10.4.10 Anchoring

Anchoring aims to directly fix unstable materials to prevent fall or detachment of bed rocks for slopes with many joints and cracks. Although this work is applied independently, this may also be done with concrete pitching, supporting type retaining wall and concrete crib work. In this study anchoring was applied in combination with the above mentioned other works. An example is shown in Figure 10.4-6. In this figure anchoring is done in combination with cast-in-place concrete crib.

Design was done as follows.

- The force against the anchor was estimated based on the sliding force along the sliding plane.
- Ultimate tensile resistance force of the bonding portion between anchor and ground was calculated from the following.

  $$T = \pi D (L - L_f) \tau$$

  Where:

  T : Ultimate tensil resistance force of anchor
  D : Diameter of main portion of anchor (cm)
  L : Total length of anchor (cm)
  L_f : Length of unanchored portion (cm)
  τ : Pull-out shearing resistance between ground and main portion of anchor (kg/cm^2)

- The value 20 kg/cm^2 for hard rocks and 10 kg/cm^2 for weathered rocks are used as τ.
- Factor of safety F_s is determined as 3 and the length of anchor was determined from the following equation.

  $$L - Lf = \frac{F_s T}{\pi D \tau}$$

Rock bolt was mainly used to anchor the sprayed concrete crib for cut slope failures to resist slight earth pressure. Rock bolt used in the Study is glued-type.

10.4.11 Re-filling

Re-filling is applied to embankment slopes with steep gradients or failured slopes. The stable gradient of an embankment can be determined by stability calculation, contrary to the case of cut slopes, but the general practice is to apply standard gradients determined empirically, such as those given in the Chapter 6 of Volume V.

Berms are provided on embankment slopes as well as cut slopes. They have the following uses: a) moderates the average gradient of the slope, thus providing greater stability and b) reduces the speed of surface water running down the slope, thus preventing erosion and scouring. Berms on embankment slopes are usually 1.0 to 2.0 m in width and placed at 5- to 7-meter intervals of height.

Taking into account the aboves, re-fillings applied in the Study were designed as follows: a) slope gradient is 1.8:1, and b) berms of 2.0-meter widths are provided at vertical intervals of 7.0 meters. Slope protection by vegetation was mainly applied where re-filling is possible with a gradient of 1.8:1 but wicker or crib is used with vegetation for larger slopes.

When topographical conditions do not allow the achievement of the standard gradient, the following measures were taken:

- Low embankments of 7 meters or less are allowed to have gradients of 1.5:1, and the slope is protected mainly by vegetation.
- Retaining walls are provided at lower parts of slopes to achieve the standard gradient of 1.8:1. The slopes are protected mainly by vegetation.
- On embankments with heights of 7 meters or more where the standard gradient cannot be applied even with the application of the above measure, the following measures were taken:
  - Where gradients of 1.0:1 to 1.5:1 can be achieved, the slopes are protected and reinforced by cast-in-place concrete cribs, stone pitching or concrete pitching.
  - Where only gradients of 1.0:1 or less can be achieved, stone masonry or gravity-type retaining walls or cast-in-place concrete cribs with PC anchors are applied.

Generally, re-fillings are easily affected by spring water from the natural ground. Therefore, the embankment structure was designed as follows:

- Existing slopes are bench cut.
- When re-filling is made at the foundation which is Valley shaped, closed conduits is always provided at the base of the re-filling.
- Horizontal drain layers of 30 cm thick made of permeable material are provided at each level of berm.
- To easily drain groundwater, gabion is mainly used.

Generally, re-filling embankment is likely to collapse due to insufficient compaction because of limited space for heavy equipment. In this case, the following points should be remembered:

- the thickness of one layer shall be less than 30 cm.
- compaction shall be done for each layer by compactor.
- completed slope shall be compacted by a bulldozer.

An illustration of re-filling is shown in Figure 10.4-8.

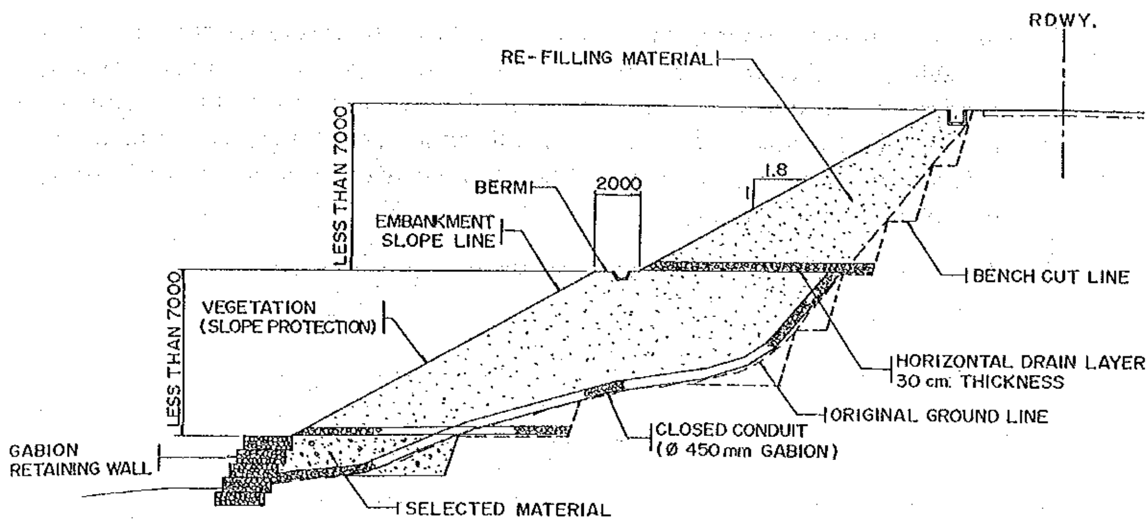

FIGURE 10.4-8 RE-FILLING

10.4.12 Catch Fence

Catch fence aims to prevent roads from damage due to rock fall. This fence consists of several types available in the market and can be selected depending on bouncing height and kinetic energy of the falling rock. The typical drawing is shown in volume IV "Drawings".

Fall at the spot which catch fence was applied was expected to have bouncing height of 2.5 m or more, so that tallest fence of 3.0 m sold on the market was selected.

An illustration of catch fence is shown in Figure 10.4-9.

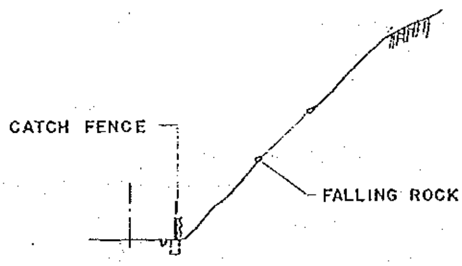

FIGURE 10.4-9 CATCH FENCE

Detailed dimensions are also shown in the typical drawing in Volume IV.

10.4.13 Anchor Wire Net

This type aims to provide resisting force to fall directly by covering slope with net. There are two kinds of net: oen is made of chemical fiber and the other is the metal net. The chemical fiber net is used for small-scale fall or rock weighing less than 60 kg. Durability of this is uncertain especially when exposed to sunlight. Due to these conditions, the metal net was adopted in the Study. This metal type wire net is also available in the market and standard is listed in typical drawing in Volume IV. Considering the volume of rock fall, galvanized net which resists fall weight of 1500 kg. was adopted in this study.

An illustration of anchor wire net is shown in Figure 10.4-10.

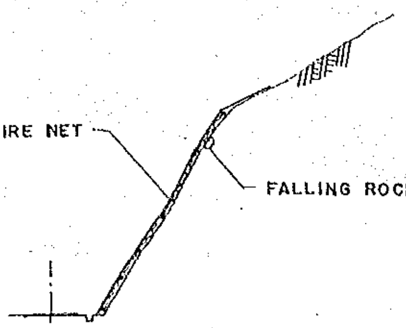

FIGURE 10.4-10 ANCHOR WIRE NET

10.4.14 Earth removal for landslide

The amount of earth to be removed was decided by the following procedure:

- sliding plane is assumed based on result of boring and seismic survey.
- assuming the safety factor to be 1.0 in the present condition, a linear equation retaining to cohesion (c) and angle of internal friction (ϕ) was estimated using the following equation.

$$F_s = \frac{\Sigma\{c \cdot \ell + (W\cos\theta - u)\tan\phi\}}{\Sigma W \sin\phi}$$

F_s = Safety factor (assuming to be 1.0)
W = Weight of a slice (t/m)
ℓ = Length of arc of sliding surface cut by equation each slice (m)
C = Cohesion (t/m^2)
ϕ = Angle of internal friction (°)
u = Pore water pressure (t/m^2)

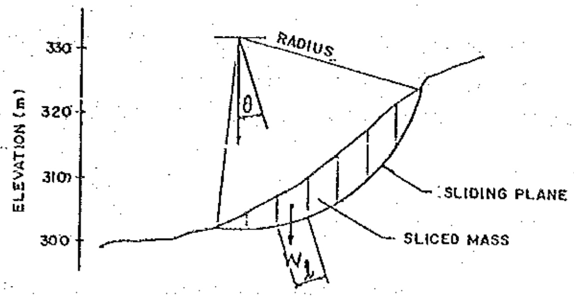

FIGURE 10.4-11 STABILITY CALCULATION (CIRCULAR RAPTURE PLANE)

Based on the linear equation pertaining to C and ϕ obtained as shown in Figure 10.4-12, the value of C was determined by referring to the empirical figures given in Table 10.4-3 and then the value ϕ was obtained.

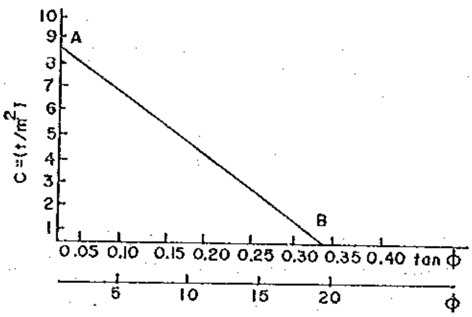

FIGURE 10.4-12 LINEAR EOUATION PERTAINING TO C AND ϕ

TABLE 10.4-3 RELATIONSHIP BETWEEN THICKNESS OF SLIDING MASS AND COHESION

Thickness of Sliding Mass (m)	Cohesion (t/m^2)
5	0.5
10	1.0
15	1.5
20	2.0
25	2.5

- Planned factor of safety was 1.1. The volume of earth to be removed was decided using above formula and C and ϕ estimated based on procedures mentioned above.

Cutting and removal work is done by bulldozer, and the removed earth is disposed of somewhere nearby but outside the landslide area. The slope that results from the removal work is shaped so that drainage is facilitated, and vegetation is used for protection.

10.4.15 *Counterweight fill for landslide*

This was designed using the same procedure as in earth removal. The amount of fill was designed so as to satisfy design factor of safety of 1.2. Fill is made up of coarse materials to drain ground water.

10.4.16 Piling

Shino type pile in which linear plates are used as a framework to dig a well and reinforced concrete is poured into the well, was adopted for countermeasure of landslides. The safety design factor is 1.1 and force acting against the pile was estimated with the formula below. C and ϕ was calculated as in the method mentioned in 10.4.14.

$$F_s = \frac{\Sigma\{ C. \ell + (W \cos\phi - u\,\ell) \tan\phi \} + P}{\Sigma W \sin\phi}$$

P = Required control force (t/m^2)

The force P was assumed to act on one-third of the thickness of the sliding mass. Pile was designed using Chang's Formula.

10.4.17 Water Way and Sabo Dam

Water ways combined with small-scale-sabo dams were applied as main countermeasure to debris flow. Assuming two years as the design probable rainfall period, the flow and the cross-section of water way are calculated according to the same procedure given in 10.4.1 for surface drainage. Stone pitching was used for water ways, as shown in Figure 10.4-13.

Sabo dam was designed in the following manner:

- Height of dam was designed with gradient of deposited debris being one half the gradient of stream bed.
- Assuming hydrostatic pressure as an external force acting on the dam, stability on overturning, sliding and bearing of foundation was analyzed following the same design condition mentioned in 10.4.9.

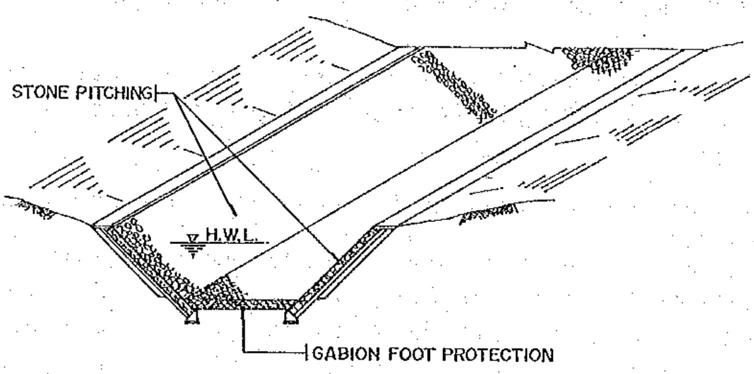

FIGURE 10.4-13 STONE PITCHING WATER WAY

10.4.18 Other Designs

1) Box and Pipe Culverts

Box and pipe culverts were planned at spots where insufficient or destroyed drainage facilities are thought to have caused road disasters. The cross-sections of box and pipe culverts are determined in accordance with the procedure given in 10.4.1 for surface drainage, assuming that the probable rainfall period for box culverts is 25 years and that for pipe culverts, 10 years. Considering maintenance works, the diameter of pipe culverts is not less than 1.0 meter.

2) Protection at Outlet of Culvert

Where outlets of existing culverts are scoured, protection of outlets was planned. Stone pitching were mainly adopted for protection of water way bank and concrete consolidation for protection of water way bed.

10.5 APPLIED COUNTERMEASURE

Countermeasures applied for each spot is shown in Appendix 10-4, including details with sketchy illustrations of slope, geological and water condition and factors for the selection of countermeasures.

Countermeasures finally applied for disaster spots are summarized in Table 10.5-1.

The largest number of countermeasures of 215 was applied for Dalton Pass Section followed by 143 for Mahaplag-Sogod Section and 121 for Kennon Road. On the other hand, as for the number of disaster spots subject to design, Dalton Pass Section has the largest 73 spots followed by 46 in Kennon Road and 40 in Mahaplag-Sogod Section.

Number of applied countermeasures per spot is about 3.0 in Dalton Passsection, about 3.6 in Mahaplag-Sogod section and about 3.0 in Kennon Road. This may indicate that there are relatively large scale disasters in which conjective application of measures is required in Mahaplag-Sogod Section, comparing with other two sections.

Among the countermeasures applied for cut slope failures and falls, number of removal/re-cutting has the largest, 55 for cut slope failures and 38 for falls. This is due to the fact that large number of removal works were applied. Removal work is applied in many cases because unstable materials have to be removed no matter what countermeasures will be applied. Therefore, it is rational to exclude number of removal works when number of countermeasures applied is discussed.

As for number of countermeasures applied for cut slope failures, except removal works, surface drain is the largest amounting at 40, followed by 32 of slope protection by vegetation and 27 of concrete spraying. This proves that most of cut slope failures are caused by surface water flow on the slopes and drainage facilities and appropriate slope protections are required to prevent failures.

As for number of countermeasures applied for embankment slope failures, re-filling is the largest at 30 followed by 28 of surface drain and subsurface drain. It can be recognized that measures to drain water is very important to prevent the failure.

