c) The present longitudinal river-bed gradient of 1/600 should be made steeper (1/550). (Refer to Fig. 3.3.1)

d) The standard design of the cross section of the channel based on the above conditions is shown in Fig. 3.3.2. The low water channel along the section between the Srandakan Bridge and the estuary is now about 500m wide. A new low water channel about 200m wide and 2 to 3m deep will be excavated in the entire existing low water channel. The result will be a composite channel with a major bed as shown in Fig. 3.3.2.

e) The remaining portion of the existing 500m channel will be regarded as a reclaimed land for agriculture, etc. For the sake of safety, the utilization may have to be limited only during dry seasons.

f) It is recommended that the flood be large enough to allow the discharge of 5,000 cu m/sec., the biggest flood in the past, through the present cross section of the channel.

g) The volume of river-bed excavation from the estuary to a point about 20km upwards is estimated to be 15,000,000 cu m. It was been recommended to utilize the excavated soil for construction of embankments and reclamation.

h) Some modification and repair of the existing irrigation intakes and bridges may also be advisable as the proposed improvement plan progresses.

(5) Countermeasures Against Functional Impairment of Irrigation

The first means of coping with functional impairment of irrigation intake is implementation of the basic countermeasures 3.3.1 (1)-(3). In view of the large amount of sediment that is carried during flooding, it is necessary to provide a gate for the Mangir intake of K. Progo since the open cut excavation could cause it to be buried during flooding. Although there is a gate for the side-type intake for K. Opak, the bottom of the gate is approximately 0.5m above the surface of the river-bed. Currently, gate is closed and intake suspended during the rainy season to prevent sedimentation. The following measures are therefore necessary for stable intake throughout the year.

a) Control of sediment discharge and improvement of river course for stabilization of the river-bed.

b) Switching from side-intake to diversion weir across the river.

c) Provision of a multi-stage gate in the case of side-intake to be able to cope with unexpected river-bed flunctuations and to allow the intake to get overflow water throughout the year.

d) Adequate maintenance and control.

(6) Other Trouble Spot Countermeasures

Inland water, river mouth closing, and lateral erosion can be coped with by implementing the basic countermeasures 3.3.1 (1)-(4), but it will also be necessary to see that sufficient maintenance is done.

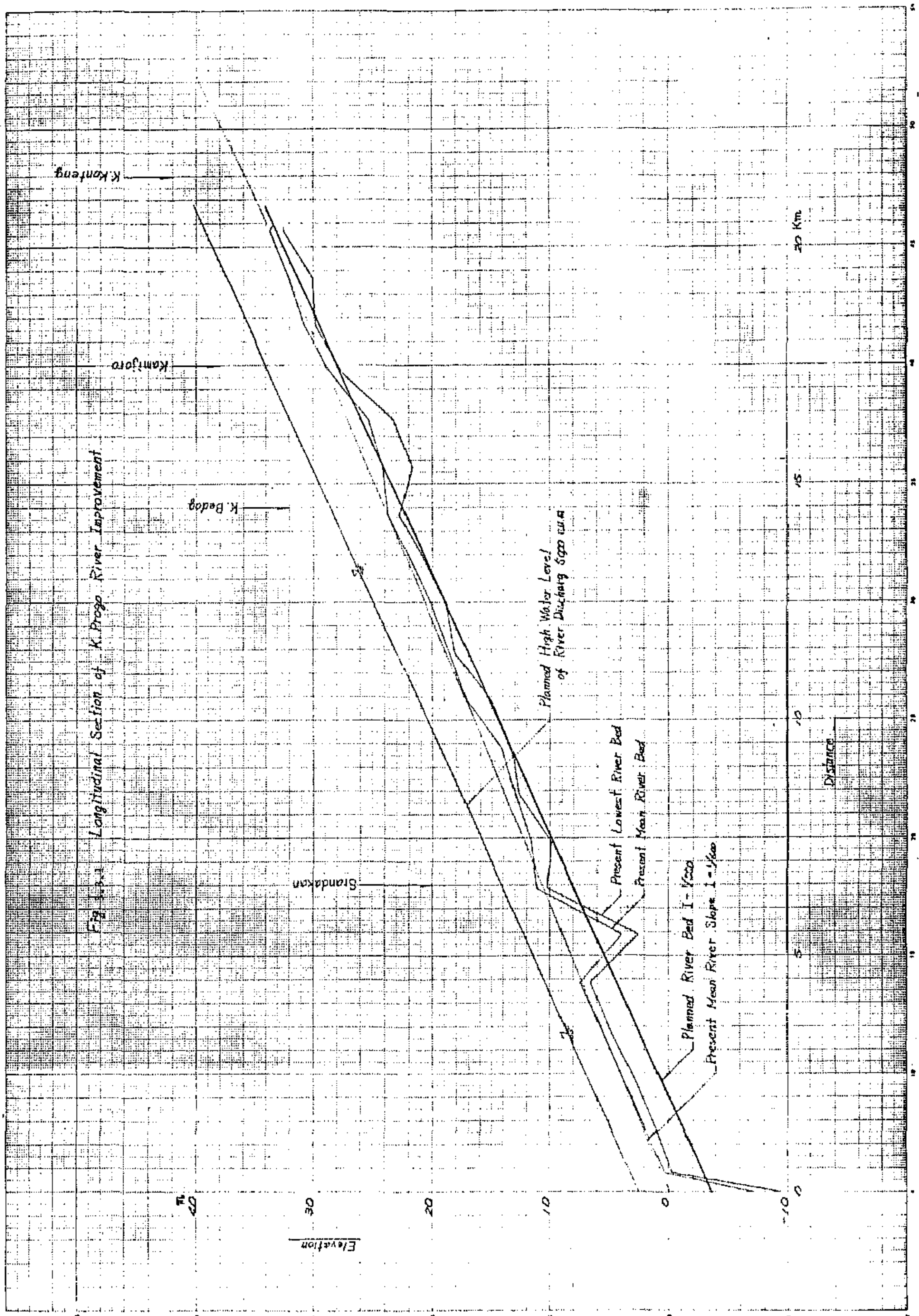
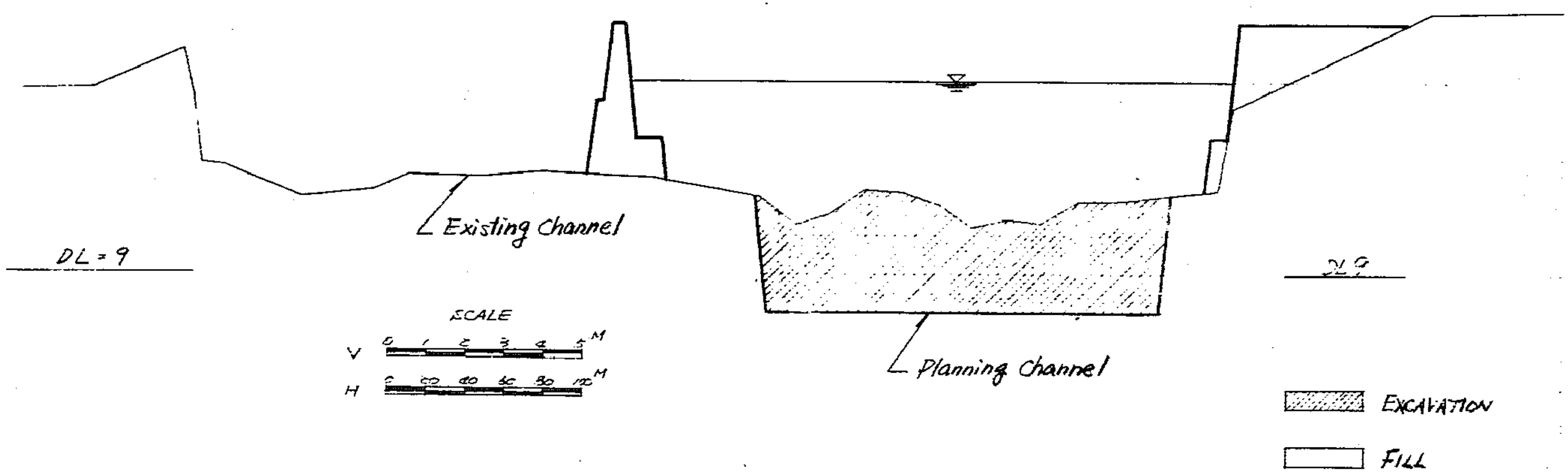


Fig 3.3.1 Longitudinal Section of K.Progo River Improvement

Fig. 3.3.2 CROSS SECTION OF K.PROGO RIVER IMPROVEMENT At SURANDAKAN BRIDGE



3.4 Evaluation

3.4.1 Cost-Benefit Analysis and Internal Rate of Return

(1) General

In this chapter the socio-economic effects of the present disaster prevention plan will be quantified and assessed on the basis of cost-benefit and internal rate of return. The area covered by the plan consists of 6,685 ha in the three model river basins and includes a population of 73,000 persons, 16,000 households, and 240 villages. It is hoped that with the implementation of the plan, life will be made safer for these inhabitants (see Table 3.4.1).

The benefits derived from the plan will include both reduction of loss or damage to livestock, crops, household effects, homes, roads, irrigation facilities, schools, hospitals, mosques, meeting places, and other social facilities, and also developmental effects, such as increase in farm income from stable production conditions, new employment opportunities, increase in income of workers employed in the project construction work, regional development, increase in harvest yield, and increase in economic and social benefit without disruption of road traffic or destruction of important economic facilities.

Survey polls taken in the project area reveal that about 65% of the residents have suffered damage or loss owing to flooding or sedimentation at some time in the past. An overwhelming majority of the respondents wanted to see construction and repair of embankments to prevent disasters as the first most effective way of improving their living conditions (see 12 and 15 of form C-2). The most frequent and extensive damage has been to farmland, roads and houses; loss of life has not been of disasterous proportions as one would have expected (see 14 of Form C-1 and 13 of Form C-2).

In the pages which follow, the benefits listed below are discussed quantatively for cost-benefit analysis and calculation of the internal rate of return.

- Reduction of damage to farmland and crops.
- Reduction of damage to yards.

- Reduction of damage to houses.
- Reduction of damage to roads.
- Increase in farm income through more stable production conditions.
- Other main socio-economic effects are mentioned for reference.

In addition, a sensitivity analysis has been included in order to evaluate the parameters chosen such as area of damage, project life, construction period, and construction cost.

(2) Benefits

a) Area of Damage

Based on a survey of the actual damage that occurred during the 8-year period 1969-1976, the size of the area that is subject to damage without implementation of the disaster prevention plan has been estimated.

In the case of Type-I, including the junction of K. Krasak and K. Bebeng, the area of rice paddies that suffered damage from the two rivers in that period was 576.1 ha, or an average 70 ha per year (see Table 3.4.2). On the basis of a questionaire survey, it was estimated that about 50% of the 70 ha, suffered damage from sedimentation (see Table 3.4, Lahar and Banjir Damage Conditions in Recent Years (2)). On the basis of the land use composition, the area subject to damage would be approximately 110 ha per year. Again assume that 50% of the land (or 55 ha) suffers from sedimentation.

Type-II data is based on K. Gendol, because it is similar to K. Woro and because of insufficient data on damage conditions in the K. Woro basin. In the same 8-year period, 139 ha of rice paddies suffered damage in the K. Gendol basin, an average of 15 ha per year. Judging from the geomorphic conditions, 8 of the 15 ha were covered by flood waters and sediment; i.e., approximately the same 50% that was found in K. Krasak area. If other land besides paddy field is considered, the area of damage increases to about 40 ha, of which 11 ha is estimated to have suffered damage from sedimentation.

