2. Natural Condition at Bojonegara

2.1 Natural Condition Survey by Study Team

2.1.1 1:10,000 Scale Digital Topographic Mapping

The existing topographic map covering the entire area of Bojonegara, a candidate construction site of a new port, is the 1:25,000 scale topographic map produced by BAKOSURTANAL early in the 1990's.

However, the aerial photos used in producing this topographic map were taken early in the 1980's, and the information represented in this topographic map was about 20 years old. Therefore, it is assumed that large secular changes appear in the present conditions.

In formulating the plan of new port development at Bojonegara, it is necessary to accurately investigate the actual conditions for construction of an access road from the existing arterial road to port facilities and those of the hinterland.

To this end, the 1:10,000 scale digital photogrammetric mapping in the range from the planned new port site at Bojonegara to the node point to connect to an arterial road was implemented.

Figure 2-1-1 "1:10,000 Scale Digital Topographic Mapping Area, Bojonegara" shows the 1:10,000 scale digital topographic mapping area by photogrammetric method. The specifications of the digital photogrammetric mapping are as follows:

1) Scale of topographic mapping	1:10,000
2) Mapping area	Approximately 3,200 ha
3) Spheroid	WGS-84
4) Map projection	Universal Transverse Mercator (U.T.M.) Zone No. 48
5) Datum level	Lowest Low Water Level
6) Reference point of elevation	TTG 307 (Existing benchmark established by BAKOSURTANAL) Elevation = Elevation from MSL + 0.6 m (Z_0) = 6.248 m + 0.6 m = 6.848 m
7) Aerial photos	1:15,000 Scale aerial photos were taken in August 2002 for this photogrammetric mapping.
8) Contour line interval	1 m
9) Format style of digital data	AutoCAD format

The horizontal coordinates and elevation of the ground control points that were established to control the horizontal positions and elevation for photogrammetric mapping are shown in Table 2-1-1 "Horizontal Coordinates and Elevation of Control Points for Photogrammetric Mapping".

Table 2-1-1 "Horizontal Coordinates and Elevation of Control Points for Photogrammetric Mapping"

BM ID	Horizontal Coordinates		Elevation (m)
	X (m)	Y (m)	
BM.1	620,152.653	9,347,472.196	2.508
BM.2	619,220.039	9,347,178.248	35.872
BM.3	622,726.899	9,344,205.970	2.294
BM.4	620,679.966	9,343,792.630	30.981
BM.5	620,589.192	9,338,548.694	1.565
BM.6	620,876.138	9,332,094.858	7.998
BM.7	619,570.905	9,333,033.430	8.388

Note: Spheroid: WGS-84, Projection: U.T.M. Zone No. 48
Datum of elevation: LLWL
Reference point for elevation: TTG 307, Elevation = Elevation from MSL + 0.6 m
= 6.248 + 0.6 m = 6.848 m

The topographic maps/sounding maps in which the results of sounding survey are added to the 1:10,000 scale topographic maps are shown in Appendix-2 and Appendix-3.

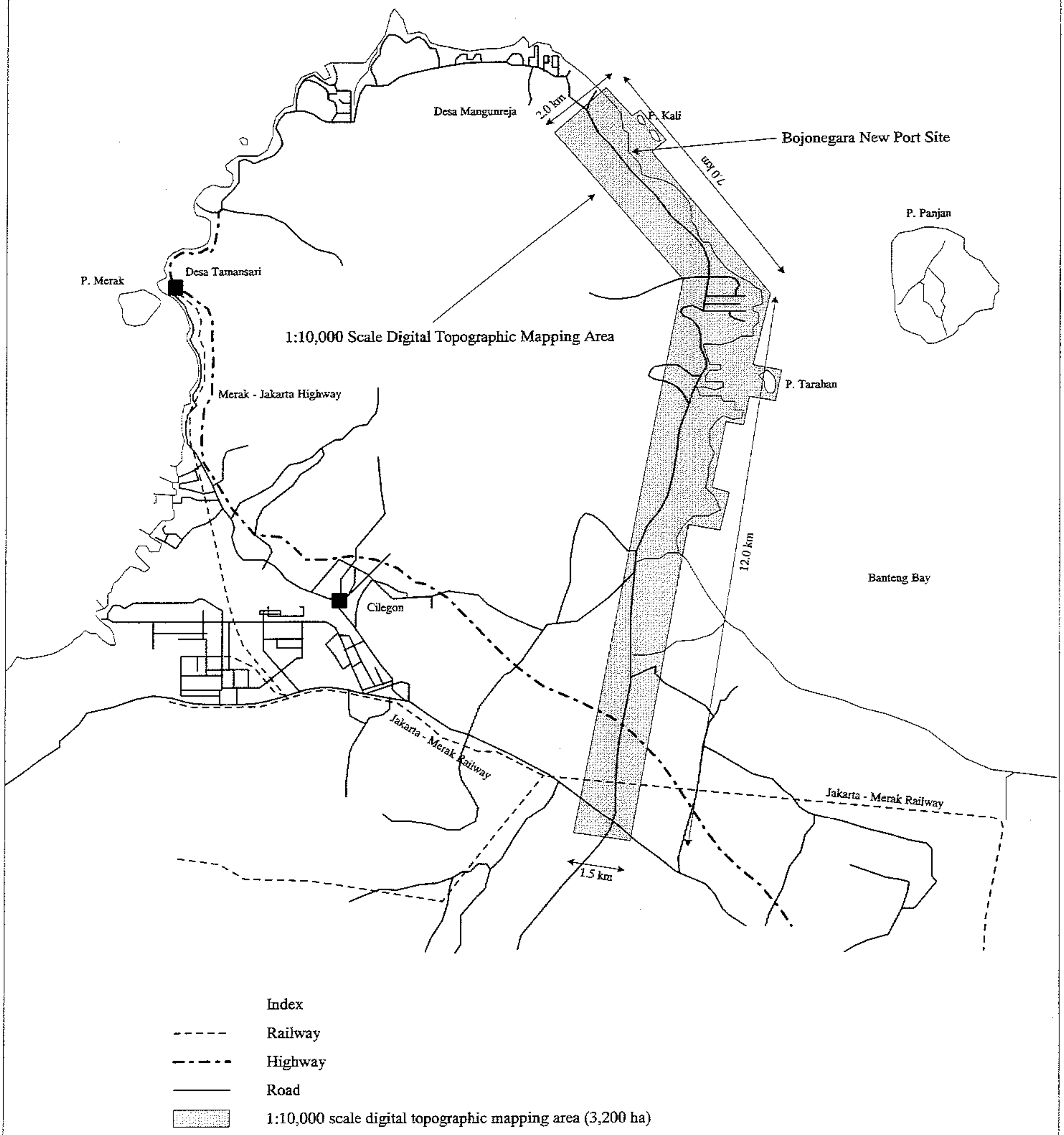


Figure 2-1-1 "1:10,000 Scale Digital Topographic Mapping Area, Bojonegara"

2.1.2 Sounding Survey

a) Existing Sounding Data

IPC-2 had executed a sounding survey at Bojonegara in September 2000 and prepared a 1:2,000 scale sounding map covering the proposed port area and access channel area.

The area covered by this existing sounding map prepared by IPC-2 is shown in Figure 2-1-2 "Existing Sounding Map, Bojonegara".

The JICA Study Team has executed a sounding survey at Bojonegara by sub-contracting the Indonesian consulting company in August 2002 and a 1:1,000 scale sounding map was prepared.

These two sounding data were used for the estimation of seabed variation at Bojonegara.

b) Sounding Survey

The sounding survey at Bojonegara Area was carried out to acquire basic information and data necessary for investigating the actual conditions of the front water area of Bojonegara Area in which is the planned site of new port development and for formulating the plans of offshore facilities and navigational channels.

The range of sounding survey is shown in Figure 2-1-3 "Topographic and Sounding Survey Area, Bojonegara". The specifications of sounding survey are described below.

1) Sounding survey area	Approximately 1.7 km×2.6 km (442 ha)
2) Sounding line direction	Perpendicular to coastal line
3) Sounding line interval	25 m
4) Positioning method	GPS
5) Sounding method	Deeper than –2 m: echo sounder less than –2 m: staff or lead
6) Scale of sounding map prepared	1:1,000
7) Spheroid	WGS-84
8) Map projection	Universal Transverse Mercator (U.T.M.) Zone No. 48
9) Datum level	Lowest Low Water Level
10) Reference point for elevation	BP-20 (benchmark established by IPC-20) Elevation = 1.283 m
11) Format style of digital data	AutoCAD format The final sounding map was combined with the 1:1,000 scale topographic map produced separately to make up a single map.

The topographic/sounding map produced is shown in Appendix 4. In this topographic/sounding map, the water depth and elevation points were thinned out from the original data and the scale was changed in order to reduce it for later use in reports.

Figure 2-1-4 "Tide Gauge for Sounding Survey, Bojonegara

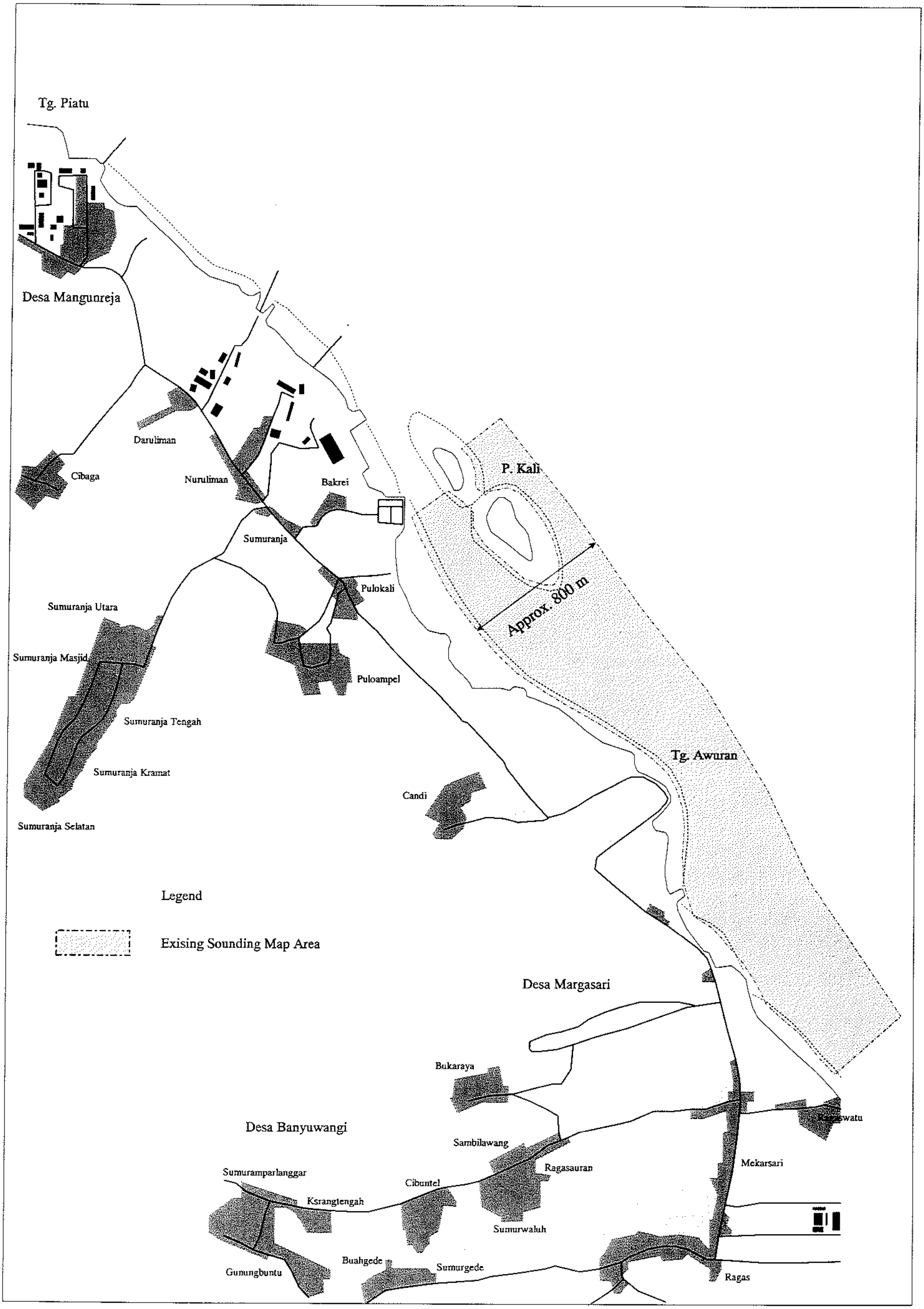


Figure 2-1-2 "Existing Sounding Map, Bojonegara"

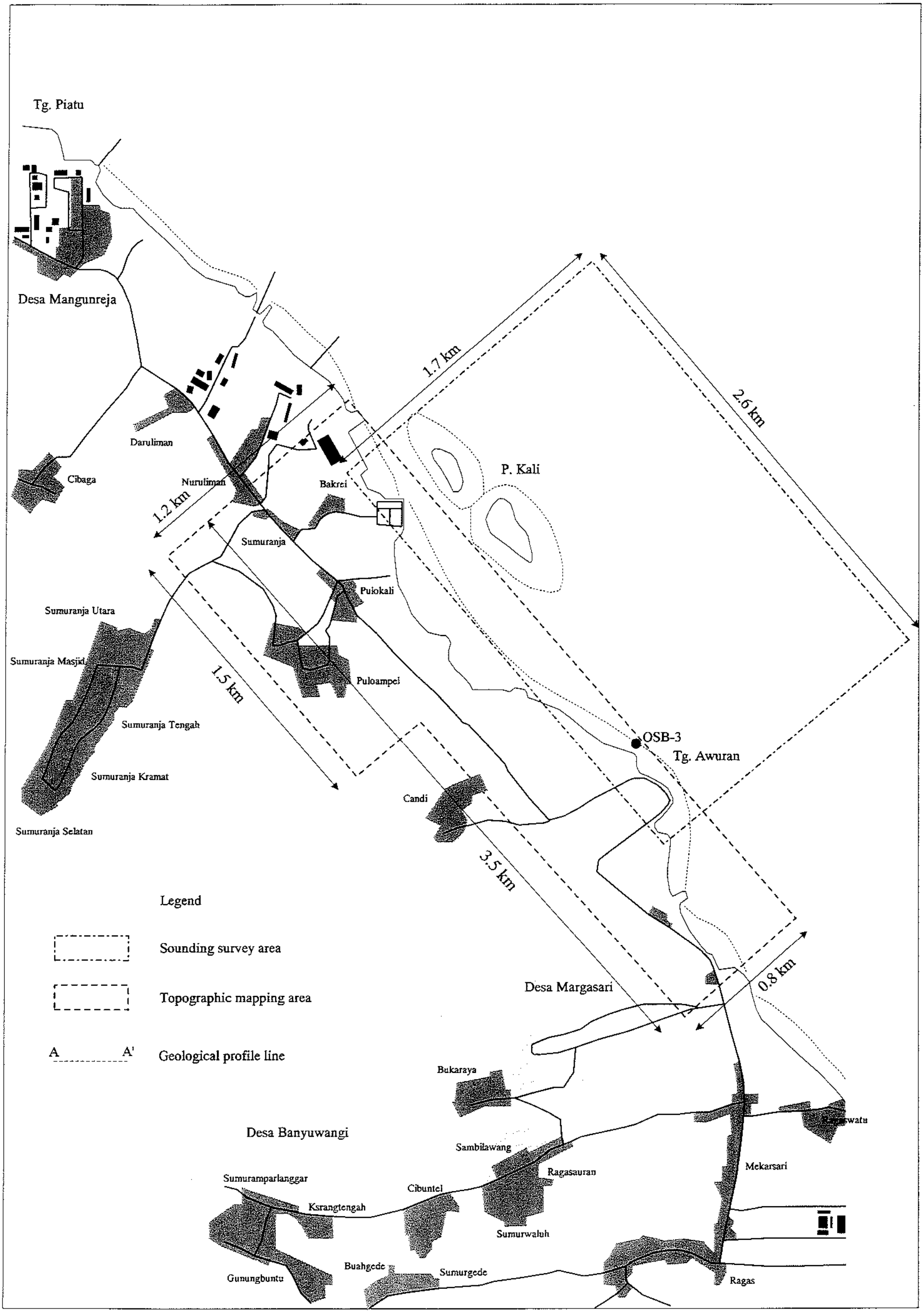


Figure 2-1-3 "Topographic and Sounding Survey Area, Bojonegara"

2.1.3 Topographic Survey

The topographic survey of Bojonegara Area was made for acquiring the basic information and materials necessary for investigating the actual conditions of the shore area of Bojonegara Area in which the planned site of new port development is located and for the design of port facilities.

Figure 2-1-3 “Topographic and Sounding Survey Area, Bojonegara” shows the location of 1:1,000 scale topographic mapping area by ground survey method.

The specifications of topographic survey are described below.

1) Topographic mapping area	Approximately 1.2 km×0.8 km (340 ha)
2) Scale of topographic mapping	1:1,000
3) Spheroid	WGS-84
4) Map projection	Universal Transverse Mercator (U.T.M.) Zone No. 48
5) Datum level	Lowest Low Water Level
6) Reference point for elevation	BP-20 (benchmark established by IPC-20) Elevation = 1.283 m
7) Survey method	Ground survey method
8) Contour line interval	1 m
9) Format style of digital data	AutoCAD format The topographic map was combined with the sounding map produced separately to make up a single map.

Two bench marks were installed through the ground survey at site for topographic mapping and their horizontal coordinates and elevation are shown in Table 2-1-2 “Horizontal Coordinates and Elevation of Control Points for Topographic Mapping”.

Table 2-1-2 “Horizontal Coordinates and Elevation of Control Points for Topographic Mapping”

BM ID	Horizontal Coordinates		Elevation (m)
	X (m)	Y (m)	
PCI. 2	6200,307.751	9,347,216.454	1.706
PCI. 3	620,773.089	9,346,609.886	3.350

Note: Spheroid: WGS-84, Projection: U.T.M. Zone No. 48
Datum of elevation: LLWL
Reference point for elevation: BP.20, Elevation = 1.283 m

The topographic/sounding map produced is shown in Appendix 4. In this topographic/sounding map, the water depth and elevation points were thinned out from the original data in order to reduce it for later use in reports.

Figure 2-1-5 “Topographic Survey, Bojonegara”

2.1.4 Soil Investigation and Soil Laboratory Test

a) Existing Boring Data

IPC-2 had conducted a soil investigation of 66 boreholes at the Bojonegara port development area since 1995. The locations of existing boreholes at Bojonegara are shown in Figure 2-1-6 “Location of Existing Boring Points, Bojonegara”.

Some of the boring logs indicate the presence of hard rock, gravel, igneous bedrock with a N-value of more than 50 from the depth of -8 m to -20 m below LLWL in the whole project site of Bojonegara.

The depth of bedrock at each borehole is shown in Table 2-1-3 “Elevation of Bedrock by the Existing Boring Data, Bojonegara”. The rocks are indicated in the name of Breccia, Basalt and Andesite in the previous soil investigation.

Figure 2-1-7 “Geological Profile (B-B’ Section) at Proposed Project Site, Bojonegara”, Figure 2-1-8 “Geological Profile (C-C’ Section) at Proposed Project Site, Bojonegara”, Figure 2-1-9 “Geological Profile (D-D’ Section) at Proposed Project Site, Bojonegara” show the geological profiles at project site produced based on the existing boring data.

b) Soil Investigation and Soil Laboratory Test

The soil survey by boring was made to investigate the actual soil conditions onshore and offshore at the planned site of new port development in Bojonegara. The soil survey is outlined below.

1) Number of boring	Offshore boring:	3 locations
	Onshore boring	1 location
2) Boring length	Total 55 m	
3) Standard penetration test	1.5 m interval, total 37 times	
4) Undisturbed sampling	6 samples	
5) Soil laboratory test	Grain size analysis	34 samples
	Specific gravity test	34 samples
	Moisture content test	34 samples
	Liquid/Plastic limit test	34 samples
	Density test	34 samples
	Unconfined compression test	6 samples
	Consolidation test	6 samples

The locations of boring points are shown in Figure 2-1-10 “Location of Soil Boring, Bojonegara”. The horizontal coordinates, water depth and boring depth of each boring point are shown below.

Table 2-1-4 “Horizontal Coordinates and Elevation, and Boring Depth, Bojonegara”

Boring No.	Coordinates		Elevation	Boring depth	SPT
	X (m)	Y (m)	H (m)		
OSB-1	620,451.5	9,347,411.3	+0.1	10 m	7 times
OSB-2	620,558.1	9,347,519.2	-2.8	15 m	10 times
OSB-3	621,670.4	9,346,438.9	-3.1	15 m	10 times
OSB-4	621,193.2	9,347,517.1	-0.3	15 m	10 times

Note: Elevation reference is LLWL.

The geological profile produced based on the results of boring is shown in Figure 2-1-11 “Geological Profile (A-A’ Section), Bojonegara”.

The boring log of each bore hole is shown in Figure 2-1-12 “Drilling Log (No. OSB-1), Bojonegara”, Figure 2-1-13 “Drilling Log (No. OSB-2), Bojonegara”, Figure 2-1-14 “Drilling Log (No. OSB-3), Bojonegara” and Figure 2-1-15 “Drilling Log (No. OSB-4), Bojonegara”.

The soil conditions based on the results of boring at Bojonegara are outlined below (Table 2-1-5 “Outline of Soil Condition at Boring No. OSB-1, Bojonegara”, Table 2-1-6 “Outline of Soil Condition at Boring No. OSB-2, Bojonegara”, Table 2-1-7 “Outline of Soil Condition at Boring No. OSB-3, Bojonegara” and Table 2-1-8 “Outline of Soil Condition at Boring No OSB-4, Bojonegara”).

Table 2-1-5 “Outline of Soil Condition at Boring No. OSB-1, Bojonegara”

Elevation from LWS	Layer Thickness	Description of Soil	N-Value	Characteristic
+0.1 ～ -4.9 m	5.0 m	Sandy clay	2	Soft
-4.9 ～ -8.9 m	4.0 m	Sandy clay	25 ～ >60	Medium to hard
-8.9 ～ -9.2 m	0.3 m	Bed rock (Andesite)	>60	Hard

Table 2-1-6 “Outline of Soil Condition at Boring No. OSB-2, Bojonegara”

Elevation from LWS	Layer Thickness	Description of Soil	N-Value	Characteristic
-3.1 ～ -6.1 m	3.0 m	Sandy clay	1 ～ 2	Soft
-6.1 ～ -9.6 m	3.5 m	Gravelly clay	>60	Hard
-9.6 ～ -18.1 m	8.5 m	Bed rock (Andesite)	>60	Hard

Table 2-1-7 “Outline of Soil Condition at Boring No. OSB-3, Bojonegara”

Elevation from LWS	Layer Thickness	Description of Soil	N-Value	Characteristic
-3.1 ～ -9.1 m	6.0 m	Sandy clay & shell fragment	1	Soft
-9.1 ～ -18.1 m	9.0 m	Gravelly clay	13 ～ >60	Medium to hard

Table 2-1-8 “Outline of Soil Condition at Boring No. OSB-4, Bojonegara”

Elevation from LWS	Layer Thickness	Description of Soil	N-Value	Characteristic
+0.3 ～ -4.2 m	4.5 m	Sandy clay & shell fragment	4 ～ 6	Soft
-4.2 ～ -8.2 m	4.0 m	Gravelly clay, shell fragment	13 ～ >60	Medium to hard
-8.2 ～ -14.7 m	6.5 m	Gravelly clay	13 ～ >60	Medium to hard

The following soil conditions can be analyzed from the above results of boring:

1) The soil conditions can be divided into three layers in boring depth.
2) The first layer consists of a sandy clay layer in the depth range from the seabed to nearly -10 m, eventually contains shell fragments. This sandy clay layer is very soft and the N-value is in a range from 1 to 4.
3) The second layer is a gravelly clay layer in the depth range from -3 m to -15 m and eventually contains shell fragments. The N-value of this layer varies in a range from 4 to 60.
4) The third layer is a bedrock layer of andesite in the depth around -9 m and this layer is so hard that it can be used as a bearing layer having the N-value of more than 60.

The results of soil laboratory test are shown in Table 2-1-9 ”Summary of Soil Laboratory Test at Boring No. OSB-1, Bojonegara”, Table 2-1-10 “Summary of Soil Laboratory Test at Boring No. OSB-2, Bojonegara”, Table 2-1-11 “Summary of Soil Laboratory Test at Boring No. OSB-3, Bojonegara” and Table 2-1-12 “Summary of Soil Laboratory Test at Boring No. OSB-4, Bojonegara”.

