	0.150	280.000	110	0.0029
3	3 -- 4	-0.0068	-0.836	-0.382	0.150	480.000	110	-0.1743
4	4 -- 8	0.0013	0.053	0.166	0.100	90.000	110	0.0594
5	4 -- 7	-0.0128	-0.738	-0.723	0.150	130.000	110	-0.5677
6	7 -- 12	-0.0198	-1.271	-1.118	0.150	100.000	110	-1.2714
7	12 -- 17	-0.0546	-0.616	-1.738	0.200	30.000	110	-2.0566
8	12 -- 13	0.0348	0.179	1.109	0.200	20.000	110	0.8959
9	9 -- 13	-0.0218	-2.149	-0.695	0.200	570.000	110	-0.3771
10	5 -- 9	-0.0060	-0.281	-0.340	0.150	200.000	110	-0.1405
11	2 -- 5	-0.0037	-0.227	-0.212	0.150	390.000	110	-0.0584
12	5 -- 10	0.0008	0.040	0.108	0.100	150.000	110	0.0267
13	9 -- 14	0.0064	0.097	0.204	0.200	250.000	110	0.0389
14	10 -- 14	-0.0015	-0.224	-0.194	0.100	280.000	110	-0.0800
15	10 -- 15	0.0010	0.121	0.124	0.100	350.000	110	0.0346
16	4 -- 6	0.0004	0.040	0.054	0.100	530.000	110	0.0076
17	6 -- 11	-0.0024	-0.376	-0.301	0.100	210.000	110	-0.1795
18	11 -- 16	0.0008	0.015	0.104	0.100	60.000	110	0.0250
19	7 -- 11	0.0051	0.401	0.288	0.150	390.000	110	0.1029
20	13 -- 18	0.0122	1.672	0.692	0.150	320.000	110	0.5226
21	18 -- 20	0.0048	0.215	0.274	0.150	230.000	110	0.0938
22	20 -- 21	0.0035	0.162	0.200	0.150	310.000	110	0.0525
23	19 -- 21	-0.0008	-0.198	-0.105	0.100	770.000	110	-0.0258
24	19 -- 23	0.0020	0.140	0.113	0.150	770.000	110	0.0183
25	14 -- 19	0.0004	0.002	0.025	0.150	230.000	110	0.0011
26	18 -- 22	0.0048	0.203	0.271	0.150	220.000	110	0.0923
27	22 -- 26	0.0011	0.013	0.062	0.150	220.000	110	0.0060
28	22 -- 24	0.0016	0.294	0.203	0.100	340.000	110	0.0865
29	24 -- 25	0.0005	0.025	0.063	0.100	260.000	110	0.0099
30	21 -- 25	0.0010	0.144	0.128	0.100	390.000	110	0.0370

****S-GANJ-1

PointNo.	EnergyHeight (M)	Turnout (M3/S)	Discharge (L/SEC)	Water Pressure (M)	G.L. (M)	No.
1	11.359	0.0015	1.5	11.359	0.000	1
2	11.545	0.0015	1.5	11.545	0.000	2
3	11.537	0.0075	7.5	11.537	0.000	3
4	12.373	0.0043	4.3	12.373	0.000	4
5	11.773	0.0015	1.5	11.773	0.000	5
6	12.333	0.0028	2.8	12.333	0.000	6
7	13.111	0.0019	1.9	13.111	0.000	7
8	12.320	0.0013	1.3	12.320	0.000	8
9	12.054	0.0097	9.7	12.054	0.000	9
10	11.733	0.0015	1.5	11.733	0.000	10
11	12.710	0.0020	2.0	12.710	0.000	11
12	14.383			14.383	0.000	12
13	14.203	0.0008	0.8	14.203	0.000	13
14	11.957	0.0054	5.4	11.957	0.000	14
15	11.612	0.0010	1.0	11.612	0.000	15
16	12.695	0.0009	0.9	12.695	0.000	16
17	15.000			15.000	0.000	17
18	12.531	0.0026	2.6	12.531	0.000	18
19	11.954			11.954	0.000	19
20	12.315	0.0013	1.3	12.315	0.000	20
21	12.153	0.0017	1.7	12.153	0.000	21
22	12.328	0.0021	2.1	12.328	0.000	22
23	11.813	0.0020	2.0	11.813	0.000	23
24	12.034	0.0011	1.1	12.034	0.000	24
25	12.008	0.0015	1.5	12.008	0.000	25
26	12.315	0.0011	1.1	12.315	0.000	26

3-10-3 Study on the proposed volume of water to be supplied

This project adopts the following figures for the planned volume of water supply.

	Volume of water supply	% population
(1) House connection	90 l/day/capita	50%(80%)
(2) Public post	34 " "	50 (20)
(3) Wastage	30% of the sum of (1) and (2) above	

From the above table, the mean water consumption per head per day will be as follows:

Portion supplied by house connection	90 l/man-day x 50%	= 45 l/day
Portion supplied by public post	34 l/man-day x 50%	= 17 l/day
Wastage	(45 + 17) x 30%	= 18.6 l/day
Total	80.6	= 81 l/day

Accordingly, the volume of water supply was calculated on the basis of 81 l/per head per day in this project.

The breakdown of the above volume of water supply is as follows:

The breakdown of the planned volume of water supply of the projects implemented under the assistance of ADB and the Netherlands were used as references.

① Domestic consumption

House connection 75 lpcd

Public post 28 lpcd

20 lpcd x (1 + α)

In view of especially high loss due to breakdown of public post, α = 40% was assumed.

② Non-domestic consumption

Non-domestic consumption means the volume of water used by restaurants, hospitals, offices, shops, household industiries, etc. Factories and research institutions and the like have their own water supply facilities. For non -domestic consumption, 20% of (1) above was adopted.

③ The volume of water for "wastage", "pipe leakage", "unaccounted for water", etc.

((1) + (2)) x 30%

Based on the above idea, and assuming that 50% of the population will be supplied by house connections and another 50% by public posts, the mean water consumption per head per day for the population would be as follows:

① By house connection	: 75 l/day x 0.5 =	37.5 l/day
② By public post	: 28 l/day x 0.5 =	14.0 l/day
	Sub-total	51.5 l/day
③ Non- domestic consumption	51.5 x 0.2 =	10.3 l/day
④ Wastage, etc.	(51.5 + 10.3) x 0.3 =	18.54 l/day
⑤ Total		80.34 = 81 l/day

This is the same as the figure calculated on the basis of the planned volume of water supply. Accordingly, it is presumed that the planned volume of water supply includes the volume of water used by restanrants, hospitals, schools, shops and household industries.

3-10-4 Study on overhead tank capacity

(1) Hourly change in water delivery

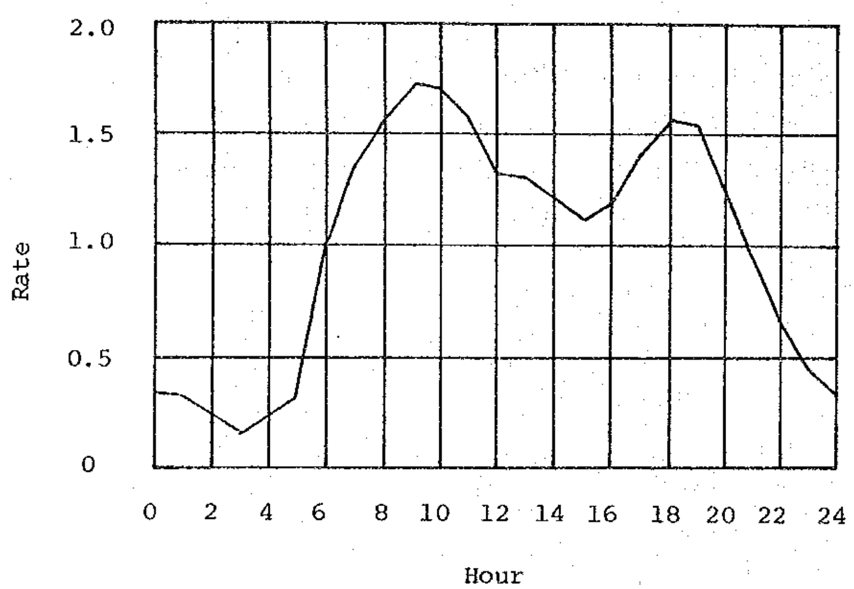
Since no data on hourly change in water delivery in Bangladesh are available, Data for Japan were used as a base for estimation.

(a) Hourly change in water supply to house connection

Data for Japan cannot be used as they are since the living environment and customs in Bangladesh are different from those in Japan. Major differences in the living environment are the use of electric washing machine, flush toilet, hot bath, etc. In order to adjust for these differences, data for the year around 1955, when the diffusion rates of these facilities were still low, will be used. The following figure presents the hourly changes in water consumption when the daily mean water consumption is set at 1.o.

Hourly Rate of Water Supply to House Connection

(Rate, mean = 1.0)



(b) Hourly change in water supply to public post

As no data are available on the public posts because although they did exist at one time immediately after the World Wat II, they no longer exist today. The following therefore is an estimate.

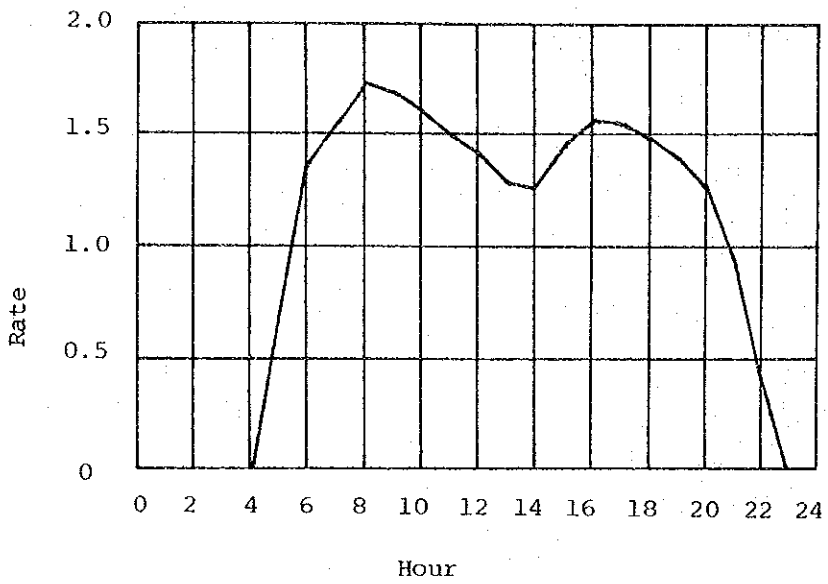
An example of the breakdown of the use of water would be as follows:

Drinking, cooking, dish washing, house cleaning	10.5 l/man-day
Laundering	5.0
Ablutions	17.5
Head flush	2.5
Others	4.0
Total	39.5

Of these, landering would be done at the place of water tap but for other uses, water would probably be carried into each house. Also, water for meal and dish washing would probably be filled into vessels one or two hours before meal. Accordingly, the morning peak consumption would be smaller and the morning and evening peak hours earlier by one or two hours than in the case of house connections. During night, the water filled in vessels would be used while tap water would hardly be used. In order to be on the safe side, the maximum hourly ratios an the morning and evening were assumed to be the same as in the case of house connections.

Hourly Rate of Water Supply to Public Post

(Rate, mean = 1.0)



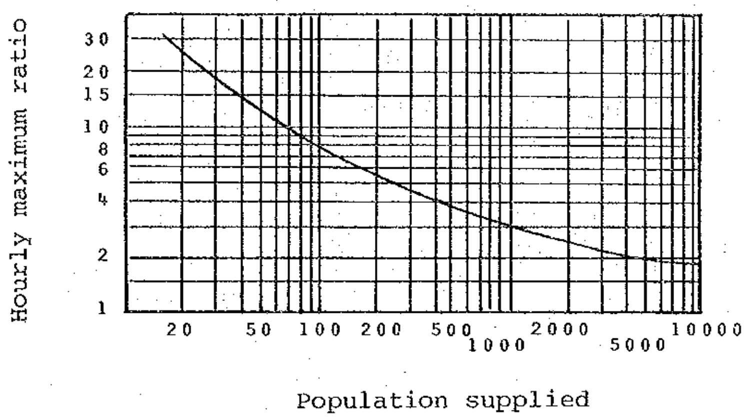
(2) Ratio of hourly maximum water consumption to daily maximum water consumption

Since no data are available on the hourly maximum ratio in Bangladesh, the following is our best estimate based on the data for Japan.

(a) House connection

The relationship between the population supplied and the hourly maximum ratio would be as illustrated below.

Fig. 3-10-4-1 Relationship Between Population Supplied and the Hourly Maximum Ratio



The hourly maximum ratio (α) is obtained as follows.

1 The hourly maximum water consumption is calculated for α obtained from Fig. 30-10-4-1.

$$Q_H = \alpha \times q_o \times p$$

2 Simultaneous tap opening water volume is calculated.

$$Q_1 = q_1 \times N^{0.475}$$

3 (a) If $Q_H = Q_1$, then Q_H is the hourly maximum water consumption.

(b) If Q_H Q_1, then Q_1 is the hourly maximum water consumption.

In the above, p : Estimated population supplied (in persons)

q_o: Maximum water consumption per head per day (l/man-day)

q_1: Volume of water used per tap (l/min. 17 l/min. for a ø 13 mm tap)

N : Total number of taps

The following is the hourly maximum water consumption calculated for Narayanganj which has the largest population.

1 From Fig. 3-10-4-1, $\alpha = 1.72$

Q_H = 1.72 x 113.7 l/man-day x 470,000 men x 0.5
= 31.915 l/min.

2 $Q_1 = 17 \text{ l/min.} \times \left(\frac{470,000}{2 \times 11}\right)^{0.475} = 1,938 \text{ l/min.}$

Since Q_H Q_1, Q_1 would be the hourly maximum water consumption, but the difference between Q_H and Q_1 is far too large. This is judges to indicate that the instance in Japan is not applicable to Bangladesh where the family size is large at 11 on average and where there is only one top for each house connection.

In view of the foregoing, it would be better to obtain Q_H from the hourly maximum ratio.

(b) Public post

For public post, Q_H shall be obtained from the hourly maximum ratio, too.

(c) Hourly maximum ratio for the total volume of water supply

When the hourly maximum ratio for the total volume of water supply is obtained from the hourly changes in water delivery, Table 3-10-4-1 results. The hourly maximum ratio would be 1.71, but under this project, a value of 2.0 was assumed to be on the safe side.

Table 3-10-4-1. Hourly Maximum Ratio for the Total Volume of Water Supply

Hour	House connection		Public post		Total
	Ratio	Water Volume (x 90 l)	Ratio	Water Volume (x 34 l)	
0	0.33	29.7	0	0	29.70
1	0.24	21.6	0	0	21.60
2	0.19	17.1	0	0	17.10
3	0.14	12.6	0	0	12.60
4	0.12	10.8	0	0	10.80
5	0.31	27.9	0.70	23.80	51.70
6	0.98	88.2	1.33	45.22	133.42
7	1.33	119.7	1.54	52.36	172.06
8	1.57	141.3	1.72	58.48	199.78
9	1.72	154.8	1.68	57.12	211.92*
10	1.69	152.1	1.60	54.40	206.50
11	1.56	140.4	1.49	50.66	191.06
12	1.34	120.6	1.40	47.60	168.20
13	1.29	116.1	1.28	43.52	159.62
14	1.22	109.8	1.26	42.84	152.64
15	1.10	99.0	1.45	49.30	148.30
16	1.17	105.3	1.56	53.04	158.34
17	1.39	125.1	1.54	52.36	177.46
18	1.56	140.4	1.50	51.00	191.40
19	1.54	138.6	1.40	47.60	186.20
20	1.25	112.5	1.25	42.50	155.00
21	0.91	81.9	0.91	30.94	112.84
22	0.62	55.8	0.39	13.26	69.06
23	0.43	38.7	0	0	38.70
Average	1.00	90.00	1.00	34.00	124.00

$$\text{Hourly maximum ratio } \alpha = \frac{211.92}{124.00} = 1.71$$

(3) Review of overhead tank capacity

The overhead tank capacity is reviewed on the basis of figures obtained in the foregoing paragraphs.