In the case of K. Boyong, Type-III, only 57 ha suffered damage in 1969. No other conspicuous damage was reported after that, up to the time of the survey in 1978. Accordingly, for the purposes of this cost-benefit analysis, it is assumed that since there was one instance of damage to about 50 ha of paddy field in the 10-year period 1969-1978, the average for this area is calculated as 5 ha per year, 2.5 ha of which can be considered to have suffered damage from sedimentation.

Data on damage during the last eight years has been used to estimate the area of damage in view of the fact that there is no accurate way of determining the frequency of occurrence of damage. On the other hand, the stabilizing effect of the project will be studied in terms of sensitivity analysis.

b) Reduction of Damage to Farmland and Crops

Damage to farmland and crops from sedimentation includes the value of crops that were being grown at the time of the disaster and the net income lost to farmers from having fields that are uncultivable, pending a considerable investment for restoration. Since the damage to the crops is negligible in comparison to the subsequent net income loss to farmers, only the fact that the farmlands are rendered uncultivable will be taken into account in this cost-benefit analysis.

An estimate of the anticipated net annual income per hectare and per crop in each area on the basis of the crop patterns in the various river basin has been calculated to determine this net loss in income (see Table 3.4.4).

Based on 1978 prices, the annual net income per hectare was as follows: Rp. 207,000 in Magelang, Rp. 875,000 in Klaten, and Rp. 668,000 in Sleman. In the case of each of the three model rivers which run through at least two of the kabupaten, the net annual loss of income per hectare to farmers calculated on the basis of their relative areas is the following: Rp. 460,000 for K. Krasak, Rp. 875,000 for K. Woro, and Rp. 668,000 for K. Boyong. Based on the amount of area in each case that is expected to suffer damage from sedimentation each year, the total decrease in damage resulting from project implementation is as follows: Rp. 16,000,000 for K. Krasak (Type-I), Rp. 3,500,000 for K. Woro (Type-II), and Rp. 1,700,000 for K. Boyong (Type-III).

Crop damage due to flooding has been calculated on the assumption that the harvest of paddy, cultivated mostly in the rainy season, would be reduced by 25% because of 1-2 days of flooding to a depth of 0.5-0.99m. Since the anticipated net income per hectare from Paddy is Rp. 171,000 in the case of K. Krasak, Rp. 348,000 in the case of K. Woro, and Rp. 248,000 in the case of K. Boyong, elimination of flooding through implementation of the project will reduce annual losses by Rp. 1,500,000 Rp. 960,000, and Rp. 160,000, in the three river-basins respectively. Unlike the damage due to soil movement, this reduction in losses is not cumulative and is therefore far smaller than that realized with respect to sedimentation damage. This being the case, the overall evaluation will hardly be affected, even if the actual loss in income from the crop flooding is 20% or 30% instead of 25%.

c) Reduction of Damage to Yards

Since it has not been possible to estimate the frequency of damage to yards, such damage has been estimated in terms of damage to fields plus land-use structures. The following figures were then calculated for annual damage to "yards" by sedimentation and flooding in the following areas: K. Krasak, 14 ha and 14 ha; K. Woro, 6 ha and 17 ha; K. Boyong, 1 ha and 1 ha.

A detailed survey is needed to determine the actual amount of damage to yards in terms of crops, orchards for home consumption, bamboo and other construction materials. For this cost-benefit analysis, however, such damage has been estimated as 10% of that suffered by fields and other agricultural land. Damage due to flooding has not been considered, in order to be conservative and in view of the fact that it is, a one-time proposition.

The total figures for annual reduction of damage to yards through implementation of the plan are as follows: K. Krasak, Rp. 650,000; K. Woro Rp. 530,000; and K. Boyong, Rp. 70,000.

d) Reduction of Damage to Houses

The records show that in the 8-year period 1969-1976, there was damage to 500 houses in the K. Krasak and K. Bebeng basins (Type-I), 150 houses in the K. Gendol basin (Type-II); but none at all in the K. Boyong basin (Type-III). For the first two cases, one house was damaged for every hectare of field damaged. Assuming that this rate remains constant, the annual number of houses subject to damage is 40 in the case of K. Krasak and 15 in K. Woro, with no damage in the case of K. Boyong.

The damage to each house, including household belongings, has been estimated on average to be Rp. 100,000 on the basis of past real estate values for houses. This gives the figures of Rp. 4,000,000 and Rp. 1,500,000 for annual damage to houses in the K. Krasak and K. Woro basins. Since such damage to houses is also a one-time proposition, the amount of damage wil will decline each year as the disaster prevention construction works progress.

e) Reduction of Damage to Roads

The road densities in the project area are as follows: K. Krasak, 3km/km^2; K. Woro, 5km/km^2, and K. Boyong, 4km/km^2. The figures for the length of roads in the areas subject to damage from sedimentation are therefore as follows: K. Krasak, 1.7km; K. Woro, 0.6km; K. Boyong 0.2km.

On the basis of past records and cost of construction, the damage to such roads (almost all village roads have gravel surfaces) is estimated at about Rp. 2,000,000 per kilometer. With implementation of the project, damage to roads will be reduced by the following amounts: K. Krasak, Rp. 3,400,000; K. Woro, Rp. 1,200,000; and K. Boyong, Rp. 400,000. Such benefits will accrue for each year following the completion of the disaster prevention works.

Damage due to flooding has not been taken into account since it is considered to be negligible.

f) Increase in Farm Income

With implementation of the disaster prevention plan, water supply and production activity in the areas benefitting from it will be stabilized, and greater increases in production can be expected, On the basis of growth trends of rice harvests determined in the surveys, it was estimated that through such stabilization harvests will increase by 1-3% a year in areas with comparatively small harvests at the present time. Since the disaster prevention project covers a period of 15 years, the overall increase expected is 16-56%.

Therefore, an average of 7% of present harvests has been taken as the increment in income that will be realized from project implementation in the comparatively low harvest level areas of K. Krasak and K. Boyong. The annual net increases in farm income that can be expected after completion of the construction work are Rp. 46,000,000 in the case of K. Krasak and Rp. 35,000,000 in the case of K. Boyong.

In the K. Woro area, however, the annual increase in income due to stabilization of production has been estimated at only about half of this, or 3%, in view of the fact that harvest levels in it are already rather high.

(3) Construction Costs and Maintenance Costs

The necessary investment for implementation of the present disaster prevention project has already been mentioned in the section on construction cost estimates. The total investment for the three model rivers will be Rp. 13,300 million. The breakdown of resources is listed in item (1) of Table 3.4. The cost of the construction work listed in item (2) of the same table (exclusive of the transfer item "taxes") is Rp. 12,670 million.

Since the construction period for all rivers will be fifteen years and since the construction schedule has not yet been decided, the construction cost for each year has been averaged, as 1/15 of the total.

Project life has been established as fifty years (actual average of 42-43 years) from the commencement of the construction works, taking into account the durability of the structures and a zero residual value for the structures after fifty years.

An annual maintenance cost during the construction period of 15% of the annual construction cost has been assigned for each year beginning from the year after completion of the construction works to the last year of the life of the project. The breakdown by resource is listed in Table 3.4.9.

(4) Internal Rate of Return Evaluation

a) Internal Rate of Return

Table 3.4.10 compares the cashflow of costs and benefits for each of the rivers. From it, the internal rates of return have been calculated as 3.5% for K. Krasak, 2.7% for K. Woro, and 4.1% for K. Boyong, with an internal rate of return of 3.1% for the project as a whole. Although this is quite a bit lower than that of development projects directly airmed at increasing production in the agricultural and industrial sectors, implementation of the project is fully justifiable in economic terms if one considers the fact that disaster prevention projects are absolutely necessary for stability of socio-economic life.

b) Sensitivity Analysis

As already mentioned, the damage if the project were not implemented was been estimated on the basis of records of such damage over the past 8 to 10 years for the purpose of the cost-benefit analysis. If the damages were to be estimated 10% lower, the internal rates of return would be brought down to 2.8% in the case of K. Krasak, 2.4% in the case of K. Woro, and 3.5% in the case of K. Boyong. If the estimates were 20% lower, the same figures would fall to 2.4%, 2.2%, and 3.2%, respectively. On the other hand, if the estimates were to be pushed up by 10%, the internal rates of return would climb to 3.7% for K. Krasak, 2.9% for K. Woro, and 4.4% for K. Boyong, and for a 20% hike, the estimates would be 4.0%, 3.1%, and 4.7%, respectively. The large fluctuation in the internal rate of return for K. Krasak depending on the area of the damage is explained by the fact that reduction of damage represents a large portion of the total benefit that will be derived in that area from implementation of the project.

If the project life were to be lowered to 40 years and the average durability of the structures to 32-33 years, the internal rates of return would fall to 2.6% for K. Krasak, 2.3% for K. Woro, and 2.8% for K. Boyong. The decline in the last case is particularly substantial, and indicates the importance of maintenance.

If the construction period were to be lengthened to twenty years, the internal rates of return would come to 4.2%, 2.9%, and 4.5%, respectively. Such lengthening of the construction period would not be advantageous since in estimating the benefits it has been assumed that all of the anticipated damage will be reduced by the construction works.

Also, if construction costs were to surpass the estimates by 10%, the internal rates of return would fall to 2.8% in the case of K. Krasak, 2.3% in the case of K. Woro, and 3.4% in the case of K. Boyong.

The internal rates of return and the results of the sensitivity analysis are given in following Tables 3.4.10 and 3.4.11.

Table 3.4.10 Internal Rate of Return

(Unit: %)

	K. Krasak	K. Woro	K. Boyong	Average
IRR	3.5	2.7	4.1	3.1

Table 3.4.11 Sensitivity Analysis

(Unit: %)

	K. Krasak	K. Woro	K. Boyong
· Damage area;			
Decrease 10%	2.8	2.4	3.5
" 20%	2.4	2.2	3.2
Increase 10%	3.7	2.9	4.4
" 20%	4.0	3.1	4.7
· Project life;			
40 years	2.6	2.3	2.8
· Conetruction period;			
Extend to 20 years	4.2	2.9	4.5
· Conetruction cost;			
Increase 10%	2.8	2.3	3.4

3.4.2 Socio-economic Effects

The socio-economic effects of implementation of the present disaster prevention project differ markedly from the types of benefits considered in the cost-benefit analysis.

The first and most important is that of protection of life. Recent records of G. Merapi disasters indicate that 26 persons have died in such disasters in recent years, mostly in the K. Krasak area at the time of the 1976 damage. Considering the fact that 73,000 people, or 16,000 families, live in the project area and the fact that another 2,200 families live along the banks of K. Code downstream of K. Boyong within the city limits of Yogyakarta, the great significance of the project in terms of making their lives safe can be appreciated.

Another important aim of the project is that of protecting the roads and social and cultural facilities on which the economic activities and social life of so many people depend. Local communities would suffer even more from the indirect consequences of dislocation of their road networks than the direct damage to roads by sediment that was considered in the cost-benefit analysis. The disaster prevention works will protect 65km of roads in the K. Krasak area, 165km in the K. Woro area, and 45km in the K. Boyong area as an essential condition for the social and economic progress of those areas.

Furthermore, the increase in farm income due to stabilization of production activities can be expected to have a regional triggering effect for a new cycle of developmental benefits. There is also a good possibility of promotion of home industry through accumulation of capital.

Regional development can also be expected in terms of creation of new employment opportunities and stabilizing what employment opportunities already exist. This will in turn contribute to the transfer of technical skills by creating more jobs and thus fulfill, one of the aims of the project--fuller utilization of human resources. The construction works themselves will provide a total of 18 million man-days of work, or 60,000 man-months a year. As a forward connected effect, the project will stimulate employment and business in industries providing materials for it, and as a backward connected effect, it will secure employment opportunities in agriculture.