Table 2-1-3 "Elevation of Bedrock by the Existing Boring Data, Bojonegara"

No.	Boring No.	Coordinates		Depth of Bedrock (m)	Description of Bedrock
		N (m)	E (m)		
1	A 1	9,347,614	620,576	-7.75	Very dense dark brown **breccia**
2	A 2	9,347,410	620,685	-11.25	Very dense dark brown **breccia**
3	A 3*	9,347,480	621,694	-11.60	Very dense dark brown **breccia**
4	A 4*	9,347,190	621,686	-12.75	Very dense dark brown **breccia**
5	A 5*	9,347,690	621,720	-8.00	Dense to very dense brown to dark **weathered breccia**
6	A 6*	9,347,085	621,810	-12.00	Medium dense dark brown **breccia**
7	A 7*	9,347,540	621,855	-8.75	**Weathered breccia**, brown to dark drown
8	A 8	9,347,317	620,625	-11.50	**Weathered breccia**, dark brown
9	A 9*	9,347,540	621,855	-11.75	Dense dark brown **breccia**
10	A 10*	9,347,540	621,855	-8.20	Dense to very dense brown to dark **weathered breccia**
11	A 11	9,346,925	620,980	-13.00	Very dense dark brown **breccia**
12	A 12	9,347,354	621,068	-14.25	Very dense dark brown **breccia**
13	A 13	9,347,000	621,200	-14.40	Dense to very dense brown to dark **weathered breccia**
14	A 14	9,347,050	621,518	-15.90	Very dense dark brown **breccia**
15	A 15	9,346,800	621,624	-16.50	Very dense dark brown **breccia**
16	B 1	9,346,996	621,658	-25.94	Very dense, gray **volcanic rock**
17	B 2	9,347,246	621,591	-27.33	Very dense, gray **volcanic rock**
18	B 3	9,347,216	621,214	-14.91	Very dense, light brown **volcanic rock**
19	B 4	9,347,739	620,837	-12.47	Very dense, gray mottled brown **volcanic rock**
20	B 5	9,347,519	620,545	-9.17	Very dense, dark gray **volcanic rock**
21	B 6	9,347,374	620,463	-10.53	Very dense, brown **breccia**
22	B 7	9,347,091	620,735	-13.93	Very dense, gray mottled brown **volcanic rock**
23	B 8	9,346,505	621,690	-21.52	Very dense, grayish brown **volcanic rock**
24	B 9	9,346,720	621,400	-15.52	Very dense, gray mottled brown **volcanic rock**
25	B 10	9,347,604	621,214	-20.12	Very dense, brown **volcanic rock**
26	GA 1	9,347,113	620,434	-7.39	Light gray and dark brown **weathered tuff**
27	GA 2	9,346,964	620,636	-9.49	Light gray and dark brown **weathered tuff**
28	GA 3	9,346,742	620,780	-8.27	Grey and brown **breccia tuff**
29	GA 4	9,346,730	621,010	----	Boring was stopped at -19.15.
30	GA 5	9,347,377	620,608	-11.56	Light gray and dark brown **weathered tuff**
31	GA 6	9,347,292	620,922	----	Boring was stopped at -16.58.
32	GA 7	9,347,126	621,182	----	Boring was stopped at -15.76.
33	GA 8	9,346,978	621,577	----	Boring was stopped at -16.71.
34	GA 9	9,347,242	621,433	----	Boring was stopped at -16.76.
35	GA 10	9,347,246	620,521	----	Boring was stopped at -15.06.
36	GA 11	9,347,516	620,876	-7.30	Grey and brown **weathered tuff**
37	GA 12	9,347,196	620,725	----	Boring was stopped at -11.96.
38	GA 13	9,347,078	620,893	----	Boring was stopped at -14.04.
39	GA 14	9,346,939	621,087	----	Boring was stopped at -15.04.
40	GA 15	9,346,708	621,287	----	Boring was stopped at -13.64.
41	GA 15A	9,346,776	621,306	-14.08	**Basalt**
42	GA 16	9,346,619	621,526	-15.77	**Basalt**
43	GA 17	9,346,919	621,401	----	Boring was stopped at -16.29.
44	GA 18	9,347,675	620,593	-10.07	**Basalt**
45	GA 19	9,347,881	620,680	----	Boring was stopped at -7.71.
46	GA 20	9,347,724	620,901	----	Boring was stopped at -6.66.
47	GA 21	9,347,436	621,062	----	Boring was stopped at -10.92.
48	GA 22	9,347,566	620,381	-2.16	**Basalt**
49	GA 23	9,347,336	620,266	-2.50	**Basalt**
50	GA 24	9,347,242	620,366	-6.56	**Basalt**
51	GA 25	9,347,159	620,237	-4.75	**Basalt**
52	GA 26	9,346,501	621,063	-5.84	**Basalt**
53	GA 27	9,346,377	621,338	-8.87	**Basalt**
54	GA 28	9,346,985	621,331	----	Boring was stopped at -17.12.
55	GA 29	9,346,819	621,771	----	Boring was stopped at -19.24.
56	GA 32	9,346,187	621,591	+11.54	**Basalt**, top of mountain
57	K 1	9,347,280	620,629	-16.47	Grey and yellow **volcanic rock**
58	K 2	9,347,144	620,812	-12.95	Brown **volcanic rock**
59	K 3	9,347,013	620,988	-17.44	Brown **volcanic rock**
60	K 4	9,346,904	621,135	-21.72	Black **volcanic rock**
61	K 5	9,347,125	620,469	-8.77	Grayish brown **volcanic rock**
62	K 6	9,347,019	620,644	-9.05	Brownish gray **volcanic rock**
63	K 7	9,347,004	620,399	----	Boring as stopped at -12.81.
64	K 8	9,346,900	620,568	-4.95	Light gray **volcanic rock**
65	K 9	9,346,790	620,734	----	Boring was stopped at -9.05.
66	K 10	9,346,920	620,819	-14.71	Purplish white **volcanic rock**

Source: Laporan survey mekanika tanah, PPST - Universitas Indonesia

Note: *: Horizontal coordinates do not coincide with the location of boring points shown on the attached map.

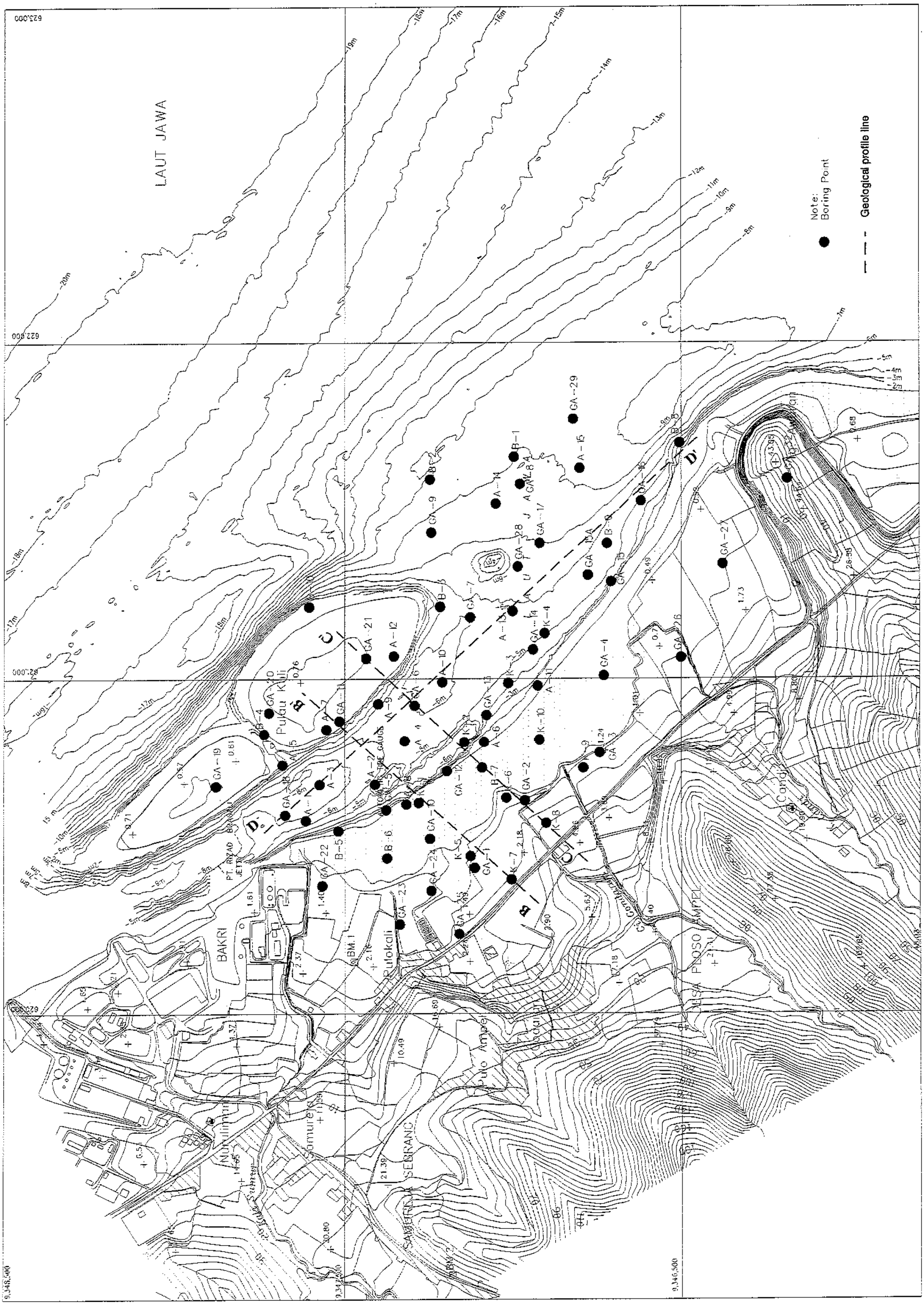
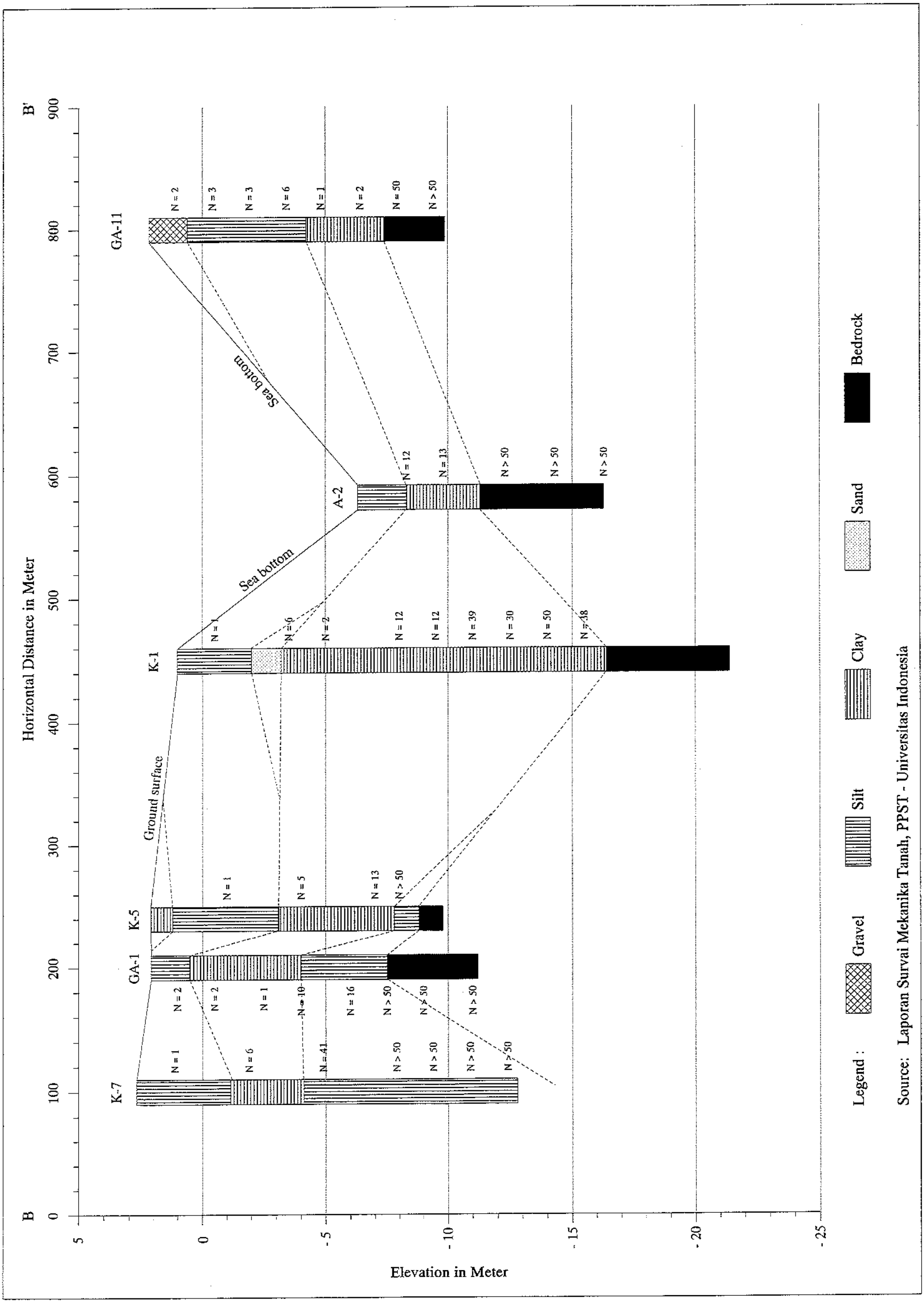
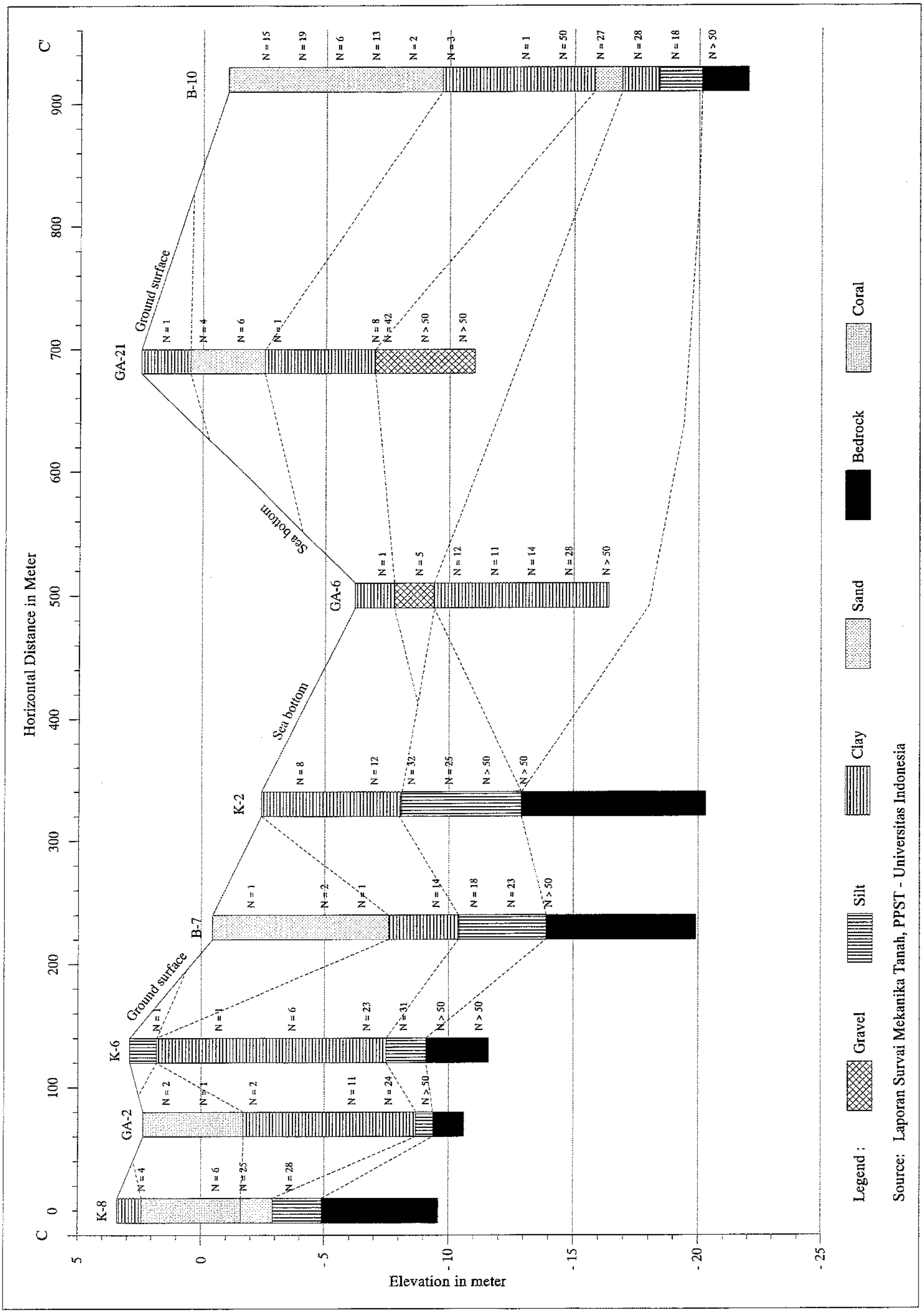


Figure 2-1-6 "Location of Existing Boring Points, Bojonegara"



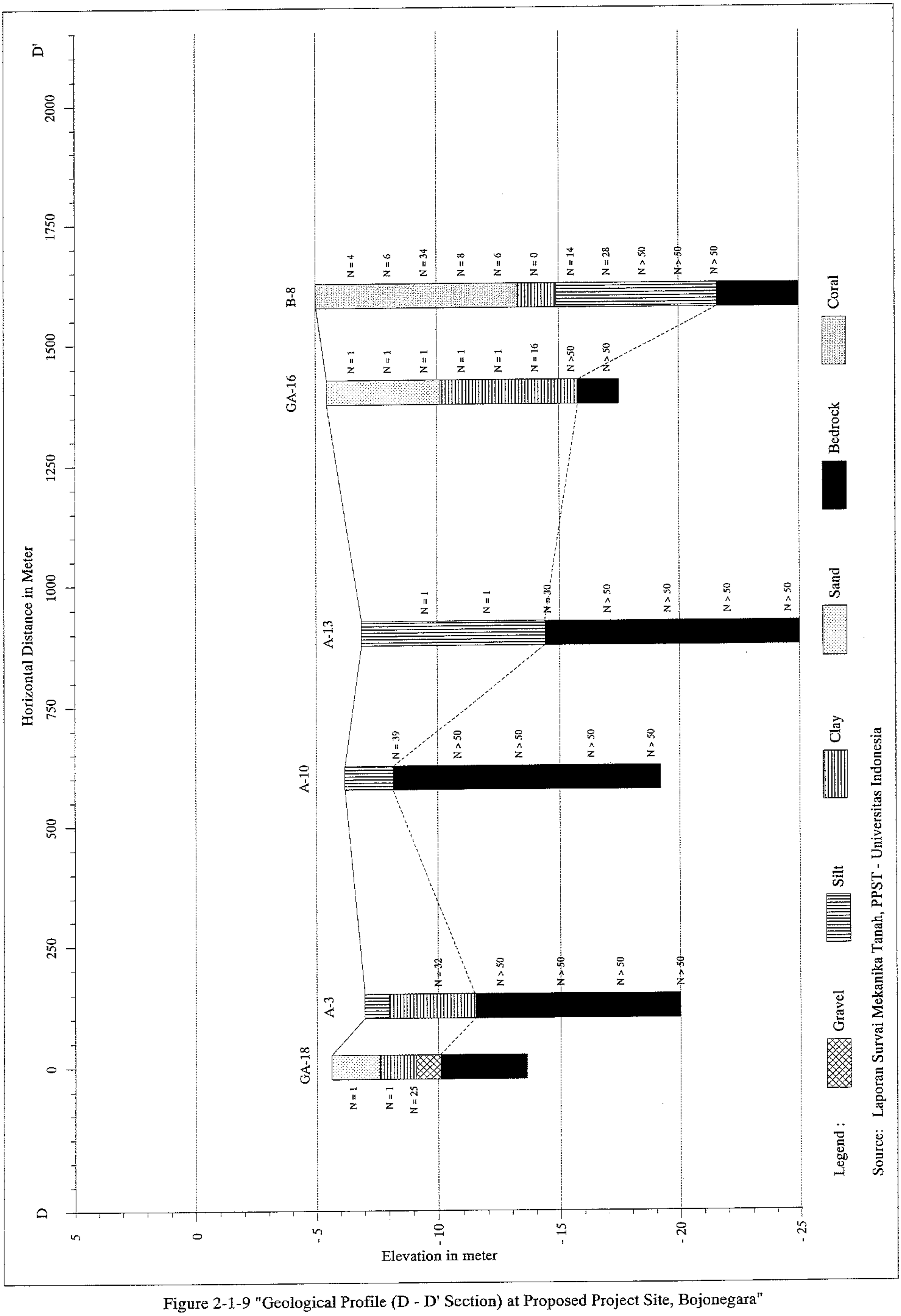
Source: Laporan Survai Mekanika Tanah, PPST - Universitas Indonesia

Figure 2-1-7 "Geological Profile (B - B' Section) at Proposed Project Site, Bojonegara"



Source: Laporan Survai Mekanika Tanah, PPST - Universitas Indonesia

Figure 2-1-8 "Geological Profile (C - C' Section) at Proposed Project Site, Bojonegara"



Source: Laporan Survai Mekanika Tanah, PPST - Universitas Indonesia

Figure 2-1-9 "Geological Profile (D - D' Section) at Proposed Project Site, Bojonegara"

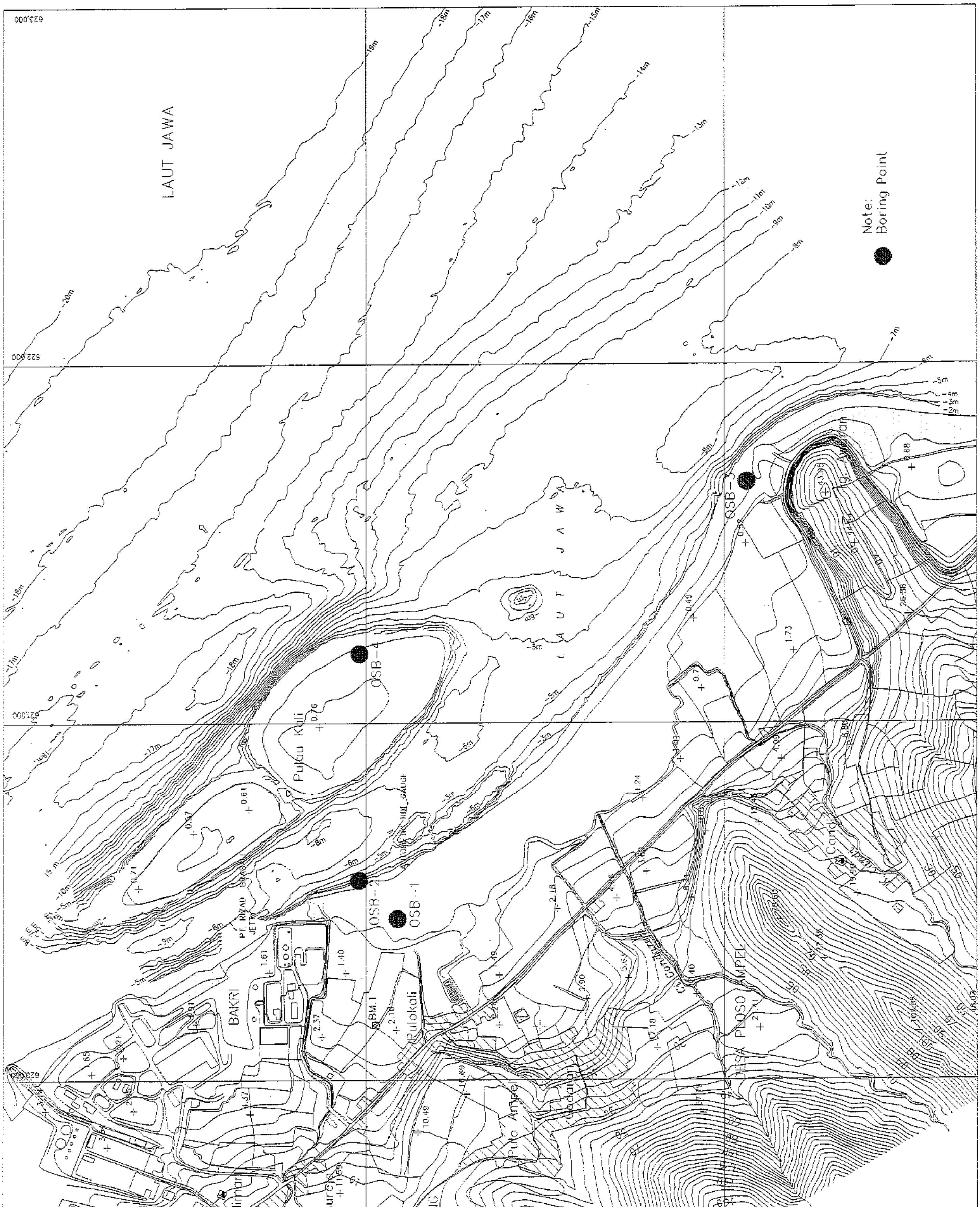
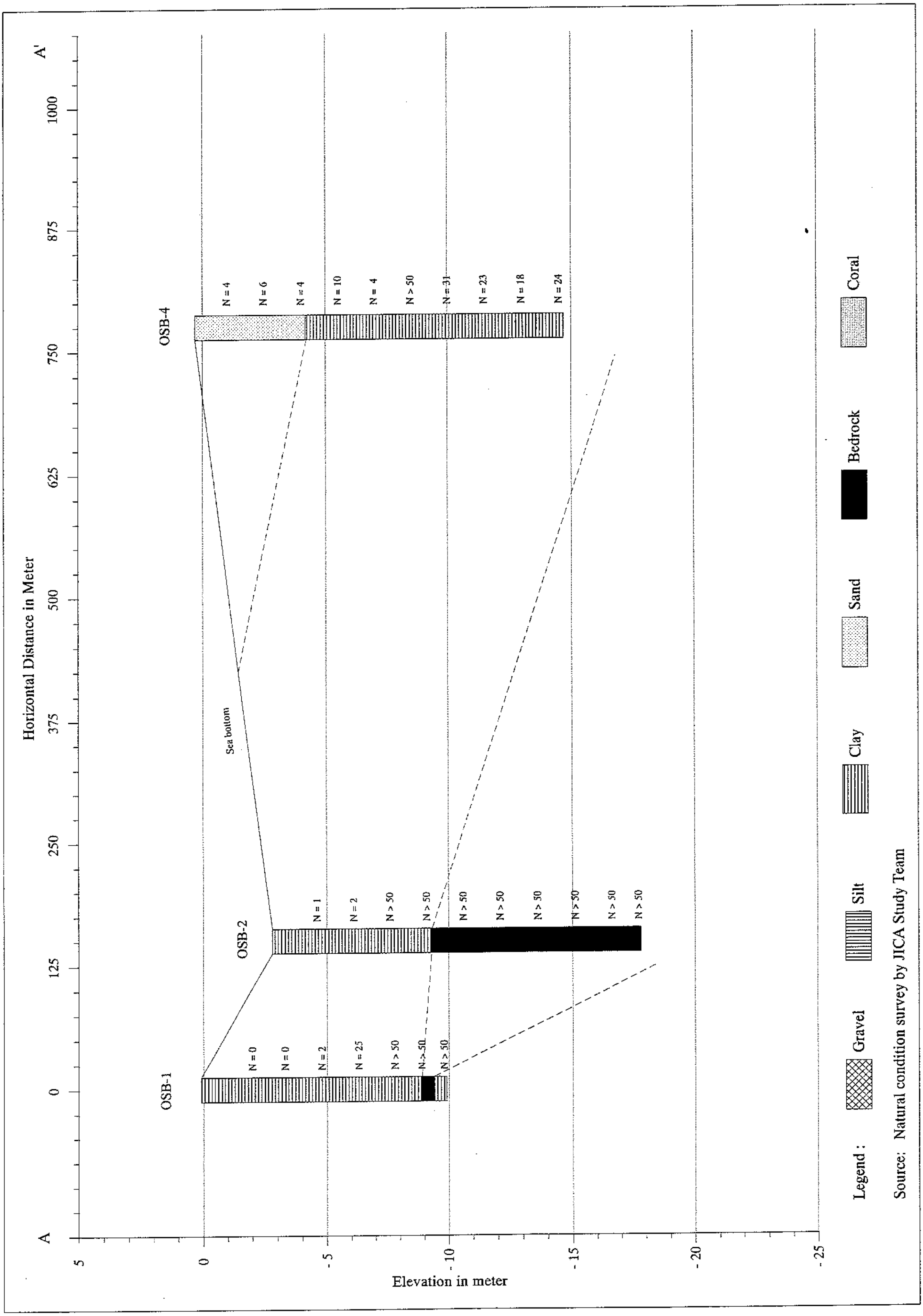


Figure 2-1-10 "Location of Soil Boring, Bojonegara"



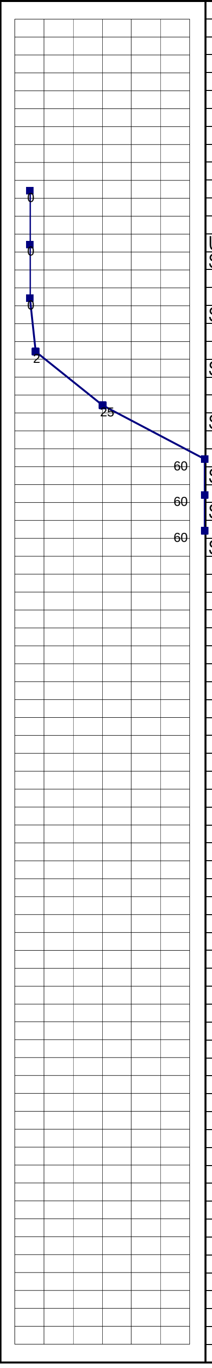
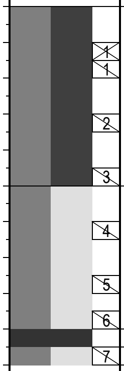
Source: Natural condition survey by JICA Study Team

Figure 2-1-11 "Geological Profile (A - A' Section), Bojonegara"