On countermeasures applied for falls, except removal work, catch works, especially anchored wire net, were applied at the greatest number of 29, followed by 14 of concrete spraying and 6 of surface drain. Rock falls occur mainly on the slopes of hard rocks which is hardly weathered and eroded. Therefore, catch works were selected at large number of spots, on the other hand, surface drain at relatively few spots comparing with cut slope failure case.

As for countermeasures applied for landslide, there were no works applied predominantly. However, if many spots of landslide to be designed existed, horizontal drain hole and earth removal for landslide would be applied at many spots.

Main countermeasures applied for debris flow were stone pitching water ways and small scale of sabo dam. In the Study, since small torrents were mainly subject to design, it is natural to select above two works as appropriate countermeasures.

TABLE 10.5-1 NUMBER OF APPLIED COUNTERMEASURES

SECTION	DISASTER		APPLIED COUNTERMEASURES																			
			EARTH WORK		DRAINAGE WORK		PROTECTION WORK					STRUCTURE WORK						TORRENT WORK				
	TYPE	NUMBER	REMOVAL / RE-CUTTING	RE-FILLING	SURFACE DRAIN	SUBSURFACE DRAIN	VEGETATION	CONCRETE SPRAYING	CONCRETE CRIB	STONE PITCHING	CATCH WORK	STONE MASONRY R.W.	GRAVITY TYPE R.W.	SUPPORTED TYPE R.W.	GABION R.W.	ANCHORING	PILING	STONE PITCHING WATER WAY	GABION F.P.	CONCRETE SABO-DAM	CULVERT	TOTAL
DALTON PASS (73 spots)	C-S.F, D.F	39	32	1	28	–	21	16	8	–	–	3	–	–	1	–	–	–	–	–	–	110
	E-S.F, D.F	13	–	11	9	11	2	–	3	9	–	4	1	1	–	–	–	–	8	–	1	60
	C-F	6	5	–	–	–	–	3	–	–	3	–	–	–	–	–	–	–	–	–	–	11
	L.S	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	D.F	14	–	1	–	–	–	–	–	–	–	–	2	–	–	–	–	13	1	11	4	32
	O.F	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	2
SUB TOTAL			37	13	37	11	23	19	11	9	3	8	3	1	1	0	0	13	9	11	6	215
MAHAPLAG-SOGOD (40 spots)	C-S.F, D.F	19	18	–	12	2	10	8	3	–	1	2	1	–	–	1	–	1	1	–	–	60
	E-S.F, D.F	14	–	14	13	13	11	–	2	–	–	2	–	1	6	–	–	–	–	–	1	63
	C-F	2	2	–	1	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	5
	L.S	3	2	1	2	2	2	–	–	–	–	–	–	–	2	–	–	–	–	–	–	11
	D.F	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
	O.F	1	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	1	3
SUB TOTAL			22	15	28	17	23	8	5	1	3	5	1	1	8	1	0	2	1	0	2	143
KENNON ROAD (46 spots)	C-S.F, D.F	5	5	–	–	–	1	3	2	–	–	–	–	–	–	–	–	–	–	–	–	11
	E-S.F, D.F	9	–	5	6	4	–	–	3	–	–	3	4	2	2	2	–	–	1	–	–	32
	C-F	31	31	–	5	–	–	11	4	–	22	–	–	1	–	1	–	–	–	–	2	77
	L.S	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1
	D.F	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
	O.F	0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
SUB TOTAL			36	5	11	4	1	14	9	0	22	3	4	3	2	3	1	0	1	0	2	121
TOTAL (159 spots)	C-S.F, D.F	63	55	1	40	2	32	27	13	–	1	5	1	–	1	1	–	1	1	–	–	181
	E-S.F, D.F	36	–	30	28	28	13	–	8	9	–	9	5	4	8	2	–	–	9	–	2	155
	C-F	39	38	–	6	–	–	14	4	–	27	–	–	1	–	1	–	–	–	–	2	93
	L.S	4	2	1	2	2	2	–	–	–	–	–	–	–	2	–	1	–	–	–	–	12
	D.F	15	–	1	–	–	–	–	–	–	–	–	2	–	–	–	–	14	1	11	4	33
	O.F	2	–	–	–	–	–	–	–	1	–	2	–	–	–	–	–	–	–	–	2	5
TOTAL			95	33	76	32	47	41	25	10	28	16	8	5	11	4	1	15	11	11	10	479

NOTE :

TYPE OF DISASTER

- C-S.F,D.F Cut slope surface failure, deep failure
- E-S.F,D.F Embankment slope surface failure, deep failure
- C-F Cut slope Rock fall
- L.S Landslide
- D.F Debris flow
- O.F Overflow

R.W RETAINING WALL

F.P FOOT PROTECTION

CHAPTER 11

PROJECT COST

11.1 GENERAL

The project cost consists of datailed engineering cost, land acquisition cost, construction cost and construction supervision cost. The project cost was estimated in October 1983 prices broken down into the foreign currency component, local currency component and taxes. The foreign component includes cost of imported equipment and spare parts, the foreign currency portion of locally purchased goods and services, wages of expatriate personnel and foreign overheads and profits. The local component includes cost of locally procured equipment, materials and supplies, local wages, local supervision, local transport and freight and local overheads and profits. The following conversion rates are applied to foreign components;

₱ 14.00 = US$ 1.00 = ¥ 234.3

The economic cost consists of local and foreign components, excluding taxes. The financial cost consists of economic cost and texes.

11.2 CONSTRUCTION COST

The market price survey was conducted to get information on market prices of construction materials and equipment. Due to two (2) times devaluation of peso currency, market prices were fluctuated. In the unit cost analysis, avarage market prices were used. The unit cost of each construction item was estimated based on market price survey findings, information from contractors and latest unit costs from other projects. Unit costs of major construction items are presented in Table 11.2-1. The unit cost of major construction equipment, materials and laborers which used in the unit cost analysis are enumerated in Tables 11.2-2 to 4. The analysis of unit costs of major items is explained in Appendix 11-1.

Total construction cost was estimated 322.69 million pesos, of which 157.42 million pesos was the Dalton Pass Section, 81.20 million pesos was the Mahaplag-Sogod Section and 84.07 million pesos was Kennon Road. (See Table 11.2-5, also refer to Appendix 11-2).

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TABLE 11.2-5 CONSTRUCTION COST - Oct. 1983 Price -

Unit : Million Pesos

Section	Foreign	Local	Tax	Total
Dalton Pass Section	93.98	43.29	20.15	157.42
Mahaplag-Sogod Section	49.37	21.11	10.72	81.20
Kennon Road	52.96	20.01	11.10	84.07
T O T A L	196.31	84.41	41.97	322.69

TABLE 11.2-1 SCHEDULE OF UNIT COST - October 1983 Price -

Item No.	Description	Unit	Unit Cost (Pesos)	Component (%) F	L	T	Subsidiary Work Item Included In Unit Cost
	MAIN WORK ITEM						
100	Earth Work						
102	Removal of Soft Rock	Cu. M.	176.00	60	26	14	
105	Re-cutting of Soft Rock	Cu. M.	221.00	67	18	15	
106	Re-cutting of Hard Rock	Cu. M.	276.00	65	19	16	
110	Re-filling of Common Material	Cu. M.	96.00	63	25	12	. Fill common material . Horizontal drain layer . Bench cut excavation
200	Drainage Work						
201	Top Slope Ditch	Li. M.	280.00	53	34	13	. Structural excavation . Rubble Concrete
205	Closed Conduit, (Ø45^{cm} Gabion)	Li. M.	277.00	60	27	13	
207	Concrete Pipe Culvert (Ø1070 mm)	Li. M.	2,232.00	54	23	13	
300	Slope Protection Work						
303	Concrete Spraying (t = 15^{cm})	Sq. M.	440.00	56	31	13	
305	Sprayed Concrete Crib With Grass	Sq. M.	792.00	64	23	13	
311.1	Stone Pitching (H = 2.0 m)	Li. M.	872.00	52	35	13	. Boulder concrete . Lean Concrete . Structural excavation etc.
400	Catch Work						
402	Anchor Wire Net	Sq. M.	290.00	65	22	13	
500	Structure Work						
504.2	Supported Type Retaining Wall for Embankment Slope (H = 3.0 m)	Li. M.	3,605.00	56	32	13	. Concrete Class "A" . Structural excavation . Steel reinforcement etc.
505.2	Supported Type Retaining Wall for Cut Slope (H = 5.0 m)	Li. M.	6,118.00	56	32	13	
	SUBSIDIARY WORK ITEM						
Sub. 1	Structural Excavation in Common Material	Cu. M.	35.00	63	25	12	
Sub. 2	Structural Excavation in Rock Material	Cu. M.	172.00	65	23	12	
Sub. 3	Bench Cut Excavation	Cu. M.	112.00	60	28	12	
Sub. 4	Fill Common Material	Cu. M.	64.00	61	20	19	
Sub. 5	Backfill Material (Selected Material)	Cu. M.	210.00	63	25	12	
Sub. 6	Horizontal Drain Layer	Sq. M.	74.00	61	20	19	
Sub. 7	Cobble Stone in Bed to Structural Base	Cu. M.	182.00	63	23	14	
Sub. 8	Lean Concrete	Cu. M.	900.00	51	35	14	
Sub. 9	Concrete Class "A"	Cu. M.	1,700.00	55	33	12	
Sub. 10	Rubble Concrete	Cu. M.	486.00	64	23	13	
Sub. 11	Boulder Concrete	Cu. M.	362.00	64	23	13	
Sub. 12	Steel Reinforcement	Kg.	12.70	61	24	15	

TABLE 11.2-2 HOURLY/DAILY COST OF CONSTRUCTION EQUIPMENT

- October 1983 Price -

Unit : Pesos

Construction Equipment	Hourly/Daily Cost	Component (%)		
		F	L	T
Bulldozer 75 HP	377.50/Hour	67	20	13
Bulldozer 125 HP	590.00/Hour	67	20	13
Bulldozer 230 HP	889.00/Hour	67	20	13
Crawler Loader 110 HP	448.30/Hour	67	20	13
Crawler Excavator 135 HP	743.50/Hour	67	20	13
Tanden Roller	310.00/Hour	67	20	13
Plate Compactor	75.64/Hour	62	20	18
Explosion Rammer	12.49/Hour	65	19	16
Concrete Batching Plant 80 HP	508.60/Hour	60	20	20
Concrete Mixer 75 HP	17.00/Hour	35	55	10
Concrete Mixer 30 HP	67.00/Hour	51	35	14
Screening Plant 25 HP	702.40/Hour	60	20	20
Crushing Plant 80～135t/H	880.00/Hour	60	20	20
Dump Truck 10 ton	254.00/Hour	63	21	16
Concrete Spraying Machine 0.8 ～ 1.2 m^3/Hour	256.00/Hour	67	20	13
Air Compressor 10.5 m^3	1960.00/day	67	20	13
Hard Hammer 15 kg	72.00/day	67	20	13
Drifter 30 kg	127.00/day	67	20	13
Crawler Drill 7 m^3 2.2 t	308.00/Hour	67	20	13
Water Pump Ø 50 mm	44.00/day	65	22	13
Belt Conveyor 7 (m)	160.50/day	67	20	13
Motor Generator 7.5 KVA	215.00/day	67	20	13
Motor Generator 15 KW	474.00/day	67	20	13
Truck Crane 20～20 ton	1260.00/Hour	67	20	13
Winch 1.0 ton 10 PS	300.00/day	40	48	12

TABLE 11.2-3 COST OF MAIN MATERIALS
- October 1983 Price -

Unit : Pesos

Main Material	Unit	Unit Price	Component (%) F	L	T
. Market Price of Purchased Materials					
Portland Cement	Ton	1,075.00	50	35	15
	(Bag)	(43.00)			
Steel Reinforcement	kg	8.79	70	12	18
Diesel Fuel	liter	4.47	62	19	19
Gasoline (Regular)	liter	5.47	62	19	19
P.V.C Pipe ø 50^{mm}	Li.M	30.00	60	24	16
Wire Net ø 2.0^{mm} - 50x50 (JIS 3552)	Sq.M	32.00	71	12	17
Wire Net ø 4.0^{mm} - 50x50 (JIS 3552)	Sq.M	139.00	71	12	17
Wire Rope ø 12 (JIS 3525)	Li.M	23.00	72	12	16
Wire Rope ø 16 (JIS 3552)	Li.M	33.00	72	12	16
Rock Anchor ø 25^{mm} ℓ= 1.0m	EA	488.00	72	12	16
Anchor Bar ø 16^{mm} ℓ= 40cm	EA	10.00	72	12	16
Anchor Bar ø 16^{mm} ℓ= 75cm	EA	19.00	72	12	16
Lumber, Yacal/Guijo	*bd.ft*	*12.00*	*30*	*55*	*15*
. Processed Materials					
. Coarse Aggregate for Cement Concrete	ton	51.84	60	24	16
. Fine Aggregate for Cement Concrete	ton	84.92	60	26	14
. Coarse Aggregate for base-coarse	ton	79.41	60	24	16
. Coarse Aggregate for sub-base coarse	ton	71.51	60	24	16
. Concrete Class "A"	Cu.M	1,020.00	55	30	15
. Lean Concrete	Cu.M	950.00	56	29	15
. Standard Strength Reinforced Concrete Pipe					
ø 1070	Li.M	1,213.00	55	31	14
ø 1220	Li.M	1,379.20	55	31	14
ø 1520	Li.M	2,117.40	55	31	14

TABLE 11.2-4 LABOR COST
- October 1983 Price -

Unit : Pesos

Labor Category	Hourly Rate	Daily Rate
Foreman	9.54	76.32
Assistant Foreman	8.95	71.60
Heavy Equipment Operator	8.04	64.32
Light Equipment Operator	7.81	62.48
Driver	7.81	62.48
Skilled Labor	7.00	56.00
Unskill Labor	6.15	49.20
Technical Expart	-	1000.00

11.3 DETAILED ENGINEERING AND CONSTRUCTION SUPERVISION COSTS

Detailed engineering cost usually amounts to 3% to 5% of construction cost, however, in view of extensive subsurface investigations required as well as complicated topographic survey of mountainous terrain, detailed engineering cost was estimated at 7% of construction cost.

Construction supervision cost which usually amounts to 5% to 9% of construction cost was estimated at 7%.

11.4 LAND ACQUISITION COST

All sections are located at the mountainous area. Road right-of-way of 120 meters is usually obtained for a road in a mountainous section. All countermeasures were planned within 120-meter right-of-way. No land acquisition cost was estimated.

11.5 PROJECT COST

Total project cost in October 1983 price was estimated at 367.85 million pesos: foreign currency component at 225.65 million pesos, local currency component at 97.99 million pesos and taxes at 44.21 million pesos (See Table 11.5-1 and 2, also refer to Appendix 11-3).

Project cost was adjusted in consideration of escalation rates forecasted by NEDA to develop project cost in current price. Total project cost in current price was estimated at 571.19 million pesos; foreign currency component at 320.19 million pesos and local currency component including taxes at 251.00 million pesos (See Table 11.5-3, also refer to Appendix 11-4).