Furthermore, it will be possible to make use of the sediment and sand deposits as construction materials and for other uses. In the case of the K. Woro check dam, the space left after excavating the deposits can be used as a reservoir for 450,000 tons of water. This irrigation of about 30ha of paddy in the dry season means an annual increase in income of about Rp. 3,800,000. Effective use will also be made of the excavated sand and add even more to the benefits from the project.

Last but not least, the project will eliminate the risk of harvest losses for 15,000ha of paddy which rely on the Mataram irrigation channel for about 50% of their irrigation water supply. In view of the fact that a 20% reduction in such harvests due to incapacitation of that irrigation system would mean an annual loss of Rp. 2,000 million, the importance of this consideration is large.

Table 3.4.1 Disaster Area, Land Use and Population Summary

Type		I	II		III	Total
Name of River		K. Krasak	K. Woro		K. Boyong	
		Sediment	Sediment	Flood	Sediment	
Disaster Area	(ha)	2,200	1,732	1,617	1,136	6,685
Lahar area		1,169	481	-	16	1,666
Banjir area		1,031	1,251	1,617	1,120	5,019
Land Use	(%)	100	100	100	100	
Paddy field		65	44	29	66	
Yard		25	50	65	23	
Others		10	6	6	11	
Population		27,630	16,380	21,490	7,740	73,240
Village		59	58	87	35	239
Household		6,010	3,720	4,880	1,760	16,370
Mean No. of Family Members		4.6	4.4	4.4	4.4	
Road Length	(km/km^2)	3	5	5	5	

Table 3.4.2 Damage to the Paddy Field and Houses (Year 1969 ∿ 1976)

(1) Type I

Year	K. Krasak Paddy field	K. Krasak Number of house
1969	62.3	-
70	-	-
71	-	-
72	-	-
73	-	-
74	90.9	100
75	126.4	6
76	296.5	378
Total	576.1	484

(2) Type II

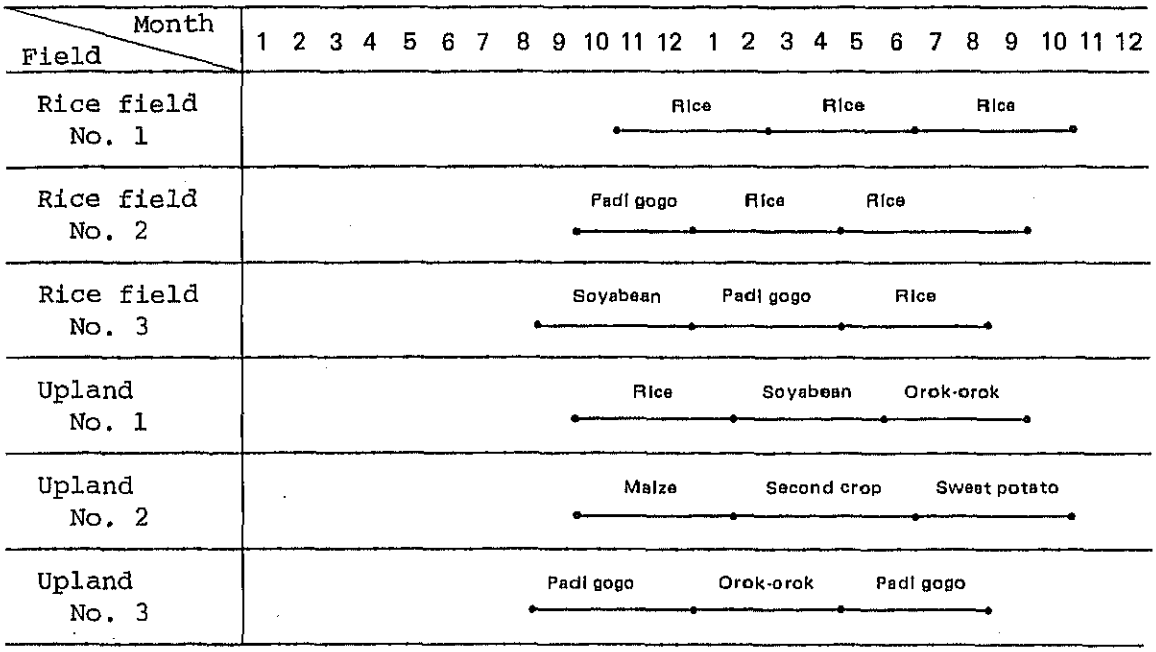
Year	K. Gendol Paddy field	K. Gendol Number of house
1969	110	150
70	-	-
71	-	-
72	-	-
73	29	-
74	-	-
75	-	-
76	-	-
Total	139	150

(3) Type III

Year	K. Boyong Paddy field	K. Boyong Number of house
1969	57	-
70	-	-
71	-	-
72	-	-
73	-	-
74	-	-
75	-	-
76	-	-
Total	57	-

Table 3.4.3 - Cropping Pattern

(1) Kab. Mageland (1976)



Note: orok-orok = green manure plant

padi gogo = *dry rice field*

Table 3.4.4 Net Earnings/ha/year (1978)

(Unit: Rupiah)

Name of Kab. / Name of Crop	Kab. Magelang	Kab. Klaten	Kab. Sleman
Paddy	113,900	696,000	620,000
Dry Paddy	78,100		
Soyabean	14,500		47,500
Tobacco		179,000	
Total	206,500	875,000	667,500

Table 3.4.5 Production Cost per Hectare

(1) Kab. Mageland (1976)

(Unit: Rp.)

Items / Crops	Seed	Pesti-cides	Ferti-lizer	Wages	Depreci-ation	Others	Total
Irrig. rice HYL	-	-	-	-	-	-	-
Irrig. Local	2.000	1.800	18.900	103.000	-	55.000	180.700
Dry rice	-	-	-	-	-	-	-
Tobacco	-	-	-	-	-	-	-
Maize	3.000	900	7.000	32.200	-	16.500	59.600
Peanut	25.200	900	-	34.000	-	26.500	86.600
Soyabean	6.000	900	-	28.825	-	21.500	57.225
Cassava	2.200	-	40.000	27.200	-	31.500	100.900
Sweet Potato	-	-	-	27.900	-	31.500	59.400

(2) Kab-Klaten (1977)

(Unit: RP.)

Items / Crops	Seed	Pesti-cides	Ferti-lizer	Wages	Depreci-ation	Others	Total
Irrig. rice HYL	-	-	-	-	-	-	-
Irrig. Local	4.500	1.500	28.000	63.400	-	40.900	138.300
Dry rice	2,500	-	37.500	49.350	-	5.650	95.000
Tobacco Java	1.000	-	63.500	63.150	-	17.350	145.000
Tobacco (Virgi-nia)	10.000	-	14.000	148.500	-	10.000	182.500
Peanut	35.000	2.250	25.600	38.900	-	8.250	110.000
Maize	1.200	-	30.500	28.500	-	4.800	65.000
Soyabean	18.000	-	-	40.500	-	8.000	66.500
Cassava	5.000	-	46.000	43.000	-	6.000	100.000
Sweet Potatos	4.000	-	24.000	32.000	-	5.000	65.000

(3) Kab. Sleman (1976)

(Unit: Rp.)

Crops \ Items	Seed	Pesti-cides	Ferti-lizer	Wages	Depreci-ation	Others	Total
Irrig. rice HYL	-	-	-	-	-	-	-
Irrig. local	3.000	4.500	23.100	78.910	-	3.750	113.260
Dry rice	-	-	-	-	-	-	-
Tobacco	-	-	-	-	-	-	-
Maize	2.700	1.000	7.000	38.450	-	1.000	50.150
Peanut	22.000	-	-	41.335	-	-	63.335
Soyabean	11.000	4.500	10.500	26.625	-	-	52.625
Cassava	12.000	-	-	40.295	-	2.000	54.295
Sweet Potato	18.000	-	-	39.750	-	2.000	59.750

Table 3.4.6 Gross Revenue per Hectare

(1) Kab. Magelang (1976)

Crops \ Items	Yield Kg	Price Rp/Kg	Value Rp
Irrig. rice HYV	-	-	-
Irrig. local	3.800	65	247.000
Dry rice	-	-	-
Tobacco	-	-	-
Maize	1.200	65	78.000
Peanut	-	-	150.000
Soyabean	472	175	82.600
Cassava	9.000	15	135.000
Sweet Potato	6.000	15	90.000

(2) Kab. Klaten (1977)

Crops \ Items	Yield Kg	Price Rp/Kg	Value Rp
Irrig. rice HYV	-	-	-
Irrig. local	6.400	72,50	464.000
Dry rice	2.800	60	168.000
Tobacco (Java	8.000	60	480.000
Virginia)	7.000	50	350.000
Maize	1.200	70	84.000
Peanut	700	325	227.500
Soyabean	550	200	110.000
Cassava	9.000	25	225.000
Sweet Potatos	6.000	25	150.000

(3) Kab. Sleman (1976)

Crops \ Items	Yield Kg	Price Rp/Kg	Value Rp
Irrig. rice HYL	-	-	-
Irrig. local	4.715	70,-	330.050,-
Dry rice	-	-	-
Tobacco	-	-	-
Maize	745	80,-	59.600,-
Peanut	681	270,-	183.870,-
Soyabean	677	200,-	135.400,-
Cassava	9.896	30,-	296.880,-
Sweet Potato	6.549	30,-	196.470,-

Table 3.4.7 Cost of Construction Work

(1) Financial Cost of Construction Work (Price of 1978)

(Unit: Rp. Million)

	K. Krasak	K. Woro	K. Boyong
Materials	1,240	770	260
Salaries & Wages	4,960	3,060	1,020
Other Expenses	1,100	670	220
Total	7,300	4,500	1,500

(2) Economic Cost of Construction Work (Price of 1978)

(Unit: Rp. million)

	K. Krasak	K. Woro	K. Boyong
Materials	1,180	730	240
Salaries & Wages	4,730	2,920	970
Other Expenses	1,040	640	220
Total	6,950	4,290	1,430

Table 3.4.8 *Cost of Maintenance Work*

(1) Financial Cost of Maintenance Work (price of 1978)

(Unit: Rp. million)

	K. Krasak	K. Woro	K. Boyong
Materials	12	8	3
Salaries & Wages	50	30	10
Other Expenses	11	7	2
Total	73	45	15

(2) Economic Cost of Maintenance Work (Price of 1978)

(Unit: Rp. million)

	K. Krasak	K. Woro	K. Boyong
Materials	12	7	2
Salaries & Wages	47	29	10
Other Expenses	11	6	2
Total	70	43	14

Table 3.4.9 Flow of Benefit and Cost

(1) K. Krasak (Unit: Rp. million)

Year	Construction Cost	Maintenance Cost	Paddy & Dry Field	Yard, House & Road	Increase of Yield	Year	Construction Cost	Maintenance Cost	Paddy & Dry Field	Yard, House & Road	Increase of Yield
0	463										
1	463		17.5	8.1	3.1						
2	463		33.5	8.8	6.1						
3	463		49.5	9.5	9.2						
4	463		65.5	10.2	12.3						
5	463		81.5	10.9	15.3						
6	463		97.5	11.6	18.4						
7	463		113.5	12.3	21.5						
8	463		129.5	13.0	24.5						
9	463		145.5	13.7	27.6						
10	463		161.5	14.4	30.7						
11	463		177.5	15.1	33.7						
12	463		193.5	15.8	36.8						
13	463		209.5	16.5	39.9						
14	468		225.5	17.2	42.9						
15		70	241.5	17.9	46.0						
16		70	257.5	18.6	46.0						
17		70	273.5	19.3	46.0						
18		70	289.5	20.0	46.0						
19		70	305.5	20.7	46.0						
20		70	321.5	21.4	46.0						

