4. BORING TEST

4.1 Iloilo

Twenty (20) boring tests were conducted along three (3) related rivers and one (1) proposed floodway. Based on the results of boring tests, four (4) soil profiles are provided.

The area is alluvial plain which mainly consists of river and coastal deposits of Holocene. Considering the layers confirmed by the soil profile and sedimentary environment, the area is classified as two (2) sedimentary basins; one is the Jaro sedimentary basin and the other is the Iloilo sedimentary basin. For further evaluation of the soil profiles, sedimentary and lithological conditions for each basin are summarized in the following subsection.

(1) Jaro Sedimentary Basin

The basin is composed only of recent river deposits of clay, silt and sand. Basement rock of Cabatuan Formation (sandstone) is confirmed by the profiles. Two (2) soil profiles of Jaro Floodway and Jaro River, located at this basin, are shown in Fig. 4.1 and Fig. 4.2, respectively. The soil strata of the basin, together with lithological description, N-value and thickness of layer, is summarized in Table 4.1. From the stratigraphical point of view, the layers are classified into the following seven (7) members.

Jaro River	Jaro Floodway	Classified Member	Sediment
	AcSa (clayey sand)	surface sand	fluvial
Asc1 (upper silty clay)	Ac1 (upper clay)	upper clay member	fluvial
Ac (upper clay)			
Ags (gravely sand)			
Acsa (clayey sand)		sand member	fluvial
As1 (upper sand)			
Asc2 (middle silty clay)	Ac2 (middle clay)	middle clay member	fluvial
Asac (sandy clay)			
As2 (lower sand)		sand intercalation	fluvial
Acs (clayey silt)	Acs (clayey silt)	lower clay member	fluvial
Asc3 (lower silty clay)	Ac 3 (lower clay)		
Q2 (sandstone)	Q2 (sandstone)	basement rock	Pleistocene terrace

The details of evaluation of subsurface soil structure for provided profiles are described in the following subsection.

(a) Jaro Floodway (refer to Fig. 4.1)

The alluvial deposit in this proposed floodway consists of surface sand at topsoil and three (3) cohesive soil members of upper clay, middle clay and lower clay, except sand member at JF-4. Thickness of the surface sand of AcSa is very thin (1 to 1.8 m) and overlaying most of the top surface of the whole profile except the area between JF-3 and JF-4.

Most of the deposit in this profile consists of cohesive soil members. These are very soft and thick (10 to over 10 m) from the river mouth to JF-3. The average N-value is 7 at Ac1, 5 at Ac2, 4 at Acs and 3 at Ac3. Especially at the river mouth of JF-1, a very low range of N-value (0-4) is confirmed at a whole sequence to the depth of more than 10 m. This soft formation is estimated to be distributed in the area between Station No. 0+000 and 1+680.

Sand member of recent Jaro river deposit consisting of Acsa and As1 are observed at the area between JF-3 and JF-4. Compared with the members mentioned above, a higher range of N-value (6-15) is obtained. The basement rock of sandstone with an average N-value of 44 is confirmed at the bottom of the whole sequence of the profile. Depth to the basement rock is 7 to over 10 m in general. A similar incline with the ground elevation is expected.

(b) Jaro River (refer to Fig. 4.2)

In this profile, three (3) clay members of upper, middle and lower and one (1) sand member consist of alluvial deposit which is overlying the basement rock of Cabutuan Formation.

Surface formation of the profile is mainly upper clay member of Asc1 and Ac except the area between JR-6 and JR-7. N-value of the surface formation is rather low. It is 8 at Asc1 and 11 at Ac on average. However, the N-value shows a very low range in the river mouth (area between JR-1 and JR-4), and rather high in the upstream part (area between JR-5 and JR-8).

Middle formation mainly consists of sand member of Ags and As1. The average N-value of these two (2) layers are 6 at Ags and 12 at As1. N-value of 6 is lower than the value which is normally expected for the gravely sand layer. Therefore, the layer is estimated as a very loose deposit. It is distributed at only the river mouth area.

Bottom formation, which is overlying a basement rock, consists of two (2) members; one is a lower clay member of Acs and Asc3 at the river mouth, and other is a middle clay member of Asc2 and Asac at the upstream part. The average N-value shows a very low range of 1 (Asc3) to 4 (Acs) at the lower clay member in the river mouth, and rather high range of 5 (Asc2) to 6 (Asac) at the middle clay member.

Basement rock (sandstone) of Cabatuan Formation is an old terrace of Pleistocene. Depth to the rock is shallow (4 m) at JR-7 and JR-8, and deep (more than 10 m) at the river mouth.

Considering the situation mentioned above, the soil structure of the Jaro River is estimated as very soft formation especially at the river mouth from Station No. 0+000 to 4+000. In spite of the existence of sand intercalation, the N-value shows very low range of 0 to 7 at a whole sequence in borehole JR-1 and JR-2. The same layers, both of clay and sand, also exist in the upstream part; however, N-value higher than the river mouth is confirmed. It is considered, therefore, that these layers at the river mouth are loose or recent sediment, and dense or compacted at the upstream part.

(2) Iloilo Sedimentary Basin

Iloilo sedimentary basin where the Iloilo and Mandurriao rivers are located, is composed of recent river and coastal deposits of clay, silt and sand layer. Much amount of shell fragment was observed mainly at the cohesive soil layer. It is presumed that marine sediments are the basal formation of the alluvial plain in this basin.

Two (2) soil profiles of Mandurriao River and Iloilo River, located at this basin, are shown in Fig. 4.3 and Fig. 4.4, respectively. Depth to the basement rock of Cabatuan Formation (sandstone) could not be confirmed from these profiles. The soil strata of the basin, together with lithological description, N-value and thickness of layer, is summarized in Table 4.2. From stratigraphical point of view, the layers are classified as the following four (4) members.

Iloilo River	Mandurriao River	Classified Member	Sediment
As1 (upper sand)		surface sand	fluvial
Ac (clay)	Ac1 (upper clay)	upper clay member	fluvial
	Acs (clayey silt)		
Asg1 (sandy gravel)			
As2 (lower sand)	As (sand)	sand intercalation	fluvial
Asg2 (sandy gravel)			and marine
	Ac2 (lower clay)	basal clayey silt	marine
Acs (clayey silt)	Acs (clayey silt)	member	

The details of evaluation of subsurface soil structure for provided profiles will be described in the following section.

(a) Mandurriao River (refer to Fig. 4.3)

A homogeneous soil bedding structure is observed in the whole area of the profile. Two (2) main members of upper clay (Ac1 and Acs) and basal clayey silt (Ac1 and Acs) is bedding in parallel except at PC-3 because of sand intercalation of the area. Very low N-value range is obtained at all boreholes in the profile. It ranges from 3 to 9 at PC-1, 3 to 7 at PC-2 and 3 to 10 at PC-3.

Most of the layers in the area are composed of soft clay to medium plastic clayey silt. Moreover, sand intercalation is estimated as very loose sediment. The area along Mandurriao River is therefore estimated to be a soft ground formation. Special design for the foundation is required in case of heavy structures.

Basement rock is not confirmed in this profile.

(b) Iloilo River (refer to Fig. 4.4)

Basal clayey silt member of Acs is widely distributed on the whole area of the profile. This member shows low N-value of 5 on average. Three (3) members of surface sand (As1), upper clay (Ac), and sand intercalation (As2) is overlying in parallel on the basal clayey silt. However, only at the area between IR-3 and IR-4, a pocket-shaped deposit of sandy gravel (Asg1 and Asg2) is observed. It is presumed that this area may be a location of the old junction of Mandurriao River.

These deposits, including sand intercalation, show a rather high N-value of 21 at Asg1 and 14.69 at As2 on average. In general, most of the layer shows a low N-value except sand intercalation and sandy gravel deposit. Hence, there are no sand intercalation in the river mouth, and the whole sequence of Borehole IR-1 has a very low range (0 - 3) of N-value.

Clay layer of Ac shows the lowest N-value of less than 3 on average. The layer is exposed as surface layer from Station No. 6+200 to the west. This area where the present junction of Mandurriao River is located, is estimated to be soft ground.

4.2 Ormoc

Nine (9) borings were conducted along two (2) related rivers on alluvial plain in Ormoc City. Based on the results of boring tests, two (2) profiles are provided.

The alluvial plain composed of recent river sediment of Holocene, is distributed at a narrow area of the city proper. Basement rock (pyroclastics) of Pliocene to Pleistocene is not confirmed by the depth (10 m) of borehole drilled. From sediment environmental point of view, two (2) related rivers of Anilao and Malbasag can be annualized as fluvial deposit; no marine deposit is considerable.

The soil strata of the two (2) rivers, together with lithological description, N-value and thickness of layer, are summarized in Table 4.3. The details of evaluation of subsurface for provided profiles are described in the following subsection.

(1) Anilao River (refer to Fig. 4.5)

The alluvial deposit along Anilao River mainly consists of sandy and gravely layers, except the top surface of Acs layer. These layers, consisting of sand (As2), gravely sand (Ags1 and Ags2) and cobble with boulder (Aco2), are distributed at the whole sequence of the profile. Thickness of this sand and gravel member is estimated at 10 to 16 m, and it is situated at elevations of 6 m to - 8 m mean sea level.

The average N-value of each layer is high. It is more than 50 at Ags1 and Aco2, 41 at Ags2, 18 at As2. Therefore, all the layers of the sand and gravel member is considered very dense and compacted, except the river mouth of Ags1 layer in the surface soil. However, the N-value of more than 50 of Aco2 does not represent the proper value of the layer itself, because of cobble and boulder existence. The Aco2 layer is thin at the river mouth, thick at the upper stream. The bearing capacity of the Aco2 layer is considered as enough for the river improvement work in this project. However, detailed investigation will be required for heavy structures, especially at the location where thick Aco2 layer is distributed.

The layer of Acs is the only cohesive soil in the area. The faces is clayey silt with average N-value of 17. The layer is distributed from Station No. 0+800 to 2+400 or may be more. A thick deposit of the clayey silt is observed at the upper part of the profile. The layer is well plastics.

(2) Malbasag River (refer to Fig. 4.6)

The profile shows a similar soil structure as Anilao River. Main components of the alluvial deposit are sandy to gravely layers and cohesive soil (Acs) at the top surface. However, another cohesive soil of Asi and Acsa layers are confirmed at the upper layer of the Ags layer. These cohesive layers are well compacted; average N-value is 25 at Asi and 44 at Acsa.

Compared with the profile of Anilao River, each layer is thin, so that general formation is categorized as small scale alternation of sand and gravel. The alternation mainly consists of strata of sand, gravel and cobble with a high range of N-value.

The area is characterized, generally, as gravel and sand dominant soil structure, having enough bearing capacity.

4.3 Sabo Dam Site

Sabo dam sites are as described below.

(1) Proposed Sabo Dam Sites

In the Master Plan stage, three (3) sabo dams are proposed for the purpose of erosion control at two (2) related rivers in Ormoc City. Two (2) sabo dams in Anilao River and one (1) sabo dam in Malbasag River are planned. Based on the site selection made in the master plan study, detailed geological survey was carried out to place the dam axis at a proper position and to examine geological and soil mechanics for the dam structure.

For the selection of the exact location of each dam, following factors are examined from the geological point of view. The selected dam site for each river is shown in the location map in Fig. 1.2.

(a) Narrow Valley

(b) Steep slope at both bank

(c) Basement rock should have necessary soundness

(d) No existence of large scale fault

(e) Low weathering of basement rock

(2) Geology of Sabo Dam Site

Location of each sabo dam is set midstream which is the boundary of the alluvial plain and hilly area. The basement rock of the Dolores Formation of Plio-Pleistocene is distributed at both the Anilao and Malbasag rivers.

Dolores Formation is widely outcropped in all areas constituting the hill area. The formation is andesitic pyroclastics consisting of well bedded volcanic breccia, sandstone, siltstone and shale. It is sometimes accompanied with a thin layer of calcareous or tuffaceous shale, sandy mudstone as lens. Volcanic breccia consists mainly of sub-angular fragments of andesite and sandy, tuffaceous cementing materials.

Two (2) boring tests 10 m deep at each sabo dam site, or a total of six (6) boring tests, were carried out. Geological column of each borehole is shown in Fig. 4.7. Based on the results of boring test and field geological reconnaissance, the following stratigraphy of the area has been confirmed.

FORMATION	CONTENTS	LITHOLOGY	AGE	
Alluvium	alluvium deposit (Qal)	clay, silt and sand	Holocene	Quaternary
	recent river deposit (Ard)	sand, gravel (cobble to boulder)		
Dolores Formation (Qtd)	andesitic Pyroclastics with sediments	volcanic breccia	Pleistocene	
		volcanic sandstone		

Detailed geological map with scale of 1/400 and geological profiles for each dam site are provided. The detailed geological condition of each site is described in the following subsection.

