PROPOSED ROUTE NO. IM - 4

Changwat : Khon Kaen

A. Chonnabot (J.R 2057) - B Kut Ru (J.R.2065)

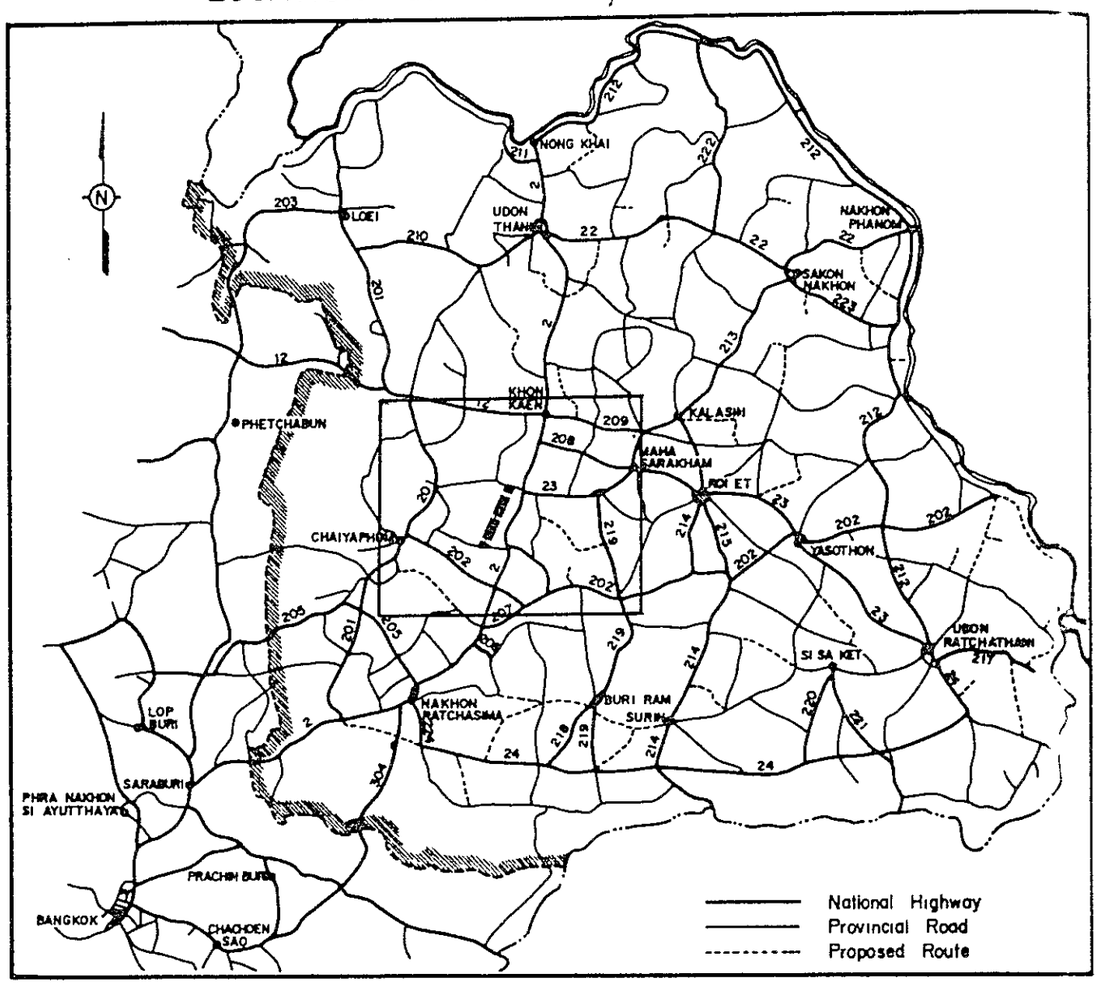
Length : 35.3 KM

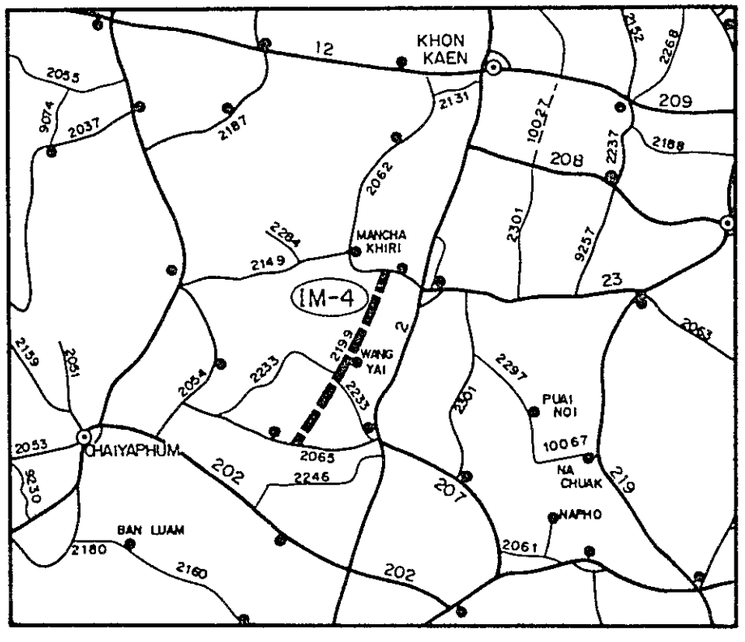
SUMMARY

PROPOSED ROUTE IM-4

Item	Description	
Changwat	Khon Kaen	
Origin	A. Chonnabot (J.R. 2057)	
Destination	B. Kut Ru (J.R. 2065)	
Length		
Total		35.3 km
Improvement Section		35.3 km
DOH Road	R. 2199	35.3 km
ARD Road		0 km
Others		0 km
New Alignment Section		0 km
Surface Type and Condition	Soil Aggregate, Good Poor	
Terrain	Flat	
Influence Area		
Area		263 km^2
Population (1982)		25,500
Principal Crops		Paddy
Traffic (ADT)		
Existing		98
1993		382
2001		507
Proposed Standard	F4 (DBST)	
Construction Cost		
Financial		60,602 . 10^3 ฿
Economic		56,439 . 10^3 ฿
IRR		6.2 %
B/C		0.58
Recommendation	For further consideration	

LOCATION OF PROPOSED ROUTE





1. GENERAL

1.1 Characteristics of the Route

The proposed route is located in the south part of Changwat Khon Kaen. The route starting at Amphoe Chonnabot runs northward passing through Ban Mai Ne Phiang, King Amphoe Waeng Yai and Ban Dok Hai and ends at Ban Kut Rue on Route 2065. Its total length is 35.3 km (Figure 4.5.2.)

The terrain is almost flat. In the influence area, there exists several villages with total population of 25,500. There are four medical centers and one secondary school, but no hospital along the proposed route.

The proposed route, upon completion, will form an important part of road network to connect two artery highways, Route 2057 and 2065 in the developed agricultural area and also play vital role to connect King Amphoe Waeng Yai.

1.2 Condition of Existing Road

Condition of existing road to be utilized for the proposed route is summarized in Table 4.1.1.

The details are shown as the results of inventory survey in Table 4.1.2.

2. TRAFFIC

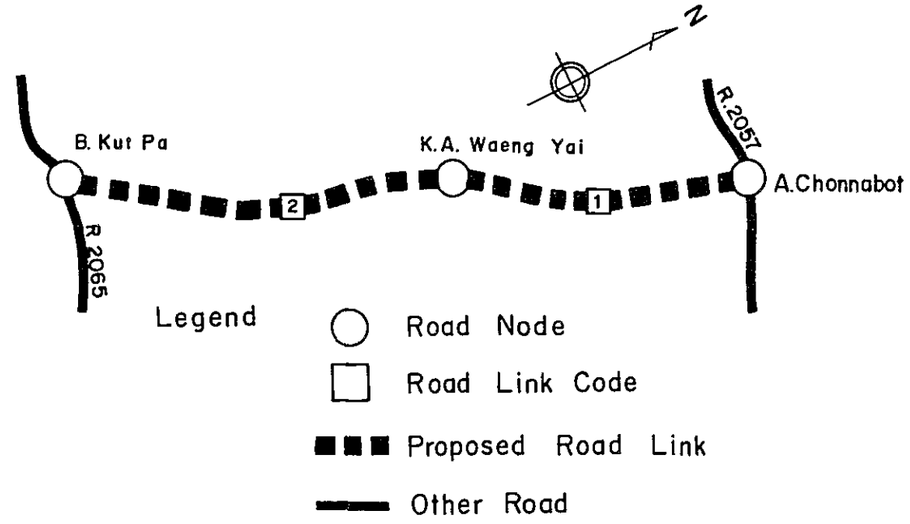
2.1 Method

Growth Rate Method was employed for traffic forecasting as no diverted traffic is expected after improvement of the subject road.

2.2 Base Year Traffic

The base year traffic by road link by vehicle type was estimated basing on manual classified counts as shown below:

Proposed Road Link



Traffic Volume in Base Year

Source (base Year)	Link No	Vehicle Type P/C	P/P	L/B	M/B	H/B	P/T	4/T	6/T	10/T	ADT
Manual Counts (1982)	1	10	42	5	69	1	5	10	32	1	175
	2	-	14	3	3	-	2	-	1	3	26

2.3 Transport Movement

Passenger movement in terms of trips per day and freight movement in terms of tonnage per day on the proposed road links were estimated multiplying traffic volume in base year by the occupancy or average load obtained from roadside interview, as shown below:

PASSENGER MOVEMENT (1982)

PROPOSED ROAD LINK	TRIPS PER DAY
1	1722
2	159

FREIGHT MOVEMENT (1982)

PROPOSED ROAD LINK	TONAGE PER DAY		
	NON-AGRI.	AGRI.	TOTAL
1	44	45	88
2	14	15	29

2.4 Future Growth of Transport Movement

The growth rates of passenger and freight movements for the periods of 1981 - 1987, 1987 - 1993 and 1993 - 2001 were predicted by the formula described in 7.3.3-2) of the Main Report. The basis for the prediction is shown in the following tables:

GROWTH RATE OF PASSENGER MOVEMENT

ITEM	GROWTH RATE (% P.A.)		
	1981 - 1987	1987 - 1993	1993 - 2001
PER CAPITA INCOME	4.2	4.5	4.7
TRANS. PRICE INCREASE	4.5	4.5	4.5
POPULATION	1.4	1.2	1.0
PASSENGER MOVEMENT	5.4	5.6	5.7

GROWTH RATE OF FREIGHT MOVEMENT

ITEM	GROWTH RATE (% P.A.)		
	1981 - 1987	1987 - 1993	1993 - 2001
NON-AGRI.	7.0	7.1	7.3
AGRICULTURE	0.1	0.2	0.2
FREIGHT	3.5	3.6	3.7

2.5 Induced and Developed Traffic

The following ratios are used for the estimation of induced and developed traffic described in 7.3.3-3) of the Main Report:

RATE OF INDUCED AND DEVELOPED TRAFFIC

(%)

ITEM	YEAR		
	1987	1993	2001
INDUCED	15.0	15.0	15.0
DEVELOPED	0.0	0.0	0.0

2.6 Future Traffic

1) Traffic Composition

The movements of passenger and freight transport were transformed into traffic volume by vehicle type applying future traffic composition as shown in the following table:

TRAFFIC COMPOSITION

(UNIT : %)

LINK NO.	YEAR	PASSENGER					FREIGHT			
		P/C	P/P	L/B	M/B	H/B	P/T	4/T	6/T	10/T
1	1982	7.9	33.1	3.9	54.3	0.8	10.4	20.8	66.7	2.1
	1987	8.5	32.5	8.5	46.9	3.6	12.1	19.6	58.3	10.0
	1993	9.2	31.7	14.0	38.1	7.0	14.2	18.0	48.3	19.4
	2001	10.2	30.8	21.3	26.2	11.5	17.0	16.0	35.0	32.0
2	1982	0.0	70.0	15.0	15.0	0.0	33.3	0.0	16.7	50.0
	1987	4.6	65.4	13.9	14.6	1.5	29.0	4.2	21.5	45.3
	1993	10.1	59.9	12.6	14.0	3.4	23.9	9.3	27.3	39.6
	2001	17.5	52.5	10.8	13.3	5.8	17.0	16.0	35.0	32.0

2) Forecasted ADT

The average of the forecasted traffic on proposed road links is shown in the following table and details by road link by traffic type are shown in Table 4.2.1.

AVERAGE FUTURE TRAFFIC ON PROPOSED ROUTE

YEAR	TYPE OF VEHICLE								ADT	M/C	TOTAL
	P/C	L/B	M/B	H/B	P/P&T	4/T	6/T	10/T			
1987	8	10	44	3	43	5	15	5	134	179	314
1993	13	20	49	9	56	5	14	7	173	210	382
2001	24	43	53	23	78	6	12	11	250	258	507

3. AGRICULTURAL DEVELOPMENT

3.1. Present Condition

Almost all cultivated land is paddy fields and there remains no more cultivable land for paddy and upland. Cassava ranks first in the upland fields followed by kenaf.

Land use and capability conditions in the area of influence are shown in Table 4.3.1 and Figure 4.3.1. A typical cropping calendar in Khon Kaen area is shown in Figure 4.3.2.