(2) K. Woro (Unit: Rp. million)

Year	Construction Cost	Maintenance Cost	Paddy & Dry Field	Yard, House & Road	Increase of Yield
0	286				
1	286		4.5	3.4	5.8
2	286		8.0	3.9	11.7
3	286		11.5	4.4	17.5
4	286		15.0	4.9	23.4
5	286		18.5	5.4	29.2
6	286		22.0	5.9	35.1
7	286		25.5	6.4	40.9
8	286		29.0	6.9	46.8
9	286		32.5	7.4	52.6
10	286		36.0	7.9	58.5
11	286		39.5	8.4	64.3
12	286		43.0	8.9	70.2
13	286		46.5	9.4	76.0
14	286		50.0	9.9	81.9
15		43	53.5	10.4	87.7
16		43	57.0	10.9	87.7
17		43	60.5	11.4	87.7
18		43	64.0	11.9	87.7
19		43	67.5	12.4	87.7
20		43	71.0	12.9	87.7
21		43	74.5	13.4	87.7
22		43	78.0	13.9	87.7
23		43	81.5	14.4	87.7
24		43	85.0	14.9	87.7
25		43	88.5	15.4	87.7
26		43	92.0	15.9	87.7
27		43	95.5	16.4	87.7
28		43	99.0	16.9	87.7
29		43	102.5	17.4	87.7
30		43	106.0	17.9	87.7
31		43	109.5	18.4	87.7
32		43	113.0	18.9	87.7
33		43	116.5	19.4	87.7
34		43	120.0	19.9	87.7
35		43	123.5	20.4	87.7
36		43	127.0	20.9	87.7
37		43	130.5	21.4	87.7
38		43	134.0	21.9	87.7
39		43	137.5	22.4	87.7
40		43	141.0	22.9	87.7
41		43	144.5	23.4	87.7
42		43	148.0	23.9	87.7
43		43	151.5	24.4	87.7
44		43	155.0	24.9	87.7
45		43	158.5	25.4	87.7
46		43	162.0	25.9	87.7
47		43	165.5	26.4	87.7
48		43	169.0	26.9	87.7
49		43	172.5	27.4	87.7

(3) K. Boyong (Unit: Rp. million)

Year	Construction Cost	Maintenance Cost	Paddy & Dry Field	Yard, House & Road	Increase of Yield
0	95				
1	95		1.8	0.4	2.3
2	95		3.6	0.4	4.7
3	95		5.4	0.4	7.0
4	95		7.2	0.4	9.3
5	95		9.0	0.4	11.7
6	95		10.8	0.4	14.0
7	95		12.6	0.4	16.3
8	95		14.4	0.4	18.7
9	95		16.2	0.4	21.0
10	95		18.0	0.4	23.3
11	95		19.8	0.4	25.7
12	95		21.6	0.4	28.0
13	95		23.4	0.4	30.3
14	100		25.2	0.4	32.7
15		14	27.0	0.4	35.0
16		14	28.8	0.4	35.0
17		14	30.6	0.4	35.0
18		14	32.4	0.4	35.0
19		14	34.2	0.4	35.0
20		14	36.0	0.4	35.0
21		14	37.8	0.4	35.0
22		14	39.6	0.4	35.0
23		14	41.4	0.4	35.0
24		14	43.2	0.4	35.0
25		14	45.0	0.4	35.0
26		14	46.8	0.4	35.0
27		14	48.6	0.4	35.0
28		14	50.4	0.4	35.0
29		14	52.2	0.4	35.0
30		14	54.0	0.4	35.0
31		14	55.8	0.4	35.0
32		14	57.6	0.4	35.0
33		14	59.4	0.4	35.0

Year	Construction Cost	Maintenance Cost	Paddy & Dry Field	Yard, House & Road	Increase of Yield
34		14	61.2	0.4	35.0
35		14	63.0	0.4	35.0
36		14	64.8	0.4	35.0
37		14	66.6	0.4	35.0
38		14	68.4	0.4	35.0
39		14	70.2	0.4	35.0
40		14	72.0	0.4	35.0
41		14	73.8	0.4	35.0
42		14	75.6	0.4	35.0
43		14	77.4	0.4	35.0
44		14	79.2	0.4	35.0
45		14	81.0	0.4	35.0
46		14	82.8	0.4	35.0
47		14	84.6	0.4	35.0
48		14	86.4	0.4	35.0
49		14	88.2	0.4	35.0

APPENDIX

APPENDIX 1. STUDY ACTIVITY SCHEDULE

Study Activity Schedule

The Study Team members carried out the study at the site according to the following schedule:

Period / Members	1978				1979
	Jun.	Jul.	Aug.	Sep.	Mar.
Team Leader (I. Tani)			21	14	
Deputy Leader/Disaster Prevention Planner (H. Suzuki)	12			14	9 18
Disaster Prevention Planner (H. Tanaka)	12			14	9 18
Sabo-facilities Planner (S. Tsuchiya)		16		9	
Sabo-facilities Planner (O. Kurokawa)		2		9	
River Engineer (K. Nobe)	18	22			
Hydrologist (Y. Matsumoto)	18		11		
Geomorphologist (Y. Maruyama)		2 31			
Geomorphologist (M. Higurashi)		2 31			
Geologist (M. Nakayama)			11	9	9 18
Geologist (A. Nakasuzi)	18			9	
Economist (K. Ishimitsu)		30	18		
Socio-economist/Coordinator (Y. Komuro)	12			14	
Socio-economist (K. Denda)		30		14	
Agro-economist (Prof. Dr. Muto)		30	28		
Aerial-Surveyor (T. Watanabe)	12 21	30	8		

APPENDIX 2. LIST OF PARTICIPATING PERSONNEL

List of Participating Personnel

1. The Japanese Government Supervisory Committee

Chair Man	Prof. Dr. Aritsune Takei
Disaster Prevention Sabo Works Plan	Usho Daikubara
Volcanic Debris	Dr. Masayoshi Matsubayashi
Geology	Masasuke Watari
Economics and Disaster Analysis	Koichi Hirao
Hydrology and River Engineering	Fujio Chikamori

2. The Indonesian Government Steering Committee

Management	Ir. Sarbini
Regional Planning	Ir. K.P.H. Probokusumo
Social Economic Survey	Dr. Sulistyo MBA
Rural Sociology	Prof. Dr. Sartono Kartodirdjo
Sabo Engineering	Ir. Djoko Legowo

3. JICA Study Team and Indonesian Counterparts

Assignment	Japanese Members	Indonesian Counterparts
Team Leader	I. Tani	Ir. Bambang Sumantri.
Deputy Leader/General Planning for Disaster Prevention Planning	H. Suzuki	Ir. Agus Sumaryono Wardhono Mujoko
Disaster Prevention Planning	H. Tanaka	
Sabo-Facilities Planning	S. Tsuchiya O. Kurokawa	Adaningkung Subarkah Yaskur
River-Engineering	K. Nobe	Sumitro BRE Diro Supangkat Susilo Djarot Suharyadi
Hydraulic and Hydrology	Y. Matsumoto	Djarot Suharyadi Drs. Sutikno
Study of Possible Lahar Inundation Area	Y. Maruyama M. Higurashi	Wardhono Nugroho Haryanto
Lahar Deposits Analysis	M. Nakayama A. Nakasuji	Ir. Sumartono Suwartoyo BE Jimmy Sinaga
Socio-economic	K. Ishimitsu Y. Komuro K. Denda	Djatiyo Djatmiko Bsc. Ir. Agus Sumaryono Bambang Sumitro
Agro-economic	K. Muto	
Aerial Survey	T. Watanabe	

APPENDIX 3. COST ESTIMATION AND UNIT COST OF CONSTRUCTION WORKS

Table 1 Summary of Sabo Facilities of K. Krasak (Plan I)

No.	Facility	Element				Construction Cost (Rp. x 1,000)	Volume of Sediment Production Suppression ($1,000m^3$)	Volume of Sediment Discharge Reduction ($1,000m^3$)	Volume of Sediment Discharge Control ($1,000m^3$)	Remarks
		Type	Height (m)	Length (m)	Volume (m^3)					
1	BE - C.1	Consolidation Dam	4.0	630.0	10,500	117,600			2,999*	Sand Pocket
2	C.2	"	"	550.0	9,200	103,040			3,154	
3	C.3	"	"	425.0	7,100	79,520				
4	C.4	"	"	108.0	4,100	57,400				
5	C.5	"	3.0	111.0	3,100	43,400	1			
6	C.6	"	4.0	"	3,200	44,800	1			
7	C.7	"	3.5	"	3,700	51,800	2			
8	C.8	"	4.5	118.0	4,100	57,400	18			
9	C.9	"	4.0	61.0	2,400	33,600	47			
10	BE - D.1	*Check Dam*			1,100	15,400	252	(144)		
11	D.2	"	6.5	85.0	6,000	84,000	155	(8)		
12	D.3	"	11.0	134.0	13,400	187,600	298	(98)		
13	D.4	"	11.5	140.0	18,600	260,400	175	(107)		
14	D.5	"	10.0	80.0	10,500	147,000	138	(33)		
15	D.6	"	7.5	88.0	7,800	109,200	138	(23)		
16	D.7	"	10.0	104.0	12,800	179,200	212	(49)		
17	D.8	"	11.0	100.0	12,500	175,000	350	(62)		
18	D.9	"	12.5	140.0	13,300	186,200	171	(38)		
19	BE - R.1	Revetment (D - 3)	3.0	220.0		14,080				
20	R.2	(D - 5)	"	750.0		27,000				

No.	Facility	Element				Construction Cost (Rp. x 1,000)	Volume of Sediment Production Suppression (1,000m^3)	Volume of Sediment Discharge Reduction (1,000m^3)	Volume of Sediment Discharge Control (1,000m^3)	Remarks
		Type	Height (m)	Length (m)	Volume (m^3)					
21	BE - R.3	Revetment (D-4)	3.0	420		21,420				
22	R.4	(D-4)	"	570		37,620				
23	R.5	(")		600		39,600				
24	R.6	(B-2)	3.0	950		41,800				
25	R.7	(")	"	1,230		54,120				
26	BE - T.1	Training Levee	6.0	950		142,500	3,123 (26–29)			
27	T.2	"	"	1,070		160,500				
28	T.3	"	"	630		94,500				
29	T.4			1,000		150,000				
30	KR - D.1	Check Dam	14.0	189	35,400	672,600	264	(178)		
31	D.2	"	14.5	178	34,600	657,400	210	(31)		
32	D.3	"	8.0	143	11,900	166,600	48	(12)		
33	D.4	"	"	155	17,200	240,800	159	(61)		
34	D.5	"	10.0	128	12,500	175,000	48	(25)		
35	KR - R.1	Revetment (B-5)	3.0	200		7,200				
36	R.2	(B-5)	"	"		7,200				
37	R.3	(")	"	430		15,480				
38	R.4	(")	"	580		20,880				
39	R.5	(")	3.0	230		8,280				
40	R.6	(")	"	350		12,600				
41	R.7	(D-2)	"	1,140		42,180				
42	R.8	(")	"	330		12,210				

