9. Longitudinal and Cross Sectional Survey

9.1 General

The topographic survey was carried out for the purposes of investigating the sediment in the sandpocket, calculating the riverbed fluctuation, estimating the flood discharge and obtaining the basic data such as river discharge capacity and river gradient and also for obtaining topographic information for planning drainage works of the Galunggung crater lake.

The survey covered 15 rivers in the southeastern slope basin and the Galunggung crater lake, and it extended to a total length of 115 Km.

The topographic survey work was made by a local consultant under management of a member of JICA study team.

The survey period and contractor are as follows:

Survey period : August 1st, 1987 - October 31st, 1987
Contractor : PT. TRICON JAYA
Jl. Penghulu H.H. Mustofa 41
Bandung

9.2 Location of Survey

The topographic survey is classified largely into the following ranges.

I). fourteen (14) rivers on the southeastern slop of Mt. Galunggung
II). lower parts of S. Ciwulan from Tonjong to river mouth
III). vicinity of crater lake.

Details are described generally in the following.

9.2.1 Fourteen (14) Rivers

The river survey section were: for S. Ciloseh, upper reach of the confluence with S. Citanduy for the other rivers, upper sections north of the irrigation canal CIKUNTEN I. (Fig.-9.1).

The length of the longitudinal and cross-sectional surveying of the rivers except the lower reach of S. Ciwulan and the vicinity of crater lake was 101 km including the downstream section 200 m from start point in the survey.

Details are shown in Table - 9.1.

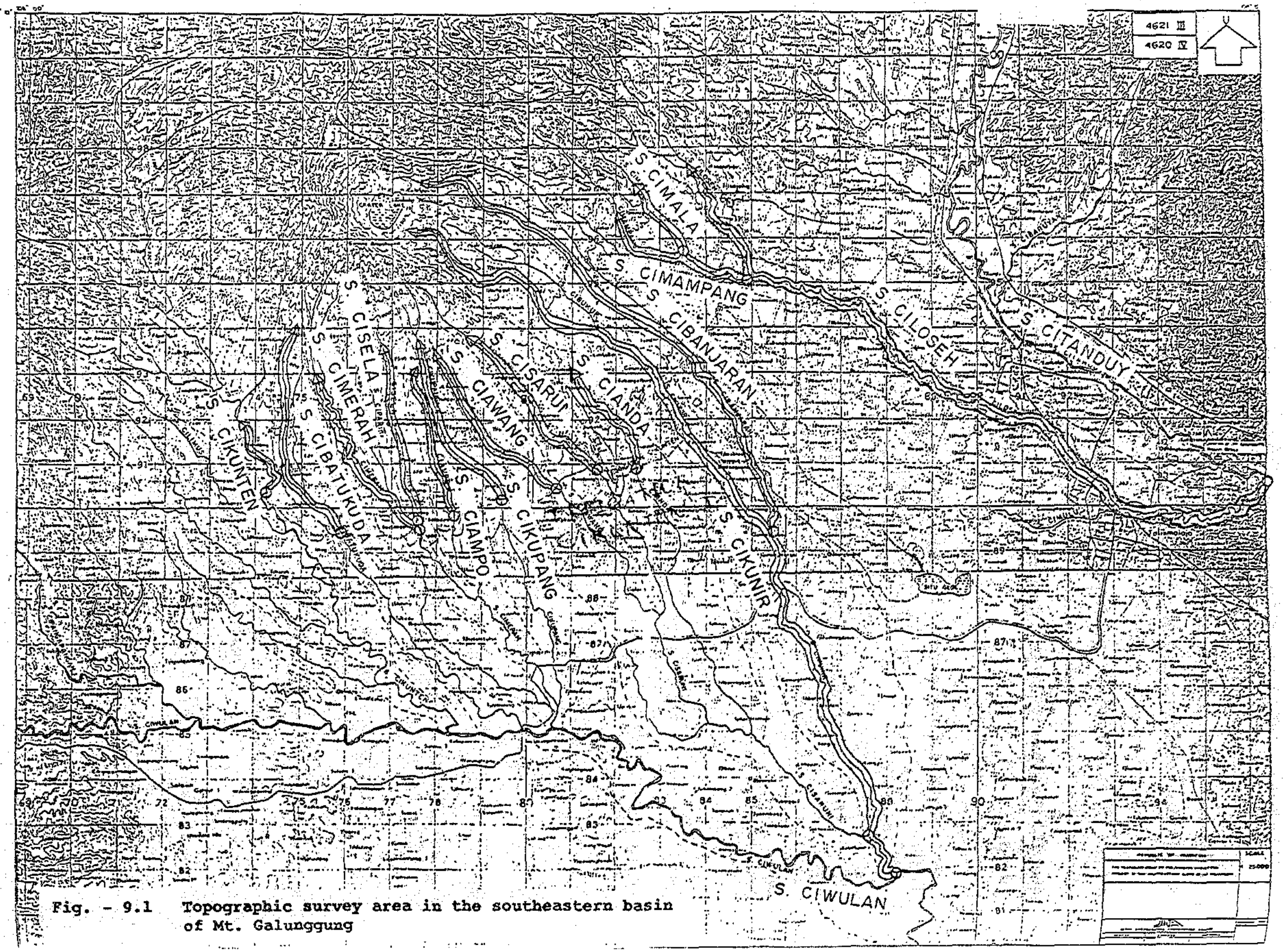


Fig. - 9.1 Topographic survey area in the southeastern basin of Mt. Galunggung

Table - 9.1 Survey Sections and its Length

Name of River	Length (km)	Number of BDM[1] (pieces)	Remarks
1) Ciloseh	22.0	22	S.Ciloseh Basin
2) Cimampamg	4.0	5	
3) Cimala	2.0	3	
4) Cibanjaran	12.5	12	S.Cikunir Basin
Ciponyo II	(4.7)		sand pocket
Ciponyo I Luar	(1.1)		ditto
Ciponyo I Dalam	(1.8)		ditto
Up Stream section	(4.9)		
5) Cikunir	21.2	22	
Down Stream section	(10.0)		
Ciponyo II	(4.6)		sand pocket
Ciponyo I Luar	(0.8)		ditto
Ciponyo I Dalam	(2.1)		ditto
Up Stream Section	(3.7)		
6) Cianda	3.2	4	Northern parts of Irrigation Cikunten I
7) Cisaruni	3.4	4	
8) Ciawang	5.2	6	
9) Cikupang	5.2	6	
10) Ciampo	4.2	5	
11) Cisera	4.0	5	
12) Cimerah	6.8	8	
13) Cibatukuda	5.2	6	
14) Cikunten	2.2	3	
Total	101.1	111	

1) "Basic Distance Mark" ; installed at interval about 1.0 km

9.2.2 Lower parts of S. Ciwulan from Tonjong to river mouth

Upon reconnaissance from the confluence of S. Cikunir and S. Ciwulan to the river mouth of S. Ciwulan, six points were selected.

Longitudinal and cross sectional surveys were made for each 2 km. Survey sections are shown in Fig. - 9.2 and Table - 9.2.

Table - 9.2 Survey Sections and their Length

Name of Section	Length (km)	Number of BDM (pieces)	Distance from River Mouth
1) Parung sela	2.0	3	7.7 km
2) Cikijing	2.0	3	15.4
3) Sukarame	2.0	3	32.6
4) Karsagalih	2.0	3	55.9
5) Sukaraja	2.0	3	69.6
6) Tonjong	2.0	3	82.4
Total	12.0	18	

9.2.3 Vicinity of Crater Lake

Considering countermeasures for the crater lake, measuring lines of total length 2,000 m in the northern parts of crater lake as well as in the origin of S. Cibanjaran was set up. Longitudinal surveys that total length of 1,700 m were carried out in the northern parts of crater lake. Longitudinal surveys including cross sectional survey were carried out for 300 m in the origin of S. Cibanjaran.

THE LOWER PARTS OF CIWULAN RIVER FROM TOWJONG TO RIVER MOUTH

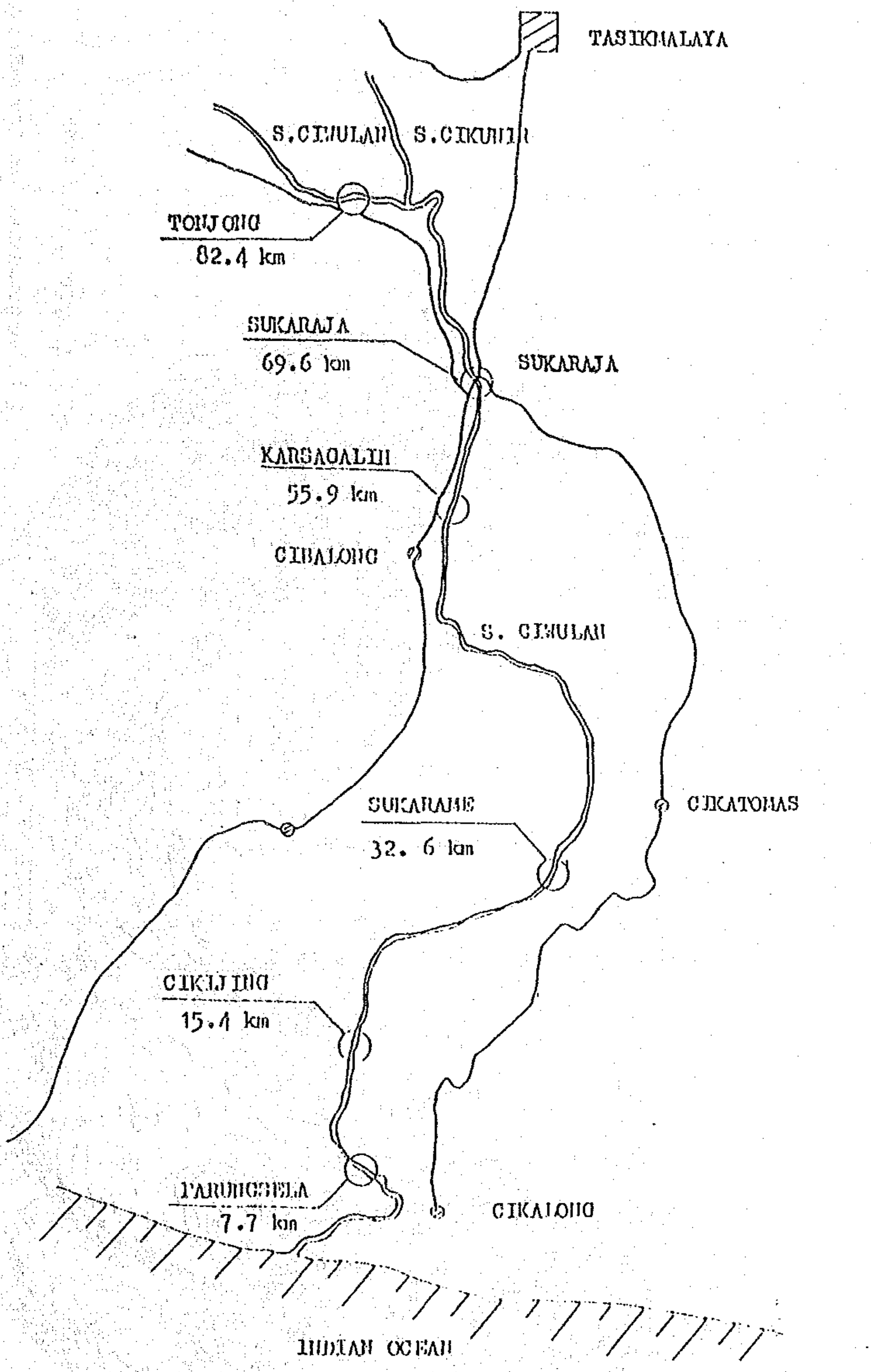
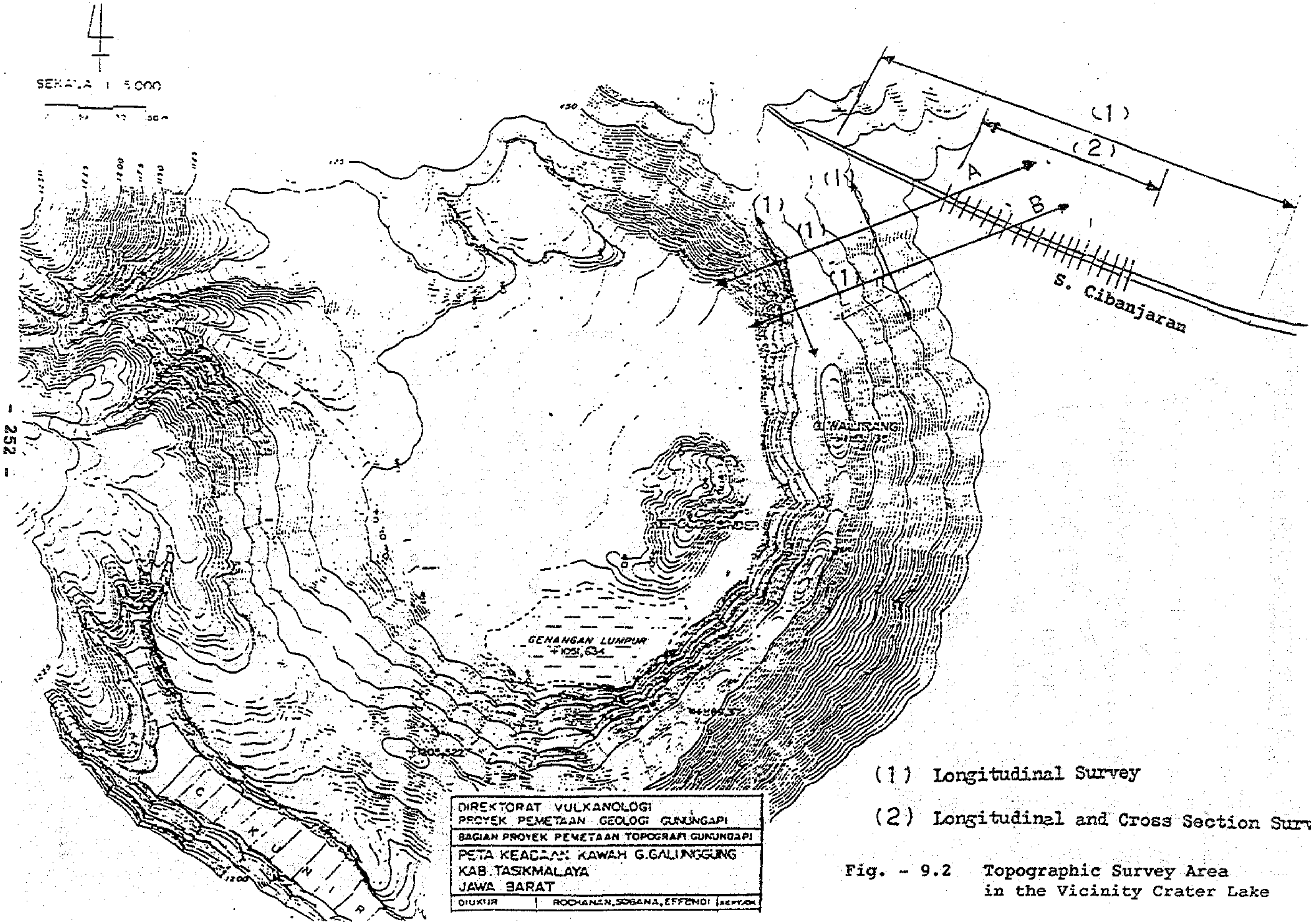


Fig. - 9.2 Topographic Survey Area in the Lower Parts of S. Ciwulan



(1) Longitudinal Survey

(2) Longitudinal and Cross Section Survey

Fig. - 9.2 Topographic Survey Area in the Vicinity Crater Lake

9.3 Existing Survey Results

The topographical survey conducted by the DPU Galunggung office until July 1986 is comprised of the following five (5) work and seven (7) survey areas.

Table - 9.3 Existing Survey conducted by Galunggung office

name of survey	place of survey	quantities of BM
1). Sand Pocket	a) NEGLA, CIMAMPANG	12 pieces
	b) CIPONYO II	13 pieces
2). Irrigation Channel	c) CIKUNTEN I	30 pieces
3). River Surveying	d) S. CILOSEH, S. CIMAMPANG	40 pieces
	e) S. CIKUNIR, S. CIBANJARAN	40 pieces
4). River Surveying	f) S. CIMERAH	40 pieces
5). Sand Pocket	g) CIPONYO I DALAM	12 pieces

9.3.1 Bench Mark of DPU

Bench Mark of DPU were installed from April, 1984 to July, 1986 by DPU.

Survey results concerning Bench Marks are as follows:

S. Ciloseh in river surveying and sandpocket of Negla, Cimampang, and S. Cikunir and sandpocket of Ciponyo II and Ciponyo I Dalam have the altitudes given on the same base level.

S. Ciloseh, S. Cikunir, S. Cimerah and irrigation channel Cikunten I have respectively the altitude obtained upon an independent base level.

In view of the foregoing, it was arranged in the present survey to employ the Bench Marks of S. Cikunir and Ciponyo II in consideration of the integrity and accuracy of the survey results to be made hereafter on Mt. Galunggung office, and the altitudes were set up on the same base level from S. Ciloseh in the east to S. Cikunten in the west.

The differences between the base level of S. Cikunir and Ciponyo II and those of the Bench Marks in the respective survey areas are as shown below.

Table - 9.4 Differences of Elevation between S. Cikunir and the Others

Name of Survey Works		Dif. of Elevation
Sand pocket	NEGLA CIMAMPANG	+ 5.7 m - + 6.1 m
River surveying	S. CILOSEH	+16.380 m
Irrigation Channel	CIKUNTEN I	+16.57 m - +16.67 m
River surveying	S. CIMERAH	+16.57 m - +16.67 m

It was clear that there was a difference of elevation of the top of cinder cone between the drawing showing the elevation EL 1085.92 m made by DIREKTORAT VOLKANOLOGI on October 1986 and the topographic survey result in this feasibility study carried by JICA.

The relations of elevation both by DIRECTORAT VOLKANOLOGI and by JICA are shown as follows:

- DIRECTORAT VOLKANOLOGI .... EL 1085.92 m
- JICA Study Team .... EL 1101.53 m

(-15.61 m)

The elevation surveyed by JICA Study Team was adopted for the planning and design of disaster prevention facilities in this study.

9.3.2 Existing Drawings of Topographic Survey

The kinds of existing drawings are topographic drawings, longitudinal drawings, and cross-sectional drawings, and their details are shown by the survey name in Table - 9.5.