3.2 Development Projection

Future agricultural development in the area of influence was projected for both cases of without project and with project. The projected planted area, unit yields by crop, and the consequent production volumes are shown in Table 4.3.2.

Farmgate prices and production costs of the selected crops are estimated as follows, referring to the Changwat data and field survey information as shown in table 4.3.3.

Based on the above projected production volume, farmgate prices, production costs and land preparation cost estimated separately, net production value (NPV) was obtained as shown in Table 4.3.4. The difference between NPV of with project case and NPV of without project case is deemed to be the development benefit of the subject road.

4. VOC SAVINGS

In accordance with the concept and basic data given in Chapter 7 of Vol. 1 Main Report, VOCs on each road link concerned were calculated in both cases of with project and without project.

Elements of road condition, which affect the calculation of additional costs of VOC of each link, are shown below.

Road Condition

Link		Without Project				With Project						
No.	Terrain	Length (km)	Road class/1	Nos. of wooden Bridge	Nos. of Narrow C.Bridge	Length (km)	Road Class/1 case 1	case 2	case 3	case 4	Nos. of Narrow	Wooden Bridge
1	Flat	17.0	2B	1	0	17.0	1	1	1	2A		0
2	Flat	18.3	3	0	0	18.3	(F4)2A	-		(F5)		0

/1 Road 1 : Paved Road
Road 2A : Laterite Road with good surface condition and alignment
Road 2B : Laterite Road with good surface condition but poor alignment
Road 3 : Laterite Road with poor surface condition and alignment
Road 4 : Earth Road

VOC savings obtained from the difference of total link VOCs in the cases of with project and those of without project case, were calculated as follows.

Vehicle Operating Cost Saving

(unit: 1,000 Baht)

Road Class	1987	1993	2001
1 (F4)	2,662	4,012	6,679
1+2A (F4+F5)	2,466	3,754	6,303
1 (F4: only Link 1)	2,206	3,416	5,819
2A (F5)	1,-23	1,973	3,883

5. ENGINEERING

5.1 Preliminary Design

Preliminary design was carried out based on the following design criteria.

Design Standard : F4 (if not feasible, F5)

Geometric Design : AASHTO (Rural Highways)

Typical Cross Section : as shown in Figure 4.5.1

Minimum Height of Embankment

Ordinary Section : 1.0m

Approach of Bridge in Flat Area : 2.0m

Flood Section : 0.7m (above flood level)

Pavement Structure

In case of F4 Standard

DBST : 2.5cm

Crushed Stone Base CBR≥80% : 15.0cm

Soil Aggregate Subbase CBR≥20% : 15.0cm

Selected Material CBR≥ 6% : 20.0cm

In case of F5 Standard

Soil Aggregate Surface CBR≥20% : 15.0cm

Selected Material CBR≥ 6% : 20.0cm

Pipe Culvert

Standard Size : ø 100cm

Standard Interval

Paddy Area : 200 m

Others : 500 m

Box Culvert

Standard Size : 2.4m x 2.4m

Location : as required

Bridge

Standard Type (width 7.0m)

Short Span Bridge : RC - Slab

Long Span Bridge : PC - Girder

Location : as shown in Bridge List in Figure 4.5.2

Alignment of the route is shown in Figure 4.5.2

5.2 Work Quantity and Construction Cost

Work quantities based on the preliminary design and construction cost together with unit rate by work item are shown in Table 4.5.1.

Total financial and economic construction costs by applied road class are as given below:

Financial and Economic Construction Cost

Road Class	Length (km)	Construction Cost (10^3 ₱) Financial Cost	Economic Cost	Remark
F4 (DBST)	35.3	60,602	56,439	
F5 (Soil Aggregate)	35.3	33,707	30,383	
F4 + F5	35.3	46,489	42,012	Adopted to link ≥300 in ADT
F4	17.0	30,939	27,999	Adopted to link ≥300 in ADT
F5	18.3	15,552	14,014	

6. ECONOMIC EVALUATION

Yearly distribution of the economic costs and benefits and the calculated economic indicators for evaluation are given in Table 4.6.1, 4.6.2, 4.6.3 and 4.6.4.

The result indicates that the proposed project seems to be not feasible under under F4 Standard and F5 Standard in case the opening year is 1987.

7. SOCIAL IMPACTS

Detailed data and results of quantification of indicators of social impacts are tabulated in Table 4.7.1.

Table 4.1.1 SUMMARY OF ROAD INVENTORY

Item	Description		
Origin	A. Chonnabot (J.R. 2057)		
Destination	B. KutI.Ru (J.R. 2065)		
Length			
Total		35.3	km
Improvement Section		35.3	km
DOH Road	R. 2199	35.3	km
ARD Road		0	km
Others		0	km
New Alignment Section		0	km
Terrain	Flat		
Alignment (Hori./Vert.)	Fair / Fair		
Formation Width	5.0 m - 9.0 m, 6.5 m (Weighted average)		
Embankment Section			
Length		35.3	km
Height	0.2 m - 0.75 m		
Cut Section			
Length		0	km
Depth	m - m		
Surface Type and Condition			
SBST or DBST	Good - Poor	2.7	km
Soil Aggregate	Good - Poor	32.6	km
Earth		0	km
Pipe Culvert	49 each		
Box Culvert	0 each	0	m
Bridge			
Permanent Bridge	0 each	0	m
Narrow Concrete Bridge	0 each	0	m (4m)
Wooden Bridge	1 each	14.2	m
Overflow Section	3 places	4.0	km

Table 4.1.2 ROAD INVENTORY (1)

PROPOSED ROUTE NO. IM-4   ROUTE NO. 2199   A. CHONNABOT (J.R. 2057) ∿ B. KUT RU (J.R. 2065)   L = 35.3

KHON KAEN

Item		Entries along STATION (Km): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30
VILLAGE - Name - Household (H) - Population (P)		A. CHONNABOT H = 600 P = 4800 ; B. NA DOK MAI H = 75 P = 825 ; B. HUAI KAE H = 145 P = 1263 ; K.A. WAENG YAI H = 685 P = 4209 ; B. DON CHIM H = 230 P = 2540 ; B. MAINA PHIANG H = 210 P = 1200 ; B. NON SALA H = 38 P = 476
TERRAIN		Flat
CROSS SECTION	Formation Width (m)	9.00 | 6.50 | 7.00 | 5.50 | 6.50 | 7.50 | 6.00 | 6.50
	Embankment Height (m)	0.45 | 0.30 | 0.20 | 0.30 | 0.75 | 0.60
	Cutting Depth (m)	
PAVEMENT	Type/Length	DT | Laterite | DT | Laterite | DT | Laterite | DT | Laterite
	Condition	Bad | Good | Poor
FLOODING	Overflow Length(Km)/Height(m)	L=1.0 H=0.3 | L=2.0 H=0.4
LAND USE	Left	Paddy | Bush | Paddy
	Right	Paddy | Bush | Paddy
PIPE CULVERT	Total Number	49 Pipes
BOX CULVERT & BRIDGE	Station (Km)	15.9
	Dimension	W-Br. 4.00 x 14.20
RIGHT OF WAY (m)		
ALIGNMENT	Horizontal	Fair
	Vertical	Fair
ROUTE NO., AGENCIES		DOH 2199

ROAD INVENTORY (2)

PROPOSED ROUTE NO. IM-4 ROUTE NO. 2199 A. CHANNABOT (J.R. 2057) ∿ B. KUT RU (J.R. 2065) (Cont'd) L = 35.3 Km.

KHON KAEN

STATION (Km)		30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60
VILLAGE - Name - Household (H) - Population (P)				B. KUT RU													
TERRAIN																	
CROSS SECTION	Formation Width (m)		5.50	5.00													
	Embankment Height (m)		0.25	0.30													
	Cutting Depth (m)																
PAVEMENT	Type/Length		Laterite														
	Condition		Poor														
FLOODING	Overflow Length(Km)/Height(m)			L=1.0 H=0.4													
LAND USE	Left		Paddy														
	Right		Paddy														
PIPE CULVERT	Total Number																
BOX CULVERT & BRIDGE	Station (Km)																
	Dimension																
RIGHT OF WAY (m)																	
ALIGNMENT	Horizontal		Fair														
	Vertical		Fair														
ROUTE NO., AGENCIES			DOH 2199														

Table 4.2.1 TRAFFIC VOLUME ON ROUTE IM - 4

YEAR		1987			1993			2001		
LINK		1	2	AVR.	1	2	AVR.	1	2	AVR.
P/C	N+D	14	1	7	20	3	12	34	9	21
	I	2	0	1	3	1	2	5	1	3
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	16	1	8	23	4	13	39	10	24
L/B	N+D	14	3	8	31	4	17	71	5	37
	I	2	1	1	5	1	3	11	1	6
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	16	4	10	36	5	20	82	6	43
M/B	N+D	76	4	39	84	5	43	88	7	46
	I	11	1	6	13	1	6	13	1	7
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	88	4	44	97	5	49	101	7	53
H/B	N+D	6	0	3	15	1	8	38	3	20
	I	1	0	0	2	0	1	6	0	3
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	7	0	3	18	1	9	44	3	23
P/P&T	N+D	58	19	38	76	22	48	111	28	68
	I	9	3	6	11	3	7	17	4	10
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	67	21	43	88	26	56	128	32	78
4/T	N+D	9	0	4	8	1	4	7	2	5
	I	1	0	1	1	0	1	1	0	1
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	10	0	5	9	1	5	9	3	6
6/T	N+D	26	2	13	21	3	12	16	5	11
	I	4	0	2	3	0	2	2	1	2
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	30	2	15	25	3	14	19	6	12
10/T	N+D	4	3	4	9	4	6	15	5	10
	I	1	1	1	1	1	1	2	1	1
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	5	4	5	10	5	7	17	6	11
ADT	N+D	208	33	117	265	43	150	381	64	217
	I	31	5	18	40	7	23	57	10	33
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	239	38	134	305	50	173	439	74	250
M/C	N+D	265	70	164	306	87	193	372	116	239
	I	23	8	15	25	10	17	26	12	19
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	288	78	179	331	97	210	397	128	258
TOTAL	N+D	472	103	281	571	130	343	753	180	456
	I	55	13	33	65	16	40	83	22	51
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	527	116	314	636	146	382	836	202	507