No.	Facility	Element				Construction Cost (Rp. x 1,000)	Volume of Sediment Production Suppression (1,000m³)	Volume of Sediment Discharge Reduction (1,000m³)	Volume of Sediment Discharge Control (1,000m³)	Remarks
		Type	Height (m)	Length (m)	Volume (m³)					
43	KR - R.9	Revetment (D-2)	3.0	450		16,650				
44	R.10	(B-1)	"	2,400		136,800				
45	R.11	(")	"	"		136,800				
46	R.12	(")	"	1,600		91,200				
47	R.13	(A.F)	"	2,050		170,150				
48	R.14	(")	"	1,100		91,300				
49	R.15	(D-1)	"	2,050		102,500				
50	R.16	(")	"	1,950		97,500				
51	KR - G	Groin			4,500m	148,500				(including K. Bebeng)
52	KR - T.1	Trining Levee	6.0	450		67,500				
53	T.2	"	"	1,250		187,500				
54	T.3	"	"	840		126,000				
55	T.4	"	"	550		82,500				
56	T.5	"	"	400		60,000				
57	KR - C.1	Consolidation Dam	4.1	69	2,100	37,560				
58		Chipping of Head Work (Protection to abutments)			13,380	13,380				Protection Work to Syphone
	Sub Total					6,319,970	5,810	(869)	2,999 * 3,154	* in case of passing through K.Bebeng
	Supplemental Works and Contingency					980,030				
	Total					7,300,000	5,810	(869)	2,999 * 3,154	

Table 2 Summary of Sabo Facilities of K. Krasak (Plan II)

No.	Facility	Element				Construction Cost (Rp. x 1,000)	Volume of Sediment Production Suppression (1,000m³)	Volume of Sediment Discharge Reduction (1,000m³)	Volume of Sediment Discharge Control (1,000m³)	Remarks
		Type	Height (m)	Length (m)	Volume (m³)					
	Sub total from No. 1 to No. 58 in Plan I; from No.15 to No.18 exclusive					5,670,370	4,939	(697)	2,750* 3,154*	* in case of passing through K. Bebeng
	BE - D.6.A		12.0	97.0	12,800	179,200	1,120	(70)		
	D.6.B	"	9.0	107.0	14,800	207,200		(245)		
	D.6.C	"	8.5	95.0	12,600	176,400		(222)		
	D.6.D	"	"	135.0	15,600	218,400		(203)		
	D.6.E	"	"	183.0	19,700	275,800		(225)		
	Sub Total					6,727,370	6,059	(1662)	2,750* 3,154	
	Supplemental Works and Contingency					972,630				
	Total					7,700,000	6,059	(1662)	2,750* 3,154	

Figures in ( ) are excluded out of the Sediment Disposal Plan

Table 3 Summary of Sabo Facilities of K. Krasak (Plan III)

No.	Facility	Element				Construction Cost (Rp. x 1,000)	Volume of Sediment Production Suppression (1,000m³)	Volume of Sediment Discharge Reduction (1,000m³)	Volume of Sediment Discharge Control (1,000m³)	Remarks
		Type	Height (m)	Length (m)	Volume (m³)					
	Sub total from No. 1 to No.58 *in* Plan I; from No. 15 to No.18 exclusive					5,670,370	4,939	(697)	1,625* 3,154	* in case of passing through K. Bebeng
	BE – D.6.A	Check Dam	12.0	103.0	16,100	225,400		(110)		
	D.6.B	"	10.0	125.0	16,800	235,200		(328)		
	D.6.C	"	"	155.0	26,100	365,400		(595)		
	D.6.D	"	8.0	240.0	26,100	365,400	1,245	(1174)	1,000*	
	BE – W.1	Guide Wall	–	550.0	–	82,500				
	W.2	"	–	620.0	–	93,000				
	W.3	"		700.0	–	105,000				
	Sub total					7,142,270	6,184	(2904)	2,625* 3,154	
	Supplemental Works and Contingency					1,057,730				
	Total					8,200,000	6,184	(2904)	2,625* 3,154	

Figures in ( ) are excluded out of the Sediment *Disposal Plan*

Table 4 Summary of Sabo Facilities in K. Woro (Plan I)

No.	Facility	Element				Construction Cost (Rp. x 1,000)	Volume of Sediment Production Suppression (1,000m^3)	Volume of Sediment Discharge Reduction (1,000m^3)	Volume of Sediment Discharge Control (1,000m^3)	Remarks
		Type	Height (m)	Length (m)	Volume (m^3)					
1	WO - C.1	Consolidation Dam	5.0	360	6,000	67,200			1,986 (Nos. 1–4)	Sand pocket
2	C.2	"	"	320	5,400	60,480				
3	C.3	"		318	5,300	59,360				
4	C.4	"	"	130	5,000	70,000	28			
5	C.5		7.0	125	8,100	113,400	19			
6	WO - D.1	Check Dam	10.0	135	13,200	184,800	88	(70)		
7	D.2		"	120	12,300	172,200	61	(21)		
8	D.3	"	13.5	125	17,500	245,000	138	(294)		
9	D.4	"	12.0	"	17,700	247,800	115	(142)		
10	D.5	"	13.0	97	15,300	214,200	377 (Nos. 10–11)	(46) (Nos. 10–11)		
11	D.5'	"	7.0	162	19,700	275,800				
12	D.6	"	13.0	55	11,300	158,200	153	(35)		
13	D.7	"	12.0	158	18,200	254,800	188	(111)		
14	D.8	"	8.0	70	7,500	105,000	137	(18)		
15	D.9.A	"	14.5	141	16,300	228,200	335 (Nos. 15–16)	(87)		
16	D.9.B	"	10.0	148	19,100	267,400		(173)		
17	D.10	"	"	72	9,500	133,000	98	(25)		
18	WO - R.1	Revetment (B - 1)	3.0	3,270		186,390				
19	R.2	(B - 5)	"	1,900		68,400				

No.	Facility	Element				Construction Cost (Rp. x 1,000)	Volume of Sediment Production Suppression (1,000m³)	Volume of Sediment Discharge Reduction (1,000m³)	Volume of Sediment Discharge Control (1,000m³)	Remarks
		Type	Height (m)	Length (m)	Volume (m³)					
20	WO – R.3	Revetment (B - 5)	3.0	1,070		38,520				
21	R.4	(B - 5)	"	650		23,400				
22	R.5	(")	"	1,570		56,520				
23	R.6	(")	"	1,050		46,200				
24	R.7	(B - 2)	"	580		25,520				
25	R.8	(")	"	600		26,400				
26	R.9	(")	"	230		10,120				
27	R.10	(")	"	350		15,400				
28	R.11	(D - C)	"	250		9,250				
29	WO – G	Groin			3,000 m	99,000				
30	Excavation				1,500,000	413,875		1,500		400 m x 200 m x 5 m
	Sum above					3,875,835	1,737	1,500	1,986	
	Supplemental works and Contingency					624,165				
	Total					4,500,000	1,737	1,500		

Table 5 Summary of Sabo Facilities of K. Woro (Plan II)

No.	Facility	Element				Construction Cost (Rp. x 1,000)	Volume of Sediment Production Suppression (1,000m^3)	Volume of Sediment Discharge Reduction (1,000m^3)	Volume of Sediment Discharge Control (1,000m^3)	Remarks
		Type	Height (m)	Length (m)	Volume (m^3)					
	Sum from No. 1 to No. 29 in Case I					3,461,960	1,737	(1,022)	1,986	
	Rising of Bank					706,950		(1,500)		1,200^m
	Sub Total					4,168,910		1,500 (2,522)	1,986	
	Supplemental Works and Contingency					631,090				
	Total					4,800,000	1,737	1,500 (2,522)	1,986	

Table 6 Summary of Sabo Facilities of K. Woro (Plan III)

No.	Facility	Element				Construction Cost (Rp. x 1,000)	Volume of Sediment Production Suppression (1,000m^3)	Volume of Sediment Discharge Reduction (1,000m^3)	Volume of Sediment Discharge Control (1,000m^3)	Remarks
		Type	Height (m)	Length (m)	Volume (m^3)					
	Sum from No. 1 to No.29 in Case I					3,461,960	1,737	(1,022)	1,986	
	Sand Pocket	(50 ha)			1,500,000	524,000		(1,500)		
	Sum above					3,985,960		1,500 (2,522)	1,986	
	Supplemental Works and Contingency					614,040				
	Total					4,600,000	1,737	1,500 (2,522)	1,986	

Table 7 Summary of Sabo Facilities of K. Boyong

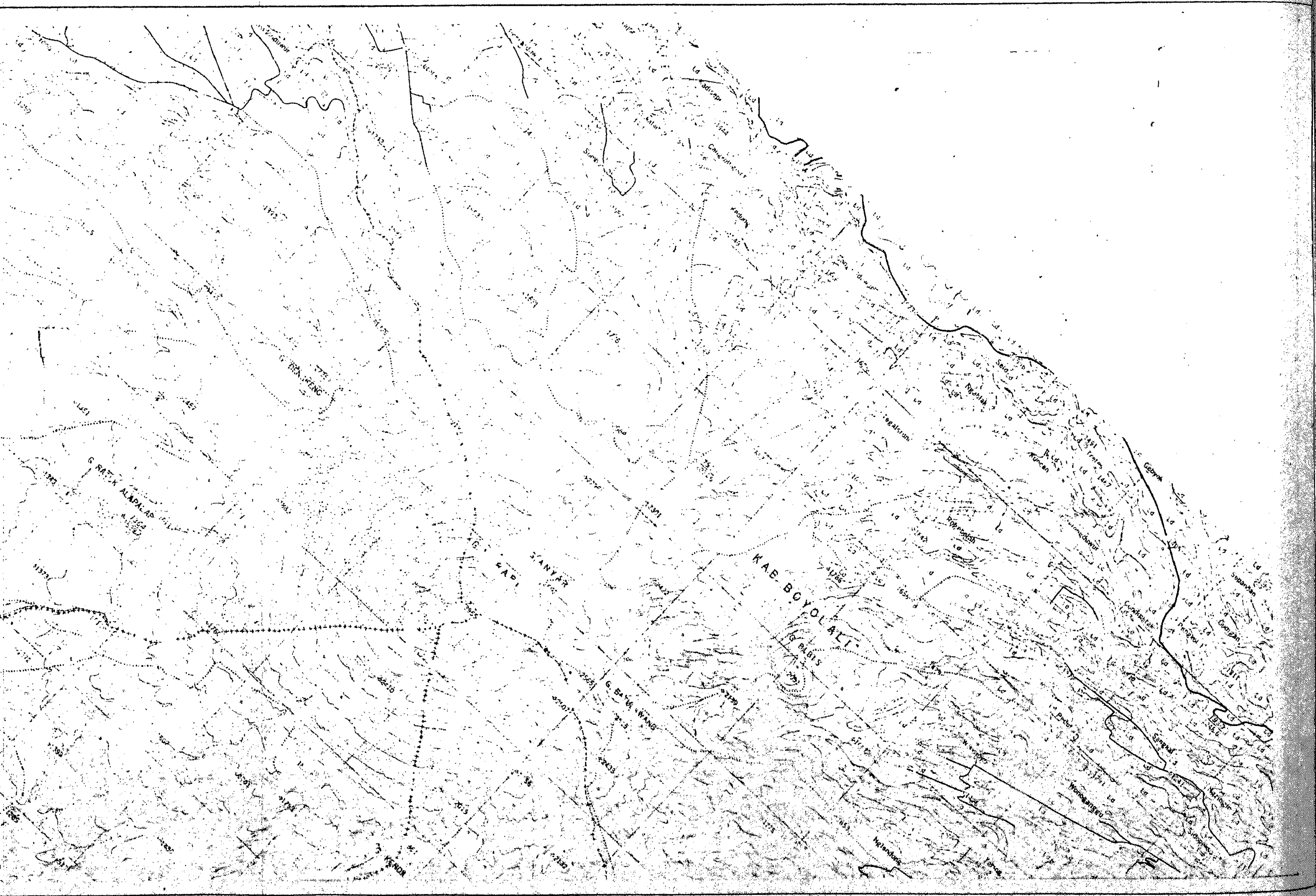
No.	Facility	Element				Construction Cost (Rp. x 1,000)	Volume of Sediment Production Suppression ($1,000m^3$)	Volume of Sediment Discharge Reduction ($1,000m^3$)	Volume of Sediment Discharge Control ($1,000m^3$)	Remarks
		Type	Height (m)	Length (m)	Volume (m^3)					
1	BO – C.1	Consolidation Dam	5.0	74	6,100	85,400				
2	C.2	"	"	"	"	85,400				
3	BO – D.1	Check Dam	8.0	61	7,900	110,600	68	(43)	67	
4	D.2		7.0	130	8,300	116,200	83	(22)	30	
5	D.3		11.0	120	14,300	200,200	156	(35)	35	
6	D.4	"	"	75	11,300	158,200	140	(58)	82	
7	D.5	"	"	80	10,300	144,200	68	(39)	54	
8	BO – R.1	Revetment (D - 2)	3.0	1,300		48,100				
9	R.2	(D - 2)	"	1,150		42,550				
10	R.3	(")	"	1,340		49,580				
11	R.4	(")	"	200		7,400				
12	R.5	(")	"	190		7,030				
13	R.6	(")	"	"		7,030				
14	R.7	(")	"	980		36,260				
15	R.8	(")	"	450		16,650				
16	R.9	(")	"	300		11,100				
17	R.10	(")	"	350		12,950				
18	R.11	(")	"	"		12,950				
19	R.12	(")	"	160		5,920				