Table - 9.5 (1) Existing drawing of Topographic Survey

Name of Survey	Kinds of Drawing	Scala	Quantity	Number of	SECTION	
					Starting point	Ending point
Irrigation channel CIKUNTEN I Oct.1984 - Nov.1984 PT. NES	Topographic map	S = 1:2000	150 m width	14 sheets	S. Cikunten	SITU GEDE
	Longitudinal section	H = 1:2000 V = 1:200	22.80 km length		Kp.Pautauy jaya	Kp. Situ Bugelan
	Cross section	H = 1:100 V = 1:100	518 sections 60m width 45m interval	72 sheets		
Sand Pocket NEGLA CIMAMPANG	Topographic map	S = 1:5000	360 ha	1 sheet	S. Ciloseh	S. Cimampang
Apr.1984 - Jun.1984 CV. KARYA INDAH	NEGLA Topographic map	S = 1:2000	150 m width	1 sheet	Ds. Sukaratu	Kp. Sukajadi
	Longitudinal section	H = 1:2000 V = 1:200	2.45 km length	1 sheet		
	Cross section	H = 1:200 V = 1:200	50 sections 30m width 50m interval	8 sheets		
	CIMAMPANG Topographic map	S = 1:2000	150 m width	1 sheet	Ds. Sukaratu	Ds. Indrajaya
	Longitudinal section	H = 1:2000 V = 1:200	1.15 km length			
	Cross section	H = 1:200 V = 1:200	24 sections 30m width 50m interval	5 sheets		

Table - 9.5 (2) Existing drawing of Topographic Survey

Name of Survey	Kinds of Drawing	Scale	Quantity	Number of	SECTION	
					Starting point	Ending point
Sand Pocket CIPONYO II	Topographic map	S = 1:5000	660 ha		Kp. Ciponyo	Kp. Tawang Banteng Confluence Cikunir and Cibanjaran River
	Right side					
	Topographic map	S = 1:2000	200 m width	2 sheets		
Apr.1984 - Jun.1984 CV. KARYA INDAH	Longitudinal section	H = 1:2000 V = 1:200	3.35 km length	1 sheet		
	Cross section	H = 1:200 V = 1:200	68 sections 30m width 50m interval	10 sheets		
	Left side				Kp. Salubeureum	Kp. Gunung Jerux
	Topographic map	S = 1:2000	200 m width	3 sheets		
	Longitudinal section	H = 1:2000 V = 1:200	2.68 km length			
	Cross section	H = 1:200 V = 1:200	57 sections 30m width 50m interval	9 sheets		
Sand Pocket CIPONYO I DALAM	Topographic map	S = 1:5000	310 ha	1 sheet	S. Cibanjaran Kp. Kokoncong Kp. Sinagar	S. Cikunir Kp. Rancailat Kp. Cibueuk
Jun.1986 - Jul.1986 CV. KARYA INDAH	Topographic map	S = 1:2000	4.64 km length	5 sheets		
	Longitudinal section	H = 1:2000 V = 1:200				
	Cross section	H = 1:100 1:200 V = 1:100 1:200	125 sections 30m width 50 m interval	6 sheets		

Table - 9.5 (3) Existing drawing of Topographic Survey

Name of Survey	Kinds of Drawing	Scale	Quantity	Number of	SECTION	
					Starting point	Ending point
River surveying S. CILOSEH S. CIMAMPANG Jul. 1985 PT. WIRANTA	S. Ciloseh					
	Topographic map	S = 1:2000	300 m width	11 sheets	Ds. Cisayong	Kp. Cimulu, TSK
	Longitudinal section	H = 1:2000 V = 1:200	14.62 km length	11 sheets		
	Cross section	H = 1:2000 V = 1:200	74 sections 180m width 200 m interval	25 sheets		
	S. Cimampang					
	Topographic map	S = 1:2000	300 m width	3 sheets	Kp. Ciakar II	Kp. Kudang Sukaratu
	Longitudinal section	H = 1:2000 V = 1:200	5.14 km length	6 sheets		
	Cross section	H = 1:200 V = 1:200	30 section 150m width 200 m interval	15 sheets		
River Surveying S. CIKUNIR S. CIBANJARAN Jul. 1985 - Aug. 1985 PT. WIRANTA	S. Cikunir					
	Topographic map Longitudinal section	S = 1:2000 H = 1:2000 V = 1:200	200 m width 14.73 km length	15 sheets	Ds. Mekar jaya	Kp. Sukamenak
	Cross section	H = 1:200 V = 1:200	81 sections 150m width 200m interval	38 sheets		
	S. CIBANJARAN					
	Topographic map	S = 1:2000	200 m width	6 sheets	Kp. Ciponyo	join to Cikunir River
	Longitudinal section	H = 1:200 V = 1:200	4.95 km length			
	Cross section	H = 1:200 V = 1:200	26 sections 180m width 200m interval	11 sheets		

Table - 9.5 (4) Existing drawing of Topographic Survey

Name of Survey	Kinds of Drawing	Scale	Quantity	Number of	SECTION	
					Starting point	Ending point
River Surveying S. CIMERAH Jun.1986 - Jul.1986 CV. KARYA INDAH	S. Cimerah					
	Topographic map	S = 1:2000	200 m width	15 sheets	Kp. Pasir bingung	Kp. Rancamaya join to Ciwulan River
	Longitudinal section	H = 1:2000 V = 1:500 1:200	14.21 km length			
	Cross section	H = 1:200 V = 1:200	119 sections 150m width 120m interval	53 sheets		
	S. Cisela					
	Topographic map	S = 1:2000	200 m width	3 sheets	Kp. Pasir bingung	Kp. Guntihilir join to Cimerah River
	Longitudinal section	H = 1:2000 V = 1:500 1:200	2.78 km length			
	Cross section	H = 1:200 V = 1:200	20 sections 150m width 140m interval	8 sheets		
	S. Cipada					
	Topographic map	S = 1:2000	200 m width	2 sheets	Kp. Pasir bingung	Kp. Leusipeusing join to Cimerah River
	Longitudinal section	H = 1:2000 V = 1:500 1:200	2.03 km length			
	Cross section	H = 1:200 V = 1:200	15 sections 150m width 135m interval	5 sheets		
	S. Cibeureum					
	Topographic map	S = 1:2000	200 m width	1 sheet	Kp. Pasir bingung	Kp. Bojongpetir join to Cimerah River
	Longitudinal section	H = 1:2000 V = 1:500	1.05 km length			
	Cross section	H = 1:200 V = 1:200	8 sections 150m width 130m interval	8 sheets		

9.4 Method of Measurement Survey

Implementation method for measurement survey is summarized as follows.

9.4.1 Distance Measurement

The distance was measured at the axis of river at intervals of 100 meters by using eslon tape. In the working of measurement, the installation of wooden pegs at the river axis was also done and on the right and left bank of river. On the certain case, such as the availability of Bridge, Weir, Intake, confluence of river, it should also measured and installed the wooden peg. In such cases as the availability of Bridge, Weir, Intake and confluence of river, they should be measured and marked with a wooden peg.

9.4.2 Installation of Basic Distance Mark (BDM)

BDM were installed at intervals of 1 Kilometer of the right of left of river bank. BDM was installed at stable area, safe from any disturbances, and easy to find.

9.4.3 Levelling Measurement

The levelling measurement was done at the axis of river and sometimes at certain places on the river bank.

The levelling measurement on the axis of river was to decide the elevation of each mark which had been installed at the axis of river. The levelling measurement on the river bank was to decide the elevation of each river bank. The levelling was also done to the elevation of each Bench Marks (BM) which has been installed by Galunggung Volcano Project previously.

The certain cases, if the elevation measurement by levelling system is impossible, the measurement by tachimetry system with theodolite was used.

The measurement were done twice. The precision of levelling measurement was 40 mm S, where S = distance in Km.

All instruments for levelling measurements are level and their precision has been checked. If the result of the levelling measurement is more than 40 mm S, the measurement will be repeated.

9.4.4 Longitudinal Measurement

Basically the longitudinal measurement is the same with levelling system.

The measurement was done at axis of river, and other data was taken from the result of cross sectional measurement.

9.4.5 Cross Sectional Measurement

Cross sectional measurement was done by levelling system and tachimetry system at interval of 100 meter.

It was done also to constructions, such as bridges, dams, confluence of rivers.

Cross sectional measurement with levelling system was carried out if the field situation relatively plain as on sandpocket area. If the levelling system is impossible to do, then the tachimetry system was used for cross sectional measurement.

The Measurement systems were:

The instrument of theodolite or transit was set up on the wooden peg whose elevation was already known or on the spot which the elevation will be decided.

After the instrument was ready to be used, then the reading of incline angle and middle line on every staff which was already installed was taken. The reading of middle line was set up on the same height of instrument. The incline distance was taken from direct measurement and was by eslon tape or EDM.

If the incline distance measurement could not be worked out with eslon tape, then the measurement was done by the optic system.

Cross sectional measurement covered both river bank and both dykes of sandpocket and a 10 meter minimum from outer part of river bank or dike.

At the certain cases, if the height distinction between riverbed and river wall was high enough, the cross sectional measurement was done at the height of 30 m.

9.5 Data Processing

9.5.1 Formulation of Data

1) The formulation was done after the result of measurement had fulfilled the conditioned tolerance.
In this work all precision of levelling measurement was under the conditioned tolerance of 40 mm $\sqrt{S}$.
The account were made up to two decimal points. For example 450.31 m.

2) Cross section formulation was processed as the quidance from JICA Study Team. The formulation was processed to get the height distinction (AH) between two spots was AH + TA - BT.
TA = Height of instrument
BT = Middle line
AH = Height distinction.
The account was made up to two decimal points, for example 450.31 m. The precision of all measurement works was under the conditioned tolerance:
Distance : S/300
height : 5 cm + 30 mm $\sqrt{S}$.
All formulation described in meter unit (m).

9.5.2 Drawing

1) Longitudinal drawing
Longitudinal drawing was made accordance with the guidance of JICA Study Team.
This longitudinal was drawn on the scale of:
Vertical : 1 : 200
Horizontal : 1 : 5.000
The size of drawing paper was "A-1."

2) Cross Sectional Drawing

Cross sectional drawings were drawn on the scale of:

Vertical : 1 : 200

Horizontal : 1 : 200, and several of them are in Vertical 1 : 200, Horizontal 1 : 500, except on the sandpocket, vertical 1 : 200, and Horizontal : 1 : 1.000.

The size of drawing paper was "A-1."

9.6 Results

The results of the topographic survey are shown as follows:

1. 1 (one) set of photographs of river condition.
2. 1 (one) set cross section drawing, and longitudinal drawing on printing paper.
3. 2 (two) sets, copies of all drawings of cross section and longitudinal drawings on printing paper.
4. 22 (twenty two) books all original data of measurement taken from the field surveys (field note books).
5. 5 (five) sets of photographs of BDM and their descriptions.
6. 5 (five) sets of Final Report Books.

9.7 Comment

As mentioned in paragraph 9.3.1, there were differences of elevation concerning the base level surveyed by Mt. Galunggung Project office and other authorities.

However, it is desirable to integrate the base level in order to prevent confusion concering elevation in the area of Mt. Galunggung southeastern basin.

The same may be desirable concerning the coordination system of the topographic survey.

10. Riverbed Materials Survey

10.1 General

The objectives of riverbed materials survey are summarized as follows:

(1) To obtain the basic characteristics of riverbed materials for the sediment hydraulic analysis.

(2) To obtain the basic characteristics of aggregate for the study of the utilization of materials in sandpockets.

Twenty (20) sampling points were selected in the S. Ciloseh (5 points of them), S. Cibanjaran (5 points), S. Cikunir (8 points) and S. Ciwulan (2 points) by consideration of river characteristics, sediment conditions deposited in the riverbed.

The kinds of test in laboratory are as follows:

1) bulk density
2) water contents
3) grain size
4) specific gravity
5) absorption

These works were carried out by a local consultant under management of JICA Study Team.

10.2 Location of Sampling

Twenty Sampling points were selected by taking accounts of river characteristics and grain condition through field reconnaissance.

The location of Sampling for each group of materials is shown in Table - 10.1 and Fig. - 10.1.

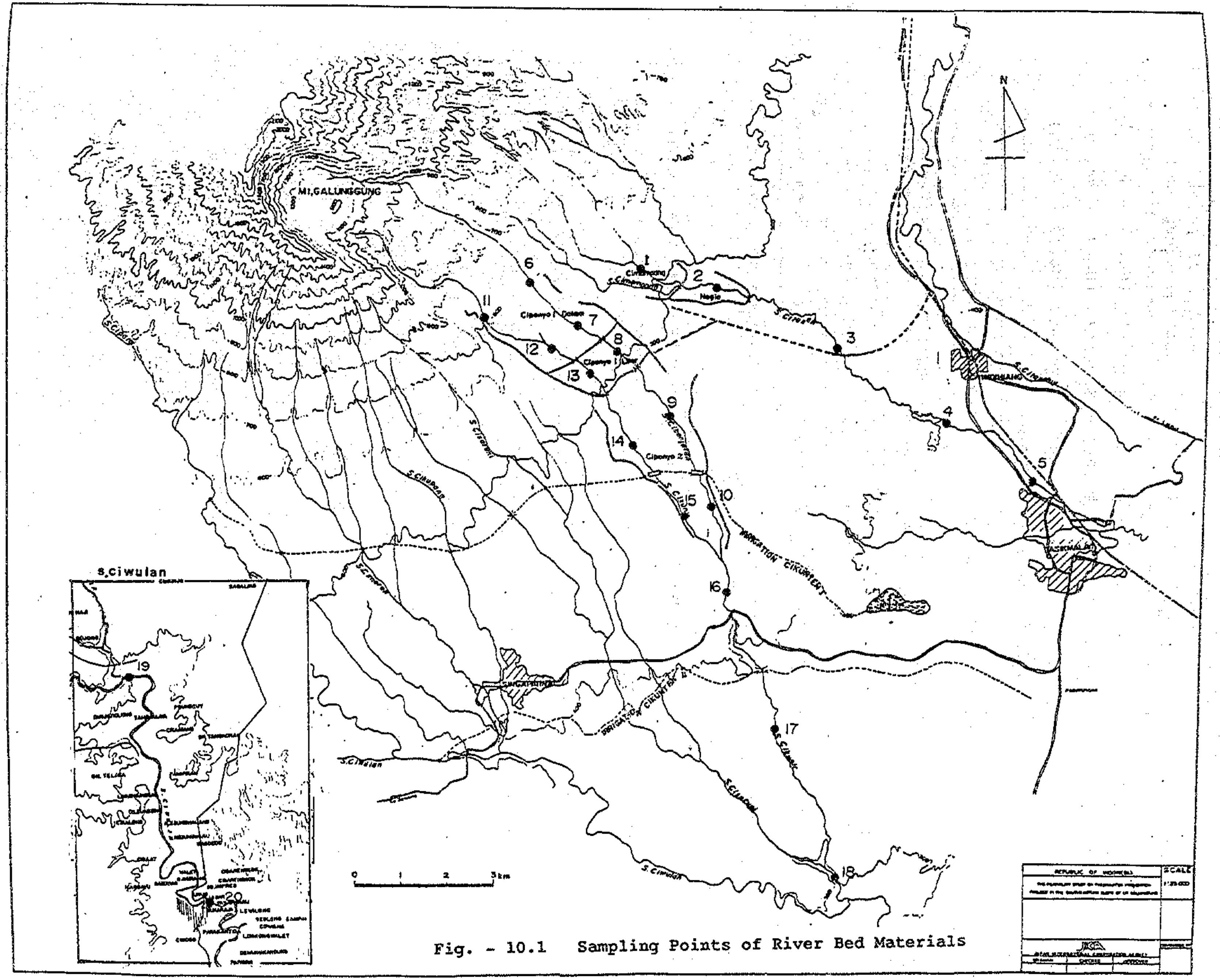


Fig. - 10.1 Sampling Points of River Bed Materials

Table - 10.1 Location of Sampling Points

Name of river	Number of Sampling Point	Number of point in the sandpocket
Ciloseh	5 points (No. 1 - No. 5)	2 points (No. 1 - No. 2)
Cibanjaran	5 points (No.6 - No.10)	5 points (No.3 - No.10)
Cikunir	8 points (No.11 - No.18)	5 points (No.11 - No.15)
Ciwulan	2 points (No.19 - No.20)	

10.3 Testing Items

The items of test for each sampling point are shown in Table - 10.2.

Table - 10.2 Testing Items and Quantity of Samples

Place of Sampling		Sampling Number	Item of Test			Remarks
			G	S	B	
Ciloseh	Sandpocket	No. 1 - No. 2	0	0	0	
	Down Stream	No. 3 - No. 5	0	0	0	
Cibanjaran	Sandpocket	No. 6 - No.10	0	0	0	
Cikunir	Sandpocket	No.11 - No.15	0	0	0	
	Down Stream	No.16 - No.18	0	0	0	
Ciwulan		No.19 - No.20	0	0	0	
Quantity of analysis			20	20	20	Total 60 samples

Note : G = Grain size anaysis S = Specific Gravity and Absorption

B = Bulk Density

10.4 Method of Riverbed material Test

The method of Riverbed material test is performed according to the Japanese Industrial Standard (JIS).

(1) Grainsize analysis (JIS A.1102 and JIS A.1204)

Grainsize analysis used according to the JIS A.1102 and JIS A.1204. The samples shall be sifted into a series of sizes using such sieves specified (the standard wire sieves).

The sieving operation shall be conducted by imparting a vertical and lateral motion of the sieve, accompanied by jarring action so as to keep the sample moving continuously all over the surface of the sieve. Sieving shall be continued until not less than 1% of the residue is not left in any sieve during one minute.

When mechanical sieving is used, the hand method of sieving shall also be conducted so as to ensure that the amount of material passing through any sieve during one minute is less than the value given above.

The grain of the sample pocket at the mesh of the sieve shall be pushed back carefully so as not to be smash them, because the grains are regarded as a residue of the sample on the sieve.

After completion of the sieving operation, the mass of the residue on each sieve shall be weighed on a balance.

(2) Specific gravity and absorption (JIS A.1109 and JIS A.1110)

The procedure of specific gravity and absorption are performed according to the JIS A.1110.

a) Fine aggregate (JIS A.1109)

After weighing the sample, it shall be placed in a flask and water will be added up to the scale mark of about 500 ml.

After expelling air bubbles by rolling the flask on a flat plate, the flask shall be soaked in a water bath at a constant temperature of 20 ± 2 °C.

After the flask is soaked in the water bath for about 1 hour, water shall further be added up to the scale mark of 500 ml.

The total weight of water added to the flask shall be measured to the nearest 0.1 g.

The sample shall be dried by the method and shall be weighed.

For Percentage of Water Absorption, after measuring the weight of the tested sample remaining to the nearest 0.1 g, the sample shall be dried at 110 °C until a constant weight can be measured to the nearest 0.1 g.

b) Coarse aggregate (JIS A.1110)

The weight of the sample shall be measured to the nearest 0.5 g. The sample placed in the cage shall be immersed in clean water at 20 ± 2 °C, and after removing the air bubbles on the particle surfaces and between particles, the weight in water of the sample shall be measured.

The sample withdrawn from the water shall be dried at 100 to 110 °C until a constant weight is reached, cooled to room temperature. It will then be weighed to the nearest 0.5 g.

(3) Bulk Density (JIS A.1004)

The procedure of Bulk Density is performed according the JIS A.1104.

The sample of aggregate shall be used in wet conditions (γm) and dry conditions (γd), it is weight of sample before drying and weight of sample after drying.

The method of Test are shown in Table - 10.3 and all of them conform to JIS method.

Table - 10.3 Method of Test

I t e m	Method of test	Remark
1. Grain size analysis	JIS A.1102 and JIS A.1204	
2. Specific gravity and absorption	Fine aggregate JIS A.1109 Coarse aggregate JIS A.1110	JIS = Japanese Industrial Standard Committee Revised 1978-07-04
3. Unit weight of aggregate (Bulk Density)	JIS A.1104	

10.5 Result of River Bed Materials Test

(1) Grain Size Distribution

The results of grain size distribution test are shown in Table - 10.4.