NOTE

N : NORMAL TRAFFIC D : DIVERTED TRAFFIC

DV : DEVELOPED TRAFFIC I : INDUCED TRAFFIC

Figure 4.3.1 LAND USE AND CAPABILITY OF INFLUENCE AREA
PROPOSED ROUTE NO. IM – 4

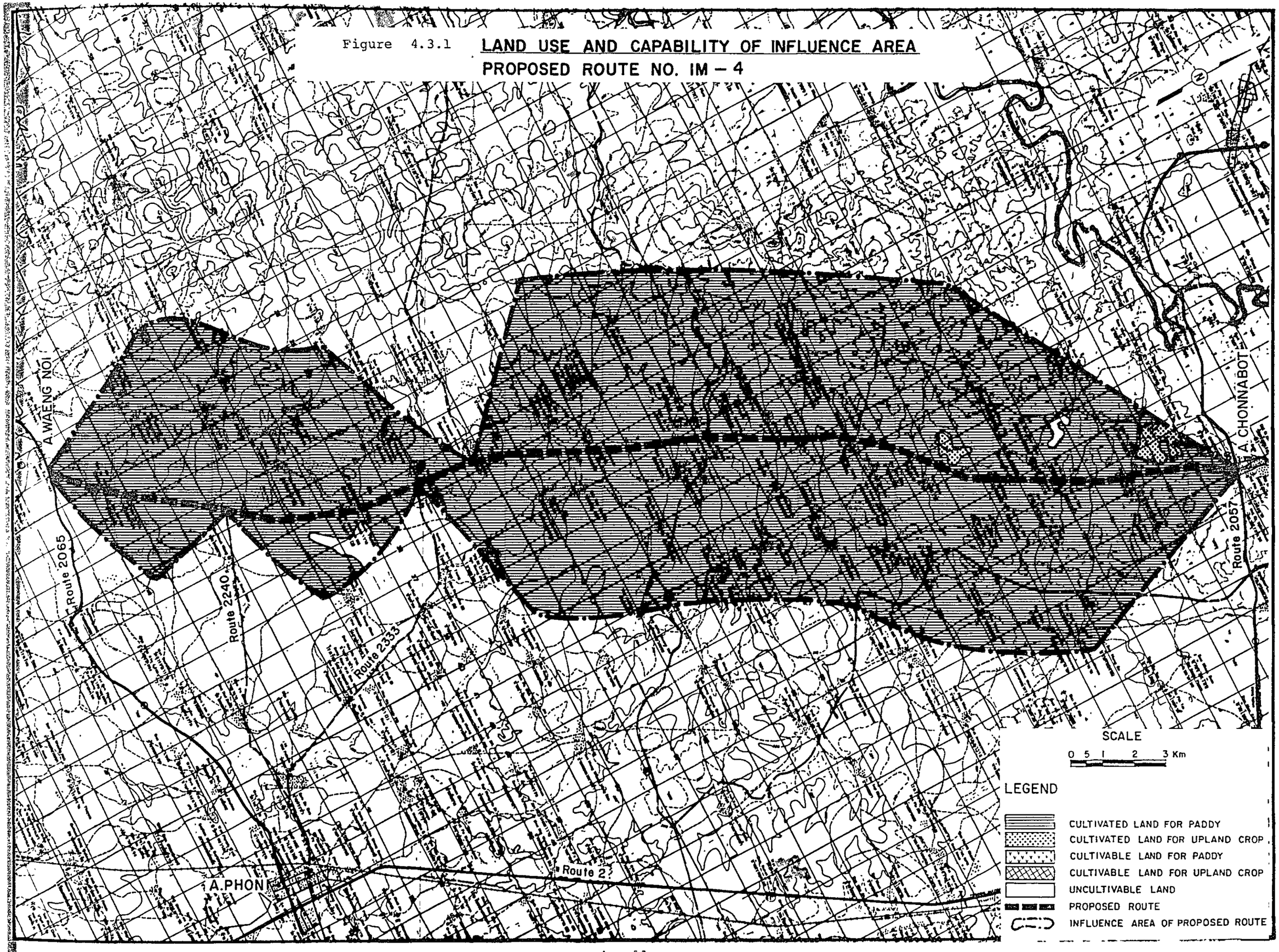


Figure 4.3.2 CROPPING CALENDAR

0600 CHANGWAT KHON KAEN

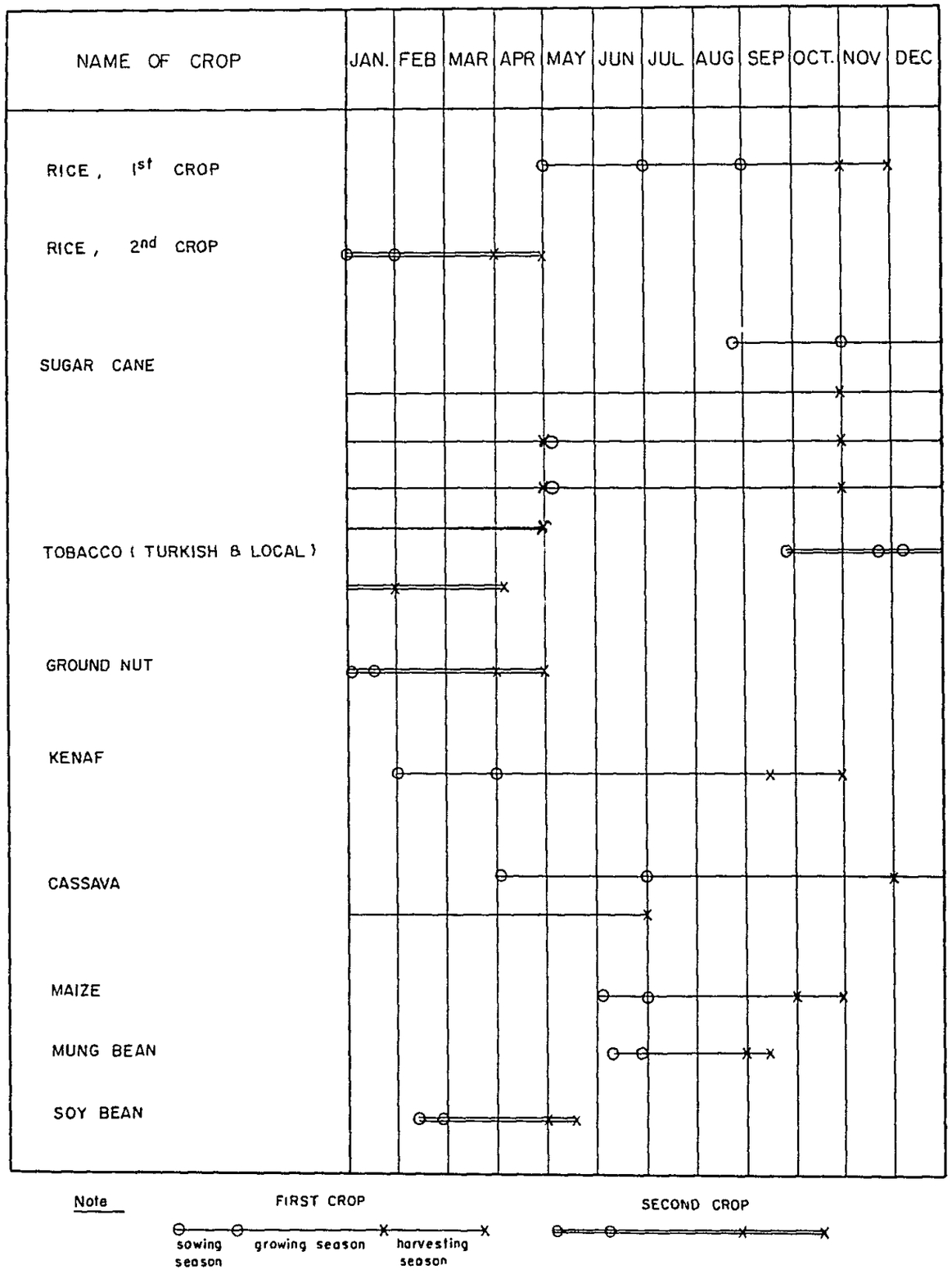


TABLE 4.3.1 CULTIVATED & CULTIVABLE LAND

(1979)

[UNIT : 1000 RAI (KM^2)]

AMPHOE CODE	AMPHOE NAME	CULTIVATED LAND			UNUSED CULTIVABLE LAND		
		PADDY	UPLAND	TOTAL	PADDY	UPLAND	TOTAL
		156.250 (250.0)	0.625 (1.0)	156.875 (251.0)	-	-	-
0613	BAN PHAI	8.125 (13.0)	-	8.125 (13.0)	-	-	-
0614	CHONNABOT	71.250 (114.0)	0.625 (1.0)	71.875 (115.0)	-	-	-
0615	WAENG YAI	41.250 (66.0)	-	41.250 (66.0)	-	-	-
0616	WAENG NOI	35.625 (57.0)	-	35.625 (57.0)	-	-	-

TABLE 4.3.2 CROP PRODUCTION

ITEM		PADDY	MAIZE	BEANS	GRUND NUTS	CASSAVA	SUGAR CANE	KENAF	COTTON	UPLAND TOTAL	TOTAL
PLANTED AREA (1000 RAI)											
1981		126.70	-	-	-	0.37	-	0.24	-	0.63	127.33
1987		126.70	-	-	-	0.42	-	0.24	-	0.67	127.37
1993	WITHOUT PROJECT	126.70	-	-	-	0.47	-	0.24	-	0.72	127.43
	WITH PROJECT	126.70	-	-	-	0.50	-	0.24	-	0.75	127.46
2001	WITHOUT PROJECT	126.70	-	-	-	0.55	-	0.24	-	0.81	127.51
	WITH PROJECT	126.70	-	-	-	0.58	-	0.24	-	0.84	127.54
CROP YIELD (KG/RAI)											
1981		246.1	-	-	-	2000.0	-	252.0	-		
1987		247.6	-	-	-	2000.0	-	252.0	-		
1993	WITHOUT PROJECT	249.1	-	-	-	2000.0	-	252.0	-		
	WITH PROJECT	253.6	-	-	-	2012.0	-	252.0	-		
2001	WITHOUT PROJECT	251.1	-	-	-	2000.0	-	252.0	-		
	WITH PROJECT	261.8	-	-	-	2028.2	-	252.0	-		
CROP PRODUCTION (TON)											
1981		31,183	-	-	-	741	-	60	-	803	31,986
1987		31,370	-	-	-	835	-	60	-	897	32,267
1993	WITHOUT PROJECT	31,559	-	-	-	940	-	60	-	1,002	32,561
	WITH PROJECT	32,131	-	-	-	1,003	-	60	-	1,065	33,195
2001	WITHOUT PROJECT	31,812	-	-	-	1,101	-	60	-	1,163	32,976
	WITH PROJECT	33,173	-	-	-	1,184	-	60	-	1,246	34,420

NOTE : SYMBOL "-" MEANS ZERO OR NEGLIGIBLE SMALL

TABLE 4.3.3 FARMGATE PRICE AND PRODUCTION COST

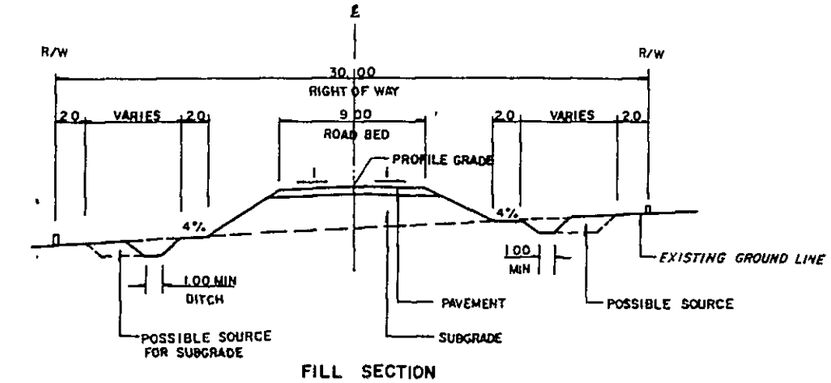
ITEM	PADDY	MAIZE	BEANS	GRUND NUTS	CASSAVA	SUGAR CANE	KENAF	COTTON
FARMGATE PRICE (BAHT/TON)								
WITHOUT PROJECT (1981 - 2001)	3,587	-	-	-	608	-	4,625	-
WITH PROJECT (1987 - 2001)	3,677	-	-	-	623	-	4,741	-
CROP PRODUCTION COST (BAHT/RAI)								
WITHOUT PROJECT (1981 - 2001)	599	-	-	-	724	-	845	-
WITH PROJECT (1987 - 2001)	619	-	-	-	744	-	845	-

TABLE 4.3.4 NET PRODUCTION VALUE

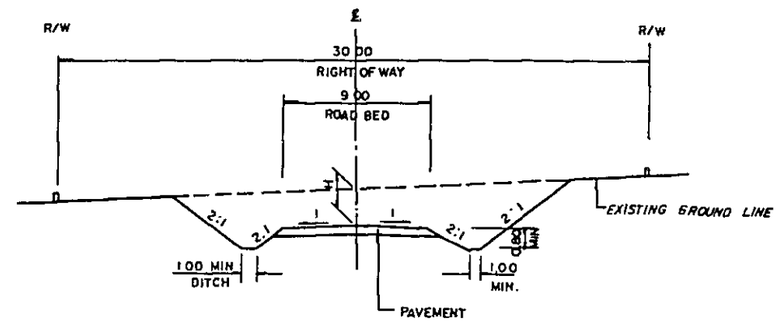
(1000 BAHT)

YEAR	WITHOUT PROJECT			WITH PROJECT		
	PADDY	UPLAND	TOTAL	PADDY	UPLAND	TOTAL
1987	36,631	288	36,919	36,920	298	37,218
1993	37,308	314	37,622	39,716	343	40,059
2001	38,216	353	38,569	43,550	393	43,943

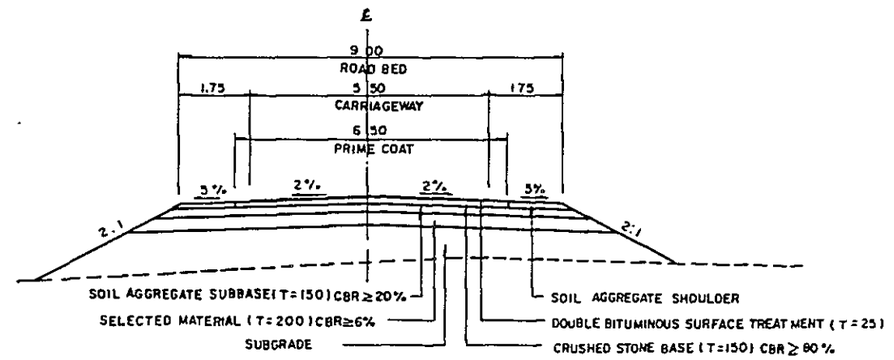
Figure 4.5.1 TYPICAL CROSS SECTION AND TYPICAL PAVEMENT STRUCTURE