TABLE 11.5-1 SUMMARY OF PROJECT COST
- October 1983 Prits -

Unit : Million Pesos

Section	Foreign	Local	Tax	Total
Dalton Pass Section	108.30	49.91	21.25	179.46
Mahaplag-Sogod Section	56.75	24.53	11.28	92.56
Kennon Road	60.60	23.55	11.68	95.83
T O T A L	225.65	97.99	44.21	367.85

TABLE 11.5-2 PROJECT COST
- October 1983 Price -

Unit : ₱ x Million

Section / Item	Dalton Pass Section				Mahaplag-Sogod Section				Kennon Road				Total			
	Financial Cost	Component			Financial Cost	Component			Financial Cost	Component			Financial Cost	Component		
		F	L	T		F	L	T		F	L	T		F	L	T
Detailed Engineering	11.02	7.16	3.31	0.55	5.68	3.69	1.71	0.28	5.88	3.82	1.77	0.29	22.58	14.67	6.79	1.12
Construction Supervision	11.02	7.16	3.31	0.55	5.68	3.69	1.71	0.28	5.88	3.82	1.77	0.29	22.58	14.67	6.79	1.12
Construction	157.42	93.98 (59.7)	43.29 (27.5)	20.15 (12.8)	81.20	49.37 (60.8)	21.11 (26.0)	10.72 (13.2)	84.07	52.96 (63.0)	20.01 (23.8)	11.10 (13.2	322.69	196.31 (60.8)	84.41 (62.2)	41.97 (13.0)
TOTAL COST	179.46	108.30 (60.3)	49.91 (27.8)	21.25 (11.9	92.56	56.75 (61.3)	24.53 (26.5)	11.28 (12.2)	95.83	60.60 (63.2)	23.55 (24.6)	11.68 (12.2)	367.85	225.65 (61.4)	97.99 (26.6)	44.21 (12.0)

Note:

1/ Includes 10% physical contingency

( ) Shows % share of each component

TABLE 11.5-3 PROJECT COST - CURRENT PRICE -

Unit : Million Pesos

	Dalton Pass Section			Mahaplag-Sogod Section			Kennon Road			Total		
	Total	Component		Total	Component		Total	Component		Total	Component	
		F	L & T		F	L & T		F	L & T		F	L & T
Detailed Engineering	14.34	8.68	5.66	7.39	4.48	2.91	7.64	4.63	3.01	29.37	17.79	11.58
Construction Supervision	17.33	9.48	7.85	8.91	4.97	3.94	9.19	5.33	3.86	35.43	19.78	15.65
Construction	247.61	135.46	112.15	127.43	71.07	56.36	131.35	76.09	55.26	506.39	282.62	223.77
TOTAL	279.28	153.62	125.66	143.73	80.52	63.21	148.18	86.05	62.13	571.19	320.19	251.00

CHAPTER 12

PROJECT EVALUATION

The Project was evaluated from the viewpoints of economic and financial viability as well as various impacts contributed to by the Project.

Various benefits not only from traffic, but also social and developmental benefits, will be derived from the Project. However, only a few of them can be quantifiable. The benefits which can not be quantified were assessed under the Project impact evaluation. In the economic evaluation, only quantifiable benefits were discussed.

12.1 ECONOMIC EVALUATION

12.1.1 Outline

1) Benefit of the Project

The traffic interruption on a road section especially on a major thoroughfare imposes direct and indirect constraints upon people's life activities as well as in the economic and development activities with in the influence areas of the road. Like -wise, the incidence of traffic interruption create the belief on the road unreliability which in turn, discourages, to a certain degree, private sectors intentions of investment to the area affected, thus interfering sound area development. On the part of the Government, large amount of investments are spent every year to restore damaged road sections.

When the project is implemented, these adverse impacts will be relieved. These relief, therefore, is considered "benefits" of the project. Among various benefits, only the benefit shown in Figure 12.1-1 can be quantified. The procedure on benefit estimates is graphically presented in Figure 12.1-2.

2) Economic Analysis

a) Basic Vehicle Operating Cost

The basic vehicle operating cost (BVOC) is composed of the following costs:

- Running Cost : That portion of the vehicle operating cost which is calculated in units of distance (kilometers) traveled.
- Basic Fixed Cost : That portion of the vehicle operating cost which is calculated in units of time traveled.
- Passenger Time Cost : Passenger time value including the time value of the car driver.

At present, the planning Service of the Ministry of Public Works and Highway (MPWH) is updating the BVOC value, but the value is still tentative. Therefore, the BVOC value is updated to November 1983 for the purpose of the Study, based on date obtained by the Planning Service and in accordance with the procedure outlined in MPWH's Highway Planning Manual. Data obtained under the Study are used for average vehicle occupancy rates and trip purpose compositions. A summary of the BVOC is given below (refer to Appendix 12-1 for details).

	PROJECT CONTRIBUTION	QUANTIFIED / UNQUANTIFIED BENEFITS	DALTON PASS SECTION	MAHAPLAG-SOGOD SECTION, (LEYTE)	KENNON ROAD
ECONOMIC EVALUATION	NO TRAFFIC INTERRUPTION	SAVING IN DETOUR COST	*	*	*
		SAVING IN COMMODITY OPPORTUNITY COST	*		
	IMPROVED VEHICLE RUNNING CONDITION	SAVING IN TRAFFIC ACCIDENT COST	*	*	*
		SAVING IN TRAVEL TIME COST	*	*	*
	NO RESTORATION WORK	SAVING IN RESTORATION COST	*	*	*
PROJECT IMPACT	IMPACT ON REGIONAL COMMUNITY / ECONOMY	STABLE TRANSPORTATION			
		STABLE COMMODITY PRICES			
		PEACE AND ORDER			
		STABLE MEDICAL SERVICES			
		GREATER OPPORTUNITY FOR EMPLOYMENT			
	IMPACT ON REGIONAL DEVELOPMENT	GREATER PRODUCTIVITY			
		EFFECTIVE USE OF EXISTING / PLANNED INVESTMENT			
		LESS REGIONAL GAP			

* : QUANTIFIED BENEFITS

FIGURE: 12.1-1 QUANTIFIED / UNQUANTIFIED BENEFITS OF THE PROJECT

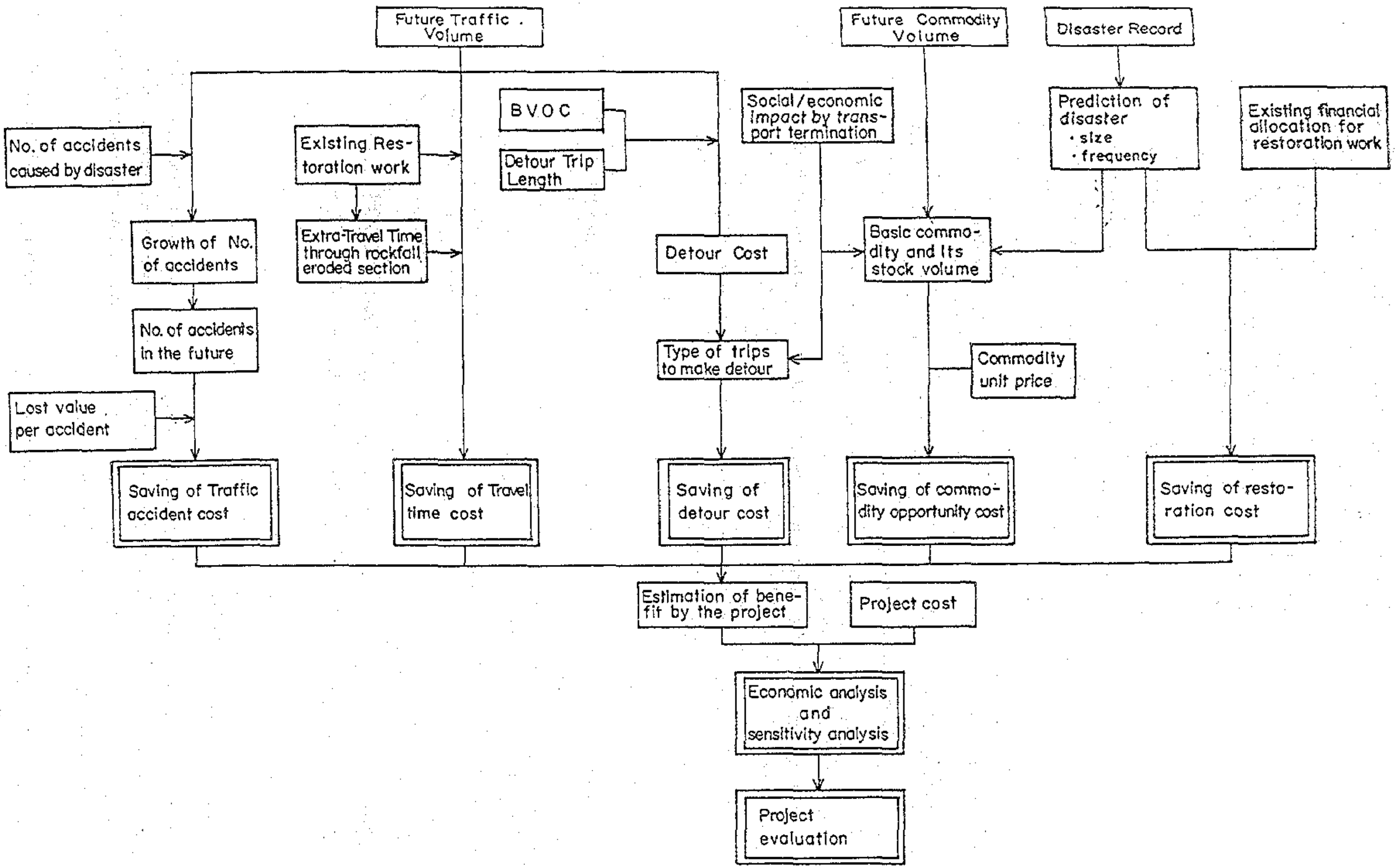


FIGURE 12.1-2 PROCEDURE OF ECONOMIC ANALYSIS

TABLE 12.1-1 BASIC VEHICLE OPERATING COSTS BY VEHICLE TYPE

Vehicle Type	Basic Running Cost (Vehicle/Km.)	Basic Fixed Cost (Vehicle/hour)	Passenger Time Cost (Vehicle/hour)
Light Car	0.90	1.89	14.78
Jeepney	0.81	14.31	7.13
Bus	2.10	25.37	24.24
Truck	2.19	28.81	-

b) Condition of Analysis

Economic analysis was carried and subjected to the following assumptions:

- The opportunity cost of capital at 15 percent.
- Benefit calculation is 20 years after the construction.
- No salvage value of the structure after the project life.
- Duration of traffic interruption was predicted based on disaster records by F/S section (refer to 12.1.2).
- Daily fluctuation of traffic through Kennon Road was taken into consideration to estimate the project benefits.

c) Sensitivity Analysis

A sensitivity test was conducted to determine the risk of the project in terms of the following factors:

Case - 1 : Construction Cost (–20%)

Case - 2 : Construction Cost (+20%)

Case - 3 : Project Benefits (+20%)

Case - 4 : Project Benefits (–20%)

Case - 5 : Construction Cost (–20%) and Project Benefits (+20%)

Case - 6 : Construction Cost (+20%) and Project Benefits (–20%)

12.1.2 Prediction of Disaster

1) Disaster Prediction Method

Predictions of road disaster and accompanying restoration costs and traffic interruption periods are extremely difficult to make, not the least because nature is the subject matter. Moreover, factors which cause road disaster change as time passes. Main factors which cause road disaster are as follows:

a) Weather conditions (typhoon frequency, rainfall intensity, rotation of dry and rainy seasons, etc.)

b) Slope conditions (geological formation, gradient, height, vegetation, degree of surface water concentration, ground-water conditions, degree of weathering, cracks and joints, spread of land behind slope, etc.)

c) Change in shape of slope due to passage of time (from the time of its construction to the time it takes to attain its stable gradient and thereafter, the failured slope expands year by year and becomes more easily affected by rainfall).

To predict road disasters by taking into account all the above factors is close to impossible because of the limited amount of data available.

In the Study, available past records and data were analyzed to obtain the relationship between typhoons and road disasters. Based mainly on the assumption that the relationship will hold true in the future, road disaster predictions were made. The frequency and scale of typhoon attacks were first predicted, and based on this typhoon scale, restoration cost and traffic interruption period were predicted. A flow chart of road disaster prediction procedure is given in Figure 12.1-3.

Typhoon records prepared by PAGASA listing date of outbreak, course, maximum 24-hour rainfall, total cost of damages and total number of casualties are available from 1948 onwards. Based on these records, typhoons which affected the F/S sections were categorized by scale, and then the frequency of typhoon attack was predicted by scale. An analysis of typhoon attack frequency by acale in each section shows that large-scale typhoons attack the sections either once every two years or once every four years. The combination of large and small typhoons attacking the sections within this reqular interval was established as the typhoon cycle.

Traffic interruption periods by scale of typhoon were established based on past records. From this, together with the typhoon cycle, traffic interruption period for a single cycle was forecasted. This was then divided by the number of years in that cycle to obtain the average annual traffic interruption period.

Estimations of the scale of road disaster and the cost of restoration work were made for large-scale typhoons based on past records. The restoration cost of small-scale typhoons was obtained by multiplying a fixed ratio to the restoration cost of large-scale typhoons. Based on the restoration cost estimations by scale of typhoon, together with the typhoon cycle, restoration cost for a single cycle was obtained. This was then divided by the number of years in that cycle to obtain the average annual restoration cost. At the same time, average annual expenditures made in the past on restoration work was calculated, and this was compared to the predicted value in order to verify the appropriateness of the predicted value.

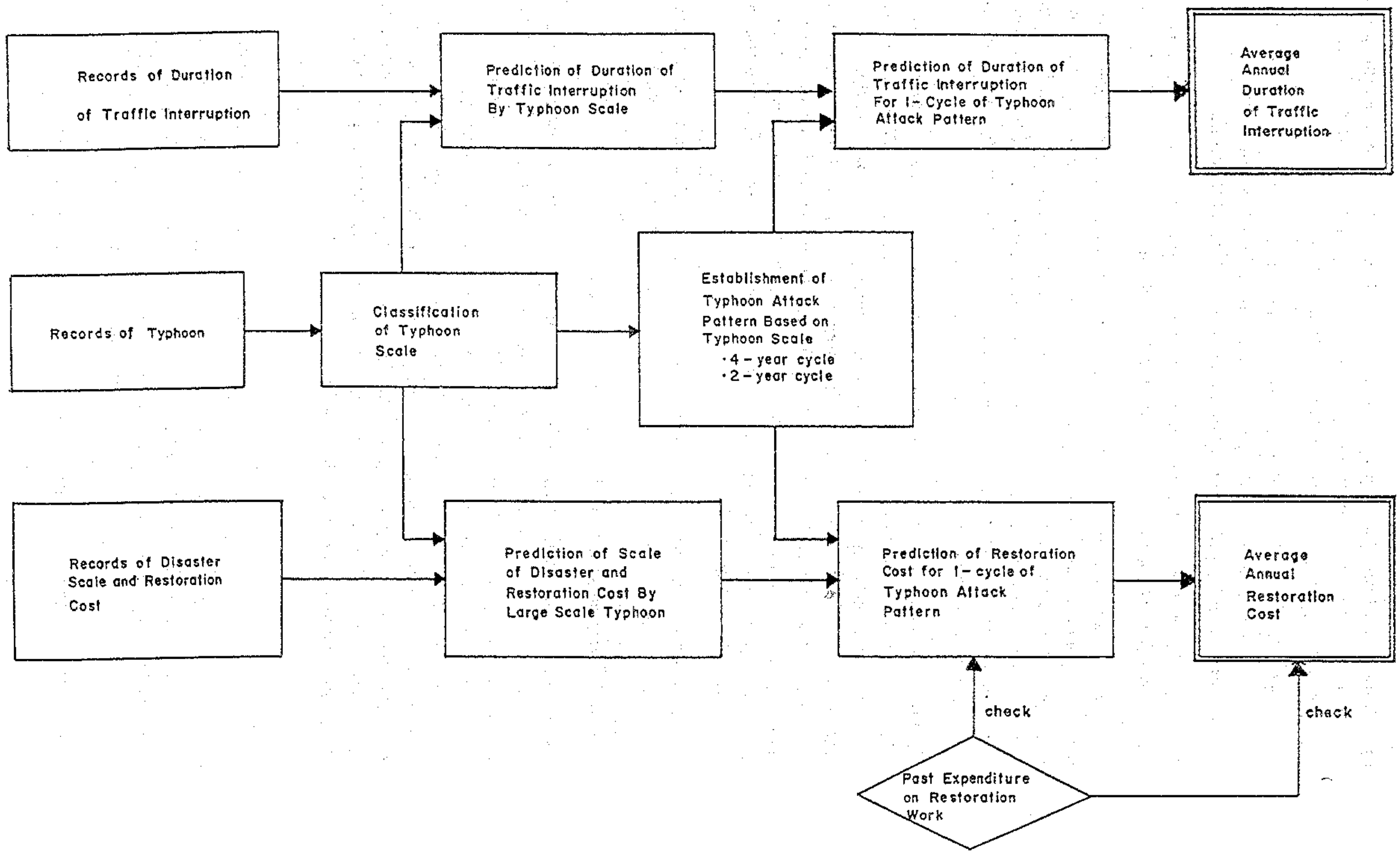


FIGURE 12.1-3 PROCEDURE OF DISASTER PREDICTION

2) Number of Typhoon Attacks

Tropical cyclones are classified into tropical depressions, tropical storms and typhoons, definitions of which are as follows:

a) Tropical Depression - maximum wind speed within the center of the disturbance up to 63 kilometers per hour (34 knots or 39 miles per hour).

b) Tropical Storm - maximum wind speed within the disturbance ranges from 64 - 118 kilometers per hour (35 - 64 knots or from 40 - 74 miles per hour).

c) Typhoon - maximum wind speed within the disturbance exceeds 118 kilometers per hour (64 knots or 74 miles per hour).