(a) Anilao Sabo Dam-1 (refer to Fig. 4.8)

The basement rock is pyroclastics of Dolores Formation consists of alternating beds of volcanic breccia at greater part, and volcanic sandstone at minor part. Profile A-A' is set along the proposed dam axis, where most of the narrow valley is situated.

Volcanic breccia is composed of various andesitic gravel of granule to cobble with bad sorting. Matrix is mainly tuffaceous sand to silt. The gravel configuration is sub-rounded to sub-angular.

Volcanic sandstone, underlying volcanic breccia of the riverbed, is confirmed by boring test at elevation between 50 and 55 m. The layer is a thin bed 1.5 to 2.5 m thick. It is also visible at the outcrop of river bank. However, due to heavily weathering and much vegetation, geological structure (dip and strike) and thickness could not be measured in detail. This volcanic sandstone is tuffaceous, less concrete than volcanic breccia.

Recent river unconsolidated deposit of sand and gravel is widely distributed along the right bank of the river. The thickness of deposit is thin at the proposed dam axis, rather thick downstream of Profile B-B'.

(b) Anilao Sabo Dam-2 (refer to Fig. 4.9)

The dam site is placed near the junction of a tributary of Anilao River. Geological condition both of lithology and facies is a similar with the Anilao Dam-1 site. A major part of the basement rock is volcanic breccia of Dolores Formation including thin alternating beds of volcanic sandstone.

By the boring test, a thin bed of volcanic sandstone is confirmed at elevation between approximately 50 and 55 m. Shown as Profile C-C', the bed dips 10° to 15° south. Therefore, depth to the volcanic sandstone is rather shallow at the proposed dam axis of Profile A-A'. However, compared with Profile B-B', volcanic breccia in both river banks is much thicker at Profile A-A'. Hence, less concretion is estimated for volcanic sandstone, and the location of Profile A-A' is much suitable for the dam axis.

(c) Malbasag Sabo Dam (refer to Fig. 4.10)

The basement rock of the area is pyroclastics of Dolores Formation composed of only volcanic breccia. No volcanic sandstone is confirmed in this area.

Steep slope and massive volcanic breccia formation is observed at the left bank. In the left bank, however, a rather gentle slope of 18° inclination made of thick alluvium deposit (Qal) is observed. No outcrop of basement rock is found at the right bank of the area. Therefore, boring test MRD-2 is conducted at the right bank to confirm the depth to the basement rock.

Based on Borehole MRD-2, river terrace composed of volcanic breccia is confirmed at elevation 137 m. The facies of the volcanic breccia is similar to Anilao River. The formation consists mainly of andesitic granule to cobble with tuffaceous matrix.

(3) Uniaxial Compression Test

Core samples of basement rock for the uniaxial compression test were taken from each borehole except MRD-1, due to no long length sample recovery. All the samples were taken from volcanic breccia of Dollars Formation. No core sample of volcanic sandstone was available because of low RQD (Rock Quality Designation) ratio.

The results of uniaxial compression test are summarized in Table 4.4. Position of sample collection in the geological column is shown in Fig. 4.7. Uniaxial compression strength of volcanic breccia shows a range from 280 to 320 kgf/cm^2. This value is considered as sufficient soundness for the construction of sabo dam.

On the other hand, the RQD ratio is low at all boreholes. Originally, it is difficult to obtain a high RQD ratio for formations such as breccia or conglomerate because there is a big difference of strength between rock and matrix. In this Dolores Formation, compression strength of tuffaceous matrix is confirmed as 280 to 320 kgf/cm^2, while andesite cobble is normally estimated to have more than 1,000 kgf/cm^2 of compression strength. Under this situation, it is very difficult to control the drilling pressure to take a core sample of more than 10 cm long.

Considering the above situation and results of geological observation on outcrop, the following conclusions are given for sabo dam construction.

(a) Volcanic breccia has enough bearing capacity for the direct foundation of proposed sabo dam.

(b) Volcanic sandstone is not well consolidated due to short period for diagenesis. However, it is thin alternating bed. Slope protection is not necessary, in case the thickness is less than 5 m.

(c) No large scale fault or fissure was found at dam sites. Moreover, high value of compression strength is confirmed. Therefore, the soundness of Dolores Formation is sufficient for the proposed sabo dam scale.

5. SOIL MECHANICS INVESTIGATION

5.1 Embankment Materials

Soil mechanics investigation for embankment materials has been done as described below.

(1) Criteria for Material Selection

Originally, embankment materials are planned to use excavated soil from the existing river bank along the proposed river improvement site and floodway. The soil samples were examined to choose the suitable material for embankment, based on the following criteria.

(a)	Grain Size Distribution	:	within 15% to 70% of silt and clay content
(b)	Moisture Content	:	less than 50%
(c)	Specific Gravity	:	approximately 2.5
(d)	Soil Grading	:	refer to Table 5.1

(2) Iloilo

Soil mechanics investigation for embankment materials in Iloilo is as described below.

(a) Results of Laboratory Test

A total of thirty (30) samples from ten (10) different test pits set along related river banks and floodway were obtained and tested for physical properties. The test results are summarized in Table 5.2.

Based on the results of grain size and consistency, triangular soil classification and plasticity chart are provided as shown in the Fig 5.1. According to the grain size distribution, all the samples are classified as fine grained soil (F). Plasticity chart shows as clay (CH) for EJR-1 and EJR-4, and cohesive soil (CL) for all other samples.

(b) Evaluation for Embankment Materials

From the results, the materials sampled are observed as mainly clayey silt, with a little proportion of sand. No gravel content is found at all samples.

Most of the samples are disqualified by the grain size distribution due to large proportion of more than 70% of silt and clay content except EJR-1 and EJR-2 of the Jaro River. On the other hand, all the samples were classified as clay (CL or CH) of Fine Soil by the grain size and consistency. This classification is evaluated as "suitable" by the soil grading criteria in Table 5.1. However, because it is very fine grained, small scale countermeasure is suggested such as drying or soil stabilization.

Based on the above situation, it is evaluated that most of the soil of the existing river bank can be used for embankment material. However, soil stabilization shall be required locally where very fine grained soil is distributed such as EJF-1 and EJF-4.

(3) Ormoc

Soil mechanics investigation for embankment materials in Ormoc is as described below.

(a) Results of Laboratory Test

A total of fifteen (15) samples from five (5) different test pits were obtained and tested for physical properties. The test results are summarized in Table 5.3.

Based on the result of grain size and consistency, triangular soil classification and plasticity chart are provided as shown in the Fig. 5.2. According to the grain size distribution, only EAR-3 is classified as sandy soil (SF), other samples of EAR-1,2 and EMR-1,2 are classified as fine grained soil (F). Plasticity chart shows all the samples as cohesive soil (CL) except EMR -2.

(b) Evaluation for Embankment Materials

From the results of grain size distribution, all the samples except EAR-2 shows less than 70% proportion of silt and clay content. Furthermore, these samples passed the other criteria of moisture content, specific gravity and soil grading. Therefore, most of the samples except EAR-2 are evaluated as suitable materials for embankment.

However, the soil sampled at the existing river bank is a surface layer of Acs which is distributed from midstream to the hilly area. The surface layer of the river mouth, at both Anilao and Malbasag river, is sandy gravel. This layer is estimated not suitable for materials because of very high permeability. Considering the soil distribution in the area, it is apprehensible that the amount of the excavated soil from existing river bank represented by the sample of EMR-2 is not enough for all improvement works.

Therefore, borrow area other than the existing river bank is recommended as shown as Fig. 5.3. Soil properties of these areas represented by EAR-3, EAR-1, EMR-2 and EMR-1 are judged as suitable for materials. The proposed borrow areas were also examined as to distance from the two (2) related rivers and land use condition of the area.

5.2 Soil Investigation for Soft Ground

Soil mechanics investigation for soft ground has been done as described below.

(1) Structure and Property of Soft Ground

Due to apprehension that the alluvial plain of Iloilo City is soft ground, detailed soil investigations were executed to determine its hardness and state of compactness, and to clarify soil layer structures. Two (2) particular areas, the junction with Mandurriao River and the river mouth of Jaro River, were examined by boring and laboratory tests (refer to location map in Fig. 1.1).

The subsurface structure of the areas clarified by the lithology and N-value of boring test is described in the following subsection.

(a) Jaro River Mouth (refer to Fig. 5.4)

The general structure of the area is alternation of silty clay and sand. Relatively high N-value is observed at several depths in borehole SJR-2. However, distinct bearing stratum could not be identified at whole sequence.

In generally, low N-value (1-7) of silty clay layer of Asc1 and Asc2 are estimated to have low bearing capacity. Moreover, low N-value of gravely sand layer of Ags is estimated as loose sand.

(b) Mandurriao Junction (refer to Fig. 5.5)

Two (2) clay layers, Ac1 and Ac, which have a low N-value (0-15), are confirmed as soft layer. The third layer, As2 (sand), can be the bearing stratum of the area. The average N-value of As2 layer is 15. Depth to the bearing stratum is 3 m in general.

(2) Results of Laboratory Test

Undisturbed block sampling were conducted on the uppermost layer adjacent to each borehole location for soft ground. Samples were collected between 1 to 2 meter depth from the ground level.

The results of laboratory test are given in Table 5.4, and summarized as follows.

Particulars	SJR-2	SIR-1	SIR-2
Activity	0.28	0.28	0.34
Clay Content (%)	35	32	16
Silt Content (%)	63	54	22
Specific Gravity	2.66	2.70	2.65
Moisture Content (%)	60	105	83
Void Ratio	1.79	2.88	2.24
Consolidation Yield Stress (Pc)	0.72	0.10	0.12
Compression Index (Cc)	0.51	1.06	0.68

As can be observed from the above results, compression index shows a relatively high range of 0.15 to 1.06, with equally high average void ratios of 2.24 to 2.88. Consolidation yield stress shows a range of 0.10 to 0.12 kgf/cm^2. These ranges show that the samples are almost the same as the existing overburden pressure. However, the clay at SJR-2 taken from the 2.5 m depth which shows a relatively high consolidation yield stress of 0,72 kgf/cm^2 and relatively low void ratio of 1.79 corresponds to a natural moisture content of 60% only. All of these collectively suggests that the clay is probably desiccated and may not be representative of the soft clay layer. Based on the results of grain size distribution analysis, much sand content is observed at samples SJR-2 and SIR-2. Soil classification for the samples made by the grain size distribution and consistency is shown in Fig. 5.6.

(3) Distribution of Soft Ground

As mentioned in the analysis of boring test in Subsection 4.1, the alluvial plain of Iloilo City is characterized as relatively low bearing capacity of soft clay and unconsolidated loose sand.

Fig. 5.7 shows the distribution of the soft layer which has a low bearing capacity of approximately less than 3 of N-value on average.

Based on the analyzed distribution of soft layers, distribution of soft ground is estimated as shown in Fig. 5.8. The area with several soft layers from the surface layer is estimated as soft ground area. This is generally characterized as low land with less than 3 m elevation, and used mainly as fishpond. Low bearing capacity with large consolidation settlement of the clay layer and liquefaction susceptibility of the loose sand is expected in this area.