DRILLING LOG

THE STUDY ON DEVELOPMENT OF THE GREATER JAKARTA METROPOLITAN PORTS IN THE REPUBLIC OF INDONESIA

Project	: JICA	Coordinate x	: 620,451.5	Drilling Machine	: ZT-100
Location	: Bojonegara	y	: 9,347,411.3	Bor Master	: Casna
Number of bor hole	: OSB - 1	Sheet Number	: 1	Description by	: Mulyadi
GWL Elevation	: - m	Day/date	: (2/07-3/07) 2002	Check by	: Donny Z

Elevation from LWS (m)	Depth from ground level (m)	Bor Profile	Description of Strata	Number of Blow N1	N2	N3	Sum of blow	S P T- N Graphic	Remarks
5.10	+ 5.00								
4.10	+ 4.00								
3.10	+ 3.00								
2.10	+ 2.00								
1.10	+ 1.00								
0.10	0.00		Sea bed						
-0.90	- 1.00								
-1.90	- 2.00		Fine sandy clay, brown, soft	0 / 15	0 / 15	0 / 15	0 / 30		UDS-1 : (1.00-1.50) m SPT-1 : (1.50-1.95) m
-2.90	- 3.00			0 / 15	0 / 15	0 / 15	0 / 30		SPT-2 : (3.00-3.45) m
-3.90	- 4.00								
-4.90	- 5.00			1 / 15	1 / 15	1 / 15	2 / 30		SPT-3 : (4.50-4.95) m
-5.90	- 6.00			6 / 15	10 / 15	15 / 15	25 / 30		SPT-4 : (6.00-6.45) m
-6.90	- 7.00		Sandy clay, grey, medium to hard						
-7.90	- 8.00			60 / 10			> 60 / 10		SPT-5 : (7.50-7.60) m
-8.90	- 9.00		Andesit Rock, grey,hard	60 / 5			> 60 / 5		SPT-6 : (8.50-8.55) m
-9.90	- 10.00		Sandy clay, grey, hard	60 / 15			> 60 / 15		SPT-7 : (9.50-9.65) m
-10.90	- 11.00								
-11.90	- 12.00								
-12.90	- 13.00								
-13.90	- 14.00								
-14.90	- 15.00								
-15.90	- 16.00								
-16.90	- 17.00								
-17.90	- 18.00								
-18.90	- 19.00								
-19.90	- 20.00								
-20.90	- 21.00								
-21.90	- 22.00								
-22.90	- 23.00								
-23.90	- 24.00								
-24.90	- 25.00								
-25.90	- 26.00								
-26.90	- 27.00								
-27.90	- 28.00								
-28.90	- 29.00								
-29.90	- 30.00								
-30.90	- 31.00								
-31.90	- 32.00								

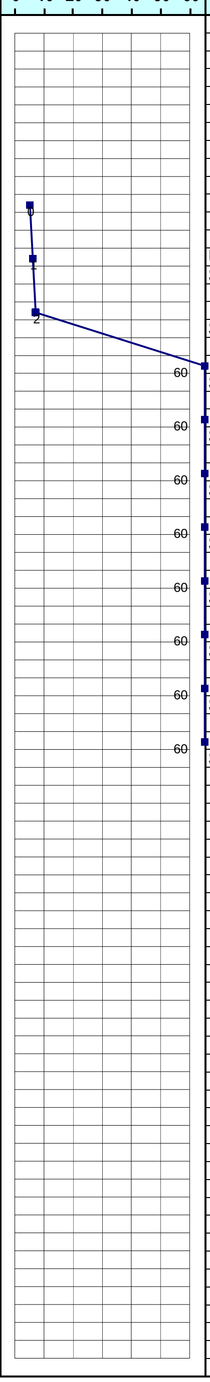
⧄	*SPT Test*	▓	*Clay*	░	*Sand*	▓	*Shell fragment*
☒	*UDS Sample*	░	*Silt*	▒	*Gravel*	■	*Andesit rock*

Figure 2-1-12 "Drilling Log (No. OSB-1), Bojonegara"

DRILLING LOG

THE STUDY ON DEVELOPMENT OF THE GREATER JAKARTA METROPOLITAN PORTS IN THE REPUBLIC OF INDONESIA

Project	: JICA	Coordinate x	: 620,558.1	Drilling Machine	: ZT-100
Location	: Bojonegara	y	: 9,347,519.2	Bor Master	: Casna
Number of bor hole	: OSB - 2	Sheet Number	: 1	Description by	: Mulyadi
GWL Elevation	: - m	Day/date	: (4/07-10/07) 2002	Check by	: Donny Z

Elevation from LWS (m)	Depth from ground level (m)	Bor Profile	Description of Strata	Number of Blow			Sum of blow	S P T- N Graphic	Remarks
				N1	N2	N3		0 10 20 30 40 50 60	
2.20	+ 5.00								
1.20	+ 4.00								
0.20	+ 3.00								
-0.80	+ 2.00								
-1.80	+ 1.00								
-2.80	0.00		*Sea bed*						
-3.80	- 1.00	1							UDS-1 : (1.00-1.50) m
-4.80	- 2.00	1	*Fine sandy clay , grey, soft*	0 / 15	0 / 15	1 / 15	1 / 30		SPT-1 : (1.50-1.95) m
-5.80	- 3.00	2		0 / 15	1 / 15	1 / 15	2 / 30		SPT-2 : (3.00-3.45) m
-6.80	- 4.00								
-7.80	- 5.00	3	*Gravelly clay & bed rock, brown, hard*	60 / 15			> 60 / 15		SPT-3 : (4.50-4.65) m
-8.80	- 6.00	4		60 / 2			> 60 / 2		SPT-4 : (6.00-6.02) m
-9.80	- 7.00								
-10.80	- 8.00	5		60 / 3			> 60 / 3		SPT-5 : (7.50-7.53) m
-11.80	- 9.00	6		60 / 2			> 60 / 2		SPT-6 : (9.00-9.02) m
-12.80	- 10.00								
-13.80	- 11.00	7	*Bedrock(andesit rock), grey, hard*	60 / 2			> 60 / 2		SPT-7 : (10.50-10.52) m
-14.80	- 12.00	8		60 / 2			> 60 / 2		SPT-8 : (12.00-12.02) m
-15.80	- 13.00								
-16.80	- 14.00	9		60 / 2			> 60 / 2		SPT-9 : (13.50-13.52) m
-17.80	- 15.00	10		60 / 3			> 60 / 3		SPT-10 : (15.00-15.03) m
-18.80	- 16.00								
-19.80	- 17.00								
-20.80	- 18.00								
-21.80	- 19.00								
-22.80	- 20.00								
-23.80	- 21.00								
-24.80	- 22.00								
-25.80	- 23.00								
-26.80	- 24.00								
-27.80	- 25.00								
-28.80	- 26.00								
-29.80	- 27.00								
-30.80	- 28.00								
-31.80	- 29.00								
-32.80	- 30.00								
-33.80	- 31.00								
-34.80	- 32.00								

⧅	*SPT Test*	▩	*Clay*	☐	*Sand*	■	*Shell fragment*
☒	*UDS Sample*	▨	*Silt*	▧	*Gravel*	■	*Andesit rock*

Figure 2-1-13 "Drilling Log (No. OSB-2), Bojonegara"

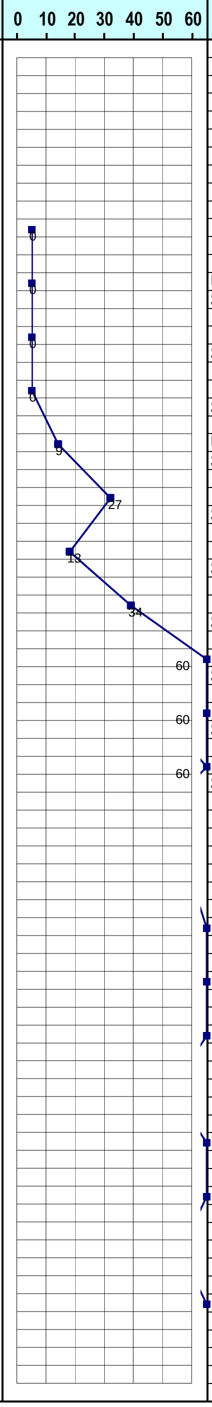
DRILLING LOG

THE STUDY ON DEVELOPMENT OF THE GREATER JAKARTA METROPOLITAN PORTS IN THE REPUBLIC OF INDONESIA

Project	: JICA	Coordinate x	: 621,670.4	Drilling Machine	: ZT-100
Location	: Bojonegara	y	: 9,346,438.9	Bor Master	: Casna
Number of bor hole	: OSB - 3	Sheet Number	: 1	Description by	: Mulyadi
GWL Elevation	: - m	Day/date	: (12/07-13/07) 2002	Check by	: Donny Z

Elevation from LWS (m)	Depth from ground level (m)	Bor Profile	Description of Strata	Number of Blow N1	N2	N3	Sum of blow	Remarks
1.90	+ 5.00							
0.90	+ 4.00							
-0.10	+ 3.00							
-1.10	+ 2.00							
-2.10	+ 1.00							
-3.10	0.00		*Sea bed*					
-4.10	- 1.00	☒ 1						UDS-1 : (1.00-1.50) m
-5.10	- 2.00	⧄ 1		0 / 15	0 / 15	0 / 15	0 / 30	SPT-1 : (1.50-1.95) m
-6.10	- 3.00	⧄ 2	*Coarse sandy clay & shell fragment, grey, soft*	0 / 15	0 / 15	0 / 15	0 / 30	SPT-2 : (3.00-3.45) m
-7.10	- 4.00							
-8.10	- 5.00	⧄ 3		0 / 15	0 / 15	0 / 15	0 / 30	SPT-3 : (4.50-4.95) m
-9.10	- 6.00	☒ 2 ⧄ 4		4 / 15	4 / 15	5 / 15	9 / 30	UDS-2 : (5.50-6.00) m SPT-4 : (6.00-6.45) m
-10.10	- 7.00		*Gravelly clay, light brown, soft to medium*					
-11.10	- 8.00	⧄ 5		8 / 15	12 / 15	15 / 15	27 / 30	SPT-5 : (7.50-7.95) m
-12.10	- 9.00	⧄ 6		4 / 15	5 / 15	8 / 15	13 / 30	SPT-6 : (9.00-9.45) m
-13.10	- 10.00							
-14.10	- 11.00	⧄ 7	*Gravelly clay, light brown, medium to stiff*	8 / 15	13 / 15	21 / 15	34 / 30	SPT-7 : (10.50-11.95) m
-15.10	- 12.00	⧄ 8		35 / 15	44 / 15	16 / 15	> 60 / 30	SPT-8 : (12.00-12.45) m
-16.10	- 13.00							
-17.10	- 14.00	⧄ 9		60 / 10			> 60 / 10	SPT-9 : (13.50-13.60) m
-18.10	- 15.00	⧄ 10	*Bed rock (andesit rock 10 cm)*	60 / 2			> 60 / 2	SPT-10 : (15.00-15.02) m
-19.10	- 16.00							
-20.10	- 17.00							
-21.10	- 18.00							
-22.10	- 19.00							
-23.10	- 20.00							
-24.10	- 21.00							
-25.10	- 22.00							
-26.10	- 23.00							
-27.10	- 24.00							
-28.10	- 25.00							
-29.10	- 26.00							
-30.10	- 27.00							
-31.10	- 28.00							
-32.10	- 29.00							
-33.10	- 30.00							
-34.10	- 31.00							
-35.10	- 32.00							

S P T- N Graphic



⧄	*SPT Test*	▩	*Clay*	░	*Sand*	▓	*Shell fragment*
☒	*UDS Sample*	▒	*Silt*	▨	*Gravel*	■	*Andesit rock*

Figure 2-1-14 "Drilling Log (No. OSB-3), Bojonegara"

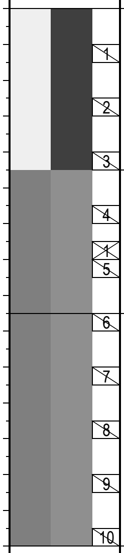
DRILLING LOG

THE STUDY ON DEVELOPMENT OF THE GREATER JAKARTA METROPOLITAN PORTS IN THE REPUBLIC OF INDONESIA

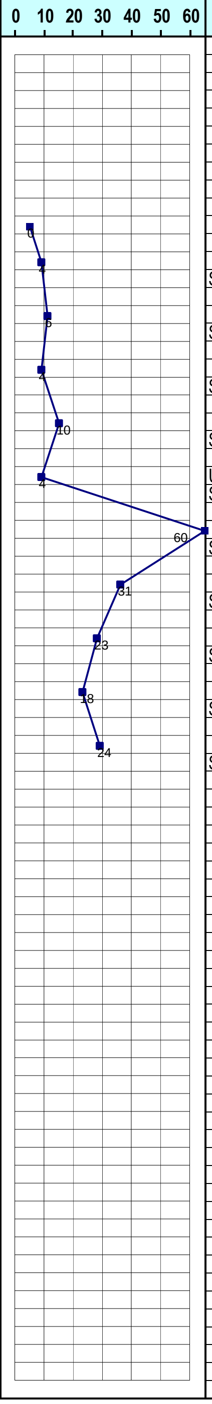
Project	: JICA	Coordinate x	: 621,193.2	Drilling Machine	: ZT-100
Location	: Bojonegara	y	: 9,347,517.1	Bor Master	: Casna
Number of bor hole	: OSB - 4	Sheet Number	: 1	Description by	: Mulyadi
GWL Elevation	: - m	Day/date	: (14/07-16/07) 2002	Check by	: Donny Z

Elevation from LWS (m)	Depth from ground level (m)	Description of Strata	Number of Blow N1	N2	N3	Sum of blow	Remarks
5.30	+ 5.00						
4.30	+ 4.00						
3.30	+ 3.00						
2.30	+ 2.00						
1.30	+ 1.00						
0.30	0.00	Sea bed					
-0.70	- 1.00		1 / 15	2 / 15	2 / 15	4 / 30	SPT-1 : (1.00-1.45) m
-1.70	- 2.00	Coarse sand & shell fragment, grey, soft					
-2.70	- 3.00		2 / 15	3 / 15	3 / 15	6 / 30	SPT-2 : (2.50-2.95) m
-3.70	- 4.00		1 / 15	2 / 15	2 / 15	4 / 30	SPT-3 : (4.00-4.45) m
-4.70	- 5.00						
-5.70	- 6.00	Gravelly clay & shell fragment, grey, soft	2 / 15	4 / 15	6 / 15	10 / 30	SPT-4 : (5.50-6.95) m
-6.70	- 7.00		1 / 15	2 / 15	2 / 15	4 / 30	UDS-1 : (6.50-7.00) m SPT-5 : (7.00-7.45) m
-7.70	- 8.00						
-8.70	- 9.00		35 / 15	43 / 15	17 / 15	60 / 30	SPT-6 : (8.50-8.85) m
-9.70	- 10.00		10 / 15	14 / 15	17 / 15	31 / 30	SPT-7 : (10.00-10.45) m
-10.70	- 11.00						
-11.70	- 12.00	Gravelly clay, ligth grey, stiff	11 / 15	10 / 15	13 / 15	23 / 30	SPT-8 : (11.50-11.95) m
-12.70	- 13.00		5 / 15	7 / 15	11 / 15	18 / 30	SPT-9 : (13.00-13.45) m
-13.70	- 14.00						
-14.70	- 15.00		6 / 15	13 / 15	11 / 15	24 / 30	SPT-10 : (14.50-14.95) m
-15.70	- 16.00						
-16.70	- 17.00						
-17.70	- 18.00						
-18.70	- 19.00						
-19.70	- 20.00						
-20.70	- 21.00						
-21.70	- 22.00						
-22.70	- 23.00						
-23.70	- 24.00						
-24.70	- 25.00						
-25.70	- 26.00						
-26.70	- 27.00						
-27.70	- 28.00						
-28.70	- 29.00						
-29.70	- 30.00						
-30.70	- 31.00						
-31.70	- 32.00						

Bor Profile



S P T- N Graphic



⧄ SPT Test	▩ Clay	☐ Sand	■ Shell fragment
☒ UDS Sample	▨ Silt	▦ Gravel	■ Andesit rock

Figure 2-1-15 "Drilling Log (No. OSB-4), Bojonegara"

Table 2-1-9 "Summary of Soil Laboratory Test at Boring No. OSB-1, Bojonegara"

Location : Bojonegara
Boring Number : OSB-1

No.	Sample Number	Depth (m)	Atterberg Limits			Density		Water Content (%)	Specific Gravity	Grain Size Analysis (%)			Consolidation		Unconfined
			Soil Classification	Liquid Limit (%)	Plast. Index (%)	Dry (gr/cm^3)	Wet (gr/cm^3)			Clay-Silt (%)	Sand (%)	Gravel (%)	Cc	Cv cm^2/sec	qu (kg/cm^2)
1	UDS. 1	1.00 ~ 1.50	C H	49.37	89.90	0.735	1.395	89.68	2.4501	68.18	26.80	5.02	0.879	7.67E-04	0.092
2	SPT. 1	1.50 ~ 1.95	C H	48.89	124.56	0.732	1.426	94.75	2.4352	66.90	28.38	4.72	-	-	-
3	SPT. 2	3,00 ~ 3,45	C H	48.41	65.09	0.922	1.571	70.38	2.6431	69.54	21.52	8.94	-	-	-
4	SPT. 3	4,50 ~ 4,95	C H	34.38	42.37	1.085	1.674	54.35	2.6702	46.70	22.26	31.04	-	-	-
5	SPT. 4	6,00 ~ 6,45	M H	32.73	26.45	2.160	1.682	48.13	2.6521	4.72	5.02	68.96	2.16	7.72E+00	-
6	SPT. 5	9.00 ~ 9.30	GW	-	N P	2.118	2.191	3.44	2.7472	0.03	0.25	99.72	-	-	-
7	SPT. 6	9.50 ~ 9.65	C L	35.73	12.38	1.481	1.889	27.57	2.7205	58.43	30.87	10.70	-	-	-
	Average		**CH**	**35.65**	**51.54**	**1.32**	**1.69**	**55.47**	**2.62**	**44.93**	**19.30**	**32.73**	**1.52**	**3.86**	**0.05**

Table 2-1-10 "Summary of Soil Laboratory Test at Boring No. OSB-2, Bojonegara"

Location : Bojonegara
Boring Number : OSB-2

No.	Sample Number	Depth (m)	Atterberg Limits			Density		Water Content (%)	Specific Gravity	Grain Size Analysis (%)			Consolidation		Unconfined
			Soil Classification	Liquid Limit (%)	Plast. Index (%)	Dry (gr/cm^3)	Wet (gr/cm^3)			Clay-Silt (%)	Sand (%)	Gravel (%)	Cc	Cv cm^2/sec	qu (kg/cm^2)
1	UDS. 1	1.00 ~ 1.50	C H	114.94	89.90	0.602	1.342	123.10	2.474	74.56	23.28	2.16	0.954	8.25E-04	0.036
2	SPT. 1	1.50 ~ 1.95	SC	-	124.56	1.063	1.655	55.74	2.6968	26.08	64.74	9.18	-	-	-
3	SPT. 2	3.00 ~ 3.45	SC	-	65.09	1.203	1.737	44.43	2.7021	21.38	39.10	39.52	-	-	-
4	SPT. 3	4.00 ~ 4.20	SC	-	42.37	1.595	1.983	24.36	2.7254	13.96	15.91	70.13	-	-	-
5	SPT. 4	4.50 ~ 4.60	GW	-	26.45	1.983	2.102	6.02	2.705	0.35	1.42	98.23	-	-	-
	Average		**SC**	**114.94**	**69.67**	**1.29**	**1.76**	**50.73**	**2.66**	**27.27**	**28.89**	**43.84**	**0.95**	**0.00**	**0.04**

Table 2-1-11 "Summary of Soil Laboraotry Test at Boring No. OSB-3, Bojonegara"

Location : Bojonegara
Boring Number : OSB-3

No.	Sample Number	Depth	Atterberg Limits			Density		Water Content	Specific Gravity	Grain Size Analysis (%)			Consolidation		Unconfined
		(m)	Soil Classification	Liquid Limit (%)	Plast. Index (%)	Dry (gr/cm^3)	Wet (gr/cm^3)	(%)		Clay-Silt (%)	Sand (%)	Gravel (%)	Cc	Cv cm^2/sec	qu (kg/cm^2)
1	UDS. 1	1.00 ~ 1.50	C H	64.02	39.22	0.825	1.503	82.21	2.605	61.46	36.34	2.20	0.882	1.08E-03	0.051
2	SPT. 1	1.50 ~ 1.95	S M	-	N P	1.176	1.727	46.90	2.7032	28.90	63.38	7.72	-	-	-
3	SPT. 2	3.00 ~ 3.45	M H	83.95	50.80	0.945	1.584	67.66	2.6314	59.06	39.44	1.50	-	-	-
4	SPT. 3	4.50 ~ 4.95	C H	80.29	48.80	0.849	1.517	78.68	2.5742	62.58	36.02	1.40	-	-	-
5	UDS. 2	5.50 ~ 6.00	C H	93.21	72.38	0.779	1.463	87.81	2.5604	70.88	26.96	2.16	0.663	1.59E-03	0.08
6	SPT. 4	6.00 ~ 6.45	M H	62.57	29.11	1.013	1.625	60.44	2.6203	60.74	37.88	1.38	-	-	-
7	SPT. 5	7.50 ~ 7.95	M H	55.81	20.21	1.081	1.669	54.38	2.6444	65.18	34.58	0.24	-	-	-
8	SPT. 6	9.00 ~ 9.45	C H	76.31	48.87	0.947	1.586	67.51	2.6345	89.78	10.22	0.00	-	-	-
9	SPT. 7	10.50 ~ 10.95	C H	75.53	49.44	1.109	1.689	52.31	2.6612	80.18	19.82	0.00	-	-	-
10	SPT. 8	12.00 ~ 12.20	G C	-	N P	1.375	1.857	35.08	2.6702	11.18	30.46	58.36	-	-	-
	Average		**CH**	**73.96**	**44.85**	**1.01**	**1.62**	**63.30**	**2.63**	**58.99**	**33.51**	**7.50**	**0.77**	**0.00**	**0.07**

Table 2-1-12 "Summary of Soil Laboraotry Test at Boring No. OSB-4, Bojonegara"

Location : Bojonegara
Boring Number : OSB-4

No.	Sample Number	Depth	Atterberg Limits			Density		Water Content	Specific Gravity	Grain Size Analysis (%)			Consolidation		Unconfined
		(m)	Soil Classification	Liquid Limit (%)	Plast. Index (%)	Dry (gr/cm^3)	Wet (gr/cm^3)	(%)		Clay-Silt (%)	Sand (%)	Gravel (%)	Cc	Cv cm^2/sec	qu (kg/cm^2)
1	SPT. 1	1.00 ~ 1.45	S C	-	N P	1.389	1.862	34.06	2.6808	16.78	47.93	35.29	-	-	-
2	SPT. 2	2.50 ~ 2.95	S C	-	N P	1.172	1.727	47.30	2.6962	15.58	46.00	38.42	-	-	-
3	SPT. 3	4.00 ~ 4.45	S C	-	N P	1.425	1.894	32.93	2.713	8.09	34.40	57.51	-	-	-
4	SPT. 4	5.50 ~ 5.95	S C	-	N P	1.206	1.743	44.56	2.6711	19.71	17.36	62.93	-	-	-
5	UDS. 1	6.50 ~ 7.00	C H	130.94	103.38	0.749	1.421	89.68	2.4613	81.02	6.52	12.46	1.093	3.03E-03	0.063
6	SPT. 5	7.00 ~ 7.45	OH - MH	105.83	69.99	0.849	1.512	78.11	2.5323	46.92	13.18	39.90	-	-	-
7	SPT. 6	8.50 ~ 8.70	S M	-	N P	1.989	2.189	10.03	2.7297	27.44	13.74	58.82	-	-	-
8	SPT. 7	10.00 ~ 10.45	M H	79.12	44.52	1.576	1.98	25.63	2.7214	67.86	13.38	18.76	-	-	-
9	SPT. 8	11.50 ~ 11.95	C H	78.51	53.66	1.415	1.849	30.65	2.6753	92.62	1.80	5.58	-	-	-
10	SPT. 9	13.00 ~ 13.45	C H	96.42	72.40	1.415	1.861	31.51	2.6772	99.32	0.68	0.00	-	-	-
11	SPT. 10	14.50 ~ 14.95	C H	110.81	85.95	1.362	1.839	35.02	2.6714	96.48	2.52	1.00	-	-	-
12	UDS. 2	15.00 ~ 15.40	C H	100.42	75.79	1.452	1.89	30.15	2.6723	90.08	2.58	7.34	0.302	5.95E-03	3
	Average		**CH**	**100.29**	**63.21**	**1.33**	**1.81**	**40.80**	**2.66**	**55.16**	**16.67**	**28.17**	**0.70**	**0.0045**	**1.53**

2.1.5 Seismic Reflection Survey

a) Outline of Seismic Profiling Survey

The boring survey of a total of 66 holes had been made by IPC-2 at the planned site of the new port development at Bojonegara.

The analysis of the results of this existing boring survey made clear that relatively hard bedrock consisting of igneous rocks exist at depths of -10 m to -15 m (from the lowest low water) at the planned site of the new port development (anchorage and navigational channel).

It is thus necessary to consider the following points for planning the layout of the new port facilities at Bojonegara:

1) To plan the access channel and anchorage so that the bedrock boring quantity is minimized.
2) To examine the appropriate structure and construction method to meet the bedrock conditions in designing the port facilities.
3) To examine the appropriate bedrock excavating method (particularly, necessity of excavating by blasting)

It is thus necessary to acquire two types of information on the bedrock as follows:

1) Detailed depth contour map of bedrock (dimensional information on bedrock)
2) Lippability of excavating the bedrock (strength of the rock)

As the dimensional information on the bedrock, the bedrock depth contour map was produced based on the existing boring data, but this bedrock depth contour map was prepared based only on the point information that was acquired from the results of existing boring data.

It is therefore necessary to acquire the depths of the bedrock as the line or plane information in order to draw an accurate bedrock depth contour map of the bedrock.

Thus, seismic reflection survey was implemented in the target sea area as additional natural condition survey in order to identify the depth distribution of the bedrock and create a detailed bedrock depth contour map of the bedrock.

The outline of the seismic reflection survey is described below. The area of the seismic reflection survey is shown in Figure 2-1-16, "Seismic Reflection Survey Area, Bojonegara".

1)	Seismic reflection survey area	Approx. 2.0 km by 0.75 km (150 ha)
2)	Survey line direction	Perpendicular to the coastline or east-west direction
3)	Survey line interval	Approx. 50 m
4)	Positioning method	GPS observation
5)	Equipment	Klein System 2000
6)	Scale of map	1:1,000 and 1:5,000
7)	Ellipsoid	WGS‐84
8)	Projection	Universal Transverse Mercator (U.T.M.) Zone No. 48
9)	Datum level	Lowest low water level
10)	Reference point for elevation	BP-20 (Benchmark installed by IPC‐2) Elevation value = 1.283 m
11)	Format style of digital data	AutoCAD format

b) Analysis of Seismic Reflection Survey Data and Creation of Bedrock Contour Map

The depth of the sea can be measured by counting the time required for a sound wave transmitted at the sea surface to come back after being reflected by the seabed and multiplying it by the sound wave velocity (about 1,500m/sec in sea water).

Although, in this case, only a reflected wave from the seabed needs to be acquired to achieve the objective, a high resolution is required.

A systematized implementation of this method is an echo sounder.