(i) Study aiming at the target year (1990)

(a) Conditions for caluculation

The conditions for caluculation shall be as follows:

① The operating hours of pump shall be from 7:00 to 19:00.

② The overhead tank capacity shall be 20% of daily water supply.

③ The overhead tank shall be filled to capacity at 19:00.

④ Calculation shall be for Narsingj.

In the event that the overhead tank becomes empty by the next morning as a result of the foregoing calculations, following additional calculations shall be made.

① The operating hours of pump shall be extended by the unit of an hour to find the operating hours which will not result in an empty overhead tank in the morning.

② 12 hours of operating time which will not result in the overhead tank becoming empty the following morning, but except during the hours from 7:00 - 19:00, shall be found.

③ In the event that the operating hours of pump were fixed to be from 7:00 to 19:00, the required overhead tank capacity shall be calculated.

(b) Calculated results

The calculated results are summarized in the table below.

Table 3-10-4-2 Results of Study on Overhead Tank

Case	Results	
Capacity: 20% Operating hrs 07:00 - 19:00 (12 hrs)	Suspension of Water Supply	Occurring, overhead Tank emptied from 04:00 to 08:00
	Water Volume conveyed	10,800 m^3
	Water Volume Capacity (12 hrs)	12,300 m^3
Capacity: 20% Operating hrs 06:00 - 21:00 (15 hrs)	Suspension of Water Supply	Not occuring
	Water Volume conveyed	13,300 m^3
	Water Volume Capacity (15 hrs)	14,400 m^3
Capacity: 35% Operating hrs 07:00 - 19:00 (12 hrs)	Suspension of Water Supply	Not occuring
	Water Volume conveyed	13,200 m^3
	Water Volume Capacity (12 hrs)	12,300 m^3

From the calculated results, if the overhead tank capacity is 20% of the daily water consumption and operating hours of pump are 12 hours, suspension of water supply occurs in the morning. If the pump is operated for 14 hours (from 6:00 to 21:00), no suspension of water supply occurs. Also, the capacity of overhead tank which does not cause suspension of water supply with 12 hour operation of pump is 35% of the daily water consumption.

(ii) Study aiming at completion of Phase 1 (- 1986)

(a) Conditions for calculation

The capacity of the overhead tank to be installed in the Phase I of our project for Jenidah Town shall be studied under the following calculation requirements:

① The operating hours of the pump shall be from 07:00 to 19:00 (12 hours operation)

② The overhead tank capacity shall be 20% of the daily water supply.

③ The overhead tank shall be filled to capacity at 19:00.

④ The calculation shall be for water supply population in 1986 in Jenidah Town.

(b) Calculation results

From the calculation results, if the overhead tank capacity is 20% of the daily water consumption and the pump is operated from 07:00 to 19:00 for 12 hours, the overhead tank would hardly be emptied.

(iii) Determination of the overhead tank capacity

The overhead tank aims at controlling water pressure and water volume. In our project no service reservoir storing potable water from wells is to be made, and the overhead tank is to act as a service reservoir as well, thus ensuring round-the-clock water supply. However, according to the present circumstances in Bangladesh administrating the water supply facilities, the pump is to be operated for 12 hours a day, and the requirement of the 24 hours water supply mentioned earier would demand extra capacity of the overhead tank, which is not coherent with other facilities.

Thus, our project aiming at the completion of Phase I shall set the capacity of the overhead tank at 20% of the daily water consumption, thus securing 24 hours water supply even with the 12 hours operation of the pump.

In the future after the completion of the facilities, increasing water demand following expected population increase shall be coped with by extending the operation hours of the facilities, which will be manned by such staff as to be trained and experienced by then.

NAME OF CITY NARSINGDI
POPURATION SUPPLIED 152700
RESERVOIR QUANTITY 20%
OPERATION HOUR FROM 7 TO 19

HR	RATIO	HOUSE	RATIO	PUBLIC	UNKNOWN	TOTAL	SUPPLY	TANK
0	0.33	94	0.00	0	118	213	0	580
1	0.24	69	0.00	0	118	187	0	393
2	0.19	54	0.00	0	118	173	0	221
3	0.14	40	0.00	0	118	158	0	62
4	0.12	34	0.00	0	118	153	0	0
5	0.31	0	0.70	0	0	0	0	0
6	0.98	0	1.33	0	0	0	0	0
7	1.33	0	1.54	0	0	0	0	0
8	1.57	0	1.72	0	0	0	1026	1026
9	1.72	492	1.68	182	118	793	1026	1259
10	1.69	484	1.60	173	118	775	1026	1509
11	1.56	447	1.49	161	118	726	1026	1809
12	1.34	384	1.40	151	118	653	1026	2181
13	1.29	369	1.28	138	118	626	1026	2462
14	1.22	349	1.26	136	118	604	604	2462
15	1.10	315	1.45	157	118	590	590	2462
16	1.17	335	1.56	169	118	622	1026	2462
17	1.39	398	1.54	167	118	683	683	2462
18	1.56	447	1.50	162	118	727	727	2462
19	1.54	441	1.40	151	118	711	1026	2462
20	1.25	358	1.25	135	118	611	0	1850
21	0.91	261	0.91	98	118	477	0	1373
22	0.62	178	0.39	42	118	338	0	1035
23	0.43	123	0.00	0	118	241	0	793
TOTAL	24.00	5672	24.00	2024	2367	10062	10809	

NAME OF CITY NARSINGDI
POPURATION SUPPLIED 152700
RESERVOIR QUANTITY 20%
OPERATION HOUR FROM 7 TO 20

HR	RATIO	HOUSE	RATIO	PUBLIC	UNKNOWN	TOTAL	SUPPLY	TANK
0	0.33	94	0.00	0	118	213	0	1192
1	0.24	69	0.00	0	118	187	0	1005
2	0.19	54	0.00	0	118	173	0	832
3	0.14	40	0.00	0	118	158	0	674
4	0.12	34	0.00	0	118	153	0	521
5	0.31	89	0.70	76	118	283	0	238
6	0.98	281	1.33	144	118	543	0	0
7	1.33	0	1.54	0	0	0	0	0
8	1.57	0	1.72	0	0	0	1026	1026
9	1.72	492	1.68	182	118	793	1026	1259
10	1.69	484	1.60	173	118	775	1026	1509
11	1.56	447	1.49	161	118	726	1026	1809
12	1.34	384	1.40	151	118	653	1026	2181
13	1.29	369	1.28	138	118	626	1026	2462
14	1.22	349	1.26	136	118	604	604	2462
15	1.10	315	1.45	157	118	590	590	2462
16	1.17	335	1.56	169	118	622	1026	2462
17	1.39	398	1.54	167	118	683	683	2462
18	1.56	447	1.50	162	118	727	727	2462
19	1.54	441	1.40	151	118	711	1026	2462
20	1.25	358	1.25	135	118	611	611	2462
21	0.91	261	0.91	98	118	477	0	1984
22	0.62	178	0.39	42	118	338	0	1646
23	0.43	123	0.00	0	118	241	0	1405
TOTAL	24.00	6041	24.00	2243	2604	10888	11421	

NAME OF CITY NARSINGDI
POPURATION SUPPLIED 152700
RESERVOIR QUANTITY 20%
OPERATION HOUR FROM 6 TO 20

HR	RATIO	HOUSE	RATIO	PUBLIC	UNKNOWN	TOTAL	SUPPLY	TANK
0	0.33	94	0.00	0	118	213	0	1192
1	0.24	69	0.00	0	118	187	0	1005
2	0.19	54	0.00	0	118	173	0	832
3	0.14	40	0.00	0	118	158	0	674
4	0.12	34	0.00	0	118	153	0	521
5	0.31	89	0.70	76	118	283	0	238
6	0.98	281	1.33	144	118	543	0	0
7	1.33	0	1.54	0	0	0	1026	1026
8	1.57	450	1.72	186	118	754	1026	1297
9	1.72	492	1.68	182	118	793	1026	1530
10	1.69	484	1.60	173	118	775	1026	1781
11	1.56	447	1.49	161	118	726	1026	2080
12	1.34	384	1.40	151	118	653	1026	2453
13	1.29	369	1.28	138	118	626	1026	2462
14	1.22	349	1.26	136	118	604	604	2462
15	1.10	315	1.45	157	118	590	590	2462
16	1.17	335	1.56	169	118	622	1026	2462
17	1.39	398	1.54	167	118	683	683	2462
18	1.56	447	1.50	162	118	727	727	2462
19	1.54	441	1.40	151	118	711	1026	2462
20	1.25	358	1.25	135	118	611	611	2462
21	0.91	261	0.91	98	118	477	0	1984
22	0.62	178	0.39	42	118	338	0	1646
23	0.43	123	0.00	0	118	241	0	1405
TOTAL	24.00	6491	24.00	2429	2722	11642	12446	

NAME OF CITY NARSINGDI
POPURATION SUPPLIED 152700
RESERVOIR QUANTITY 20%
OPERATION HOUR FROM 6 TO 21

HR	RATIO	HOUSE	RATIO	PUBLIC	UNKNOWN	TOTAL	SUPPLY	TANK
0	0.33	94	0.00	0	118	213	0	1669
1	0.24	69	0.00	0	118	187	0	1482
2	0.19	54	0.00	0	118	173	0	1309
3	0.14	40	0.00	0	118	158	0	1151
4	0.12	34	0.00	0	118	153	0	998
5	0.31	89	0.70	76	118	283	0	715
6	0.98	281	1.33	144	118	543	0	173
7	1.33	381	1.54	167	118	666	1026	533
8	1.57	450	1.72	186	118	754	1026	804
9	1.72	492	1.68	182	118	793	1026	1037
10	1.69	484	1.60	173	118	775	1026	1288
11	1.56	447	1.49	161	118	726	1026	1587
12	1.34	384	1.40	151	118	653	1026	1960
13	1.29	369	1.28	138	118	626	1026	2359
14	1.22	349	1.26	136	118	604	1026	2462
15	1.10	315	1.45	157	118	590	590	2462
16	1.17	335	1.56	169	118	622	1026	2462
17	1.39	398	1.54	167	118	683	683	2462
18	1.56	447	1.50	162	118	727	727	2462
19	1.54	441	1.40	151	118	711	1026	2462
20	1.25	358	1.25	135	118	611	611	2462
21	0.91	261	0.91	98	118	477	477	2462
22	-0.62	178	0.39	42	118	338	0	2123
23	0.43	123	0.00	0	118	241	0	1882
TOTAL	24.00	6872	24.00	2596	2840	12308	13345	

NAME OF CITY NARSINGDI
POPURATION SUPPLIED 152700
RESERVOIR QUANTITY 35%
OPERATION HOUR FROM 7 TO 19

HR	RATIO	HOUSE	RATIO	PUBLIC	UNKNOWN	TOTAL	SUPPLY	TANK
0	0.33	94	0.00	0	118	213	0	2427
1	0.24	69	0.00	0	118	187	0	2240
2	0.19	54	0.00	0	118	173	0	2067
3	0.14	40	0.00	0	118	158	0	1908
4	0.12	34	0.00	0	118	153	0	1756
5	0.31	89	0.70	76	118	283	0	1473
6	0.98	281	1.33	144	118	543	0	930
7	1.33	381	1.54	167	118	666	0	264
8	1.57	450	1.72	186	118	754	1026	536
9	1.72	492	1.68	182	118	793	1026	769
10	1.69	484	1.60	173	118	775	1026	1020
11	1.56	447	1.49	161	118	726	1026	1319
12	1.34	384	1.40	151	118	653	1026	1691
13	1.29	369	1.28	138	118	626	1026	2091
14	1.22	349	1.26	136	118	604	1026	2512
15	1.10	315	1.45	157	118	590	1026	2948
16	1.17	335	1.56	169	118	622	1026	3352
17	1.39	398	1.54	167	118	683	1026	3694
18	1.56	447	1.50	162	118	727	1026	3993
19	1.54	441	1.40	151	118	711	1026	4308
20	1.25	358	1.25	135	118	611	0	3696
21	0.91	261	0.91	98	118	477	0	3219
22	0.62	178	0.39	42	118	338	0	2881
23	0.43	123	0.00	0	118	241	0	2639
TOTAL	24.00	6872	24.00	2596	2840	12308	12308	

NAME OF CITY JANIDAH
POPURATION SUPPLIED 50740
RESERVOIR QUANTITY 1200 m^3
OPERATION HOUR FROM 7 TO 19

HR	RATIO	HOUSE	RATIO	PUBLIC	UNKNOWN	TOTAL	SUPPLY	TANK
0	0.33	31	0.00	0	39	71	0	575
1	0.24	23	0.00	0	39	62	0	513
2	0.19	18	0.00	0	39	57	0	455
3	0.14	13	0.00	0	39	53	0	403
4	0.12	11	0.00	0	39	51	0	352
5	0.31	29	0.70	25	39	94	0	258
6	0.98	93	1.33	48	39	180	0	78
7	1.33	127	1.54	55	39	221	0	0
8	1.57	0	1.72	0	0	0	341	341
9	1.72	164	1.68	60	39	263	341	418
10	1.69	161	1.60	58	39	258	341	501
11	1.56	148	1.49	54	39	241	341	601
12	1.34	127	1.40	50	39	217	341	725
13	1.29	123	1.28	46	39	208	341	857
14	1.22	116	1.26	45	39	201	341	998
15	1.10	105	1.45	52	39	196	341	1142
16	1.17	111	1.56	56	39	207	341	1200
17	1.39	132	1.54	55	39	227	227	1200
18	1.56	148	1.50	54	39	242	242	1200
19	1.54	147	1.40	50	39	236	236	1200
20	1.25	119	1.25	45	39	203	0	997
21	0.91	87	0.91	33	39	159	0	838
22	0.62	59	0.39	14	39	112	0	726
23	0.43	41	0.00	0	39	80	0	646
TOTAL	24.00	2134	24.00	801	904	3839	3772	

3-10-5 Study for the Foundation of Structures

(1) Condition of foundation ground in each town

The foundation ground on which structures such as the overhead tank are planned to be erected has not been surveyed in any of the towns yet. The condition of the foundation ground in each town, however, may be inferred from the results of test boring conducted for the constuction of production wells.

Geological columnar sections obtained by test boring in each town are shown in Par. 3-10-1. Judging from these columnar sections, the ground formation to the depth of around 50m in every town consists of alternate layers of CL (clay), SCL (sandy clay) and FS (fine sand).

(2) Selection of foundation work method

As foundation work methods, direct foundation, pile foundation, caisson foundation, ground improvement, etc. may be considered, but in view of the structures planned under this project, the direct foundation or pile foundation seem to be the most appropriate in view of workability and economy.