The area affected by tropical cyclones (hereinafter called the cyclone influence zone) was established for each F/S sections, and the average annual number of tropical cyclones passing through that zone was obtained from past records covering 18 years (1965 to 1982). The cyclone influence zone was established as follows based on past tropical cyclone records:

Road Section	Cyclone Influence Zone
Dalton Pass Section Kennon Road	From 14° 00' to 18° 30' north latitude (from Batangas to Aparri)
Mahaplag-Sogod Section	From 9° to 13° 00' north latitude (from Surigao Strait to San Bernardino Strait)

The average annual number of tropical cyclones passing through the cyclone influence zone was as follows (see Figure 12.1-4).

Number of Tropical Cyclone Attacks (annual average)

	Dalton Pass Section and Kennon Road	Mahaplag-Sogod Section
Typhoon	2.6	1.6
Tropical storm & tropical depression	2.1	1.6
Tropical cyclone	4.7	3.2

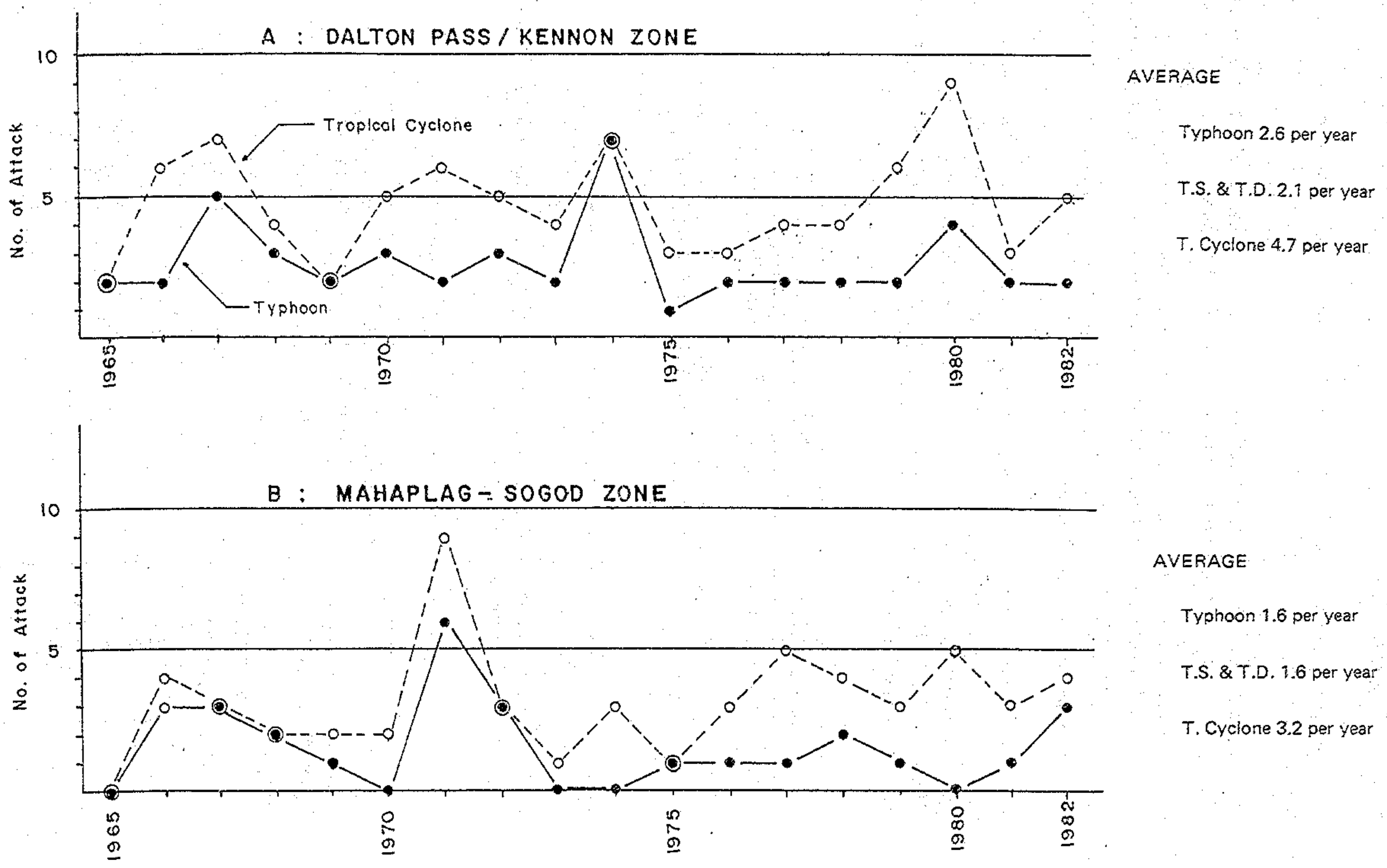


FIGURE: 12.1-4 NUMBER OF TYPHOON ATTACKS

3) Scale and Probability of Typhoon Attack

In order to elicit the relationship between tropical cyclone scale and road disaster, typhoons, which are large-scale tropical cyclones as defined above, were divided into large-and small-scale typhoons using the following indices: 24-hour rainfall, total cost of damages (estimated value) and total number of casualties (dead + missing). Typhoons showing values higher than any of the standards given below for the indices were classified as large-scale typhoons. The rest of were classified as small-scale typhoons.

Typhoon Scale Evaluation Criteria

	Dalton Pass Section and Kennon Road	Mahaplag-Sogod Section
24-hour rainfall	400 mm or more	200 mm or more
Cost of damages	500 mil. or more	100 mil. or more
Number of casualties	150 persons or more	100 persons or more

The scale of typhoons passing through the cyclone influence zone of the Mahaplag-Sogod section is generally smaller than the scale of typhoons passing through the cyclone influence zone of the Dalton Pass/kennon Road sections. For this reason, typhoon scale evaluation criteria were established for each cyclone influence zone in order to judge the relative scale of typhoons for each cyclone influence zone. The results are given in Appendix 12-3.

The cyclone influence zone of the Dalton Pass/Kennon Road sections shows a more or less set pattern in typhoon attacks. In other words, the zone tends to be hit by large-scale typhoons in even-numbered years, while odd-numbered years show attacks by small-scale typhoons. Moreover, the number of large-scale typhoons in even-numbered years tend to be two.

Even-numbered years . . . . . about two large-scale typhoons
Odd-numbered years . . . . . only small-scale typhoons

No set pattern is seen in typhoons striking the cyclone influence zone of the Mahaplag-Sogod section. However, the 18-year average shows that the zone is hit by a large-scale typhoon once every two years.

4) Traffic Interruption Period

When a road disaster causes traffic interruption, the MPWH releases the Regional Director's discretionary fund and/or maintenance fund for effecting urgent restoration work, in which opening to traffic is given emphasis. Complete restoration work is effected after the contingent fund or calamity fund is made available.

The period required for urgent restoration work, namely the traffic interruption period, depends not only on the number of disaster spots, their locations and the types and scales of disasters, but also on the availability of construction equipment and the number of days required to mobilize those equipment. To forecast traffic interruption periods after first predicting all the above factors is quite difficult because of the limited amount of required data available. Therefore, prediction of traffic interruption periods in this Study were made mainly on the basis of past traffic interruption periods, under the assumption that past tendencies would continue in the future.

Bacause there were little recorded data on past traffic interruption periods, such data were collected for the F/S sections by interviewing maintenance engineers and foremen of nearby residents.

a) Dalton Pass Section

Road improvement work in this section was completed in 1975. Traffic interruptions during the seven years from 1975 to 1982 totalled 108 days and averaged 15.4 days a year (see Table 12.1-2). There were five traffic interruptions to seven large-scale typhoon attacks, which leads us to assume that traffic is interrupted every time a large-scale typhoon attacks. The section was hit by a super-scale typhoon, such as "Didang" in 1976 and "Aring" in 1980, once every four years, at which time traffic was interrupted for about a month. From these facts, together with the average annual number of typhoons mentioned in 2) above, a four-year typhoon cycle and corresponding traffic interruption period were determined as follows:

Year	Typhoon Cycle	Traffic Interruption Period (days)
n	super + large + small	29 + 7 = 36
n + 1	small + small	3 + 3 = 6
n + 2	large + large + small	7 + 7 = 14
n + 3	small + small	3 + 3 = 6
Total	10 typhoons	62 days
Average	2.5 typhoons/year	15.4 days/year

Traffic interruptions in the Dalton Pass section were Predicted to occur average twice a year for a total of 15.5 days a year.

TABLE 12.1-2 DURATION OF ROAD CLOSURE AT DALTON PASS SECTION

Year	Name of T. Cyclone	Date of Occurrence	Classification of T. Cyclone	Duration of Road Closure
1976	Didang	May 15-26	T. Large	30 days
	Huaning	June 22-July 2	T. Small	-
1977	Openg	Sept. 14-20	T. Small	-
	Unding	Nov. 10-17	T. Small	7 days
1978	Yaning	Oct. 7-14	T. Small	3 days
	Kading	Oct. 25-27	T. Large	7 days
1979	Trining	Oct. 3-5	T. Storm	4 days
	Yayang	Nov. 4-7	T. Small	-
1980	Ditang	May 10-21	T. Large	-
	Gloring	May 22-26	T. Storm	4 days
	Isang	June 30-July 2	T. Depression	3 days
	Nitang and Osang	July 18-27	T. Large	7 days
	Aring	Nov. 1-7	T. Large	29 days
1981	Elang	July 3-5	T. Storm	7 days
	Anding	Nov. 21-27	T. Large	7 days
1982	Norming	Aug. 19-Sept. 4	T. Small	-
	Weling	Oct. 11-15	T. Large	-
			Total	108 days

Average - 15.4 days per year

Note:

T. Large - - - - - - - - - - Large scall typhoon
T. Small - - - - - - - - - - Small scall typhoon
T. Storm- - - - - - - - - - Tropical storm
T. Depression - - - - - - - Tropical depression

Source: Nueva Vizcaya and Nueva Ecija District Engineering Office.

b) Mahaplag-Sogod Sections

This section was completed in 1978. During the four years from 1979 to 1982, traffic interruptions in this section occurred five times, twice due to tropical cyclones and three times due to continuous heavy rain (see Table 12.1-3). This section belongs to the Type II climate zone, which is characterized by maximum rainfall between November and January, and continuous heavy rain during this period often causes traffic interruption.

Assuming that the trend seen in the past four years will continue in the future, the section's typhoon cycle and corresponding traffic interruption period were predicted based on number of traffic interruptions mentioned above and average annual number of typhoons mentioned in 2) above.

Year	Typhoon Cycle	Traffic Interruption Period (days)
n	Large + continuous heavy rain	60
n + 1	small + small + continuous	60
Total	3 typoons + 2 continuous heavy rains	120
Average	1.5 typhoons/year continuous heavy rain	60 days/year

As disaster in this section tend to be large year by year, the estimated traffic interruption period of 60 days per annum was raisad to 90 days (or 1.5 times) based on the engineering judgement.

c) Kennon Road

Kennon Road was completed in 1937, and 47 years have passed Since it was first opened to traffic. Since rainfall in and around Baguio City is extremely heavy, the road might have encountered a number of disasters necessitating restoration and improvement work over the years.

Information on seven traffic interruptions were obtained through interviews, as shown in Table 12.1-4. The 1979 and 1980 traffic interruptions, which occurred at the same place, were caused by large-scale disaster not subject to this Study (the road was washed away due to the fact that the river running along the road was dammed by slope failure of the hillside on the opposite bank from the road). When the two are excluded., there were five cases of traffic interruptions during the 16 years from 1976 to 1983, but judging from slope conditions and rainfall intensity in this section, more than this number must have occurred.

TABLE 12.1-3 DURATION OF ROAD CLOSURE AT MAHAPLAG - SOGOD SECTION

Year	Name of T. Cyclone	Date of Occurrence	Classification of T. Cyclone	Duration of Road Closure
1979	Bebeng	April 12-20	T. Large	-
	Karing	May 10-16	T. Depression	1 month
	Krising	Dec. 21-24	T. Storm	-
1980	Asiang	Feb. 12-14	T. Depression	-
	Biring	March 20-27	T. Depression	-
	Heavy Rain	April 15		1 week
	Huaning	June 22-25	T. Storm	-
	Seniang	Aug. 30- Sept. 4	T. Depression	-
	Basiang	Nov. 11-13	T. Depression	-
	Heavy Rain	Dec. 10- Jan. 26		3 months
1981	Saling	Sept. 24-26	T. Depression	-
	Unsing	Oct. 12-14	T. Storm	-
	Heavy Rain	Nov. 23- Dec. 3		2 months
	Dinang	Dec. 23-28	T. Large	-
1982	Bising	March 22-29	T. Large	2 months
	Norming	Aug. 19- Sept. 4	T. Small	-
	Aning	Dec. 2-8	T. Small	-
	Bidang	Dec. 7-11	T. Storm	-

Note:

T. Large - - - - - - - - - - Large scale typhoon
T. Small - - - - - - - - - - Small scale typhoon
T. Storm- - - - - - - - - - Tropical storm
T. Depression - - - - - - - Tropical depression

Source: First Leyte and Southern Leyte District Engineering Offices.