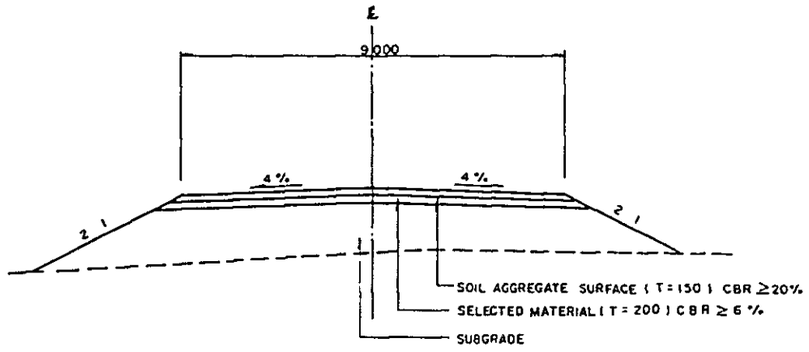
FILL SECTION



CUT SECTION

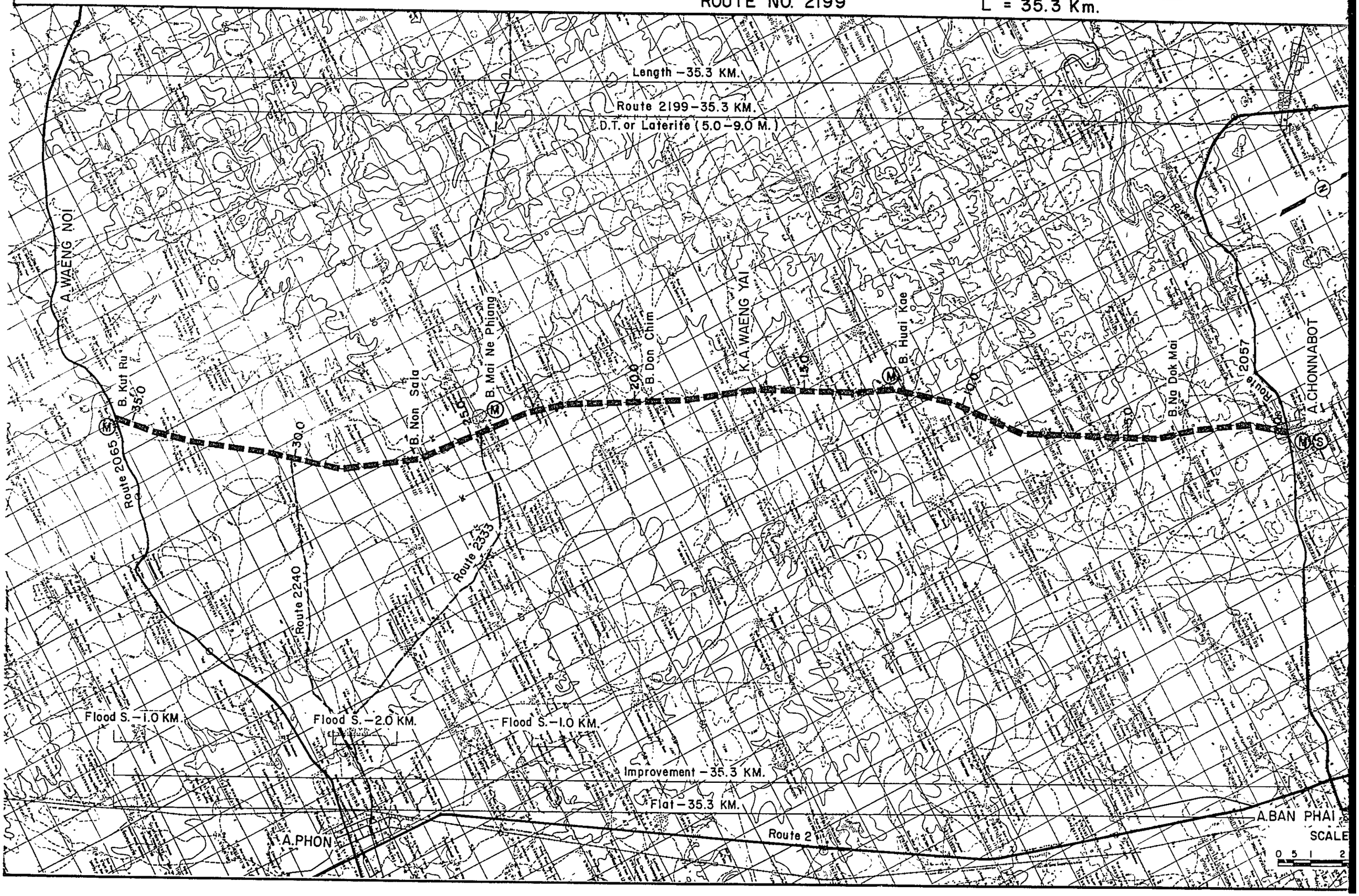


DOUBLE BITUMINOUS SURFACE TREATMENT (DBST) ROAD (Class F4)



SOIL AGGREGATE SURFACED ROAD (Class F5)

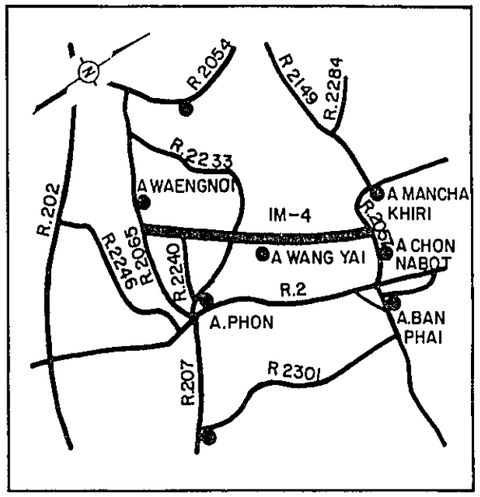
Figure 4.5.2 PROPOSED ROUTE NO. IM-4 C. KHON KAEN A. CHONNABOT (J.R. 2057) — B. KUT RU (J.R. 2065)
ROUTE NO. 2199 L = 35.3 Km.



C. KHON KAEN

A. CHONNABOT (J.R. 2057) – B. KUT RU (J.R. 2065)
ROUTE NO. 2199
L = 35.3 Km.

LOCATION MAP



BRIDGE LIST

No.	Station Km.	Proposed Bridge	Existing Bridge
1	15 9	C – 700 x 16 00	W – 4 00 x 14 20

LEGEND

- PROPOSED ROUTE (IMPROVEMENT)
- PROPOSED ROUTE (NEW CONSTRUCTION)
- PAVED ROUTE
- UNPAVED ROUTE
- INVENTORY SURVEY ROUTE
- (H) HOSPITAL
- (M) MEDICAL CENTER
- (S) SECONDARY SCHOOL

Table 4.5.1 CONSTRUCTION QUANTITIES AND COSTS IM-4 (35.3 km) (1)

Items	Unit of Q'ty	Financial Unit Rate ฿	(DBST) Q'ty	(DBST) Financial Cost (10^3฿)	(DBST) Economic Cost (10^3฿)	(Soil Aggregate Surface) Q'ty	(Soil Aggregate Surface) Financial Cost (10^3฿)	(Soil Aggregate Surface) Economic Cost (10^3฿)
DIRECT CONSTRUCTION COST								
Clearing and Grubbing	ha	15,000	83	1,245	1,132	83	1,245	1,132
Excavation - Soil	m^3	20	0	0	0	0	0	0
Excavation - Hard Rock	m^3	160	0	0	0	0	0	0
Embankment	m^3	45	120,600	5,427	4,938	120,600	5,427	4,938
Selected Material	m^3	80	74,800	5,984	5,325	74,800	5,984	5,325
Soil Aggregate Surface or Subbase	m^3	105	52,400	5,502	4,896	52,400	5,502	4,896
Crushed Stone Base	m^3	370	34,400	12,728	11,709	4,900	1,813	1,667
Soil Aggregate Shoulder	m^3	105	14,800	1,554	1,383	2,100	220	196
Prime Coat and DBST	m^2	55	194,200	10,681	9,613	27,500	1,513	1,361
Pipe Culvert	m	2,100	1,360	2,856	2,627	1,360	2,856	2,627
Box Culvert	m	16,000	0	0	0	0	0	0
Long Span Bridge	m	80,000	0	0	0	0	0	0
Short Span Bridge	m	40,000	16	640	569	16	640	569
Sub Total (a)				46,617	42,197		25,201	22,716
Miscellaneous Works (a) x 7%				1,865	2,954		1,764	1,590
Total (b)				48,482	45,151		26,965	24,306
PHYSICAL CONTENGENCY (b) x 15%				7,272	6,773		4,045	3,646
ENGINEERING AND ADMINISTRATION (b) x 10%				4,848	4,515		2,697	2,431
Sub Total				12,120	11,288		6,742	6,077
LAND ACQUISITION								
Highly Developed Land	ha	50,000	0	0	0	0	0	0
Less Developed Land	ha	15,000	0	0	0	0	0	0
Sub Total				0	0		0	0
GRAND TOTAL				60,602	56,439		33,707	30,383

CONSTRUCTION QUANTITIES AND COSTS (DEST + Soil Aggregate Surface) (2)

Items	Unit of Q'ty	Financial Unit Rate ฿	Proposed Route Number: IM-4 (1-2) (17.0 km) 1/ Q'ty	IM-4 (1-2) Financial Cost (10^3฿)	IM-4 (1-2) Economic Cost (10^3฿)	IM-4 (2-3) (18.3 km) 2/ Q'ty	IM-4 (2-3) Financial Cost (10^3฿)	IM-4 (2-3) Economic Cost (10^3฿)	IM-4 (T) (35.3 km) 3/ Q'ty	IM-4 (T) Financial Cost (10^3฿)	IM-4 (T) Economic Cost (10^3฿)
DIRECT CONSTRUCTION COST											
Clearing and Grubbing	ha	15,000	39	585	532	44	660	600	83	1,245	1,132
Excavation - Soil	m^3	20	0	0	0	0	0	0	0	0	0
Excavation - Hard Rock	m^3	160	0	0	0	0	0	0	0	0	0
Embankment	m^3	45	69, 00	3,132	2,850	51,000	2,295	2,088	120,600	5,427	4,938
Selected Material	m^3	80	36,000	2,880	2,563	38,800	3,104	2,762	74,800	5,984	5,325
Soil Aggregate Surface or Subbase	m^3	105	25,200	2,646	2,354	27,200	2,856	2,541	52,400	5,502	4,896
Crushed Stone Base	m^3	370	16,600	6,142	5,650	1,500	555	510	18,100	6,697	6,161
Soil Aggregate Shoulder	m^3	105	7,100	745	663	600	63	56	7,700	808	719
Prime Coat and DBST	m^2	55	93,500	5,143	4,629	8,300	457	411	101,800	5,599	5,039
Pipe Culvert	m	2,100	580	1,218	1,120	780	1,638	1,506	1,360	2,856	2,627
Box Culvert	m	16,000	0	0	0	0	0	0	0	0	0
Long Span Bridge	m	80,000	0	0	0	0	0	0	0	0	0
Short Span Bridge	m	40,000	16	640	569	0	0	0	16	640	569
Sub Total (a)				23,132	20,934		11,628	10,478		34,758	31,411
Miscellaneous Works (a) x 7%				1,619	1,465		814	733		2,433	2,199
Total (b)				24,751	22,399		12,442	11,211		37,191	33,610
PHYSICAL CONTENGENCY (b) x 15%				3,713	3,360		1,866	1,682		5,579	5,041
ENGINEERING AND ADMINISTRATION (b) x 10%				2,475	2,249		1,244	1,121		3,719	3,361
Sub Total				6,188	5,600		3,110	2,803		9,298	8,402
LAND ACQUISITION											
Highly Developed Land	ha	50,000	0	0	0	0	0	0	0	0	0
Less Developed Land	ha	15,000	0	0	0	0	0	0	0	0	0
Sub Total				0	0		0	0		0	0
GRAND TOTAL				30,939	27,999		15,552	14,014		46,489	42,012

Note: 1/ = DBST Link

2/ = Soil Aggregate Surface Link

3/ = Total Link

Table 4.6.1 COST AND BENEFITS

(F4 STANDARD)

(1000 BAHT)

YEAR	COST	BENEFITS				DISCOUNTED(12%)	
	CONST. COST	AGRI. BENEFIT	VOC SAVING	RMC SAVING	TOTAL	COST	BENEFIT
1984	0	0	0	0	0	0	0
1985	22,574	0	0	0	0	28,317	0
1986	33,863	0	0	0	0	37,927	0
1987	0	299	2,662	-194	2,767	0	2,471
1988	0	655	2,887	-187	3,354	0	2,674
1989	0	1,010	3,112	-181	3,942	0	2,806
1990	0	1,366	3,337	-174	4,529	0	2,878
1991	0	1,721	3,562	-167	5,116	0	2,903
1992	0	2,077	3,787	-160	5,704	0	2,890
1993	0	2,433	4,012	-153	6,291	0	2,846
1994	17,085	2,800	4,345	-143	7,002	7,728	2,828
1995	0	3,168	4,679	-133	7,713	0	2,781
1996	0	3,535	5,012	-123	8,424	0	2,712
1997	0	3,903	5,346	-113	9,135	0	2,626
1998	0	4,271	5,679	-103	9,846	0	2,527
1999	0	4,638	6,013	-93	10,557	0	2,419
2000	0	5,006	6,346	-84	11,268	0	2,306
2001	-25,962	5,373	6,679	-74	11,979	-4,743	2,189
TOTAL	47,560	42,254	67,459	-2,084	107,629	69,229	39,856

DISCOUNTED ECONOMIC COSTS : 69,229

DISCOUNTED ECONOMIC BENEFITS : 39,856

AGRICULTURAL DEVELOPMENT BENEFIT	14,204
VOC SAVING	26,716
RMC SAVING	-1,064

NET PRESENT VALUE : -29,372

BENEFIT COST RATIO : 0.58

INTERNAL RATE OF RETURN : 6.2 %

Table 4.6.2 COST AND BENEFITS

(F4&F5 COMBINED)