Seismic reflection survey has physically the same principle as echo sounding. However, seismic reflection survey, intended to observe reflection also from geological layers beneath the seabed, uses sound waves with a lower frequency and larger oscillation energy than echo sounding.

In general, seismic reflection survey, using electrical or mechanical energy, receives and records sound waves generated through an underwater sound source by reflecting on the acoustical discontinuity surface on the ocean floor or seabed and coming back as feeble acoustic signals.

Seismic reflection survey records are analyzed by tracing the continuity of reflected waves. This is based on the idea that reflected waves correspond to geological layer interfaces.

During the tracing the continuity of reflected waves, sometime, there comes a point when the reflected waves become so weak that we can no longer trace the continuity. This phenomenon reflects a lateral change in properties as well as reflection strength corresponding to a change in faces.

Geological layers are generally stacked with a hierarchical relationship. The constituents and properties of the layers change at the interfaces of the layers. Seismic reflection survey is fundamentally based on such property changes in the depth direction. Geological layers, large or small, have their own unique properties and constitute a ratio of acoustic impedances at the interfaces.

As described above, seismic reflection survey bases its analysis on the differences of properties between geological layers. The nature of each of the geological layers can only be determined after the result of acoustic exploration is compared with the boring materials.

Therefore, the data recorded on the recording sheets of seismic reflection survey for the survey lines was analyzed, and the existing and new boring materials for locations close to the survey lines were used as reference to interpret the geological layers.

Figure 2-1-17, "Original Seismic Reflection Survey Data and Interpreted Sub-bottom Profile" shows the recording sheet, boring log data, and interpretation result for a typical survey line.

After the interpretation of recording sheets of seismic reflection survey for all the survey lines was completed, the result was two-dimensionally expanded to create a 1:1,000 and 1:5,000 scale bedrock depth contour map.

Through the analysis result, the geological layers of the port development area at Bojonegara can be roughly classified into the four types shown in the table below.

Table 2-1-13 "Soil Situation of Planned Site of Port Development at Bojonegara through Analysis of Seismic Reflection Survey"

Depth	Geological layer	Characteristic
↑ Shallow	Alluvium	Soft layer
		Relatively stiff layer
	Igneous rock	Significantly weathered layer
↓ Deep		Moderately weathered layer

The soft layer in the alluvium mainly consists of clay but sometimes of sand. This layer is assumed to be soil that accumulated on the seabed recently.

The alluvium extends over the entire port development area at Bojonegara with a significantly varying thickness depending on the location.

The relatively stiff layer in the alluvium consists mainly of clay or sand. This layer is also assumed to be sediments in the lower part of soil that accumulated on the seabed recently. This layer is scattered about the port development area at Bojonegara.

The bedrock that exists up to the planned dredging depth (-15 m from the lowest low water) is assumed to be mainly significantly weathered tuff breccia. This tuff breccia consists mainly of andestite gravel.

Figure 2-1-18 “Bedrock Contour Line Map, Bojonegara” shows the area of bedrock existing above –15 m (LLWS), which is considered as dredging depth, and area with moderately weathered rock exposed on the rock surface in the sea bottom of Bojonegara.

Appendix-5 is the topographic/bedrock depth contour map which was prepared by the combination of 1:10,000 scale digital topographic maps and results of seismic reflection survey.

Figure 2-1-19 “Tow Fish for Seismic Reflection Survey, Bojonegara”

Figure 2-1-20 “Equipment for Seismic Reflection Survey, Bojonegara”

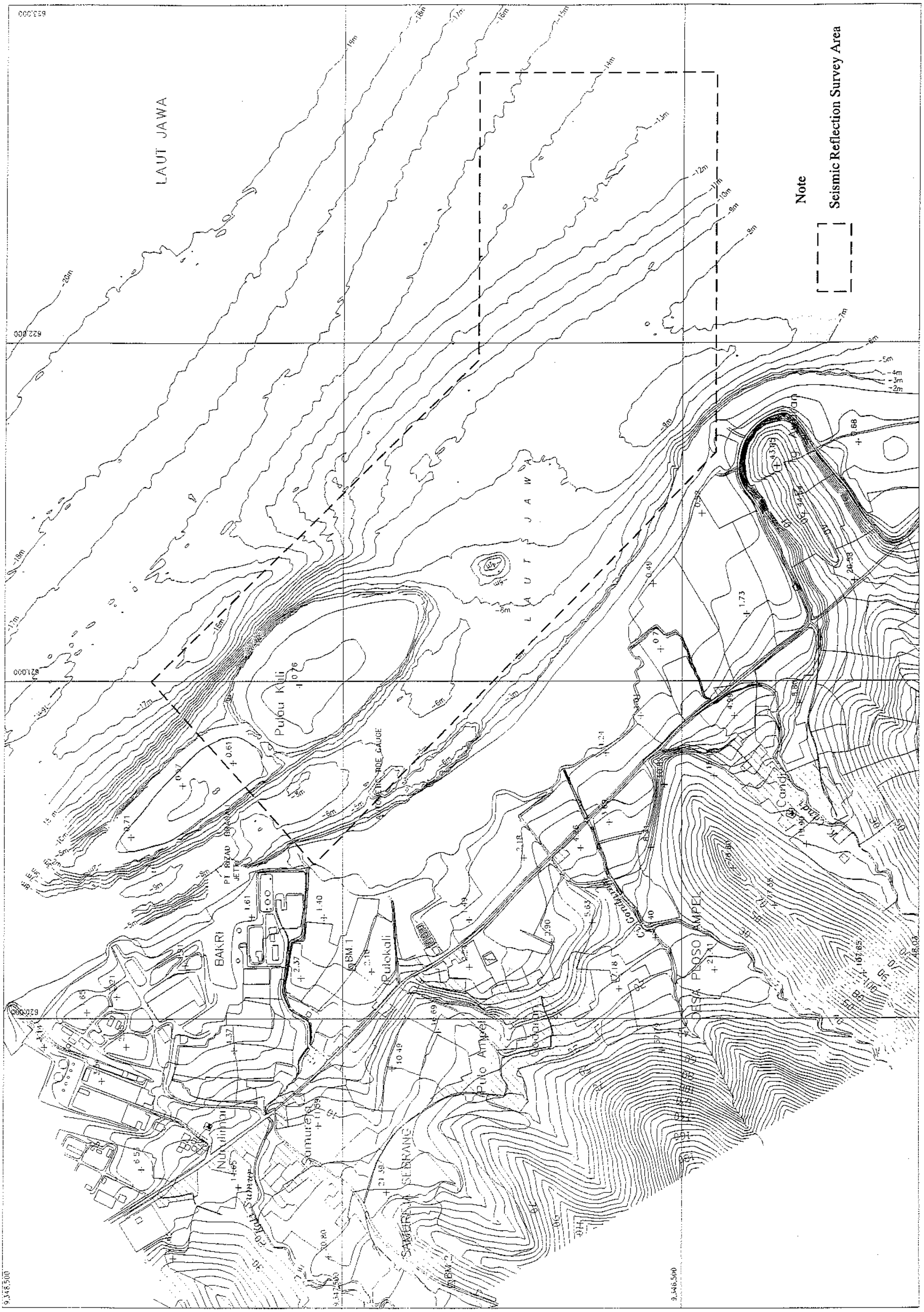
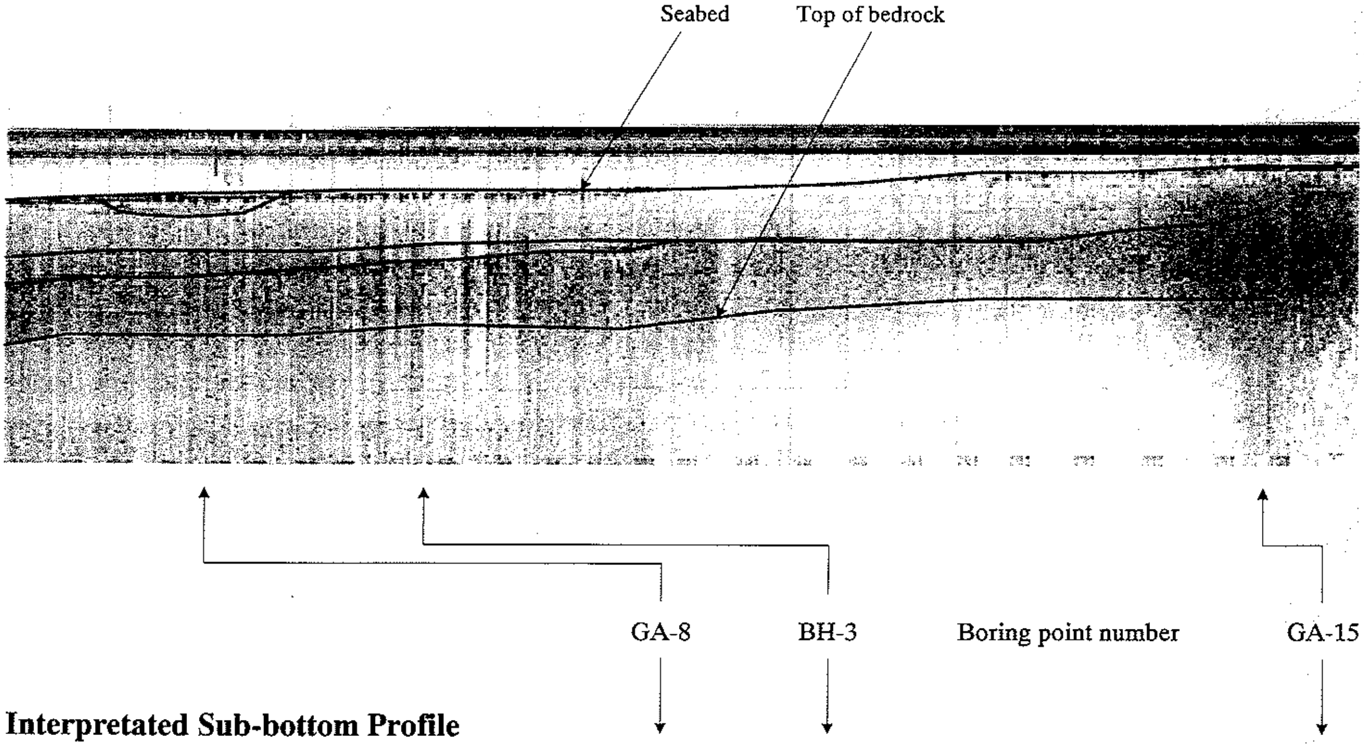


Figure 2-1-16 "Seismic Reflection Survey Area, Bojonegara"

Original Sub-bottom Profiling Survey Data



Interpretated Sub-bottom Profile

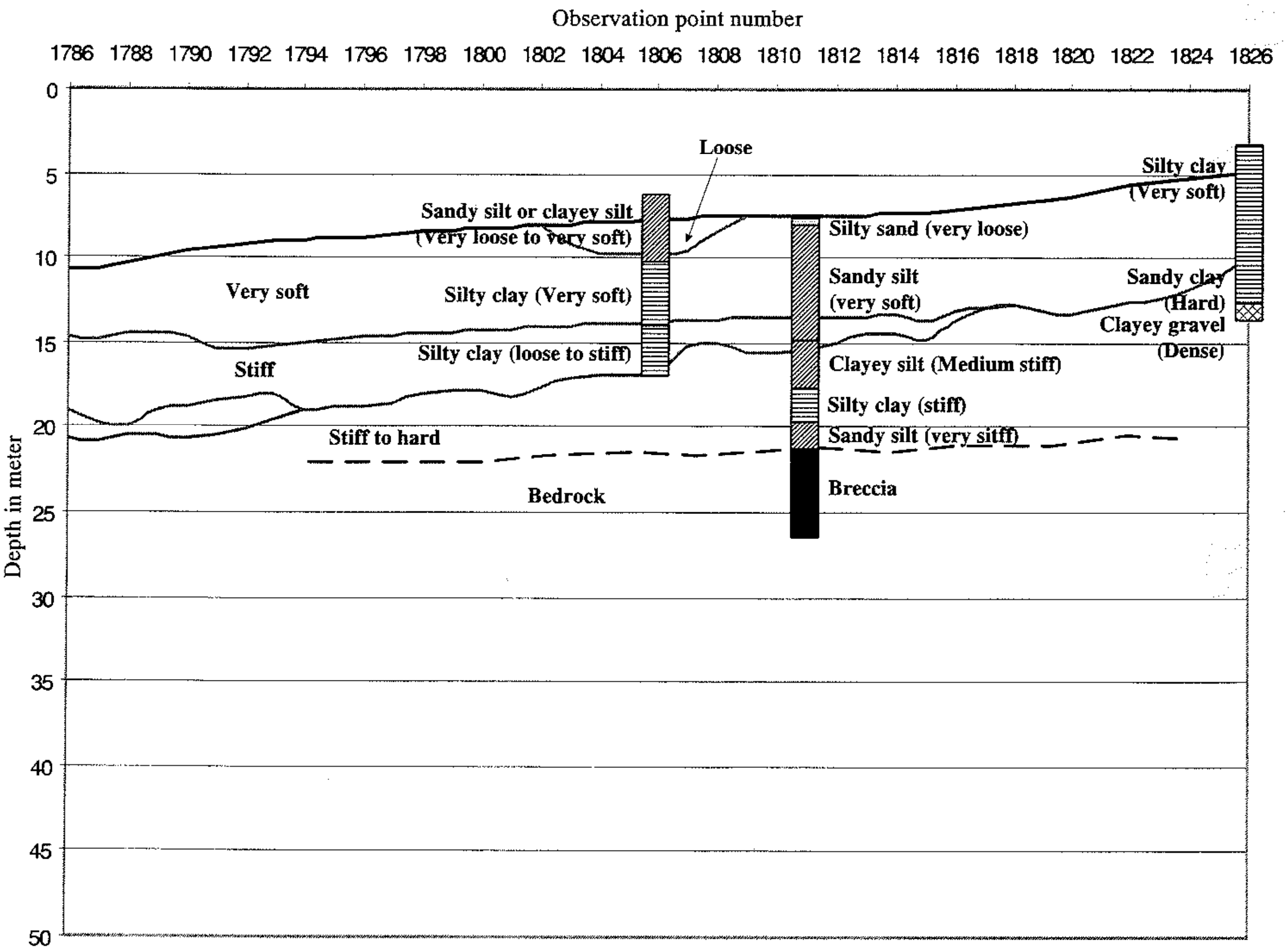


Figure 2-1-17 "Original Seimic Reflection Survey Data and Interpretated Sub-bottom Profile"

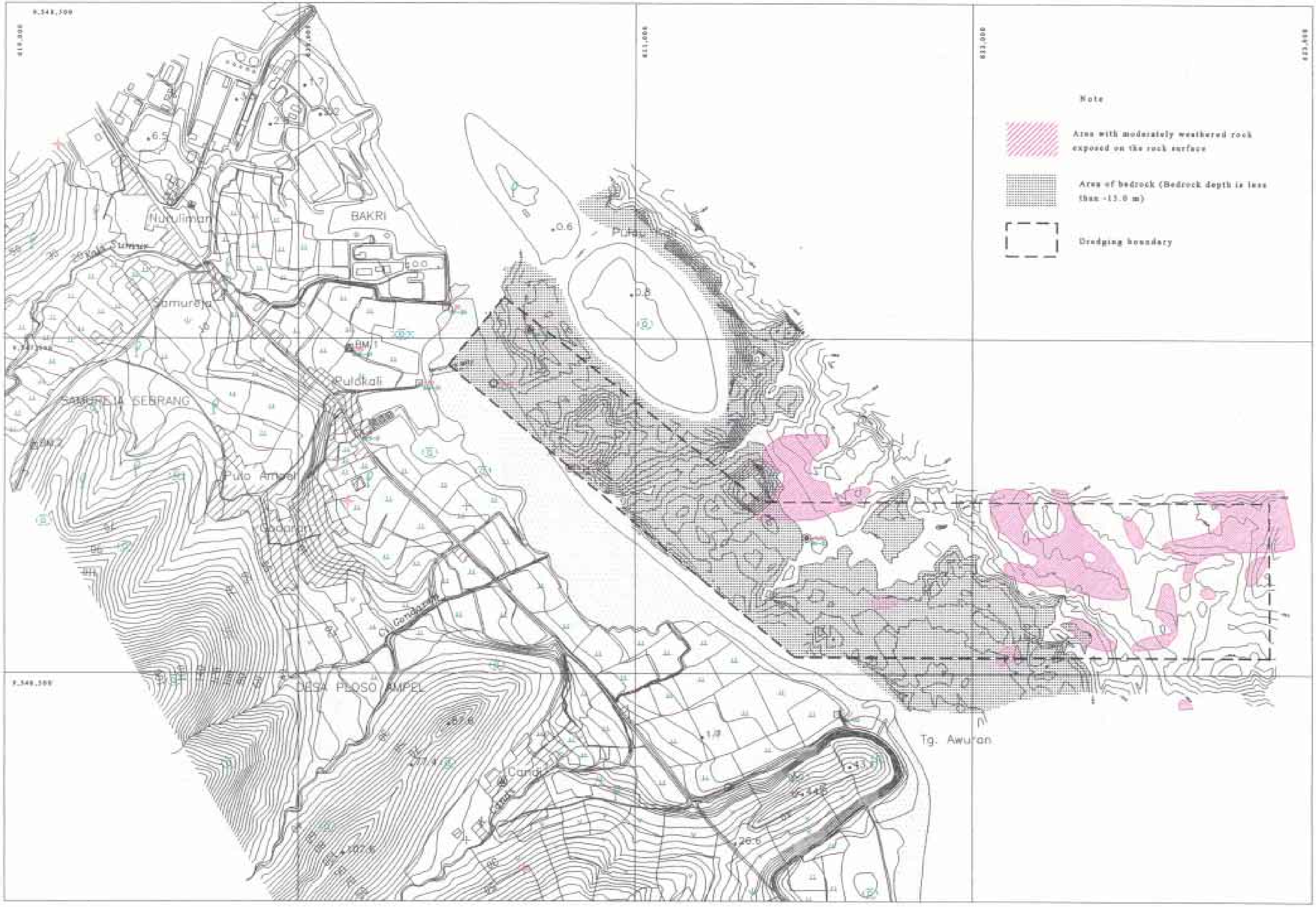


Figure 2-1-18 "Bedrock Contour Line Map, Bojonegara"

2.1.6 Primary Wave Logging

a) Outline of P-Wave Logging

To identify the possibility of excavating the bedrock, it is necessary to estimate the strength of rocks. In general, the primary wave velocity is used as information for judging the possibility of excavating the bedrock (strength of the bedrock).

Since no such survey was conducted on the existing boring data, it is necessary to implement primary wave logging using boring holes to measure the primary wave velocity of the bedrock.

Under such circumstances, the rock boring was conducted and the primary wave logging using boring holes was carried out as the additional natural condition survey.

The outline of the primary wave logging is described below.

1)	Number of boring locations	Three, offshore boring	
2)	Extension of boring	70 m in total	
3)	Standard penetration test	1.5 m intervals, 20 times in total	
4)	Acquired undisturbed samples	4 samples	
5)	Longitudinal wave velocity logging	3 holes (every 2 m, 27 times in total)	
6)	Soil laboratory test	Uniaxial compression test	4 samples
		Load test	9 samples
		Rupture test	11 samples

The locations of boring points are shown in Figure 2-1-21, "Location of Rock Boring, Bojonegara". The horizontal coordinates, water depth, and boring depth of each boring point are shown in Table 2-1-14 “Horizontal Coordinates, Elevation, and Boring Depth of Rock Boring Points Required for Primary Wave Velocity Logging, Bojonegara”.

Table 2-1-14 "Horizontal Coordinates, Elevation, and Boring Depth of Rock Boring Points Required for Primary Wave Velocity Logging, Bojonegara"

Point number	Coordinate value (m)			Boring depth	Standard penetration test
	X	Y	H		
BH-1	620,806.707	9,347,114.637	-6.49	30 m	8 times
BH-2	620,685.975	9,347,526.459	-7.12	20 m	4 times
BH-3	621,509.407	9,346,907.319	-7.50	20 m	8 times

Note: The height reference is the lowest low water.

The drilling logs of the boring holes are shown in Figure 2-1-22, "Drilling Log (No. BH-1)", Figure 2-1-25, "Drilling Log (No. BH-2)", and Figure 2-1-27, "Drilling Log (No. BH-3)".

Figure 2-1-29 “Offshore boring, Bojonegara”

The photos of obtained core samples area shown in Figure 2-1-23 “Boring Core of Rock Boring at BH-1, Bojonegara”, Figure 2-1-24 “Boring Core of Rock Boring at BH-1, Bojoengara”, Figure 2-1-26 “Boring Core of Rock Boring at BH-2, Bojonegara” and Figure 2-1-28 “Boring Core of Rock Boring at BH-3, Bojonegara”.

The outline of the boring results is shown in Table 2-1-15 “Outline of Rock Boring Results, Bojonegara

(No. BH-1)”, Table 2-1-16 “Outline of Rock Boring Results, Bojonegara (No. BH-2)” and Table 2-1-17 “Outline of Rock Boring Results, Bojonegara (No. BH-3)”.

Table 2-1-15 "Outline of Rock Boring Results, Bojonegara (No. BH-1)"

Depth (LWS)	Layer thickness	Outline of soil type	N-value	Characteristic
-6.49 to -7.19 m	0.7 m	Sand	1	Loose
-7.19 to –11.59 m	4.4 m	Silty clay	1 to 4	Soft
-11.59 to –13.99 m	2.4 m	Silty clay	25	Very stiff
-13.99 to –37.49 m	23.5 m	Breccia	＞50	Very dense

Table 2-1-16 "Outline of Rock Boring Results, Bojonegara (No. BH-2)"

Depth (LWS)	Layer thickness	Outline of soil type	N-value	Characteristic
-7.11 to –8.22 m	1.1 m	Sand with shell fragment	12	Loose
-8.22 to –10.22 m	2.0 m	Silty clay or clayey silt	＞50	Stiff
-10.22 to –13.22 m	3.0 m	Sandy silt	＞50	Hard
-13.22 to –27.12 m	13.9 m	Breccia	＞60	Very dense

Table 2-1-17 "Outline of Rock Boring Results, Bojonegara (No. BH-3)"

Depth (LWS)	Layer thickness	Outline of soil type	N-value	Characteristic
-7.50 to -8.15 m	0.65 m	Silty sand	0	Very loose
-8.15 to –19.5 m	11.35 m	Sandy silt or Clayey silt	0 to 11	Soft to stiff
-19.5 to –21.25 m	1.75 m	Sandy silt	50	Very stiff
-21.25 to –27.50 m	6.25 m	Breccia	＞50	Hard

Laboratory tests were carried out for rock samples to obtain compression and tensile strength characteristic of the rock formation. The original program of laboratory tests consisting of unconfined compression tests to determine compressive strengths and Brazilian tests to indirectly determine tensile strengths.

However, as majority of core samples were short and were unable to meet the required ratio of length to diameter for the unconfined compression tests, point load tests were assigned to short core samples to indirectly obtain the compressive strengths.

There were 4 unconfined compression tests, 9 points load tests and 11 Brazilian tests conducted on rock core samples in the present study. The core samples were collected from all the sound portion of the cores having the length of larger than 5 cm.

It should be pointed out that almost all the core samples having the length larger than 5 cm were obtained below –15m LLWS (the proposed dredging level) because the rock mass above –15 m LLWS confirmed in all the 3 boreholes was highly to completely weathered.

The summary of results of laboratory test is shown in Table 2-1-18 “Strength Characteristics of Rock Core Samples, Bojonegara”.

b) Core sampling ratio, maximum core length, and RQD

The indexes used to determine the quality of bedrock in boring are core sampling ratio, maximum core length, and rock quality designation (RQD).

A core sampling ratio refers to the ratio of a sampled core length to the driving length equivalent to the length of a sampler core barrel. The higher the core sampling ratio, the better the bedrock status. However, a core sampling ratio largely depends on the boring technology.

The higher the maximum core length, the better the bedrock status. Normally, the maximum core length per meter is indicated because consideration must be given to organization and storage of cores in core boxes.

An RQD, an index that shows whether bedrock is good, represents the percentage of the 10 cm total core length to one-meter driving length. In general, the relationship between an RQD and a rock quality level are as shown below. In general, a low RQD value means that the bedrock is fragile and destructible.

Table 2-1-19 "Relationship between RQD and Rock Quality Level"

RQD（%）	Rock quality level
0 to 25	Very bad
25 to 50	Bad
50 to 75	Fair
75 to 90	Good
90 to 100	Very good

Table 2-1-20 "RQDs of Rock Samples, Bojonegara" shows RQDs listed in the existing boring data and RQDs obtained during rock boring in this Study.

From this table, it is presumed that the bedrock quality level is very bad because almost all the RQDs up to the planned dredging depth of -15 m (LLWS) are 0% and the average value is about 13%, which is lower than 25%.

Most of the sampled cores are about 5 cm long and there were very few cores longer than 10 cm. Therefore, we can conclude that the bedrock in the planned site of port development at Bojonegara up to the planned dredging depth of -15 m has a very bad level and will easily be destroyed.

Based on these results and the following rock mass classification criteria for boring core appraisal shown in Table 2-1-21 “Rock Mass Classification by the CRIEPI” and Table 2-1-22 “Physical Property and CRIEPI Classification”, the bedrock in the planned site of port development at Bojonegara up to the planned dredging depth of -15 m is classified approximately into CL to D class (soft rock).

c) Analysis of Primary Wave Logging Data

The method of survey for continuously measuring the physical properties of bedrock using boring holes is called logging. In this sense, logging is included in the scope of site test. Primary wave logging is a method for checking the bedrock status by giving an artificial vibration using bore holes and observing how it travels. In offshore geological survey, primary waves are used because no appropriate device that generates secondary waves on the seabed is yet available.

Primary wave logging is a method of continuously measuring the sound wave velocity and wave form of sound waves that travel between the generators and receivers of sound waves installed as built-in devices in a logging sonde at certain intervals. This method is intended to measure the velocity of sound waves (primary wave in this Study) in the target rock layer.

The test was carried out by inserting inflatable geophone at the intended testing depths. A shock wave was generated by hammering the casing pipe that was installed up to the surface of the rock formation. Reference geophones were also installed in the casing pipe for the correction of the wave propagation along the casing pipe. The hammering was done several times to obtain the best signal recorded by the geophone.

The result of primary wave logging survey in the boreholes is shown in Figure 2-1-14, "Result of P-wave Logging Survey, Bojonegara" and Table 2-1-29 “Summary of P-wave Logging Survey Results, Bojonegara”.

Table 2-1-23 “Summary of P-Wave Logging Survey, Bojonegara”

Borehole No.	Depth (m)	Elevation (m from LLWS)	P-wave Velocity (km/sec)	Rock/Soil Type
BH-1	12.0 to 18.0	-18.5 to –24.5	2.5 – 3.3	Highly fractured breccia
	18.0 to 30.0	-24.5 to –36.5	2.9 – 3.8	Highly fractured breccia
BH-2	6.5 to 9.0	-13.6 to –16.1	1.8	Highly to completely weathered breccia
	9.0 to 15.0	-16.1 to –22.1	2.4 – 3.3	Highly fractured breccia
	15.0 to 20.0	-22.1 to –27.1	3.4	Highly fractured breccia

BH-3	10.0 to 13.0	-17.5 to –20.5	1.0 – 1.2	Stiff silty clay and sandy silt
	13.0 to 16.0	-20.5 to –23.5	1.6 – 2.0	Highly to completely weathered breccia
	16.0 to 19.0	-23.5 to –26.5	2.3 – 5.0	Highly to completely weathered breccia

Source: Results of natural condition survey by JICA Study Team

This figure shows that the primary wave velocity in the bedrock is approximately 1.8 m/sec up to the planned dredging depth of -15 meters (LLWS) and 2.4 to 3.3 m/sec in the range of -15 to -20 m (LLWS).