Table - 10.4 Results of Grain Size Distribution

Sampling Point	Diameter of Gravel(mm)			Uniformity Coef.	Per.Pass 2.0 mm(%)	Per.Pass 0.42 mm(%)	Per.Pass 0.074mm(%)	Classification
	Dmax	D60	D10					
TP 1	6.30	0.75	0.032	23.4	90	45	18	SM
TP 2	195	40	0.30	133.3	31	13	4	GP
TP 3	174	19	0.16	118.8	44	22	4	GP
TP 4	208	20	0.18	111.1	45	20	2	GP
TP 5	273	35	0.80	43.8	22	9	4	GP
TP 6	282	50	0.22	227.2	33	15	4	GP
TP 7	186	3.60	0.25	14.4	56	25	3	SP
TP 8	184	10	0.19	52.6	47	20	4	GP
TP 9	206	23	0.12	107.5	29	14	8	GW
TP 10	75	0.7	0.01	70.0	76	52	33	SP
TP 11	210	50	0.30	166.6	28	13	2	GP
TP 12	196	1.20	0.11	10.9	57	20	4	SP
TP 13	140	20	0.21	95.2	40	16	4	GP
TP 14	25	8.0	0.20	40.0	45	18	4	GP
TP 15	186	1.5	0.05	30.0	64	28	14	SW
TP 16	157	4.0	0.09	44.4	54	28	9	GW
TP 17	172	6.0	0.16	37.5	51	19	7	SW
TP 18	149	19	0.21	90.5	38	17	4	GP
TP 19	189	18	0.04	450	53	38	14	GP
TP 20	171	50	0.065	769.2	29	19	11	GW

Note) Soil Classification is based on Japanese Unified Soil Classification System (JUSC).

(2) Specific Gravity and Absorption

The specific gravity of coarse aggregate is nearly the same as that of the riverbed material. They range from 2.66 - 2.71 while general coarse aggregate range from 2.6 - 2.8.

The Result of specific gravity and absorption test is shown in Table - 10.5.

Table - 10.5 Specific Gravity and Absorption

Sample	No.	Coarse aggregate		fine aggregate	
		Specific	Absorption	Specific	Absorption
Ciloseh River	1.	2.70	3.2	2.41	8.1
	2.	2.68	5.4	2.49	4.8
	3.	2.71	3.0	2.51	4.1
	4.	2.67	3.1	2.51	3.9
	5.	2.67	3.6	2.51	2.6
Cinbanjaran Sandpocket	6.	2.68	5.0	2.49	4.7
	7.	2.66	2.5	2.48	4.9
	8.	2.66	3.3	2.52	4.6
	9.	2.70	2.4	2.49	5.0
	10.	2.69	4.1	2.43	5.1
Cikunir Sandpocket	11.	2.68	4.4	2.51	4.9
	12.	2.66	2.9	2.50	3.1
	13.	2.70	3.9	2.46	4.0
	14.	2.70	3.9	2.44	4.7
	15.	2.66	3.9	2.53	4.4
Cikunir River	16.	2.70	4.0	2.54	3.7
	17.	2.61	4.7	2.44	3.5
	18.	2.71	3.3	2.51	4.3
	19.	2.67	3.3	2.42	8.0
	20.	2.70	2.8	2.44	5.6

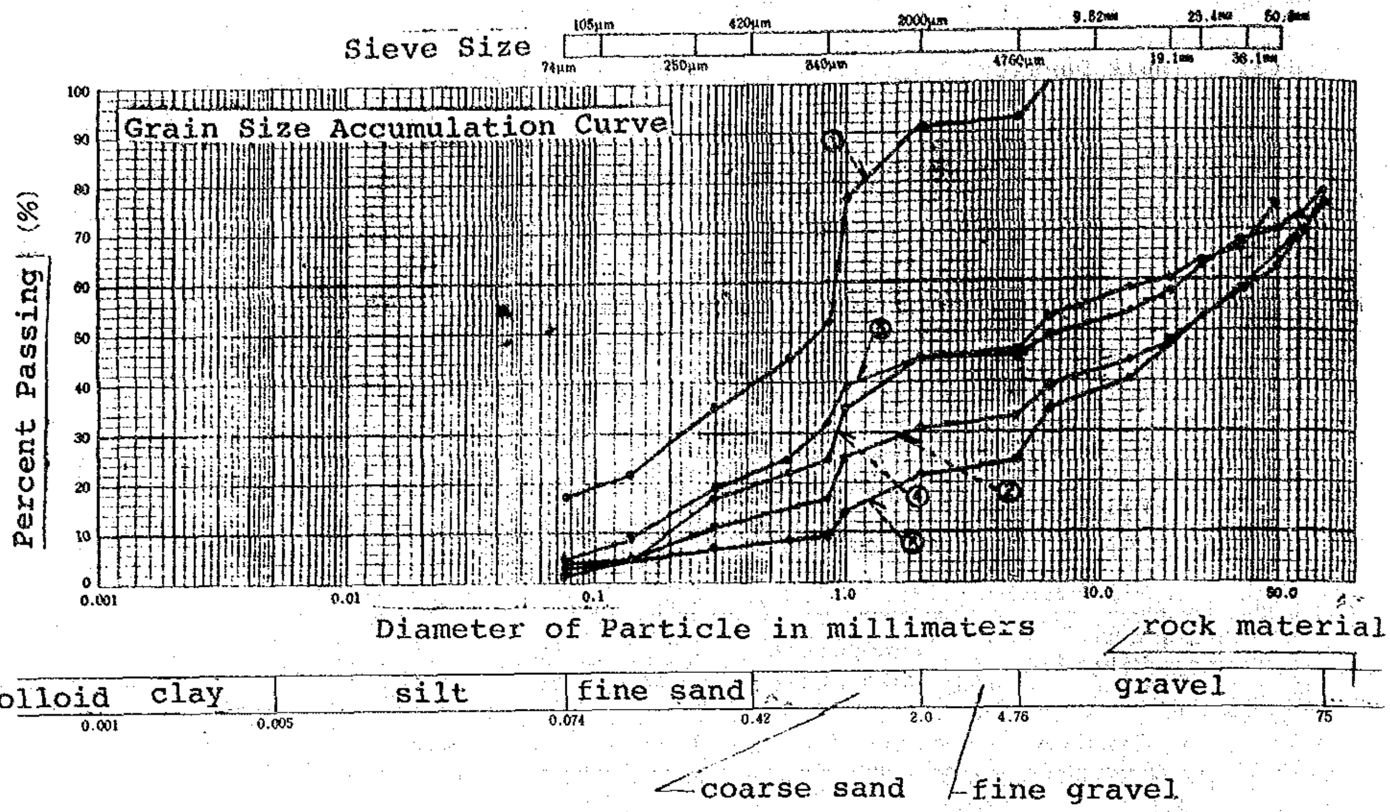
(3) Bulk Density

The Result of Bulk Density and water content test is summarized in Table - 10.6.

Table - 10.6 Result of Bulk Density and Water Content

		Bulk Density	Water content
Ciloseh	Sandpocket	1.63 - 1.79	9.0 - 10.1
	Down Stream	1.87 - 1.98	8.0 - 9.9
Cibanjaran	Sandpocket	1.60 - 1.85	5 - 17%
Cikunir	Sandpocket	1.77 - 1.85	5.6 - 13.2
	Down Stream	1.82 - 1.86	7.9 - 10.5
Ciwulan	Down Stream	1.62 - 1.76	8.6 - 14.2

The similarity of natural water content between the sandpocket and down stream is remarkable.



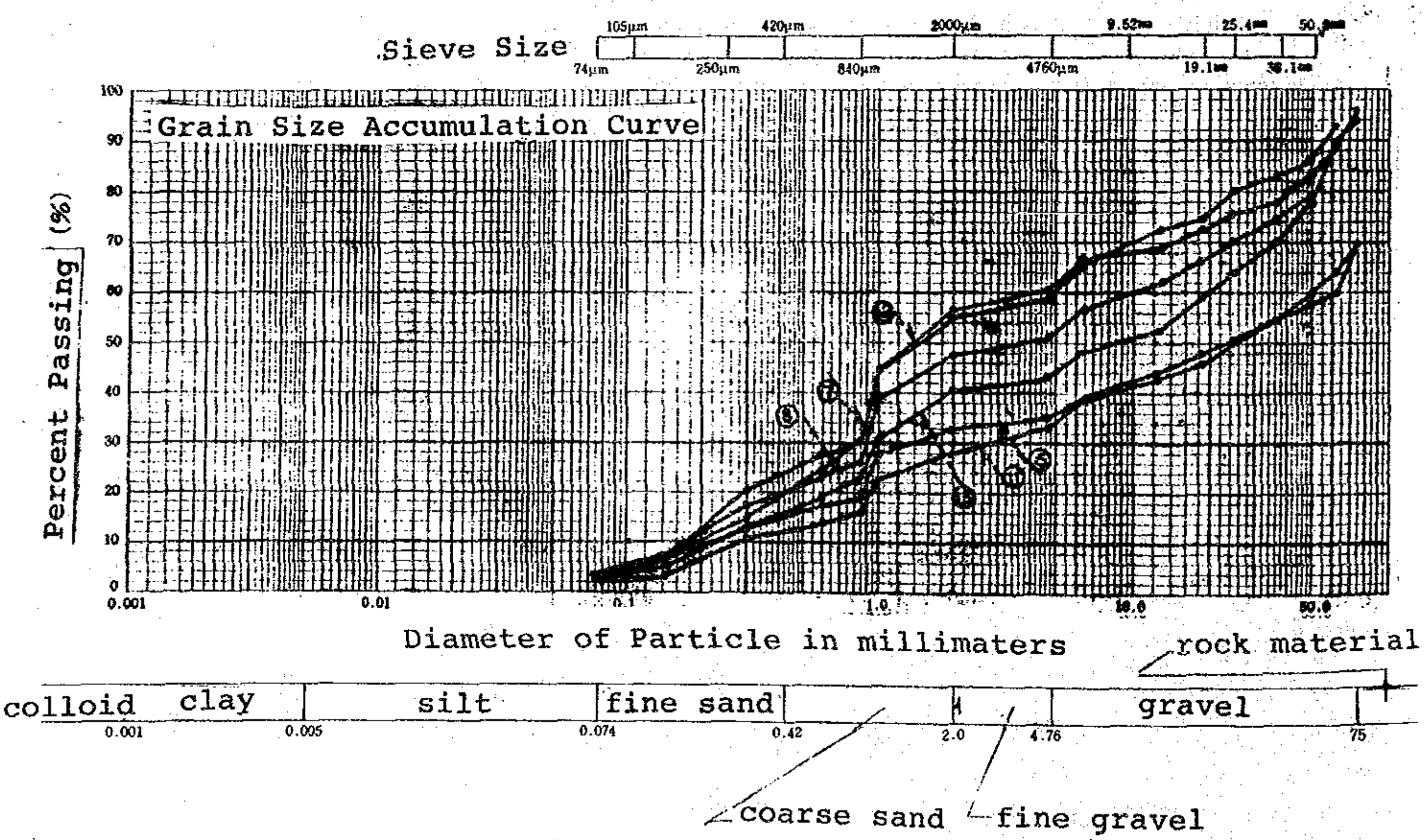
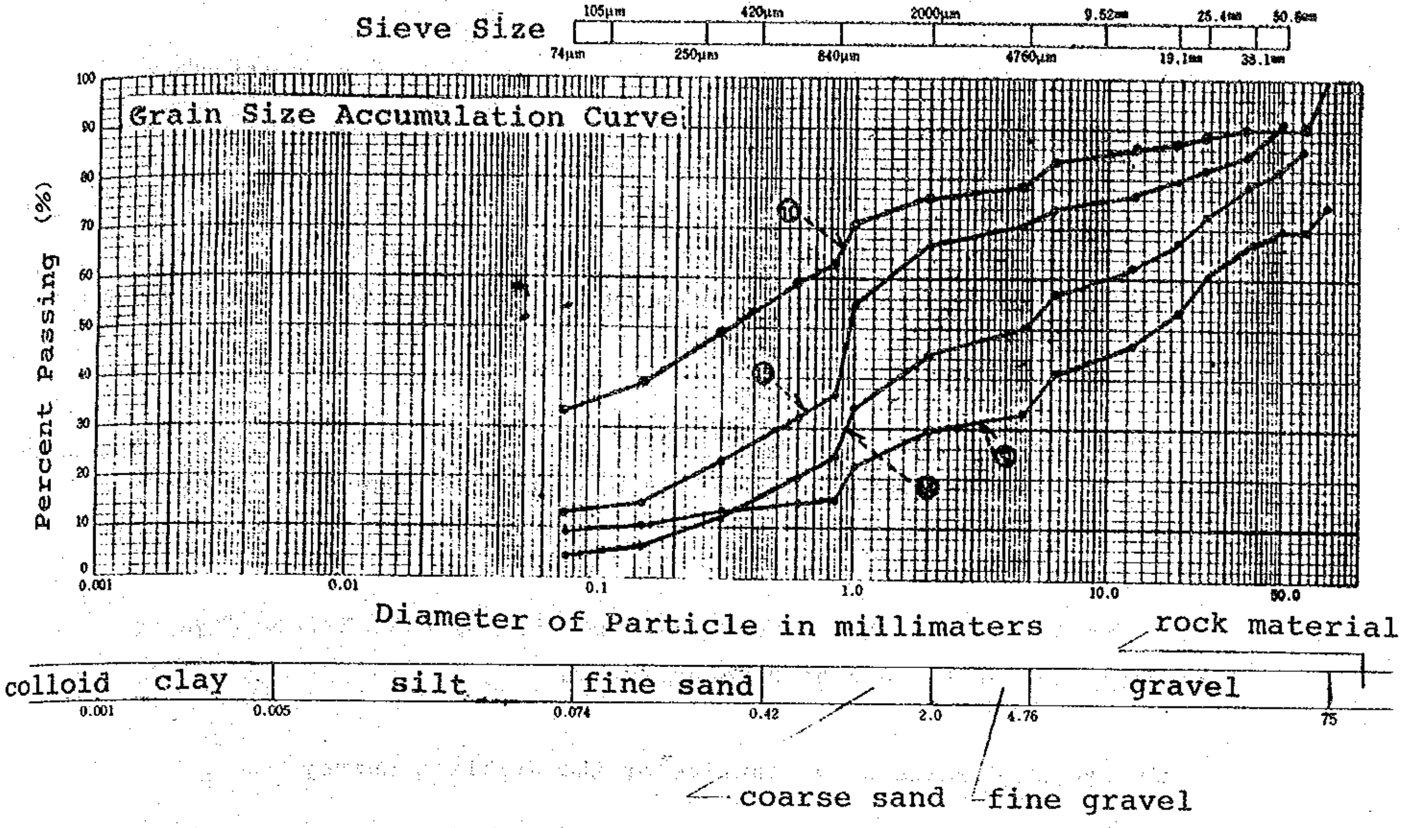


Fig. - 10.2 Results of Grain Size Analysis(No. 1- 13)



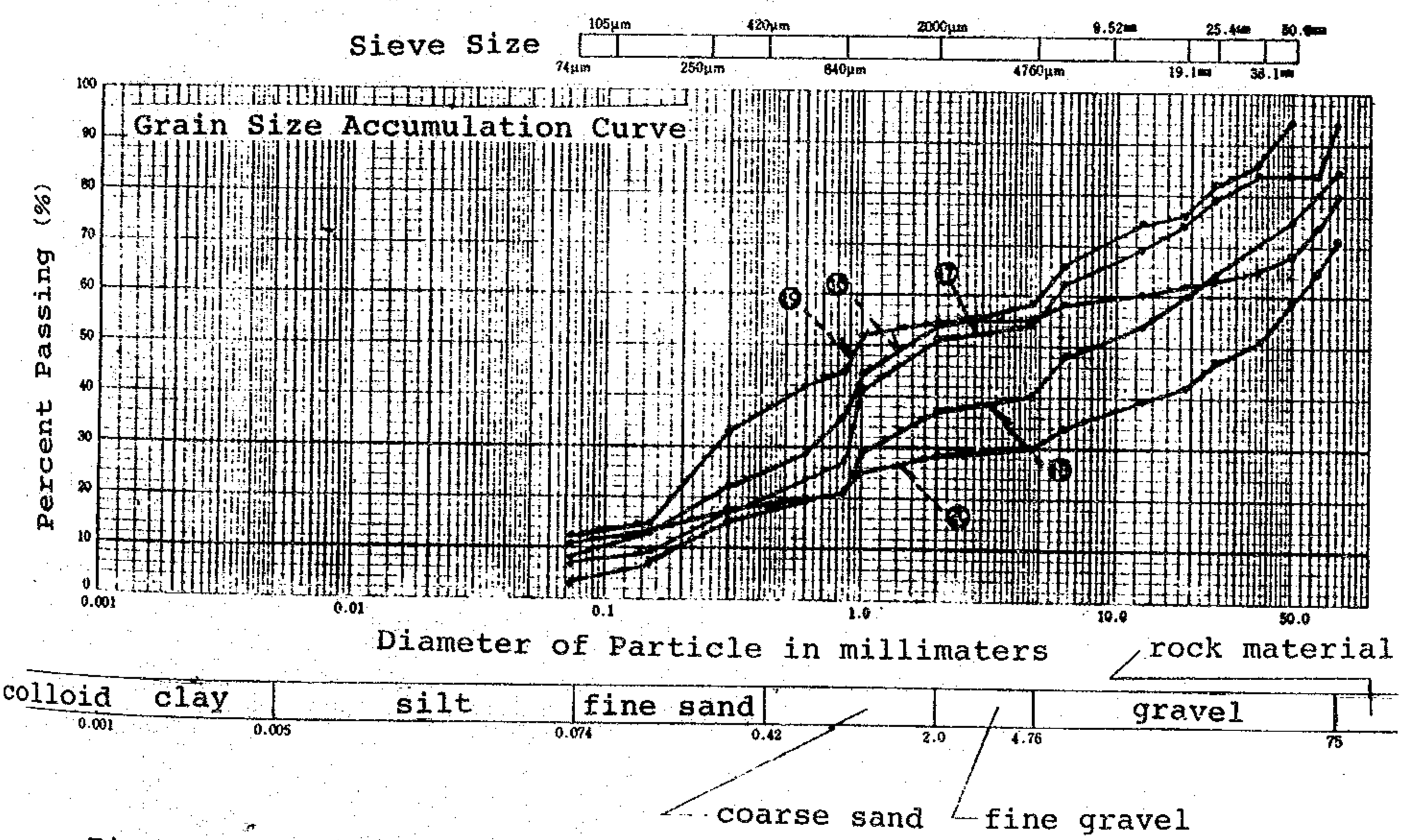


Fig. - 10.3 Results of Grain Size Analysis(No.14- 20)

11. Drilling

11.1 General

This drilling survey is a part of the geological survey for the Feasibility Study on the Disaster Prevention Project in the Southeastern Slope of Mt. Galunggung, West Java.

The drilling survey was executed by P.T. Tricon under the order and supervision of the JICA Study Team from the beginning of August until the end of October in 1987.

The final report of the survey was submitted by P.T. Tricon Jaya to the JICA Study Team on the end of October in 1987.

This report describes the outline of the drilling survey.

11.2 Object

The object is to investigate the geological condition, especially for tunnelling engineering around the crater lake for the planning of drainage facilities, and to verify the seismic data.

11.3 Items and Quantities

The drilling survey consists of the drilling works, permeability test, measurement of temperature of fumarole, ground water level and installation of piezometer in the drilling hole.

Three (3) bore holes, B-1, B-2 and B-3, are set on the A-A line of seismic survey to verify the both of drilling and seismic survey. More detail information is shown in Table - 11.1 and Fig. - 11.1.