TABLES

Table 1.1 Quantity of Geological and Soil Mechanical

City	River	Boring Test						
		Borehole (BH)			Standard Penetration Test		Number of Core Sample	Uniaxial Compression Test
		BH Number	Depth/BH	Total Depth	Interval	Times		
Iloilo	Jaro Flood Way	4	10 m	40 m	1 m	40	-	-
	Jaro River	8	10 m	80 m	1 m	80	-	-
	Iloilo River	5	10 m	50 m	1 m	50	-	-
	Pandan Creek	3	10 m	30 m	1 m	30	-	-
	Sub Total	20	-	200 m	-	200	0	0
Ormoc	Anilao River	5	10 m	50 m	1 m	50	-	-
	Malbasag River	4	10 m	40 m	1 m	40	-	-
	Sabo Dam Anilao-1	2	10 m	20 m	-	-	2 (1/BH)	2 test (1/sample)
	Sabo Dam Anilao-2	2	10 m	20 m	-	-	2 (1/BH)	2 test (1/sample)
	Sabo Dam Malbasag	2	10 m	20 m	-	-	1 (1/BH)	1 test (1/sample)
	Sub Total	15	-	150 m	-	90	5	1
	Grand Total	35	-	350 m	-	290	5	1

City	River	Soil Test for Embankment Materials			
		Sampling Location	Number of Samples	Total Sample Amount	Laboratory Test Item
Iloilo	Jaro Flood Way	2 sites	3	6	(1),(2),(3)&(4)
	Jaro River	4 sites	3	12	(1),(2),(3)&(4)
	La Paz Floodway	1 site	3	3	(1),(2),(3)&(4)
	Pandan Creek	2 sites	3	6	(1),(2),(3)&(4)
	Iloilo River	1 site	3	3	(1),(2),(3)&(4)
	Sub Total	10 sites	-	30	-
Ormoc	Anilao River	3 sites	3	9	(1),(2),(3)&(4)
	Malbasag River	2 sites	3	6	(1),(2),(3)&(4)
	Sub Total	5 sites	-	15	-
	Grand Total	15 sites	-	45	45 tests

City	River	Soil Test for Soft Ground							
		Sampling Location	Number of Samples	Total Sample Amount	Laboratory Test Item	Borehole (BH)		Standard Penetration Test	
						BH Number	Depth/BH	Interval	Times
Iloilo	Jaro River	2 sites	3	6	(1),(2),(3),(4)&(5)	2	10 m	1 m	20
	Iloilo River	2 sites	3	6	(1),(2),(3),(4)&(5)	2	10 m	1 m	20
	Total	4 sites	6	12	12 tests	4	-	-	40

Remarks : (1), Grain size analysis (2), Specific gravity (3), Moisture content (4), Consistency (5), Consolidation

Table 2.1 Stratigraphy of Iloilo City Area

Geological Period	Age: Epoch	Age: Stage	Surface Deposit	Sedimentary Rock	Volcanic Rock
Quaternary	Holocene		Qal Alluvium		
Quaternary	Pleistcene	Latte Early		Cabtuan Formation	
Tertiary	Pliocene	Late		Apdo Formation	
		Early		Panlupan Conglomerate	
	Miocene	Late		Mayos Formation	
				Lagdo Formation	
		Middle Early		Sewarangon Formation	Papnan Basalt
	Oligocene	Late Early			

Table 2.2 Stratigraphy of Cebu City Area

Geological Period	Age: Epoch	Age: Stage	Surface Deposit	Sedimentary Rock	Volcanic Rock
Quaternary	Holocene		Qal Alluvium		
Quaternary	Pleistcene	Late Early		Carcar Formation	
Tertiary	Pliocene	Late Early		Barili Formation	
	Miocene	Late		Maingit Formation	
		Middle			Bulacao Andesite
		Early		Maludog Formation	
	Ologocene	Late Early		Cebu Formation	
Cretaceous				Mananga Formation	

Table 2.3 Stratigraphy of Ormoc City Area

Geological Age Period	Epoch	Stage	Surface Deposit	Sedimentary Rock	Volcanic Rock
Quaternary	Holocene		Qal Alluvium		
	Pleistcene	Late			Qv Volcanic
		Early		Dolores Formation	
Tertiary	Pliocene	Late			
		Early		Pangasugan Formation	
	Miocene	Late			
		Middle			Central Highland Volcanic
		Early			
	Oligocene	Late			
		Early			

Table 2.4 Stratigraphy of Tacloban City Area

Geological Age Period	Epoch	Stage	Surface Deposit	Sedimentary Rock	Volcanic Rock
Quaternary	Holocene		Qal Alluvium		
	Pleistcene	Late			
		Early			
Tertiary	Pliocene	Late			
		Early		Bagahuip Formation	
	Miocene	Late			
		Middle		Sanricardo Formation	
		Early			
	Oligocene	Late			
		Early			
Cretaceous					Tacloban Volcanics

Table 3.1 Soil Strata of Cebu City

Symbol	Soil Description	N - Value		Range of Thickness	No. of Sample
		Range	Average		
Natural Soil					
Ac 1	Upper Clay	4 - 15	10.0	2 - 3m	6
Asc 1	Upper Sandy Clay	4 - 60	29.3	2 - 11m	15
As 1	Upper Sand	14 - 30	23.7	1 - 4m	3
Ac 2	Middle Clay	6 - 18	12.9	1 - 10m	8
Ag 1	Upper Gravel	11 - 31	21.0	1 - 4m	2
Asc 2	Middle Sandy Clay	3 - 62	27.5	3 - 9m	29
Ag 2	Lower Gravel	13 - 95	43.5	1 - 5m	13
Asc 3	Lower Sandy Clay	5 - 105	32.9	7 - 10m	64
Ac 3	Lower Clay	80 - 87	83.5	1 - 2m	2
Caf	Carcar Formation (Limestone)	2 - 99	45.1	More than 10m	41
Reclaimed Soil					
Rs 1	Upper Sand	6 - 23	14.5	3 - 5m	4
Rs 2	Middle Sand	15 - 34	22.1	2 - 5m	5
Rs 3	Lower Sand	5 - 30	15.8	5 - 7m	13
Rg 1	Upper Gravel	1 - 60	13.8	2 - 12m	29
Rsc	Upper Sandy Clay	0 - 3	1.6	2 - 10m	21
Rg 2	Lower Gravel	0 - 38	9.5	2 - 6m	23
Rc 1	Upper Clay	3 - 4	3.2	4 - 5m	5

Table 3.2 Soil Property of Each Layer, Cebu City

Symbol	Specific Gravity			Water Content (%)			Average Grain Size (%)			
	Average	Range	No.	Average	Range	No.	Clay Silt	Sand	Gravel	No.
Natural Soil										
Ac 1	2.60	-	1	24.0	10.8 - 31.0	5	67	30	3	5
Asc 1	2.60	2.51 - 2.64	5	22.8	12.0 - 36.5	17	31	35	34	17
As 1	2.65	2.63 - 2.67	2	19.4	11.2 - 29.6	3	10	89	1	2
Ac 2	-	-	0	25.9	20.0 - 35.0	8	66	29	5	8
Ag 1	-	-	0	19.5	19.0 - 20.0	2	13	31	56	3
Asc 2	2.62	2.55 - 2.69	5	28.5	10.0 - 45.1	30	56	31	13	30
Ag 2	2.58	2.46 - 2.72	3	23.3	15.0 - 32.0	12	31	37	32	12
Asc 3	2.65	2.59 - 2.74	12	25.3	10.4 - 37.2	43	53	30	17	38
Ac 3	-	-	0	37.8	29.3 - 64.9	6	66	28	6	11
Caf	2.65	2.53 - 2.73	21	21.6	7.3 - 39.2	43	33	30	37	40
Reclaimed Soil										
Rs 1	2.70	-	1	14.9	3.0 - 43.7	5	9	41	50	4
Rs 2	2.70	2.68 - 2.72	2	15.4	14.3 - 17.0	4	12	71	17	6
Rs 3	2.70	2.67 - 2.72	5	24.7	11.6 - 35.8	11	14	73	13	10
Rg 1	2.69	2.60 - 2.77	10	22.5	7.1 - 34.2	19	17	53	30	20
Rsc	2.64	2.57 - 2.70	13	46.1	30.1 - 76.9	19	70	26	4	19
Rg 2	2.65	2.58 - 2.70	6	30.0	13.6 - 45.8	16	34	49	17	16
Rc 1	2.71	2.69 - 2.72	2	30.5	23.9 - 35.4	5	37	55	8	6

Table 3.3 Soil Strata of Tacloban City

Symbol	Soil Description	N - Value		Range of Thickness	No. of Sample
		Range	Average		
Ass	Silty Sand	10 - 20	14.7	1 - 5m	3
As	Sand	11 - 22	16.5	2 - 3m	2
Acs	Clay Silt	10 - 15	11.7	4 - 20m	6
Ac	Clay	10 - 22	15.4	10 - 20m	15
Asc	Sandy Clay	20 - >50	43.6	More than 5m	7

Table 3.4 Soil Property of Each Layer, Tacloban City

Symbol	Specific Gravity			Water Content (%)		
	Average	Range	No.	Average	Range	No.
Ass	-	-	-	-	-	-
As	2.64	-	-	31	-	-
Acs	-	-	-	-	-	-
Ac	-	2.60 - 2.63	-	-	36 - 114	-
Asc	-	2.62 - 2.65	-	-	13 - 29	-

Table 4.1 Soil Strata of Jaro Sedimentary Basin

River	Symbol	Layer	Description		N-Value			Thickness (m)	
			Lithology	Color	min.	max.	average	min.	max.
JARO	Asc1	upper silty Clay	Silty clay to clayey silt with trace of fine sand.	brown	3	19	7.50	0	3.4
	Acsa	clayey Sand	Clayey to silty fine sand with trace of root fibers.	brown	4	13	7.22	0	3.8
	Ac	Clay	Medium stiff and plastic clay.	brown	7	14	10.75	0	4.4
	Ags	gravely Sand	Gravely fine grained sand	gray	3	20	6.20	0	4.2
	Asc2	middle silty Clay	Silty clay with a trace of fine sand	gray/brown	2	13	4.54	0	3.8
	As1	upper sand	Medium to fine grained sand, and a trace of gravel at JR-6,7	brown	10	22	13.57	0	3.4
	As2	lower Sand	Medium to coarse grained sand.	gray	2	22	12.00	0	3.3
	Asac	Sandy Clay	Sandy clay to clayey fine sand with a trace of organic Materials (shell, root fiber)	gray	2	13	5.50	0	3.3
	Acs	clayey Silt	Clayey silt with a trace of fine sand.	gray	2	8	3.70	0	5.2
	Asc3	lower silty clay	Very loose and soft silty clay with a trace of fine sand.	gray	1	2	1.16	0	4.2
	Q2	Cabatuan Formation (sandstone)	Pleistocene basement rock of alluvium deposit. Fine to coarse grained sand with a trace of gravel and shell fragment at locally.	gray	11	44	25.53	>1	>4.2
JARO FLOODWAY	BM	Backfilled Materials	Mixture of gravel, sand, silt, clay and limestone fragment.	brown	-	-	-	0	0.6
	Acsa	clayey Sand	Clayey sand to sandy clay, slightly plastic.	brown	8	8	8.00	0	1.8
	Ac1	upper Clay	Clay with a trace of sand.	brown	5	8	6.50	0	2.1
	Ac2	middle Clay	Soft clay, slightly plastic and with a trace of fine sand.	gray	0	8	4.88	0	4.2
	Acs	clayey Silt	Clayey silt, slightly plastic.	gray	3	6	4.33	0	1.2
	Ac3	lower Clay	Soft clay, medium to high plastic.	gray	0	4	3.44	0	7.2
	Ass	silty Sand	Loose silty sand with a trace of clay and root of fibers.	gray	8	8	8.00	0	1
	Q2	Cabatuan Formation (sandstone)	Pleistocene basement rock of alluvium deposit. Fine to coarse grained sand with a trace of gravel and shell fragment at locally.	gray	11	44	25.53	>1	>4.2

Table 4.2 Soil Strata of Iloilo Sedimentary Basin

River	Symbol	Layer	Description		N-Value			Thickness (m)	
			Lithology	Color	min.	max.	average	min.	max.
Iloilo	BM	Backfilled Materials	Mixture of gravel, sand, silt or silty sand and a trace of limestone fragment is contained at locally.	dark to light brown	3	4	3.20	0	2.4
	As1	upper Sand	Fine sand with trace of gravel.	dark gray to black	3	37	20.00	0	1.1
	Ac	Clay	Mainly consists of clay, locally sandy to silty clay with organic materials (shell). Very loose and soft layer	dark gray	0	9	2.88	0	2.1
	Asg1	upper sandy Gravel	Medium densely sandy gravel	gray	17	25	21.00	0	2.1
	As2	lower Sand	Fine sand with organic materials (shell) and a trace of silt gravel is contained at locally.	gray	3	31	14.69	0	7.5
	Asg2	lower sandy Gravel	Sandy gravel with shell fragment.	gray	3	6	4.50	0	1.7
	Acs	clayey Silt	Clayey silt with a trace of fine sand, and contained shell fragment at locally.	gray	0	11	4.57	>0.4	>7.5
Manduriao	Ac1	upper Clay	Mainly consists of clay, locally silty clay and with trace of fine sand. Medium to highly plastic.	brown	3	15	6.50	0.5	4.6
	Asc	clayey Silt	Soft clayey silt with trace of fine sand and organic materials (shell, wood).	gray	3	7	4.30	0	3.2
	As	Sand	Fine sand to silty fine sand with thin rider of clay. Trace of shell included.	gray	3	10	5.25	0	4.4
	Ac2	lower Clay	Clay to silty clay with trace of fine sand and organic materials. Soft and slightly plastic.	gray	2	7	3.38	0	2.8
	Ass	silty Sand	Clayey and silty fine sand with trace of shell.	gray	6	9	7.50	0	2.4