Whereas an elastic wave velocity in metal, etc. is roughly constant, an elastic wave velocity in rocks has varying values even though the rocks are classified into one rock type. In general, an elastic wave velocity has the following tendencies:

1) In general, the older the rock, the higher the primary wave velocity.
2) A primary wave that travels in a weathered rock or bedrock has a lower velocity than in a fresh rock. The more weathered the rock or bedrock, the significantly lower the velocity.
3) A primary wave in a sedimentary rock tends to have a higher velocity at a greater depth. However, a velocity measured at a distance less than a few meters has significantly wide variations.
4) In general, the higher the porosity of a rock, the lower the velocity of an primary wave.

A primary wave in a rock, depending on various conditions as described above, cannot be easily determined. However, it can be concluded that an elastic wave has a low velocity in a soft rock and a high velocity in a hard rock.

The primary wave velocities in rocks in Japan and their distribution are shown in Figure 2-1-30, "Distribution of Primary Wave Velocities in Rocks in Japan". This figure shows that the velocities in andesite are distributed approximately between 1 and 5 km/sec.

The primary wave velocity of 1.8 m/sec for the bedrock up to the planned dredging depth of -15 m (LLWS), which has been identified through the primary wave velocity logging in the Study, is found to be a low velocity among the velocity distribution by rocks.

Figure 2-1-31 “Hammering Casing Pipe to Generate Source Wave, Bojonegara”

Figure2-1-32 “Geophone to be Lowered into Borehole, Bojonegara”

d) Reppability and Classification of Rock Quality for Dredging

Apart from the case of manual excavation, bedrock excavation is most commonly classified into machine excavation and blasting, each of which further corresponds to the target bedrocks of hard rock, soft rock, and earth and sand.

Normally, the bedrock primary wave velocities frequently classify bedrock excavation because it is common to use only one parameter for bedrock classification as a representative one instead of using a combination of many parameters.

For excavation types in this case, note that excavation types and geological types are different as shown in Figure 2-1-33 “Rippability Guide Value”.

In this classification, the boundary at which ripping from earth and sand is required is set at an elastic wave velocity of 450 m/sec and the ripping limit at 1,500 to 2,000 m/sec (varying depending on the model), which then corresponds to the four types of earth and sand and soft rock and middle to hard rock.

As a result of primary wave logging in the planned port site at Bojonegara, the primary wave velocity up to the planned dredging depth of -15 m is approximately 1.8 m/sec. In this classification, the bedrock was found to be soft or middle to hard rock, on which machine excavation is possible.

The Rock Quality Designation (RQD) and the joint spacing are generally the important information for workability other than the strengths of the rock masses as shown in Figure 2-1-34, Figure 2-1-35 and Figure 2-1-36. The figures that the rock mass with RQD values smaller than 20 % and with close joint spacing of smaller than 50 mm are generally rippable without blasting.

The unconfined compressive strengths of the core samples obtained from BH-1 to BH-3 are plotted in Figure 2-1-34, Figure 2-1-35 and Figure 2-1-36 together with the RQD values and joint spacing observed during the investigation. The elevations of the core samples are also plotted in the figures.

As shown in the figures, the highly to completely weathered rocks above –22 m LLWS are generally rippable without blasting. Occasionally, chiseling or drilling to loosen the rock masses may be required if there are large size andesite fragments.

The information of the present 3 boreholes may not present the condition of the entire site area. The nature of rock above –15 m (LLWS) from the borehole information in the previous soil report was thus summarized in Table 2-1-34. The table indicates that the expected thickness of the rock excavation at the site varies from 0.5 to 7.5 m. The RQD values obtained from the present 3 boreholes and the previous boreholes of B-series, GA-series and K-series are generally less than 20 %.

Based on Figure 2-1-34, ripping of such soft is possible. Nevertheless, as the remark with andesite intercalation was often given in the A-series boreholes, dredging with difficulty may be expected if large andesite fragments are encountered. Dredging difficulty may also be faced in minor areas where moderately weathered rocks are expected on the bedrock surface as indicated in Figure 2-1-18. Chiseling or pre-boring to loosen the rock before dredging may be necessary.

Underwater excavation is generally conducted as machine excavation using a ship or workbench (ship). These machines have a limited scope of application depending on the target bedrock.

Dredging of a navigational channel is the most common case of underwater excavation. The machines used for this purpose are listed below.

1) Grapple dredge
2) Dipper dredge
3) Bucket dredge
4) Plain suction dredge
5) Self-propelled hopper dredge
6) Cutterhead pipeline dredge

In addition to these machines, there are drilling barges and rock breaking barges, which crushes a bedrock by dropping crushing rods.

When a workboat used for dredging is selected, such items as the type and amount of soil, hydrographic conditions, disposal method, work periods, and capabilities of the workboat must be considered. Among these items, the soil type has a significant influence.

A bedrock or hard soil with an N-value of 30 or more needs to be crushed through blasting or by using a rock breaking barge before dredging. In general, the soil types and compatible boat types are as shown in Table 2-1-25 "Soil Types and Compatible Dredging Ship Types".

Excavation using a dipper dredge or rock breaking barge is assumed to be possible for the bedrock in the planned port site at Bojonegara up to the dredging depth of -15 m (LLWS), which is classified into a soft or middle to hard rock.

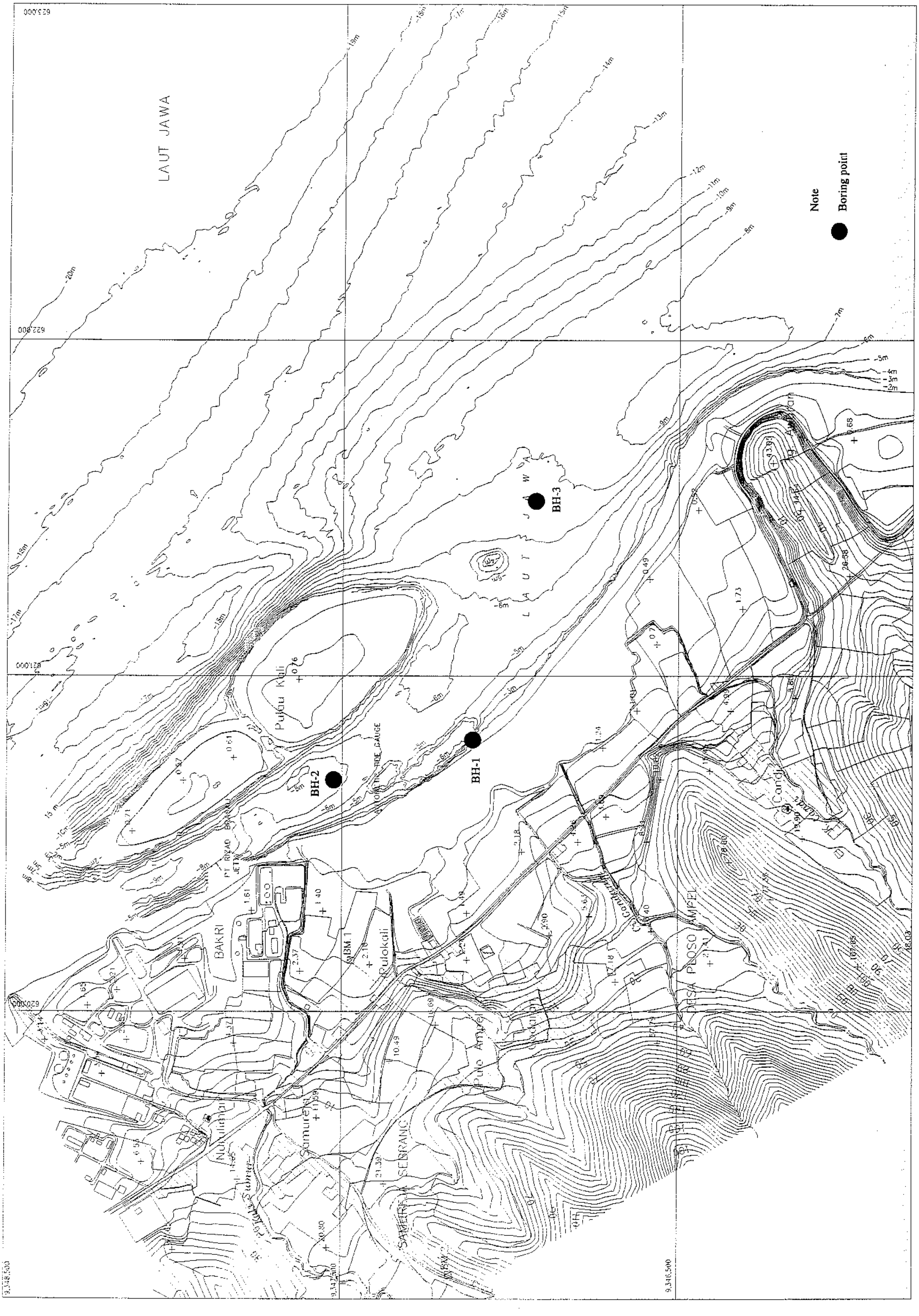


Figure 2-1-21 "Location of Rock Boring, Bojonegara"

FIG DRILLING LOG

Project No. J1406
Hole Number BH-1 (PAGE 1 of 1)
Water Table is 6.5m above Sea Bed

Project Soil Investigation & Marine Survey of Proposed Bojonegara Sea Port
Elevation EL.-6.49 m.

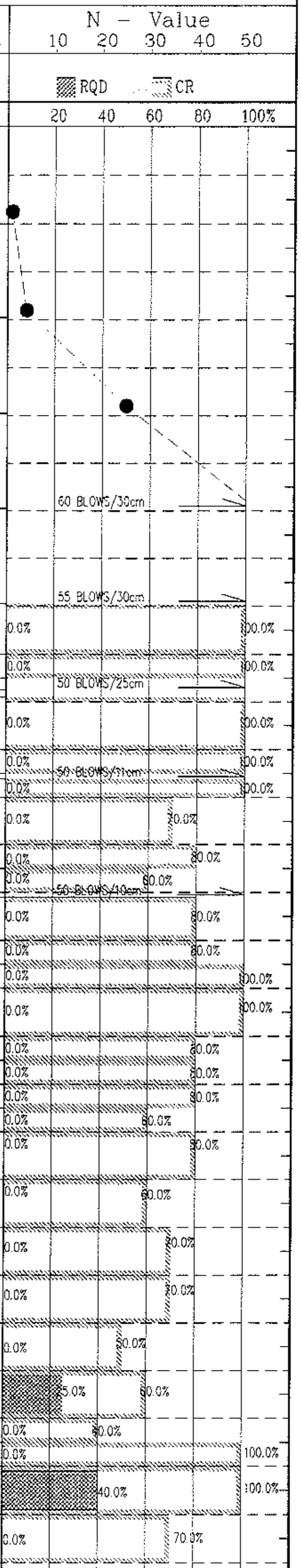
Type of Drilling Rotary (Coring)
Date 2 - 10 Oct. 2002
Driller Wrtmn (Saleh/Radius)

Remarks
P= Standard Penetration Test
C= Coring
Weathering: 1 - 5 (very fresh to strongly weathered)
Hardness: 1 - 5 (very hard to soft)
Interval of cracks: 1 - 5 (>300mm to <10mm)
Classification by CRIEPI. A, B, CH, CM, CL, D

Scale in m	Elevation in m	Depth in m	Thickness in m	Legend	Type of Soil	Colour	Relative Density or Consistency	General Remarks
	-7.19	0.70	0.70		Sand	Greenish Gray	(Very Loose)	Sand is fine grained. Contains a lot of sea shell fragments and a few corals.
1 2 3	-12.79	3.30	2.60		Sandy Clay	Greenish Gray	Very Soft	High clay content, low plasticity. Sand is fine grained. Contains a lot of sea shell fragments. Clay content increases with depth
4	-11.59	4.10	0.80		Silty Clay	Dark Gray to Brownish Gray	Soft	High clay content. High plasticity. Contains a little coral fragments. Mottled with yellowish brown.
5 6	-13.99	6.50	2.40		Silty Clay	Brownish Dark Gray	Very Stiff	High clay content. High to medium plasticity. Mottled with yellowish brown. Contains a few sea shells fragments. Occasionally contains weakly to moderately cemented Breccia lava.
7 8					Breccia	Light Brown to Light Green	Very Dense	Highly to completely weathered. Occasionally contains some coarse gravels from original rock.
9 10 11 12 13 14						Yellowish Brown to Light Green		
15 16 17 18 19 20 21			21.00 21.30		Core Lost	Brownish Gray to Dark Gray	Dense to Very Dense	Highly fractured around GL.-14-14.80m; 15.20-15.80m; 16-16.30m; 16.00-16.80m; 17-17.30m; 18-18.30m; 19-19.40m; 20-20.50m; 21-21.40m; 22-22.80m; 23-23.60m; 24-24.60m; 25-25.80m; 26-26.60m; 27-27.50m; 28.70-29m; 29.90-30m. With a little dark brown clayey silt and fine gravel around GL-15-15.60m; 15.90-16 16.40-16.60m; 18.20-18.70m; 19.80-20m. With some brownish gray silty sand around GL-21.60-21.90m. Dip of cracks 45-60 degree. The matrix consists of brownish grey silty sand and clayey silt with andesite fragments.
22			22.00 22.40		Core Lost			
23			23.00 23.30		Core Lost			
24			24.00 24.30		Core Lost			
25			25.00 25.50		Core Lost			
26			26.00 26.40		Core Lost			
27			27.00 27.30		Core Lost			
28 29 30	-37.49	30.00	23.50					
31	-				-END OF DRILLING-			

Sampling / **Standard Penetration Test & Core Recovery (CR)**

Depth in m.	Sample No.	N-Value Blows/30cm	Blows Per Each 10 cm: 10cm	10cm	10cm
		CRIEPI	W	H	i
1.50 2.00	P-1	1/50	1/50		
3.65 3.95	P-2	4	1	1	2
5.65 5.95	P-3	25	7	8	10
7.65 7.95	P-4	60	33	13	14
9.65 9.95	P-5	55	10	21	24
11.00	C-1	CL-D	4-5	4-5	4-5
11.50	C-2	CL-D	4-5	4-5	4-5
11.75 11.90	P-6	50/25	31	15	4/5
13.00	C-3	CL-D	4-5	4-5	4-5
13.50	C-4	CL-D	4-5	4-5	4-5
	P-7	50/11	50/11		
13.61 14.00	C-5	CL-D	4-5	4-5	4-5
15.00	C-6	CM-CL	4	3-4	3-4
15.50	C-7	CM-CL	4-5	3-4	3-7
16.00	C-8	CM-CL	4-5	3-4	3-4
16.10	P-8	50/10	50		
17.00	C-9	CM	4	3	3
17.50	C-10	CH-CM	3-4	3-4	3-4
18.00	C-11	CH	3	2-3	2-3
19.00	C-12	CM-CL	4-5	3-4	3-4
19.50	C-13	CM-CL	4-5	3-4	3-4
20.00	C-14	CM-CL	4-5	3-4	3-4
20.50	C-15	CM-CL	4-5	3-4	3-4
21.00	C-16	CH-CL	3-4	3	3-4
22.00	C-17	CM-CL	4-5	3-4	3-4
23.00	C-18	CH-CM	3-4	3-4	3-4
24.00	C-19	CH-CM	3-4	3-4	3-4
25.00	C-20	CH-CM	3-4	3-4	3-4
26.00	C-21	CH-CM	3-4	3-4	3-4
27.00	C-22	CH	2-3	2-3	2-3
27.50	C-23	CH-CM	3-4	3-4	3-4
28.00	C-24	CH-CM	3-4	3-4	3-4
29.00	C-25	CH	2-3	2-3	2-3
30.00	C-26	CH-CM	3-4	3-4	3-4



PT. PONDASI KISOCON RAYA

Figure 2-1-22 "Drilling Log (No. BH-1), Bojonegara"

Sandy clay (from 0.7 m depth, -7.19 m from LLWS)

0 - 5 m

Silty clay (from 3.3 m depth, -12.79 m from LLWS)

Silty clay (from 4.1 m depth, -11.59 m from LLWS)

Breccia (from 6.5 m depth, -13.99 m from LLWS)

5 - 10 m

10 - 15 m

15 - 20 m

Core Box of Borehole BH-1 (0 - 20m)

Figure 2-1-23 "Boring Core of Rock Boring at BH-1, Bojonegara"

Core Box of Borehole BH-1 (20 - 30m)

Figure 2-1-24 "Boring Core of Rock Boring at BH-1, Bojonegara"

FIG DRILLING LOG

Project No. J1406

Hole Number BH-2 (PAGE 1 of 1)

Water Table is 8.30m above Sea Bed

Project Soil Investigation & Marine Survey of Proposed Bojonegara Sea Port

Elevation EL -7.12 m.

Type of Drilling Rotary (Coring)

Date 10 - 13 Oct. 2002

Driller Wrimn (Soleh/Rodios)

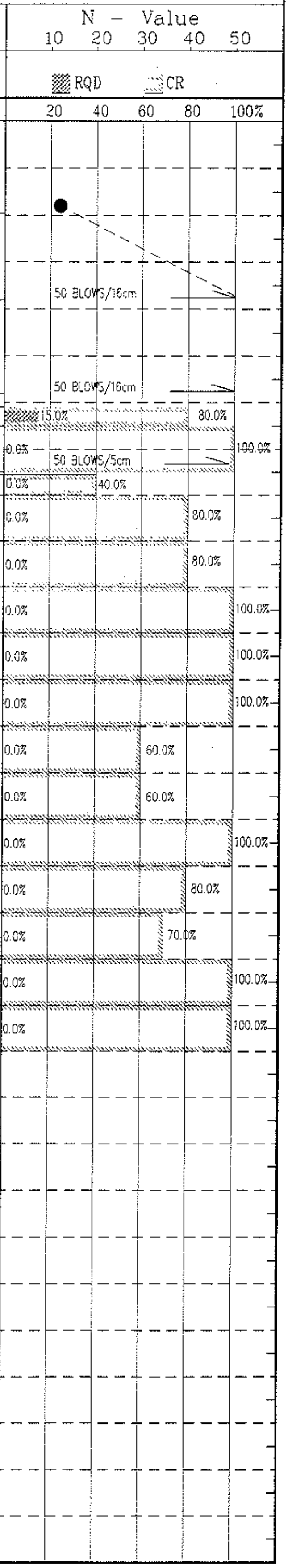
Remarks

P= Standard Penetration Test
C= Coring
Weathering: 1 - 5 (very fresh to strongly weathered)
Hardness: 1 - 5 (very hard to soft)
Interval of cracks: 1 - 5 (>300mm to <10mm)
Classification by CRIEPI: A, B, CH, CM, CL, D

Scale in m	Elevation in m	Depth in m	Thickness in m	Legend	Type of Soil	Colour	Relative Density or Consistency	General Remarks
1	-8.22	1.10	1.10		Sand	Greenish Gray	(Loose)	Sand is fine to medium grained. Contains a lot of sea shell fragments. With trace of clay at bottom portion
2	-9.12	2.00	0.90		Silty Clay	Dark Greenish Gray	Stiff	High plasticity. Contains some sea shell fragments and slightly weathered coral fragments.
3	-10.22	3.10	1.10		Clayey Silt	Greenish Gray	(Stiff)	With black organic matters. High clay content. Mottled with yellowish brown. Gravel is fine grained.
4 5 6	-13.22	6.10	3.00		Sandy Silt	Pinkish Gray	Hard	High clay content. Weakly to moderately cemented. Occasionally with a few of fine to medium gravels.
7 8 9 10 11 12 13 14 15 16 17 18 19 20	-27.12	20.00	13.00 13.50 14.00 14.50 13.90		Breccia Core Lost Core Lost	Grayish Purple to Greenish Gray Brownish Gray to Light Gray	Very Dense	Porphyritic texture. The matrix consits of brownish grey silty sand and gravelly clayey silt with andesite fragments. Dip of cracks 45-70 degree. Occasionally highly to completely weathered. Highly fractured around GL-7.5 to 8.5m. 9.0-9.5m; 11-11.6m; 12-12.3m; 12.6-12.7m; 13-13.5m; 14-14.6m; 16-16.5m; 16.6-16.7m; 17-17.8m; 19-19.7m. With a lot of brownish silty sand and gravelly clayey silt around GL-6.5-7.5m; 10.7-11m; 11.6-12m; 12.8-13m; 13.7-13.8m; 14.9-15m; 15.4-15.8m; 18-19m. The cracks are straigh and occasionally infilling with clay/mineral powder.
21 22 23 24 25 26 27 28 29 30 31					-END OF DRILLING-			

Sampling / Standard Penetration Test & Core Recovery (CR)

Depth in m.	Sample No.	N-Value Blows/30cm	Blows Per Each 10 cm 10cm	 10cm	 10cm
		CREIPI	W	H	I
1.55 1.95	P-1	12	4	4	4
3.65 3.81	P-2	50/16	30	20/6	
5.65 5.81	P-3	50/16	13	37/6	
6.10 6.50	C-1	CM-CL	4-5	4-5	3-4
	C-2	CL-D	4-5	4-5	4-5
7.50 7.55	P-4	50/5	50/5		
8.00	C-3	CL	4-5	4-5	4-5
9.00	C-4	CM-CL	4	3-4	3-4
10.00	C-5	CM-CL	4-5	3-4	3-4
11.00	C-6	CL-D	4-5	4-5	3-4
12.00	C-7	CM-CL	4-5	4-5	3-4
13.00	C-8	CM-CL	4-5	4-5	3-4
14.00	C-9	CM-CL	4-5	4-5	3-4
15.00	C-10	CM-CL	4-5	4-5	3-4
16.00	C-11	CL-D	4-5	4-5	3-4
17.00	C-12	CL-D	4-5	4-5	3-4
18.00	C-13	CM-CL	4-5	4-5	3-4
19.00	C-14	CL-D	4-5	4-5	3-4
20.00	C-15	CM-CL	4-5	4-5	3-4



PT. PONDASI KISOCON RAYA

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Figure 2-1-25 "Drilling Log (No. BH-2), Bojonegara"

Silty clay (from 1.1 m depth, -8.22 m from LLWS)

0 - 5 m

Sandy silt (from 2.0 m depth, -9.12 m from LLWS)

Breccia (from 6.1 m depth, -13.22 m from LLWS)

5 - 10 m

10 - 15m

15 - 20 m

Core Box of Borehole BH-2 (0 - 20m)

Figure 2-1-26 "Boring Core of Rock Boring at BH-2, Bojonegara"

FIG DRILLING LOG

Project No. J1406
Hole Number BH-3 (PAGE 1 of 1)
Water Table m.

Project Soil Investigation & Marine Survey of Proposed Bojonegara Sea Port
Elevation EL-2.1 m.

Type of Drilling Rotary (Coring)
Date 17 - 19 Oct. 2002
Driller Wrimn (Saleh/Heru)

Remarks
C : Coring
P : Standard Penetration Test
R : Rock Mass Classification
W : Weathering Grade

Elevation in m	Depth in m	Thickness in m	Type of Soil	Colour	Relative Density or Consistency	General Remarks
-2.75	0.65	0.65	Silty Sand	Gray to Dark Gray	Very Loose	Sand is fine to coarse grained. Poorly cemented.
-9.60	7.50	6.85	Sandy Silt	Gray	Very Soft	With shell and coral fragments. Fine to coarse size. Low plasticity. Mottled with whitish dots.
-12.10	10.00	2.50	Clayey Silt	Dark Gray	Medium Stiff	With shell and coral fragments Fine to coarse size. Occasionally trace of organic silt (block) mottled with whitish dots.
-14.10	12.00	2.00	Silty Clay	Yellowish Gray	Stiff	Mottled with brown. With shell and coral fragments. High plasticity.
-15.85	13.75	1.75	Sandy Silt	Yellowish Gray	Very Stiff	Mottle with brown, High clay content
-22.10	20.00	6.25	Breccia	Brownish Gray	Hard	Highly to completely weathered With silt and sand as matrix. With some gravels, cobble of andesite and coral fragments Weakly cemented. 17.0 to 17.06m.