Table - 11.1 List of Drilling Quantity

NO.	BORE HOLE		DEPTH (m)	WATER TEST (PACKER TEST)	CASING (m)					BORE HOLE PROTECTION	PVC INSTALLA-TION
	NO.	ELV. (m)			ϕ 6" (SW)	ϕ 5" (PW)	HW (ϕ 115 mm)	NW (ϕ 89 mm)	BW (ϕ 73 mm)		
1.	B - 1	+1161.70	80.00	8 X	12.50	20.50	48.00	76.00	—	1	80.00
2.	B - 2	+1155.70	80.00	—	11.50	25.00	35.00	40.00	70.00	1	80.00
3.	B - 3	+1115.10	40.00	2 X	2.00	—	9.00	31.00	—	1	40.00
TOTAL			200.00	10 X							

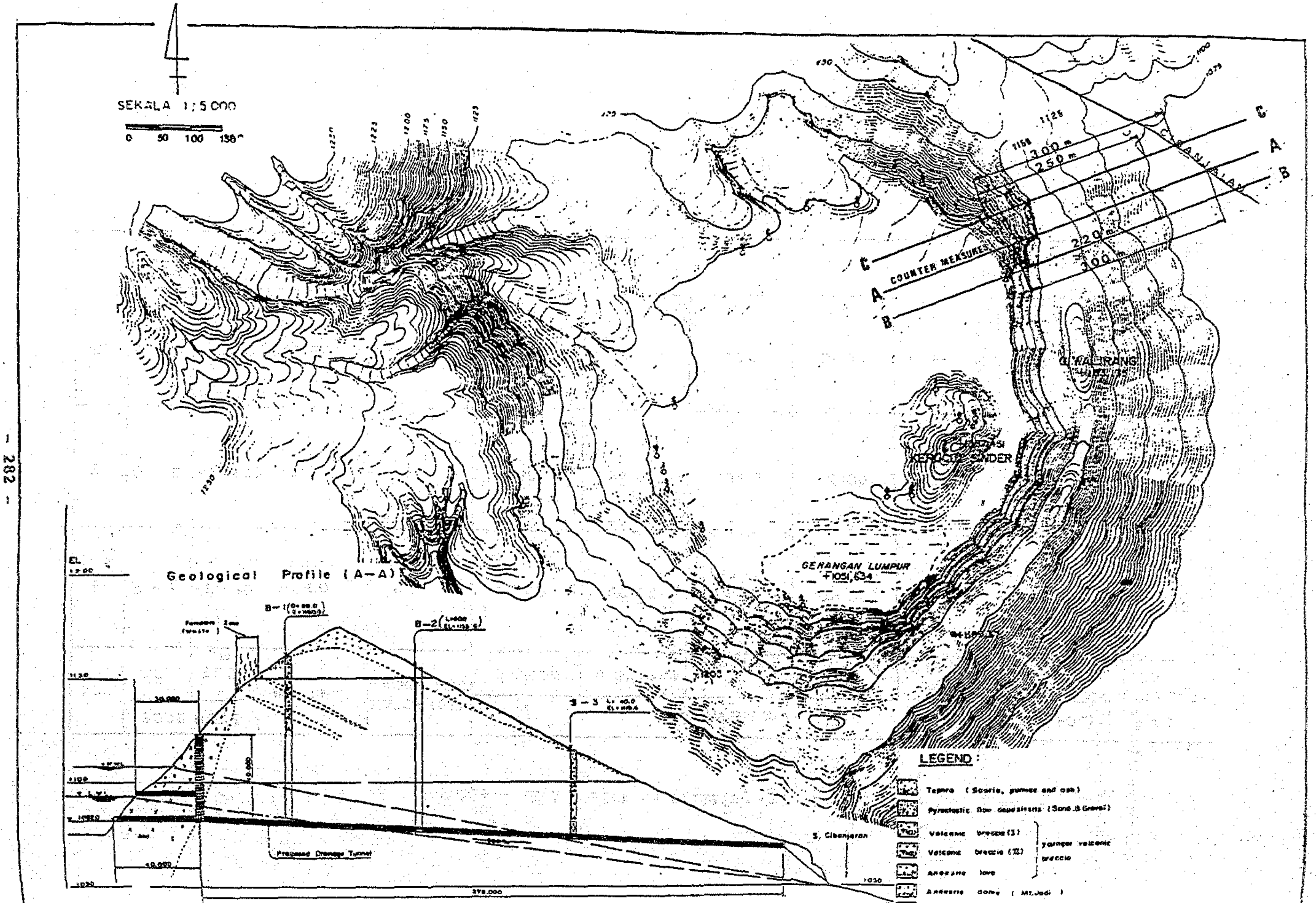


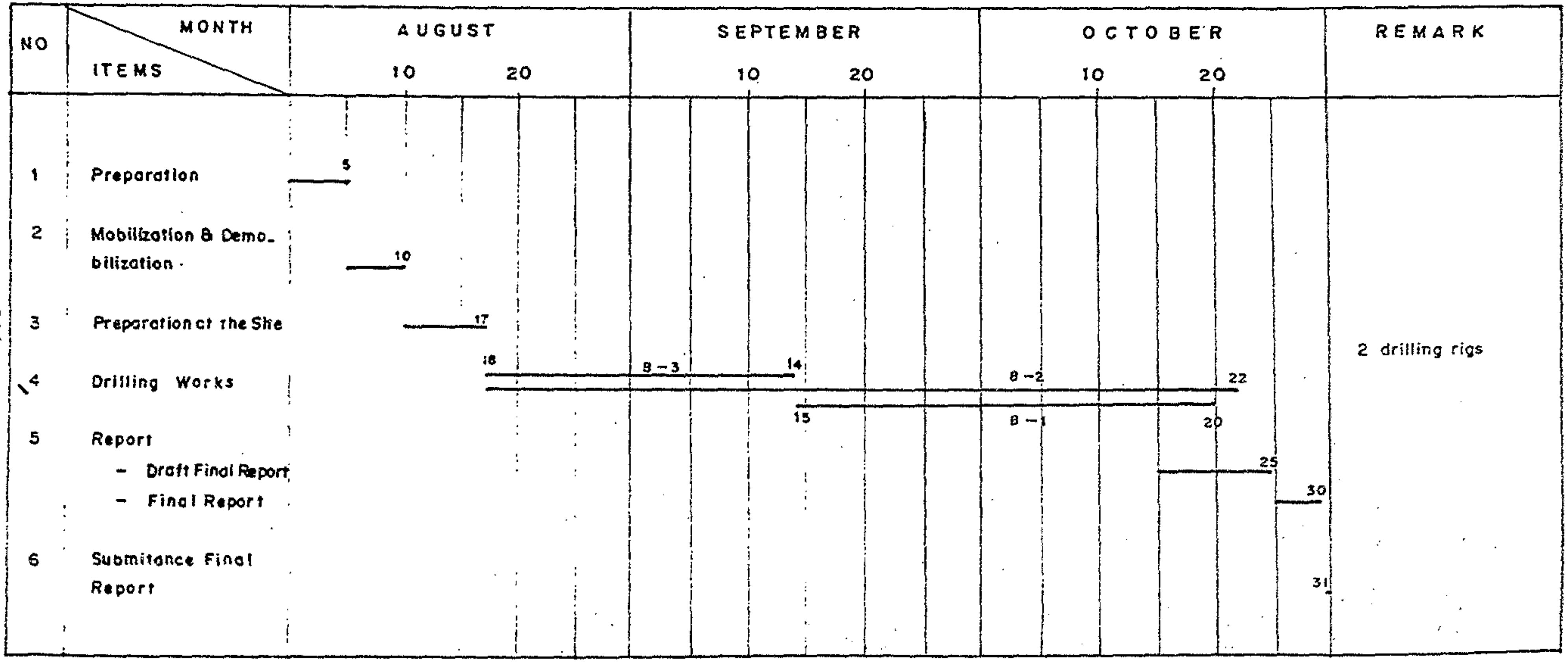
Fig. 11.1 Location Map of Survey

11.4 Working Schedule

The working schedule is shown in Fig. - 11.2. The transportation of the drilling rigs were started from Bandung on the 5th of August in 1987, and all of the equipment was transported by helicopter on the 10th of August.

The drilling started on the 18th of August and finished on the 22nd of August 1987.

Fig. - 11.2 Time Schedule of the Drilling Work for the Geotechnical Investigation
Mt. Galunggung Disaster Tunnel Project



11.5 Procedure

11.5.1 Drilling Method

Rotary drilling method had been used for drilling work in Galunggung Project. Based on litologic condition (cohesionless sandy), the drilling was done by dry drilling on the upper part and wet drilling on the lower part. Beside that, a telescopic drilling system had also been used. In detail see Table - 11.2 and Fig. - 11.3.

Table - 11.2 Drilling System

No.	Bore Hole No.	Depth (m)	Drilling System
1.	B-1	0.00-70.00	Dry Drilling
		70.00-80.00	Wet Drilling
2.	B-2	0.00-40.00	Dry Drilling
		40.00-80.00	Wet Drilling
3.	B-3	0.00-40.00	Dry Drilling

11.5.2 Transportation

The drilling rig and all of accessary equipments were transported by truck from Bandung to Koconcong village, foothill of Mt. Galunggung, and they were transported by helicopter from Koconcong to the site.

After completion of drilling works, all of equipment was transported down to Koconcong by manpower.

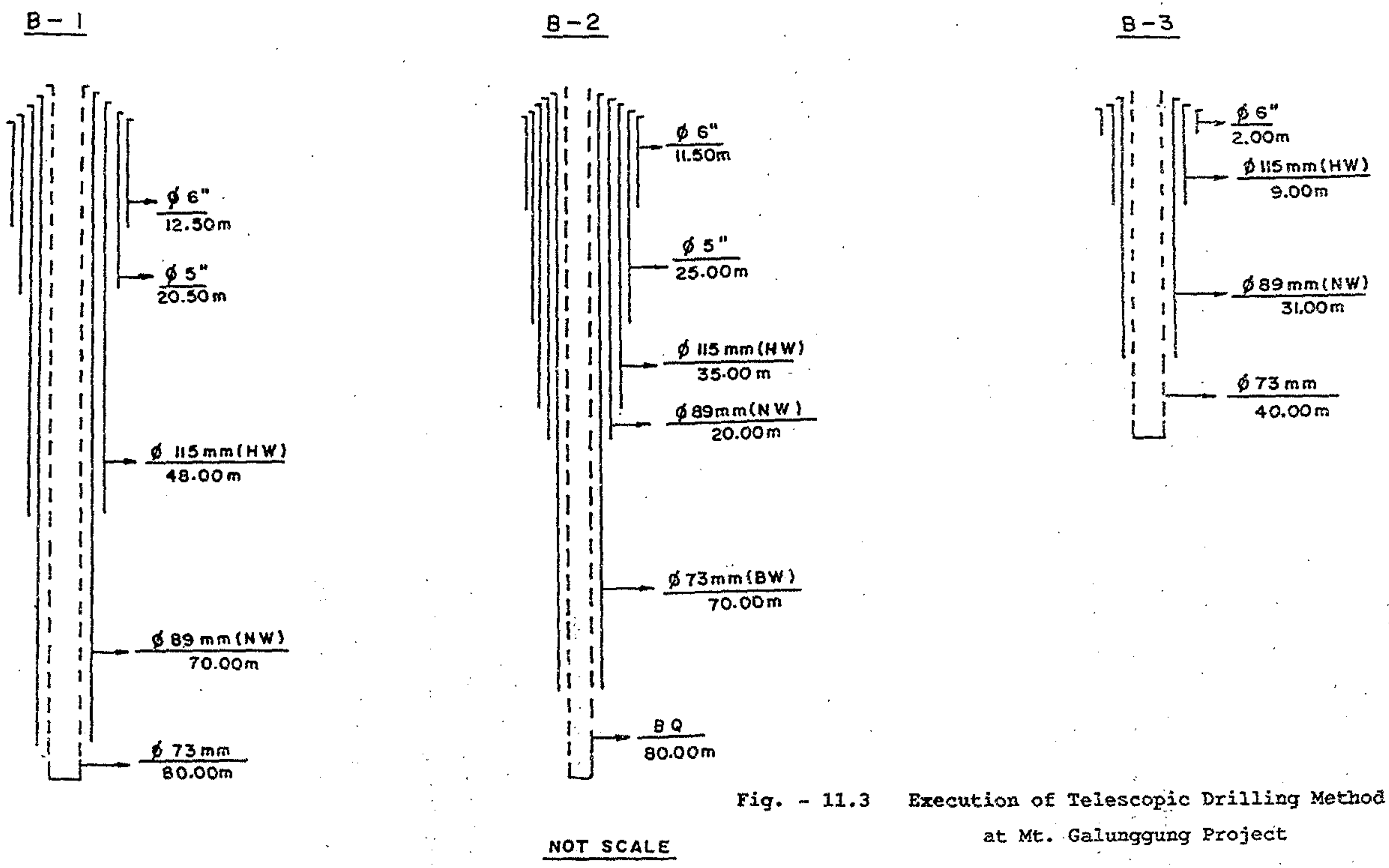


Fig. - 11.3 Execution of Telescopic Drilling Method at Mt. Galunggung Project

11.5.3 Equipment

The main equipments used in drilling works are as follows:

- Drilling machine (YBM 3E type) = 1set
- Drilling machine (YSD 2E type) = 1 set
- Spare pump = 2 units
- Supply pump = 1 unit
- Pump for packer test = 1 unit
- Double core barrel = 1se t
- Single core barrel = 2 sets
- Rod = 200 m
- Casing Ø 6 inch = 30 m
  - Ø 6 inch = 50 m
  - Ø 115 mm (HW) = 90 m
  - Ø 89 mm (NW) = 120 m
  - Ø 73 mm (BW) = 80 m
- Packer apparatus = 1 set
- GWL measurement apparatus = 1 set
- Piezometer = 3 sets for 200 m
- Tools = 1 set
- other accessories.

11.5.4 Permeability Test

Ten (10) permeability tests were carried out at the drilling holes No. B-1 and B-3, mainly, 8 (eight) times in B-1 and 2 (two) times in B-3.

In the normal condition in site test will be tested at 5 steps of pressure condition, by packer test method. Flow rate of injection water will be observable under each step of pressure to 5 minutes after the flow rate becomes stable, and recorded by every one minute.

The results of permeability test are shown in annex-1.

11.5.5 Ground Water Level

No ground water level was met in any drilling hole. This means that until elevation + 1035 m there is no ground water.

11.5.6 Fumarole

Fumarole blew out from drilling hole No. B-1 and also a little from hole No. B-2. They have high temperature, especially in bore hole No. B-1. The measurement had been carried out and their temperature attained until 90°C. In the drilling hole No. B-1, the hot fumarole started from 7.00 m depth down until the bottom (80 m). The result of the measurements were that the highest temperatures lie at depths between 8.00 m until 27.00 m. At more than 27 m depth, the temperature decreased. In the hole No. B-2 fumarole blew out after at 23 m depth, their temperature had been measured.

11.6 Lithology

Based on the surface geological mapping and drilling results, the lithology of the project area can be divided into six rock units. They are Tephra, Pyroclastic flow deposit, young volcanic breccia, older volcanic breccia and andesite dome.

Drill logs of three (3) bore holes are attached in Annex-3. Stratigraphy of the volcanic rocks is shown in Table - 11.3.

Table - 11.3 Stratigraphy of the Volcanic Rocks around the Crater Lake

B e d	Rock of Sediment Facies	period of eruption
Tephra	Scoria, pumice and ash, accompanied with volcanic bomb.	1982-1983
Pyroclastic Flow deposits	Coarse sand and gravel	1982-1983
Young volcanic breccia	Matrix soft, loose, not consolidated, breccia small - big.	1894
Andesite dome	Hard, cracky, every joints opened, partially autobreccia.	1918
Older volcanic breccia	Matrix soft - a little consolidated breccia small - big.	1822

11.7 Geological Problems for Tunnel Works

Drilling survey revealed some serious geological problems for tunnel works from the crater lake to S. Cibanjaran.

a) Weakness of the foundations:

All units except andesite are very soft, loose, not consolidated and heterogeneous.

Judging from the drilling core and seismic velocity (max 2.30 km/sec) the strength of the four (4) units is estimated to be very weak.

b) High permeability

The foundation is very pervious originally and the permeability is presumed to be approximately $k = 10^{-3}$ order.

c) High temperature fumarole and poinsonous gas

Fumarole which temperature is approximately ranged from 80° to 90°C is blown up from B-1 and B-2 drilling holes, including small amount of poinsonous gas.

d) Instability of excavated slopes

The andesite near the proposed shaft is highly cracked and all joints opened, therefore, creep occurs on steep slopes that were excavated.

Near the outlet of the proposed drainage tunnel, the foundation consists of pyroclastic flow deposits and is very soft, loose and not consolidated.

12. Seismic Survey

12.1 General

The seismic survey is a part of the geological survey for the feasibility study on disaster prevention in the southeastern slope of Mt. Galunggung, West Java, Republic of Indonesia.

The seismic survey was executed by P.T. Tricon Jaya, an Indonesian consulting firm in Bandung, under the order and supervision of JICA study team from the beginning of August until the end of September, 1987.

The final report of the survey was submitted by P.T. Tricon Jaya to JICA study team on the beginning of October, 1987.

This report describes the outline of the seismic survey.

12.2 Object

The object is to investigate the geological conditions, especially for tunnelling engineering, around the crater lake for the planning of drainage facilities.

12.3 Item and Quantities

Item and quantities of the survey are described in Table - 12.1 and location of each line is shown in Fig. - 12.1.

Table - 12.1 Item and Quantities of Seismic Survey

Item	Line	Length (meters)
Seismic Survey	A Line	230 m
	B Line	345 m
	C Line	230 m
	D Line	230 m
	Total	1,035 m

A total of 1.035 meters of seismic prospecting was carried out such as line A, line B, line C and line D. Those lines were interconnected to each other and controlled by three (3) bore holes B-1, B-2, and B-3.