Table 4.3 Soil Property of Anilao/Malbasag River

Symbol	Layer	Description		N-Value			Thickness (m)	
		Lithology	Color	min.	max.	average	min.	max.
Ass	Silt, Sand	Mixture of fine sand and silt	brown	10	10	10.00	0	2
As	upper Sand	Coarse sand with some coarse gravel	light brown	18	18	18.00	0	6.4
Acs	clayey Silt	Clayey silt to silty clay with a trace of fine grained sand. Gravel is contained at locally	brown	3	>50	16.90	0	8.2
Aco 1	upper Cobble	Cobble and gravel, distributed at only Malbasag River	gray	>50	>50	>50	0	2.4
Acsa 1	upper clayey Sand	Coarse grained clayey sand with a trace of gravel	gray	5	5	5.00	0	2.4
Ags 1	upper gravely Sand	Medium to coarse gravely sand, and locally alternation with sand and gravel	brown to gray	3	>50	>50	0	4.2
Asi	Silt	Silt with a trace of fine grained sand	brown	25	25	25.00	0	1.1
Aco 2	lower Cobble	Cobble layer and gravel and boulder at locally	gray	>50	>50	>50	0	>8
Acsa 2	lower clayey Sand	Clayey sand with a trace of gravel	brown	41	48	44.00	0	4.6
Ags 2	lower gravely Sand	Coarse grained gravely Sand	gray to brown	9	72	40.70	1.4	>6.3
As 2	lower Sand	Fine sand with shell fragments. The layer is confirmed at only Anilao River	gray	10	30	18.40	>2.2	>6.2

Table 4.4 **Summary of Result of Uniaxial Compression Test**

River	Sampling Borehole No. (depth, m)	Compression Strength Qu (kgf/cm2)	Failure Strain Ef (%)	Moisture Content W (%)	Wet Density Pt (g/cm3)	Dry Density Pd (g/cm3)
Anilao River	ARD-1 (9.5)	280.00	1.34	0.81	2.49	2.47
	ARD-2 (9.1)	324.70	1.00	0.79	2.41	2.39
	ARD-3 (1.5)	282.00	1.15	1.00	2.45	2.42
	ARD-4 (3.5)	286.00	1.20	2.00	2.38	2.33
Malbasag River	MRD-1	NS	NS	NS	NS	NS
	MRD-2 (4.5)	320.00	1.40	3.00	2.36	2.29

Remarks: NS, No Sample is available

Table 5.1 Soil Grading for Embankment Materials

Name of Soil		Soil Classification (classificated by plasticity chart)	Evaluation	Attention to Construction	Counter Measure
Coarse soil	Gravel	(GW), (GP)	Suitable	Too high permeability	Cut-off of water Sodding
	Gravely soil	(G-M),(G-C),(G-O), (G-V), (GM), (GC), (GO), (GV)	Suitable		
	Sand	(SW), (SP)	Suitable	Erosion of slopes by high permeability	Cut-off of water Sodding
	Sandy soil	(S-M), (S-C), (S-O), (S-V), (SM), (SC), (SO), (SV)	Suitable		
Fine soil	Silt	(ML), (MH)	Suitable	A case contained water, difficult compaction by mechanical earth work	Drying, Soil stabilization
	Clay	(CL), (CH)			
	Volcanic clay	(OV), (VH1), (VH2)			
	Organic soil	(OL), (OH)	Necessary counter measure	For highly water content, difficult compaction and plastic by mechanical earth	Lowering of water content Soil stabilitation Mechanical stabilization
Highly organic soil		(Pt), (Mk)	Unsuitable	Highly water content Impossible compaction Highly compressibility Instability by wet and drying	

Table 5.2 Summary of Laboratory Test Result for Embankment Materials, Iloilo City

River	Location (depth)	Sample No.	Grain Size Distribution				Specific Gravity	Moisture Content (%)	Consistency			
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)			Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Activity
Jaro Floodway	EJF-1 (0.40m)	A	0	3	52	45	2.57	48	63	19	44	0.45
		B	0	4	38	58	2.60	44	63	18	45	0.47
		C	0	3	59	38	2.57	43	63	18	45	0.46
		Average	**0**	**3**	**50**	**47**	**2.58**	**45**	**63**	**18**	**45**	**0.46**
	EJF-2 (0.30m)	A	0	18	45	37	2.58	28	38	15	23	0.28
		B	0	21	39	40	2.65	32	45	16	29	0.37
		C	0	8	50	42	2.62	34	50	16	34	0.37
		Average	**0**	**15**	**45**	**40**	**2.62**	**31**	**44**	**16**	**29**	**0.34**
Jaro River	EJR-1 (2.00m)	A	0	49	51	0	2.65	39	NP	NP	NP	NA
		B	0	24	76	0	2.66	35	NP	NP	NP	NA
		C	0	33	67	0	2.62	41	NP	NP	NP	NA
		Average	**0**	**35**	**65**	**0**	**2.64**	**38**	**NP**	**NP**	**NP**	**NA**
	EJR-2 (2.50m)	A	0	32	55	13	2.63	29	31	20	11	0.16
		B	0	52	40	8	2.62	31	31	18	13	0.27
		C	0	15	70	15	2.62	25	27	18	9	0.11
		Average	**0**	**33**	**55**	**12**	**2.62**	**28**	**30**	**19**	**11**	**0.18**
	EJR-3 (1.80m)	A	0	30	52	18	2.60	37	31	17	14	0.20
		B	0	39	43	18	2.63	37	30	14	16	0.26
		C	0	13	69	18	2.65	41	31	16	15	0.17
		Average	**0**	**27**	**55**	**18**	**2.63**	**38**	**31**	**16**	**15**	**0.21**
	EJR-4 (0.30m)	A	0	8	20	72	2.64	31	66	21	45	0.49
		B	0	11	20	69	2.65	44	71	22	49	0.55
		C	0	6	24	70	2.58	44	74	21	53	0.56
		Average	**0**	**8**	**21**	**70**	**2.62**	**40**	**70**	**21**	**49**	**0.53**
La Paz Floodway	ELP-1 (1.20m)	A	0	25	54	21	2.66	31	36	21	15	0.20
		B	0	24	51	25	2.67	34	30	20	10	0.13
		C	0	24	51	25	2.62	33	31	20	11	0.14
		Average	**0**	**24**	**52**	**24**	**2.65**	**33**	**32**	**20**	**12**	**0.16**
Pandan Creek	EPC-1 (0.50m)	A	0	23	46	31	2.63	63	29	13	16	0.21
		B	0	25	40	35	2.70	61	30	14	16	0.21
		C	0	25	35	40	2.64	67	25	15	10	0.13
		Average	**0**	**25**	**40**	**35**	**2.66**	**64**	**28**	**14**	**14**	**0.18**
	EPC-2 (1.20m)	A	0	23	45	32	2.65	60	31	15	16	0.21
		B	0	25	38	37	2.57	68	33	15	18	0.24
		C	0	25	40	35	2.69	68	33	14	19	0.25
		Average	**0**	**24**	**41**	**35**	**2.64**	**65**	**32**	**15**	**18**	**0.23**
Iloilo River	EIR-1 (0.30m)	A	0	14	56	30	2.57	78	48	25	23	0.27
		B	0	15	53	32	2.53	85	45	25	20	0.24
		C	0	16	53	31	2.56	81	48	24	24	0.29
		Average	**0**	**15**	**54**	**31**	**2.55**	**81**	**47**	**25**	**22**	**0.27**

Remarks : NP : Not plasticized
NA : No activity

Table 5.3 Summary of Laboratory Test Result for Embankment Materials, Ormoc City

River	Location (depth)	Sample No.	Grain Size Distribution				Specific Gravity	Moisture Content (%)	Consistency			
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)			Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Activity
Western Area of Anilao River	EAR-1 (2.0m)	A	0*	34*	66*	0*	2.67	43	NP	NP	NP	NA
		B	0	32	38	30	2.64	31	35	17	18	0.26
		C	0	34	59	7	2.65	31	34	16	18	0.27
		Average	**0**	**33**	**49**	**18**	**2.65**	**35**	**35**	**17**	**18**	**0.27**
	EAR-2 (2.0m)	A	0	13	63	24	2.66	54	42	22	20	0.23
		B	0	18	39	43	2.65	39	48	21	27	0.33
		C	0	29	50	21	2.63	45	46	19	27	0.38
		Average	**0**	**20**	**51**	**29**	**2.65**	**46**	**45**	**21**	**25**	**0.31**
	EAR-3 (2.0m)	A	11	49	24	16	2.64	33	35	17	18	0.45
		B	23	42	12	23	2.65	26	32	17	15	0.43
		C	18*	52*	30*	0*	2.68	37	NP	NP	NP	NA
		Average	**17**	**46**	**18**	**19**	**2.66**	**32**	**34**	**17**	**17**	**0.44**
Malbasag River	EMR-1 (2.0m)	A	1	50	25	24	2.69	33	36	20	16	0.33
		B	1	44	29	26	2.67	36	38	21	17	0.31
		C	2	46	25	27	2.62	37	37	17	20	0.38
		Average	**1**	**47**	**26**	**26**	**2.66**	**35**	**37**	**19**	**18**	**0.34**
	EMR-2 (2.0m)	A	0	32	68	0	2.68	59	NP	NP	NP	NA
		B	0	39	61	0	2.69	70	NP	NP	NP	NA
		C	0	28	72	0	2.66	68	NP	NP	NP	NA
		Average	**0**	**33**	**67**	**0**	**2.68**	**66**	**NP**	**NP**	**NP**	**NA**

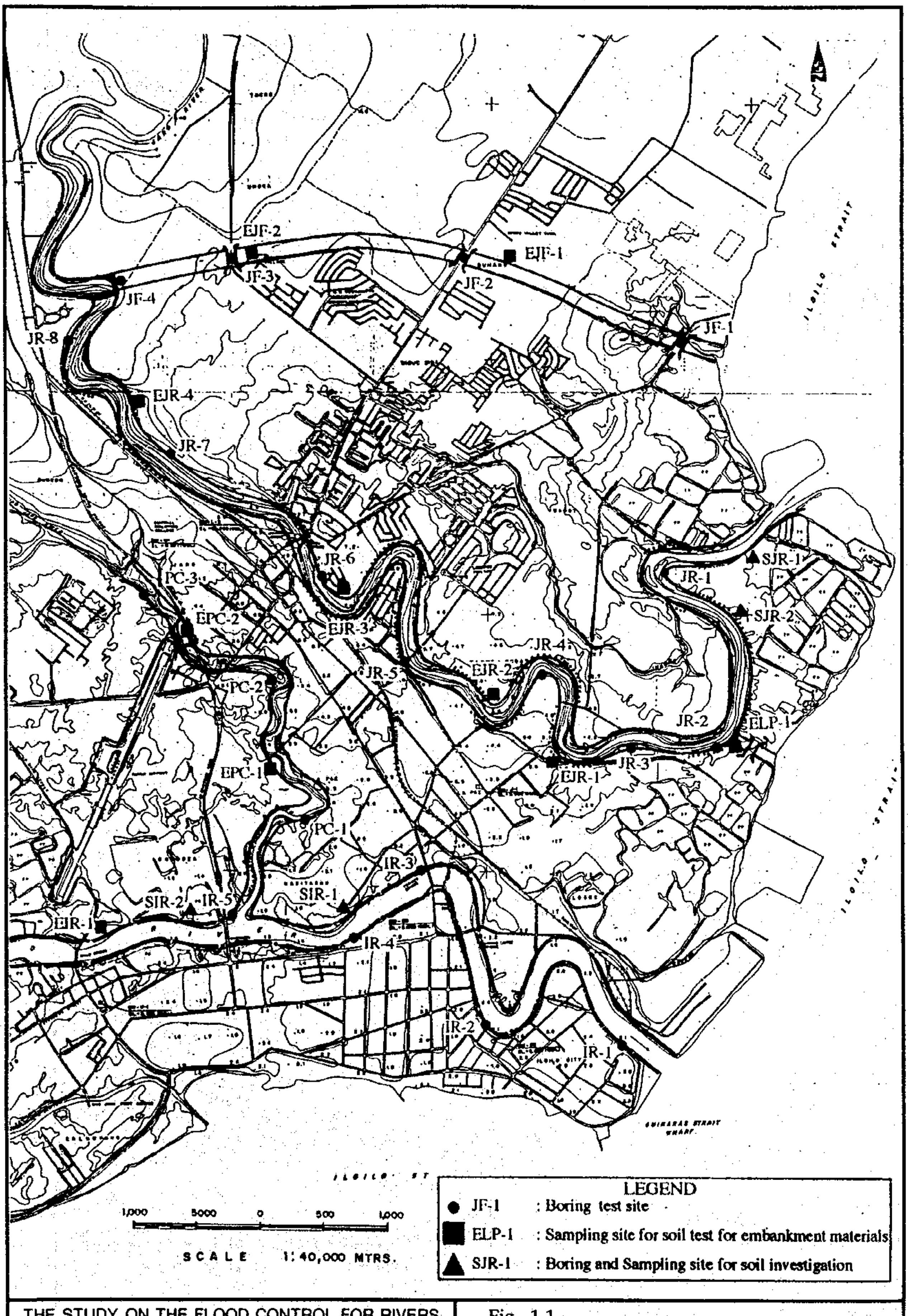
Remarks : NP : Not plasticized
NA : No activity
* : Not considered in the average