For pile foundation, factory pre-fabricated concrete pile, steel pipe pile or cast-in-place concrete pile may be used, but factory pre-fabricated concrete pile is not produced in Bangladesh, and steel pipe pile must be imported and is therefore not suitable in terms of cost. Accordingly, cast-in-place concrete pile is the most popularly used foundation pile for structures in Bangladesh. This work can be executed by the same machine used for drilling production wells, with which the local construction contractors are quite capable of doing the work. In the case of factory pre-fabricated concrete pile or steel pipe pile, a pile driver for placing them would have to be imported.

In view of the foregoing, cast-in-place concrete pile shall be adopted as the foundation pile for this project. Where piles are unnecessary, the direct foundation work method shall be adopted.

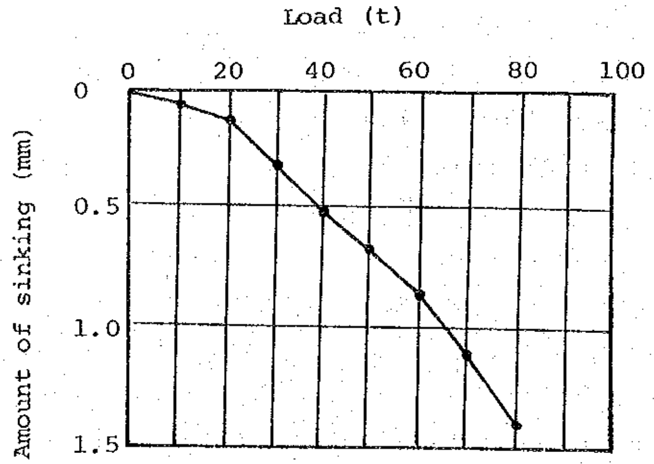
(3) Estimation of soil bearing capacity and bearing capacity of pile

The results of soil bearing capacity test which were conducted for Japan's grants-in-aid projects in Bangladesh are as follows:

Allowable bearing capacity at			Khulna	: $q_a = 6.4\ t/m^2$
"	"	"	Bogra	: $q_a = 6.1 - 6.9\ t/m^2$
"	"	"	Chittagong	: $q_a = 7.9 - 8.0\ t/m^2$
"	"	"	Mymensingh	: $q_a = 6.8 - 8.5\ t/m^2$

A loading test of the piles has been conducted for the hospital project which is now under construction in Narayanganj Town. The foundation piles adopted here are ø400 mm in caliber and 16.0 m in length. Fig. 30-10-5-1 shows the load-sinking curve prepared on the basis of this loading test results.

Fig. 3-10-5-1 Load-Sinking Curve



As can be seen from the above figure, the curve has not reached the point of abrupt bend (load at yield point). This is because the test was stopped while within the allowable load of the pile itself which is ø400 mm in caliber.

The formula for estimating the allowable bearing capacity of the pile by loading test is as follows:

$R_a = 1/3\ R_u = 1/2\ R_y$,

in which R_a : Allowable bearing capacity of pile (t)

R_u : Ultimate bearing capacity of pile (t)

R_y : Load at yield point of pile (t)

The test in Fig. 3-10-5-1 shows that the load is still short of the pile's yield point, but to be on the safe side, the load at yield point was assumed to be 80 t, from which the allowable bearing capacity of pile was calculated to be:

$R_a = 1/2 \times 80 = 40$ t/pile

The ground formation at Narayangaj and Khulna, Bogra, Chittagong and Mymensingh consists of alternate layers of clay, sandy clay and fine sand as in the towns covered under this Project.

Accordingly, the soil bearing capacity of the direct foundation was assumed to be 6.0 t/m^2 and the allowable bearing capacity of the cast-in-place concrete pile 400 mm in caliber and 16.0 m long to be 40 t/pile.

(4) Foundation of the overhead tank

The stability of the overhead tank was studied for the following two cases:

(1) When the water storage tank is empty and subject to wind load.

(2) When the water storage tank is filled to capacity and subject to wind load.

The foundation for the overhead tank was also studied for the foregoing two cases. Since there are no data on wind load for the seven towns in question, the maximum wind velocity was assumed to be 60 knots (30.9m/sec) based on the observation records for Dhaka.

On the aforementioned conditions, the number of piles and maximum load were obtained for the overhead tank by capacity as summarized in the table below.

	Item \ Capacity	200 m^3	300 m^3	400 m^3	500 m^3
	Dead weight (t)	474.0	629.0	758.0	916.4
	Wegiht of water (t)	200.0	300.0	400.0	500.0
	Sum of vertical load (t)	674.0	929.0	1,158.0	1,416.4
	Wind load (horizontal load, t)	8.64	9.87	11.62	12.20
	No. of piles (pcs.)	21	27	32	38
When empty	Tumbling moment (t.m)	130	153	178	194
	Resistance moment (t.m)	1,422	1,887	2,463	3,207
	Safety factor	10.9	12.3	13.8	16.5
	Pile reaction (maximum t/p)	30.0	29.5	30.1	30.1
	" " (Minimum t/p)	15.2	17.1	17.3	18.1
When filled to capacity	Tumbling moment (t.m)	130	153	178	194
	Resistance moment (t.m)	2,022	2,787	3,763	4,957
	Safety factor	15.5	18.2	21.1	25.5
	Pile reaction (maximum t/p)	39.5	40.6	39.4	39.9
	" " (minimum t/p)	24.7	28.2	33.0	34.6

(notes) (1) The wind velocity of 60 knots corresponds to 30.9 m/sec. which can be converted into horizontal load as follows:

$$q = 1/2.p.v^2 = 1/2 \times 0.125 \times 30.9^2 = 60 \ kg/m^2$$

in which q : Wind load

p : Air density, 0.125 $kg/sec^2/m^4$

v : Wind velocity, 30.9 m/sec.

As a result of the above calculation, the pile reaction is certified to be not more than the allowable bearing capacity of 40 t/pile, and the structure is estimated to be tolerable for the piles with Number and the diameter assumed.

(5) Foundation of the structures at Sumamganj Purification Plant

The required number of piles for the various structures at the purification plant was obtained on the basis of their deadweight, weight of water, loas exerted by the pump, valve, pipe, etc. as tabulated below.

Item \ Structure	Intake Work	Receiving Well	Flocculation, Sedimentation Basin	Rapid Sand Filter	Clear Water Reservoir	Sludge and Washing Water Basin
Dead Weight (t)	372.5	135.6	1,838.4	931.5	1,176.0	196.8
Weight of Water (t)	0	35.6	1,107.3	504.6	499.1	53.8
Pumps, valves, Pipes, etc. (t)	2.5	0.8	54.3	33.9	54.9	4.4
Total Weight (t)	380.0	172.0	3,000.0	1,470	1,730	255.0
Area of foundation (m^2)	36.0	28.8	407.8	170.8	281.5	46.2
Weight per m^2 (t/m^2)	10.5	5.9	7.3	8.6	6.1	5.5
Need for foundation pile	Yes	No	Yes	No	Yes	No
No. of Piles	10	0	76	37	44	0

(6) Other structures

Structures other than those of the purification plant and the overhead tank covered by the project are pump house, public post, valve room, etc. The public post and valve room will be built by the direct foundation method as the load is small.

The pump house is also being planned to be erected by the direct foundation method. Its reaction was reviewed as follows.

(1) Deadweight of pump house

Reinforced concrete	$17.59\ m^3 \times 2.4 =$	42.21
Brick	$22.73\ m^3 \times 2.0 =$	45.46
Total		87.67

(2) Pump, motor, valve and operating panel, etc. can be loaded directly on the ground.

(3) As the extended area of foundation is $17.0\ m^2$, the load per unit area would be: $q = 87.67 \div 17.0 = 5.2\ t/m^2$

(4) Since the above load is below $6.0\ 5/m^2$, the direct foundation method shall be employed.

Table 5-10-5-2 Maximum Wind Velocity

(Unit : Knots)

Station / Year / Month	Dacca							Narayanganj						
	1967	1968	1969	1970	1971	1972	1973	1967	1968	1969	1970	1971	1972	1973
Jan.	-	NW 5	SW 17	NW 15	V 14	N 12	W 6		NW 4	SW 17	NW 3	V 2	V 2	V 2
Feb.	-	S 9	N/NW9	W 28	S 13	SW 22	N 60		S 3	N/NW9	V 2	V 2	NE 3	V 10
Mar.	-	SW 43	W 30	W 60	-	SE 13	NW 20		NW 6	W 30	S 4	S 9	V 4	SE 5
Apr.	-	NW 60	NE 17	NW 60	-	E 60	W 60		S 12	NE 17	SE 7	-	V 8	SW 14
May	-	NE 60	V 9	NW 40	NW 50	SW 40	W 40		NE 9	V 9	V 6	-	S 10	V 4
Jun.	-	V 9	S 13	V 20	E 25	N 29	N 13		ESE 7	S 13	V 6	V 5	V 4	SE 3
Jul.	-	SW 31	V 9	SSW28	V 25	SE 42	-		SE/SW16	V 9	SE 9	SW 3	SE 9	-
Aug.	S 13	S/SW 9	E 13	SSW18	SSE20	SE 26	-	SE 6	E/SE5	E 13	V 3	SE 12	SE 23	-
Sep.	SE13	S 13	S 17	SSE29	V 13	ESE20	-	SSE10	SE 3	S 17	SE 4	SE 12	SE 3	-
Oct.	-	SE 13	E 13	SSE 28	SE 20	SE 18	-	E 10	SE 6	E 13	V 7	SE 10	V 3	-
Nov.	N 9	NNE 12	SW 5	NNE40	NE 20	NW 15	-	NW 2	NW 3	SW 5	NNW 6	V 5	V 2	-
DEc.	N/NW5	N 5	V 5	V 10	-	V 10	-	NW 3	NW 3	V 5	-	-	V 2	-

3-10-6 Review of the Sanitary Facility Improvement Plan

(1) Prevalent State of the Sanitary Facility Improvement Plan

It is said that 80% of the diseases in Bangladesh are related to "water". Thirty to thirty-two percent of child deaths (between the ages of one and nine) are reportedly caused by diarrhea, and this situation is being exacerbated by cases of malnutrition.

In view of the situation, the Government of Bangladesh is promoting the sanitary facilities improvement program in order to improve its public health environment. The water seal latrine was introduced into Bangladesh since around 1962 and, so far, it has been installed at about 200,000 locations. Only about 60% of these, however, are being properly used.

In district towns and sub-divisional towns (which are also district towns now), DPHE intends to implement a sanitary facilities improvement program by including it as a part of its water supply scheme for each town. In the rural areas, it has established village sanitation schemes which it is now implementing. Under the Village Sanitation Scheme (Phase I), sanitary facilities at 137,000 places have been improved between 1976 and 1982 with the Project cost of 809.0 Lakh Taka. The Village Sanitation Scheme (Phase II) has been in effect since 1983, and it plans to improve the sanitary facilities at 225,000 places.

(2) Structural Design of Water Seal Latrine

DPHE is planning two types of water seal latrine: the two pit system which it is recommending for urban areas such as district towns, and the one pit system which it is recommending for the rural areas.

Since the towns covered by this Project are the sub-divisional towns (which are also district towns), the scheme is to construct the two pit water seal latrine. The structural design of this two pit water well latrine is as shown in Fig. 3-10-6-1. There are two dropping pits, and when one pit becomes full, the other pit is used while the full one is removed manually. As seen from Fig. 3-10-6-1, holes are provided in the dropping pit so that the liquid portion of faces and urine will seep into the ground.

The construction cost of the two pit water seal latrine is estimated to be about 2,800 TK, 70% of which is the material cost and 30%, labor cost. Construction materials used are:

(1) P-Trap (made of plastic)
(2) Cement
(3) Gravel and sand
(4) Steel bar reinforcement (ø1/4" dia.) for RCC pit cover
(5) Brick
(6) Drain pipe, etc.

As a reference, the structural design of the one pit water seal latrine planned for the rural areas is shown in Fig. 3-10-6-2.

(3) DPHE's Plan

DPHE has not established any sanitation scheme for the district towns and sub-divisional towns (which are district towns now), as an independent project but has included it as a part of its water supply scheme. DPHE therefore desires that the construction work of the sanitary facilities or the provision of materials for it be included as a part of this water supply project.