(1000 BAHT)

YEAR	COST	BENEFITS				DISCOUNTED(12%)	
	CONST. COST	AGRI. BENEFIT	VOC SAVING	RMC SAVING	TOTAL	COST	BENEFIT
1984	0	0	0	0	0	0	0
1985	16,804	0	0	0	0	21,079	0
1986	25,208	0	0	0	0	28,233	0
1987	0	299	2,466	-97	2,668	0	2,382
1988	0	655	2,681	-91	3,244	0	2,586
1989	0	1,010	2,895	-85	3,821	0	2,720
1990	0	1,366	3,110	-79	4,397	0	2,795
1991	0	1,721	3,325	-72	4,974	0	2,822
1992	0	2,077	3,539	-66	5,550	0	2,812
1993	0	2,433	3,754	-60	6,127	0	2,771
1994	9,680	2,800	4,073	-51	6,822	4,379	2,755
1995	0	3,168	4,391	-42	7,517	0	2,711
1996	0	3,535	4,710	-33	8,212	0	2,644
1997	0	3,903	5,029	-24	8,907	0	2,561
1998	0	4,271	5,347	-15	9,603	0	2,465
1999	0	4,638	5,666	-6	10,298	0	2,360
2000	0	5,006	5,984	3	10,993	0	2,249
2001	-19,326	5,373	6,303	12	11,688	-3,531	2,135
TOTAL	32,366	42,254	63,273	-706	104,822	50,160	38,768

DISCOUNTED ECONOMIC COSTS : 50,160

DISCOUNTED ECONOMIC BENEFITS : 38,768

AGRICULTURAL DEVELOPMENT BENEFIT	14,204
VOC SAVING	24,991
RMC SAVING	-427

NET PRESENT VALUE : -11,391

BENEFIT COST RATIO : 0.77

INTERNAL RATE OF RETURN : 9.2 %

Table 4.6.3 COST AND BENEFITS

(F4,SECTION 1)

(1000 BAHT)

YEAR	COST	BENEFITS				DISCOUNTED(12%)	
	CONST. COST	AGRI. BENEFIT	VOC SAVING	RMC SAVING	TOTAL	COST	BENEFIT
1984	0	0	0	0	0	0	0
1985	11,199	0	0	0	0	14,048	0
1986	16,800	0	0	0	0	18,816	0
1987	0	144	2,206	-22	2,328	0	2,079
1988	0	315	2,408	-17	2,706	0	2,157
1989	0	487	2,609	-12	3,084	0	2,195
1990	0	658	2,811	-7	3,463	0	2,200
1991	0	829	3,013	-1	3,841	0	2,179
1992	0	1,001	3,214	4	4,219	0	2,137
1993	0	1,172	3,416	9	4,597	0	2,079
1994	8,228	1,349	3,716	16	5,082	3,722	2,052
1995	0	1,526	4,017	24	5,567	0	2,007
1996	0	1,703	4,317	31	6,051	0	1,948
1997	0	1,880	4,618	39	6,536	0	1,879
1998	0	2,057	4,918	46	7,021	0	1,802
1999	0	2,234	5,218	53	7,506	0	1,720
2000	0	2,411	5,519	61	7,990	0	1,635
2001	-12,879	2,588	5,819	68	8,475	-2,353	1,548
TOTAL	23,348	20,354	57,819	292	78,465	34,233	29,620

DISCOUNTED ECONOMIC COSTS :	34,233
DISCOUNTED ECONOMIC BENEFITS :	29,620
AGRICULTURAL DEVELOPMENT BENEFIT	6,842
VOC SAVING	22,733
RMC SAVING	45
NET PRESENT VALUE :	-4,613
BENEFIT COST RATIO :	0.87
INTERNAL RATE OF RETURN :	10.3 %

Table 4.6.4 COST AND BENEFITS

(F5 STANDARD)

(1000 BAHT)

YEAR	COST	BENEFITS				DISCOUNTED(12%)	
	CONST. COST	AGRI. BENEFIT	VOC SAVING	RMC SAVING	TOTAL	COST	BENEFIT
1984	0	0	0	0	0	0	0
1985	12,153	0	0	0	0	15,245	0
1986	18,230	0	0	0	0	20,418	0
1987	0	299	1,023	-67	1,255	0	1,121
1988	0	655	1,181	-64	1,772	0	1,413
1989	0	1,010	1,340	-61	2,289	0	1,629
1990	0	1,366	1,498	-58	2,806	0	1,783
1991	0	1,721	1,657	-55	3,322	0	1,885
1992	0	2,077	1,815	-53	3,839	0	1,945
1993	0	2,433	1,973	-50	4,356	0	1,970
1994	1,210	2,800	2,212	-46	4,966	547	2,006
1995	0	3,168	2,451	-42	5,577	0	2,011
1996	0	3,535	2,690	-38	6,187	0	1,992
1997	0	3,903	2,928	-34	6,797	0	1,954
1998	0	4,271	3,167	-30	7,408	0	1,901
1999	0	4,638	3,406	-26	8,018	0	1,838
2000	0	5,006	3,645	-22	8,628	0	1,766
2001	-13,976	5,373	3,883	-18	9,239	-2,553	1,688
TOTAL	17,617	42,254	34,869	-663	76,460	33,656	26,902

DISCOUNTED ECONOMIC COSTS :	33,656
DISCOUNTED ECONOMIC BENEFITS :	26,902
AGRICULTURAL DEVELOPMENT BENEFIT	14,204
VOC SAVING	13,047
RMC SAVING	-349
NET PRESENT VALUE :	-6,755
BENEFIT COST RATIO :	0.80
INTERNAL RATE OF RETURN :	9.6 %

Table 4.7.1 SOCIAL INDICATORS

(Proposed Route IM-4)

Population (1,000)		
1982	:	25.5
1993	:	29.3
Average travelling speed, without (kph)	:	44
Isolation		
Access to Amphoe		
Average distance to Amphoe (km) 1/	:	6.5
Per capita time savings (10^{-4})	:	0.020
Score	:	59
Access to Artery Highway		
Average distance to highway (km) 1/	:	17
Per capita time savings (10^{-4})	:	0.051
Score	:	111
Impassability		
Impassable week a year	:	2
Impassability per year	:	0.038
Impassability per capita (10^{-4})	:	0.013
Score	:	108
Health		
Access to Hospital		
Average distance to Hospital (km) 1/	:	18.0
Per capita time savings (10^{-4})	:	0.054
Score	:	126
Access to Medical Facilities		
Average distance to facilities (km) 1/	:	3.6
Per capita time savings (10^{-4})	:	0.011
Score	:	44
Education		
Access to Secondary School		
Number of Student in 1993 (1,000) 2/	:	5.3
Average distance to school (km)	:	12.5
Per capita time savings (10^{-4})	:	0.208
Score	:	112
Teacher Intensity		
Number of teachers 3/		
University graduate	:	-
Total	:	8
Number of Student	:	183
Indicators		
E1 4/	:	-
E2 5/	:	43.7
E 6/	:	43.7
Degree of Improvement 7/	:	1.57
Score	:	100
Disparity		
G.P.V. in 1993 (Mn B) 8/		
With project	:	119.1
Without project	:	114.1
Per capita G.P.V. in 1993 (B)		
With project (W)	:	4,065
Without project (w)	:	3,894
Degree of Disparity		
(A/W) - (A/w) 9/	:	0
Score	:	0
Total Score	:	660

Note:

1/ ( ) shows the length or distance in without project case. Unless otherwise, lengthes are same both in with project case and without project case.

2/ Number of secondary school student estimated based on the projected population of the areas of influence applying ratios of secondary school students to the total population in the sample area.

3/ Numbers of the sample areas

4/ (Number of University Graduate Teachers)/(Total Number of Student) x 1,000

5/ (Total of Teachers)/(Total Number of Student) x 1,000

6/ Sum of 4/ and 5/

7/ Ratio of E value of each route to an average value of the same indicator E in case of the sample areas, 33 in number, along paved road near the proposed routes.
The average value of E in case of paved roads were calculated at 68.4 from the following data:

Number of university graduate teachers	438
Number of Teachers	1,285
Number of student	25,196

8/ Estimated gross value of crop production in the areas of influence

9/ "A" indicates an average per capita value of crop production in the Northeastern Region, which is estimated assuming that:
- GRP per capita of the Northeast is estimated at 11,897 Baht in 1993,
- Agricultural sector shares 40% of GRP, and
- Crop production shares 80% of agricultural production.

PROPOSED ROUTE NO. IM-5

Changwat : Khon Kaen

A. Nam Phong (J.R.2039) -J.R. 209

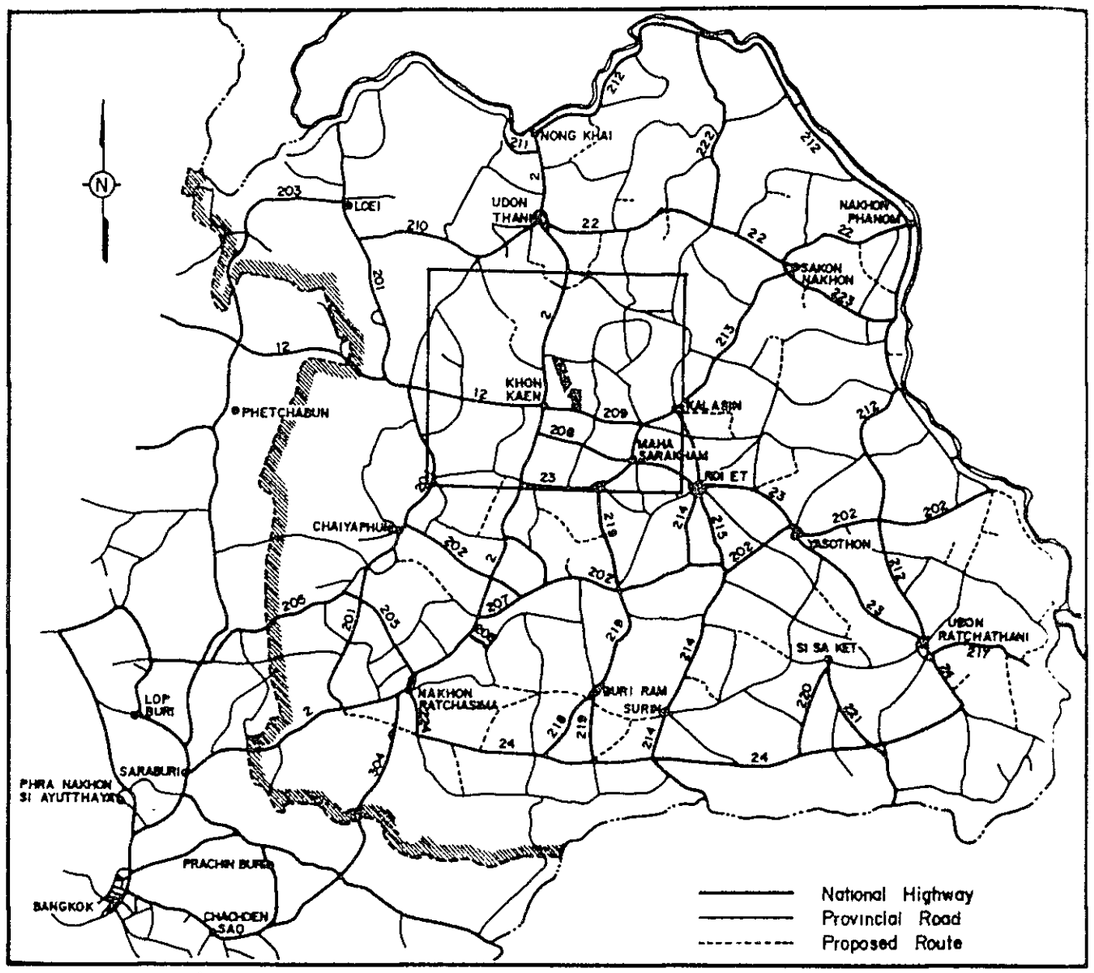
Length : 29.1 KM.