TABLE 12.1-4 DURATION OF ROAD CLOSURE AT KENNON ROAD

Year	Name of T. Cyclone	Date of Occurance	24-hour Rainfall at Baguio	Classification of T. Cyclone	Duration of Road Closure	Remarks
1967	Trining	Oct. 14-18	979.4	T. Large	3 weeks	Whole Section.
1969	Elang	July 24-27	512.2	T. Large	2 weeks	At Camp 6. Detour road opened after 2 weeks. Main road opened Dec. 16, 1967.
1974	Susang	Oct. 8-12	781.4	T. Large	3 weeks	At Camp 6. Detour road opened after 3 weeks. Main road opened Dec. 20, 1974.
1979	Ising Luding Mameng	July 29- Aug. 2 Aug. 3-6 Aug. 9-15	33.6 14.6 285.4	T. Small T. Depression T. Small	4 months	At Camp 3. Total closure. Opened Dec. 15, 1979.
1980	Nitang Osang	July 18-22 July 22-27	165.3 536.3	T. Small T. Large	4.5 months	At Camp 3. Total closure. Opened Dec. 16, 1980.
1981	Rubing	Sept. 15-21	228.8	T. Large	2 weeks	At Camp 3.
1983	Diding/ Etang	Aug. 7-15	103.9	T. Small	1 day	At several sections.

Notes: T. Large - - - - - - - - - - Large scale typhoon
T. Small - - - - - - - - - - Small scale typhoon
T. Depression - - - - - - Tropical Depression

Source: Benguet District Engineering Office, MPWH

The relationship between 24-hour rainfall recorded in baguio City and traffic interruption period was as follows:

24-hour Rainfall	Traffic Interruption Period
979.4	3 weeks
781.4	3 weeks
512.2	2 weeks
228.8	2 weeks
103.9	1 day

The previous classification of typhoons by scale (large and small) was further broken down into smaller categories (super, large, medium and small), based on 24-hour rainfall recorded in Baguio City. The relationship between typhoon scale and traffic interruption period was assumed to be as follows:

Typhoon Category		24-hour Raintall (mm)	Traffic Interruption Period
Large	Super	600 or more	3 weeks
	Large	400 – 600	2 weeks
Small	Medium	200 – 400	1 week
	Small	200 or less	–

Number of typhoons by scale and estimated traffic interruption periods based on the above assumption for the 18 years between 1965 and 1982 were summarized below (also see Table 12.1-5).

	Number	Traffic Interruption Period
Super	7	21 weeks
Large	5	10 weeks
Medium	15	15 weeks
Small	(20)	–
Total	27 (47)	
Annual Average	1.5 (2.6)	

TABLE 12.1-5 CLASSIFICATION OF TYPHOONS AND ESTIMATED DURATION OF ROAD CLOSURE AT KENNON ROAD

Year	Name of Typhoon	Max. 24-Hour Rainfall at Baguio City (mm)	Classification of Typhoon	Obtained Information on Road Closure	Estimated Duration of Road Closure (week)
1965	Miling	214	M	-	1 week
	Unding	204	M	-	1 week
1966	Klaring	286	M	-	1 week
	Loleng	99	S	-	-
1967	Karing	138	S	-	-
	Gening	427	L	-	2 weeks
	Rosing	266	M	-	1 week
	Trining	979	Super	3 weeks	3 weeks
	Welming	96	S	-	-
1968	Huaning	364	M	-	1 week
	Nitang	650	Super	-	3 weeks
	Toyang	208	M	-	1 week
1969	Elang	512	L	2 weeks	2 weeks
1970	Pitang	120	S	-	-
	Sening	205	M	-	1 week
	Yoling	103	S	-	-
1971	Luding	116	S	-	-
	Aring	145	S	-	-
1972	Konsing	213	M	-	1 week
	Edeng	58	S	-	-
	Gloring	480	L	-	2 weeks
1973	Luming	342	M	-	1 week
	Narsing	74	S	-	-
1974	Bising	277	M	-	1 week
	Iliang	74	S	-	-
	Susang	781	Super	3 weeks	3 weeks
	Tering	228	M	-	1 week
	Wening	679	Super	-	3 weeks
	Aning	410	L	-	2 weeks
	Bidang	15	S	-	-
1975	Herming	87	S	-	-
1976	Didang	605	Super	-	3 weeks
	Huaning	334	M	-	1 week
1977	Openg	359	M	-	1 week
	Unding	76	S	-	-

TABLE 12.1-5 (Cont'd.)

Year	Name of Typhoon	Max. 24-Hour Rainfall at Baguio City (mm)	Classification of Typhoon	Obtained Information on Road Closure	Estimated Duration of Road Closure (week)
1978	Kading	90	S	-	-
	Yaning	67	S	-	-
1979	Mameng	285	M	4 months	1 week
	Yayang	2	S	-	-
1980	Ditang	730	Super	-	3 weeks
	Nitang	165	S	-	-
	Osang	536	L	4.5 months	2 weeks
	Aring	699	Super	-	3 weeks
1981	Rubing	229	M	2 weeks	1 week
	Anding	145	S	-	-
1982	Norming	88	S	-	-
	Weling	103	S	-	-
					46 weeks

Average:
2.56 weeks/year
or
17.9 days/year

Summary

Classification of Typhoon	24-Hour Rainfall	No. of Typhoon
Super (Super large scale)	more than 600^{mm}	7
L (Large scale)	400 - 600^{mm}	5
M (Medium scale)	200 - 400^{mm}	15
S (Small scale)	less than 200^{mm}	20
Total	-	47

Based on the aboves, the typhoon cycle and traffic interruption periods for this section were forecasted as follows:

Year	Typhoon Cycle	Traffic Interruption Period (week)
n	Super + Medium + Small	3 + 1 = 4
n = 1	Large + Medium + Small	2 + 1 = 3
n + 1	Medium + Small	1 = 1
Total	8 Typhoons	8 weeks
Average	2.67 Typhoons/Year	2.67 weeks/year (18.6 days/year)

One to two traffic interruptions were predicted to occur on Kennon Road annually, for a total period of 18 days per year.

12.1.3 Traffic Benefit

1) Savings in Detour Cost

When a road section becomes impassable due to a disaster, people make detours even if it means extra cost, in order to sustain their normal socio-economic activities. The implementation of this Project will create the benefit of removing detours caused by road disasters.

- Dalton Pass Section

  Detour of the Dalton Pass Section is the Manila North Road. The detour distance is inevitably a long one, so that some vehicles detour while some discontinue their trip. The choice of continuing the trip of detouring or discontinuing the trip is assumed to depend mainly on the urgency of the trip. Based on the results of interview surveys conducted under the Study, the following assumption is established (see Figure 12.1-5).

  - Concerning car traffic, only cars making business trips are expected to detour.
  - Of commodities, basic commodities such as food and gasoline will necessitate detouring.
  - Truck detours are expected to occur only when the stock of the commodity concerned is depleted (see Figure 12.1-6).

				STOCK OR NOT	DETOUR OR NOT	AVERAGE NUMBER OF DETOUR DAYS PER YEAR
CAR		BUSINESS TRIP		—	○	15.5
		PRIVATE TRIP		—	X	—
PUV				—	X	—
COMMODITY (TRUCK)	CAGAYAN VALLEY ↓ MANILA	CRITICAL COMMODITY	PALAY, MILLED RICE	○	○	5.5
			LOG, LUMBER	○	X	—
			AGRICULTURAL PRODUCTS, OTHERS	X	X	—
	CAGAYAN VALLEY ↑ MANILA	BASIC COMMODITY	PROCESSED FOODSTUFF, GASOLINE	○	○	5.5
			APPLIANCES, OTHERS	X	X	—

○ STOCK/DETOUR

X NO

Figure : 12.1-5 ASSUMPTION ON DETOUR IN DALTON PASS SECTION

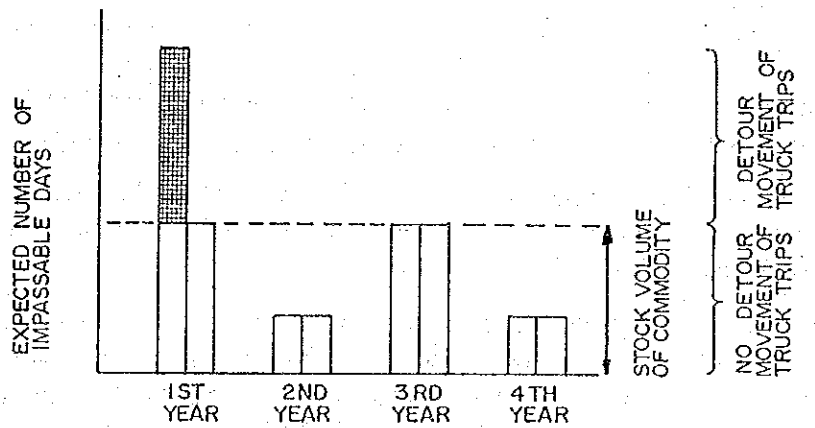


FIGURE : 12.1-6 DETOUR MOVEMENT OF TRUCK TRIPS IN DALTON PASS SECTION

Saving in detour cost is calculated from future traffic volume, number of impassable days, detour distance per zone pair and vehicle operating cost. Benefit in relation to discontinued traffic is difficult to quantify and is not calculated. Therefore, the benefit value calculated here is considered to be conservative.

- Mahaplag-Sogod Section (Leyte)

  Detour of the Mahaplag-Sogod section is a short 68 kilometers, so all vehicles make detours. The detour routes are the Mahaplag-Baybay Road, Western Leyte Road and Bato-Bontoc Road.

- Kennon Road

  Detour of the Kennon Road is via the Naguilian and Manila North Roads, and the extra distance required by the detour is 63 kilometers.

TABLE: 12.1-6 DETOUR DURATION/TRIP LENGTH

F/S SECTION	EXPECTED NUMBER OF IMPASSABLE DAYS PER YEAR	TYPICAL DETOUR PATTERN		
		USUAL TRIP LENGTH (KM)	EXTRA TRIP LENGTH (KM)	ZONE PAIR
DALTON PASS SECTION	15.5	485	306	TUGUEGARAO MANILA
MAHAPLAG-SOGOD SECTION (LEYTE)	90.0	119	68	SOGOD TACLOBAN
KENNON ROAD	18.0	244	63	BAGUIO MANILA

2) Saving in Commodity Opportunity Cost

Suspension of cargo truck trips results in economic loss, which was interpreted that in anticipation of traffic interruption, additional commodity reserves or stocks will be made to maintain normal operation of factories, stores, etc. even during traffic interruption. Interview surveys brought to light the fact that stock quantities are raised during the rainy season, when road disasters are more apt to occur.

Commodities lose opportunity cost when reserved but, if the stock quantity decreases, threr is a benefit in a smaller amount of loss of opportunity cost. This benefit was considered only at Dalton Pass Section.

Savings in commodity opportunity cost in relation to the Dalton Pass Section is calculated for timber and milled rice/palay, critical to the socio-economic activities of Manila and its surrounding regions, and processed food and gasoline, basic commodities for the Cagayan Valley (see Figure 12.1-5). The calculations are based on future commodity flow per day, number of days to be covered by stock, stock period and unit price of commodity. From past disaster break-out patterns, seven days is established as the number of days to be covered by stock and 180 days, which corresponds to the rainy season, is established as the stock period.

$$SA = \sum_i \left(V \times P \times D \times \frac{\alpha}{365} \times \frac{1}{100000}\right)$$

Where:

SA = Total savings (MP/year)

V = Stock quantity = C x S (tons)

C = Commodity flow per day (tons/day)

S = Number of days covered by stock (days)

P = Unit price of commodity (P/kg)

D = Stock period

α = Discount rate (percent)

i = Commodity item

Because detour of the Mahaplag-Sogod section and Kennon Road are short, it is assumed that commodities will continue to be transported by detouring. Hence, no increase in stock quantity is expected.

3) Savings in Traffic Accident Cost

The implementation of this Project will reduce the number of traffic accidents caused by road disasters. This benefit is also quantified.

According to traffic records kept at Baguio City, there were six traffic accidents caused by road disasters on Kennon Road in 1983 with an annual average number of four. Assuming that the accident number increases as traffic volume increases, the reduction of number of accidents expected in the future is forecasted by F/S section. The cost of damages per accident given in MPWH's Highway Planning Manual is updated and established as 34,000 pesos/accident.

4) Savings in Travel Time Cost

Even after urgent restoration work to make a road passable, one-lane traffic operation remains and road surface as well remains in bad condition. Under such circumstances, drivers reduce speed, resulting in loss of travel time. Decrease in running speed is especially drastic in the Mahaplag-Sogod section, where the road surface is covered over with a light layer of mud because of poor side ditch facilities and heavy rainfall.

The implementation of this Project will prevent a decline in running speed, and this benefit is quantified as savings in travel time cost, which were estimated based on travel time survey results and duration of restoration work.

12.1.4 Savings in Restoration Cost

1) Conditions

Without the Project, in other words if no countermeasures are applied to potential disaster spots, disasters will recur every year and restoration expenditures will be required. With the Project, such expenditures will become unnecessary, and they can be added as Project benefit.

Basic conditions considered were as follows:

a) Road Service Level

The service level of the F/S sections is currently low, because of the facts that there are sections where soils and gravels still remain on the road surface even after restoration work, only one lane is open to traffic because of partial restoration, etc. In a with-and-without analysis, the service level should be the same in order to make a proper comparison. Therefore, it was assumed that under the without-project case, the restoration work would be undertaken perfactly to ensure two-lane traffic as well as to provide smooth road surface conditions so as vehicles to flow freely.

b) Restoration Method

It was assumed that current restoration methods would continue to be used in the future: removal of earth and rock from road surface in the case of cut slope failures, landslide and debris flows and stone masonry in the case of embankment slope failures.

c) Restoration Cost

Number of typhoons by typhoon scale was predicted in 12.1.2. Restoration cost was calculated for super-scale typhoons, and such costs for large, medium and small-scale typhoons were obtained by multiplying the restoration cost for super-scale typhoons with a certain ratio. The ratio was determined on the basis of 24-hour rainfall, which was one of the criteria used in determining typhoon scale.

d) Disasters Caused by Tropical Storms and Depressions

Past records show that tropical storms and depressions sometimes cause road disasters, while typhoons sometimes do not. From the fact that there were about the same numbers of tropical storms and depressions that caused road disasters and typhoons that did not, disasters caused by tropical storms and depressions were considered to be taken into account by assuming that all typhoons cause road disasters.

2) Restoration Cost

a) Dalton Pass Sections

Typhoon "Aring" in November 1980 caused damages at 60 spots in the Dalton Pass section and necessitated the expenditure of an estimated 23 million pesos (in 1980 prices) on restoration work. Information obtained from maintenance engineers and foremen indicated that nearly all spots designated as disasters potential A or B by the Study Team were damaged by typhoon "Aring". From this, it was assumed that all A and B spots would be damaged by any super-scale typhoon. The extent of damage in such case was assumed to be as follows for each type of disaster;

- Cut Slope Failure

  Disaster Potential A : The entire road surface is covered by earth and sand from the failure.

Disaster Potential B : Helf (road shoulder + one lane) the road surface is covered by earth and sand from the failure.

- Embankment Slope Failure

  Corresponds to the extents confirmed by field surveys.

- Falls

  Disaster Potential A : Half (road shoulder + one lane) the road surface is covered by fallen rocks.

  Disaster Potential B : Half the extent of disaster potential A.

- Debris flow

  Disaster Potential A : The entire road surface is covered by 2.0 meters of debris.

  Disaster Potential B : The entire road surface is covered by 1.0 meters of debris.