Fig. 3-10-6-1 Two Pit Water Seal Latrine System

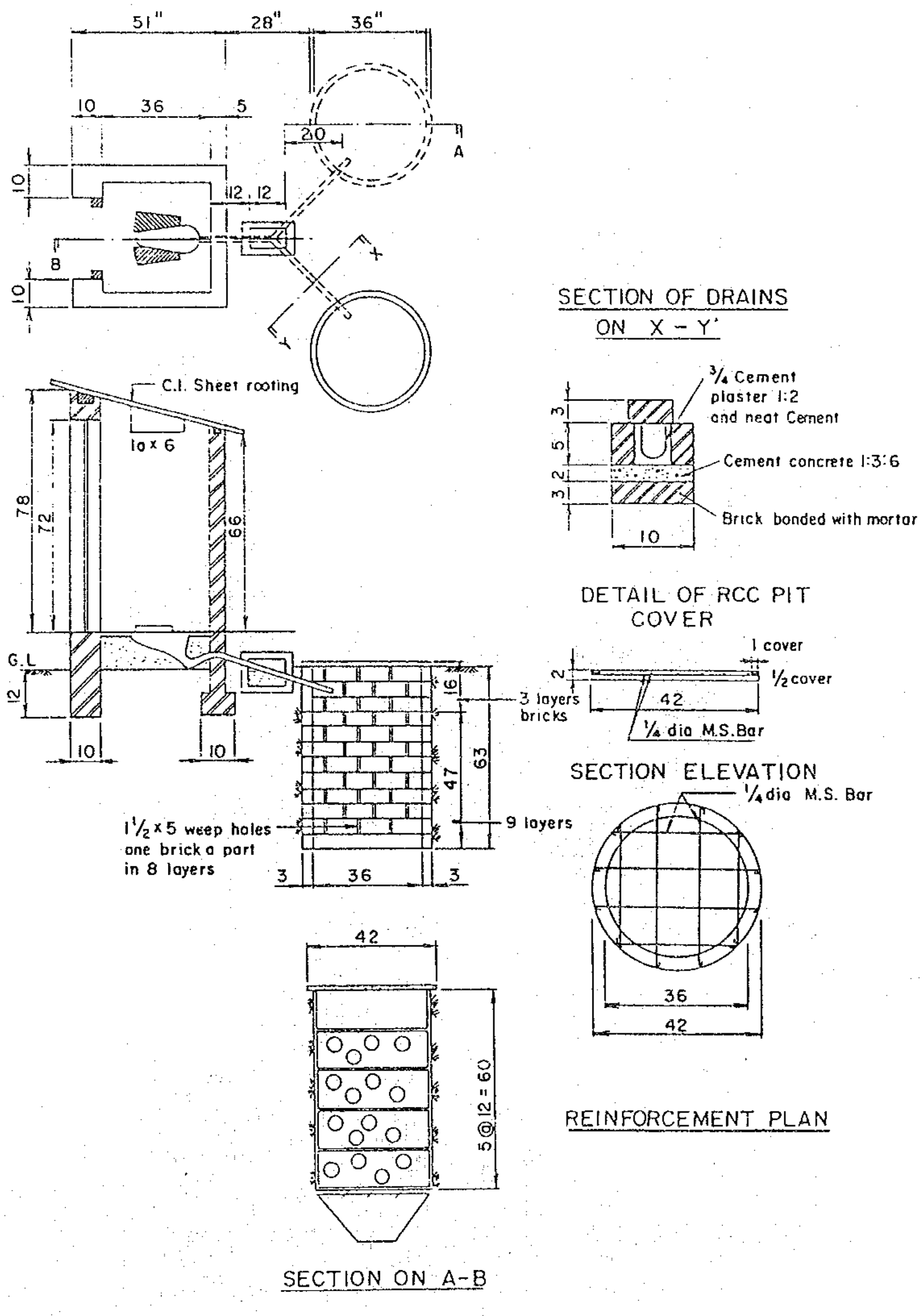
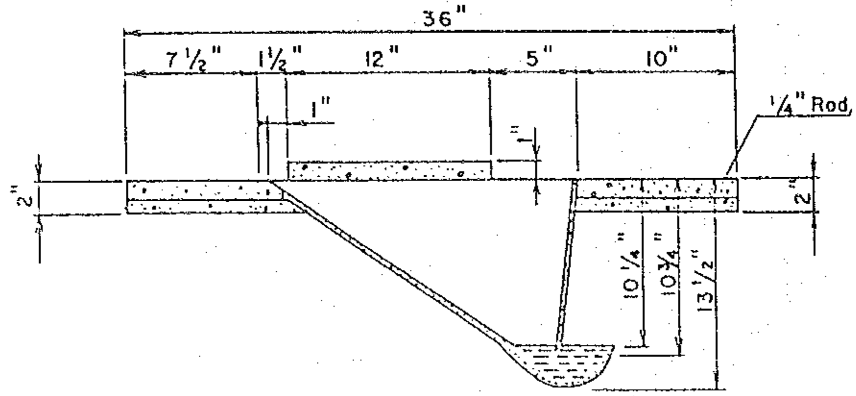
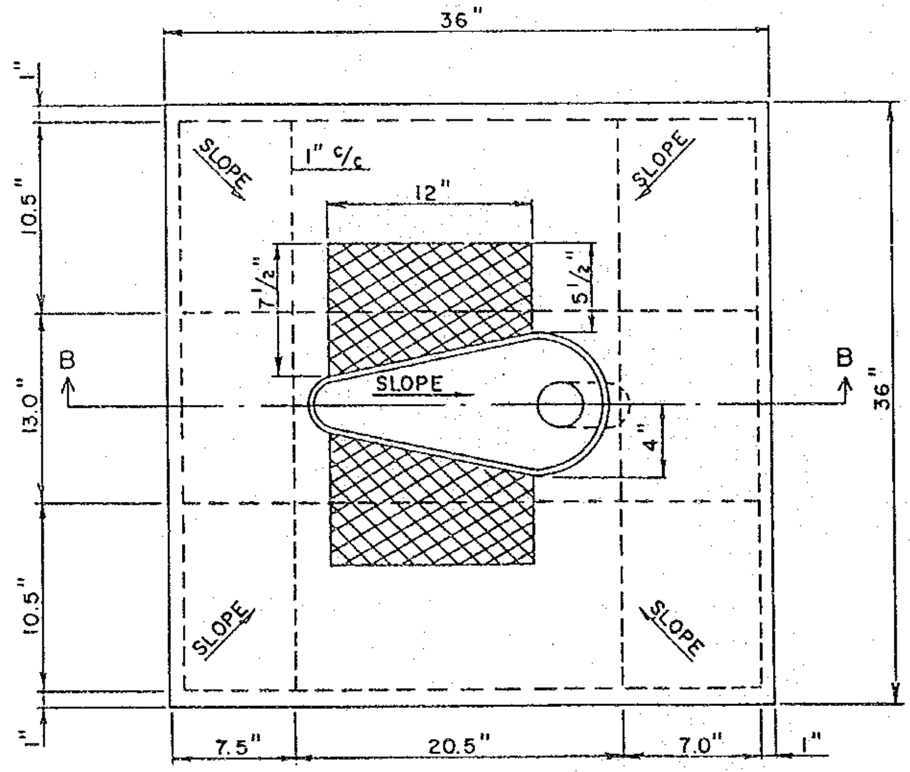


Fig. 3-10-6-2 One Pit Water Seal Latrine System



SECTION B-B



PLAN

	SL. No.		QUANTITY
	R.C.C	SLAB WITH FC PAN	
	1	CEMENT	35 Lbs.
	2	SAND	1.00 cft
	3	KHOA	1.25 cft
	4	ø ¼" M.S.BAR	4 Lbs
		FC PAN	
Executive Engineer P.H.E. V.S. Division – I Dhaka	1	CEMENT	10 Lbs
	2	SAND	0.15 cft
	3	3"x12" SIZE CHIKEN WIRE MESH I.RC	

(4) Observations

The actual situation of the sanitary facilities was investigated by reviewing the data on sanitary facilities submitted by DPHE and conducting field surveys in the seven towns in question.

The conditions of the sanitary facilities in the seven towns are as tabulated below.

Town	Sanitary Latrine	Water Seal Latrine	Service Latrine	Pit/Open Latrine
Jenidah	25%	5% (50 Nos.)	45%	25%
Chuadanga	Approximately the same as in Jenidah			
Narsingdi	20%	(32 Nos.)	50%	30%
Kurigram	Almost all are service latrines. Water seal latrines are being produced mainly for rural areas, but 5% of the production volume is being provided to the townspeople who wish to have one.			
Gaibandha	Almost all are service latrines. About 10% of the water seal latrines produced are being provided to the towns-people who wish to have one. So far, about 150 sets have been offered.			
Feni	Almost all are service latrines. 45 sweepers are being employed and a treatment plant with a high embankment to prevent flood from entering it has been built in the outskirts of the town.			
Sunamganj	20%	20% (about 200 sets)	2-3%	50%-60%

As a result of field survey, it is considered advisable not to include the construction of the water seal latrines, which was additionally requested, within the scope of the grants-in-aid program for the following reasons.

(1) The master plan for excreta treatment has not been established yet in any of the towns. The means for disposing of excreta is approximately the same in every town, being mostly service latrines (of the dipping up system). In some towns, the service latrine clearing is being systematically carried out.

(2) Every town at least distinguishes its ponds for bathing and washing from the shallow places and pools for sanitary facilities. However, the spacing between them seems to be inadequate where the population density is high. Also, their separation is distinctive only during the dry season whereas during the rainy season and flood period, they become commingled by the river water and become indistinguishable.

(3) Since the design of the water seal latrine is to let excreta seep into the ground, it is not in any way different from now in that it is likely to pollute the ground water in the shallow layers where the ground water level is high. When installing a water seal latrine, therefore, it would have to be adequately spaced from the ponds for bathing and washing or from shallow wells.

(4) The field inspection has led to the judgement that improvement of sanitary facilities is of greater urgency in the areas where the population density is high. Such places, however, usually have no other place in which to build the new sanitary facilities than at the existing spots. Also, at places where the population density is high, it is considered more desirable to plan for a centralized excreta disposal system by dipping up rather than the system of allowing excreta to seep into the ground.

(5) The water seal latrine has some desirable aspects in improving the sanitary condition as it seals off the excreta pot from the outside environment with a small amount of water. Further studies on it, including the structural design of the excreta pot and the treatment facilities, are therefore necessary.

(6) The excreta disposal system is somewhat different in each town, which must be thoroughly investigated and reviewed. At the same time, the topography, gradient, distribution of water ponds, distribution and degree of concentration of pollution, flood stage during the rainy season and flood period, flooded areas and other circumstances in each town must be surveyed and reviewed, upon which the master plan for sanitary facilities improvement including the excreta disposal system and the treatment method must be worked out. It is judged more desirable to consider whether the grants-in-aid program should cover the construction work or provision of materials for it only after then.

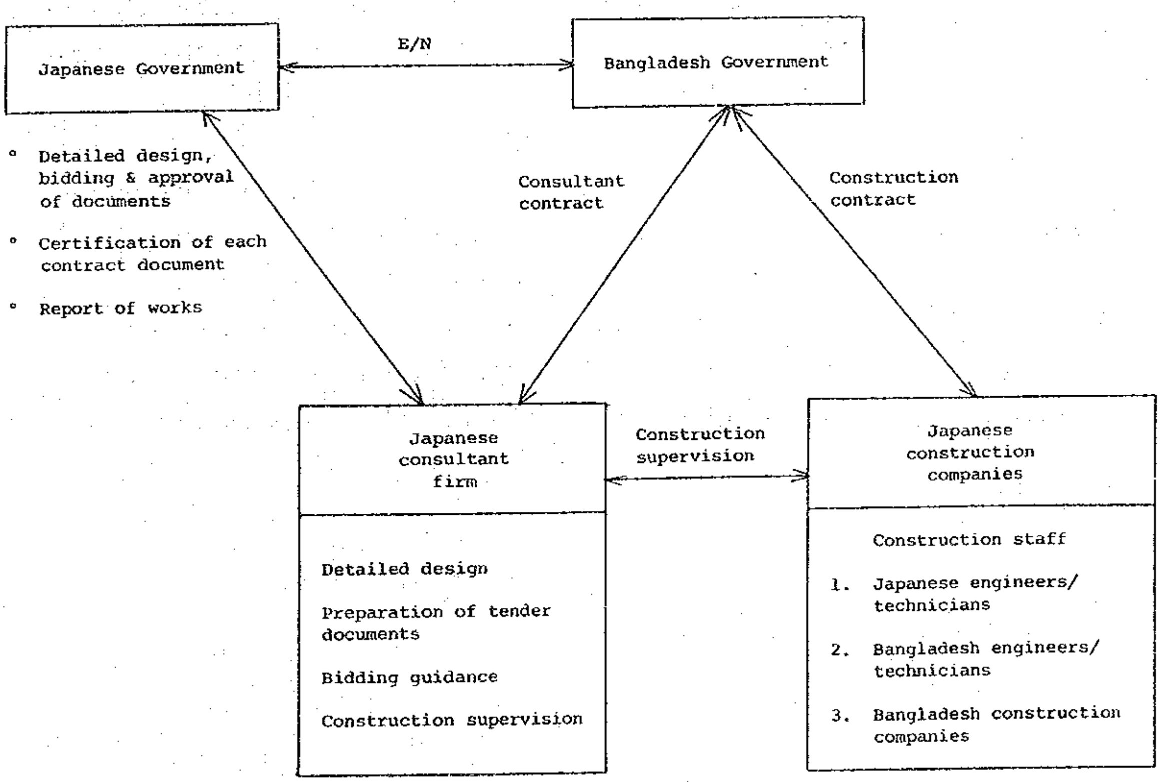
(7) The construction or improvement of sanitary facilities is totally contingent on the awareness of the inhabitants, so that even if such an effort were to be included as a part of the assistance program, its publicity, acceptance of applications and determination of the construction sites are likely to take much longer than in the case of building house connections in the water supplying facilities. It is therefore considered inappropriate as the object of the grants-in-aid program which requires that the construction work be completed within a limited time period. As for the provision of materials, such a program would seem difficult to implement as all of the required construction materials can be procured within Bangladesh.

CHAPTER 4 IMPLEMENTATION SYSTEM FOR THE PROJECT

4-1 Organizations Involved in Implementation of Works

(1) Overall Relationships

This Project will be implemented by the non-compensational fund cooperation by the Japanese Government. The overall relationships among organizations concerned may be illustrated as follows:



(2) Bangladesh Organizations Involved in Implementation of Project

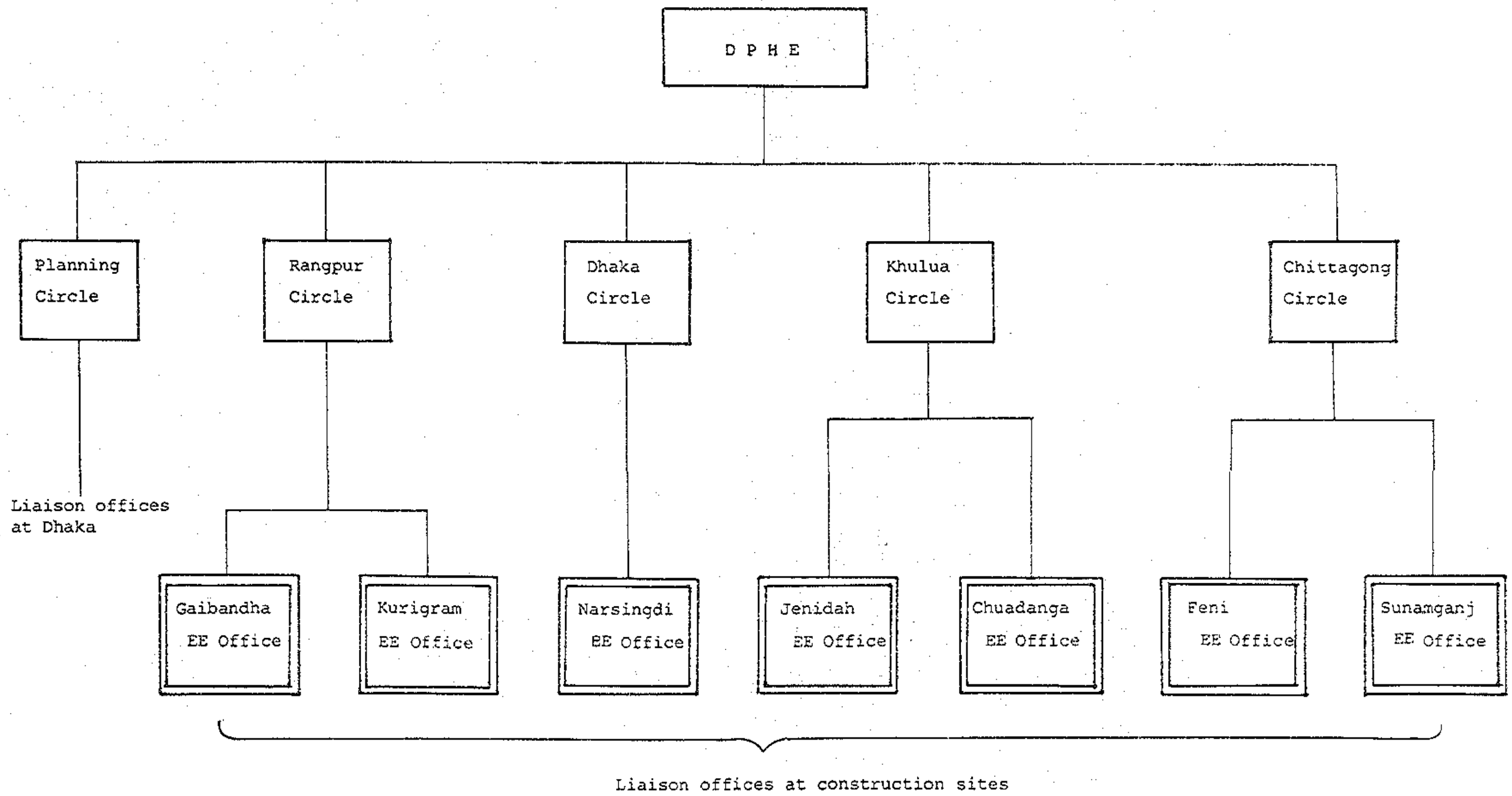
The Project will be implemented by the Bangladesh Government, the Ministry of Local Governments, Rural Development & Cooperatives, Local Government Division and the Department of Public Health Engineering (DPHE).