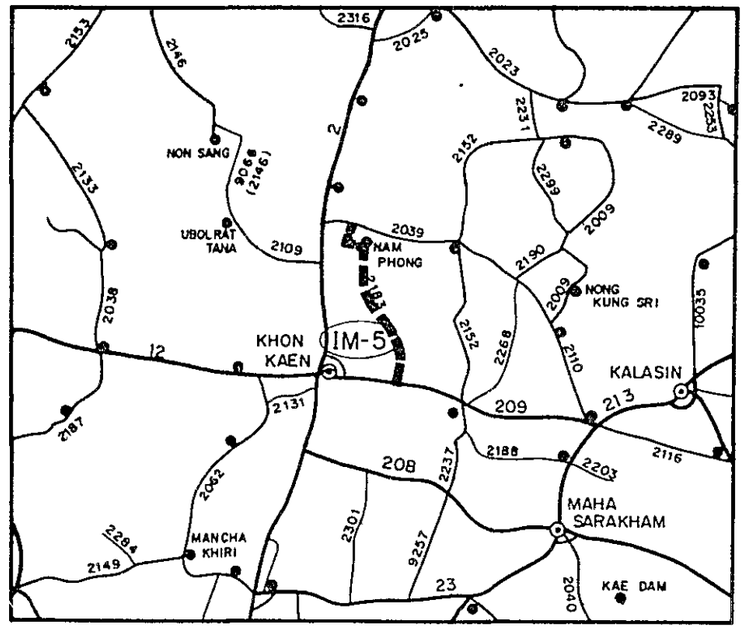
SUMMARY

PROPOSED ROUTE IM- 5

Item	Description	
Changwat	Khon Kaen	
Origin	A Nam Phong (J.R. 2039)	
Destination	J.R. 209	
Length		
Total		29.1 km
Improvement Section		29.1 km
DOH Road	R.2183	23.1 km
ARD Road		6.0 km
Others		0 km
New Alignment Section		0 km
Surface Type and Condition	Soil Aggregate, Good	
Terrain	Flat and Rolling	
Influence Area		
Area		173 km^2
Population (1982)		27,200
Principal Crops		Paddy
Traffic (ADT)		
Existing		299
1993		1,055
2001		1,426
Proposed Standard	F4 (DBST)	
Construction Cost		
Financial		61,472 . 10^3 ฿
Economic		55,565 . 10^3 ฿
IRR		20.0 %
B/C		1.76
Recommendation	For further consideration	

LOCATION OF PROPOSED ROUTE





1. GENERAL

1.1 Characteristics of the Route

The proposed route is located in the northeast part of Changwat Khon Kaen. The route originating at Amphoe Nam Phong on Route 2039 runs northward passing through Ban Hong Saeng, Ban Bung Peng and Ban Nong Tum and ends at the intersection with Route 209. Its total length is 29.1 km (Figure 5.5.2). The terrain is almost flat and rolling. In the influence area, there exists several villages with total population of 27,200. There are two medical centers and two secondary schools, but no hospital along the proposed route. The proposed route, upon completion, will form an important part of road network on the right bank of the Phong River to connect two artery highways, Route 2039 and 209 in the developed agricultural area.

1.2 Condition of Existing Road

Condition of existing roads to be utilized for the proposed route is summarized in Table 5.1.1. The details are shown as the results of inventory survey in Table 5.1.2.

2. TRAFFIC

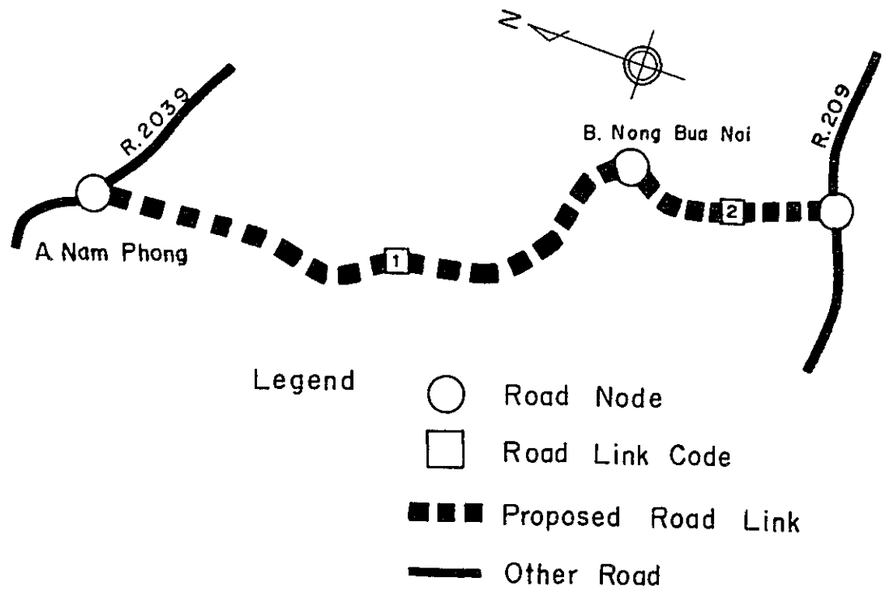
2.1 Method

Growth Rate Method was employed for traffic forecasting as no diverted traffic is expected after improvement of the proposed road.

2.2 Base Year Traffic

The base year traffic by road link by vehicle type was estimated referring to the DOHs traffic records and manual classified count as shown below:

Proposed Road Link



Traffic Volume in Base Year

Source (Base year)	Link No	Vehicle Type									
		P/C	P/P	L/B	M/B	H/B	P/T	4/T	6/T	10/T	ADT
DOH (1981)	1 /1	25	46	25	30	9	8	22	61	22	248
	2	N.A.									
Manual Counts (1982)	1	N.A.									
	2	17	139	20	123	1	16	93	77	8	494
Estimated	1	25	46	25	30	9	8	22	61	22	248
	2	17	139	20	123	1	16	93	77	8	494

Note: /1 Route 2183, Station 0100, Station km 24 + 200

2.3 Transport Movement

Passenger movement in terms of trips per day and freight movement in terms of tonnage per day on the proposed road links were estimated multiplying traffic volume in base year by the occupancy or average load obtained from roadside interview, as shown below:

PASSENGER MOVEMENT (1982)

PROPOSED ROAD LINK	TRIPS PER DAY
1	1661
2	3442

FREIGHT MOVEMENT (1982)

PROPOSED ROAD LINK	TONAGE PER DAY		
	NON-AGRI.	AGRI.	TOTAL
1	277	88	365
2	239	76	314

2.4 Future Growth of Transport Movement

The growth rate of passenger and freight movements for the periods of 1981 - 1987, 1987 - 1993 and 1993 - 2001 were predicted by the formula described in 7.3.3-2) of the Main Report. The basis for the prediction is shown in the following tables:

GROWTH RATE OF PASSENGER MOVEMENT

ITEM	GROWTH RATE (% P.A.)		
	1981 - 1987	1987 - 1993	1993 - 2001
PER CAPITA INCOME	4.2	4.5	4.7
TRANS. PRICE INCREASE	4.5	4.5	4.5
POPULATION	2.4	2.0	1.7
PASSENGER MOVEMENT	6.4	6.4	6.3

GROWTH RATE OF FREIGHT MOVEMENT

ITEM	GROWTH RATE (% P.A.)		
	1981 - 1987	1987 - 1993	1993 - 2001
NON-AGRI.	8.2	8.2	8.2
AGRICULTURE	0.5	0.1	0.1
FREIGHT	6.4	6.2	6.2

2.5 Induced and Developed Traffic

The following ratios are used for the estimation of induced and developed traffic described in 7.3.3-3) of the Main Report:

RATE OF INDUCED AND DEVELOPED TRAFFIC

(%)

ITEM	YEAR		
	1987	1993	2001
INDUCED	15.0	15.0	15.0
DEVELOPED	0.0	0.0	0.0

2.6 Future Traffic

1) Traffic Composition

The movements of passenger and freight transport were transformed into traffic volume by vehicle type applying future traffic composition as shown in the following table:

TRAFFIC COMPOSITION

(UNIT : %)

LINK NO.	YEAR	PASSENGER					FREIGHT			
		P/C	P/P	L/B	M/B	H/B	P/T	4/T	6/T	10/T
1	1982	18.5	34.1	18.5	22.2	6.7	7.1	19.5	54.0	19.5
	1987	16.9	35.7	18.1	21.9	7.4	10.1	18.4	48.3	23.2
	1993	15.3	37.3	17.7	21.5	8.2	13.0	17.4	42.6	27.0
	2001	13.1	39.4	17.1	21.1	9.2	17.0	16.0	35.0	32.0
2	1982	5.7	46.3	6.7	41.0	0.3	8.2	47.9	39.7	4.1
	1987	7.6	44.4	9.5	35.8	2.7	10.6	39.5	38.5	11.5
	1993	9.9	42.1	12.8	29.6	5.5	13.3	29.4	37.0	20.3
	2001	13.0	39.0	17.3	21.3	9.3	17.0	16.0	35.0	32.0

2) Forecasted ADT

The average of the forecasted traffic on proposed road links is shown in the following table and details by road link by traffic type are shown in Table 5.2.1.

AVERAGE FUTURE TRAFFIC ON PROPOSED ROUTE

YEAR	TYPE OF VEHICLE								ADT	M/C	TOTAL
	P/C	L/B	M/B	H/B	P/P&T	4/T	6/T	10/T			
1987	37	41	72	16	123	44	85	38	455	384	840
1993	51	61	93	28	180	48	99	61	622	432	1055
2001	80	105	129	57	299	55	121	111	957	469	1426

3. AGRICULTURAL DEVELOPMENT

3.1 Present Condition

Almost all cultivated land is covered by paddy field, as the area of influence extends along the Chi River basin. There is very few upland crop fields. The area of influence is fully developed and unused cultivated land are very few. In Amphoe Nam Phong, there is a large sugar factory of 8,000 ton/day capacity and the absorptive capacity of sugar cane amounts nearly 1.4 million ton per year. For this reason, sugar cane ranks first in the upland field followed by cassava, kenaf, beans and groundnuts.

Land use and capability conditions in the area of influence are shown in Table 5.3.1. and Figure 5.3.1. Typical cropping calendar in Khon Kaen area is shown in Figure 5.3.2.

3.2 Development Projection

Future agricultural development in the area of influence was projected for both cases of without project and with project. The projected planted area, unit yields by crop, and the consequent production volumes are shown in Table 5.3.2.

Farmgate prices and production costs of the selected crops are estimated as follows, referring to the Changwat data and field survey information as shown in Table 5.3.3.

Based on the above projected production volume, farmgate prices, production costs and land preparation cost estimated separately, net production value (NPV) was obtained as shown in Table 5.3.4. The difference between NPV of with project case and NPV of without project case is deemed to be the development benefit of the subject road

4. VOC SAVINGS

In accordance with the concept and basic data given in Chapter 7 of Vol. 1 Main Report, VOCs on each road link concerned were calculated in both cases of with project and without project.

Elements of road condition, which affect the calculation of additional costs of VOC of each link, are shown below.

Road Condition

Link No.	Terrain	Without Project: Length (km)	Without Project: /1 Road Class	Without Project: Nos. of Wooden Bridge	Without Project: Nos. of Narrow C.Bridge	With Project: Length (km)	With Project: Road Class	With Project: /1 Class	With Project: Nos. of Wooden Narrow	With Project: Bridge
1	Flat	23.1	2B	8	2	23.1	1 (F4)		0	
2	Flat	6.0	2B	0	1	6.0			0	

/1;

Road 1: Paved Road

Road 2A: Laterite Road with good surface condition and alignment

Road 2B: Laterite Road with good surface condition but poor alignment

Road 3: Laterite Road with poor surface condition and alignment

Road 4: Earth Road

VOC savings, obtained from the difference of total link VOCs in the cases of with project and those of without project case, were calculated as follows.

Vehicle Operating Cost Saving

(unit: 1,000 Baht)

Road Class	1987	1993	2001
1 (F4)	10,487	16,188	28,131

5. ENGINEERING

5.1 Preliminary Design

Preliminary design was carried out based on the following design criteria.

Design Standard : F4 (feasible)

Geometric Design : AASHTO (Rural Highways)

Typical Cross Section : as shown in Figure 5.5.1

Minimum Height of Embankment

Ordinary Section : 1.0m

Approach of Bridge in Flat Area : 2.0m

Flood Section : 0.7m (above flood level)

Pavement Structure

In case of F4 Standard

DBST : 2.5cm

Crushed Stone Base CBR≥80% : 15.0cm

Soil Aggregate Subbase CBR≥20% : 15.0cm

Selected Material CBR≥ 6% : 20.0cm

Pipe Culvert

Standard Size : ø 100cm

Standard Interval

Paddy Area : 200 m

Others : 500 m

Box Culvert

Standard Size : 2.4m x 2.4m

Location : as required

Bridge

Standard Type (width 7.0m)

Short Span Bridge : RC - Slab

Long Span Bridge : PC - Girder

Location : as shown in Bridge List in Figure 5.5.2.

Alignment of the route is shown in Figure 5.5.2.

5.2 Work Quantity and Construction Cost

Work quantities based on the preliminary design and construction cost together with unit rate by work item are shown in Table 5.5.1.

Total financial and economic construction costs by applied road class are as given below:

F4 Standard (DBST) L = 29.1 km

Financial Cost 61,472 . 10^3 ฿

Economic Cost 55,565 . 10^3 ฿

6. ECONOMIC EVALUATION

Yearly distribution of the economic costs and benefits, and the calculated economic indicators for evaluation are given in Table 5.6.1.

The result indicates that the proposed project seems to be feasible under F4 Standard (DBST).

7. SOCIAL IMPACTS

Detailed data and results of quantification of indicators of social impacts are tabulated in Table 5.7.1.