-END OF DRILLING-

Sampling / **Standard Penetration Test & Core Recovery (CR)**

Depth in m	Sample No.	N-Value Blows/30cm	Blows Per Each 10 cm 10cm	10cm	10cm
1.50 2.00	P-1	0/50	0/50		
3.50 4.00	P-2	0/50	0/50		
5.50 6.00	P-3	1/50	1/50		
7.65 7.95	P-4	6	2	2	2
9.65 9.95	P-5	6	2	2	2
11.15 11.45	P-6	11	3	4	4
12.65 12.95	P-7	48	11	17	20
13.95 15.50	C-1	CL-D	4	3-4	3-4
15.50 15.60	P-8	50/10	50/10		
16.50	C-2	CM-CL	4	3-4	3-4
17.00	C-3	CM-CL	4-5	3-4	3-4
18.00	C-4	CM-CL	4-5	3-4	3-4
19.00	C-5	CM-CL	4-5	3-4	3-4
20.00	C-6	CL-D	4-5	3-4	3-4

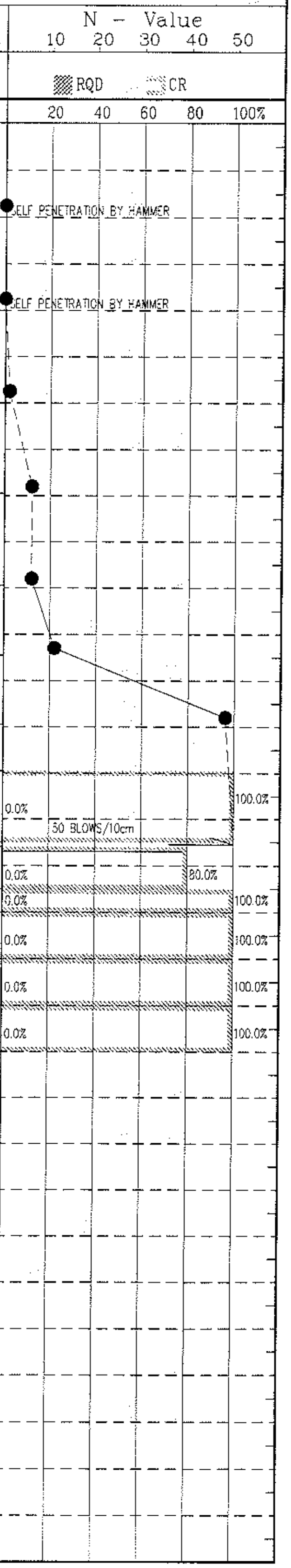

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Figure 2-1-27 "Drilling Log (No. BH-3), Bojonegara"

Sandy silt (from 0.65 m depth, -2.75 m from LLWS)
0 - 5 m
Sandy silt (from 2.0 m depth, -9.12 m from LLWS)

Clayey silt (from 7.5 m depth, -9.60 m from LLWS)
5 - 10 m

Silty clay (from 10.0 m depth, -14.10 m from LLWS)

Sandy silt ((from 12.00 m, -14.10 m from LLWS)
10 - 15 m

Breccia (from 13.75 m, -15.85 m from LLWS)

15 - 20 m

Figure 2-1-28 "Boring Core of Rock Boring at BH-3, Bojonegara"

Table 2-1-18 "Strength Characteristics of Rock Core Samples, Bojonegara"

Borehole No.	Depth (m)	Elevation (m from LWS)	Type of test	Strength (MN/m2)		Remark
				Compressive	Tensile	
BH-1	12.13 to 12.19	-18.62 to -18.68	PL Test	105.19	----	
	14.80 to 14.85	-12.29 to -21.34	PL Test	46.37	----	
	17.65 to 17.75	-24.14 to -24.24	UC Test	44.12	----	Shear along joint plane
	17.85 to 17.90	-24.34 to -24.39	BR Test	----	7.58	
	19.50 to 19.0	-25.99 to -26.09	BR Test	----	5.18	
	20.78 to 20.86	-27.27 to -27.35	BR Test	----	5.21	
	20.86 to 20.91	-27.35 to -27.40	BR Test	----	3.61	
	23.88 to 23.94	-30.37 to -30.43	BR Test	----	3.04	
	23.94 to 24.00	-30.43 to -30.49	BR Test	----	4.04	
	26.65 to 26.80	-33.14 to -33.29	UC Test	119.38	----	
	27.50 to 27.65	-33.99 to -34.14	BR Test	----	2.91	
	28.25 to 28.40	-34.74 to -34.89	UC Test	139.17	----	
	28.50 to 28.70	-34.99 to -35.19	UC Test	112.76	----	
	29.65 to 29.72	-36.14 to -36.21	BR Test	----	3.97	
	29.72 to 29.80	-36.21 to -36.29	BR Test	----	9.98	
BH-2	6.13 to 6.24	-13.25 to -13.36	PL Test	43.4	----	
	8.55 to 8.58	-15.67 to -15.70	PL Test	57.07	----	
	11.40 to 11.45	-18.52 to -18.57	PL Test	96.03	----	
	12.50 to 12.55	-19.62 to -19.67	PL Test	60.02	----	
	14.50 to 14.58	-21.62 to -21.70	PL Test	48.26	----	
	15.25 to 15.33	-22.37 to -22.45	BR Test	----	7.44	
	16.45 to 16.50	-23.57 to -23.62	BR Test	----	2.77	
BH-3	14.00 to 14.23	-21.50 to -21.73	PL Test	3.69	----	
	17.10 to 17.15	-24.60 to -24.65	PL Test	29.9	----	

Note:

UC Test : Unconfined Compression Test

PL Test : Point Load Test

BR Test : razilian Test

Figure 2-1-20 "RQDs of Rock Samples, Bojonegara"

Boring	Existing Boring Data																						New Boring Data			Total	Sample number	Average
Elevation	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	GA-1	GA-2	GA-3	GA-5	GA-11	K-1	K-2	K-3	K-4	K-5	K-6	K-8	K-10	BH-1	BH-2	BH-3			
0-1 m																													
1-2 m																													
2-3 m																													
3-4 m																													
4-5 m																													
5-6 m																						0.0					0.0	1	0.0
6-7 m																						0.0					0.0	1	0.0
7-8 m																						0.0					0.0	1	0.0
8-9 m													26.0		0.0							0.0					26.0	3	8.7
9-10 m					0.0						0.0		75.0							0.0	0.0	0.0					75.0	6	12.5
10-11 m					0.0						0.0	69.0	99.0								0.0						168.0	5	33.6
11-12 m					0.0	60.0					0.0			0.0													60.0	4	15.0
12-13 m					0.0	16.0								0.0													16.0	3	5.3
13-14 m				0.0	0.0	63.0								0.0											15.0		78.0	5	15.6
14-15 m				0.0	0.0	13.0	0.0																		0.0		13.0	5	2.6
15-16 m			0.0	0.0	0.0	0.0	0.0										0.0						0.0		0.0		0.0	9	0.0
16-17 m			0.0	0.0		11.0	0.0		0.0							0.0	0.0						0.0	0.0	0.0		11.0	10	1.1
17-18 m			55.0	13.0		40.0	30.0		0.0							0.0	0.0	0.0						0.0	0.0		138.0	10	13.8
18-19 m			54.0	0.0			23.0		0.0							0.0	0.0	0.0						0.0	0.0		77.0	9	8.6
19-20 m			20.0	0.0			0.0		50.0							0.0								0.0	0.0		70.0	7	10.0
20-21 m			68.0				0.0			0.0														0.0	0.0		68.0	5	13.6
21-22 m			21.0					26.5		0.0									27.5					0.0	0.0	0.0	75.0	7	10.7
22-23 m			0.0					24.0		0.0									23.0					0.0	0.0	0.0	47.0	7	6.7
23-24 m			37.5					66.5		0.0														0.0	0.0	0.0	104.0	6	17.3
24-25 m										0.0														0.0	0.0	0.0	0.0	4	0.0
25-26 m	12.0									0.0														0.0	0.0	0.0	12.0	5	2.4
26-27 m	0.0									0.0														0.0	0.0	0.0	0.0	5	0.0
27-28 m	0.0	0.0								0.0														0.0	0.0		0.0	5	0.0
28-29 m	0.0	55.0																						0.0			55.0	3	18.3
29-30 m	0.0	15.0																						0.0			15.0	3	5.0
30-31 m	0.0	67.0																						0.0			67.0	3	22.3
31-32 m	0.0																							0.0			0.0	2	0.0

RQD	Rock quality
0 - 25	Very poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Note: Bore holes at B-6, GA-2 and GA-3 are onshore boring.
🟦 shows more than 50 % of RQD.

Table 2-1-21 "Rock Mass Classification by the CRIEPI"

Rock grade	Description
A	The rock mass is very fresh and the rock forming minerals and grains undergo neither weathering or alteration. Joints are extremely tight and their surfaces have no visible sign of weathering. Sound by hammer blow is clear.
B	The rock mass is solid. There is no opening joint and crack (even of 1mm). But, rock forming minerals and grains undergo a little weathering and alteration in partially. Sound by hammer blow is clear.
C	The rock mass is relatively solid. The rock forming minerals and grains undergo weathering except for quartz. The rock is contaminated by limonite etc. The cohesion of joints and cracks is slightly decreased and rock blocks are separated by fine hammer blow along joints. Clay minerals remain on the separation surface. Sound by hammer blow is a little dim.
CM	The rock mass is somewhat soft. The rock forming minerals and grains are somewhat softened by weathering, except for quartz. The cohesion of joints and cracks is somewhat decreased and rock blocks are separated by ordinary hammer blow along the joints. Clay minerals remain in the separation surface. Sound by hammer blow is somewhat dim.
CL	The rock mass is soil, The rock forming minerals and grains are softened by weathering. The cohesion of joints and crack is decreased and rock blocks are separated by hammer blow along the joints. Clay materials remain on the separation surface. Sound by hammer blow is dim.
D	The rock mass is remarkably soil. The rock forming minerals and grains are softened by weathering. The cohesion of joints and crack is almost absent. The rock mass collapses by light hammer blow. Clay materials remain on the separation surface. Sound by hammer is remarkably dim.

Table 2-1-22 "Physical Property and CRIEPI Classification"

Rock Grade	Deformability (kg/cm2)	Modulus of Elasticity (kg/cm2)	Cohesion (kg/cm2)	Internal Friction Angle (")	Seismic Velocity (km/sec)
A - B	over 50,000	over 80,000	over 40	65 - 55	over 3.7
CH	50,000 - 20,000	80,000 - 40,000	40 - 20	55 - 40	3.7 - 3.0
CM	20,000 - 5,000	40,000 - 15,000	20 - 10	45 - 30	3.0 - 1.5
CL - D	less than 5,000	less than 15,000	less than 10	38 - 15	less than 1.5

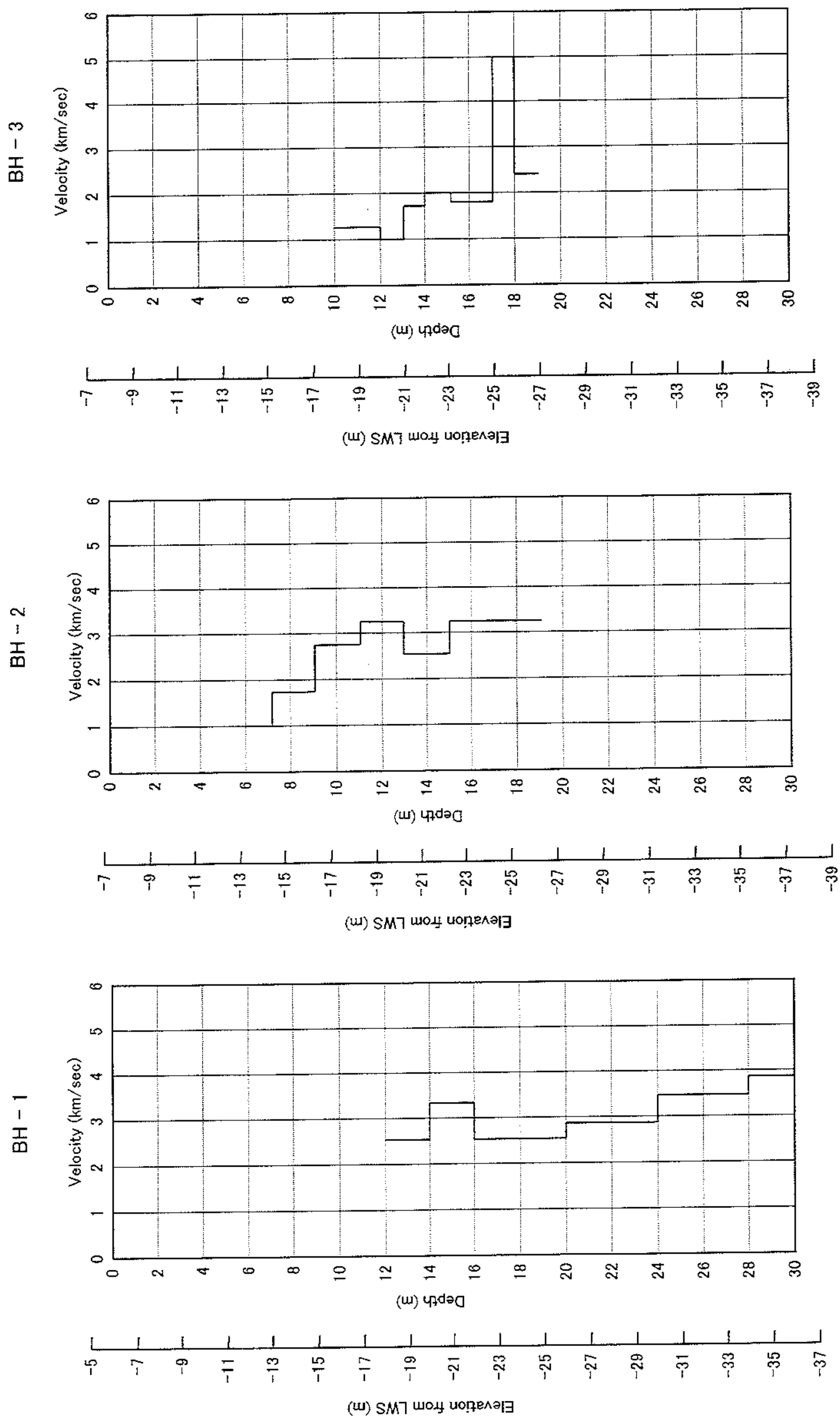


Figure 2-1-29 "Results of P-Wave Logging Survey, Bojonegara"

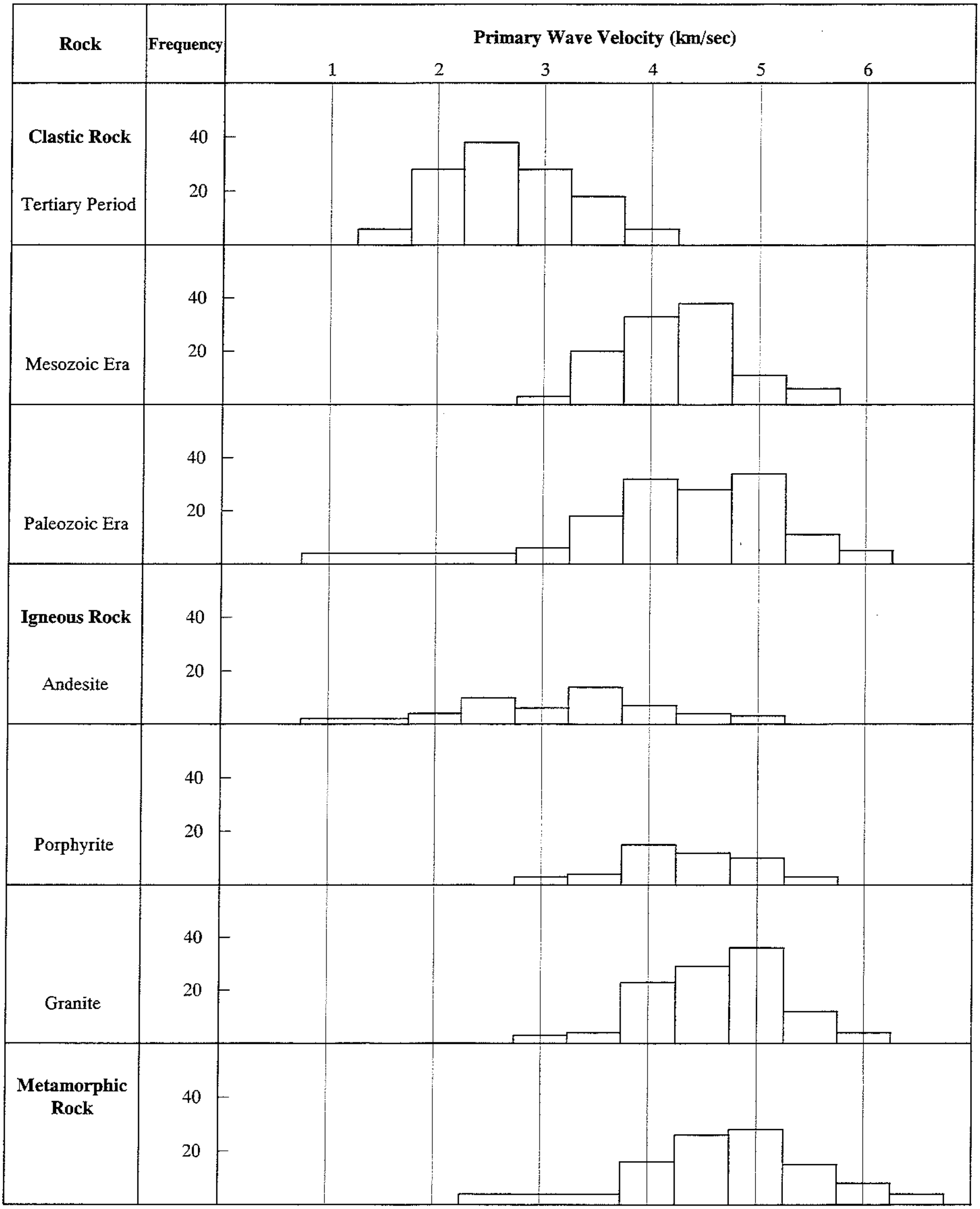
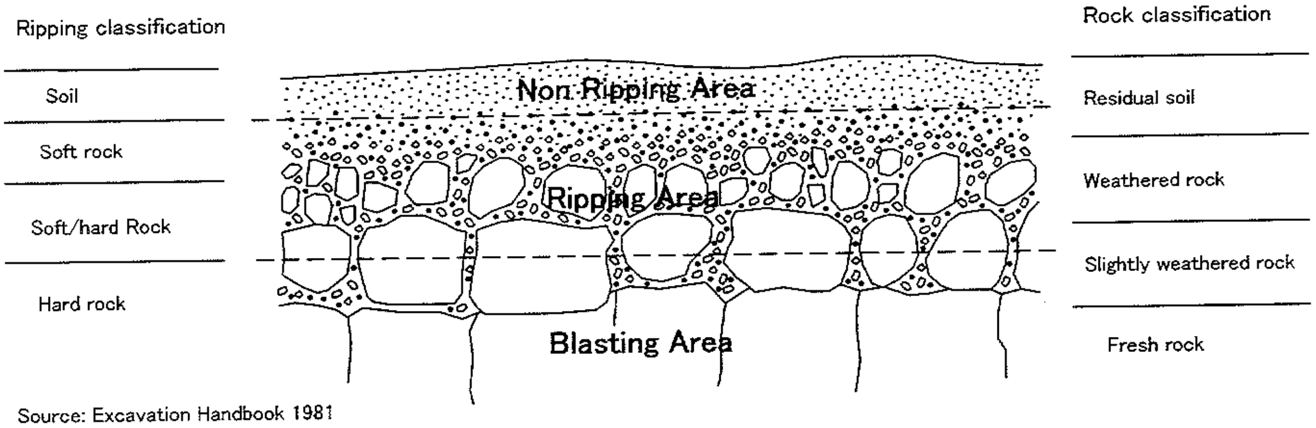


Figure 2-1-30 "Distribution of Primary Wave Velocities in Rocks in japan"

<table>
<tr><th>Veolocity
Ripper</th><th colspan="7">Vp (m/sec)
500 1000 1500 2000 2500</th></tr>
<tr><td>Middle size tracter ripper
200 hp – 300 p</td><td>Ripping is not necessary.</td><td>Easy</td><td>Normal</td><td>Difficult</td><td>Very difficult or blasting</td><td colspan="2">Blasting</td></tr>
<tr><td>Large size tractor ripper
300 hp – 525 hp</td><td>Ripping is not necessary.</td><td colspan="2">Easy</td><td>Normal</td><td>Difficult</td><td>Very difficult or blasting</td><td>Blasting</td></tr>
</table>



Source: Excavation Handbook 1981

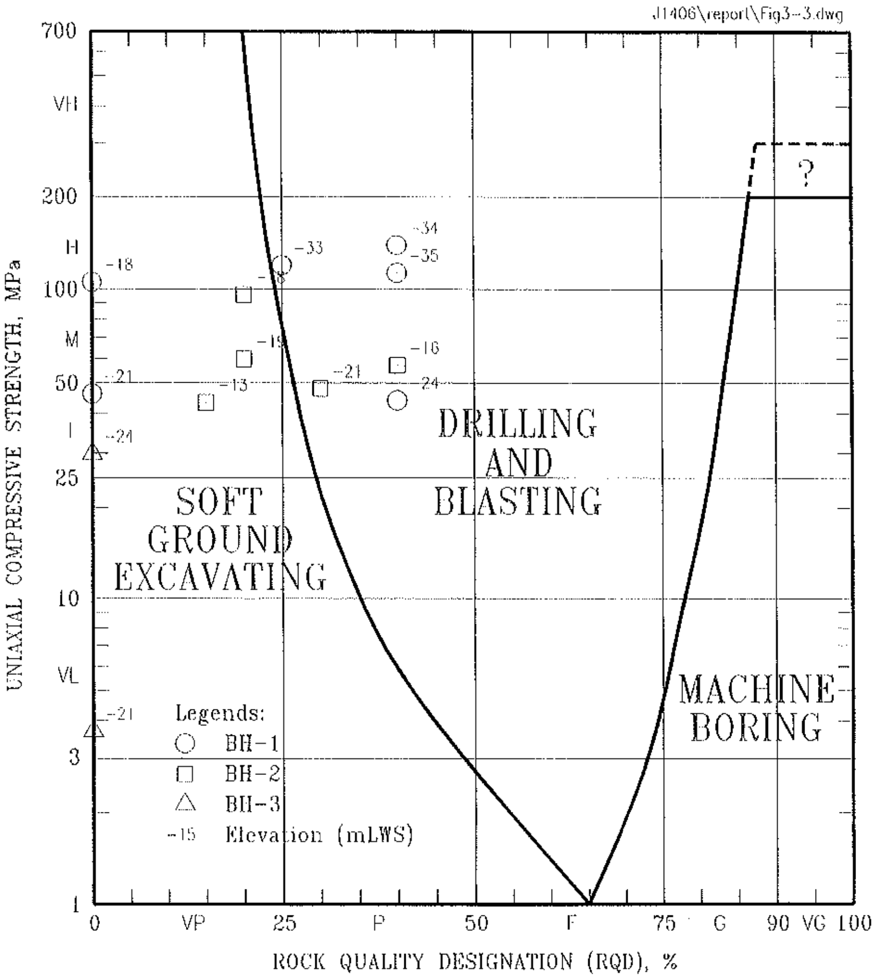
Figure 2-1-33 "Rippability Guide Value"

<table>
<tr><th colspan="2">Soil</th><th colspan="5" rowspan="2">Dredging Ship Type</th><th rowspan="2">Note</th></tr>
<tr><th>Classification</th><th>Condition</th></tr>
<tr><td rowspan="4">Soil</td><td>Soft</td><td rowspan="3">G</td><td></td><td rowspan="5">P</td><td></td><td></td><td>N = 10 or less</td></tr>
<tr><td>Midium</td><td></td><td></td><td></td><td>N = 10 ～ 20</td></tr>
<tr><td>Hard</td><td></td><td></td><td></td><td>N = 20 ～ 30</td></tr>
<tr><td>Very hard</td><td></td><td>D</td><td>C</td><td></td><td>N = 30 or more</td></tr>
<tr><td rowspan="2">Soil with Gravel</td><td>Soft</td><td>G</td><td></td><td></td><td></td><td>N = Approx. 30 or less</td></tr>
<tr><td>Hard</td><td></td><td rowspan="2">D</td><td></td><td rowspan="3">C</td><td></td><td>N = Approx. 30 or more</td></tr>
<tr><td rowspan="2">Rock</td><td>Soft</td><td></td><td></td><td rowspan="2">B</td><td>Available by Dipper Ship</td></tr>
<tr><td>Hard</td><td></td><td></td><td></td><td>Not available by Dipper Ship</td></tr>
</table>

Note: G = Grab ship D = Dipper ship P = Pomp ship C = Crasher ship B = Blasting

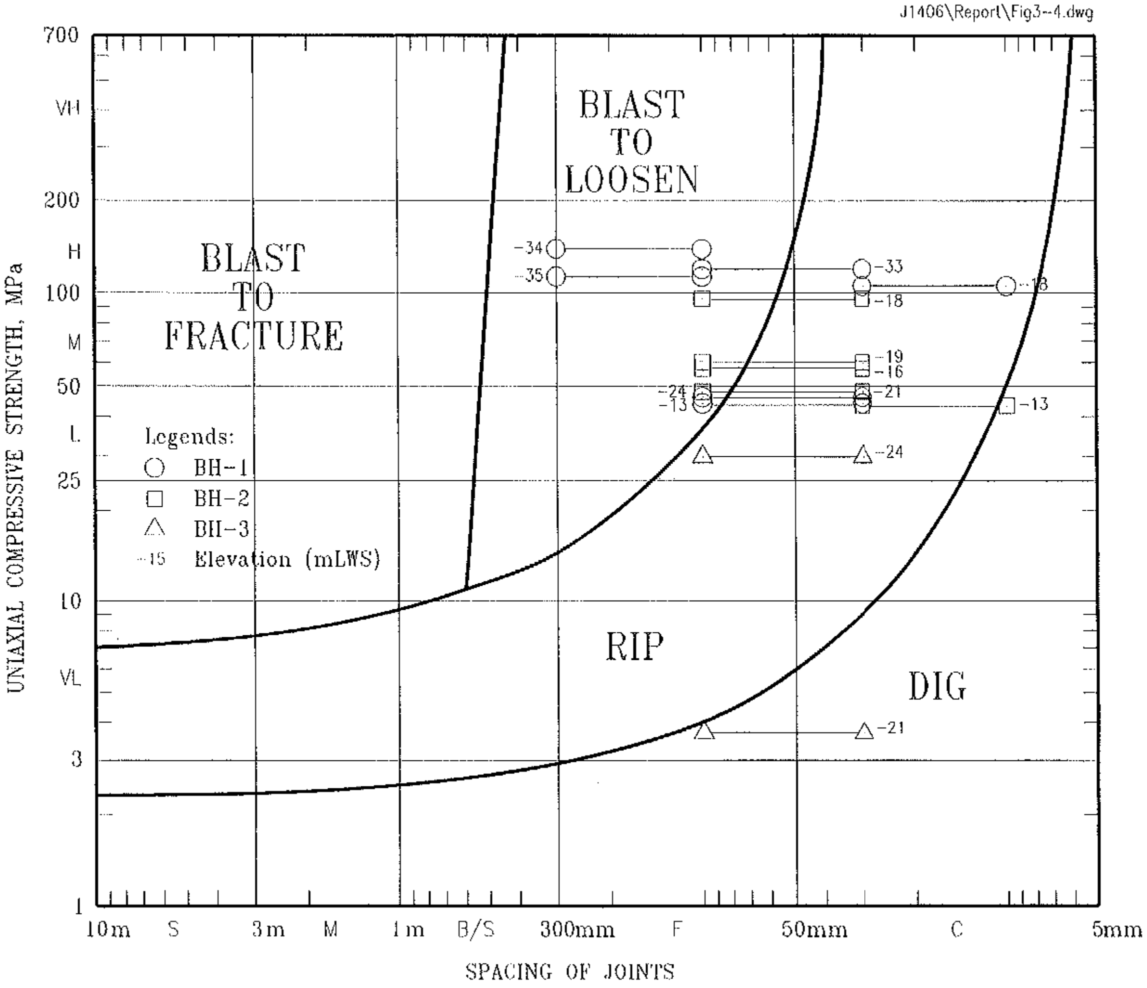
Source: Civil Engineering Handbook

Table 2-1-25 "Soil Type and Compatible Dredging Ship"



VG = very good quality; G = good quality; F = fair quality; P = poor quality; VP = very poor quality
VH = very high strength; H = high strength; M = medium strength; L = low strength; VL = very low strength

Figure 2-1-34 "Workability of Rock (after Muir Wood, 1972)



S = solid (almost no jonint); M = massive; B/S = blocky/seamy; F = fractured; C = crushed
VH = very high strength; H = high strength; M = medium strength; L = low strength; VL = very low strength

Figure 2-1-35 "Workability of Rock (after Franklin et al., 1971)