Under the above conditions, restoration of damages caused by a super-scale typhoon will cost 12.80 million pesos (refer to Appendix 12-4). Of this, the cost of applying stone masonry to embankment slope failures is 5.92 million pesos. Stone masonry will protect embankment slopes fairly well, so that the slopes will not fail everytime there is a typhoon. However, there is still danger that the slopes, or adjacent slopes, will fail due to inadequate drainage facilities (such as lack of groundwater drainage and in-adequate side ditches). For this reason, it was assumed that embankment slopes restored with stone masonry would be damaged again four times during the Project life of 20 years (or once every five years).

Disasters other than embankment slope failures occur everytime there is a typhoon. Restoration cost by typhoon scale was assumed as follows:

Typhoon Scale	24-hour Rainfall	Restration Cost	Ratio
Super	600 mm or more	6.89 million pesos	1.00
Large	400 – 600 mm	4.82	0.70
Small	400 mm or less	2.07	0.30

Taking the typhoon cycle and restoration cost by typhoon scale, into consideration the total cost of restoration (excluding restoration of embankment slope failures) was calculated as follows:

Year	Typhoon Cycle	Restoration Cost
n	(Super) + (Large) + (Small)	6.89 + 4.82 + 2.07 = 13.78
n + 1	(Small) + (Small)	2.07 + 2.07 = 4.14
n + 2	(Large) + (Large) + (Small)	4.82 + 4.82 + 2.07 = 11.71
n + 3	(Small) + (Small)	2.07 + 2.07 = 4.14

Total ------------ 33.77 million

Then, average annual restoration cost is calculated as follows:

Restoration cost excluding embankment slope failures	33.77/4 = 8.44
Restoration cost for embankment slope failures	5.92/5 = 1.18
Total	= 9.62

Average annual restoration cost was estimated at 9.6 million pesos for the Dalton Pass section.

b) Mahaplag-Sogod Section

Geological conditions in this section are worse than in the other two sections, so that even small typhoons with only about 200 millimeters of 24-hour rainfall can create major road disasters, In addition, continuous heavy rains between November and January causes large damages each year. There is record that earth and rock mass of 82,700 cubic meters fell down on the road surface along a 4.6 kms. section between kms. 1,009 + 412 and kms. 1,013 + 980 (corresponds to spot VIII-76 to 86 in this Study) which was caused by continuous heavy rains between December 10, 1980 and January 26th the following year. For these reasons, it was assumed that all spots designated as disaster potential A or B would be damaged by continous heavy rains between November and Junuary.

The same assumptions as the Dalton Pass section were used for this section in estimating the extent of damages. As disasters in this section tend to be large year by year, the estimated value was raised to 1.5 times on the basis of the engineering judgement.

The cost of restoring damages caused by continuous heavy rains was 7.3 million pesos, of which 3.54 million pesos was the cost of restoring embankment slope failures and 3.77 million pesos was the cost of restoring all other damages. Restoration cost (excluding that of embankment slope failures) by typhoon scale was assumed to be as follows:

Typhoon Scale	24-hour Rainfall	Restoration Cost	Ratio
Continuous heavy rainfall		3.77	1.00
Large Typhoon	200 mm or more	3.39	0.90
Small Typhoon	less than 200 mm	1.89	0.50

Average annual restoration cost was calculated as follows:

Restoration cost excluding embankment slope failures	14.71/2 = 7.36
Restoration cost for embankment slope failures	3.54/5 = 0.71
Total - - - - -	= 8.07

Average annual restoration cost was estimated at 8.1 million pesos for the Mahaplag-Sogod sections.

c) Kennon Road

Fifteen spots (one third of the total number of potential disaster spots identified in this Study) were damaged by typhoon "Diding" in August 1983, of which 24-hour rainfall was 104 millimeters, whereas 24-hour rainfall of super-scale typhoons was established as 600 millimeters or more. Thus, it was assumed that all spots would be damaged by super-scale typhoons.

The cost of restoring damages caused by super-scale typhoons was estimated at 6.80 million pesos under the same assumptions as were made for the Dalton Pass section. Of this, the cost of restoring embankment slope failures was 2.58 million pesos and the cost of restoring all other damages was 4.22 million pesos. Restoration cost (excluding that of embankment slope failures) by typhoon scale and average annual reatoration cost are shown in the following two tables:

Restoration Cost by Typhoon Scale

Typhoon Scale	24-hour Rainfall (mm)	Restoration Cost (Million ₱)	Ratio
Super	600 or more	4.22	1.00
Large	400 – 600	2.95	0.70
Medium	200 – 400	2.11	0.50
Small	200 or less	1.06	0.25

Restoration Cost Per Typhoon Cycle

Year	Typhoon Cycle	Restoration Cost (Million ₱)
n	Super + Medium + Small	4.22 + 2.11 + 1.06 = 7.39
n + 1	Large + Medium + Small	2.95 + 2.11 + 1.06 = 6.12
n + 2	Medium + Small	2.11 + 1.06 = 3.17
		Total ------------- = 16.68

Restoration cost excluding embankment slope failures	16.68/3	= 5.56
Restoration cost excluding embankment slope failures	2.58/5	= 0.52
Total - - - - -		= 6.08

Average annual restoration cost was estimated at 6.1 million pesos for Kennon Road.

3) Previous Expenditures on Restoration Work

Expenditures on restoration work are made from the following four (4) funds:

- Regional Director's discretionary fund
- Maintenance fund
- Contingent fund
- Calamity fund

Allocation or releases made from the above funds between 1980 and 1982 are shown in Appendices 12-5 to 12-6. Expenditures on restoration work for the F/S sections were estimated as shown in Appendix 12-7. Past average annual restoration cost in each F/S section and future average annual restoration cost predicted by the Study Team are shown in Table 12.1-7.

Future expenditures were predicted to be larger than past expenditures because road conditions are becoming worse due to neglected restoration work of same spots. In order to maintain the same level of traffic service as under with-project case, restoration expenditures must be 1.6 times more than in the past in the Dalton Pass section, 2.8 times more in the Mahaplag-Sogod section and 1.5 times more in Kennon Road.

TABLE 12.1-7 PAST AND ESTIMATED FUTURE RESTORATION COST

Section	Most Probable Expenditure 1980	1981	1982	Cycle of Typhoon Attack Pattern	Average Annual Expenditure	Estimated Future Annual Cost	Ratio
Dalton Pass	(3.8)	(8.8)	(3.0)	4-year	6.1	9.6	1.59
Section	5.5	11.6	3.6	4-year	6.1	9.6	1.59
Mahaplag-Sogod	(2.5)	(1.9)	(1.6)	2-year	2.9	8.1	2.79
Section	3.6	2.5	1.9	2-year	2.9	8.1	2.79
Kennon Road	(5.7)	(1.5)	(1.9)				
	8.3	2.0	2.3	3-year	4.2	6.1	1.45

Notes: Current Price
( ) : 1983 Price

12.1.5 ECONOMIC EVALUATION OF F/S SECTIONS

The streams of costs and benefits of feasibility study sections including their respective economic evaluation results are shown in Tables 12.1-9 to 12.1-11. The summary result of economic evaluation and sensitivity tests are given below.

TABLE 12.1-8 ECONOMIC EVALUATION

		Dalton Pass Section	Mahaplag-Sogod Section	Kennon Road
Best Estimte Case (Discount Rate 15%)	IRR (%)	18.7	14.4	16.6
	NPV (Million Pesos)	36.55	-2.68	7.75
	B/C	1.28	0.96	1.11
			IRR (%)	
Sensitivity Analysis	Case - 1 (Cost - 20%)	22.5	17.7	20.1
	Case - 2 (Cost + 20%)	16.0	12.0	14.0
	Case - 3 (Benefit + 20%)	21.8	17.1	19.4
	Case - 4 (Benefit = 20%)	15.4	11.5	13.4
	Case - 5 (Cost = 20%, Benefit + 20%)	26.0	20.7	23.3
	Case - 6 (Cost + 20%, Benefit - 20%)	12.9	9.3	11.1

1) Dalton Pass Section

The economic evaluation under the best estimate case shows favorable result for this section, indicating an IRR of 18.7%, NPV of 36.55 million pesos and B/C of 1.28. Of the total project benefits (before discounting), the highest share which is 42% is contributed by savings in commodity opportunity cost, followed by savings in detour cost (36%) and savings in restoration cost (20%). The average annual growth rate of total benefits is 4.3%. The result of sensitivity test on almost all cases, however, shows an IRR exceeding 15% except in the worst case (case 6).

2) Mahaplag-Sogod Section

The best estimate case indicates that IRR of this section is 14.4%. The total Project benefits are mostly derived from savings in detour cost (48%) and saving in restoration cost (46%). The annual growth of the total benefits is 3.4%, while that of savings in detour cost is 6.7%, which reflects that a sharp increase in traffic volume is observed in this section. The sensitivity test shows that IRRs under optimistic cases (cases 1 and 3) are about 17%, while on the pessimistic cases (case 2 and 4) are about 12%.

3) Kennon Road

The best estimate case of the economic evaluation of this section indicates a favorable result showing an IRR of 16.6%, NPV of 7.75 million pesos and B/C of 1.11. Savings in detour cost have the highest share of the total benefits accounting for 63%, next is the savings in restoration cost. As for sensitivity test, IRRs under the optimistic cases are about 20%, while those under the pessimistic cases are slightly below 15%.

TABLE 12.1-9 ECONOMIC COST - BENEFIT STREAMS OF DALTON PASS SECTION

(Unit : MP at 1983 Prices)

	BEFORE DISCOUNT							AFTER DISCOUNT (15%)	
		BENEFITS							
	Cost	Saving in Detour Cost	Saving in Commodity Opportunity Cost	Saving in Traffic Accident Cost	Saving in Travel Time Cost	Saving in Restoration Cost	Total	Cost	Benefit
1985	1.05							1.32	
1986	9.42							10.83	
1987	7.38							7.13	
1988	51.72							45.00	
1989	59.11							44.69	
1990	29.53	6.48	9.44	0.14	0.27	7.25	23.58	20.11	14.97
1991		8.29	11.83	0.18	0.34	8.70	29.34		16.78
1992		8.84	12.36	0.19	0.35	8.70	30.44		15.13
1993		9.44	12.91	0.20	0.37	8.70	31.62		13.66
1994		10.07	13.49	0.22	0.39	8.70	32.87		12.36
1995		10.74	14.09	0.23	0.41	8.70	34.17		11.17
1996		11.46	14.72	0.24	0.43	8.70	35.55		10.10
1997		12.23	15.37	0.26	0.46	8.70	37.02		9.14
1998		13.05	16.06	0.27	0.48	8.70	38.56		8.29
1999		13.92	16.77	0.29	0.50	8.70	40.18		7.51
2000		14.85	17.52	0.31	0.53	8.70	41.91		6.83
2001		15.85	18.33	0.33	0.56	8.70	43.77		6.17
2002		16.91	19.19	0.34	0.59	8.70	45.73		5.62
2003		18.05	20.08	0.36	0.62	8.70	47.81		5.12
2004		19.26	21.01	0.38	0.65	8.70	50.00		4.65
2005		20.56	21.99	0.40	0.68	8.70	52.33		4.24
2006		21.94	23.01	0.42	0.72	8.70	54.79		3.84
2007		23.41	24.08	0.44	0.76	8.70	57.39		3.50
2008		24.99	25.20	0.46	0.80	8.70	60.15		3.19
2009		26.67	26.37	0.49	0.84	8.70	63.07		2.90
2010		4.74	4.60	0.09	0.15	1.45	11.03		0.46
TOTAL	158.21	311.75	358.42	6.24	10.90	174.00	861.31	129.08	165.63

NPV = 36.55 MP

B/C = 1.28

IRR = 18.7 %

TABLE 12.1-10 ECONOMIC COST - BENEFIT STREAMS OF MAHAPLAG - SOGOD SECTION, LEYTE

(Unit : M₱ at 1983 Prices)

	BEFORE DISCOUNT							AFTER DISCOUNT (15%)	
		BENEFITS							
	Cost	Saving in Detour Cost	Saving in Commodity Opportunity Cost	Saving in Traffic Accident Cost	Saving in Travel Time Cost	Saving in Restoration Cost	Total	Cost	Benefit
1985	0.54							0.68	
1986	4.85							5.58	
1987	3.80							3.67	
1988	26.56							23.11	
1989	30.35							22.94	
1990	15.18	2.77	0.00	0.02	0.22	5.55	8.56	10.34	5.44
1991		3.97	0.00	0.03	0.47	7.40	11.87		6.79
1992		4.27	0.00	0.03	0.51	7.40	12.21		6.07
1993		4.59	0.00	0.03	0.55	7.40	12.57		5.43
1994		4.94	0.00	0.03	0.59	7.40	12.96		4.87
1995		5.31	0.00	0.03	0.64	7.40	13.38		4.38
1996		5.71	0.00	0.03	0.69	7.40	13.83		3.93
1997		6.15	0.00	0.03	0.74	7.40	14.32		3.54
1998		6.61	0.00	0.03	0.80	7.40	14.84		3.19
1999		7.11	0.00	0.03	0.86	7.40	15.40		2.88
2000		7.65	0.00	0.03	0.93	7.40	16.01		2.61
2001		8.10	0.00	0.03	0.99	7.40	16.52		2.33
2002		8.57	0.00	0.04	1.05	7.40	17.06		2.10
2003		9.07	0.00	0.04	1.11	7.40	17.62		1.89
2004		9.60	0.00	0.04	1.18	7.40	18.22		1.69
2005		10.15	0.00	0.05	1.25	7.40	18.52		1.53
2006		10.75	0.00	0.05	1.32	7.40	19.52		1.37
2007		11.37	0.00	0.05	1.40	7.40	20.22		1.23
2008		12.04	0.00	0.06	1.49	7.40	20.99		1.11
2009		12.74	0.00	0.06	1.58	7.40	21.78		1.00
2010		3.37	0.00	0.02	0.84	1.85	6.08		0.26
TOTAL	81.28	154.84	0.00	0.76	19.21	148.00	322.81	66.32	63.64

NPV = 2.68 M₱

B/C = 0.96

IRR = 14.4 %

TABLE 12.1-11 ECONOMIC COST - BENEFIT STREAMS OF KENNON ROAD

(Unit : M₱ at 1983 Prices)

	BEFORE DISCOUNT							AFTER DISCOUNT (15%)	
		BENEFITS							
	Cost	Saving in Detour Cost	Saving in Commodity Opportunity Cost	Saving in Traffic Accident Cost	Saving in Travel Time Cost	Saving in Restoration Cost	Total	Cost	Benefit
1985	0.56							0.70	
1986	5.03							5.78	
1987	3.93							3.80	
1988	27.50							23.93	
1989	31.43							23.76	
1990	15.70	5.69	0.00	0.17	0.58	4.67	11.11	10.60	7.05
1991		7.23	0.00	0.21	0.73	5.60	13.77		7.88
1992		7.65	0.00	0.23	0.77	5.60	14.25		7.08
1993		8.09	0.00	0.24	0.82	5.60	14.75		6.37
1994		8.57	0.00	0.26	0.86	5.60	15.29		5.75
1995		9.06	0.00	0.27	0.91	5.60	15.84		5.18
1996		9.59	0.00	0.29	0.97	5.60	16.45		4.67
1997		10.15	0.00	0.31	1.02	5.60	17.08		4.22
1998		10.74	0.00	0.33	1.08	5.60	17.75		3.82
1999		11.37	0.00	0.35	1.14	5.60	18.46		3.45
2000		12.03	0.00	0.37	1.21	5.60	19.21		3.13
2001		12.70	0.00	0.39	1.28	5.60	19.97		2.82
2002		13.40	0.00	0.41	1.35	5.60	20.76		2.55
2003		14.14	0.00	0.43	1.42	5.60	21.59		2.31
2004		14.93	0.00	0.45	1.50	5.60	22.48		2.09
2005		15.75	0.00	0.48	1.58	5.60	23.41		1.90
2006		16.63	0.00	0.50	1.67	5.60	24.40		1.71
2007		17.55	0.00	0.53	1.76	5.60	25.44		1.55
2008		18.52	0.00	0.55	1.86	5.60	26.53		1.41
2009		19.55	0.00	0.58	1.96	5.60	27.69		1.27
2010		3.44	0.00	0.10	0.35	0.93	4.82		0.20
TOTAL	84.15	246.78	0.00	7.45	24.82	112.00	391.05	68.66	76.41

NPV = 7.75 M₱
B/C = 1.11
IRR = 16.6 %

12.2 FINANCIAL EVALUATION

12.2.1 Expenditures on Road Development

The MPWH expenditures (highway portion only) from 1970 to 1982 are presented in Table 12.2-1. The expenditures on construction and improvement of roads in 1982 were 3,120 million pesos. About 60% to 70% of total MPWH expenditures were invested on construction and improvement of roads.