Table 5.4 Summary of Laboratory Test Result for Soft Ground, Iloilo City

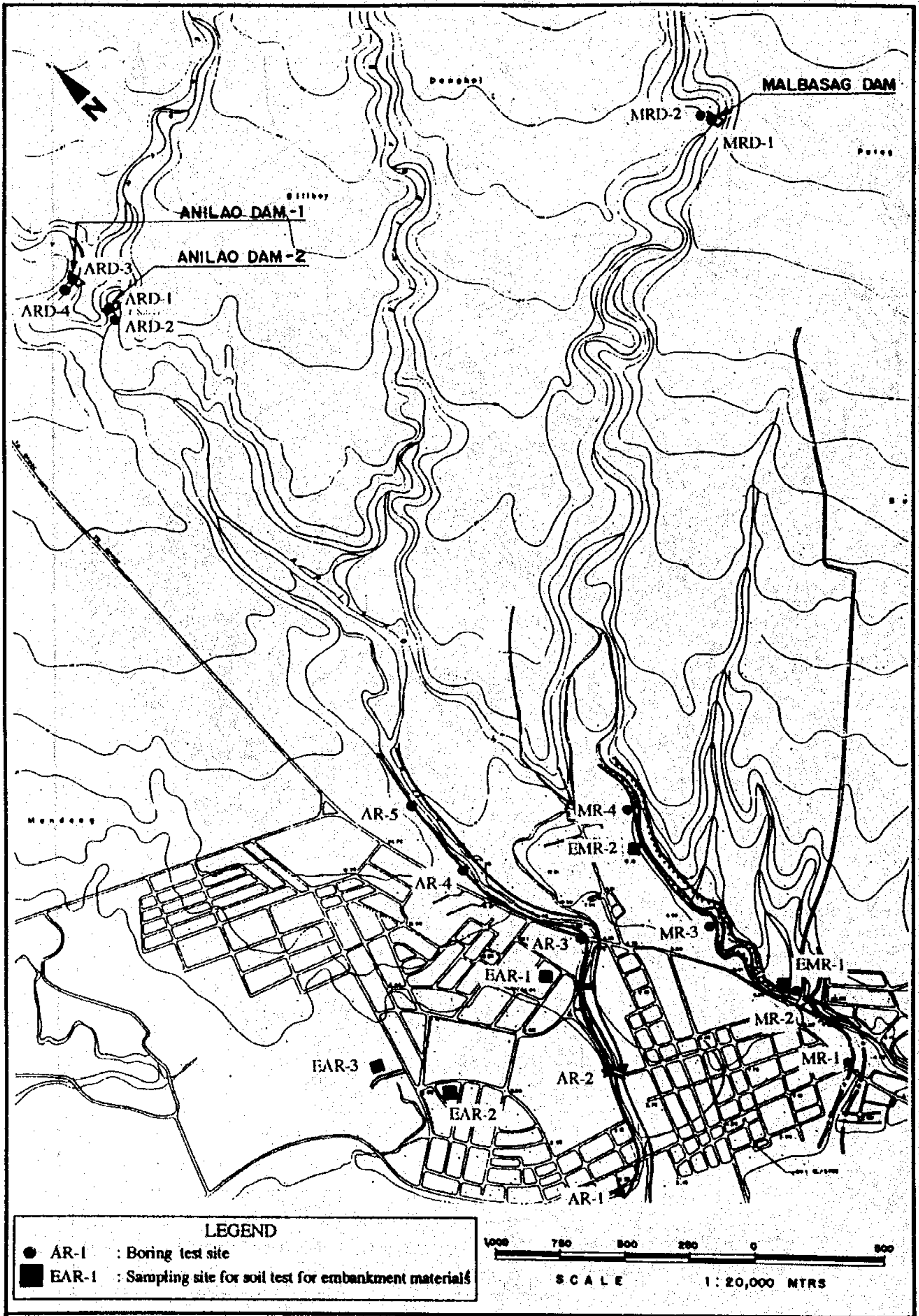
River	Location (depth)	Sample No.	Grain Size Distribution				Specific Gravity	Moisture Content (%)	Consistency				Consolidation	
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)			Liquid Limit (%	Plastic Limit (%	Plasticity Index	Activity	*Pc* (kgf/cm2	*Cc*
Jaro River	SJR-1 (1.40m)	A	0	41	22	37	2.63	36	28	17	11	0.19	-	-
		B	0	28	46	26	2.62	48	33	18	15	0.21	-	-
		C	0	35	31	34	2.63	40	32	17	15	0.23	-	-
		Average	**0**	**35**	**33**	**32**	**2.63**	**41**	**31**	**17**	**14**	**0.21**	**-**	**-**
	SJR-2 (2.50m)	A	0	2	67	31	2.64	53	49	21	28	0.29	2.35*	0.44
		B	0	2	30*	68*	2.71	63	53	21	32	0.33	0.90	0.80*
		C	0	4	58	38	2.62	64	44	21	23	0.24	0.54	0.58
		Average	**0**	**3**	**63**	**34**	**2.66**	**60**	**49**	**21**	**28**	**0.29**	**0.72**	**0.51**
Iloilo River	SIR-1 (0.30m)	A	0	18	55	27	2.66	108	42	21	21	0.26	0.10	1.24*
		B	0	14	45	41	2.71	105	45	20	25	0.29	-	1.03
		C	0	11	61	28	2.73	103	45	20	25	0.28	-	1.09
		Average	**0**	**14**	**54**	**32**	**2.70**	**105**	**44**	**20**	**24**	**0.28**	**0.10**	**1.06**
	SIR-2 (1.50m)	A	0	61	21	18	2.60	58*	26	13	13	0.33	-	0.55
		B	0	64	26	10	2.68	78	30	14	16	0.44	-	0.88
		C	0	60	18	22	2.66	88	25	15	10	0.25	0.12	0.60
		Average	**0**	**62**	**22**	**17**	**2.65**	**83**	**27**	**14**	**13**	**0.34**	**0.12**	**0.68**

Remarks : *Pc* : Consolidation yield stress *: Not considered in the average
Cc : Compression index

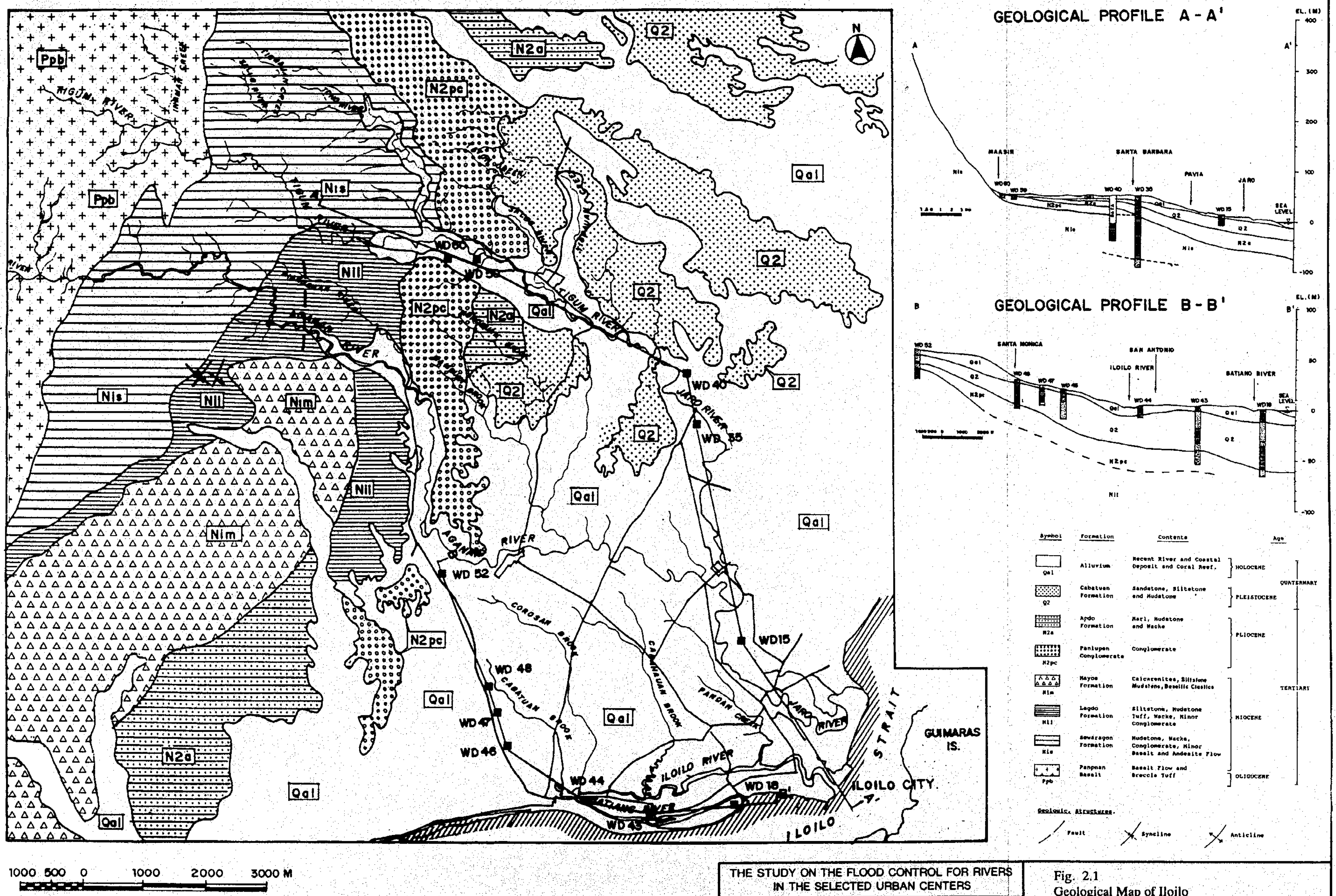
FIGURES



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 1.1 Location of Geological and Soil Mechanics Survey in Iliolo
JAPAN INTERNATIONAL COOPERATION AGENCY	



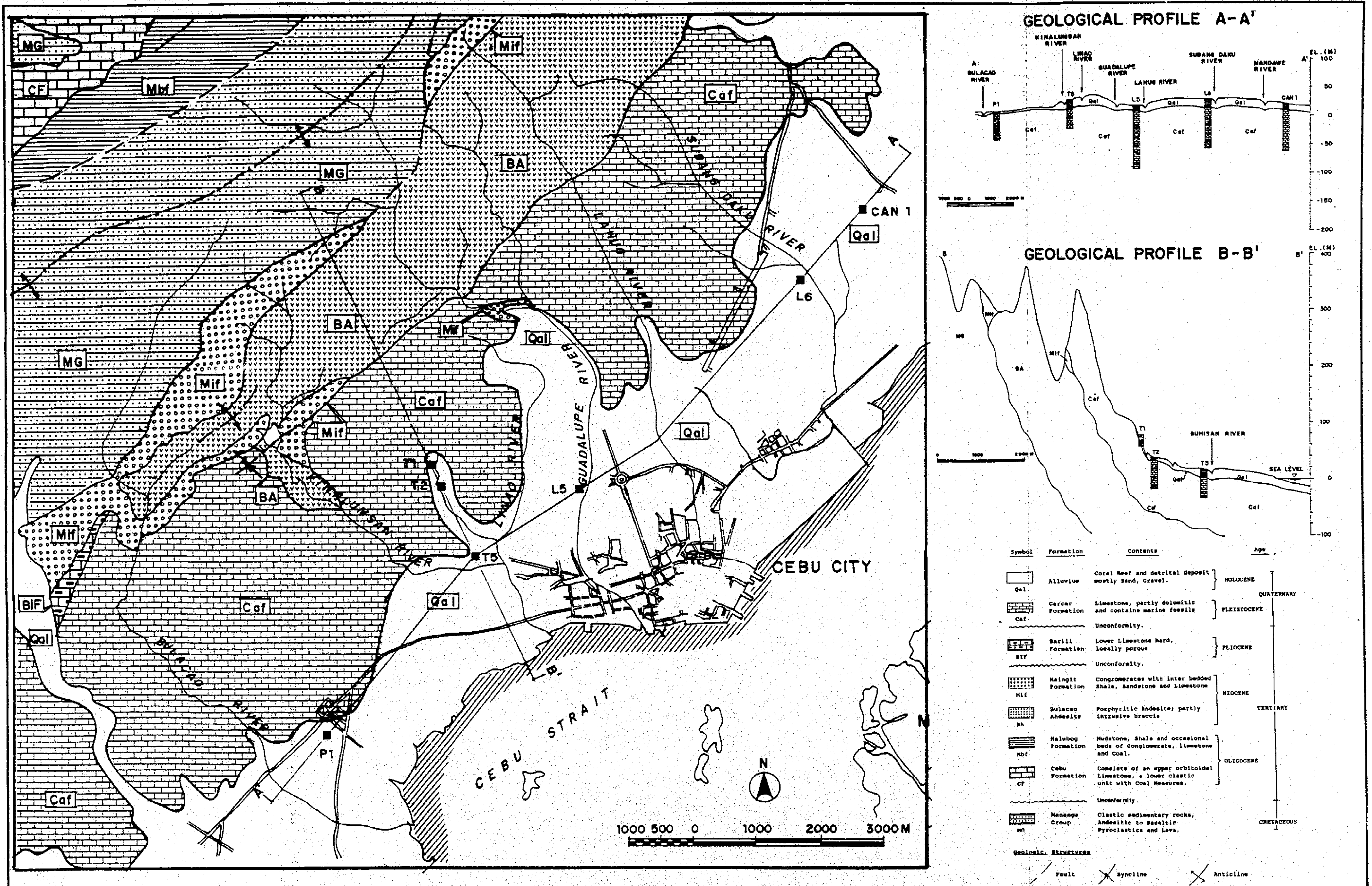
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 1.2
JAPAN INTERNATIONAL COOPERATION AGENCY	Location of Geological and Soil Mechanics Survey in Ormoc