Quantity of Survey

Seismic Survey	A	line	230 m
	B	line	345 m
	C	line	230 m
	D	line	230 m
		Total	1035 m
Drilling	B - 1	L = 80 m	(EL = 1100,6 m)
	B - 2	L = 80 m	(EL = 1155,6 m)
	B - 3	L = 40 m	(EL = 1115,6 m)
	Total	200 m	

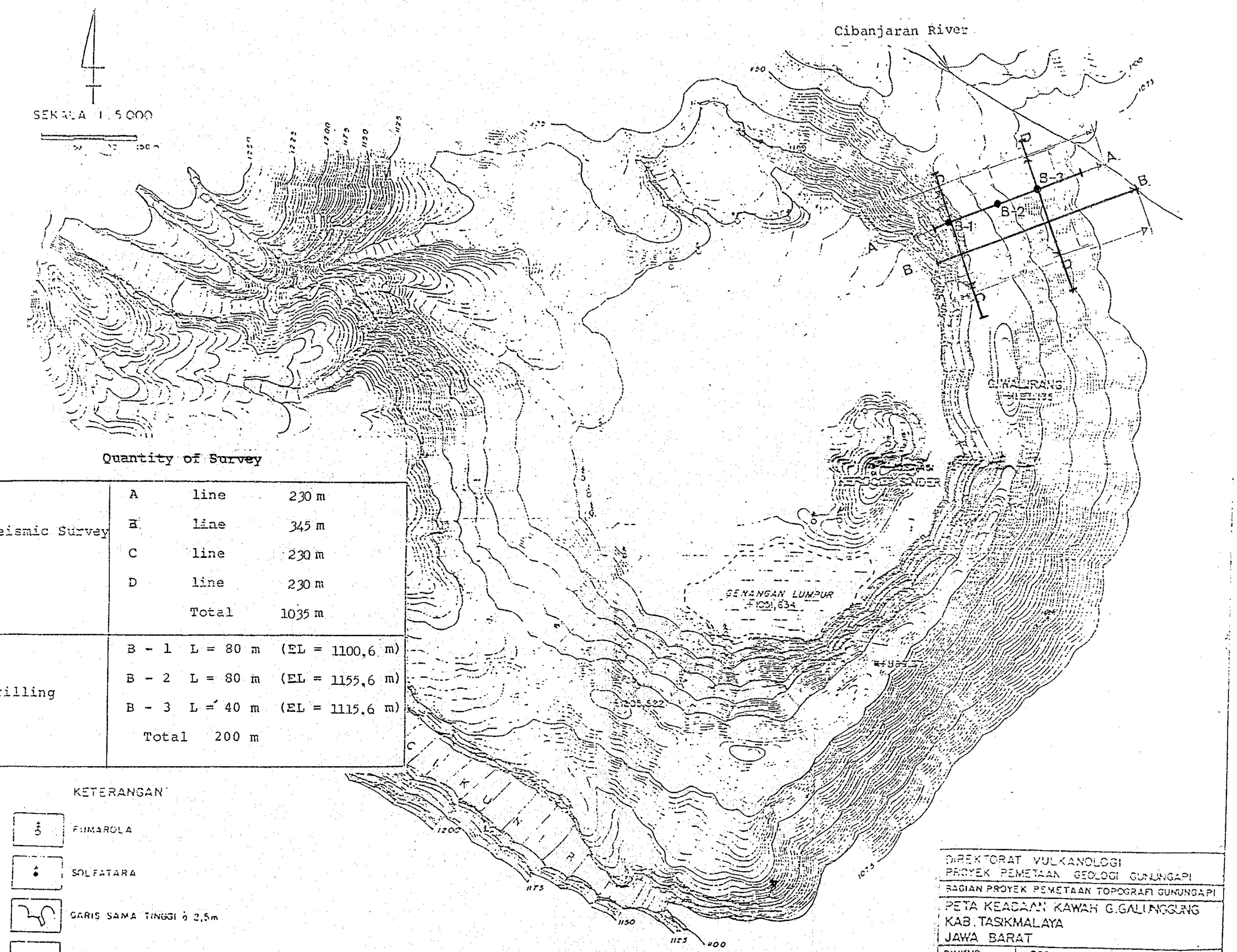


Fig. 12.1 Location Map of Seismic and Drilling Survey

12.4 Working Schedule

The working schedule was described as follows:

1. The blasting permit was arranged from August 1st until September 1st, 1987. It was almost one (1) month.

2. After recommendation was received, the team prepared from September 1st until September 8th, 1987.

3. Seismic investigation was conducted from September 12th up to September 20th, 1987.

4. Data processing and the final report were made from September 22nd to October 10th, 1987.

12.5 Procedure

12.5.1 Field Procedure

The Seismic profiling conducted for Mt. Galunggung Feasibility Study area was constructed for depth of penetration up to 100 meters.

The Seismic profiling was conducted by placing seven shoots for each spread. The seven shoots were distributed as follows: Two shoots were placed at both end of the seismic spreads (forward, reverse). Two shoots were blasted at distances 100 m and 200 m from each last end of geophone in the spread line. This is known as phanthom shot. Inside the line, the geophones were spaced 5 meters each, the nearby shot was placed at 2.5 meters. The total length of geophone spread is 115 meters, which was divided into two half spreads.

The maximum penetration of this technique depends on velocity distribution. In the case of the Galunggung Study, the maximum penetration was about 30-60 meters for third layer, and 60-100 meters for fourth layer.

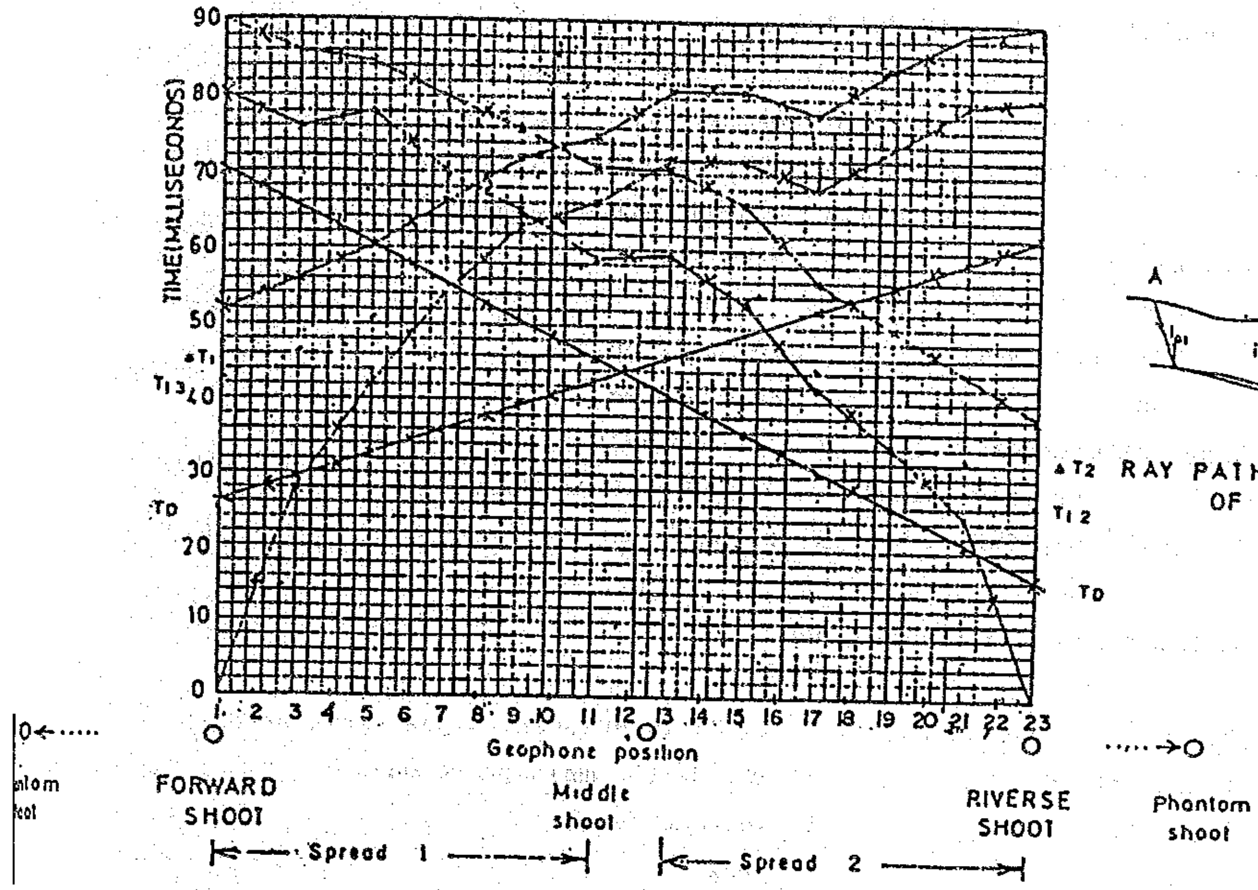
A seismic survey of a total of 1.035 meters successfully conducted, for this project. The distribution is as follows:

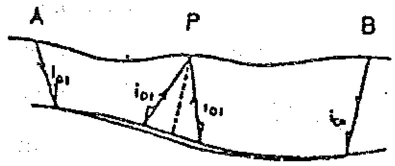
Table - 12.2 Detail Specification of Seismic Survey

Line	Total Spread	Direction	Total Length	Shot
Line A	2	NE - SW	230 meters	14
Line B	3	NE - SW	345 meters	21
Line C	2	NW - SE	230 meters	14
Line D	2	NW - SE	230 meters	14
		Total	1,035 meters	63

In the interpretation and correlation of the geological data, three bore holes were used to check the seismic results. Those bore holes are B-1, B-2, and B-3.

Fig. - 12.2 Layers Travel-Time Graph





RAY PATH IN CALCULATIO OF TIME-DEPTH

12.5.2 Seismic Instruments

Specification of seismic instruments are described below.

- Amplifier module (Model 1062)

No. of channel	:	14
Input impedance	:	600 (balance transformer)
Gain	:	90 dB (current gain)
Frequency	:	5 to 200 Hz
Filters	:	
LPF (low pass)		70 Hz 12 dB.oct
Notch		50 or 60 Hz
Input attenuator	:	1/1 and 1/10
Noise (input conversion)	:	0.3 uV peak-to-peak
Power consumption	:	20 mA

- Control module (Module 1063)

Calibration oscillator	:	20 Hz 10 uV peak-to-peak xxxx waves
Timing lines	:	100 Hz (10 ms) square wave
Test circuits	:	Voltage level
		peak
		Leakage test
Telephone circuit	:	For communication with blaster operator
Power consumption	:	60 mA (average)

The explosive used for seismic survey at Mt. Galunggung was "damotin type", which is packed with 180 gram each. The explosive was purchased from PT. Dahana at Tasikmalaya.

12.5.3 Depth Calculation

The interpretation procedure for the seismic prospecting here, is done by combining the Hagiwara, Matsuda and Hawkins Methods.

The depth determination in reciprocal method, is based on the calculation of time depth. The time depth defined as time delay associated with delay time, produced by critical ray path, travelling at low velocity and in underlaying refractor, below every geophone position.

12.6 Result of Seismic Survey

Based upon compressional seismic velocities (Vp), which were analyzed for Mt. Galunggung Project and correlation with bore hole result, we can classify the volcanic material into two kinds of rock with different physical properties.

The first class is the upper part velocity layers. The velocity layer which has Vp = 300 m/s and Vp = 600 m/s. These layers are classified as very soft ground and loose material. These rocks are interpretated as the recent volcanic activity deposit.

The second class is the rock which is interpretated as older volcanic activity deposit, which is as Vp3 = 1500 m/s, and Vp4 = 2300 m/s.

This rock is classified as strong compact and dense rock. The complete interpretation of rock properties is presumed as shown in Table - 12.3.

Table - 12.3 Velocity Layer and its Physical Properties Interpretation

No.	Layer	Vp	Properties
1.	1	300- 350 m/s	Very soft ground and loss material.
2.	2	600- 650 m/s	Soft ground and rather compact.
3.	3	1450-1500 m/s	Rather strong rocks and medium dense and medium compact.
4.	4	2000-2500 m/s	Strong, dense and compact rock.

It is recommended in excavating the proposed tunnel, to take into consideration the low velocity layers, especially the first layer which has very low velocity and loose material.

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1. General

In consideration of assumed damage conditions and the frequency of disaster, the disaster prevention plan for Mt. Galunggung is divided up into plans concerning the runoff basin on the southeastern slope, and plans concerning the crater lake. (see Fig. - 1.1)

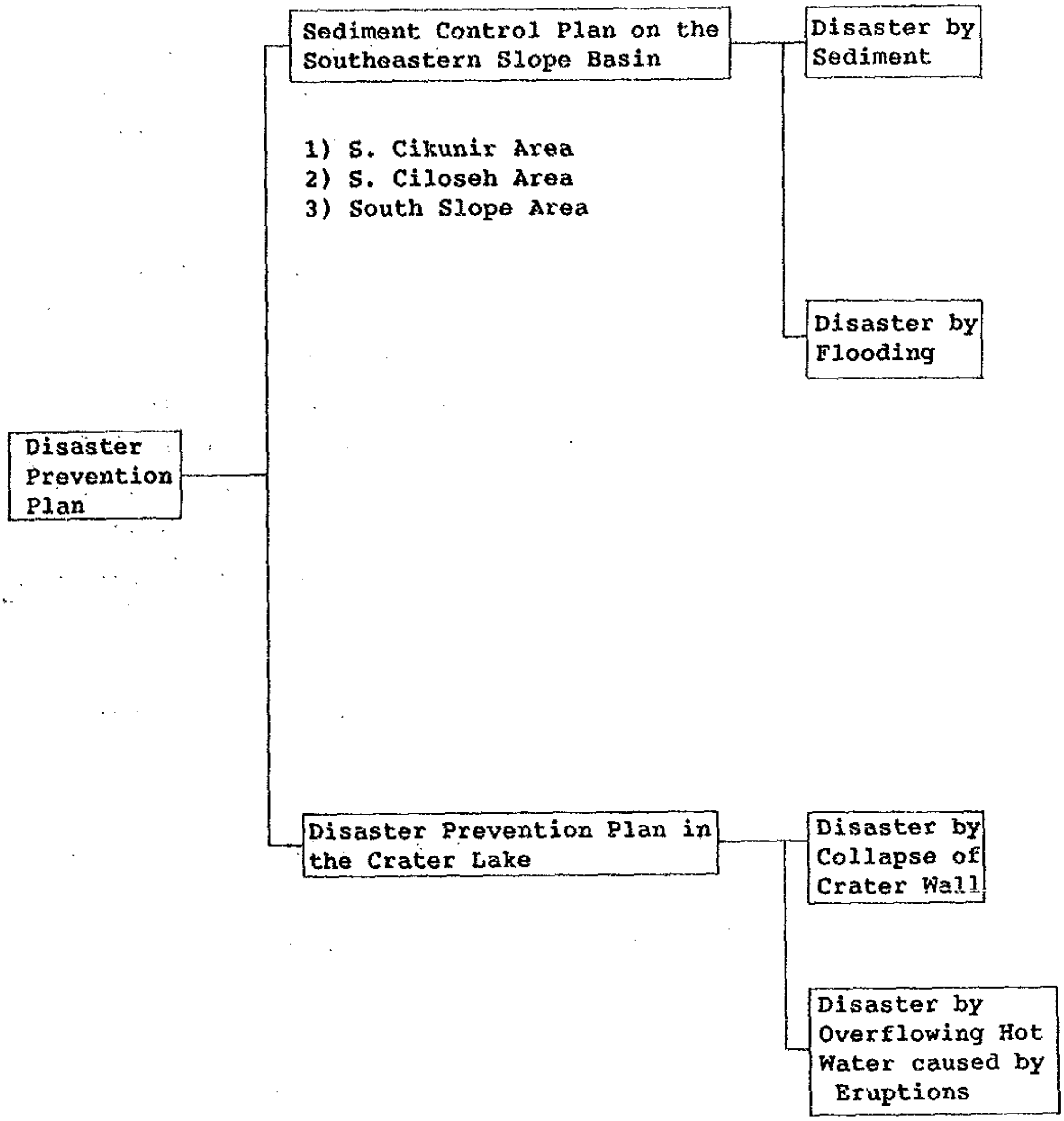

Fig. - 1.1 Division of Disaster Prevention Plan and Assumed Disaster

The disaster prevention plans for the runoff basin on the southeastern slope are to prevent disaster by sediment from another movement of the sediment accumulated on the mountainside along the rivers from eruption of Mt. Galunggung in 1982. They are also to prevent disaster by flooding.

The disaster prevention plans for the crater lake are to prevent the collapse of the crater lake wall and damage from the accompanying mud flow. They are further to prevent the disaster by overflowing hot water from eruptions.

While it is possible to grasp the size and frequency of damage on the southeastern slope basin from the amount of sediment and flooding, damage to the crater lake is impossible to estimate. The fact that it is impossible to know the location and extent of ruptures makes it difficult to grasp the size and frequency of damage. For this reason, the southeast runoff basin and crater lake were treated separately in the disaster prevention plan study. As the plans for the southeast basin include suppression and control of sediment yield and runoff, study was pursued under the title "Sediment Control Plan".

The existing basic plan for the disaster prevention of Mt. Galunggung area prepared by Indonesia government was reviewed by JICA study team on the occasion of the study for the sediment control plan.

The items shown in this report are the following;

1) Review of Existing Basic Plan
2) Sediment Control Plan
    a) S. Cikunir Area
    b) S. Ciloseh Area
    c) South Slope Area
3) Countermeasures for Crater Lake
4) Disaster Prevention Project

The Study Flow for the decision of the specifications for the disaster prevention facilities mentioned above are shown in Fig. - 1.1.

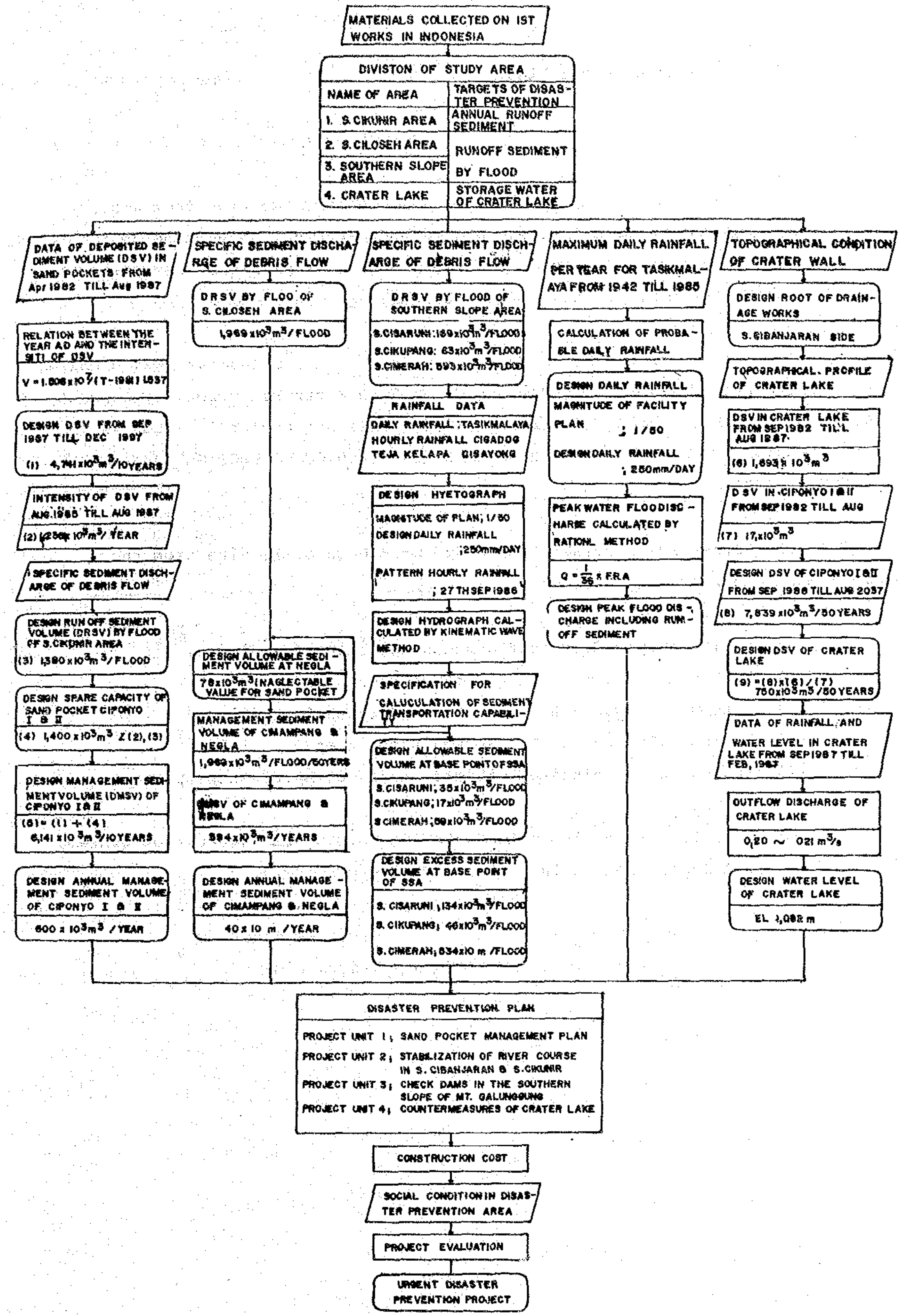

Fig. - 1.1 Study Flow for Decision of Specifications for Disaster Prevention Facilities in Southeastern Slope of Mt. Galunggung

2. Review of Existing Basic Plan

2.1 General

The objectives of review concerning Existing Basic Plan (hereinafter referred to as "Basic Plan") are to understand a basic idea for the sediment control and obtain useful information for planning of Disaster Prevention Plan in the southeastern slope basin of Mt. Galunggung.