The Planning Circle of DPHE will become direct channels, through which various deliberations and negotiations at the Central Office (Dhaka) will be done.

While construction sites are scattered around the country, each town has a local office of the DPHE that will become the liaison office at each construction site at the time of construction. The organizational structure of the DPHE central and local offices is as shown in Fig. 4-1.

After the completion of construction works, the DPHE will directly control and manage the facilities. To be in association with the Japanese Consultant and Construction firms, the DPHE should provide one senior engineer assisted by appropriate personnel at each town for bettwe implementation and management and subsequently for operation and maintenance.

Fig. 4-1 Bangladesh Organizations for Implementation of Project



4-2 Implementation schedule

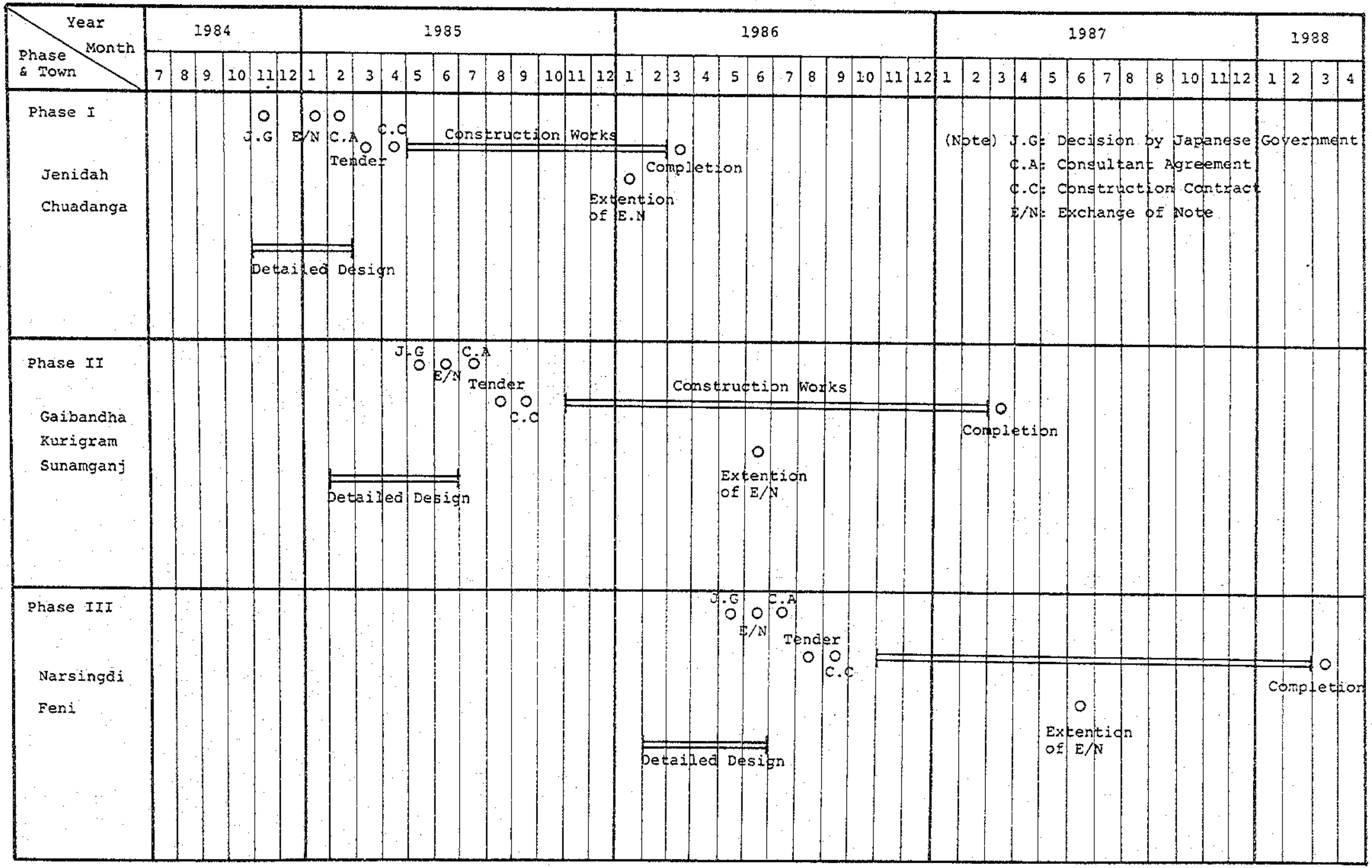
The implementation schedule of this Project is as shown in Fig. 4-2, provided all the towns are to execute the construction work simultaneously.

However, it would not be realistic to start construction of all seven towns at once as to do so would involve technical and economic difficulties. Accordingly, the schedule as a suggestion for the construction work for water supplying facilities in the seven towns was devided into phases upon a review of the scale and contents of water supply project in each town and the degree of difficulty in executing the work in each town. The phased construction schedule is shown in Fig. 4-3. Regarding this phasing, however, it is to be clearly stated here that the Japanese Government has neither approved such phasing nor promised to implement the work according to such phasing.

Fig. 4-2 Construction Schedule for the Establishment Project for Water Supply Facilities

Town	Kind of Works	Quantity	Construction Period 1–28
	Japanese Government		E/N; Approval; Approval
	Bangladesh Government		E/N; Contract with Consultants; Approval of Tender Documents; Approval; Contract for Construction; Certificate of Completion
	Consultants		Consultant Contract; Surveying, Test Boring, Detailed Design, Preparation of Tender Documents; Tender; Construction Supervision
Narsingdi	Production Well	Depth 169m/115m; 11 wells	
	Pumping Facilities	Turbin Pump; 14 sets	
	Overhead Tanks	$500m^3$; 5 towers	
	Distributing Pipes	ℓ = 40,680m	
	Others	Public Post ; 10	
Jenidah	Production Well	Depth 135m; 1 well	
	Pumping Facilities	Turbin Pump; 3	
	Overhead Tanks	$400m^3$; 3 towers	
	Distributing Pipes	ℓ = 20,120m	
	Others	Public Post ; 10	
Chuandanga	Production Well	Depth 120m; 1 well	
	Pumping Facilities	Turbine Pump; 3	
	Overhead Tanks	$400m^3$; 3 towers	
	Distributing Pipes	ℓ = 17,860m	
	Others	Public Post ; 10	
Gaibandha	Production Well	Depth 105m; 3 wells	
	Pumping Facilities	Turbin Pump; 3	
	Overhead Tanks	$400/500m^3$; 2 towers	
	Distributing Pipes	L = 24,470m	
	Others	Public Post ; 10	
Kurigram	Production Well	Depth 73m; 1 well	
	Pumping Facilities	Turbin Pump; 2	
	Overhead Tanks	$400m^3$; 2 towers	
	Distributing Pipes	L = 23,390m	
	Others	Public Post ; 10	
Feni	Production Well	Depth 200/219	
	Pumping Facilities	Turbine Pump; 4	
	Overhead Tanks	$200/300m^3$; 3 towers	
	Distributing Pipes	ℓ = 16,770m	
	Others	Public Post ; 10	
Sunamganj	Purification Plant Works	Body Concrete	
	Overhead Tanks	$200m^3/400m^3$; 2 towers	
	Distributing Pipes	ℓ = 21,590m	
	Others	Public Post ; 10	

Fig. 4-3 Phased Construction Schedule for the Establishment Project for Water Supply Facilities (Draft)



4-3 Scheme of Execution

(1) Execution Method

Facilities to be constructed under the Project will be as follows.

- Production wells
- Overhead tanks
- Distributing pipes
- Public Post
- Purification plants (Sunamganj Town)

Following methods are considered in order to build facilities mentioned above.

(1) Semi-turn key method
(2) Direct operation method

Both methods have their own merits and demerits, but the direct operation method in particular requires some increase in DPHE staff, resulting in the increase of efforts on the part of consultants as well. Recently, the direct operation method often involves works with their volumes of works hart to determine, but this is not likely to happen for above mentioned facilities. Non-compensational fund cooperation projects generally employ the semi-turn method. Taking account of the foregoing, the semi-turn key method will be employed.

(2) Scheme of Execution

(i) Production well works

Since it is impossible to employ the water jet method in Kurigram and Gaibandle, well works will be done by means of rotary or percussion boring machines. For strainers, those made of stainless steel will be used, around which gravel fed and selected will be filled. The ground surface portion of each well will be filled by mortar.

(ii) Overhead tank works

Piling-in-site method is employed for the foundation of each overhead tank. Boring machines will be used for the well boring as well. At the concrete placing site, scaffolds and bearing piles will be installed. Concrete will be conveyed to height using elevators.

(iii) Distributing pipes works

Excavation for the installation of pipelines will be all done manually. In the back filing and sand placing works, transoms will be used for the tamping.

Pipes with apertures 200 mm (8") or smaller will be mainly used, all of which will be installed manually.

(iv) Purification plants and iron removal plants

All excavation and back filling works will be done manually. Direct foundation (footing) will be used as a rule, but footing-in-site method will be used instead where foundation beds are required, such as moist places, etc. Concrete punching will be done by installing scaffolds, bearing piles, etc.

(3) Period of Works

Taking account to meteorological conditions in Bangladesh, it is desirable to execute works in the dry season between November and June. The elevation of Bangladesh is low, with the majority of the land being planes. Therefore, the rainy/flood season from July to October brings about high water levels at rivers, creeks, etc., and the underground water level will also rise at the same level with that of the ground surface. Under such conditions, foundation works for structures, boring works for the piping and plumbing will become extremely difficult.

The implementation of the non-conpensational fund cooperation on the part of Japan, on the other hand, is subject to various restrictions. Therefore, care should be taken to execute the works in such a manner that merits of the dry season (from November to June) can be maximized.

(4) Time Period for Carrying out the Detailed Working Design Study

As stated in the foregoing paragraph, it is desirable that the civil engineering works be executed during the dry season from November to June in view of the climatic conditions in Bangladesh. As with civil engineering work, plane surveying (on the planned pipeline route and proposed sites of various structures), test boring, foundation survey and so forth for the detailed working design are difficult to carry out during the rainy season. Therefore, the timing for various surveys necessary for detailed working design must be adequately studied in conjunction with the timing for executing construction works. As these surveys will require 28 months after exchanging official notes, as shown in Fig. 4-2, it is judged difficult to complete them in the normal form of the grants-in-aid assistance program, and therefore it is considered necessary to take some measures to permit execution of surveys and studies for detailed working design prior to exchanging of official notes and conclusion of the consultancy agreement.

4-4 Scope of Works

The scope of the construction works in our project is as follows:

(1) The range the Bangladesh Government bears responsibility:

① Acquisition and development of land necessary for constructing the water supply facilities.

② Taxes and handling charges for imported materials and equipment required for the construction works

③ Cost of facilities and equipment to maintain and operate the water supply facilities. Such costs as to build a control office building and spare-part storehouse as well as to purchase small jeeps and motorcycles in each town.

④ Purchasing cost of the followings which are part of the expansion/installation expenses of Mechanical & Electrical Division of DPHE:

			unit
a	Boring machine	ø: 550 mm, L: 350 M	1
b	"	ø: 750 mm, L; 150 m	1
c	Microbus		2
d	Jeep		2

⑤ House connection works.

⑥ Public post works excluding those at 10 locations which are to be build by the Japanese Government. (provided, however, the above 5 and 6 are not to be included in the project cost in our report)

(2) The range the Japanese Government bears the responsibility:

① The construction works of the water supply facilities (production well, filter plant, pumping facilities, pumping house overhead tank transmission pipe, distributing pipe, related structure of pipeline and 10 public posts in each town)

② Freight and insurance charges on imported materials and equipment from Japan.

③ Cost puchasing water examination equipment which will constitute part of the maintenance/ operation facilities and be stationed in each town.

④ Such necessary equipment as is following which will be included in the items in the Plan expanding the functions of Mechanical & Electrical Division of DPHE, and which will be necessary to check, maintain and repair wells:

		unit
a	Pumping test equipment loaded on a truck	1
b	Compressor 600 cfm, 300 psi	1
c	Compressor 300 cfm, 250 psi	1
d	Tools (such as jetting tool)	1
e	Truck (5 ton-car) for transporting matorials/equipment	2

⑤ Cost designing and supervising the project works.

4-5 Detailed Design and Construction Supervision

(1) Contents of Detailed Design

(a) Topographic Survey and Geological Survey

1 Topographic Survey

2 Test Boring

3 Study of Foundation by Boring, and

4 Water Quality Test

(b) Detailed Design

(2) Contents of construction supervision

(a) Guidance and assistance in tender and contracting works

The consultant shall invite and execute tender on construction works on behalf of the Government of Bangladesh as entrusted by it, and shall guide and assist so as to conclude the construction contract as between the Government of Bangladesh and the Contractor as promptly as possible.

(b) Construction supervision activities

Major works of the consultant are the control of (1) work schedule, (2) quality and (3) cost. In the grants-in-aid of Japan, the contract will be on a semi-turn key basis, and the control functions other than the above three - for example, material management, machinery and equipment management, labor management, safety and health management - will be within the scope of responsibility of the construction contractor.

Since the construction sites of the project are dispersed over seven towns in Bangladesh and the consultant's duties must be performed only with limited manpower, the consultant's personnel, although they may be stationed in Bangladesh, would be able to give only a part of their time for supervision at each construction site. The construction contractor(s) will be some Japanese enterprise, and the consultant would be performing its supervisory duties on the basis of the reports submitted by that construction contractor.

The construction supervision activities of the consultant will be performed by civil engineer, pipeline engineer and geohydrogist, etc. who will be dispatched to Bangladesh. The civil engineer will be stationed in Bangladesh throughout the construction period.

(c) Interim and final inspection

Final inspection and, if necessary, interim inspection of construction works will be performed by consultant.

CHAPTER 5 MAINTENANCE AND MANAGEMENT SCHEME

5-1 Organization

(1) Current Maintenance/Management Organizational Structure

As mentioned in the section describing the background in the Chapter 2, water services throughout Bangladesh excluding Dhaka and Chittagong are provided by the DPHE. The maintenance/management of water services are to be done primarily by the municipality (Poroushoava) of each city. At present, however, water services of only 19 cities are being run by respective municipalities, whereas the services of 24 cities are run by the DPHE and seven cities by the joint efforts of the municipalities and the DPHE under the guidance given by Netherland and the ADB.

Of seven cities included in the Project, Jenidah and Feni alone provide water services, while water supply facilities in Gaibandha are far from the completion. Water supply facilities in the remaining four cities are completed, but the house connections have been delayed and the water supply is not provided due to other reasons. At present, however, all of the seven cities are provided with construction works and water supply by the DPHE, but each municipality (Poroushoava) does not have a system to take over such services.

The current organizational structure of each Municipality (Poroushoava) is as shown in the Fig. 5-1 & 5-2, and the structure of other towns is nearly the same as that of the municipalities. The division in charge of drinking water in each municipality is the Water Supply Supervisor Office that maintains and controls tube wells.