TABLE 12.2-1 MPWH EXPENDITURES (Highway Portion)
- Current Price -

Unit : Million Pesos

Year	Administration	Maintenance	Construction and Improvement	T o t a l
1970	55.0 (10)	104.0 (18)	414.4 (72)	573.4
1971	52.5 (13)	121.6 (30)	231.2 (57)	405.3
1972	70.2 (12)	155.6 (27)	354.1 (61)	579.9
1973	105.6 (12)	216.1 (25)	530.7 (63)	852.4
1974	179.4 (17)	269.9 (25)	609.4 (58)	1,058.7
1975	284.4 (13)	533.5 (25)	1,339.5 (62)	2,157.4
1976 1/	234.5 (6)	795.9 (20)	2,879.7 (74)	3,910.1
1977	238.9 (9)	874.9 (32)	1,618.5 (59)	2,732.3
1978	284.8 (10)	893.8 (32)	1,586.1 (57)	2,764.7
1979	305.6 (8)	871.8 (23)	2,664.0 (69)	3,841.4
1980	317.6 (9)	1,107.4 (30)	2,227.9 (61)	3,652.9
1981	249.6 (6)	1,138.7 (26)	2,948.0 (68)	4,336.3
1982	480.1 (10)	983.8 (21)	3,120.4 (68)	4,584.3

Notes: 1/ Expenditures from July 1, 1975 to December 31, 1976

2/ Figure in ( ) shows share in %

Source: MPWH

Table 12.2-2 shows the MPWH medium term infrastructure program from 1983 to 1992, which was prepared by the MPWH in February 1984. Due to economic crisis the counry is now suffering, investments on road development will be limited to the required minimum for at least next 5 years, if there is no drastic improvement in economic conditions.

TABLE 12.2-2 MPWH MEDIUM TERM INFRASTRUCTURE PROGRAM
- Current Price -

Unit : Million ₱

Year	Major Road	Minor Road	Total
1983	3,155.3	476.4	3,631.7
1984	2,311.7	556.2	2,867.9
1985	2,137.0	408.0	2,545.0
1986	2,255.0	440.0	2,695.0
1987	2,338.0	480.0	2,818.0
1988	2,398.0	530.0	2,928.0
1989	2,590.0	580.0	3,170.0
1990	2,660.0	640.0	3,300.0
1991	2,800.0	700.0	3,500.0
1992	2,982.0	760.0	3,742.0

Note: Medium Assumption (As of February 1984)

Source: MPWH

12.2.2 Possible Amount of Budget Allocation to one Project

The budget allocations to local portion of the foreign assisted highway projects in 1983 were summarized as shown in Table 12.2-3. The maximum budget allocation to one project was 253 million pesos which were equivalent to about 1/12 of the total budget for construction/improvement of major roads in the country.

TABLE 12.2-3 BUDGET ALLOCATION TO LOCAL PORTION OF FOREIGN ASSISTED PROJECT IN 1983

Budget Allocation (Million)	No. of Projects	Budget for one Project/ Budget for Major Roads
less than 50	27	1/63 - 1/32
50 - 100	6	
100 - 150	2	1/32 - 1/16
150 - 200	1	
200 - 250	2	1/16 - 1/13
more than 250	1	

Source: MPWH 1983 Infrastructure Program

The possible amount of budget allocation to local portion of one project was estimated to be 1/15 of the total budget for construction/improvement of major roads as high (or optimistic) assumption, 1/40 as low (or pessimistic) assumption and 1/25 as medium (or most feasible) assumption. The result are shown in Table 12.2-4.

TABLE 12.2-4 POSSIBLE AMOUNT OF BUDGET ALLOCATION (LOCAL PORTION)

- Current Price -

Unit : Million Pesos

Year	Estimated Budget for Major Roads[1/]	Possible Amount of Budget Allocation to One Project			Required Investment of the Project
		Low Assumption	Medium Assumption	High Assumption	
1983	3,155	79	126	210	-
1984	2,311	58	92	154	-
1985	2,137	53	85	142	1.1
1986	2,255	56	90	150	10.5
1987	2,338	58	94	156	10.6
1988	2,398	60	96	160	79.5
1989	2,590	65	104	173	97.3
1990	2,660	67	106	177	52.0

[1/] MPWH Medium Term Infrastructure Program (as of February 1984)

12.2.3 Financial Evaluation

In view of the budgetary constraints, a financial assistant from a foreign country or international financing institutions will be necessary. Amount equivalent to foreign currency portion of the Project should be procured from foreign sources.

In respect to the local currency portion of the Project, the maximum investment of the Project was estimated to occur in 1989 at 97.3 million pesos in current price which are almost equivalent to the estimated possible amount of budget allocation under the medium assumption (see Table 12.2-4). Therefore, the Project is financially viable.

12.3 PROJECT IMPACTS

Benefits which could not be quantified were summarized as project impacts. Traffic interruption due to road disasters adversely affects socio-economic activities in the influence areas of a section. These adverse impacts of the "without project" case which are described hereunder will be alleviated when the Project is implemented.

12.3.1 Dalton Pass Section

1) Socio-Economic Impact

- The areal influence magnitude of traffic interruptions due to road disaster along Dalton Pass extend to 730 kilometers covering the whole of Cagayan Valley as direct influence area. The limit of expansion of influence area extend to Metro Manila wherein the Dalton Pass Section plays a vital role in strengthening the linkage between the two regions. This directly affects 2.2 million population in 1983 to 3.7 population in the year 2010.
- About 1990[1] tons of daily inbound commodities to Cagayan Valley are directly affected, consisting mainly of building and construction materials (40%), manufactured foodstuff (22%) and mineral oil products (13%). This reflects the massive on-going construction activities in Cagayan Valley and is forecasted to continue in the future, wherein the total inbound commodity movement will increase to 9,100 tons per day in 2010.
- The cancellation or delays in transporting these basic commodities to Cagayan Valley due to the regional temporary isolation will set a disturbing pattern of chain reaction, from artificial price increases to social uneaseness and unstable peace and order, in the area. The Study Team conducted a survey to assess the impact of traffic interruption along Dalton Pass. The result of the survey is shown in Appendix 12-8.
- The transportation of major products from the Cagayan Valley Region to Metro Manila will be suspended or delayed. Metro manila depends upon Cagayan Valley to supply about 40 percent of its rice and logs/lumber requirements. About 6,400 tons [1] of daily regional outbound commodities, consisting mostly of forestry products and rice, will be seriously disturbed. An analysis based on logs and lumber regional requirements shows that Cagayan Valley supply a significant portion to the national deficiency and any disturbance due to interruption of the Dalton Pass is considered of national magnitude.

2) Transportation

- Daily traffic[1] of 2,128 vehicles and 8,220 tons of cargoes will be seriously disturbed due to unreliability of Dalton Pass. This will be further aggravated in the future affecting the estimated increase of daily traffic of 8,500 vehicles and 26,500 tons of cargoes in the year 2010.
- Likewise, the present number of daily PUV passengers of 8,400[1], which is estimated to increase to 29,000 in the year 2010, will be seriously affected because of the region's high dependency on road transport, accounting for 99 percent share of all transport mode in the Cagayan Corridor.

- A detour of additional 300–400 kms. in length will be needed to complete a trip. This detour trip will require 6–8 hours travel time and additional transport cost of ₱500–670 in case of car trip.

- A serious traffic problem is forecasted for Manila North Road (MNR) in the future being an alternative route for northern portion of Maharlika Highway. If Dalton Pass is closed to future traffic of 8500 vehicles/day in 2010, majority of this traffic will detour, thus imposing a burden to MNR. A total of this future detour traffic and MNR future traffic is more than the road's maximum capacity for a 2-lane, 2-direction road. Manila North Road will be congested for a stretch of about 680 kms.

3) Regional Development

- The traffic interruptions along Dalton Pass hinder the economic return from investments on projects such as the Cagayan Integrated Rural Development Project. The delays/cancellations of needed materials for completion of the project's various components would induce some damage/inefficiency to the project's operation and expected benefits.

- The Cagayan Valley Region has a vast potential for agricultural development, having an estimated 413,000 hectares of potential cropland for cultivation. The inefficiency of Dalton Pass portion of the Maharlika Highway will impose a constraint to planned development targets for the regions by lowering the potential productivity. This inefficiency, such as delays in transporting vital materials and products, discourages the full utilization of potential regional resources and act as barrier in attracting intensive flow of private investments in the region.

12.3.2 Mahaplag-Sogod Section

1) Socio-Economic Impact

- The scope of present influence area of Mahaplag-Sogod Section extend to 150 kilometers affecting only South Leyte and Leyte provinces. However, the magnitude of future expansion of the section's influence area will extend to 520 kilometers, from Southern portion of Samar to Northern Mindanao, due to the completion and operation of ferry services. The Liloan-Surigao ferry service is the last link to complete the whole system of the Maharlika Highway from Aparri to Mindanao. About 300,000 people in 1983 and 430,000 people in 2010 in Southern Leyte will be directly affected.

- Southern Leyte heavily relied in Tacloban, Leyte to supply its deficient basic consumption requirements, wherein the Maharlika Highway plays a vital role by providing the province access to the regional trading and distribution center. Transportation of basic commodities, consisting mainly of manufactured foodstuffs, consumed in Southern Leyte amounting to 90 tons[1] daily will be delayed due to road disaster along the section.

- This will set a series of economic disturbances due to temporary isolation of the province from the rest of the region. Intentional price increase, social disturbance and unstable peace and order will be induced in the affected area.

- Likewide, medical services will be seriously affected since the Maharlika Highway provides the shortest and most convenient access to higher level of medical facilities located in Tacloban, Leyte.

2) Transportation

- The traffic flow of 134[1] vehicles/day and 144[1] tons/day of commodities will be disturbed. This will increase to 1320 vehicles/day and 1020 tons/day in the year 2010. About 330[1] daily PUV passengers will be affected by traffic interruption along the project section. These passengers using PUV's and have trips mostly of business purpose is estimated to increase to 1200 to 2010. An additional 1.3 hours travel time and ₱110 travel cost will be incurred due to detour.

3) Regional Development

- The disparity in per capita income between the province and the national average will be further aggravated in the future due to the discouraging effect of Mahaplag-Sogod unreliability. Per capita income of Southern Leyte at present is only half of the national average. The low productivity in the province due to under-utilization of existing and potential cropland will continue in the future due to frequent isolation of the province. This will result in heavier dependency of the province to the rest of the region, becoming a burden to regional development in the long run. The government policies and projects designed to uplift the socioeconomic status of the province as depressed area will be hard to implement since the necessary investment from the private sector will not be attracted to the province.
- The effective use of ferry services between Leyte and Mindanao will be blocked, thus economic return from investment on the ferry service project will become less.

12.3.3 Kennon Road

1) Socio-Economic Impact

- The direct influence area of Kennon Road is considered to be the whole of Benguet Province, although specifically the 3 roads leading to Baguio-Naguilian, Agoo-Baguio and Kennon have each a separate direct influence area within Benguet Province. The total area of Benguet is about 2,655 kms. with a total affected population of about 350,000 in 1983 and expected to increase up to 570,000 in the year 2010. The influence area is assumed to extend up to 310 kms. southwards with Metro Manila as the endpoint.
- Based on the OD Survey about 770[1] tons of basic commodities for daily consumption is transported to Baguio per day through Kennon Road. Most of these commodities are unprocessed agricultural cash crops (15%) such as rice, manufactured foodstuffs (16%), construction materials (30%) such as cement and manufactured producers goods (18%). Without the project transportation of these commodities will be delayed in case of disaster, thus, the reliability of Kennon Road is essential for development of Baguio City.

- The sphere of life in Baguio City is extended up to the areas along the Kennon Road, wherein the daily life activities are centered along these areas. Any disturbances along Kennon Road will therefore hamper these activities. It is estimated that about 2,300[1] /commuters and students will be affected due to unreliability of Kennon Road.

- Baguio City is one of the most important tourist-attracting spot in the country because of its cool climate and beautiful sceneries. Most of foreign and local tourists coming from Manila travel by land using Kennon Road. With the unreliability of Kennon Road tourism industry in Baguio City will surely suffer a serious economic loss even for the country as a whole, since tourism is one of the important foreign exchange earning industry in the country.