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

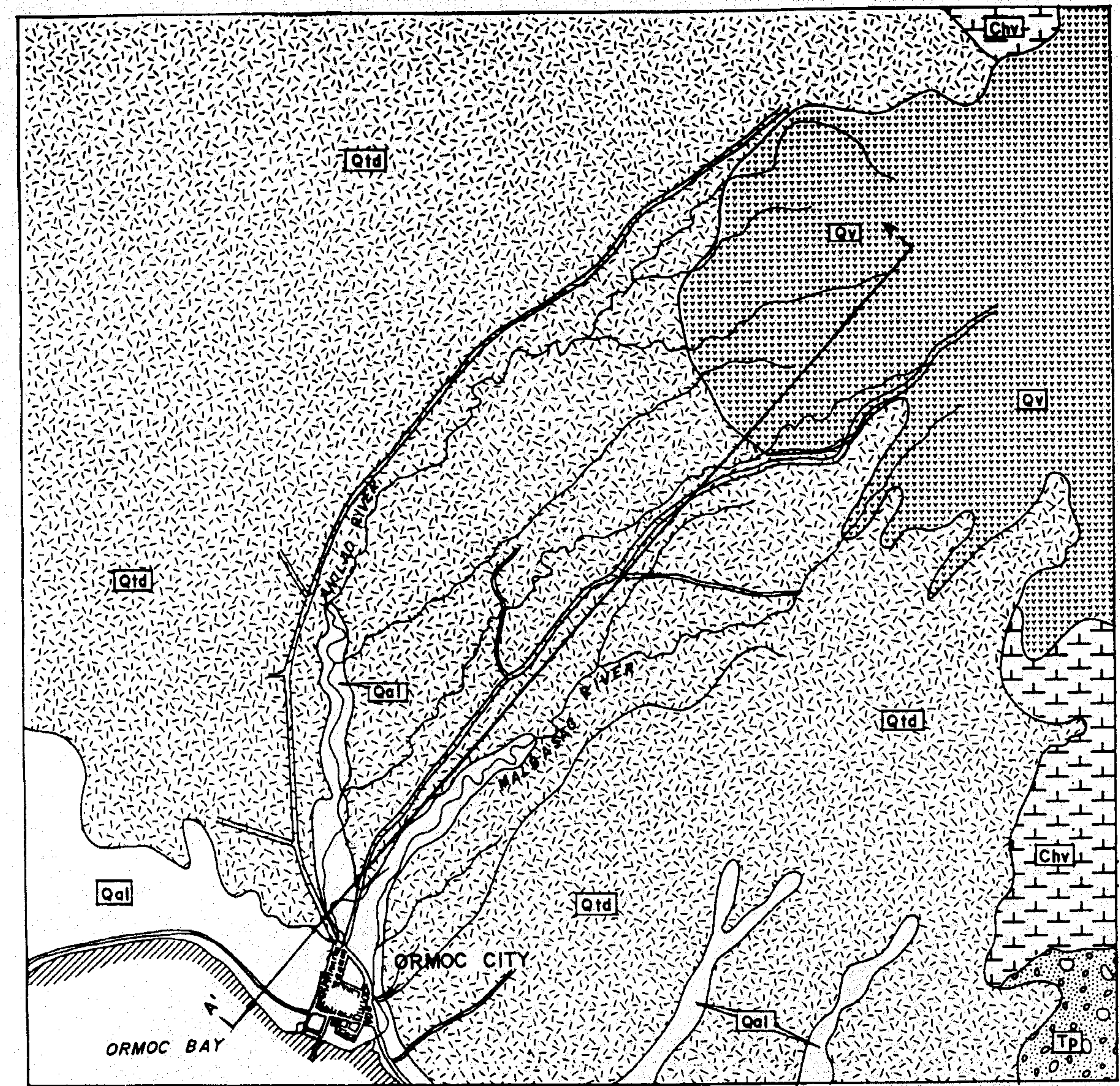
Fig. 2.1
Geological Map of Iloilo

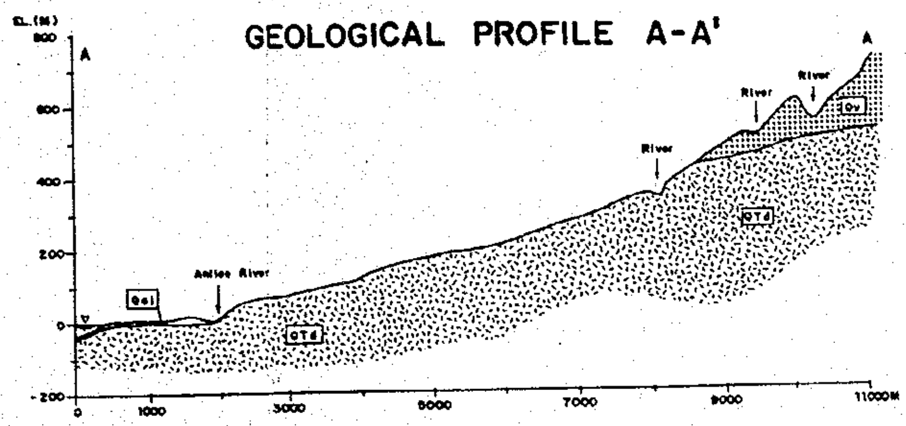


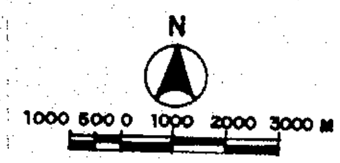
THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 2.2
Geological Map of Cebu