Fig. 5-1 Current Organizational Structure of Poroushoava (Municipality) (Example: Jenidah)

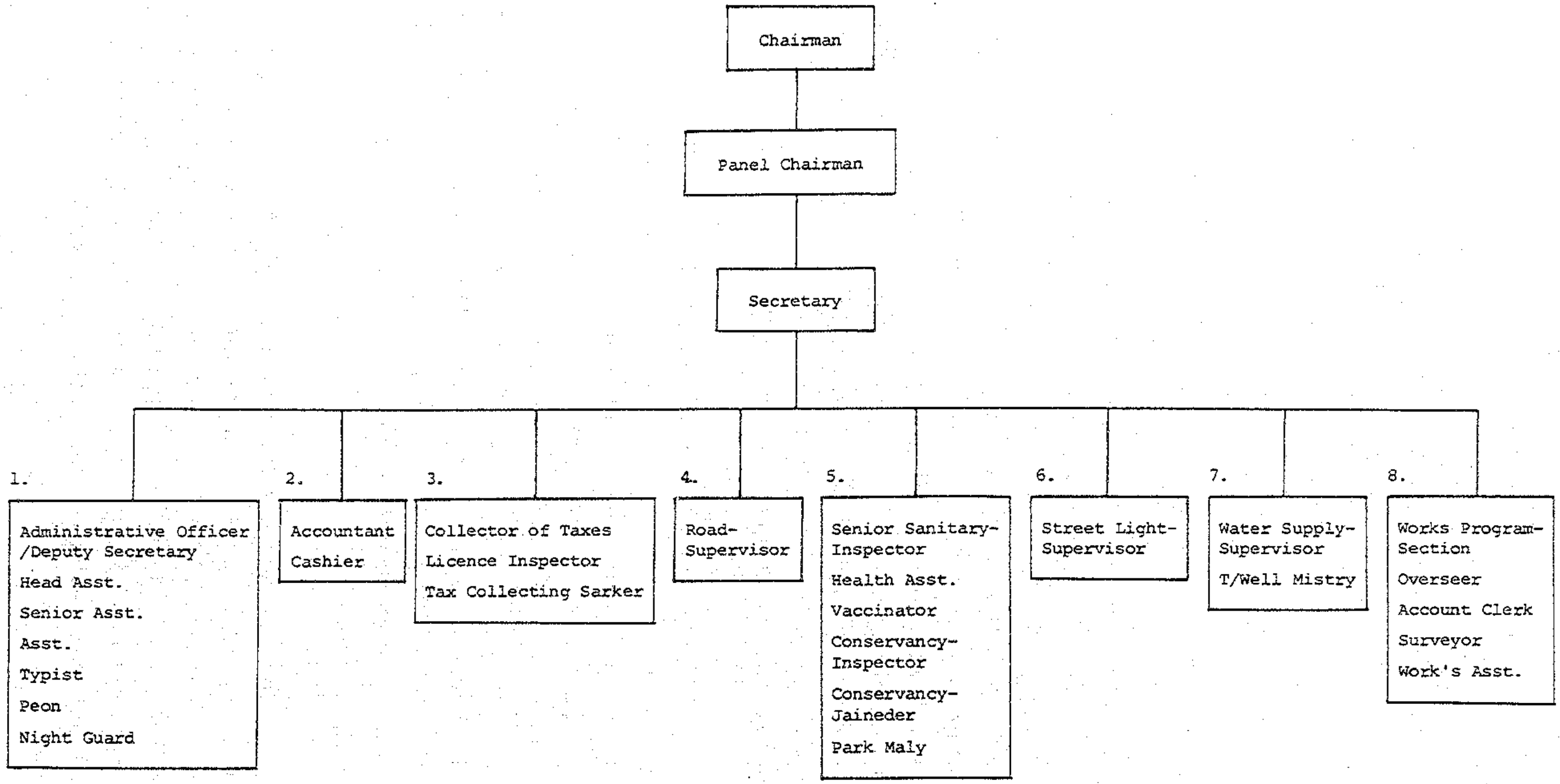
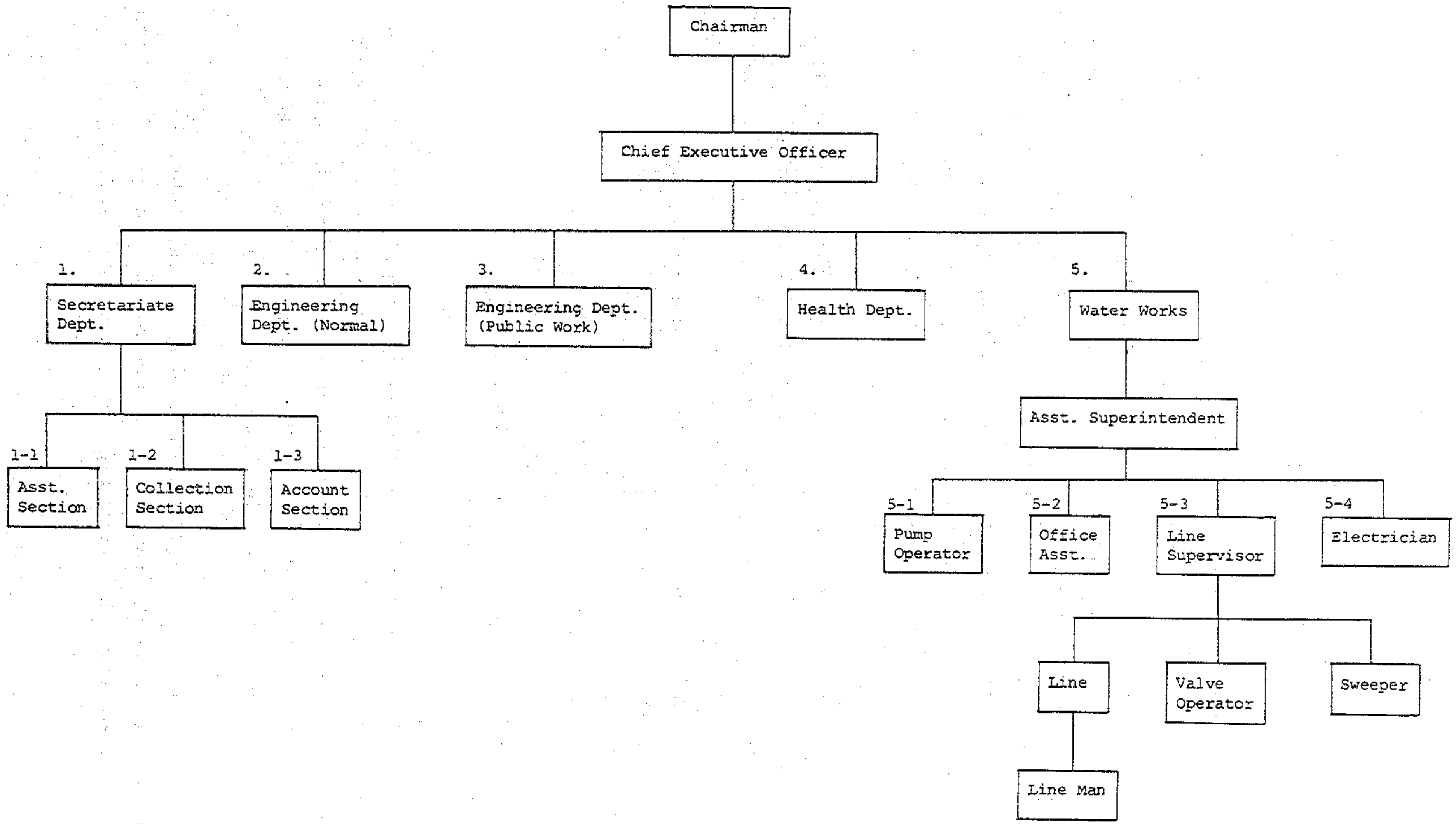


Fig. 5-2 Current Organizational Structure of Narayanganj Town



(2) Recommendation on New Organization

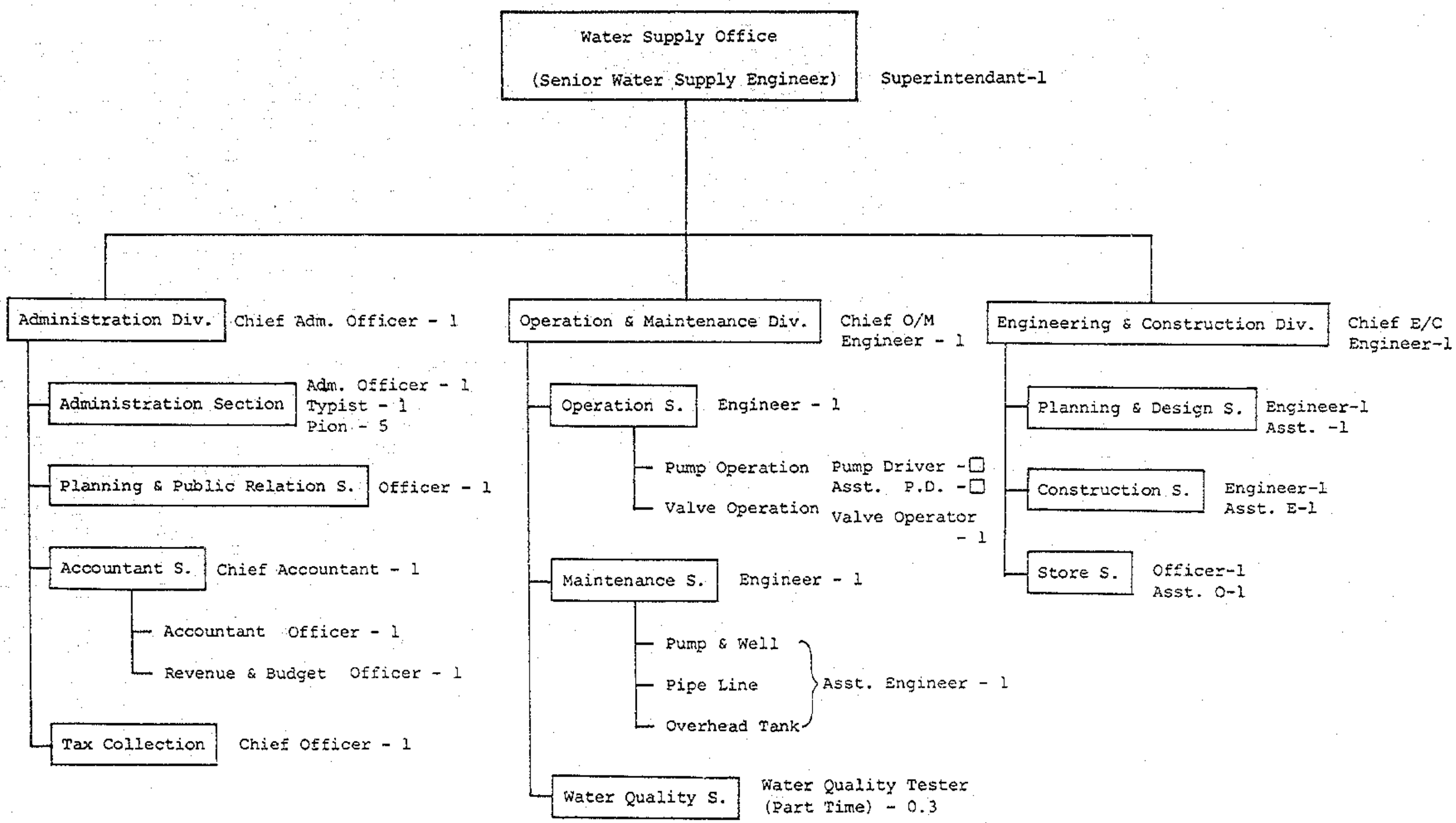
In order to ensure an appropriate maintenance and management of water supply services, it is necessary to have a proper managing body capable of efficient operations. It is also necessary to establish a new division with responsibilities appropriately assigned to individual staff to clarify respective areas of responsibilities, and to ensure smooth communications and liaison among colleagues and different divisions. The water supply organization to be established anew should have at least following divisions to carry out operations given below.

(1) Public relations division for the P.R. and diffusion of house connection type water supply
(2) Division to operate water supply facilities and to ensure stable water supply
(3) Water (utility) charge collection division
(4) Estimation of operating/administrative costs of water supply facilities
(5) Maintenance/control of materials
(6) Investigation, planning and design
(7) Construction and repair works
(8) Water quality control

We recommend a new organizational structure such as that shown in Fig. 5-3, based on discussions held with the DPHE staff, organizational structures found in existing similar facilities (WASA and Narayanganj), etc. as water supply organization at the town level.

It is vital to form a proper administrative organization according to this recommendation, while taking account of the administration system of Bangladesh.

Fig. 5-3 Recommendation of Implementation, Operation and Maintenance Organization



Note: □ is decided according to number of pumps.

The outline of the new organization recommended above in as follows.

(1) Administration Division: In addition to the general administration over the entire organization, planning of future water supply projects, diffusion and PR of house connection water supply, calculation and payment of salaries and other expenses, preparation and analysis of fiscal budget and maintenance/management cost, collection of utility charges, etc. are their responsibilities.

(2) Operation and Management Division: operation and management of water supply facilities are their direct responsibilities. Namely, the operation of pumps and valves that are water supply equipment, in order to ensure stable water supply for the residents, maintenance/control of structures such as well, water towers, pipe lines, etc. and equipment including pumps and valves, and water quality control on the part-time basis. Should any abnormalities occur at water supply facilities/equipment, the division contacts the Construction Section of the Engineering and Construction Division so as to take appropriate steps.

(3) Engineering and Construction Division: planning and design of water supply facilities expansion works, investigation of new water sources, etc. that may be planned in future. Management of construction works of such new projects and repair works of existing facilities/equipment, and storage/maintenance control of materials, etc.

It is also desirable that the duties of the Engineering and Construction Department be carried out by DPHE. This is because the duties to be handled by the Engineering and Construction Department require advanced technical knowledge and experience, and it is extremely difficult and costly to secure engineers possessed of such technical knowledge and experience in each town.

No problem is foreseen in this respect since DPHE has offices in every town.

5-2 Operation and Maintenance

It goes without saying that the operation and maintenance organization recommended in the foregoing must be put into a proper order in order to operate the constructed water supply facilities effectively. The appropriate assignment of operation and maintenance staff consisting the organization is also vital. Such staff should be engineers/technicians and others with adequate educational backgrounds or experience in their respective areas. In Bangladesh, however, 50 cities of 64 cities or so are providing water supply services at present, which have just recently started the services, following the WASA covering Dhaka and Chittagong.

It is obvious from the above that there are only limited number of engineers/technicians with experience over the entire services of water supply. When the Project and other water supply projects are completed, the shortage of engineers/technicians and other staff will become inevitable, posing a threat to the proper operation of maintenance and management of water supply facilities. In this regard, it is vital to train engineers/technicians and other staff to be engaged in this line of services.

Although the DPHE will manage directly the facilities following the completion of the construction, the training of the staff mentioned above is a must. It will be appropriate to give the on-site training to such staff using already completed facilities. However, other staff who supervise over the entire water supply services should also be trained, which requires technical cooperations from Japan and other countries concerned. The operation of each facility/equipment will be explained adequately by the construction companies on delivery of such facilities/equipment.

As for the number of staff to be engaged in the operation and maintenance, one staff or so per 1,000 residents is dominant in Japan for water facilities of a similar size with the facilities under this Project.

The current number of staff of Dhaka WASA and that of Chittagong WASA are at respective ratios of 1/1,250 and 1/1,200 residents, while it is about 1/3,000 residents in Narayanganj Town.

Assuming that the Engineering and Construction Department responsible for design and construction will be taken care of by DPHE, the number of personnel required in each town, built up on the basis of Fig. 5-3, is between 30.3 persons and 54.3 persons. In terms of the ratio to population, the number of personnel ranges between 1/1,500 and 1/1.900 or therebout.