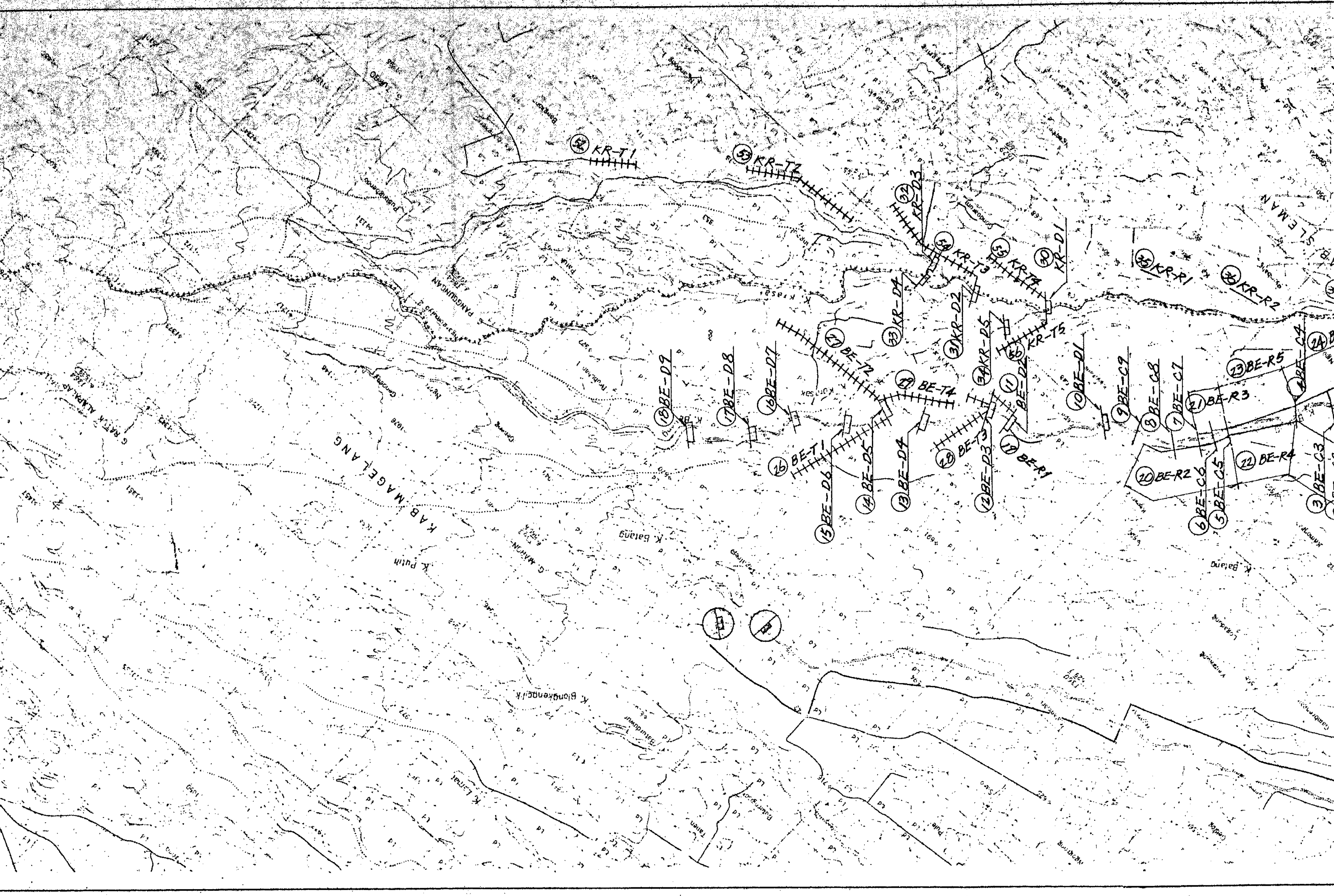
No.	Facility	Element				Construction Cost (Rp. x 1,000)	Volume of Sediment Production Suppression (1,000m³)	Volume of Sediment Discharge Reduction (1,000m³)	Volume of Sediment Discharge Control (1,000m³)	Remarks
		Type	Height (m)	Length (m)	Volume (m³)					
20	BO - B.1	Bridge				50,000				
21	B.2	"				50,000				
	Sub Total					1,257,720	515	(197)	269	
	Supplemental Works and Contingency					242,280				
	Total					1,500,000	515	(197)	269	

Table 8 Unit Cost of Construction Works

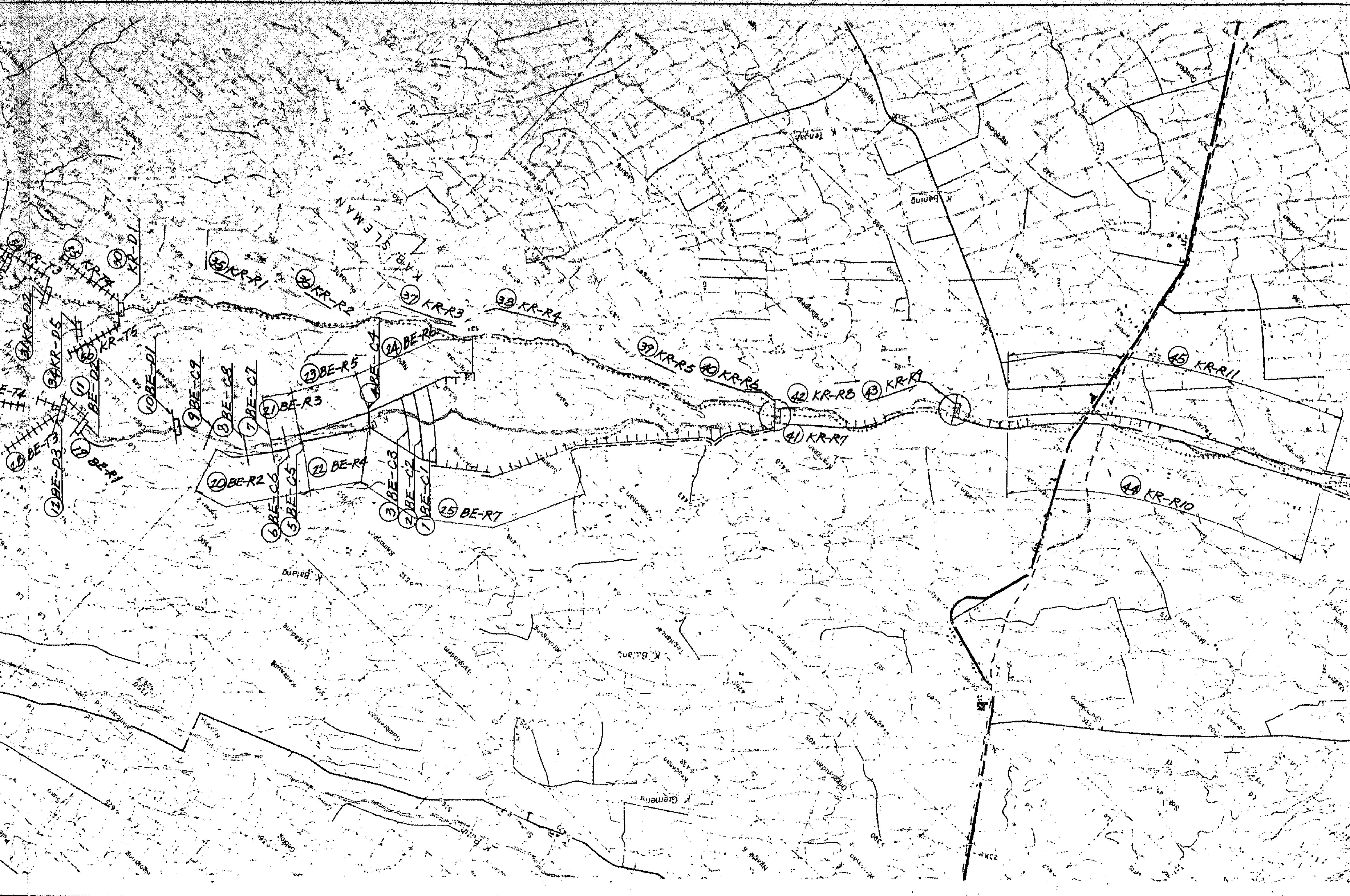
Work	Type	Unit Cost (1,000Rp.)	Remarks
Check Dam	Concrete + cobble	14 $/m^3$	Contain of cobble : much
	Concrete	19 "	" : less
Consolidation dam	Crib works	11.2 "	
Levetment	A	59 /m	
	B-1	57 "	
	B-2	44 "	
	B-3	79 "	
	B-4	66 "	
	B-5	36 "	
	C	63 "	
	D-1	50 "	
	D-2	37 "	
	D-3	64 "	
	D-4	51 "	
	E	43 "	
	F	24 "	
Training Levee		150 /m	
Groin		33 /m	
Plan I of K. Woro (Excavation)			
1. Excavation		225,000	750,000m^3 x 300Rp/m^3
2. Bedding clay on the Bottom of Reservoir		45,000	90,000m^2 x 500Rp/m^3
3. Side Wall of Reservoir		66,300	1,300m x 51,000Rp/m
4. Compensation for Spoil Bank		56,175	21.4ha x 875,000Rp/ha x 3 Year
5. Land Reclamation		21,400	21.4ha x 1,000,000Rp/ha (Dry Field)
Sub total		413,875	
6. Maintenance (Excavation)		225,000	750,000m^3 x 300Rp/m^3
Total		638,875	
Plan II of K. Woro (Sand Pocket)			
1. Enclosing Levee		37,400	850m x 44,000Rp/m (B-2)
2. River Improvement (Embankment)		52,800	300m x 2 x 2 x 44,000Rp/m (B-2)
3. Temporary Dike		29,250	375m/Block x 52m^3/m x 300Rp/m^3 x 5Block
4. Compensation		437,500	50ha x 875,000Rp/ha x 10 Year
5. Recovery of farm land		150,000	50ha x 3,000,000Rp/ha (Paddy Field)
Total		706,950	
Plan III of K. Woro (Rising of Bank)			
1. Embankment		524,000	1,200m x 44,000Rp/m (B-2)