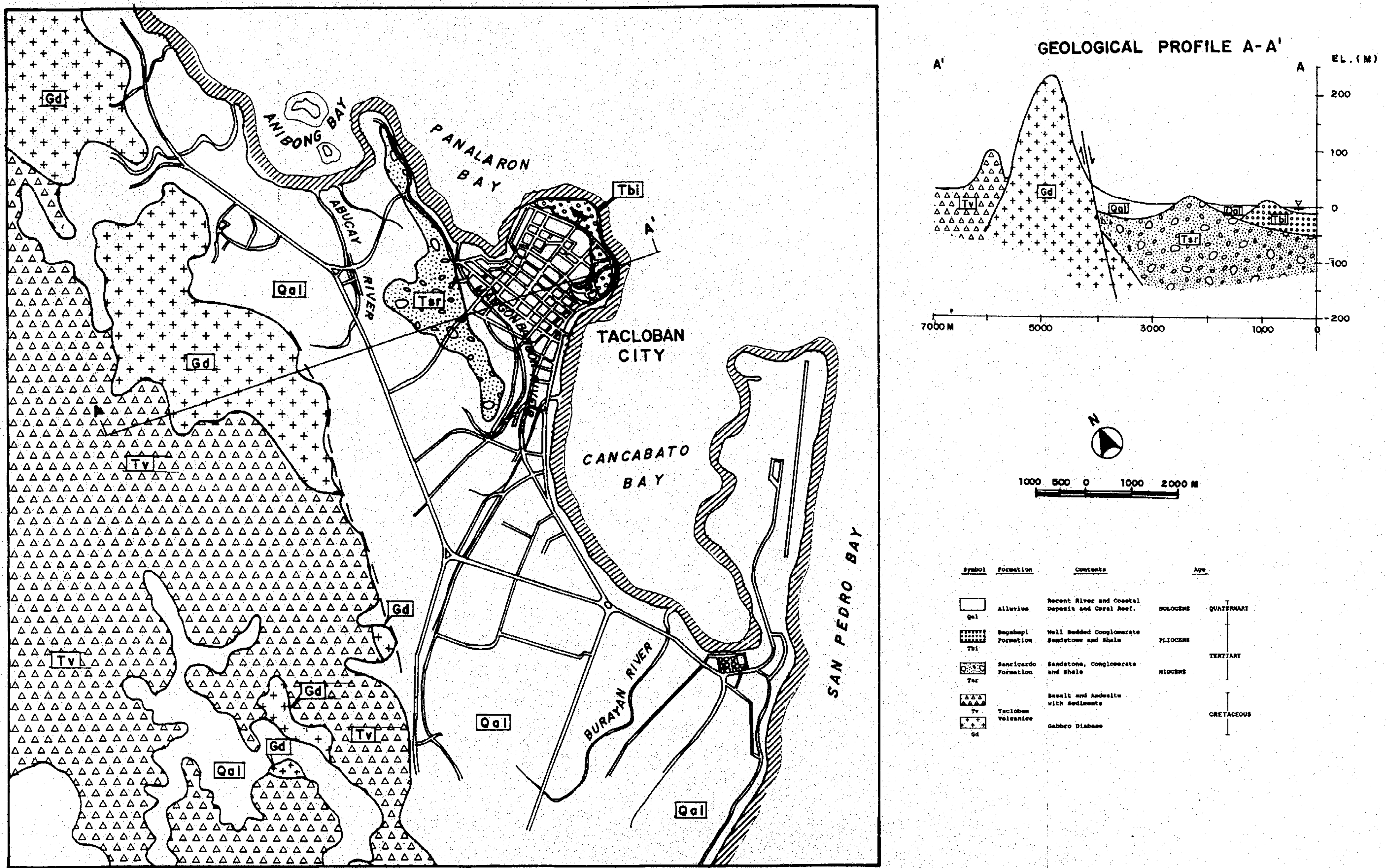




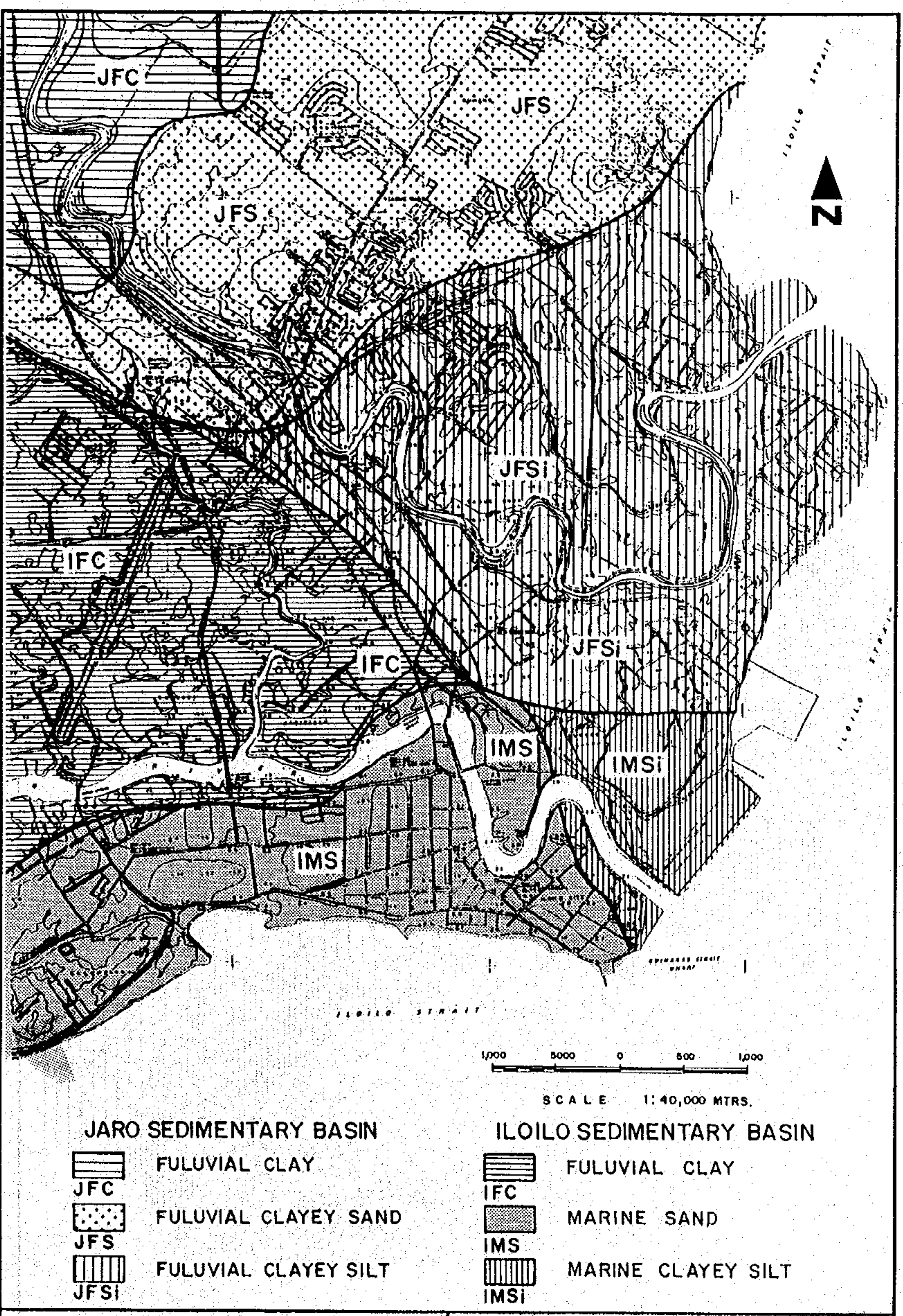


Symbol	Formation	Contents	Age	
Qal	Alluvium	Recent River and Coastal Deposits, and Coral Reef	HOLOCENE	QUATERNARY
Qv		Yong Volcanic Cone	HOLOCENE	QUATERNARY
QTd	Dolores Formation	Andesitic Pyroclastics with Alternation of Low Dipping Sediments	PLEISTOCENE	QUATERNARY
Tp	Pangasugan Formation	Massive and Compact Conglomerate and Pyroclastic Rocks.	PLIOCENE	TERTIARY
Chv	Central Highland Volcanic	Flows and some Intrusive Hornblend Pyroxene Andesite.	MIOCENE	TERTIARY

THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 2.3 Geological Map of Ormoc
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 2.4 Geological Map of Tacloban
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

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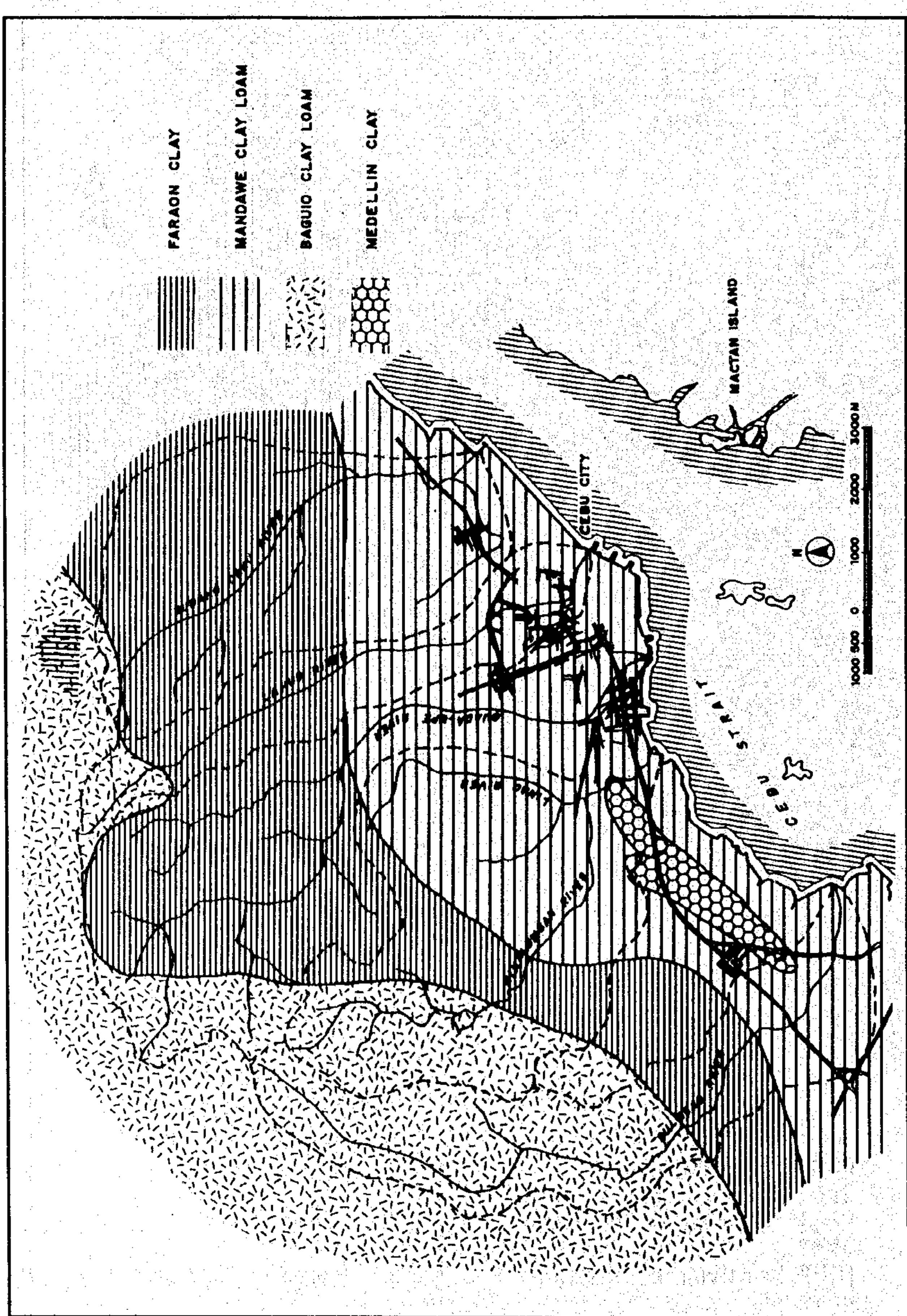
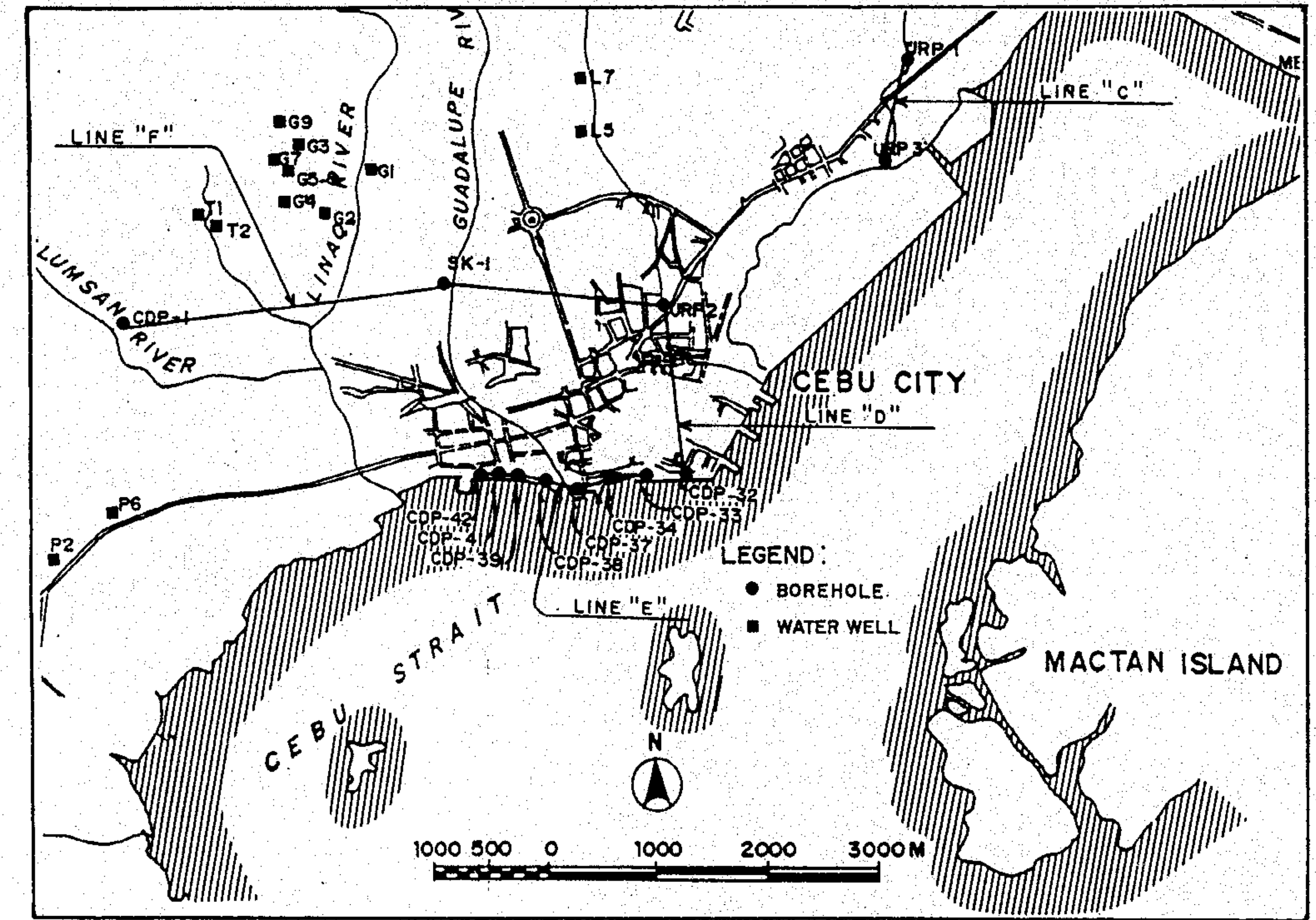
Fig. 3.1
Soil Map of Iloilo City

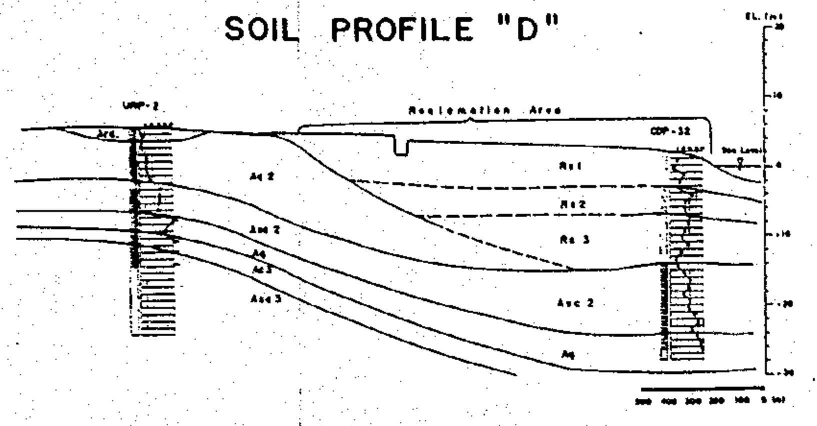


THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 3.2 Soil Map of Cebu City
JAPAN INTERNATIONAL COOPERATION AGENCY	