The Basic Plan in the southeastern slope of Mt. Galunggung was prepared by Directorate of Rivers, Directorate General of Water Resources Development, Ministry of Public Works in February, 1984. This Basic Plan is reported in "PERENCANAAN MENYELURUH DAERAH BENCANA GUNUNG GALUNGGUNG PROPINSI JAWA BARAT PEBRUARI 1984".

JICA Study Team reviewed the above-mentioned Basic Plan from the following angles:

a) Notion of yield, runoff and accumulation of sediment.
b) Setting of danger area and countermeasures.
c) Setting of method for basic design specifications.
d) Notions of disaster prevention facilities.
e) Evaluation of disaster mitigation effect by disaster prevention facilities.
f) Disaster prevention plan including warning and evacuation systems and regulation of land use.

2.2 Contents of Basic Plan

2.2.1 *Proposed Control Sediment Volume*

Total volume of ejected materials accumulated on the slope of Mt. Galunggung has been estimated as follows by Directorate of Volcanology:

Table - 2.1 Total Volume of Ejected Materials (Ash deposits)

	Volume in Aug. 1982 (10^6 m^3) (1)	Volume in Jan. 1984 (10^6 m^3) (1)	Transported Volume (%) (3)=(1)-(2)/(1)
S. Cikunir - S. Cibanjaran	(14.2) *1 14	6.6	54
S. Cimampang - S. Ciloseh	(7.2) *2 8.5	1.8	75
Southern Slope	18.5	6.8	63
Western Slope	(9.5) *3 (9.3)	5.1	46

NOTES: According to the report of J.A. Katili and Adjat Sudradjat (1984), total volume of ejected materials during April 1982 - August 1982 is written as follows:

*1 S. Cikunir - S. Cibanjaran : 14.2 million m^3

*2 S. Cimampang - S. Ciloseh : 7.2 million m^3

Southern Slope : 18.5 million m^3

*3 Western Slope : 9.5 million m^3

In this study, the above-mentioned volumes are adopted.

2.2.2 Danger Area

(1) Disaster classification

The type of disaster related to the forms of sediment movement can be classified into the following three (3) types;

1) Primary disaster

The disaster is caused directly by volcanic eruptions. Main danger from primary disaster is pyroclastic flow with high temperatures more than 900°C.

2) Secondary disaster

The disaster is caused by secondary movement of volcanic materials. The damages in Mt. Galunggung area were mostly caused by secondary disaster.

3) Landslide

The sediment of deposits was supplied not only from volcanic materials but also from landslide such as in 1868 and 1950.

(2) Danger Area

Danger area on the slope of Mt. Galunggung has been provided by Volcanological Directorate in 1967 (see Fig. - 2.1).

In this map, two (2) danger areas were proposed as follows;

1) Area to be evacuated hastily. This area may be affected directly by eruption disaster such as volcanic eruption and Lahar.

2) Warning area. This area is likely affected by flood (banjir) during the rain. This area also must be evacuated.

After Mt. Galunggung eruption, the above-mentioned danger areas have been extended.

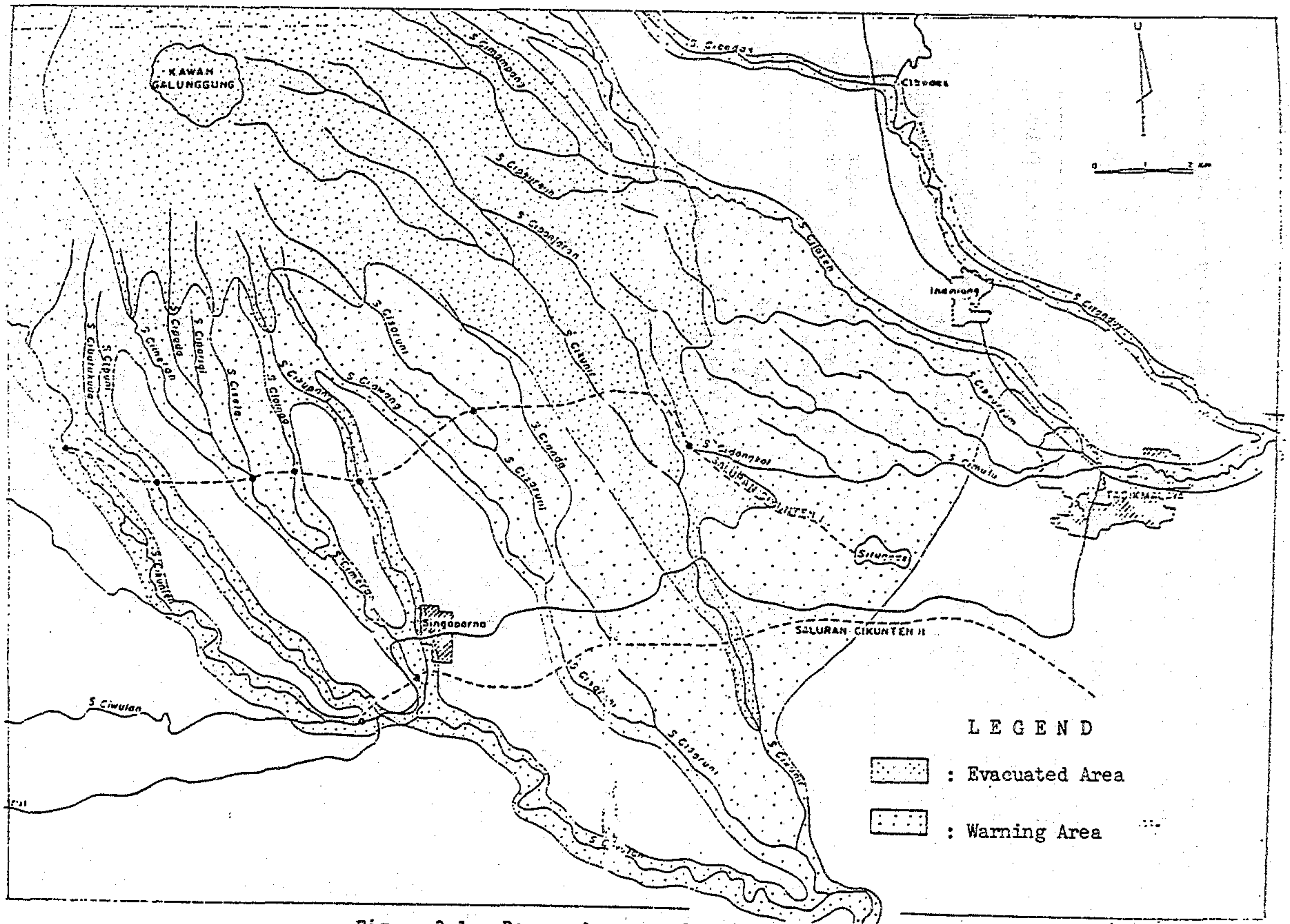

Fig. - 2.1 Danger Area on the Slope of Mt. Galunggung
(Provided by Volcanological Directorate in 1967)

(3) Critical area along the river

After January 1984, the location of critical area along the rivers were proposed as follows (see Fig. - 2.2).

Table - 2.2 Location of Critical Point

Order of Degree of Danger	River Name	No.	Location of Criteria Point Location
1	S. Cikunir - S. Cibanjaran	1.	From Citere up to confluence of both rivers
		2.	From Sinagar up to confluence of both rivers
2	S. Ciloseh -	3.	From Cihujung up to Negla
	S. Cimampang	4.	From Indrajaya up to Narengtong and Negla
3	S. Cikupang	5.	At Leuwisari
	S. Cimerah	6.	At Cilenga
	S. Cisaruni	7.	At Paniis

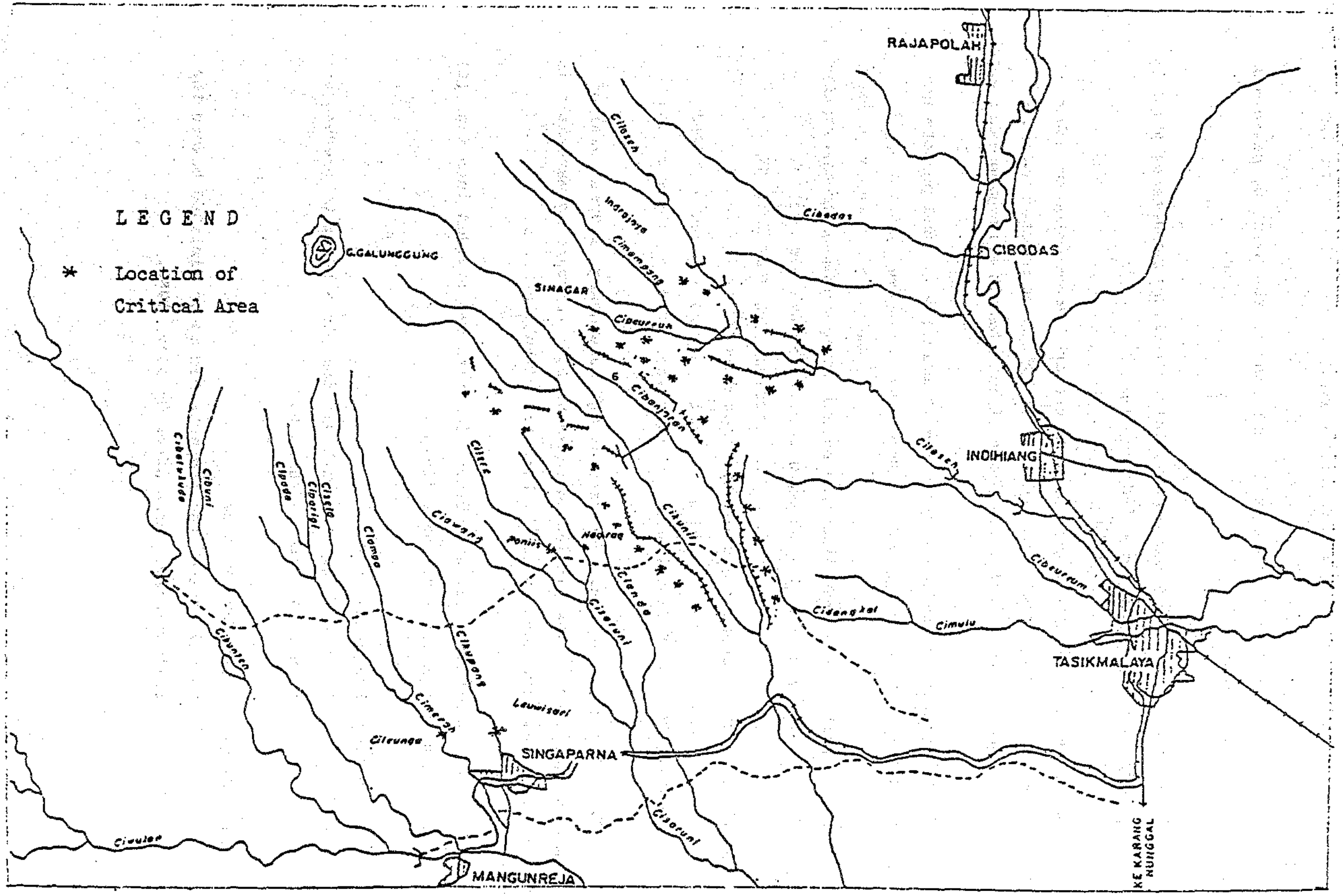

Fig. - 2.2 Location of Critical Point

2.2.3 Basic Principles of Sediment Control Plan

The main principles of sediment control plan in the existing basic plan is summarized as follows;

1) *To stabilize river course at sediment discharge occurrence point by* dikes, groines and consolidation dams.

2) To restrain sediment discharge in the area accumulated unstable materials by consolidation dams. The area accumulated unstable materials are rivers whose slope of riverbed is more than 3%.

3) To control the sediment discharge temporarily by sand pockets and check dams.

4) To control sediment discharge by utilizing sediment transportation capability in the downstream area.

5) To prevent channel erosion by check dams.

2.2.4 Sediment Control Facilities

Since the first volcanic activity of Mt. Galunggung, a great deal of sediment control facilities, including railways for transporting materials in sand pockets, has been constructed by Ministry of Public Works.

The above-mentioned disaster prevention plan was divided into four (4) stages and those stage areas are as follows;

1st Stage: Emergency Works
On this stage, the work was done in a hurry to prevent or reduce the danger from Lahar.

2nd Stage: Short Term Program
On this stage, the projects had to be finished before the coming rainy season after October, 1982.

3rd Stage: Middle Term Program

On this stage, the projects were executed during the first rainy season after the eruption, from November 1982 to May 1983.

4th Stage: Long Term Program

This plan is the final stage of disaster prevention plan. The term of this program has not been determined.

Sediment control facilities to have been executed in 1st stage and 2nd stage are as shown in Table - 2.3. The location of these facilities are shown in Fig. - 2.3.

Considering above-mentioned program, Basic Plan was determined from the following two points of view.

1) To complete and strengthen the existing sediment control facilities.
2) To construct new sediment control facilities.

Sediment control facilities of Basic Plan are as shown Table - 2.4 - 2.7. The location of these facilities are shown in Fig. - 2.4.

Table - 2.3 (1) Existing Sediment Control Facilities of Basic Plan
(S. Cikunir - S. Cibanjaran Basin)

No.*	Facility Name	Remarks
1.	Right dyke	Sand Pocket Ciponyo I
2.	Right overflow (Consolidation dam)	"
3.	Cross dyke	"
4.	Left overflow (Consolidation dam)	"
5.	Groynes	"
28.	Sinagar dyke	"
29.	Cibueuk dyke	"
30.	Kubangmanyar dyke	"
31.	Kubangbuleud dyke	"
32.	Kedung dyke	"
33.	Citere dyke	"
34.	Kokoncong dyke	"
35.	Rancailat dyke	"
7 - 9	Right dyke	Sand Pocket Ciponyo II
10 - 12	Left dyke	"
13	Groynes	"

* Numbers are as shown in Fig. - 2.3.

Table - 2.3 (2) Existing Sediment Control Facilities of Basic Plan (S. Ciloseh - Cimampang Basin)

No.*	Facility Name	Remarks
14.	Right dyke	Sand Pocket Cimampang
15.	Right overflow (consolidation dam)	"
16.	Cross dyke	"
17.	Left overflow (consolidation dam)	"
18.	Left dyke	"
19.	Left groynes	
20.	Right dyke	Sand Pocket Negla
21.	Overflow (consolidation dam)	"
22.	Left dyke	"
23.	Groynes	"
24.	Check dam I	S. Ciloseh (Broken)
25.	Check dam II	"
26.	Check dam III	"
27.	Check dam IV	

* Numbers are as shown in Fig. - 2.3.

Table - 2.4 (1) Sediment Control Facilities of Basic Plan
(S. Cikunir - S. Cibanjaran Basin)

Facility	No.*	Location	Remarks
Dykes	1.	Left side of Ciponyo I	Dimension is not planned
	2.	Right side of Ciponyo I	
	3.	Left side of Ciponyo II	
	4.	Right side of Ciponyo II	
	5.	Down stream of Cikunir Bridge	
Check dam	6.	Upper reaches of S. Cikunir	Height of dam = 5 - 8 m
	7.	"	"
	8.	"	"
Overflow	9.	Confluence of S. Cikunir and S. Cibanjaran (Ciponyo II)	Dimension is not planned
Consolidation dam	10.	Down stream of Cikunir Bridge	Height of dam = 0.5 m
Groyne	11.	Ciponyo I	Length = 20 m
	12.	Ciponyo II	

Numbers are as shown in Fig. - 2.4.

Table - 2.4 (2) Sediment Control Facilities of Basic Plan
(S. Cimampang - S. Ciloseh Basin)

Facility	No.*	Location	Remarks
Dykes	13.	Right side of Cimampang (at Desa Cipeureu)	Construction
	14.	Right side of Cimampang	Increasing
	15.	Left side of Cimampang	"
	16.	Right side of Negla	"
	17.	Left side of Negla	"
	18.	Old check dam I	Height = 3 - 5 m
	19.	" II	"
	20.	Between check dam I & II	"
	21.	Old check dam III	"
	22.	Old check dam IV	"
Consolidation dam	23.	Upper stream of Ciloseh Bridge	
Groyne	24.	Sand Pocket Cimampang	Length = 20 m
	25.	Sand Pocket Negla	

Numbers are as shown in Fig. - 2.4.

Table - 2.4 (3) Sediment Control Facilities of Basic Plan (S. Ciwulan - S. Cikunten Basin)

Facility	No.*	Location	Remarks
Dykes	26.	S. Cisaruni (Nagrak)	
	27.	S. Cikupang (Leuwisari)	
	28.	S. Cimerah (Leuwiseeng)	
	29.	S. Cikunten	
	30.	S. Ciwulan	
Check dam	31.	S. Cisaruni	
	32.	"	
	33.	S. Cikupang	
	34.	"	
	35.	S. Cimerah	
	36.	"	
	37.	"	
	38.	S. Cikunten	
	39.	"	
	40.	"	
Consolidation	41.	S. Cimerah	
	42.	S. Cikunten	

* Numbers are as shown in Fig. - 2.4.