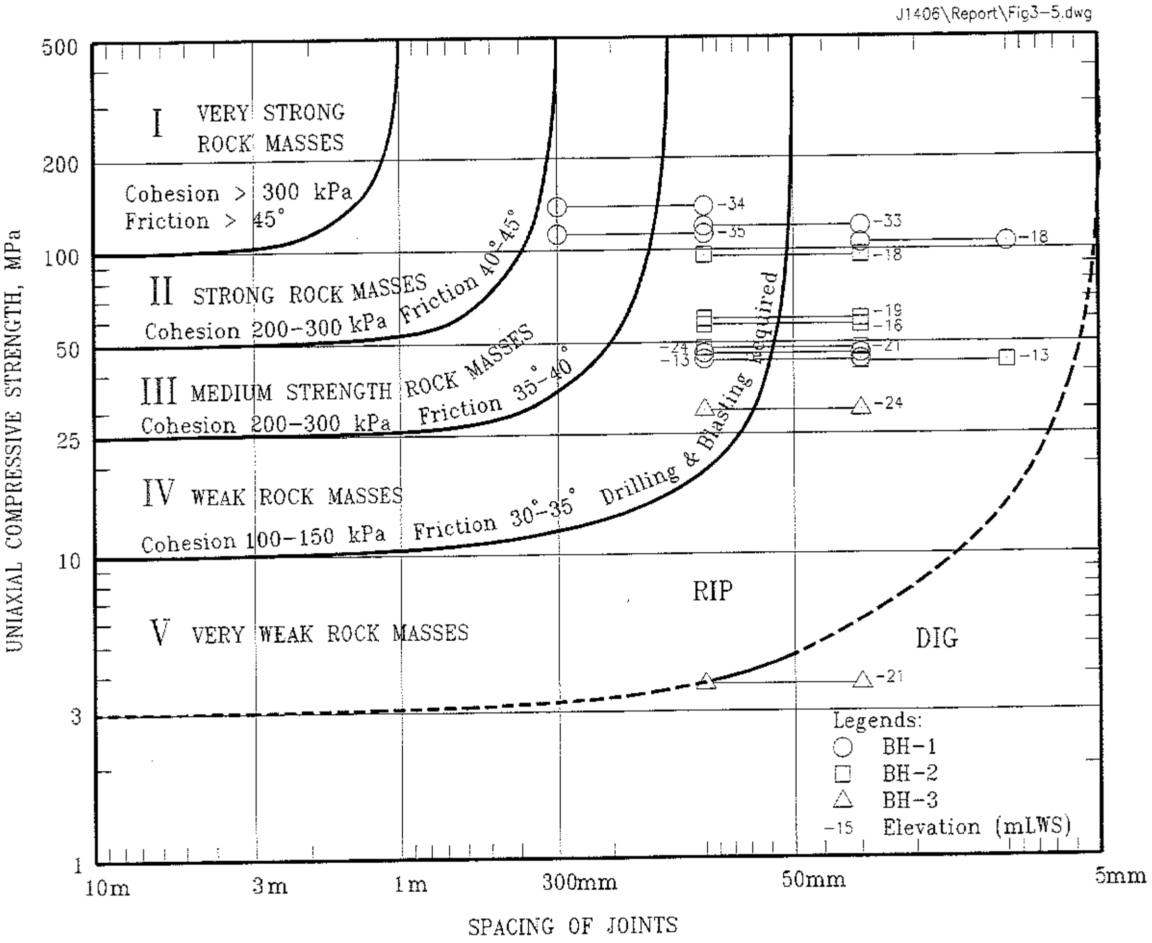


Figure 2-1-36 "Strength Diagram for Jointed Rock Masses (after Bieniawski, 1974)"

Table 2-1-24 "Anticipated Materials to be Dredged up to -15 m (LLWS)"

Borehole No.	Seabed Elevation (mLWS)	Rock surface Elevation (mLWS)	Dredging Thickness in Alluvial Soil, (m)	Dredging in Volcanic Rock up to -15mLWS			
				Thickness (m)	RQD (%)	SPT N-Value	Nature of Rock According to the Soil report
BH-1	-6.49	-13.99	7.50	1.01	0	60	Clay, silt, sand with andesite fragments
BH-2	-7.12	-13.22	6.10	1.78	0 - 15	Rebound	Clay, silt, sand with andesite fragments
BH-3	-7.50	-21.25	13.75	No rock	-	-	-
A1	-6.75	-7.75	1.00	7.25	Not known	Rebound	Clayey silt with andesite fragments*
A2	-6.25	-11.25	5.00	3.75	Not known	Rebound	Clayey silt with andesite fragments*
A3	-7.10	-11.60	4.50	3.40	Not known	Rebound	Clayey silt with andesite fragments*
A4	-5.75	-13.75	8.00	1.25	Not known	44	Clayey silt with andesite fragments
A5	-3.00	-8.00	5.00	7.00	Not known	Rebound	Clayey silt with andesite fragments*
A6	-1.50	-14.50	13.00	0.50	Not known	28	Clayey silt with andesite fragments
A7	-1.75	-8.75	7.00	6.25	Not known	30 - 50	Clayey silt with andesite fragments
A8	-3.50	-13.00	9.50	2.00	Not known	25 - Rebound	Clayey silt with andesite fragments*
A9	-3.75	-11.75	8.00	3.25	Not known	40 - 50	Clayey silt with andesite fragments*
A10	-6.20	-11.20	5.00	3.80	Not known	40 - Rebound	Clayey silt with andesite fragments*
A11	-3.00	-15.00	12.00	No rock	Not known	27	Clayey silt with andesite fragments*
A12	-0.25	-14.25	14.00	0.75	Not known	Rebound	Clayey silt with andesite fragments
A13	-6.90	-14.40	7.50	0.60	Not known	30	Clayey silt with andesite fragments
A14	-7.40	-15.90	8.50	No rock	-	-	-
A15	-8.00	-18.00	10.00	No rock	-	-	-
B1	-8.94	-25.94	17.00	No rock	-	-	-
B2	-10.33	-27.33	17.00	No rock	-	-	-
B3	-4.32	-14.92	10.60	No rock	-	-	-
B4	-0.67	-12.47	11.80	2.53	0	50 - Rebound	Very dense volcanic rock
B5	-0.02	-9.17	9.15	5.83	0	-	Very dense volcanic rock
B6	-0.03	-10.53	10.50	4.47	15 - 60	Rebound	Very dense volcanic rock
B7	-0.43	-13.93	13.50	1.07	0	50	Very dense volcanic rock
B8	-5.02	-21.52	16.50	No rock	-	-	-
B9	-4.52	-15.52	11.00	No rock	-	-	-
B10	-1.02	-20.12	19.10	No rock	-	-	-
GA4	1.85	-	16.85	No rock	-	-	-
GA5	-4.07	-11.57	7.50	3.43	0	-	Highly to slightly weathered basalt
GA6	-6.26	-16.58	10.32	No rock	-	-	-
GA7	-5.27	-15.77	10.50	No rock	-	-	-
GA8	-6.27	-	8.73	No rock	-	-	-
GA9	-6.27	-	8.73	No rock	-	-	-
GA10	1.39	-	16.39	No rock	-	-	-
GA12	-1.47	-	>13.53	?	?	-	-
GA13	-2.54	-	12.46	No rock	-	-	-
GA14	-3.54	-	11.46	No rock	-	-	-
GA15	-3.14	-	11.86	No rock	-	-	-
GA15A	-3.08	-14.08	11.00	0.92	0	50	Highly weathered Basalt
GA16	-5.37	-15.77	10.40	No rock	0	50	Highly weathered Basalt
GA17	-5.30	-	9.70	No rock	-	-	-
GA18	-5.58	-10.16	4.58	4.85	Not known	-	Fractured basalt
GA28	-5.13	-	9.88	No rock	-	-	-
GA29	-7.30	-	7.70	No rock	-	-	-
K1	1.02	-16.48	17.50	No rock	-	-	-
K2	-2.46	-12.96	10.50	2.05	0	-	Very dense volcanic rock
K3	-3.95	-17.45	13.50	No rock	-	-	-
K4	-4.12	-21.72	17.60	No rock	-	-	-
K10	1.08	-14.72	15.80	No rock	-	-	-
Summary			1.00 to 19 m	0.5 to 7.5m	Generally < 20	25 to Rebound	

Note: * Intercalation with andesite sheeting or layer

2.2 Topography

The candidate site of Bojonegara for the development of a complementary port of Tanjung Priok Port is located north of the Town of Bojonegara and belongs to Desa Pulosoampel, Kecamatan Pulosoampel, Kabupaten Serang, Banten Province.

The site is close to deep water on the west coast of Banten Bay and adjacent to Sunda Strait. It is situated at about 16 km north of the City of Cilegon and 100 km west of Jakarta.

The land use in the area is generally industrial. There are small heavy industries adjacent to the development site and a major Suralaya power station is located at about 10 km west of the site.

The general topography of the area consists of a narrow band of low-laying coastal flats and steeply rising foothills to the west and south.

The coastal flats are currently cultivated with a mixture of paddy field farming and dry crops such as corn and occasional grove of banana plants.

Some areas adjacent to the shoreline are not cultivated and have either a cover of low scrubby bushed or are bare mud flats. The shoreline is covered by dead coral reef and appears stable without erosion and/or accretion.

At approximately 500 m offshore, there are two small and low islands that cover areas of 400 m×150 m and 250 m×100 m, respectively. These islands have a cover of low scrubby bush.

Figure 2-2-1 “Project Site, Bojonegara”

Figure 2-2-2 “Project Site, Bojonegara”

Figure 2-2-3 “Project Site, Bojonegra”

2.3 Seabed Depth Condition

The depth contour lines that represent the depths of seabed at Bojonegara run nearly in parallel with the coastline, but the slope of the seabed is not regular.

Figure 2-3-1 “Longitudinal Water Depth Profile (A-A’ Section), Bojonegara” and Figure 2-3-2 “Longitudinal Water Depth Profile (B-B’ Section), Bojonegara” show the cross-sectional diagrams of the seabed terrain that were prepared from the results of sounding survey.

Figure 2-3-3 “Location of Longitudinal Water Depth Profile at Bojonegara” shows the location of the profile of seabed terrain.

These profiles show the characteristics of the seabed terrain at Bojonegara as mentioned below.

Seabed Terrain around Pulau Kali

1) The seabed slopes on the east side of the coastline at Bojonegara and on the west side of Pulau Kali are relatively steep and the water depth is found at -5m at a distance of about 100 m from the coastline.
2) The seabed on the east side of Pulau Kali is abruptly deep and the water depth at the distance of about 100 m from the coastline on the east side of Pulau Kali is so deep at -15m.
3) The slope of the seabed that is deeper than that area is very gentle, and the water depth at the distance of about 1900 m from the coastline of Bojonegara is -20m.

Seabed Terrain on the south side of Pulau Kali

1) The slope in the vicinity of the coastline of Bojonegara is relatively steep and the water depth at the distance of about 50 m from the coastline is about -5 m.
2) The slope of seabed over the distances of about 50 m to 750 m from the coastline is relatively gentle and the depth is from -5 m to -9 m.
3) At the distances of about 750 m to 1100 m from the coastline, the slope of seabed is lightly steep and the depth varies from -9 m to -15 m.
4) At the distance of more than 1100 m from the coastline, the slope of seabed is relatively gentle again and the water depth at the distance of about 1700 m from the coastline is -20 m.

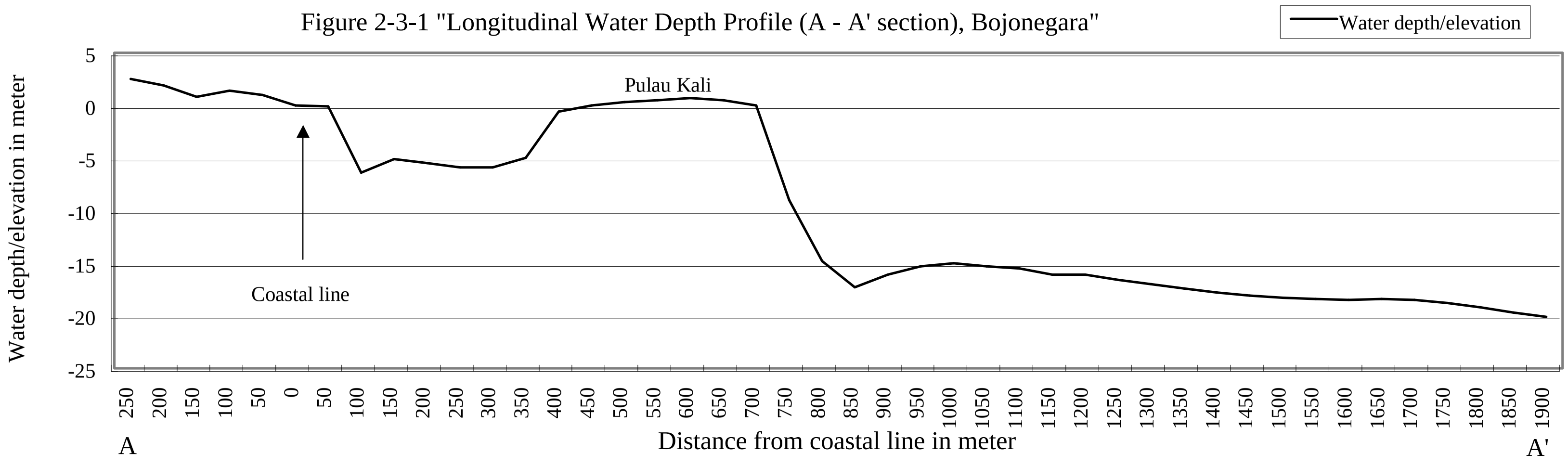


Figure 2-3-1 "Longitudinal Water Depth Profile (A - A' section), Bojonegara"

Source: Natural condition survey by JICA Study Team

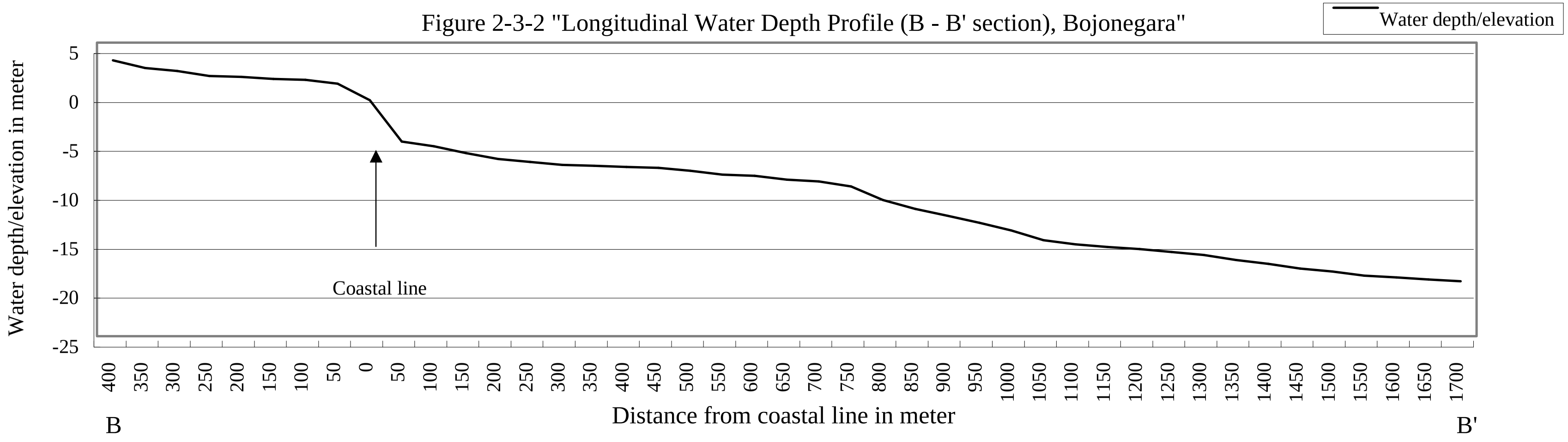


Figure 2-3-2 "Longitudinal Water Depth Profile (B - B' section), Bojonegara"

Source: Natural condition survey by JICA Study Team

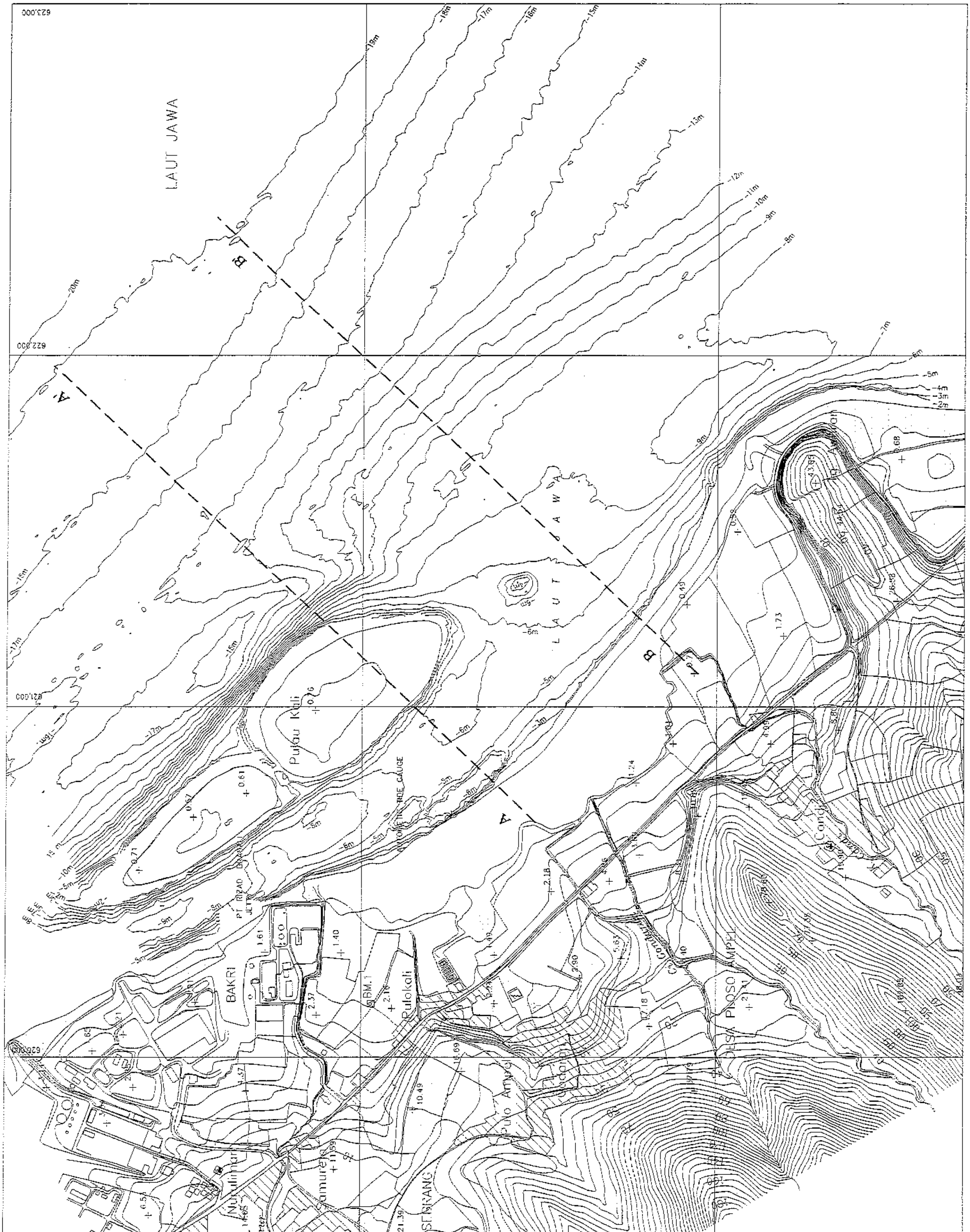


Figure 2-3-3 "Longitudinal Water Depth Profile, Bojonegara"

2.4 Climate

As there is no meteorological observatory station in the vicinity of Bojonegara, no climatic data could be acquired, but it is presumed that that the climate in this area does not change from that found in Jakarta City.

2.5 Tide

According to the tidal data published by Dinas Hidro-Oseanografi, the nearest point from Bojonegara is Suralaya.

IPC‐2 made the tidal observation at Bojonegara in 1993 and obtained the harmonic constant. The tidal data are shown in Table 2-5-1 “Tide and the Principal Harmonic Components at Suralaya” and Table 2-5-2 “Tide and the Principal Harmonic Components at Bojonegara”.

Table 2.5.1 “Tide and the Principal Harmonic Components, Suralaya”

Components	M_2	S_2	N_2	K_2	K_1	O_1	P_1	M_4	MS_4	Z_0
Amplitude (cm)	12	10	2	3	12	6	1	1	1	60

Source: Tide Tables 2002, Dinas Hidro-Oseanografi

Ratio of principal harmonic constants

$(K_1 + O_1) / (M_2 + S_2) = 0.82$ Mixed, dominant semidiurnal type

Table 2.5.2 “Tide and the Principal Harmonic Components, Bojonegara”

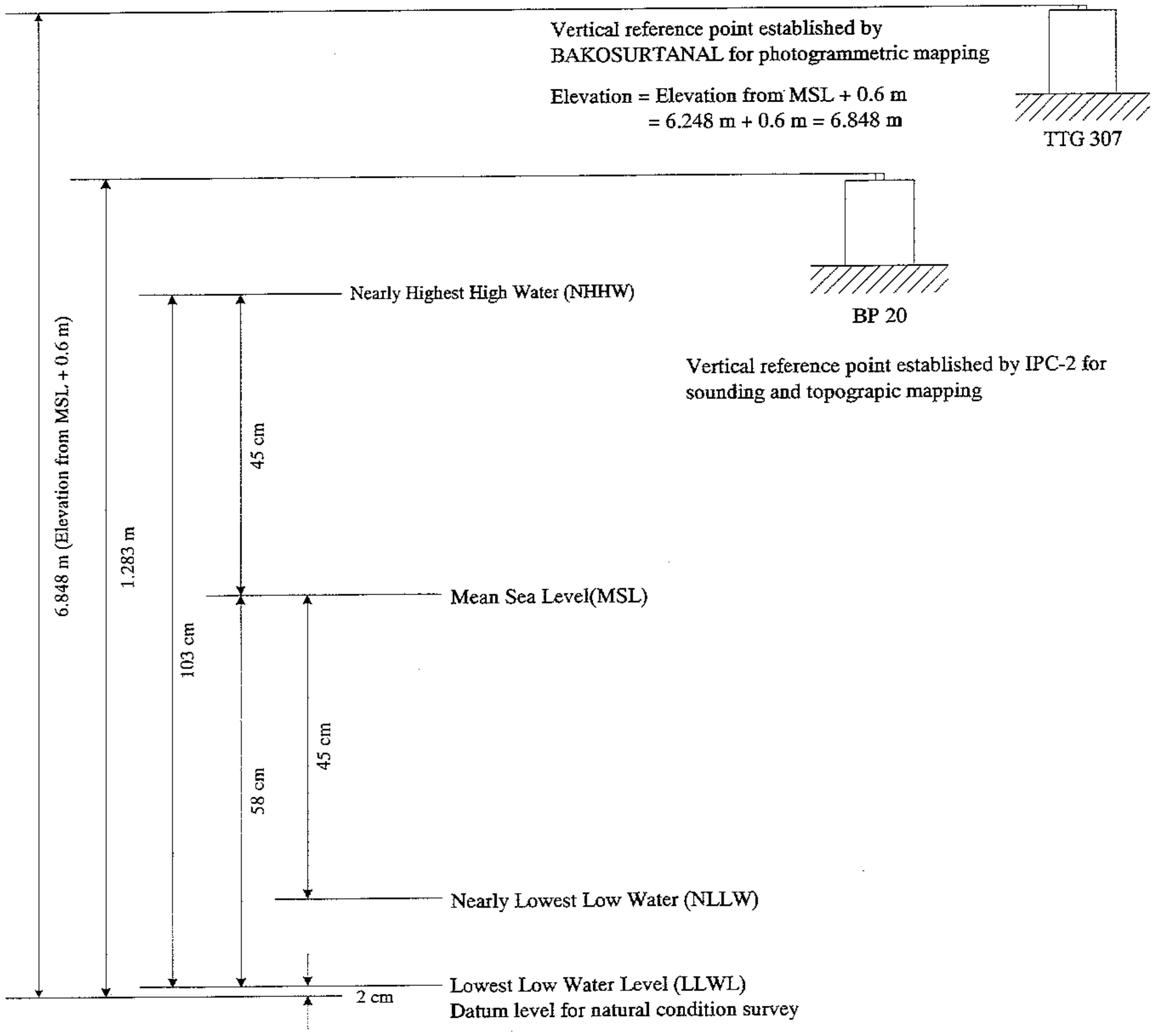
Components	M_2	S_2	N_2	K_2	K_1	O_1	P_1	M_4	MS_4	Z_0
Amplitude (cm)	21.1	11.1	3.9	3.0	9.4	3.7	5	0.7	0.4	58.3

Source: IPC-2 report for Pelabuhan Ciwadan and Pelabuhan Umum Bojonegara, December 1993, PT. Sarana

Ratio of principal harmonic constants

$(K_1 + O_1) / (M_2 + S_2) = 0.41$ Mixed, dominant semidiurnal type

The relation between tidal range, bench mark which was used for 1:10,000 scale digital topographic mapping, and sounding and topographic survey is indicated in Figure 2.5.1 “Relation between Vertical Reference Points for Natural Condition Survey and Tide, Bojonegara”.



Tide and Principal Harmonic Components at Bojonegara

Components	M2	S2	N2	K2	K1	O1	P1	M4	MS4	Z0
Amplitude (cm)	21.1	11.1	3.9	3.0	9.4	3.7	5.0	0.7	0.4	58.3

Source: IPC-2 Report for Pelabuhan Ciwadan and Pelabuhan Umum Bojonegara, December 1993, PT. Sarana

Lowest Low Water Level ≒(M2 + S2 + N2 + K2 + K1 + O1 + P1 + M4 + MS4) below MSL
≒21.1 + 11.1 + 3.9 + 3.0 + 9.4 + 3.7 + 5.0 + 0.7 + 0.4 = 58.3 cm below MSL

Nearly Lowest Low Water = (MS2 + S2 + K1 + O1) below MSL
= 21.1 + 11.1 + 9.4 + 3.7 = 45.3 cm below MSL

Nearly Highest High Water = (MS2 + S2 + K1 + O1) above MSL
= 21.1 + 11.1 + 9.4 + 3.7 = 45.3 cm above MSL

Tide and Principal Harmonic Components at Suralaya

Components	M2	S2	N2	K2	K1	O1	P1	M4	MS4	Z0
Amplitude (cm)	12	10	2	3	12	6	1	1	1	60

Source: Tide Tables 2002, Dinas Hidro-Oseanografi

Lowest Low Water Level ≒(M2 + S2 + N2 + K2 + K1 + O1 + P1 + M4 + MS4) below MSL
≒12 + 10 + 2 + 3 + 12 + 6 + 1 + 1 + 1 = 48 cm below MSL

Nearly Lowest Low Water = (MS2 + S2 + K1 + O1) below MSL
= 12 + 10 + 12 + 6 = 40 cm below MSL

Nearly Highest High Water = (MS2 + S2 + K1 + O1) above MSL
= 12 + 10 + 12 + 6 = 40 cm above MSL

Fig. 2-5-1 "Relation between Vertical Reference Points for Natural Condition Survey and Tide, Bojonegara"

2.6 Wave

The wave frequency of offshore Bojonegara by the wave hindcast is mentioned in Table 2.6.1 “Wave Characteristics off-Bojonegara by Wave Hindcast (1997 – 2001).

The wave condition is generally calm in the western portion of Jawa Sea and the cumulative frequency of wave height of less than 0.5 m is about 87 %.

Westerly incident wave are most frequent in the table with about 11 % frequency due to the wind of northwest monsoon and transitional season. N～NNE～NE incident wave are also frequent accounting for about 14 % of the frequency.