5-3 Details of Operation and Maintenance

Maintenance and management of water supply facilities are roughly divided into following three types of operations.

(1) Maintenance/management of facilities/equipment
(2) Water quality control
(3) Hygienic control

(1) Maintenance/Management of Facilities

Water supply facilities must maintain adequate functions against the demand, and proper steps/measures are expected to be taken as called for. Therefore, it is vital to prepare and maintain drawings, books/files, records, etc. of constructed facilities. Such data are necessary not only for the daily operation but also for emergency cases such as accidents and disasters, in order to ensure prompt steps to be taken for the proper restoration of the facilities.

Since major water sources are wells, it is vital to record the daily quantity of water pumped up and water levels at the time of water pumping and at the time when the pumping is stopped to ensure appropriate well control.

Most of pipe lines are installed under roads. Thus pipes may be broken and joints may be derailed due to the road traffic. Water may also leak due to the broken pipe, etc., all of which must be discovered and repaired immediately.

(2) Water Quality Control

The primal objective of water supply facilities is to supply safe and clean water to residents always. The quality of water is, therefore, one of crucial factors in terms of maintenance and control. Since the Projects makes use of wells as the main water source, the variation in water quality should be insignificant, but periodical water quality tests should be carried out. EPCB criteria should be used for the judgement of water quality.

(3) Hygienic Control

As mentioned (2) above, the primal objective of water supply facilities is to supply safe and clean drinking water extensively to residents, in order to contribute to the improvement of public health/hygiene and the betterment of living environments. In light of this objective, hygienic control of the facilities is of the primal importance.

Should no proper maintenance and management are ensured, not only the primal objective will be lost but also the water supply facilities, which suppose to improve the public health/hygiene and living environments, may even become media for infectious diseases of the digestive system. It must not be forgotten that the deterioration of maintenance/control level in water supply facilities always poses a threat of causing infectious diseases in addition to the reduction of service life of the facilities/equipment and the deterioration of functions, different from many other public facilities/equipment.

In this regard, it is recommended that the health control be implemented for engineers/technicians and other staff engaged in the operation of water supply facilities, and to maintain environments surrounding wells, etc. in clean conditions so that no hygienic problems would occur.

5-4 Facilities and Equipment for Maintenance and Control

Offices, storehouses, etc. are necessary for the operation and maintenance organization to execute its functions. It is desirable to utilize existing buildings for offices and storehouses, which shall be arranged by the Government of Bangladesh, but in the event that these must be constructed anew, these in each town would be as follows, as per the projects aided by the ADB and the Netherlands.

(1) Main administrative office building:
1,000 sft (92.9 m^2); 1 building

(2) Storage building for spare parts, etc.:
2,000 sft (185.8 m^2); 1 building

A room for pump operators, office and lodging will be provided in every pump house to be build anew.

Following vehicles will be required to visit various water supply facilities for each towns.

(1) A small jeep: 1

(2) Motorcycles : 2

A set of simple water quality test equipment should be installed in each town.

5-5 Maintenance & Control Cost and Water Rate Revenue

(1) Maintenance/Control Costs

For the organization recommended in 5-1, the new organization would require following costs/expenses

(a) Personnel cost: 373,500 TK/month

(b) Office consumables, etc.: 1,000 TK x 7
= 7,000 TK/month

(c) Vehicle fuel cost: 100 liters x 17.5 TK/liter x 7
= 12,250 TK/month

(d) Building maintenance cost: 1,000 x 7
= 7,000 TK/month

(e) Operation cost for pumps, etc.: 618,527 TK/month

(f) Consumable including pumps: 5%, 30,926 TK/month

(g) Chemicals cost: 40,783 TK/month

Total 1,089,986 TK/month

The construction cost of the administrative office building, etc. and the purchase cost of vehicles, etc. will be as follows.

(a) Construction cost for the administrative office building, etc.: 4,220,447 TK

(b) Purchase cost for vehicles, etc.: 2,714,138 TK

(2) Water rate revenue

The planned water rate in the potable water supply project presently under construction supervised by DPHE is 20 TK per month for a general household. Assuming that our project can rate the same, and that in the target year the projected water supply for the house holds will be completed, the revenue amounts approximately to 324,700 TK per month. The breakdown of the revenue according to the town is shown in Table 5-4.

(3) Comparison between maintenance/operation cost and rate revenue

As is calculated in the former section, the maintenance/operation costs about 1,090,000 TK per month, while

Table 5-1 Maintenance/Control Costs/Expenses by Town (Totalization)

(per month)

Item	Narsingdi	Jenidha	Chuadanga	Gaibaudha	Kurigram	Feni	Sunamganj	Total
Personal cost	68,900	50,200	50,200	50,200	48,500	51,900	53,600	373,500
Office consumables, etc.	1,000	1,000	1,000	1,000	1,000	1,000	1,000	7,000
Vehicle fuel cost,100ℓx17.5TK/ℓ	1,750	1,750	1,750	1,750	1,750	1,750	1,750	12,250
Building maintenance cost	1,000	1,000	1,000	1,000	1,000	1,000	1,000	7,000
Operation cost for pumps, etc.	212,940	81,900	81,900	81,900	54,600	58,240	47,047	618,527
Consumable including pumps	10,647	4,095	4,095	4,095	2,730	2,912	2,352	30,926
Chemicals cost	-	-	-	-	-	-	40,783	40,783
Total	296,237	139,945	139,945	139,945	109,580	116,802	147,532	1,089,986

Table 5-2 Maintenance/Control Costs/Expenses by Town (Personnel Cost)

(per month)

Occupation	Payment	Narsingdi		Jenidah		Chuadanga		Gaibandha		Kurigram		Feni		Sunamganj		Total
		No. of workers	Amount	No. of workers	Amount	No. of workers	Amount	No. of workers	Amount	No. of workers	Amount	No. of workers	Amount	No. of workers	Amount	
Superintendant	4,500	1	4,500	1	4,500	1	4,500	1	4,500	1	4,500	1	4,500	1	4,500	31,500
Chief Admi. Officer	3,500	1	3,500	1	3,500	1	3,500	1	3,500	1	3,500	1	3,500	1	3,500	24,500
Chief O/M Engineer	3,500	1	3,500	1	3,500	1	3,500	1	3,500	1	3,500	1	3,500	1	3,500	24,500
Chief E/C Engineer	3,500	1	3,500	1	3,500	1	3,500	1	3,500	1	3,500	1	3,500	1	3,500	24,500
Section Chief/Engineer	2,000	9	18,000	9	18,000	9	18,000	9	18,000	9	18,000	9	18,000	9	18,000	126,000
Officer	1,500	2	3,000	2	3,000	2	3,000	2	3,000	2	3,000	2	3,000	2	3,000	21,000
Pump Driver	900	14	12,600	3	2,700	3	2,700	3	2,700	2	1,800	4	3,600	5	4,500	30,600
Valve Operator	900	1	900	1	900	1	900	1	900	1	900	1	900	1	900	6,300
Asstt. Engineer	900	4	3,600	4	3,600	4	3,600	4	3,600	4	3,600	4	3,600	4	3,600	25,200
Asstt. P. Driver	800	14	11,200	3	2,400	3	2,400	3	2,400	2	1,600	4	3,200	5	4,000	27,200
Typist	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	10,500
Pion	500	5	2,500	5	2,500	5	2,500	5	2,500	5	2,500	5	2,500	5	2,500	17,500
Water Quality Tester (Part Time)	2,000	0.3	600	0.3	600	0.3	600	0.3	600	0.3	600	0.3	600	0.3	600	4,200
Total			68,900		50,200		50,200		50,200		48,500		51,900		53,600	373,500

Table 5-3 Maintenance/Control Costs/Expenses by Town (Operation Cost of Pumps)

(per month)

Item	Narsingdi	Jenidah	Chuadanga	Gaibaudha	Kurigram	Feni	Sunamganj	Total
1. Total Output of Motor	234	90	90	90	60	64	51.7	-
2. Basic 10 TK/KW	2,340	900	900	900	600	640	517	6,797
3. Energy Consumption KWH	84,240	32,400	32,400	32,400	21,600	23,040	18,612	-
4. Electric Charge 2.5 TK/KWH	210,600	81,000	81,000	81,000	54,000	57,600	46,530	611,730
Total	212,940	81,900	81,900	81,900	54,600	58,240	47,047	618,527

Table Sunamganj Chemicals Consumption

Water processing volume: 2,997 m^3/day x 1.1 x 30 days = 98,901 m^3

Ammonium sulfate consumption: 98,901 m^3 x 0.010 x $\frac{100}{17}$ = 5,817.7 kg

Bleaching powder consumption: 98,901 m^3 x 0.002 x $\frac{100}{60}$ = 329.7 kg

Chemicals cost: Ammonium sulfate: 5,817.7 kg x 5.73 TK/Kg = 33,335 TK)

Bleaching powder: 329.7 kg x 22.59 TK/Kg = 7,448 TK) ..... Total: 40,783 TK the rate revenue is about 324,000 TK per month. Thus, water rate revenue amount to about 30% of maintenance/ operation cost. The balance of 70% is to be filled by the Bangladesh Government finding some other source of fund.

Table 5-4 Town Water Rate Revenues

Town	Households to be rated	Rate TK/Month	Revenue TK/Month
Narsingdi	3,570	20	71,400
Jenidah	2,115	20	42,300
Chuadanga	2,270	20	45,400
Gaibandha	2,470	20	49,400
Kurigram	1,980	20	39,600
Feni	2,205	20	44,100
Sunamganj	1,630	20	32,600
Total	16,240		324,800

5-6 Expansion of DPHE Mechanical and Electrical Division

The major source of water under this Project is wells, which amount to 29 wells including existing ones. It is anticipated, however, that the number of such wells and wells to be built in future will amount a considerable number.

In the current framework of the DPHE, investigations and the construction of wells are being done by the Ground Water and Exploration Division, while the pumping equipment and motors are the responsibility of the Mechanical and Electrical Division.

Since the present organizational structure of the Mechanical and Electrical Division does not have sufficient capacity to cover the maintenance, control and repair of wells to be built, a plan to expand the organization is being considered within the DPHE.

Pipelines, water towers, etc. under this Project are structures on the ground, and their maintenance and control should be easy. Wells are, however, located underground, and the maintenance and control of such wells will require technical skills and experience as well as machinery, since direct visual inspection is impossible. It is, nevertheless, considered unnecessary to install such machinery in every one of the seven towns, in terms of technical consideration.

It would be more economical to have an appropriate organ with engineers/technicians within the framework of the DPHE in order to assist the staff of such towns. It will, therefore, be necessary to procure following equipment for the maintenance and repair of wells, together with the expansion and betterment of the DPHE Mechanical and Electrical Division.

(1) Equipment for inspection and repair of wells

1) Pumping test equipment mounted on a truck for pumping test before and after repair of the well: 1 set

2) Compressor; 600 cfm, 300 psi for pressure feed of water to clean the screen: 1 unit

3) Compressor; 300 cfm, 250 psi for pressure feed of water to clean the screen: 1 unit

4) Tools (jetting tools, etc.) parts for cleaning the screen: 1 set

(2) Well boring equipment (for use in drilling a new well as an urgent countermeasure when the well is choked up)

1) Boring Machine; ø550 mm, L = 350 m: 1
2) Boring Machine; ø750 mm, L = 150 m: 1

(3) Transportation equipment (for carring materials and workers)

1) Trucks (5 ton loading capacity): 2
2) Microbuses : 2
3) Jeeps : 2

CHAPTER 6 ASSESSMENT OF PROJECT OPERATIONS

6-1 Studies on Water Cost

The cost of water may be obtained by the following formula.

$$\text{Cost} = \frac{\dfrac{\text{Construction cost + interest}}{\text{Service life}} + \text{annual expenses}}{\text{Total annual water supply}}$$

Assuming that the construction cost is the total cost for the seven towns with the low interest rate of 3.0% of Japanese OECF with the annual expenses calculated in Chapter 5, the total quantity of water to be supplied per year will be as given below, and the cost of water calculated for house connection water supply alone is as follows.

Construction cost	:	384,006,000 TK
Interest	:	3.0%
Annual expenses	:	1,090,000 TK/month x 12 = 13,080,000 TK
Service life	:	20 years
Total annual water supply	:	Total population of seven towns subject to water supply: 468,700 The house connection type water supply accounts for 50% of the total population. Since the quantity of water to be supplied per person is 90 liters/day, the total annual water supply will be as follows.

Quantity = 468,700 pax x 0.50 x 90 liters/day x 365 days

$= 7{,}698{,}397.5\ m^3$

Therefore,

$$\text{Cost} = \frac{\dfrac{384{,}006{,}000 \times (1 + 0.03)^{20}}{20} + 13{,}080{,}000}{7{,}698{,}397.5} = 6.20\ TK/M^3$$

6-2 Estimated Benefits and Benefits/Cost Ratio

Effects of water supply operations due to the betterment of drinking water supply facilities will be seen in various aspects. The direct benefit that can be calculated is the water utility charge revenue resulted from the house connection water supply. The water utility charge planned by the DPHE for other similar projects is 20 TK per month per house connection for the household use. The total number of house connections to be completed by 1990 will be 16,240 households, which will amount to 16,525 households including existing ones and those to be completed under this Project. The sum of water utility charges per year to be obtained through the house connection water supply will be as follows.

B = 16,240 households x 20 TK x 12 months
= 3,897,600 TK

The sum of the construction cost under this Project and that of the house connection mentioned above is as follows.

C = 384,066,000 + 131,642,000 = 515,708,000 TK

Therefore, the benefit/cost ratio per year may be calculated as follows.

B/C = 0,008

Table 6-1 Unit water cost for each town

Town	Construction cost 1,000TK	Monthly expenses TK/Month	Annual expenses 1,000TK/Year	50% of water supplying population (persons)	Day water volume supplied m^3/Day	Unit water cost TK/m^3
Narsingdi	95,221	296,237	3,555	76,350	6,871.5	4.85
Jenidah	41,705	139,945	1,679	34,500	3,105.0	4.80
Chuadanga	40,323	139,945	1,679	34,000	3,060.0	4.76
Gaibandha	57,445	139,945	1,679	27,000	2,430.0	7.74
Kurigram	47,224	109,580	1,315	24,000	2,160.0	7.08
Feni	32,980	116,802	1,402	20,000	1,800.0	6.68
Sunamgani	69,168	147,532	1,770	18,500	1,665.0	13.19
Total	384,066 *	1,089,986	13,079	234,350	21,091.5	6.20

x 1000TK

(*) 445,024 - 60,958 = 384,066

Table 6-2 Comparison between Maintenance/Control Cost and Water Rate Revenue for Each Town

Town	Maintenance/control cost (TK/month)	Households rated	Water rate (TK/month)	Ratio of water rate revenue to maintenance/control cost
Narsingdi	296,237	3,570	71,400	24%
Jenidah	139,945	2,115	42,300	30
Chuadanga	139,945	2,270	45,400	32
Gaibandha	139,945	2,470	49,400	35
Kurigram	109,580	1,980	39,600	36
Feni	116,802	2,205	44,100	38
Sunamganj	147,532	1,630	32,600	22
Total	1,089,986	16,240	324,800	30%

6-3 Effects of Water Supply Services

(1) Socio-econimic assessment

The Bangladesh Government has proclaimed in the Second 5-year Plan (1980 - 1985) that to provide all the people of the nation with safe and clean potable water is one of the most important policies of the plan which gives the improvement of livelihood standard of the piople the first priority.