2) Impact to Transportation

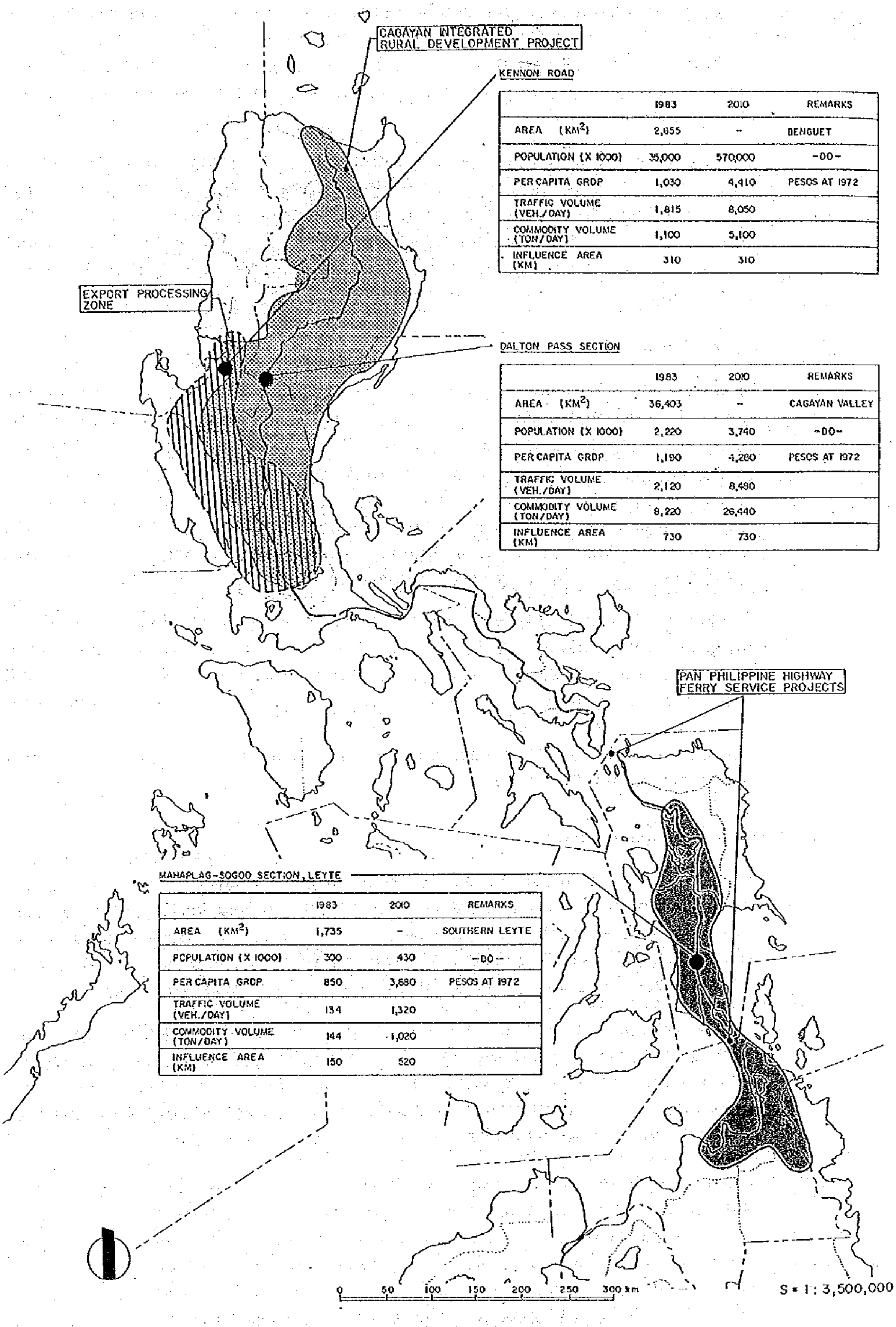
- Kennon Road is mainly utilized as a passenger route. Based on traffic survey about 13,776[1] PUV passenger per day pass along the road. The total traffic flow surveyed along the road is about 1,800[1] vehicles per day while commodity flow is 1,200[1] per day. These are expected to increase to 8,050 vehicles per day and 5,100 tons per day in the year 2010. Without the project these flows will surely be disturbed due to unreliability of Kennon Road in case of disaster. If the detour route will be utilized, additional travel time of 1.3 hours and travel cost of ₱110 will be incurred for an additional route length of about 63 kms.

- Naguilian Road and Manila North Road are the alternative route in case of disaster in Kennon Road. Future traffic in Naguilian Road will reach 5,300 vehicles per day in the year 2010. If Kennon Road is closed future traffic of about 8,050 vehicles per day will be diverted to Naguilian Road passing through Manila North Road. Thus, a severe traffic congestion will be observed in Naguilian Road in the future since the 13,300 vehicles per day is too heavy for a stiff and narrow two lanes road such as Naguilian.

3) Impact to Regional Development

- One of the most important development project initiated in Region I is the establishment of Export Processing Zone (EPZA) in Baguio City. Such project have already been started, which is geared to promote the industrial activities of the region. In case of disaster the unreliability of Kennon Road will greatly affect the said project since the delivery of raw materials will be delayed.

  Baguio City is not considered a selft-reliant city and is dependent upon the neighboring areas. Considering the instability of the 3 roads leading to it, Baguio City will be completely isolated in case of super heavy typhoon. Baguio City, therefore, needs at least one stable road, which is most probably Kennon Road if we take into consideration its shortest access to Metro Manila.



KENNON ROAD

	1983	2010	REMARKS
AREA (KM²)	2,655	-	BENGUET
POPULATION (X 1000)	35,000	570,000	-DO-
PER CAPITA GRDP	1,030	4,410	PESOS AT 1972
TRAFFIC VOLUME (VEH./DAY)	1,815	8,050	
COMMODITY VOLUME (TON/DAY)	1,100	5,100	
INFLUENCE AREA (KM)	310	310	

DALTON PASS SECTION

	1983	2010	REMARKS
AREA (KM²)	36,403	-	CAGAYAN VALLEY
POPULATION (X 1000)	2,220	3,740	-DO-
PER CAPITA GRDP	1,190	4,280	PESOS AT 1972
TRAFFIC VOLUME (VEH./DAY)	2,120	8,480	
COMMODITY VOLUME (TON/DAY)	8,220	26,440	
INFLUENCE AREA (KM)	730	730	

MAHAPLAG-SOGOD SECTION, LEYTE

	1983	2010	REMARKS
AREA (KM²)	1,735	-	SOUTHERN LEYTE
POPULATION (X 1000)	300	430	-DO-
PER CAPITA GRDP	850	3,680	PESOS AT 1972
TRAFFIC VOLUME (VEH./DAY)	134	1,320	
COMMODITY VOLUME (TON/DAY)	144	1,020	
INFLUENCE AREA (KM)	150	520	

FIGURE 12.3-1 EXPANSION OF INFLUENCE AREA BY F/S SECTION

12.4 OVERALL EVALUATION

1) Dalton Pass Section

- Internal Rate of Return (IRR) under the best estimate is 18.7%. Results of sensitivity analysis show that IRRs in all cases except the worst case exceeds 15%.
- In the year 2010, about 8,500 vehicles and 26,400 tons of commodities will be transported daily through this section. Occurrence of a road disaster in this section will seriously affect socio-economic activities of the influence areas of the section.
- The Project will contribute to the improvement of productivity of Cagayan Valley which shares 12% of total land area of the country.

Implementation of disaster prevention work of this section is feasible in view of high economic return as well as various favorable impacts on social and developmental activities in Cagayan Valley.

2) Mahaplag – Sogod Section

- IRR under the best estimate is 14%.
- Scale of road disaster in this section will grow year by year. Technical assessment suggests that countermeasures for road disaster be undertaken immediately, otherwise, the section would be totally destroyed.
- The Project will greately contribute to sound areal development of Southern Leyte.
- Unless this section is improved, the ferry service between Leyte and Mindanao, which will be in operation in 1984, will not be efficiently utilized.
- The ferry service between Leyte and Mindanao will finally realize the linkage of 4 major islands by vehicle traffic, by way of the Maharlika Highway. This section, a part of the Maharlika Highway, will function as a principal national trunk highway.

The Project is economically feasible. In view of technical assessment as well as favorable impacts on social and developmental activities in the influence areas, the Project should be implemented.

3) Kennon Road

- IRR under the best estimate is 16.6%.
- Baguio City must be provided with at least one reliable and all-weather access road. Kennon Road, the shortest route to link Baguio City and Metro Manila, should be given top priority.
- The Project is a vital need to support and develop the tourism and the education/culture establishments as well as the modern technology industry at the Export Processing Zone in Baguio City.

- The Project contributes to formation of cohesive community centered at Baguio City and extended along Kennon Road.

The Project is feasible from the viewpoints of high economicreturn and various favorable impacts on social and developmental activities in Baguio City and surrounding areas.

4) Financial Evaluation

Financial evaluation indicates that even if three (3) sections are implemented simultaneously, the Project is financially feasible.

5) Conclusion

Overall evaluation of the Project shows that the Project is feasible in terms of technical, economic and financial viability and various impacts which the project brings about.

CHAPTER 13

PROJECT IMPLEMENTATION

13.1 IMPLEMENTATION SCHEDULE

As experienced in the past, the three (3) F/S sections, being situated within the Pacific typhoon belt, might suffer destructive damages again by a large scale typhoon, resulting in prolonged traffic interruption and paralyzing socio-economic activities of the respective influence areas. The Project should be implemented as soon as possible. The recommended implementation schedule is as follows;

- Proparation of the Project Funds - - - - - 1984 - 1985
- Detailed engineering Study - - - - - 1985 - 1986
- Tender - - - - - 1987
- Construction - - - - - 1987 - 1990

13.2 PREPARATION OF PROJECT FUNDS

Total fund requirement brocken into foreign and local currency components is shown in Table 13.2-1. In October 1983 price, total fund requirement was estimated at 367.85 million pesos. of which foreign component at 225.65 million pesos and local component at 142.20 million pesos.

TABLE 13.2-1 TOTAL FUND REQUIREMENT

Unit : Million Pesos

	October 1983 Price			Current Price		
	Foreign	Local/Tax	Total	Foreign	Local/Tax	Total
Detailed Engineering	14.67	7.91	22.58	17.79	11.58	29.37
Supervision	14.67	7.91	22.58	19.78	15.65	35.43
Construction	196.31	126.38	322.69	282.62	223.77	506.39
TOTAL	225.65	142.20	367.85	320.19	251.00	571.19

As discussed in the financial analysis, financial assistance from a foreign country or an international financing institution will be necessary. Negotiation of loans equivalent to the amount of foreign currency component (225.65 million pesos in 1983 price) should be made as soon as possible to meet the implementation schedule. Local fund amounting at 142.20 million pesos in October 1983 price should be made available by the Government.

Annual fund requirement broken down into foreign and local currency component is shown in Table 13.2-2.

TABLE 13.2-2 ANNUAL FUND REQUIREMENT

Unit : Million ₱

	Year	October 1983 Price			Current Price		
		Foreign	Local/Tax	Total	Foreign	Local/Tax	Total
Detailed Engineering	1985	1.47	0.79	2.26	1.70	1.06	2.76
	1986	13.20	7.12	20.32	16.09	10.52	26.61
	Sub-Total	14.67	7.91	22.58	17.79	11.58	29.37
Construction and Supervision	1987	10.55	6.72	17.27	13.69	10.59	24.28
	1988	73.85	47.00	120.85	101.18	79.54	180.72
	1989	84.39	53.71	138.10	122.61	97.25	214.86
	1990	42.19	26.86	69.05	64.92	52.04	116.96
	Sub-Total	210.98	134.29	345.27	302.40	239.42	541.82
TOTAL		225.65	142.20	367.85	320.19	251.00	571.19

13.3 DETAILED ENGINEERING STUDY

The detailed engineering study will need 15 months to complete in view of extensive sub-surface investigations required and topograhic surveys of complicated mountainous terrain. Geological and underground water conditions should be identified prior to selection of countermeasures. Extra care should be paid to the drainage facilities to drain surface water as well as underground water in due consideration of rainfall intensity of the area. As the Project is the first one in the country, documents, especially technical specifications, should be prepared carefully taking into full consideration local conditions.

13.4 CONSTRUCTION

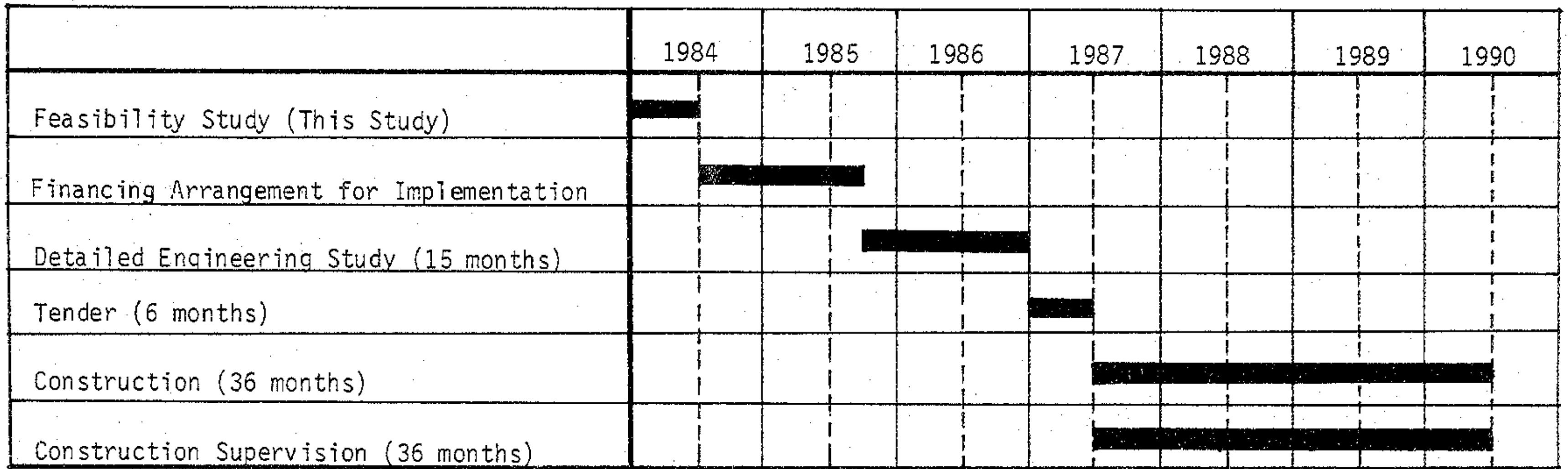
As the topographic conditions during the detailed engineering study might be greatly changed, by typhoon damages the construction should start soon after the completion of the detailed engineering study.

The construction period will require 36 months (or 3 years). The Project should be implemented by three contracts, each of three (3) sections composing of a construction segment.

The experience construction supervisors in this sort of projects should be employed. Changes in the design should be made flexibly to cope with new findings of geological or underground conditions during construction.

13.5 SUMMARY

Implementation schedule and annual financial requirements are shown in figure 13.5-1.



		1984	1985	1986	1987	1988	1989	1990
Financial Requirement - October 1983 Price - Unit : Million Pesos	Foreign Component	-	1.47 (1.70)	13.20 (16.09)	10.55 (13.69)	73.85 (101.18)	84.39 (122.61)	42.19 (64.92)
	Local and Tax Component	-	0.79 (1.06)	7.12 (10.52)	6.72 (10.59)	47.00 (79.54)	53.71 (97.25)	26.86 (52.04)
	T O T A L	-	2.26 (2.76)	20.32 (26.61)	17.27 (24.28)	120.85 (180.72)	138.10 (219.86)	69.05 (116.96)

Note : Figure in ( ) shows financial requirement in current price.

FIGURE 13.5-1 IMPLEMENTATION SCHEDULE

CHAPTER 14

PROPOSITION BASED ON FINDINGS

It should be realized that the disaster has, without exception, the great potentiality to be grave and severe in size and degree of disaster and eventually cut road.

In recognition of this fact and the constraint behind, the following are sincerely recommended.

RECORD OF DISASTER

The record of heavy rain, typhoon, and calamity should be completely compiled. These records can provide the basic engineering data to be analyzed for the identification of disaster spots, the frequency of the occurrence of disaster, and the selection of the appropriate countermeasures. The informations to be covered are topography, geology, influence of water, cause and size of road disaster, precipitation and the like.

The format prepared in the Study is recommended for this purpose.

INVESTIGATION OF DISASTER POTENTIAL SPOT

All spots where failures are likely to occur should be identified and recorded by the concerned agencies. The availability of the data will enable those concerned to prepare and install appropriate warning signs at specific location for the information of the road users. Moreover, with the availability of such records, the engineering approach to the solution of the problem can be developed and coorresponding preventive measures can be formulated.

The check table used in the Study is recommended for the purpose.

PROVISIONAL REMEDIAL MEASURE

The Study shows that the main causes of road disaster is water and the simple measures recommended to control water include;

- provision of earth ditch
- provision of drainage facilities for groundwater and spring water such as horizontal drain hole and closed conduits
- utilization of gabion, whenever applicable

ROAD ALIGNMENT

As mentioned in Chapter 3 and 8, the Maharlika Highway runs parallel to the Philippine Fault as a result of which large scale slope failures have occurred. Protection works needed are more extensive.

For the selection of appropriate route, a more comprehensive route study is suggested. Alternative routes should be evaluated according to the road functions, costs and extent of disaster control works.

JICA