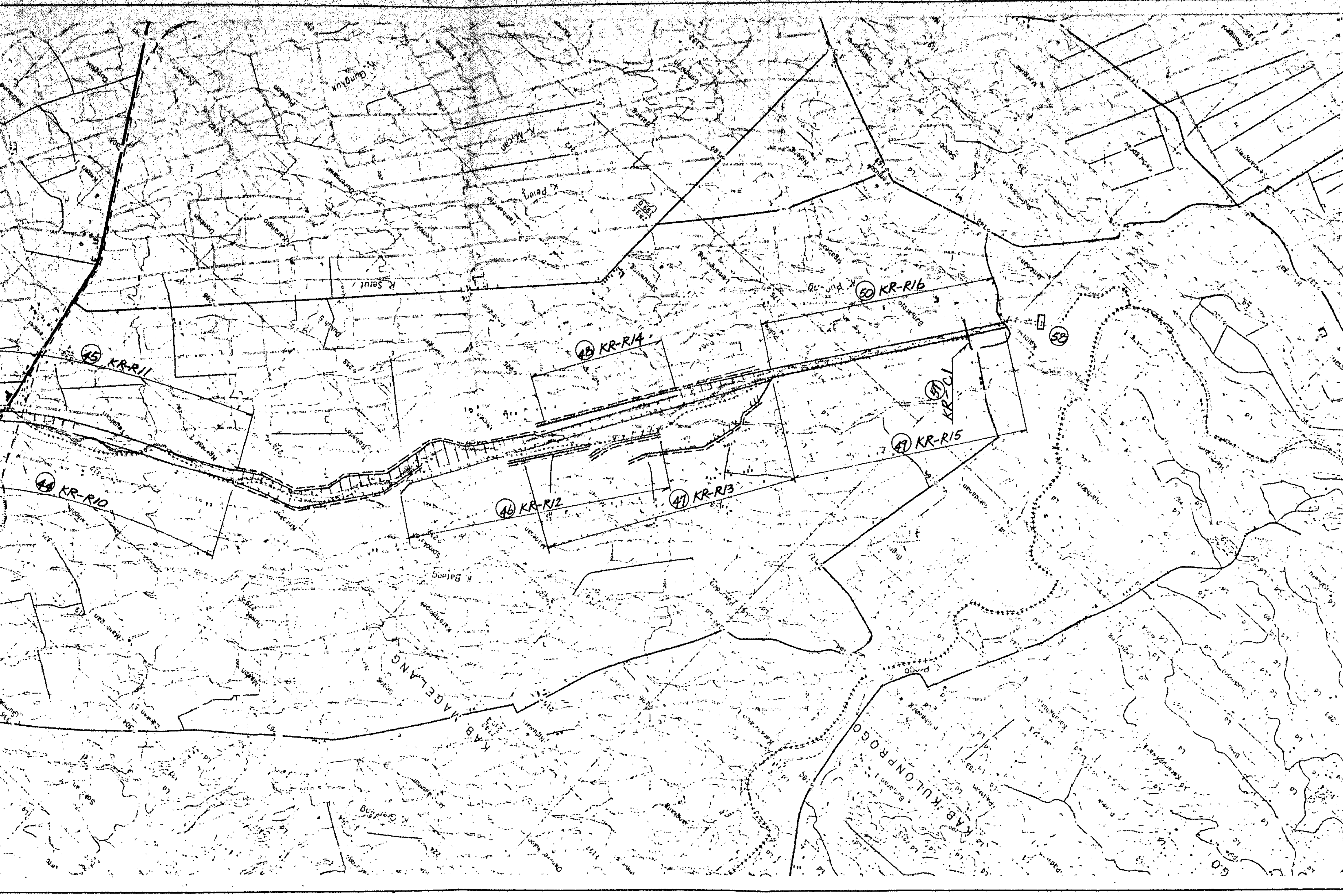
APPENDIX 4. DRAWINGS OF SABO FACILITIES


KAB. BOYOLALI
G. BIBIS
SANYAR
G. RATAK ALAPALAP
G. BATU GWANG
KENOR
Gebyok
Kurcen
Regalsrum

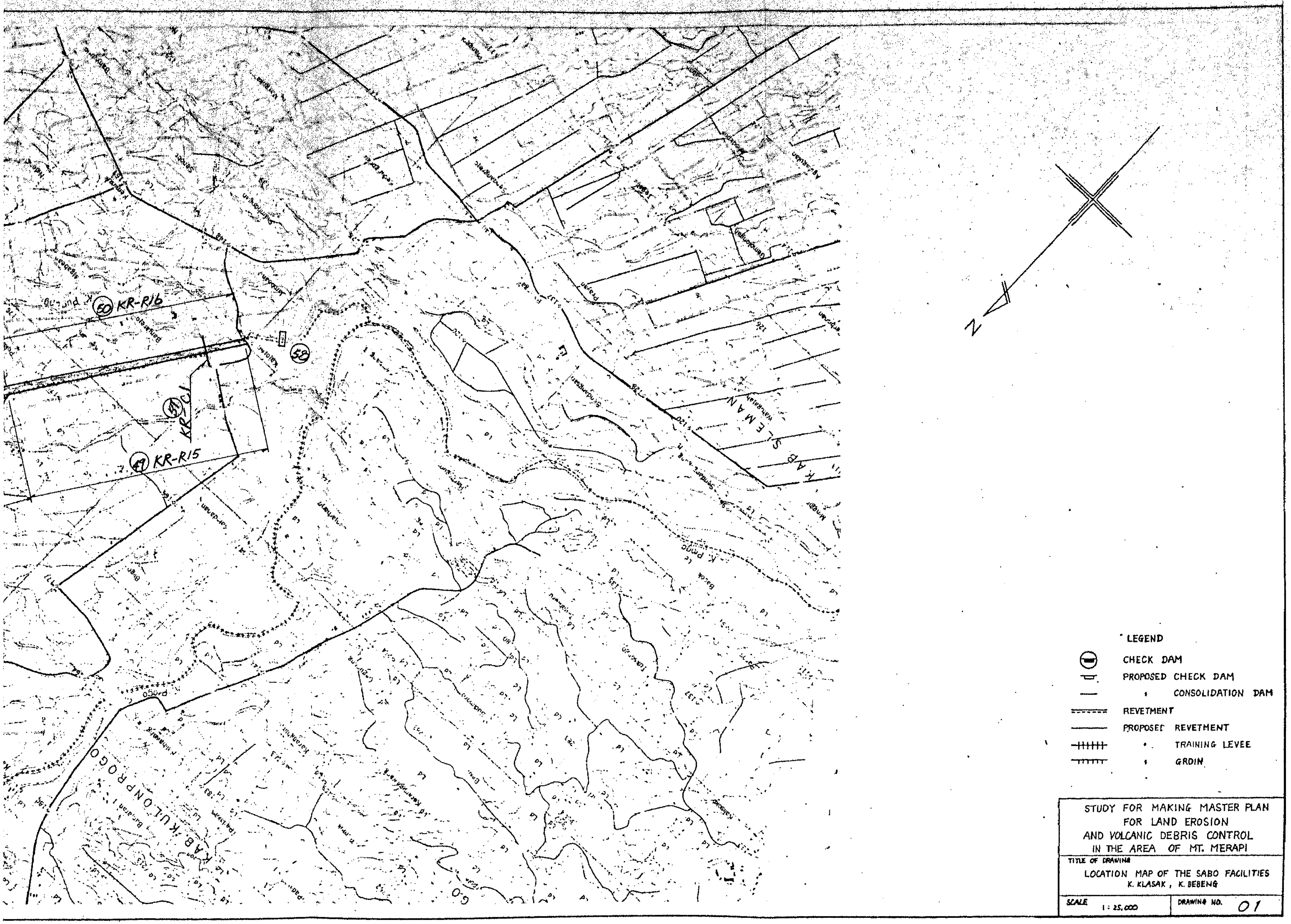


52 KR-T1
53 KR-T2
32 KR-D3
54 KR-T3
55 KR-T4
30 KR-D1
35 KR-R1
36 KR-R2
33 KR-D4
31 KR-D2
34 KR-D5
56 KR-T5
27 BE-T2
29 BE-T4
18 BE-D9
17 BE-D8
16 BE-D7
11 BE-D2
10 BE-D1
9 BE-C9
8 BE-C8
7 BE-C7
23 BE-R5
4 BE-C4
21 BE-R3
26 BE-T1
15 BE-D6
14 BE-D5
13 BE-D4
28 BE-T3
12 BE-D3
19 BE-R1
20 BE-R2
6 BE-C6
5 BE-C5
22 BE-R4
3 BE-C3
KAB. MAGELANG
SLEMAN

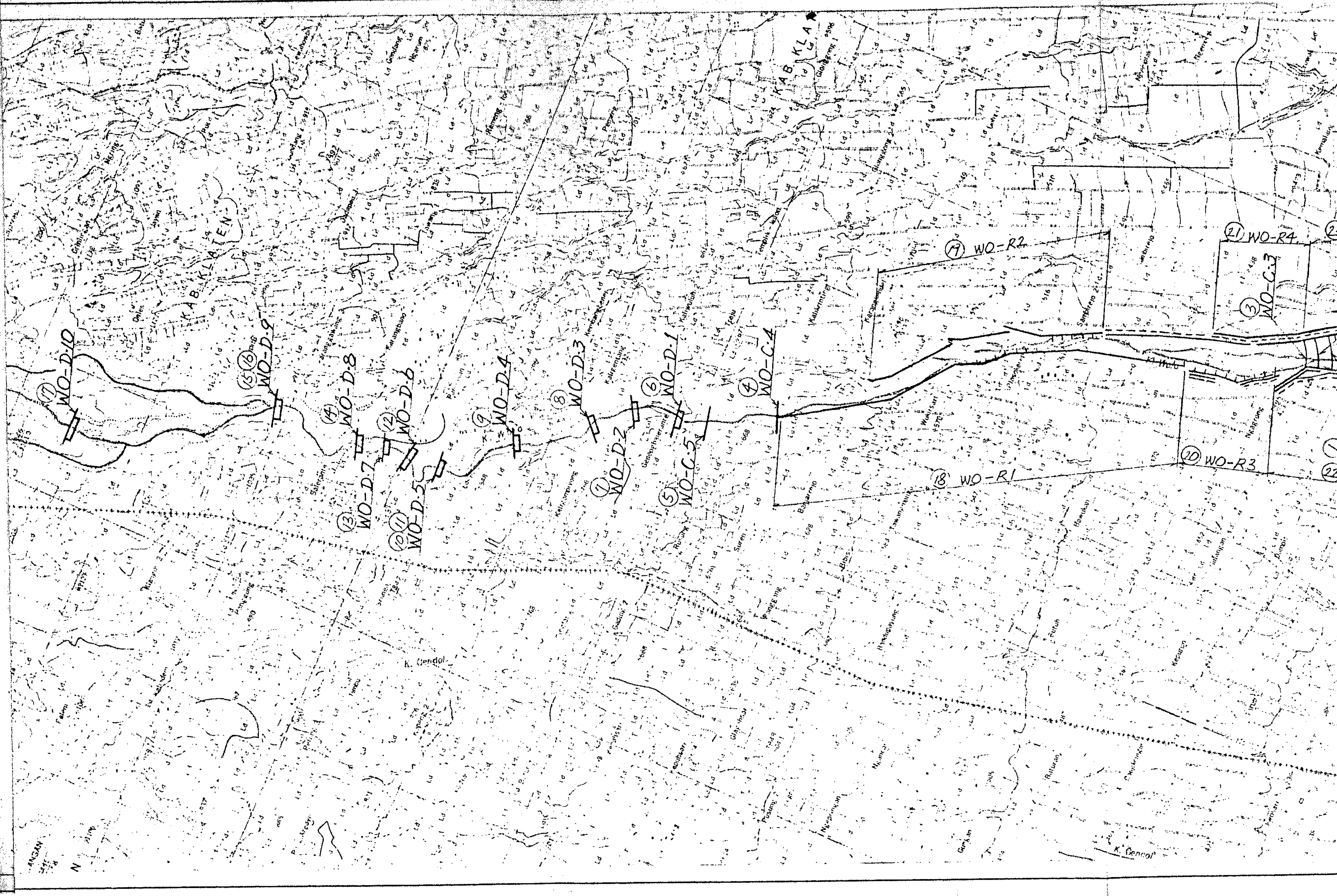

KAB. SLEMAN
35 KR-R1
36 KR-R2
37 KR-R3
38 KR-R4
39 KR-R5
40 KR-R6
41 KR-R7
42 KR-R8
43 KR-R9
44 KR-R10
45 KR-R11
KR-D1
KR-D2
KR-D5
KR-T3
KR-T4
KR-T5
19 BE-R1
BE-R2
21 BE-R3
22 BE-R4
23 BE-R5
24 BE-R6
25 BE-R7
1 BE-C1
2 BE-C2
3 BE-C3
4 BE-C4
5 BE-C5
6 BE-C6
7 BE-C7
8 BE-C8
9 BE-C9
10 BE-D1
11 BE-D2
12 BE-D3
18 BE-T3
BE-T4