According to the basic policy, the Bangladesh Government has been constructing potable water supply systems by means of piping in the urban areas and of hand pumping in the rural areas under the supervision of DPHE and WASA.

With foreign aid, DPHE has been implementing construction and betterment of potable water supply facilities in district towns totalling 30 towns out of entire 62 district towns, the ballancing 32 towns including major 2 cities of which have also been implementing the same works with local funds.

However, pupulation increase in Bangladesh, especially rapid concentration to local urban areas has been making proper water supply there increasing difficult. Furthermore, the situation is worsening the livelihood and hygienic circumstances of local urban dwellers because the government has been failing to cope with the increasing demand for potable water due to the lack of funds to construct enough water supply facilities, thus the gap widening.

Under the situation, the on-going Japanese free aid in the forms of construction and betterment of potable water supply facilities must generally be accelerating and giving a big momentum to the progress of the Bangladesh water supply project, although the towns receiving the Japanese aid are limited.

We haope that the Japanese aid will also be helping establish stabilized and ever improving livelihood of the Bangladesh people since the newly built facilities can switch the labor and time so far expended in daily water drawing to more productive activities together with helping establish expected improvement on hygienic circumstances in the country (as to be told soon after).

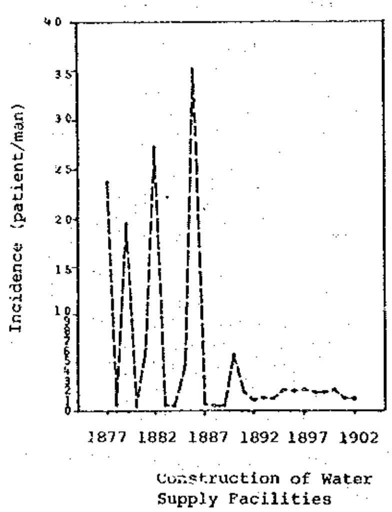
(2) Hygienic Assessment

It is said that 80% of diseases in Bangladesh are related with water, and 30% of deaths of children are caused by diarrhea. The betterment of potable water supply facilities is expected to supply safe and clean water and to drastically decrease gastroentric diseases caused so far by drinking water.

To show the effect, the following figure taken in City of Yokohama, in Japan before and after the construction of its water supply facilities will be useful.

Fig. 1 Incidences of Infections Diseases Before and After Construction of Yokohama Water Supply Facilities

(Water Supply of Developing Nation: OECF, Ryotaro Yamane)



CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

7-1 Conclusions

The basic design study carried out this time covers surveys and analyses on the drinking water supply facilities improvement project for the following eight towns, including those made on Narayanganj Town shown in a separate report.

(1) Narayanganj Town
(2) Narsingdi Town
(3) Jenidah Town
(4) Chuadanga Town
(5) Gaibandha Town
(6) Kurigram Town
(7) Feni Town
(8) Sunamganj Town

As a result of the investigation and the studies, it was found that safe and clean drinking water which the Bangladesh Government aims to provide can be supplied to residents of towns concerned if the drinking water supplying facilities in the aforementioned towns were improved. Substantial reductions in infectious diseases that have occurred due to the use of inhygienic water and other diseases can be expected, which will contribute greatly to the stabilization and improvement of the living level of the residents in the towns, as well as to the improvement of public health and sanitation environments. It is considered that the effects will be drastic. Therefore, it is hoped that the drinking water supplying facilities improvement schemes in the aforementioned towns will be implemented as soon as possible.

As regards the additional requests placed by the Bangladesh Government at the time of preliminary survey, however, the sanitary facility/improvement project was found to have following shortcomings.

(1) The basic plan of hygienic treatment of human waste does not exist in the district towns except Dhaka.

(2) The water seal latrine is done by penetrating human wastes in the soil. Therefore adequate investigation and studies will be required in relation to shallow wells, relative locations of water seal latrines and washing/bathing ponds, etc. as well as their elevations, possible occurrence of floods, etc.

(3) Comparative studies with other human waste treatment methods are also required.

Due to the reasons mentioned above, it would be proper to eliminate the additional projects from the current cooperation project in the form of grants in aid.

7-2 Recommendations

(1) General

As described so far, it is expected that the Project will have drastic effects on the stabilization and the improvement of living quality of the residents and the improvement in health/hygienic environments. The target year of the Project is assumed to be 1990, and it is urgently desired that various pending matters be solved as soon as possible and the construction under the Project be executed as soon as possible. In order to do so, it is required that the Bangladesh Government takes following steps prior to the implementation of the Project.

(a) Procurement of construction sites including those for production wells, pump houses, overhead tank, public post, etc. and payment of their compensations, etc.

(b) Approval of road supervisors for the installation of water distribution pipe lines and transmission pipe lines, etc., and coordination with land owners (compensations, etc.)

(c) Cutting and removal of trees within construction sites and pipeline installation sites for detailed surveying to prepare the scheme of execution for the facilities mentioned in the foregoing.

(d) Securing/providing sites required for materials storage, construction site offices, etc. necessary for construction works.

(e) Regulatory lawful procedures required on execution of construction works for water supply facilities.

(f) Provision of expenses including tariff, etc. for materials and equipment that should be imported from Japan.

(2) Construction Period

If civil engineering works such as laying foundations for overhead tanks, installing pipe lines, etc. are to be included in the Project, such works will become extremely difficult during the rainy season in Bangladesh, since the level of the underground water would approach the ground surface. In this regard, appropriate steps should be taken by the governments of Japan and Bangladesh so that construction works can be executed during the dry season.

(3) Study Period for Detailed Design

It is necessary to prepare road maps along the pipe lines, and to carry out test borings at the proposed well sites, foundation borings and ground bearing power tests at proposed sites of structures in the detailed working design work. Thus, it will be necessary to prepare a work schedule with due consideration to the time period necessary to carry out these works before exchanging the official notes.

(4) Operation and maintenance of facilities

The importance of operation and maintenance in water supply works has already been discussed in Chapter 5, Maintenance and Control Plan. In carrying out proper maintenance and control of water supply works, the important matters are improvement in administrative systems, development of personnel, control and operation of facilities, as a matter of course, and also securing of maintenance and control expenses by collecting water charges.

As estimated on a trial basis in Par. 6-2, Chapter 6, the estimated revenues from water charges (in 1990) at the ongoing water charge rate schedule would amout to only 30% or so of the maintenance and control expenses. The Government of Bangladesh explained that there would be no problem in maintenance and control of facilities as any shortfall in the fund to cover the expenses would be defrayed from the budget of the Bangladesh Government. We consider that proper control and administration of water supply works would be performed under α sound financing arrangement and that safe and clean potable water would be supplied to the people. The Government of Bangladesh will consider improving the maintenance and control plan and the systems for it including a proper water charge rate schedule, and that the various water supplying facilities completed under this

Project will be controlled and operated as originally planned to accomplish their purposes.

The capacity of overhead tank was designed to be around 20% of daily water consumption, but as explained in Chapter 3 on reference data, the results of water balance calculation with respect to the relationship between the capacity of overhead tank and the operating hours of pump indicated that for water requirement in 1990, a 24-hour water supply is impossible with 12-hour per day operation of the pump. Because of this, it is necessary to establish proper operating hours of the pump on the basis of a survey on hourly water consumption in Bangladesh. The operating hours of pump would vary depending on the state of diffusion of house connections, or quantity of water demanded, so that these factors should also be taken into account.

(5) Future plan

The long-range target of the Government of Bangladesh is to realize 100% water supply by year 2,000. The estimated population supplied in year 2,000 is anticipated to be about 1.5 times of 1990. The estimated volume of water supply would expand at a higher growth rate than that accompanying the rise in the ratio of water supply by house connections. If the operating hours of the pump which is assumed to be 12 hours under this project were to be extended to 16 hours or 24 hours, the water requirement projected for year 2,000 would be sufficiently met with the water source facilities which are currently planned. (Refer to Table 7-1)

Table 7-1 Review of the Future Plan

Town	1981 Population	Population growth rate, p.a. 1981 -1990 %	1990 Population supplied	1990 Water Requirement m^3/Day	Population growth rate, p.a., 1990 -2,000 %	2,000 Population supplied	2,000 Water Requirement m^3/Day	Observation
Narsingdi	70,006	10	152,700 (165,000)	12,369	5	248,732	25,480	$18.2m^3/min \times 60 \times 24 = 26,208m^3/day$ 23 hours and 20 minutes operation
Jenidah	49,355	10	69,000 (116,000)	5,589	5	112,394	11,514	$180m^3/hr \times 24 \times 3 = 12,960m^3/day$ 21 hours and 20 minutes operation
Chuadanga	47,815	6	68,000 (81,000)	5,508	3	91,386	9,362	$180m^3/hr \times 24 \times 3 = 12,960m^3/day$ 17 hours and 20 minutes operation
Gaibandha	38,342	6	54,000 (64,800)	4,374	3	72,571	7,434	$150m^3/hr \times 24 \times 3 = 10,800\ m^3/day$ 16 hours and 30 minutes operation
Kurigram	46,132	6	48,000 (78,000)	3,888	3	64,508	6,608	$180m^3/hr \times 24 \times 2 = 8,640m^3/day$ 18 hours and 20 minutes operation
Feni	23,199	6	40,000 (40,000)	3,240	3	53,756	5,507	$84m^3/hr \times 24 \times 4 = 8,160m^3/day$ 16 hours and 10 minutes operation
Sunamganj	21,565	6	37,000 (37,000)	2,997	3	49,725	5,094	The capacity of treatment facilities were designed to be $5,275m^3$/day
Total	296,414		468,700	37,965		693,072	69,999	Can be supplied be operating 16-24 hours a day

(1) Current Plan: Well pumps 12 hr/day operation
Purification plants 15 hr/day operation

(2) The estimated volume of water supply in year 2,000 is calculated on the assumption that 80% of the population will be supplied by house connection at a rate of 90L/day, and that 20% of population will be supplied by public posts at a rate of 34L/day, and the wastage 30%

(3) Figures in Parentheses under the colum of 1990 population supplied indicate the total population of each town.

A N N E X

Annex - I

Minutes of Discussion

on

The Establishment Project for Water Supply Facilities

in

The Peoples' Republic of Bangladesh

In response to the request made by the Government of The Peoples' Republic of Bangladesh for a Project for water supply facilities(hereinafter referred to as "the Project"), the Government of Japan has sent, through the Japan International Cooperation Agency(hereinafter referred to as "JICA") which is an official agency implementing the technical cooperation of the Government of Japan, a team headed by Mr. Yutaka HOSONO, the deputy director of Grant Aid Department, JICA, to conduct the survey for 73 days from April Ist to June 12th 1984.

The team carried out a field survey, held a series of discussions and exchanged views with the authorities concerned of the Government of the Peoples' Republic of Bangladesh.

Both parties have agreed to recommend to their respective Governments and the authorities concerned to examine the result of the survey attached herewith toward the realisation of the Project.

June 11th, 1984.

YUTAKA HOSONO

Head, Japanese Basic Design Survey Team.

M. AZIZUL HAQUE

Joint Secretary, LG Division, Ministry of LGRD & Cooperatives, Govt. of the Peoples' Republic of Bangladesh.

Attachment

1. The objective of the project is to establish the most appropriate water supply facilities for the eight towns described below on priority basis

1. Narayangonj	5. Shunamganj
2. Gaibandah	6. Feni
3. Kurigram	7. Jenidah
4. Narsingdi	8. Chuadanga

2. Both parties confirmed the basic concept of water supply facilities and location plan for each town.
The basic concept is shown in Annex I.

3. The Japanese survey team will convey to the Government of Japan the desire of the Government of the Peoples' Republic of Bangladesh that the former takes necessary measures to cooperate in implementing the project and bears the cost of the water supply systems requested by the latter shown in Annex I within the scope of Japanese economic cooperation program in grant form.

4. The Government of the Peoples' Republic of Bangladesh will take necessary measures listed in Annex II under the condition that the grant aid assistance by the Government of Japan is extended to the Project.

5. In spite of clause 2 and 3 in Annex II, the Government of the Peoples' Republic of Bangladesh requested the Government of Japan to bear the costs of access roads and the costs for extension of electric lines to the sites including transformers etc and fences around the facilities to be constructed under the Project. The request has been made due to the constraints of local resources of the Government of Bangladesh.

6. The Government of Peoples' Republic of Bangladesh requested the association of local consultant(s)/Engineers with the Japanese consultant in course of the field survey for detailed design and construction supervision period.

7. The Japanese team explained the difficulty to include the sanitation component in the project. But Government of Bangladesh made strong request for the inclusion of sanitation component for the reason of improvement of health.

8. Both parties confirmed that the Survey team explained Japan's grant aid program and the Bangladesh side has understood it.

9. The Japanese team requested the Bangladesh side to ensure prompt aqusition of construction sites and payment of taxes etc for imported goods as mentioned in clause 1 and 5 of annex - II in order that delay or interference is not caused in project implementation.

(Annex I)

1. The basic concept of water supply facilities and location plan for each town requested by the Proples' Republic of Bangladesh, are shown on the attached maps.

2. Regarding Shunamgonj, study will be made on, surface water in comparison to ground water as water source and the result will be included in draft final report.

3. Priority of implementation for Narayangonj Town requested by the Bangladesh side is as follows:

   (1) Expansion of the treatment Plants.

   (2) Rehabilitation of the main pipe line system.

   (3) Construction of overhead tanks.

   (4) Rehabilitation of distribution system other than the main pipe line system.

   (5) Extension of distribution system.

(Annex II)

The following arrangements are requested to be taken by the Government of the Peoples' Republic of Bangladesh.

1. To secure necessary lands for the Project, and to clear, fill and level the sites as needed before the start of the works.

2. To provide facilities for distribution of electricity,and other incidental facilities outside of the site if necessary.

3. To construct access roads to the sites when necessary.

4. Provision of respective data and information to a Japanese consultant and a contractor necessary for the detailed engineering services and construction.

5. To ensure prompt unloading, tax payment, customs clearance, and prompt internal transportation therein of the products purchased under the grant.

6. To exempt Japanese nationals from customs duties,internal taxes and other fiscal levies which may be imposed in Bangladesh with respect to the supply of the products and services under the verified contracts of the Project.

7. To provide and accord necessary permissions, licences and other authorization required for execution of the Project.

8. To maintain and use properly and effectively the facilities constructed under the grant, and to arrange the budget for maintenance and operation.

9. To bear all the expenses, other than those to be borne by the grant, necessary for the Project.

Annex - II

Member list of the Basic Design Study Team

[A] JICA Official Member

1. Yutaka Hosono	: Team Leader	: Deputy Director Grant Aid Department Japan International Cooperation Agency (JICA)
2. Junji YOKOKURA	: Project Coordinator	: Basic Design Div. Grant Aid Department JICA

[B] Study Team

1. Fumio TAMURA	: Water Supply Planning Engineer	: Chief Engineer Japan Engineering Consultants Co., Ltd.(JEC)
2. Hisao OGURI	: Geo-hydrologist	: Chief Engineer JEC
3. Tatsuro USUI	: Water Supply Facilities Planning Engineer	: Chief Engineer JEC
4. Masami MORISHITA	: Pipe Line Engineer	: Engineer, JEC
5. Hisashi MUTO	: Socio-Survey	: Chief Engineer, JEC
6. Junji OHAMA	: Survey Coordinator	: Administration Officer JEC