Table 2-6-1 "Wave Characteristics off-Bojonegara by Wave Hindcast (1997 - 2001)

Combined Frequency of Wave Height and Period (Unit: meter and second)

Period Height	0	2	3	4	5	6	7	8	8	Total	Cumu-lative
Calm										68.55	68.55
0≦H＜0.25	5.36									5.36	73.92
0.25≦H＜0.5	5.06	8.03								13.09	87.01
0.5≦H＜0.75		5.15	2.15							7.30	94.31
0.74≦H＜1.0		0.13	3.09	0.05						3.27	97.58
1.0≦H＜1.25			1.07	0.32						1.39	98.97
1.25≦H＜1.5			0.08	0.51	0.02					0.62	99.58
1.5≦H＜1.75			0.00	0.19	0.03					0.22	99.80
1.75≦H＜2.0			0.00	0.07	0.07					0.14	99.95
2.0≦H＜2.5				0.04	0.01					0.05	100.00
2.5≦H＜3.0											
3.0≦H＜3.5											
3.5≦H＜4.0											
4.0≦H											
Total	10.42	13.31	6.39	1.18	0.13	0.00	0.00	0.00	0.00	100.00	

Combined Frequency of Wave Height and Direction (Unit: meter)

Period Height	W	WNW	NW	NNW	N	NNE	NE	ENE	E	Total	Cumu-lative
Calm										68.55	68.55
0≦H＜0.25	2.15	0.33	0.31	0.39	0.54	0.54	0.46	0.28	0.37	5.36	73.92
0.25≦H＜0.5	4.18	0.89	0.92	1.15	1.30	1.49	1.67	0.85	0.64	13.09	87.01
0.5≦H＜0.75	2.52	0.40	0.46	0.52	0.43	0.72	1.11	0.81	0.33	7.30	94.31
0.74≦H＜1.0	1.30	0.24	0.17	0.14	0.09	0.24	0.51	0.44	0.15	3.27	97.58
1.0≦H＜1.25	0.42	0.20	0.07	0.05	0.02	0.10	0.24	0.20	0.08	1.39	98.97
1.25≦H＜1.5	0.17	0.13	0.02	0.03	0.01	0.03	0.08	0.12	0.03	0.62	99.58
1.5≦H＜1.75	0.05	0.04	0.01	0.01	0.01	0.01	0.04	0.05	0.01	0.22	99.80
1.75≦H＜2.0	0.01	0.03	0.01	0.01	0.00	0.01	0.03	0.04	0.00	0.14	99.95
2.0≦H＜2.5	0.02	0.00					0.00	0.02	0.00	0.05	100.00
2.5≦H＜3.0											
3.0≦H＜3.5											
3.5≦H＜4.0											
4.0≦H											
Total	10.82	2.25	1.97	2.28	2.41	3.14	4.14	2.80	1.62	100.00	

Combined Frequency of Wave Period and Direction (Unit: second)

Period Height	W	WNW	NW	NNW	N	NNE	NE	ENE	E	Total	Cumu-lative
Calm										68.55	68.55
0≦H＜2.0	3.72	0.68	0.68	0.83	1.07	1.09	1.08	0.60	0.67	10.43	78.98
2.0≦H＜3.0	4.16	0.84	0.91	1.10	1.12	1.47	1.96	1.17	0.59	13.31	92.29
3.0≦H＜4.0	2.69	0.50	0.33	0.30	0.18	0.49	0.88	0.75	0.28	6.39	98.68
4.0≦H＜5.0	0.24	0.24	0.05	0.05	0.02	0.08	0.21	0.22	0.08	1.19	99.87
5.0≦H＜6.0				0.01	0.00	0.01	0.03	0.06	0.01	0.13	100
6.0≦H＜7.0											
7.0≦H＜8.0											
8.0≦H＜9.0											
9.0≦H											
Total	10.82	2.25	1.97	2.29	2.41	3.14	4.14	2.81	1.62	100.00	

2.7 Tidal Stream

The direction of tidal stream at offshore of the proposed site of Bojonegara is generally parallel to the coastal line with a maximum velocity of 0.5 m/sec during spring tide.

2.8 Maintenance Dredging

At present, Bojonegara has no port facilities. Therefore, no maintenance dredging has been executed up to now.

2.9 Estimation of Seabed Variation

The seabed variation was estimated from two types of sounding data. The mesh data of the water depth in 40 m steps was obtained using a sounding survey chart and the water depths at the same point in two different time points were compared to calculate the seabed variation.

However, the seabed variation was obtained as the average value of all the meshes of 200 square meter per mesh (a maximum of 25 water depth data sets) in order to clear the observation errors and the reading errors of the water depths.

The estimated seabed variation is shown in Figure 2-9-1 “Estimation of Yearly Seabed Variation at Bojonegara”. From this result, the following points can be pointed out:

1) The seabed of the basins and navigational channel at the planned port site at Bojonegara rises for nearly 10 cm to 20 cm per year.
2) The rise of the seabed in the vicinity of Tg. Awuran is high compared with other areas. This is understandable from the fact that the sand bank extends in the west direction from Tg. Awuran.
3) According to the hearing results from the villagers near the project site, no significant change of coastal line has not been occurred during past several decade years at project site of Bojonegara.

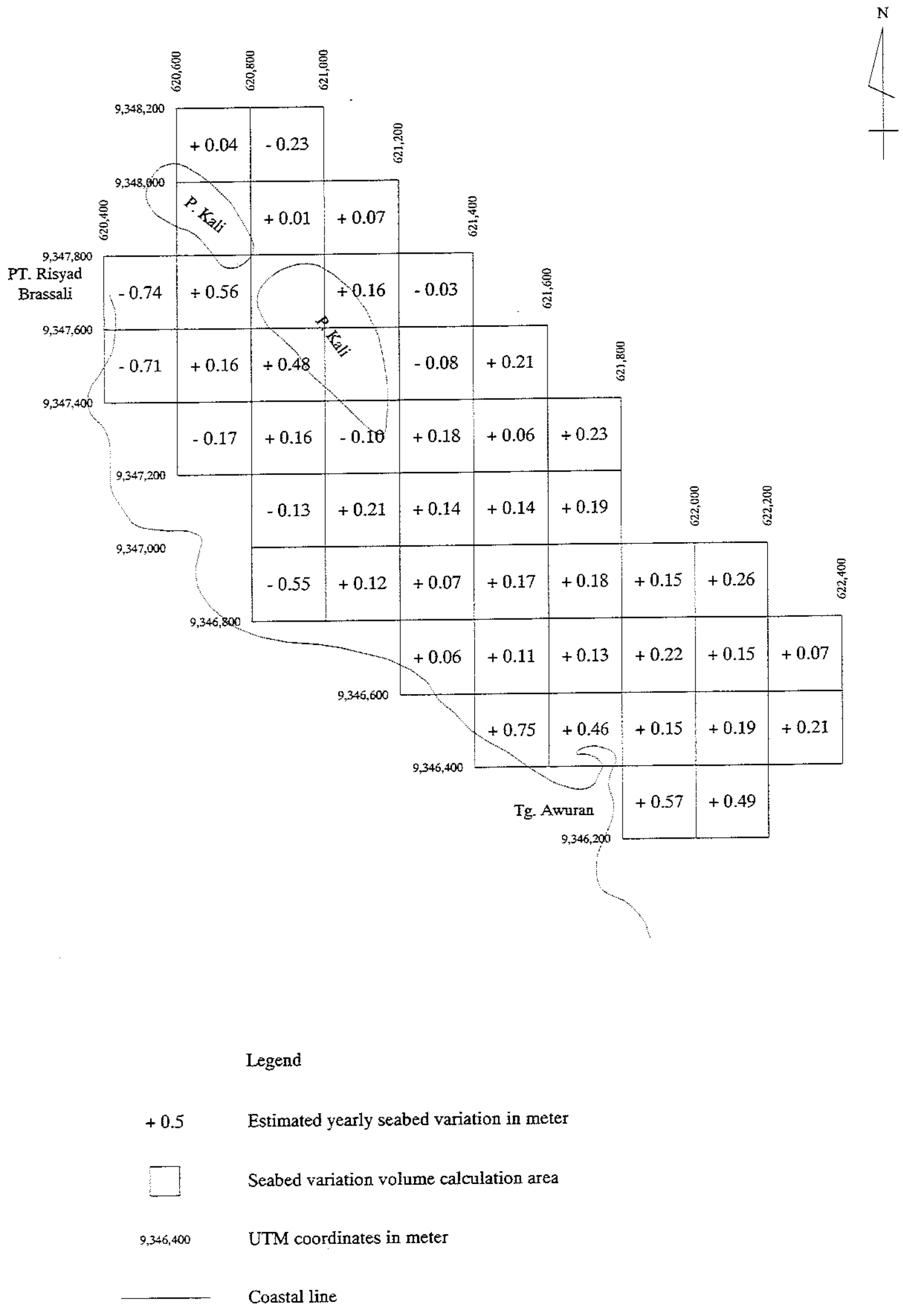
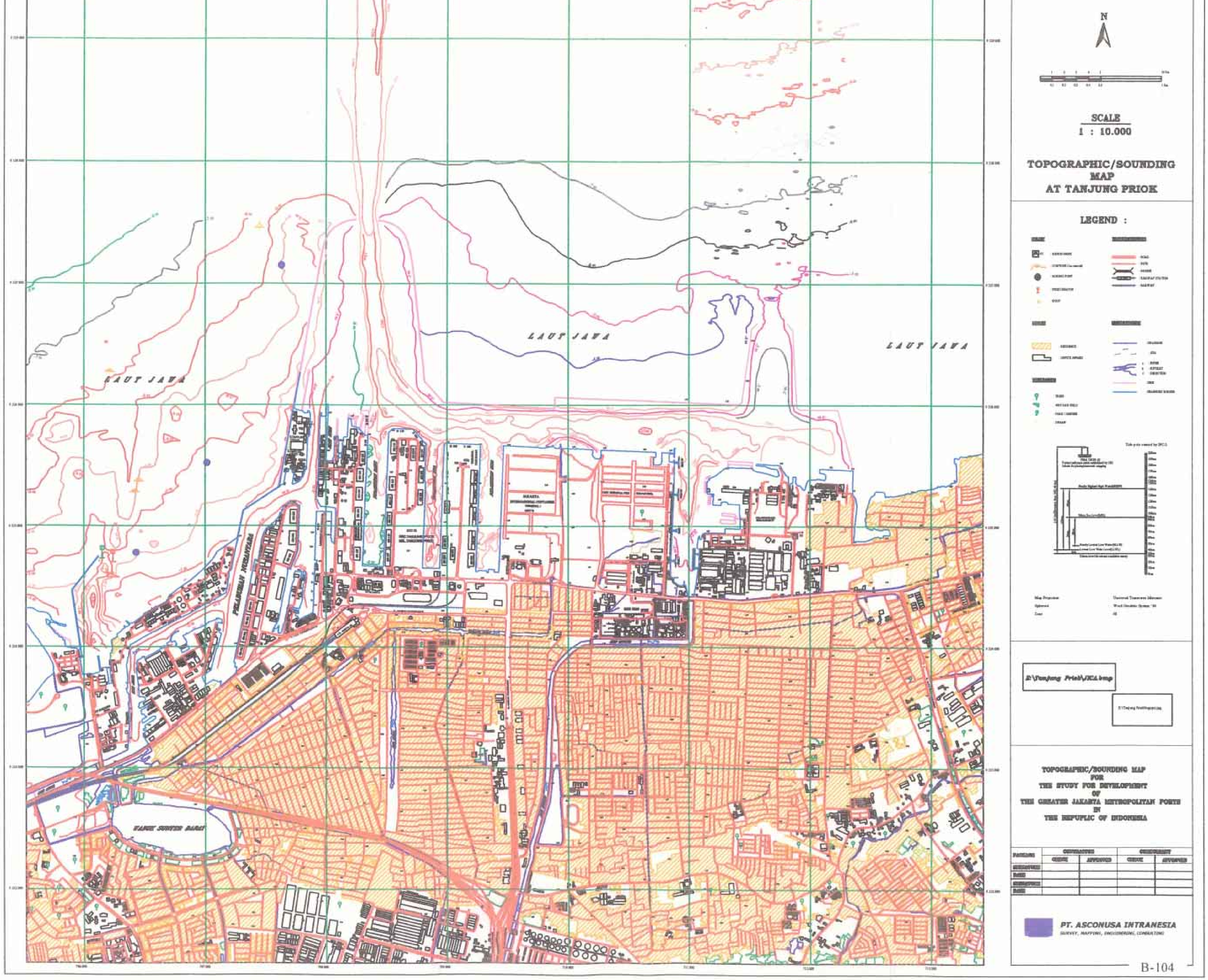


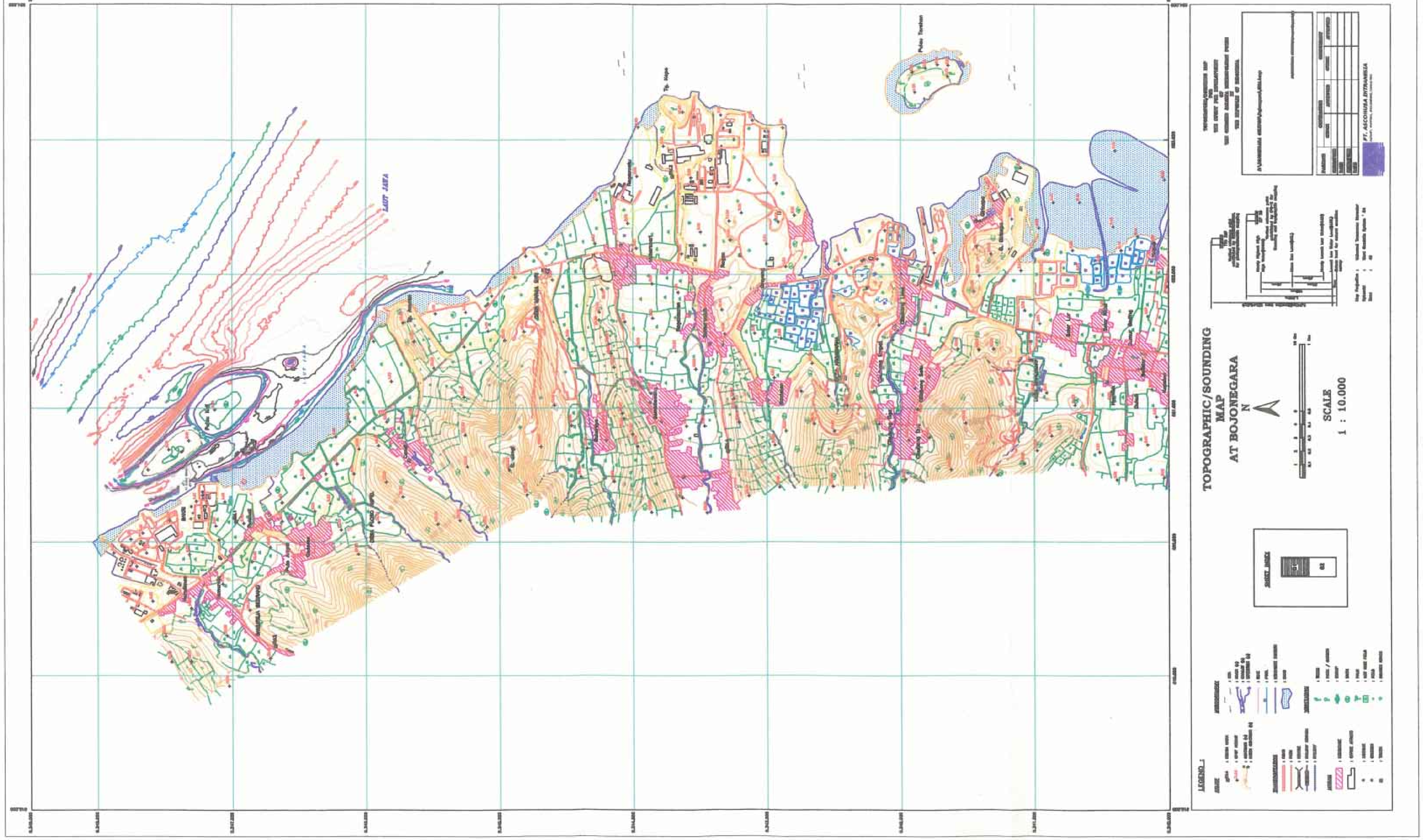
Figure 2-9-1 "Estimation of Yearly Seabed Variation at Bojonegara"

Appendix - 1



TOPOGRAPHIC/SOUNDING MAP
FOR
THE STUDY FOR DEVELOPMENT
OF
THE GREATER JAKARTA METROPOLITAN PORTS
IN
THE REPUPLIC OF INDONESIA

Appendix - 2


TOPOGRAPHIC/SOUNDING
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AT BOJONEGARA
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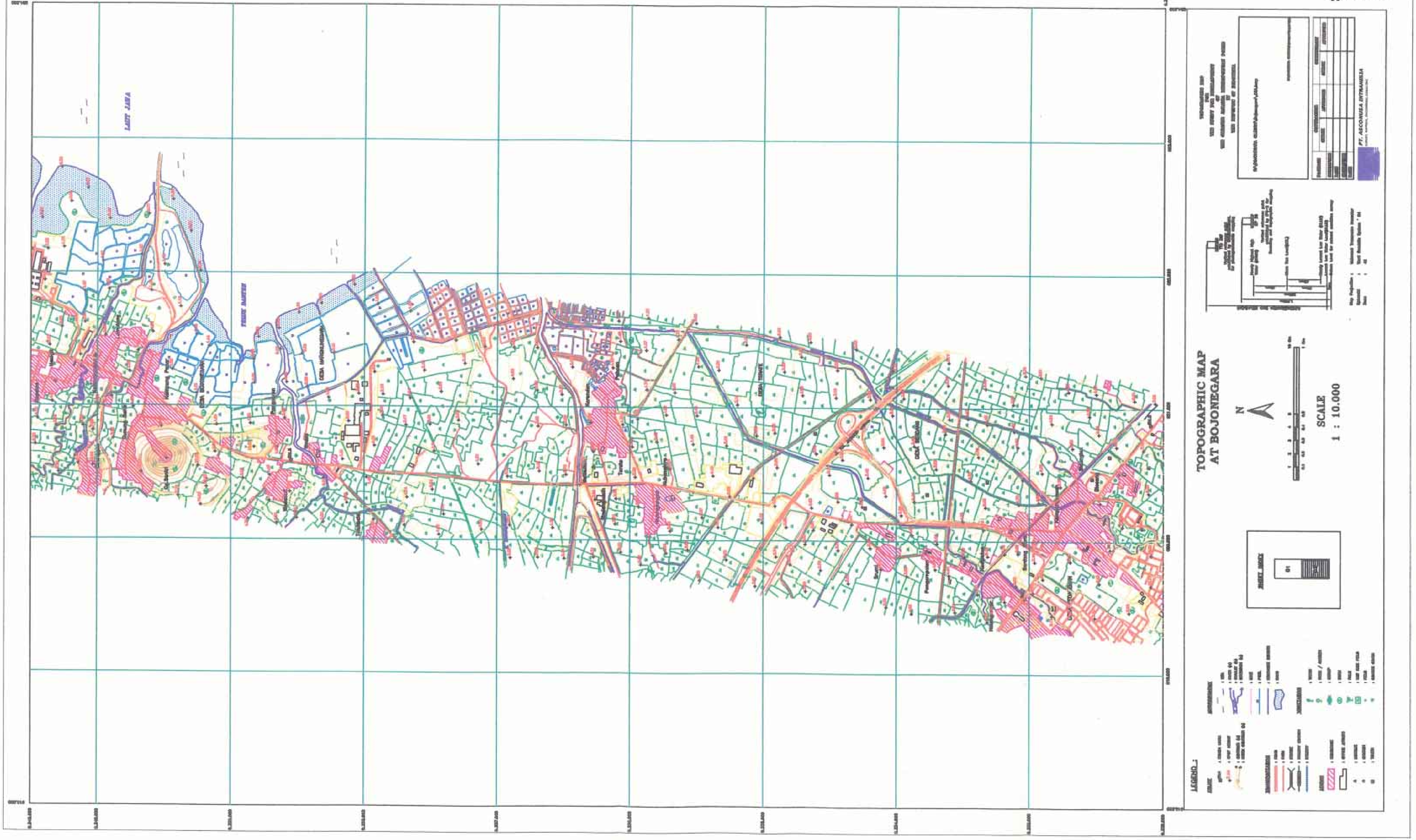
LEGEND :
LAUT JAWA

Appendix - 3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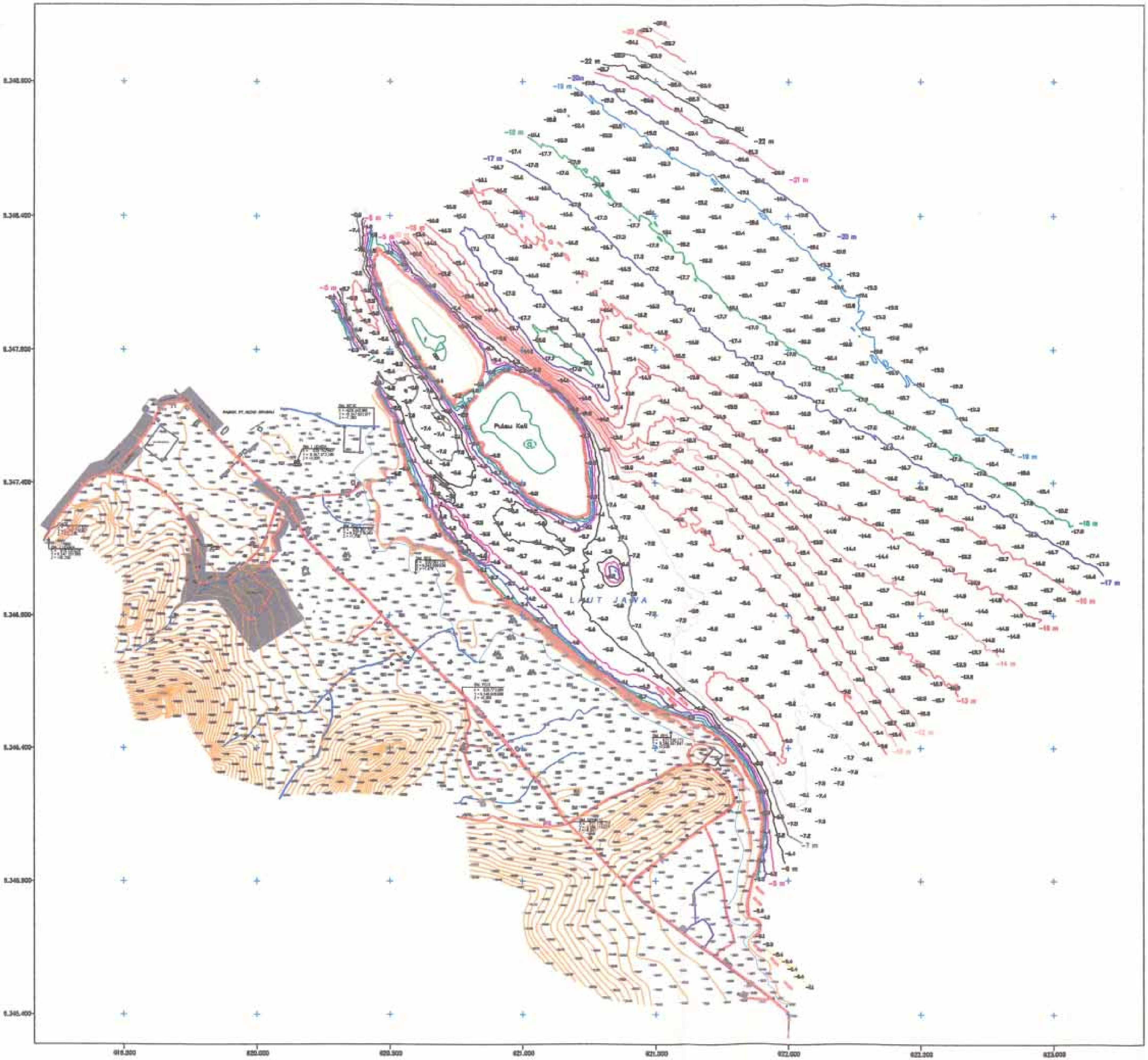


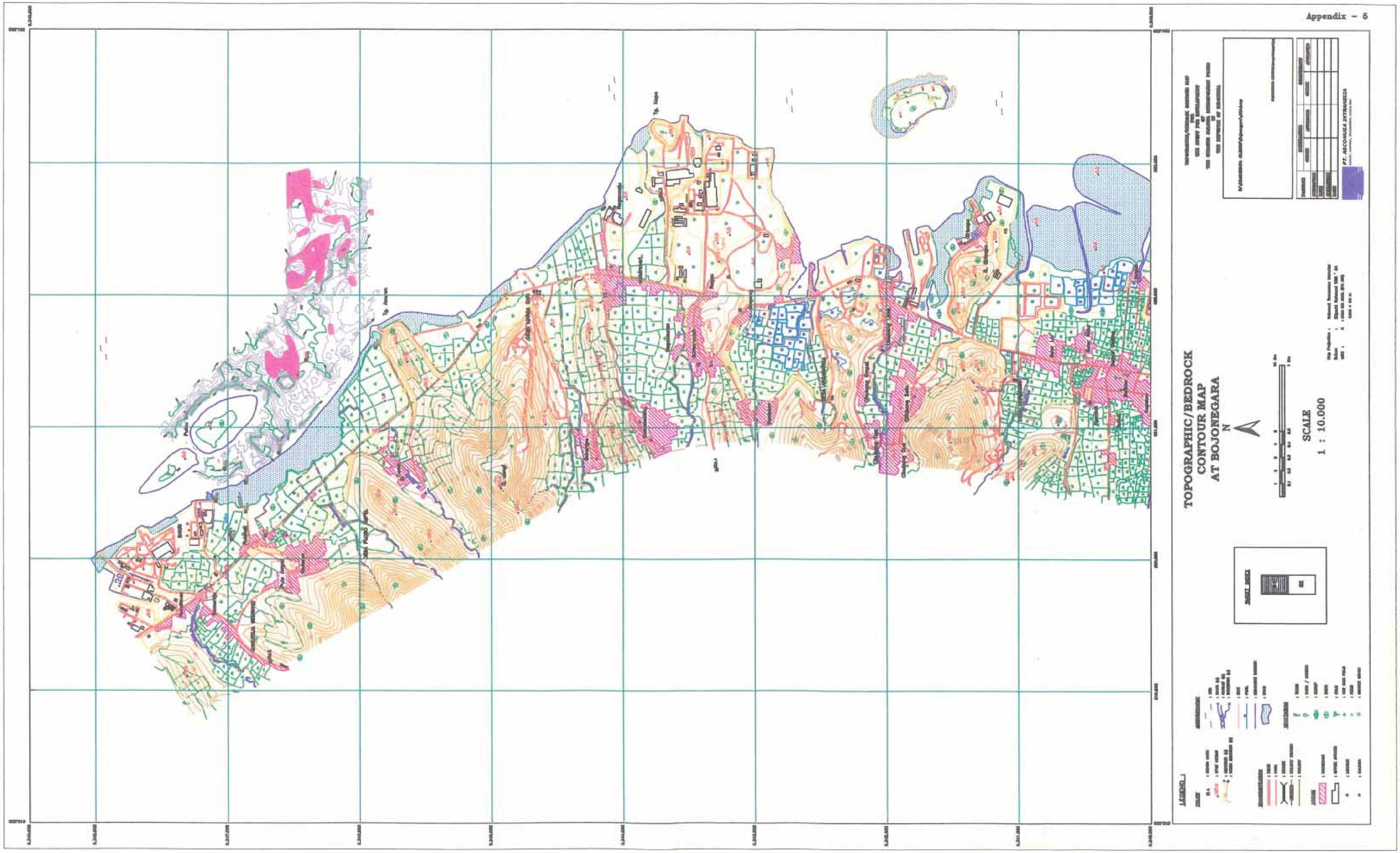
TOPOGRAPHIC/HYDROGAPHIC MAP BOJONEGARA

Japan International Cooperation Agency

TOPOGRAPHIC/HYDROGRAPHIC MAP
FOR
THE STUDY FOR DEVELOPMENT
OF
THE GREATER JAKARTA METROPOLITAN PORTS
IN
THE REPUBLIC OF INDONESIA

PACKAGE	CONTRACTOR		CONSULTANT	
	CHECK	APPROVED	CHECK	APPROVED
SIGNATURE				
DATE				
SIGNATURE				
DATE				

PT. RISKI PENDAWA TRIPOD
KONSULTAN PERENCANAAN, SURVEI, DAN MANAGEMENT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