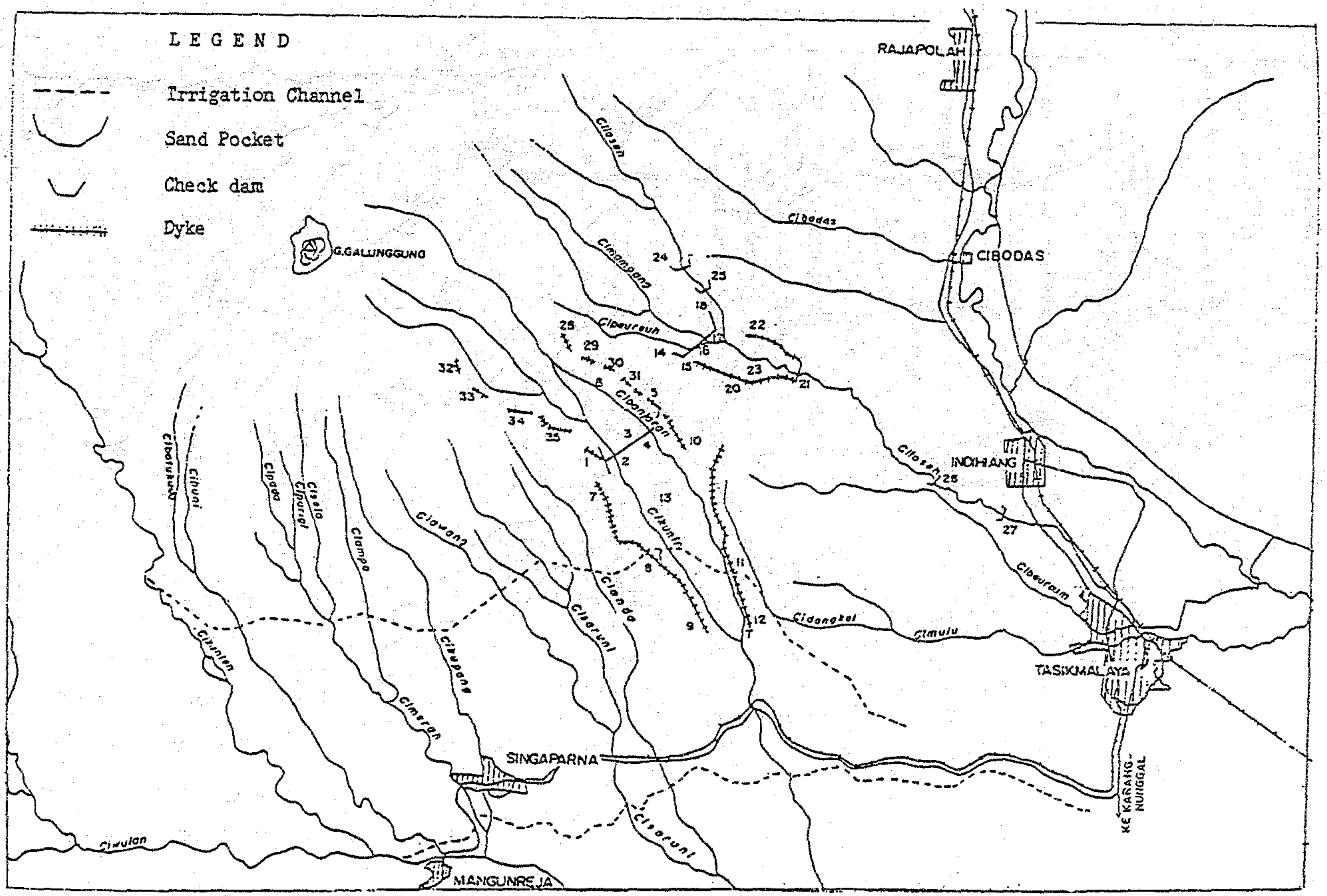

Fig. - 2.3 Existing Sediment Control Facilities of Basic Plan

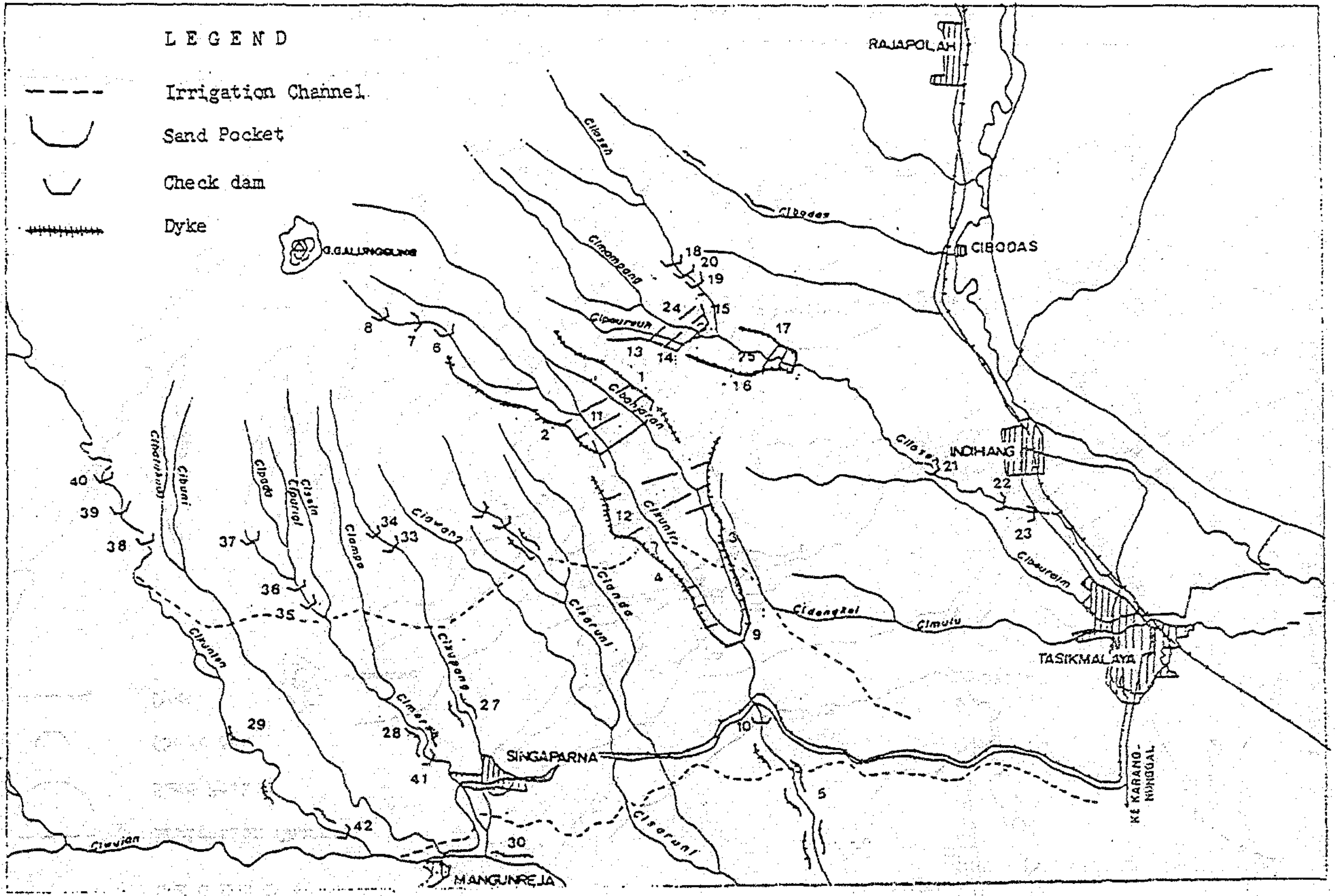

Fig. - 2.4 Sediment Control Facilities of Basic Plan

2.2.5 Social and Economic Damages

The social and economic damages during the eruption of 1982 in Kabupaten Tasikmalaya is shown as Table - 2.5. The total monetary value has been estimated at 52,298.4 million Rupia.

2.2.6 Warning and Evacuation System

The warning and evacuation system has been supplied by the Government of Japan for Mt. Galunggung Project.

The equipment of the system was as follows;

a) One (1) unit raingauge radar
b) Three (3) units of mudflow sensor
c) Two (2) units of automatic rainfall measurement equipment
d) Display equipment for radar
e) Hydrological equipment with telemetering system
f) Other equipment for information station, such as wireless communication system and Public Information Mobile unit

It is necessary to form the organization and the communication system for completing the above-mentioned warning system, and noticing of the information concerned to danger and evacuation of people.

Table - 2.5 Damage to Kabupaten Tasikmalaya from the Mt. Galunggung Eruption

Sector	Item	Quantities	Amount of Damage
Social Sector	Elementary School	237	3,359.7
	High School	3	27.0
	Mosque	103	141.4
	Islamic School	116	45.2
	Islamic College	21	13.0
	Public Health	10	21.4
	Public Utilities	189	12.0
	House	7,740	4,199.2
	Sub Total		7,818.9
Economic Sector	Agriculture	-	18,141.0
	Plantation	-	3,645.8
	Forestry	-	11,761.7
	Fischer	-	2,664.2
	Livestock	-	1,713.8
	Commercial	-	232.6
	Industry	-	195.2
	Road, Bridge, Irrigation Cha	-	3,372.6
	Sub Total	-	42,727.3
General Sector	Loss of Government Income	-	1,641.7
	Government	-	110.5
	Sub Total	-	1,752.2
	Grand Total	-	52,298.4

Source: LAPORAN BENCANA ALAM GUNUNG API GALUNGGUNG SERTA USAHA PENANGGULANGANYA SEJAK 5 APRIL 1982 S/D SEPTEMBER 1987 DI KABPATEN DT II TASIKMALAYA

2.2.7 Other Ideas of Disaster Prevention Plan

The ideas of disaster prevention plan which were known are as follows:

(1) Flood-channel to connect S. Ciloseh and S. Citanduy

The aim of this idea was to protect Tasikmalaya city from sediment flood, by making a flood-channel from S. Ciloseh to S. Citanduy.

This idea had some problems such as construction cost, influence of sedimention concentration in S. Citanduy, land use, etc.

(2) The channel along the rivers

The aim of this proposal was to carry down the sediment discharge of Mt. Galunggung area hastily to the sea.

This idea had some constraints such as sediment transportation capability of rivers in the lower reaches, occurrence of new floods along the channel, construction cost, land acquisition, etc.

This proposal was very hard to implement.

(3) Carrying the deposited materials in sand pockets

The aim of this idea is to keep the capacity of sand pocket and to use the accumulated materials for the aggregate in Jakarta.

New railway line to connect sand pockets (Ciponyo I and Negla) and the existing railway of Tasikmalaya - Ciawi were constructed in Babakan Jawa.

The sediment discharge volume of sand pocket Ciponyo I were estimated at one (1) million m^3/year for the rainy season of 1983/84. On the other hand, the transportation capacity by train was about 200,000 m^3/year.

The suggestions for the proposal are as follows;

1) To continue the excavation and the transportation of accumulated materials in sand pockets.

2) To rehabilitate road facilities and to construct roads of Tasikmalaya.

3) To manage the traffic on the roads by the local government.

2.3 Comments and Recommendation for Existing Basic Plan

2.3.1 Proposed Control Sediment Volume

In this Basic Plan, the proposed control sediment volume (which corresponds to the term "design excess sediment volume*" according to the Technical Standard of River and Sabo Engineering, Ministry of Construction Japan) of each river is not discussed. It is necessary to estimate the proposed control sediment volume of each river from the sediment volume of deposits resulting from past disasters.

* ..... Design sediment volume is subject of the sediment control plan. Design excess sediment volume at the reference point = Proposed sediment discharge volume at the reference point = Proposed allowable sediment discharge volume at the reference point.

2.3.2 Classification of Sediment Transport Flow Type

In this Basic Plan, classification of sediment transport flow type is not discussed. Its classification is essential to make a plan of sediment control facilities.

On the basis of results of the field investigation, JICA Study Team proposes the following classification according to transportation system and sedimentation form. This classification is aiming at an index of sediment control projects plan and the disaster due to its flow type.

1) Debris flow

Sediment transport flow at the upper stream, and shows the following characteristics of sedimentation.

a) Semicylindrical cross section
b) Bolder concentration at the front
c) Banking along the river course.

2) Mud flow

Sediment transport flow at middle stream, and transitional flow between debris flow and bed-load flow.

2.3.3 Main Principles of Sediment Control Works

The following must be taken into consideration in order to make the sediment control plans;

1) The storage system of sediment control works is not discussed in Basic Plan. The following items shall be set up as the basic specification to plan the sediment control works.
   a) Object disaster in the plan and its magnitude
   b) Reference point and sub reference point
   c) Probable sediment volume such as yield sediment volume, runoff sediment volume and allowable sediment volume

2) In selecting work execution method, it is desirable to investigate the relation between the order of work execution and the transition of the river conditions.

3) Selection of work execution method and order of work execution is desired to be centered around the requirement that the disaster preventing effect will be secured immediately.

2.3.4 Other Recommendations

(1) Sediment control facility

The aim of sediment control facilities of Basic Plan are basically good, but its disaster reduction effect is not reasonable enough to prevent flood disaster. Therefore, sediment balance estimation of study area will be executed by JICA Study Team in this study.

(2) Sediment transportation capability

In this Plan Basic, the sediment allowable volume is not discussed. The sediment transportation capability of reference point, Sub reference point and the lower reaches of S. Ciwulan will be calculated and analyzed by JICA Study Team.

(3) Project evaluation

The project evaluation of Basic Plan is not executed. In this study, the project evaluation will be executed in consideration of several kinds of aspects, such as, not only occurrence frequency and damage potential of disaster but social and financial importance of the project, urgency of the project etc.

3. Sediment Control Plan

3.1 General

The disaster prevention plan on the southeastern slope of Mt. Galunggung is fundamentaly the sediment control plan to prevent disasters due to the debris flow and the floods around the lower reaches basin, which are caused by the re-movement of the accumulated materials of the 1982 volcanic activities in a rainfall.

The disaster prevention plan on the southeastern slope of Mt. Galunggung deal with the synthetic sediment control plan in which, not only the construction of new facilities but also the improvement of existing facilities and their rehabilitation are studied by reviewing of Basic Plan.

The investigation concerning the runoff sediment volume and the accumulated sediment volume after the 1982 eruption have been made by the Volcanological Survey of Indonesia, Directorate of Rivers as well as JICA Study Team.

The study items in this chapter are summarized as follows:

- : To establish the following fundamental sediment volume for the devasted rivers on the southeastern slope of Mt. Galunggung based on the data obtained from first work in Indonesia from June 1987 to November 1987.

  a. Design runoff sediment volume
  b. Design allowable runoff sediment volume
  c. Design excess runoff sediment volume

- : To conduct the sediment control plan on the southeastern slope of Mt. Galunggung on the basis of the fundamental sediment volume established above.

- : To decide the facility plan which design runoff sediment volume is decreased to less than the allowable run of sediment volume at the reference point.

As for the disaster prevention plan, the following works are considered.

(1) Construction of check dam and consolidation dam

(2) Improvement of sandpockets and restoration of sediment regulation capacity

(3) Channel works and revetment works

3.2 Basic Principle for the Sediment Control Plan

The runoff sediment volume in each reference point is determined taking into consideration the conditions of the topography, the geological features, the soil condition of land, the depth of rainfall and the volcanic activities. If there is a difference between the runoff sediment volume from the upper reaches of the reference point and the sediment transportation capability of the river in the downstream section from reference point, there is a possibility of disaster occurrence by aggradation or degradation.

The runoff sediment volume which does not occurs the disaster to the assumed disaster prevention area is the allowable sediment volume, and the difference between the allowable sediment volume at the reference point and the runoff sediment volume from the upper reaches of the reference point is the design excess sediment volume of the reference point.

The characteristics of sediment runoff for the rivers on the southeastern slope of Mt. Galunggung are divided into two groups given below according to the existing survey data and the results of the field investigation.

a) S. Cikunir - S. Cibanjaran Basin;

The accumulated materials of the 1982 eruption remains in the river channels at the Sandpocket Ciponyo I upper reaches basin, and a large amount of the sediment runoff still continues by the secondary erosion, such as their re-movement, the bank erosion and so on.

There is the anxiety of disaster by annual runoff sediment around the lower reaches of this basin.

b) S. Ciloseh - S. Cimampang Basin and the Southern Slope Basin;

The ash deposits by the 1982 eruption do not remain on the hillside around the basin of S. Ciloseh, S. Cimampang, nor by the rivers on the southeastern slopes of Mt. Galunggung. Vegetation covers the hillside slope widely. The sediment runoff form of these rivers is mainly the suspended flow.

There is anxiety concerning the surface erosion, the lateral and deeping erosion of valleys by heavy rainfall in S. Cimampang, S. Cimerah, S. Ciserah as well as S. Cikupang basin.

Taking these sediment runoff characteristics into consideration, the design management sediment volume is for the annual runoff sediment volume around the S. Cikunir - S. Cibanjaran basin, and for the sediment runoff volume by flood around the other basin.

The study flow for decision of specifications of sediment control plan is shown in Fig. - 3.1.

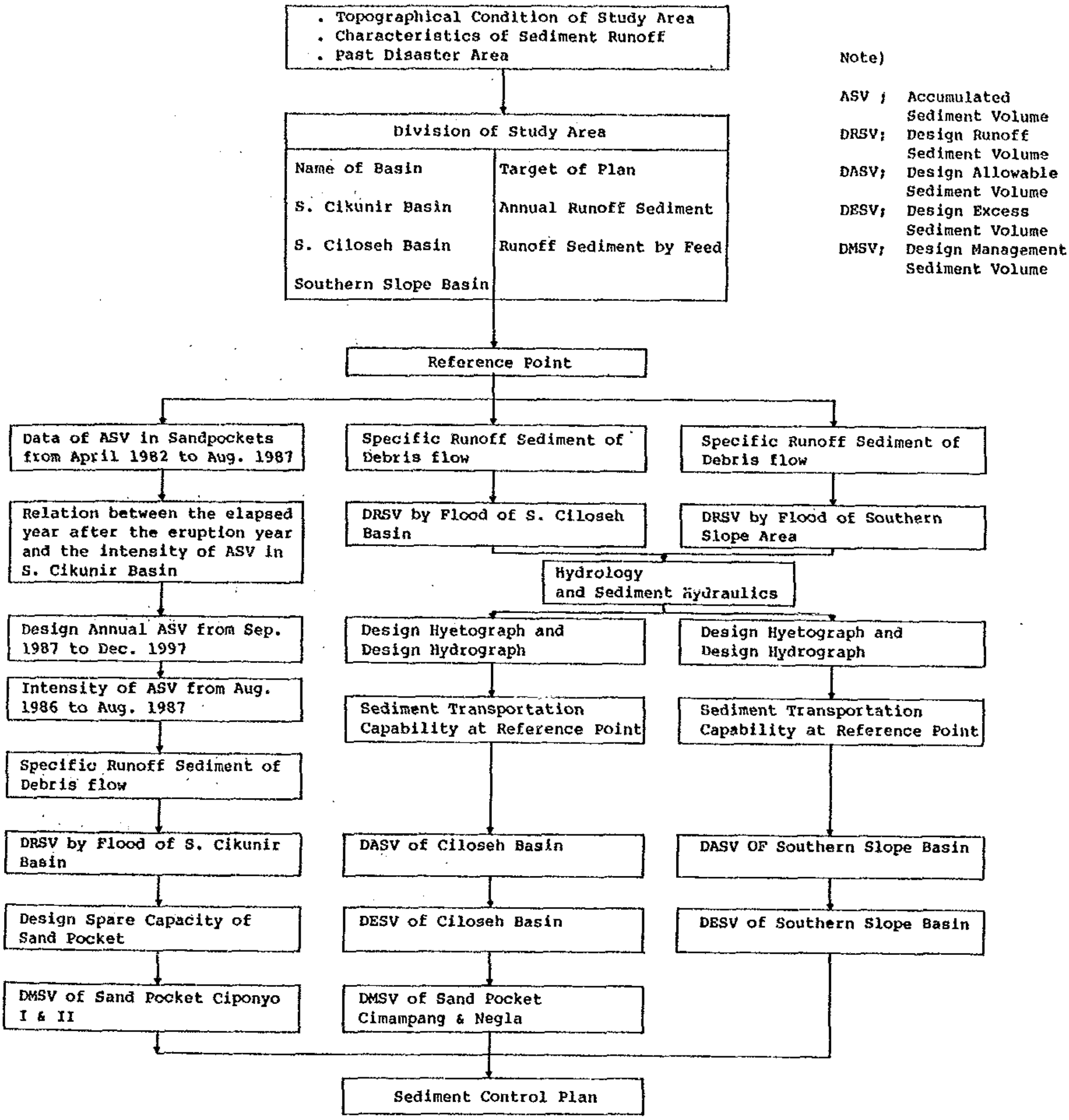

Fig. - 3.1 Study Flow for Decision of Specifications for Sediment Control Plan

3.3 Fundamental Items for Sediment Control Plan

3.3.1 Conservation Areas

The areas to be conserved have been set for each river by taking into consideration the purpose of the disaster prevention, the project units, and the evaluation of the project. The status of disaster damage and resource distribution have been taken into account in the establishment of conservation areas. A list of the areas is shown in Table - 3.1.