Table 5.1.1 SUMMARY OF ROAD INVENTORY

Item	Description		
Origin	A. Nam Phong (J.R. 2039)		
Destination	J.R. 209		
Length			
Total		29.1	km
Improvement Section		29.1	km
DOH Road		23.1	km
ARD Road		6.0	km
Others		0	km
New Alignment Section		0	km
Terrain	Flat and Rolling		
Alignment (Hori./Vert.)	Fair / Fair		
Formation Width	6.0 m - 10.0m, 6.9 m (Weighted average)		
Embankment Section			
Length		29.1	km
Height	0.2 m - m		
Cut Section			
Length		0	km
Depth	m - m		
Surface Type and Condition			
SBST or DBST	Good	4.1	km
Soil Aggregate	Good	25.0	km
Earth		0	km
Pipe Culvert	36 each		
Box Culvert	2 each	31.5	m
Bridge			
Permanent Bridge	1 each	30.0	m
Narrow Concrete Bridge	1 each	22.0	m (4m)
Wooden Bridge	10 each	109.0	m
Overflow Section	0 place	0	km

Table 5.1.2 ROAD INVENTORY

PROPOSED ROUTE NO. IM-5 ROUTE NO. 2183 ARD

A. NAM PHONG (J.R. 2039) ~ J.R. 209

KHON KAEN

L = 29.1 km

STATION (Km)		0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
VILLAGE - Name - Household (H) - Population (P)		B. NONG NOK KUIEN H = 82 P = 240; B. NA YOM H = 40 P = 350; B. NONG SAENG H = 88 P = 700; B. THA KRA SOEM H = 200 P = 2000; B. KUT PHANG KHUT H = 120 P = 960; B. THA MADUA H = 239 P = 1307; B. KHOK THA H = 174 P = 870; B. NONG TUM H = 280 P = 2800; B. NONG NGU LUAM H = 160 P = 960; B. NONG BUA NOI H = 216 P = 2200; B. KHOK SI H = 280 P = 1400
TERRAIN		Rolling | Flat | Rolling | Flat | Rolling
CROSS SECTION	Formation Width (m)	6.50 | 6.00 | 6.50 | 7.00 | 6.00 | 5.50 | 6.00 | 7.00 | 6.00 | 8.00 | 10.00 | 6.00 | 10.00 | 8.60
	Embankment Height (m)	0.20
	Cutting Depth (m)	
PAVEMENT	Type/Length	DT | Laterite | DT | Laterite | DT | Laterite | DT | Laterite
	Condition	Good
FLOODING	Overflow Length(Km)/Height(m)	
LAND USE	Left	Bush | Paddy
	Right	Bush | Paddy
PIPE CULVERT	Total Number	36 Pipes
BOX CULVERT & BRIDGE	Station (Km)	3.8 4.1 4.6 6.4 7.2 9.8 11.0 11.8 13.0 17.3 17.9 20.7 23.2 29.0
	Dimension	C-Br. 8.50 x 30.00; W-Br. 4.50 x 10.00; C-Box 2.50 x 2.00 x 12.50; W-Br. 4.50 x 10.00; W-Br. 4.50 x 10.00; W-Br. 4.50 x 10.00; W-Br. 4.00 x 9.00; W-Br. 4.50 x 6.50; C-Box 3-3.30 x 3.00 x 19.00; W-Br. 4.00 x 15.50; W-Br. 4.00 x 30.00; W-Br. 4.00 x 4.00; W-Br. 4.00 x 4.00; C-Br. 3.50 x 22.00
RIGHT OF WAY (m)		20.0
ALIGNMENT	Horizontal	Fair
	Vertical	Fair
ROUTE NO., AGENCIES		DOH 2183 | ARD

Table 5.2.1 TRAFFIC VOLUME ON ROUTE IM - 5

YEAR		1987			1993			2001		
LINK		1	2	AVR.	1	2	AVR.	1	2	AVR.
P/C	N+D	32	30	32	42	56	45	57	117	70
	I	5	5	5	6	8	7	9	17	10
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	37	35	37	48	64	51	66	134	80
L/B	N+D	35	38	35	48	73	53	75	155	91
	I	5	6	5	7	11	8	11	23	14
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	40	44	41	55	84	61	86	179	105
M/B	N+D	42	143	63	59	168	81	92	191	112
	I	6	22	9	9	25	12	14	29	17
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	48	165	72	67	193	93	106	220	129
H/B	N+D	14	11	13	22	31	24	40	84	49
	I	2	2	2	3	5	4	6	13	7
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	16	12	16	26	36	28	46	96	57
P/P&T	N+D	83	199	107	128	267	157	225	395	260
	I	13	30	16	19	40	24	34	59	39
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	96	228	123	148	307	180	259	454	299
4/T	N+D	28	78	38	36	64	42	50	43	48
	I	4	12	6	5	10	6	7	6	7
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	32	89	44	41	73	48	57	49	55
6/T	N+D	74	76	74	88	80	86	108	94	105
	I	11	11	11	13	12	13	16	14	16
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	85	87	85	101	92	99	125	108	121
10/T	N+D	36	23	33	56	44	53	99	85	96
	I	5	3	5	8	7	8	15	13	14
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	41	26	38	64	50	61	114	98	111
ADT	N+D	344	597	396	479	782	541	746	1163	832
	I	52	90	59	72	117	81	112	175	125
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	395	686	455	550	899	622	858	1338	957
M/C	N+D	341	439	361	397	472	413	457	474	461
	I	24	19	23	22	9	19	10	0	8
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	365	458	384	419	482	432	467	474	469
TOTAL	N+D	685	1036	757	876	1254	954	1204	1638	1293
	I	76	108	82	94	127	100	122	175	133
	DV	0	0	0	0	0	0	0	0	0
	TOTAL	760	1144	840	970	1381	1055	1325	1812	1426

NOTE
N : NORMAL TRAFFIC D : DIVERTED TRAFFIC
DV : DEVELOPED TRAFFIC I : INDUCED TRAFFIC

Figure 5.3.1 LAND USE AND CAPABILITY OF INFLUENCE AREA

PROPOSED ROUTE NO. IM – 5

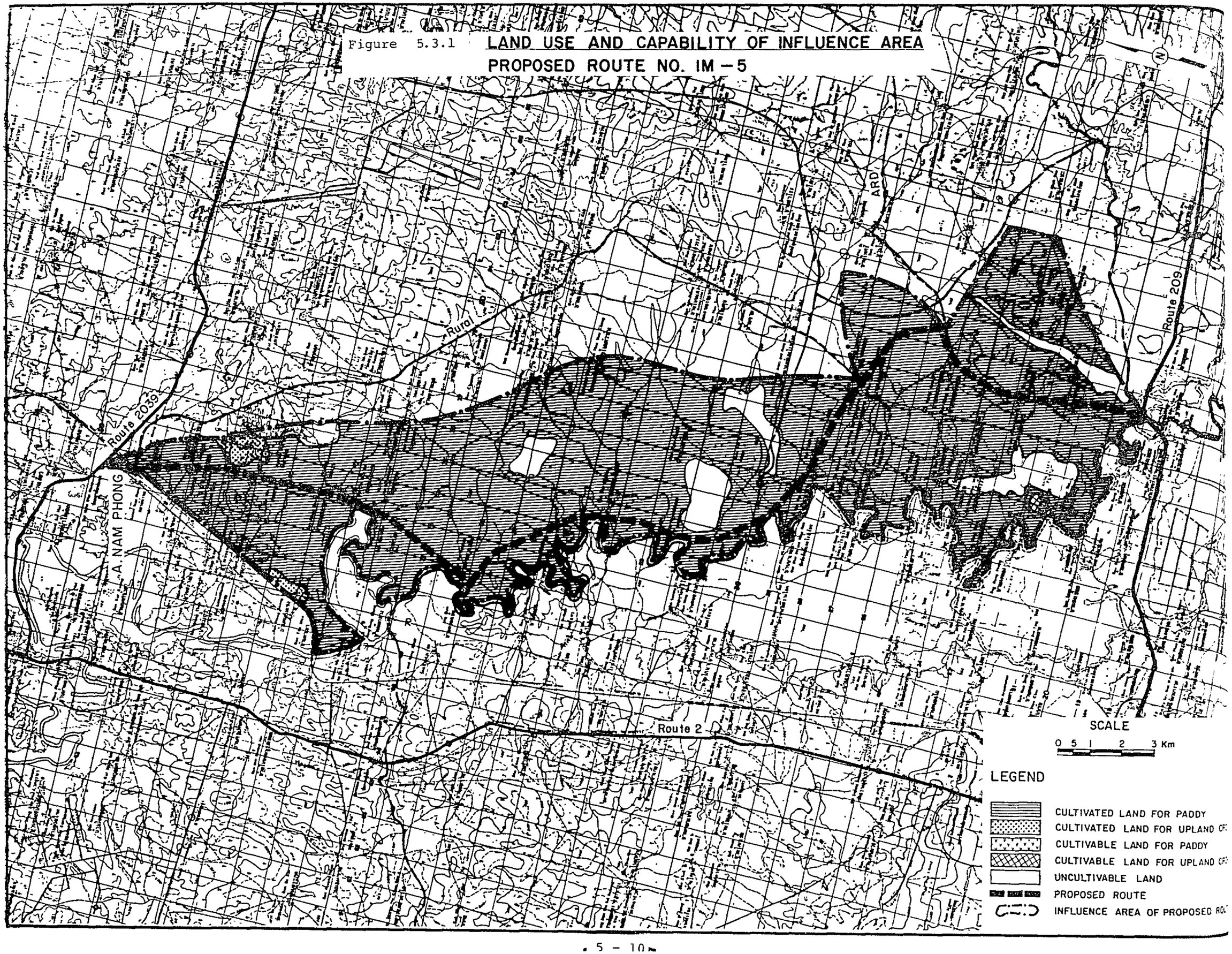


Figure 5.3.2 CROPPING CALENDAR

0600 CHANGWAT KHON KAEN

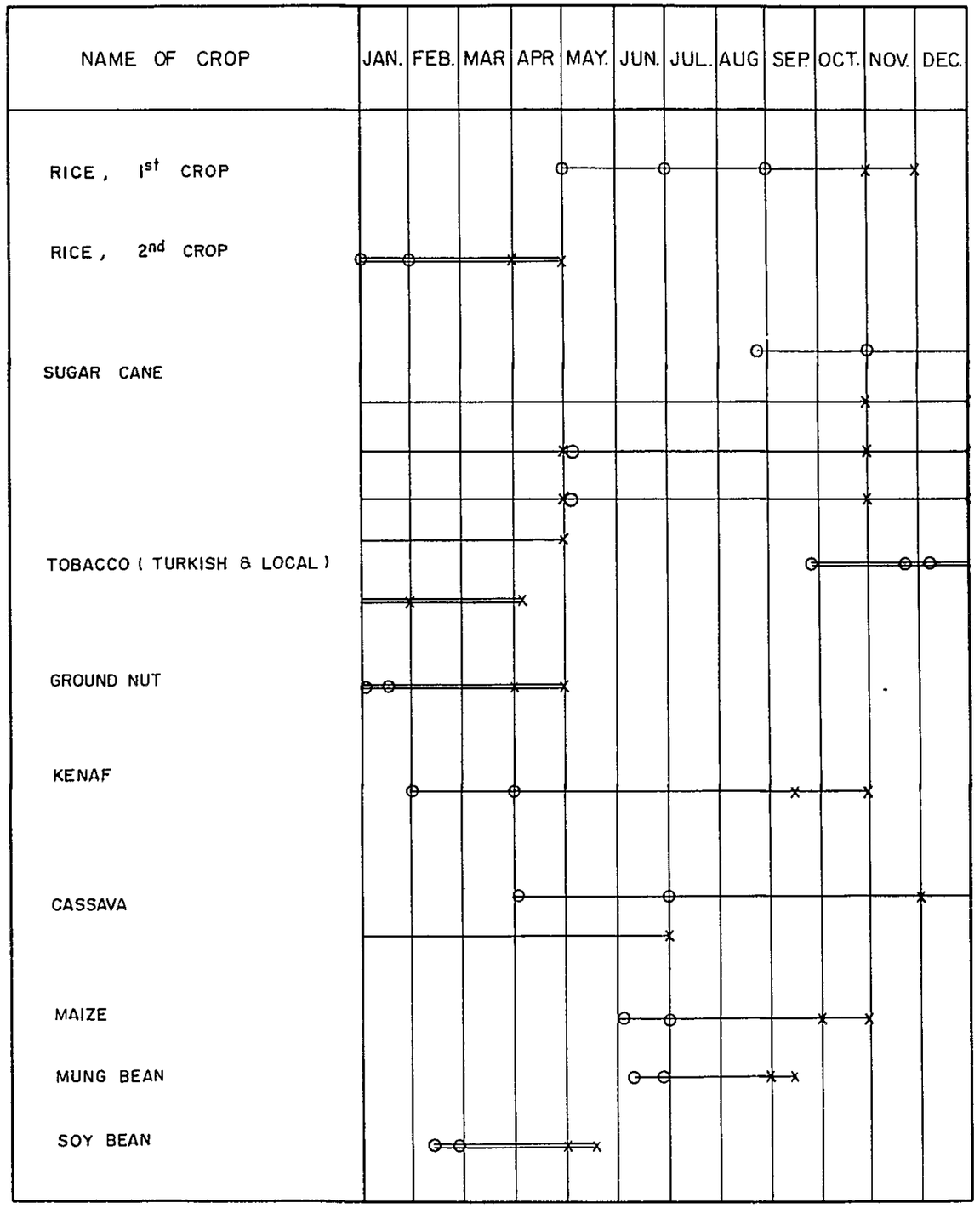


TABLE 5.3.1 CULTIVATED & CULTIVABLE LAND

(1979)