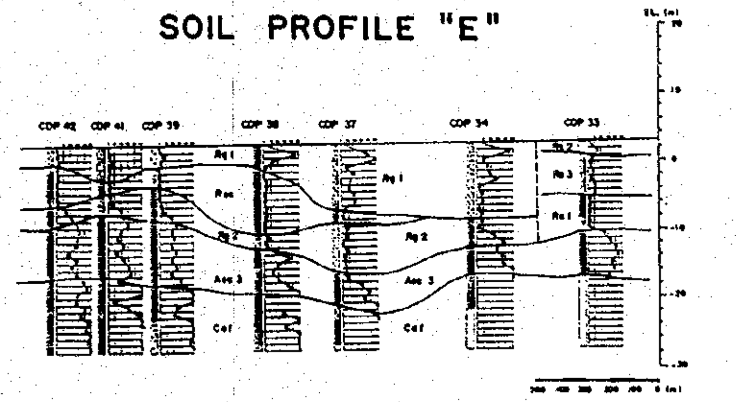
LOCATION OF EXISTING BOREHOLES



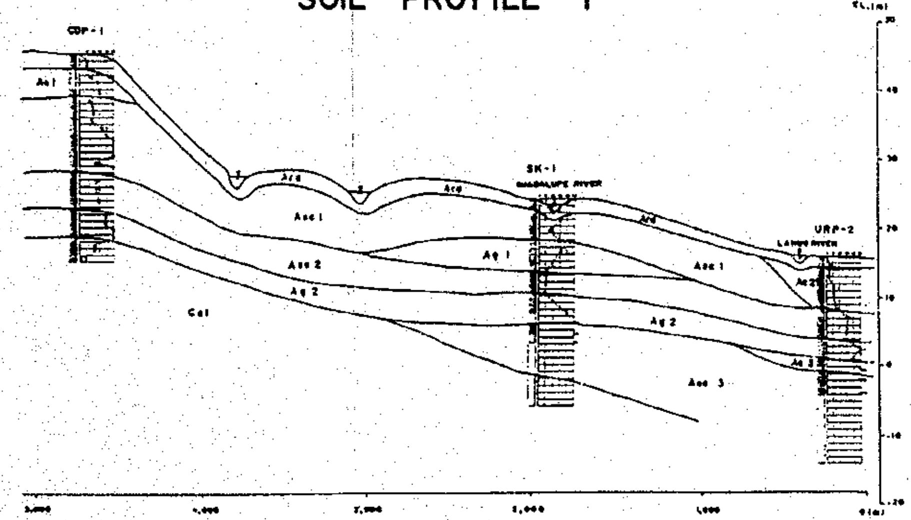
SOIL PROFILE "D"



SOIL PROFILE "E"



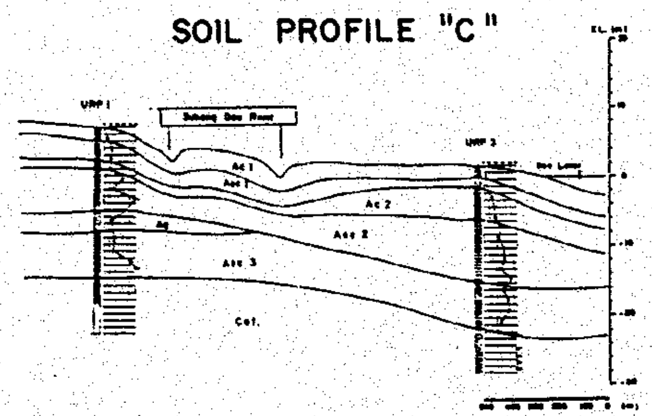
SOIL PROFILE "F"



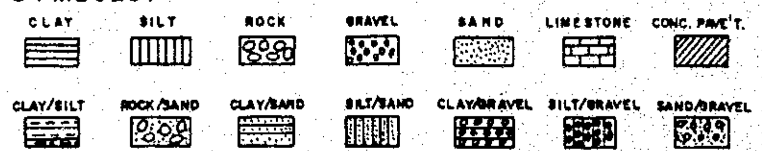
SOIL STRATA OF SEBU CITY

Symbol	Soil Description	N - Value		Range of Thickness	No. of Sample
		Range	Average		
Natural Soil					
Ac 1	Upper Clay	4 - 15	10.0	2 - 3m	6
Asc 1	Upper Sandy Clay	4 - 60	29.3	2 - 11m	15
As 1	Upper Sand	14 - 30	23.7	1 - 4m	3
Ac 2	Middle Clay	6 - 18	12.9	1 - 10m	8
Ag 1	Upper Gravel	11 - 31	21.0	1 - 4m	2
Asc 2	Middle Sandy Clay	3 - 62	27.5	3 - 9m	29
Ag 2	Lower Gravel	13 - 95	43.5	1 - 5m	13
Asc 3	Lower Sandy Clay	5 - 105	32.9	7 - 10m	64
Ac 3	Lower Clay	80 - 87	83.5	1 - 2m	2
Caf	Carcar Formation (Limestone)	2 - 99	45.1	More than 10m	41
Reclaimed Soil					
Rs 1	Upper Sand	6 - 23	14.5	3 - 5m	4
Rs 2	Middle Sand	15 - 34	22.1	2 - 5m	5
Rs 3	Lower Sand	5 - 30	15.8	3 - 7m	13
Rg 1	Upper Gravel	1 - 60	13.8	2 - 12m	29
Rsc	Upper Sandy Clay	0 - 3	1.6	2 - 10m	21
Rg 2	Lower Gravel	0 - 38	9.5	2 - 6m	23
Rc 1	Upper Clay	3 - 4	3.2	4 - 5m	5

SOIL PROFILE "C"



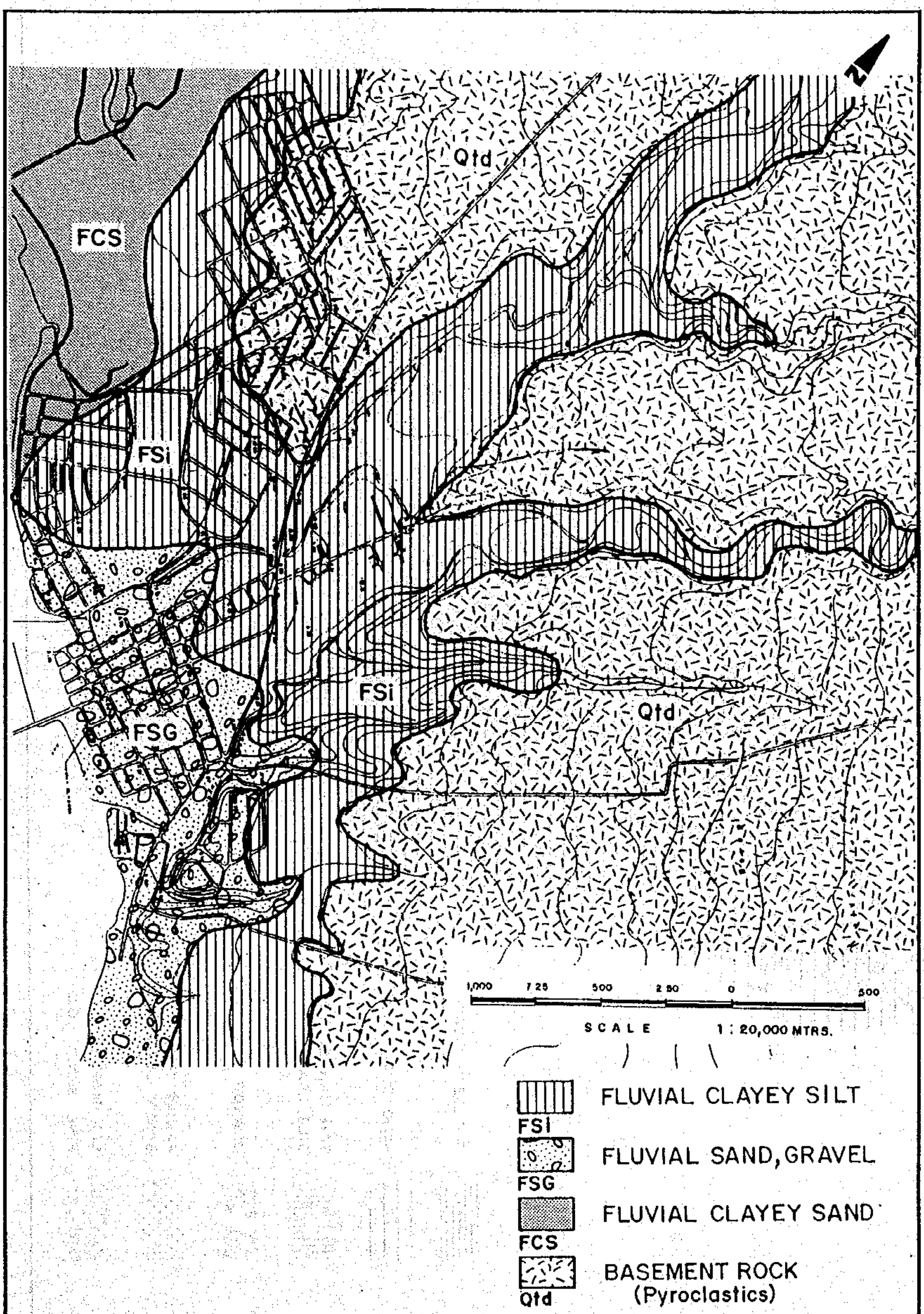
SYMBOLS:



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

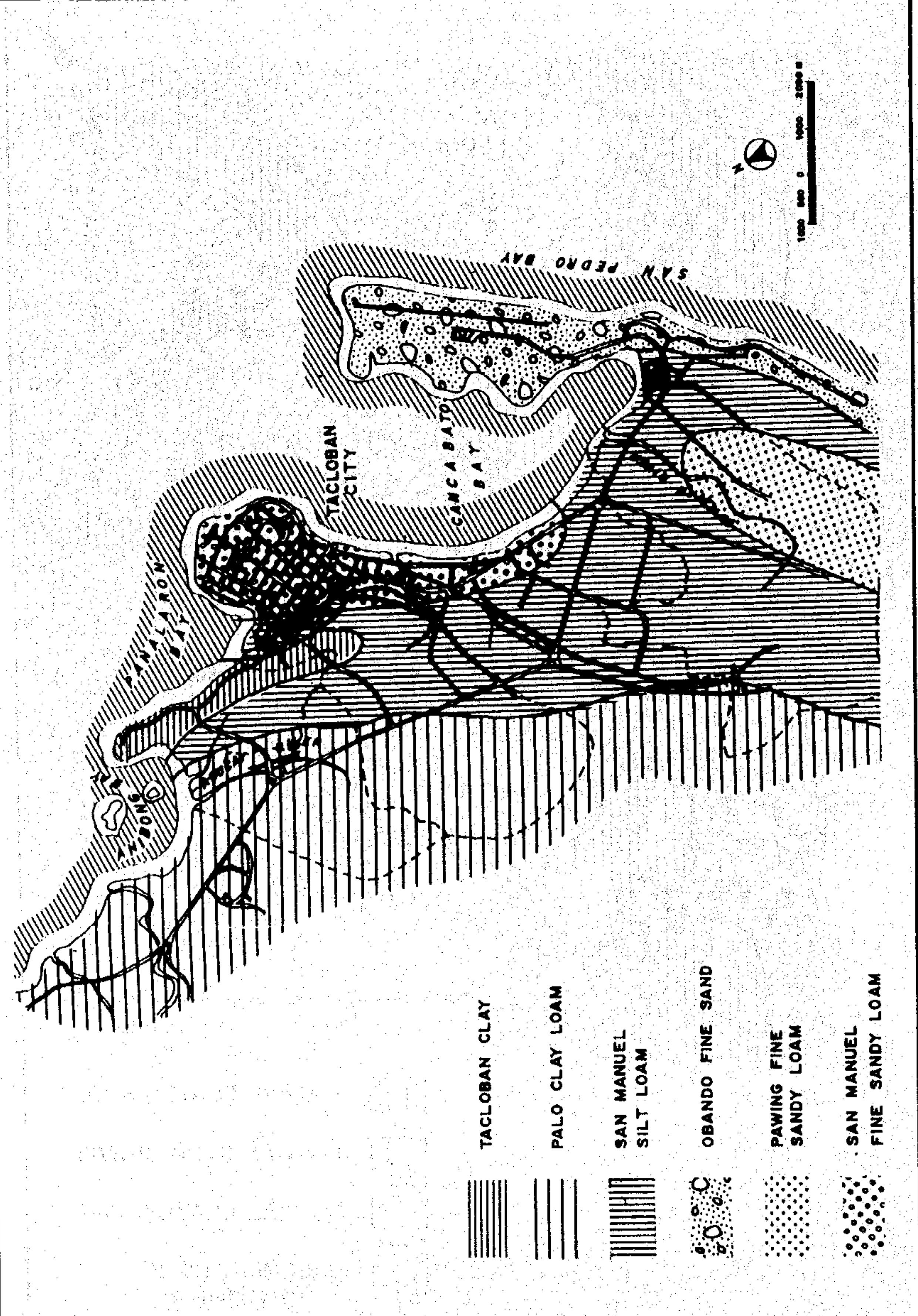
Fig. 3.3 Soil Profiles of Cebu City



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 3.4
Soil Map of Ormoc City



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 3.5 Soil Map of Tacloban
JAPAN INTERNATIONAL COOPERATION AGENCY	