It should be noted that there are more channel ruptures in the South Slope Area than for the other rivers, and more unstable sediment on the riverbed. Sediment control plans have been drafted for S. Cisaruni, S. Cikupang and S. Cimerah.

The areas to be conserved, their area and related rivers are shown below.

Table - 3.1 Conservation Areas and Related Rivers

Name of Conservation Area	Area (km^3)	Related Rivers
Area I S. Ciloseh Area	20.65	S. Ciloseh, S. Cibeureum
Area II S. Cikunir Area	50.29	S. Cikunir, S. Cibanjaran, S. Cianda S. Ciloseh, S. Cimula, S. Cibeureum
Area III S. Sisaruni Area	5.95	S. Cisaruni, S. Ciloseh, S. Cimula, S. Cibeureum
Area IV S. Cikupang Area	2.05	S. Cikupang
Area V S. Cimerah Area	3.30	S. Cimerah

3.3.2 Scale of Disaster Prevention Plans

The scale of the disaster prevention plan for each area was determined by taking into account the sediment runoff characteristics.

(1) The scale of the annual runoff sediment volume after 1988 is adopted for S. Cikunir - S. Cibanjaran area.

(2) The scale of the runoff sediment volume by flood is adopted for S. Ciloseh S. Cimampang area as well as for Southern Slope area.

The scale of this plan was evaluated with a return period of 50 years as a rule in accordance with the following reasons.

a) The scale of the disaster prevention plan of Mt. Semeru basin in East Java is 50 years, and the continued sediment runoff of the area is similar to that of Mt. Galunggung basin.
b) The waterway of the river facilities in Indonesia has been planned generally based on 50 years of return period level.

3.3.3 Reference Points

The reference points as well as the sub reference points to determine fundamental sediment volume of the design runoff sediment volume and allowable runoff sediment volume in the disaster prevention plans settled in each river are shown in Table - 3.2.

The reference points and the sub reference points are basically decided at the points below based on the geomorphological study, the socio-economic condition study and the disaster prevention area study.

(1) Upper reaches of the conservation areas

(2) Confluence of each river in the study area with main river such as S. Citanduy and S. Ciwulan.

(3) Cross points of Irrigation Channel CIKUNTEN I

The reference points and the sub reference points are shown in Fig. - 3.2.

Table - 3.2 Reference Points and Sub Reference Points

	No. of Point	River Name	Site Name		Catchment Area (km^2)
Base Point	I	S. Ciloseh	Ciloseh Bridge		38.16
	II	S. Ciloseh	Tasikmalaya	*1	63.64
	III	S. Cikunir	Cikunir Bridge		24.66
	IV	S. Cikunir	Bojongparang	*2	84.42
	V	S. Cisaruni	Nagrag	*3	6.26
	VI	S. Cikupang	Kondang	*3	3.40
	VII	S. Cimerah	Bonjongpel	*3	10.95
	1	S. Cimanpang	Cimampang	*4	14.56
	2	S. Coloseh	Negla	*5	32.07
	3	S. Cikunir	Kokoncong	*6	7.11
	4	S. Cibanjaran	Sinagar	*6	6.77

Note; *1 Confluence with S. Citanduy

*2 Confluence with S. Ciwulan

*3 Cross point with Cikunten I

*4 Overflow point of Sandpocket Cimampang

*5 Overflow point of Sandpocket Negla

*6 Overflow point of Snd Pocket Ciponyo I Dalam

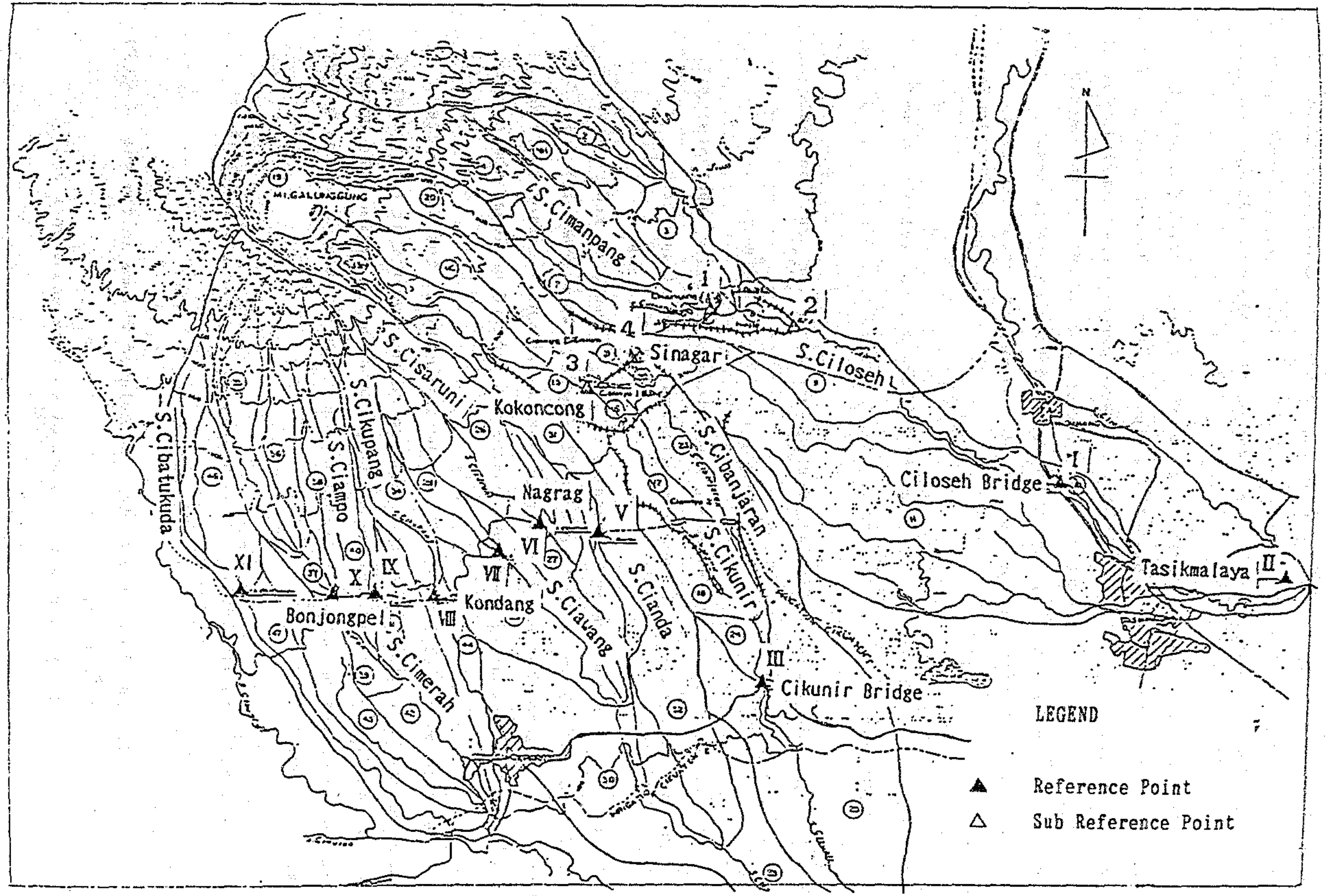

Fig. - 3.2 Location of Reference Points

3.4 Design Management Sediment Volume of S. Cikunir - S. Cibanjaran Basin

3.4.1 Design Annual Accumulated Sediment Volume of Sandpocket Ciponyo I & II

The calculation of the average intensity of the accumulated sediment volume around the Sandpocket Ciponyo I and Ciponyo II area during each investigation period was shown in Table - 3.3 according to the materials which were arranged on the basis of the existing survey data as well as the result of the 1st work in Indonesia by JICA Study Team concerning the sediment balance on the southeastern slope basin of Mt. Galunggung after the 1982 eruption.

Accumulated Sediment Volume shown in Table - 3.2 was calculated on the following conditions.

(1) The sediment accumulation was started just after the eruption early April 1982.

(2) All the quantity of the sediment accumulated till July, 1985 around Sandpocket Cimampang and Negla overflowed from S. Cibanjaran.

Assuming that the average intensity of the accumulated sediment volume occurred in the middle of each investigation period, it becomes like Fig. - 3.3 when the relation between the elapsed year after the eruption and the intensity of the accumulated sediment volume was plotted on logarithmic graph.

In accordance with Fig. - 3.3, if the intensity of the accumulated sediment volume is reduced in a straight line on the logaritmic graph that of Ciponyo I and Ciponyo II is shown below when the relation between the year and the intensity of the accumulated sediment volume was calculated by the method of least squares.

$$V = 1,506 \times 10^3/(T-1981)^{1,537} \quad \text{.........................} \quad (3.1)$$

Where;

V; The intensity of the accumulated volume in the year T (A.D) (m^3/year).

T; The year under the name of each calendar year end

Table - 3.4 and Fig. - 3.4 shows the design annual accumulated sediment volume (DAASV) of Ciponyo I and Ciponyo II after September, 1987 calculated by using formula (3.1).

Table - 3.3 Accumulated Sediment Volume in Sandpocket Area of Ciponyo I and Ciponyo II

Accumulated Period		From Apr. 1982 till Aug. 1982	From Sep. 1983 till Apr. 1984	From May 1984 till Jul. 1985	From Aug. 1985 till Aug. 1987
Accumulated Sediment Volume (10^3 m^3)	Ciponyo I & II	-	7,900	3,450	2,576
	Cimampang Negla	-	2,400	1,450	-
	Total	22,270	10,300	4,900	2,576
Accumulated Period	Month	5	20	15	25
	Years	0.42	1.66	1.25	2.08
Intensity of Accumulated Sediment Volume	10^3 m^3/month	4,454	515	327	103
	10^3 m^3/year	53,448	6,180	3,920	1,236
	10^3 m^3/year/km^2 *1	4,414	510	324	102

Note: *1 Catchment Area of Sandpocket Ciponyo I = 12.11 km^2

Fig. - 3.4 Intensity of Deposited Sediment Volume in Sand Pocket Ciponyo I & II

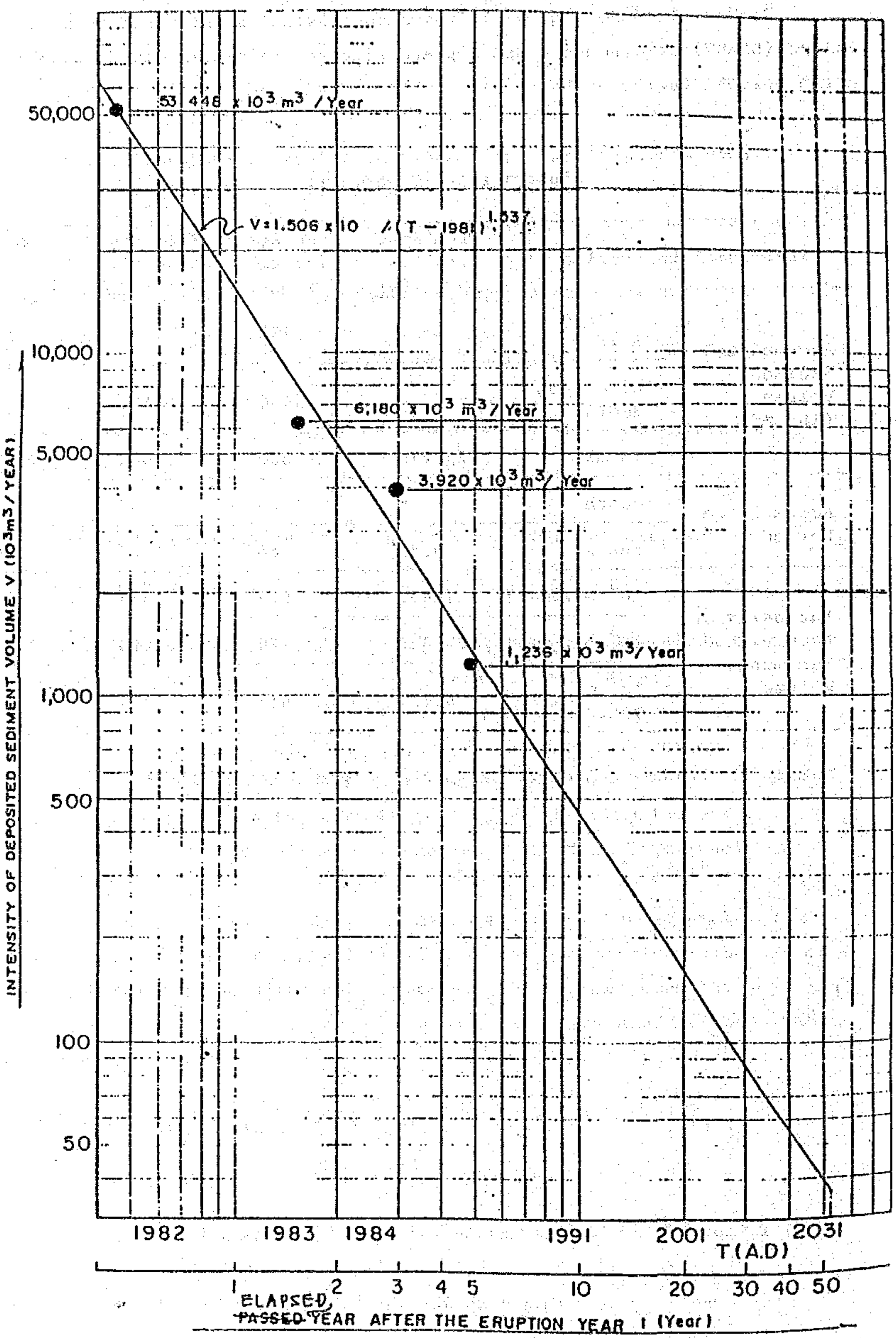

Fig. - 3.3 Intensity of Accumulated Sediment Volume in Sandpocket Ciponyo I and Ciponyo II

Table - 3.4 Design Annual Accumulated Sediment Volume (DAASV) of Sandpocket Ciponyo I and Ciponyo II after Sep. 1987

Year		Annual Accumulated Sediment Volume [Va] (10^3 m^3)	Sum [Va] (10^3 m^3)	Year		Annual Accumulated Sediment Volume [Va] (10^3 m^3)	Sum [Va] (10^3 m^3)
Sep. - Dec. 1987		334	334	25	2012	79	6,634
				26	2013	75	6,709
1	1988	858	1,192	27	2014	72	6,781
2	1989	687	1,879	28	2015	68	6,849
3	1990	565	2,444	29	2016	65	6,914
4	1991	476	2,920	30	2017	62	6,976
5	1992	408	3,328	31	2018	60	7,036
6	1993	354	3,682	32	2019	57	7,093
7	1994	311	3,993	33	2020	55	7,184
8	1995	277	4,270	34	2021	53	7,201
9	1996	248	4,518	35	2022	51	7,252
10	1997	223	4,741	36	2023	49	7,301
11	1998	203	4,944	37	2024	47	7,348
12	1999	185	5,129	38	2025	46	7,394
13	2000	170	5,299	39	2026	44	7,438
14	2001	157	5,456	40	2027	43	7,481
15	2002	145	5,601	41	2028	41	7,522
16	2003	135	5,736	42	2029	40	7,562
17	2004	126	5,862	43	2030	39	7,601
18	2005	118	5,980	44	2031	37	7,638
19	2006	110	6,090	45	2032	36	7,674
20	2007	104	6,194	46	2033	35	7,709
21	2008	98	6,293	47	2034	34	7,743
22	2009	92	6,384	48	2035	33	7,776
23	2010	88	6,172	49	2036	32	7,808
24	2011	33	6,555	50	2037	31	7,839

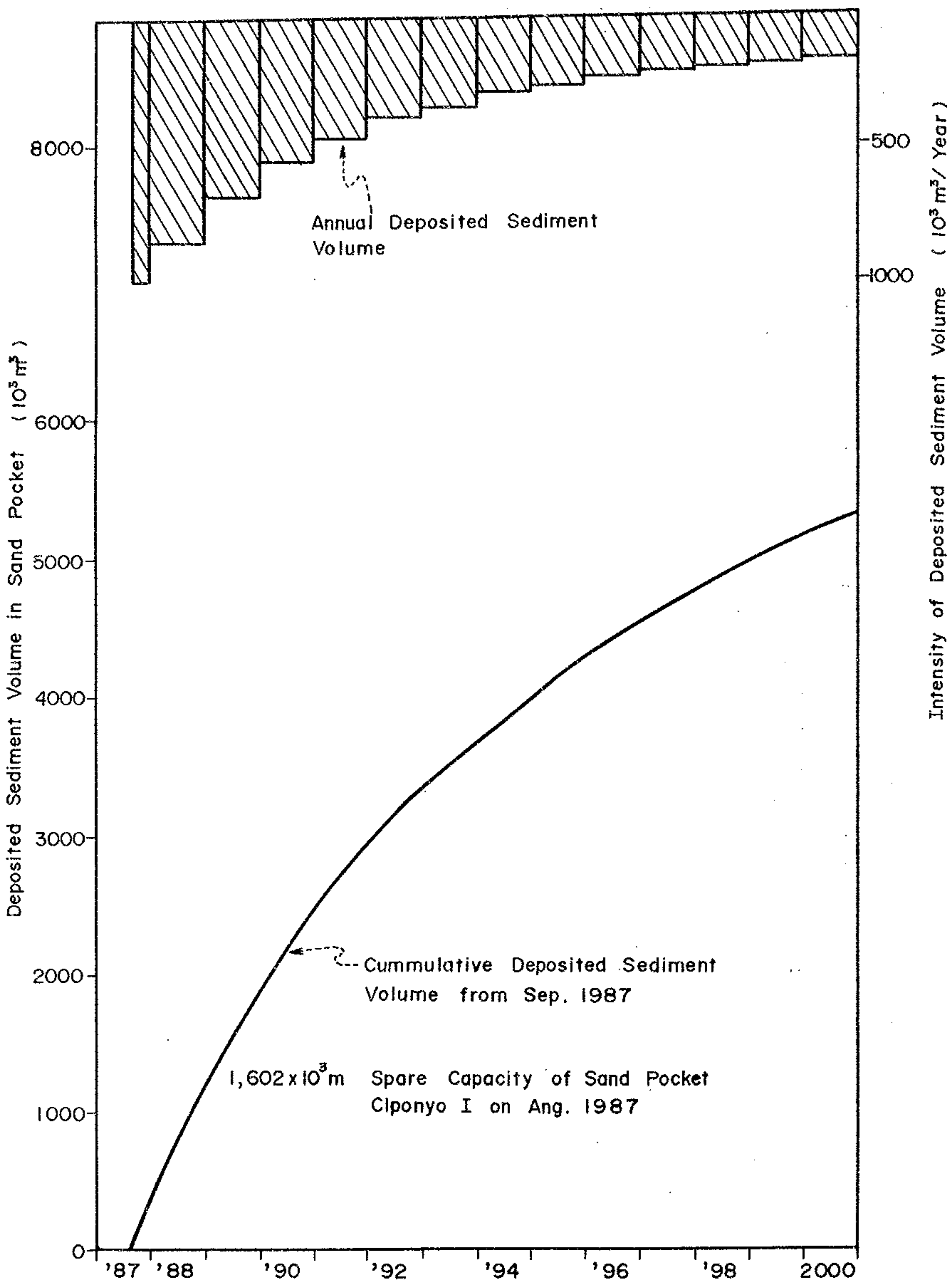

Fig. - 3.4 Annual Accumulated Sediment Volume (DAASV) Sandpocket Ciponyo I and Ciponyo II