44 KR-R10
45 KR-R11
46 KR-R12
47 KR-R13
48 KR-R14
49 KR-R15
50 KR-R16
51 KR-C1
52
K A B . M A G E L A N G
K A B . K U L O N P R O G O


KR-R16
KR-R15
KR-C1
KAB. SLEMAN
KAB. KULONPROGO
K. Progo
N
LEGEND
CHECK DAM
PROPOSED CHECK DAM
" CONSOLIDATION DAM
REVETMENT
PROPOSED REVETMENT
" TRAINING LEVEE
" GROIN
STUDY FOR MAKING MASTER PLAN FOR LAND EROSION AND VOLCANIC DEBRIS CONTROL IN THE AREA OF MT. MERAPI
TITLE OF DRAWING
LOCATION MAP OF THE SABO FACILITIES
K. KLASAK, K. BEBENG
SCALE 1 : 25.000
DRAWING NO. 01

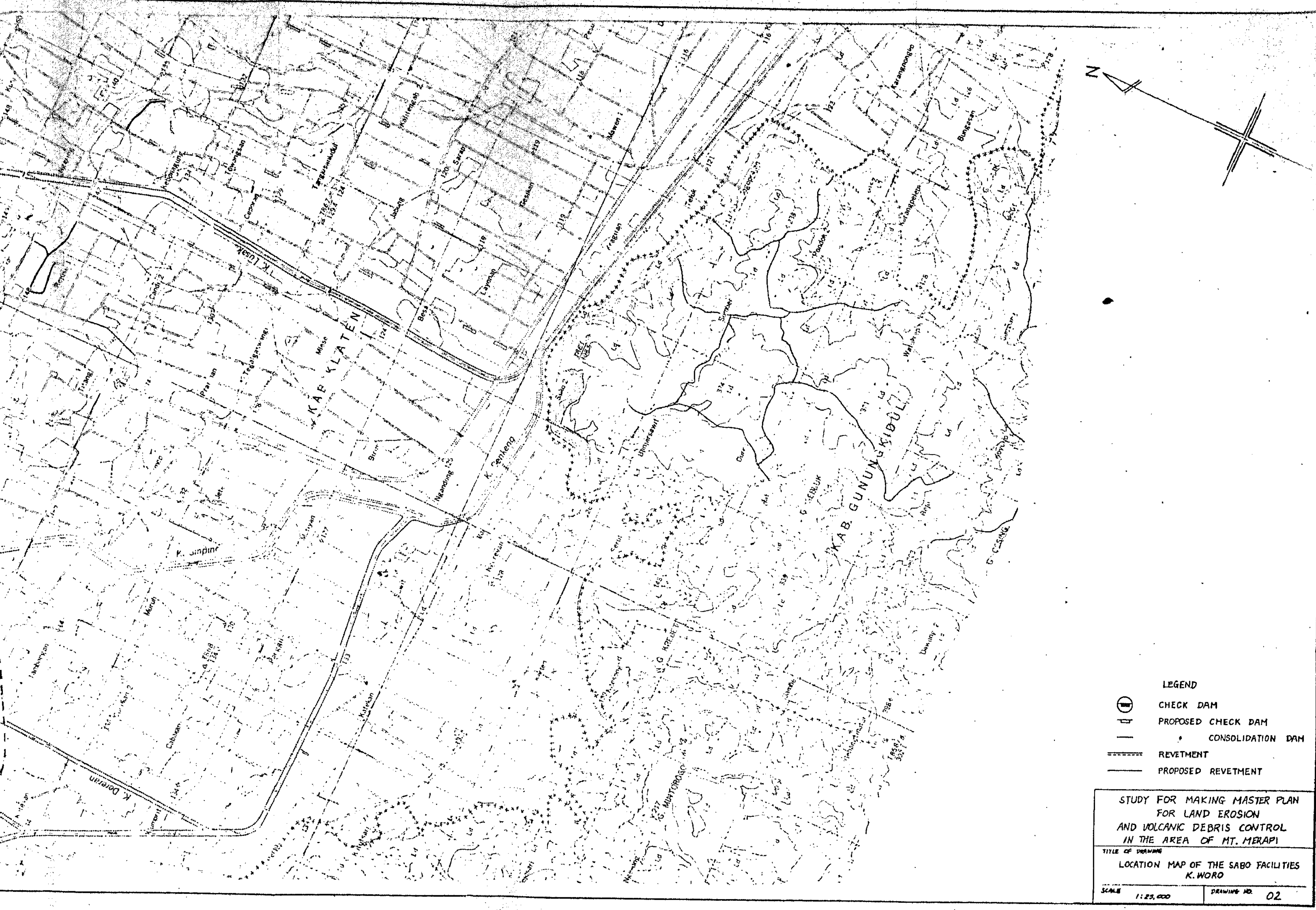

KAB. BOYOLALI
G. MERAPI
WO-D-10
(17)



KAB. KLATEN
KAB. KLA
(17) WO-D-10
(15)(16) WO-D-9
(14) WO-D-8
(13) WO-D-7
(12) WO-D-6
(10)(11) WO-D-5
(9) WO-D-4
(8) WO-D-3
(7) WO-D-2
(6) WO-D-1
(5) WO-C-5
(4) WO-C-4
(3) WO-C-3
(18) WO-R1
(19) WO-R2
(20) WO-R3
(21) WO-R4
K. Gendol


21 WO-R4
23 WO-R6
3 WO-C-3
2 WO-C-2
1 WO-C-1
20 WO-R3
22 WO-R5
24 WO-R7
25 WO-R8
26 WO-R9
30 EXCAVATING AND SCAPING WORK
KAB. KLATEN
KAB. KLATEN
K. Siling

(30) EXCAVATING AND SCRAPING WORK
(27) WO-R10
(28) WO-R11
WO-R8
(26) WO-R9
KAB. KLATEN
K. Lusah
K. Woro
K. Dereran
K. Gendeng

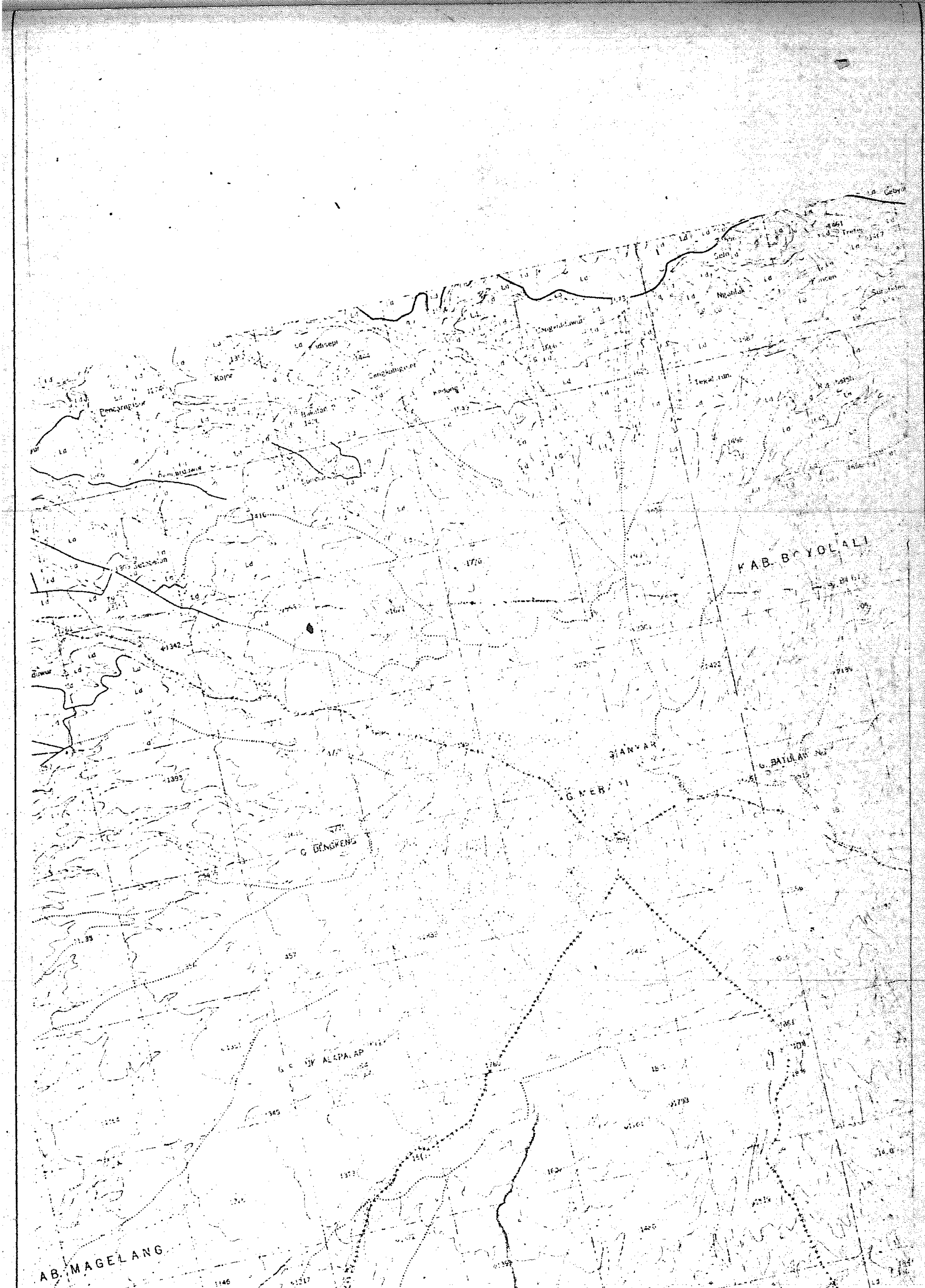


STUDY FOR MAKING MASTER PLAN FOR LAND EROSION AND VOLCANIC DEBRIS CONTROL IN THE AREA OF MT. MERAPI

TITLE OF DRAWING: LOCATION MAP OF THE SABO FACILITIES K. WORO

SCALE: 1:25,000

DRAWING NO. 02


KAB. B YOLALI
G. DENGKENG
AB. MAGELANG