[UNIT : 1000 RAI (KM^2)]

AMPHOE CODE	AMPHOE NAME	CULTIVATED LAND			UNUSED CULTIVABLE LAND		
		PADDY	UPLAND	TOTAL	PADDY	UPLAND	TOTAL
		98.750 (158.0)	0.938 (1.5)	99.688 (159.5)	0.250 (0.4)	-	0.250 (0.4)
0601	M. KHON KAEN	40.000 (64.0)	-	40.000 (64.0)	0.250 (0.4)	-	0.250 (0.4)
0609	NAM PHONG	56.250 (90.0)	0.938 (1.5)	57.188 (91.5)	-	-	-
0610	KRANUAN	2.500 (4.0)	-	2.500 (4.0)	-	-	-

TABLE 5.3.2 CROP PRODUCTION

ITEM		PADDY	MAIZE	BEANS	GRUND NUTS	CASSAVA	SUGAR CANE	KENAF	COTTON	UPLAND TOTAL	TOTAL
PLANTED AREA (1000 RAI)											
1981		77.47	-	-	-	0.38	0.48	0.07	-	0.94	78.41
1987		79.44	-	-	-	0.40	0.46	0.06	-	0.94	80.37
1993	WITHOUT PROJECT	79.44	-	-	-	0.43	0.44	0.06	-	0.94	80.37
	WITH PROJECT	79.44	-	-	-	0.42	0.45	0.06	-	0.94	80.37
2001	WITHOUT PROJECT	79.44	-	-	-	0.46	0.42	0.06	-	0.94	80.37
	WITH PROJECT	79.44	-	-	-	0.45	0.43	0.05	-	0.94	80.37
CROP YIELD (KG/RAI)											
1981		266.3	-	-	-	2000.0	7117.5	176.0	-		
1987		269.5	-	-	-	2000.0	7160.3	176.0	-		
1993	WITHOUT PROJECT	272.8	-	-	-	2000.0	7203.4	176.0	-		
	WITH PROJECT	276.1	-	-	-	2012.0	7246.7	176.0	-		
2001	WITHOUT PROJECT	277.2	-	-	-	2000.0	7261.2	176.0	-		
	WITH PROJECT	285.0	-	-	-	2028.2	7363.4	176.0	-		
CROP PRODUCTION (TON)											
1981		20,630	-	-	-	757	3,415	12	-	4,185	24,816
1987		21,410	-	-	-	805	3,300	11	-	4,118	25,528
1993	WITHOUT PROJECT	21,668	-	-	-	852	3,180	11	-	4,045	25,712
	WITH PROJECT	21,929	-	-	-	844	3,284	10	-	4,140	26,068
2001	WITHOUT PROJECT	22,017	-	-	-	917	3,014	10	-	3,942	25,959
	WITH PROJECT	22,640	-	-	-	916	3,140	9	-	4,066	26,707

NOTE : SYMBOL "-" MEANS ZERO OR NEGLIGIBLE SMALL

TABLE 5.3.3 FARMGATE PRICE AND PRODUCTION COST

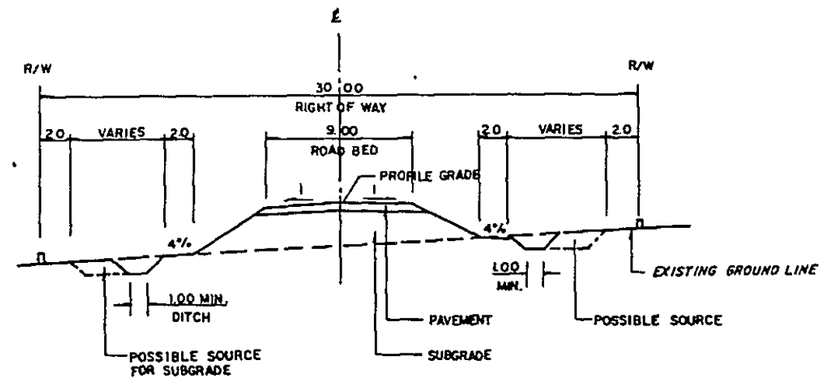
ITEM	PADDY	MAIZE	BEANS	GRUND NUTS	CASSAVA	SUGAR CANE	KENAF	COTTON
FARMGATE PRICE (BAHT/TON)								
WITHOUT PROJECT (1981 - 2001)	3,587	-	-	-	608	652	4,625	-
WITH PROJECT (1987 - 2001)	3,677	-	-	-	623	652	4,741	-
CROP PRODUCTION COST (BAHT/RAI)								
WITHOUT PROJECT (1981 - 2001)	599	-	-	-	724	2,879	745	-
WITH PROJECT (1987 - 2001)	619	-	-	-	744	2,904	745	-

TABLE 5.3.4 NET PRODUCTION VALUE

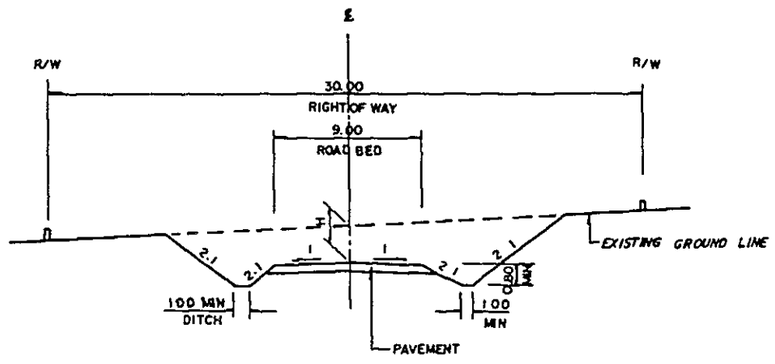
(1000 BAHT)

YEAR	WITHOUT PROJECT			WITH PROJECT		
	PADDY	UPLAND	TOTAL	PADDY	UPLAND	TOTAL
1987	29,214	1,030	30,244	29,551	1,024	30,575
1993	30,140	1,019	31,159	31,460	1,047	32,507
2001	31,392	1,002	32,394	34,076	1,051	35,127

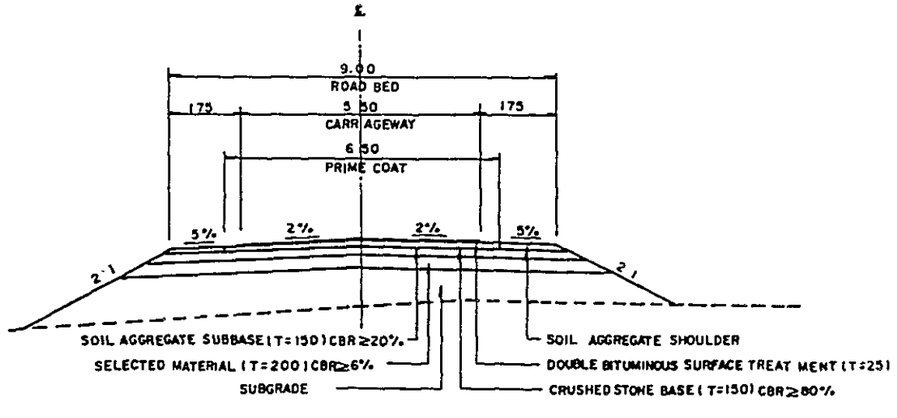
Figure 5. 5. 1 TYPICAL CROSS SECTION AND TYPICAL PAVEMENT STRUCTURE



FILL SECTION

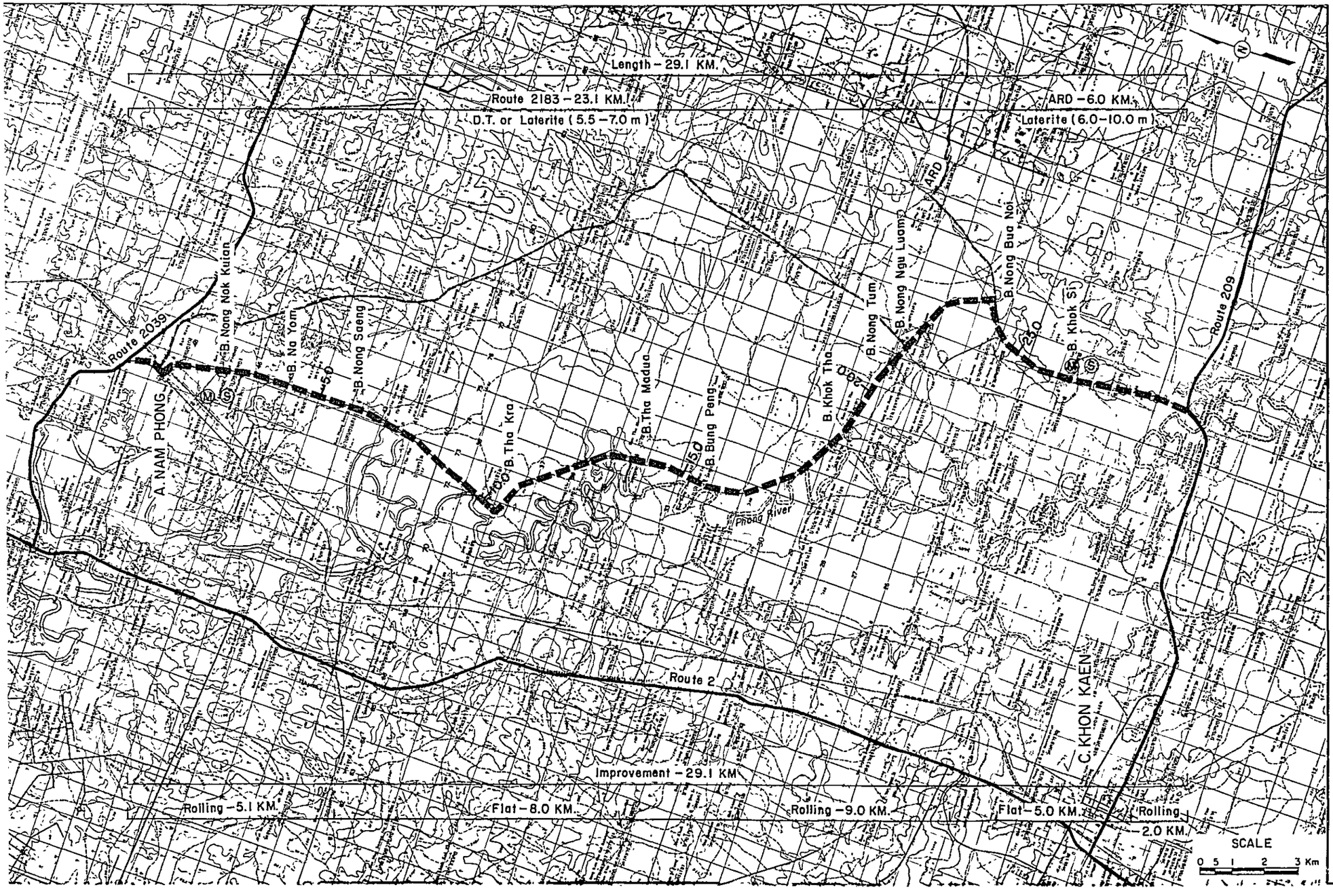


CUT SECTION

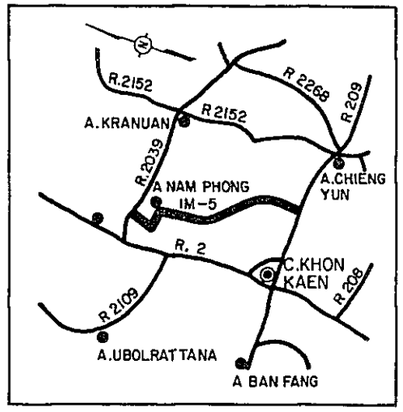


DOUBLE BITUMINOUS SURFACE TREATMENT (DBST) ROAD (Class F4)

Figure 5.5.2 PROPOSED ROUTE NO. IM – 5 C.KHON KAEN A.NAM PHONG (J.R. 2039) – J.R. 209
ROUTE NO. 2183 + ARD L = 29.1 Km.



LOCATION MAP



BRIDGE LIST

No.	Station Km.	Proposed Bridge	Existing Bridge
1	3.8	—	C – 8.50 x 30.00
2	4.1	C – 7.00 x 12.00	W – 4.50 x 10.00
3	6.4	C – 7.00 x 12.00	W – 4.50 x 10.00
4	7.2	C – 7.00 x 12.00	W – 4.50 x 10.00
5	9.8	C – 7.00 x 12.00	W – 4.50 x 10.00
6	11.0	C – 7.00 x 12.00	W – 4.00 x 9.00
7	11.8	C – 7.00 x 9.00	W – 4.50 x 6.50
8	17.3	C – 7.00 x 18.00	W – 4.00 x 15.50
9	17.9	C – 7.00 x 32.00	W – 4.00 x 30.00
10	20.7	(BOX CULVERT)	W – 4.00 x 4.00
11	23.2	(BOX CULVERT)	W – 4.00 x 4.00
12	29.0	C – 7.00 x 22.00	C – 3.50 x 22.00

LEGEND

- PROPOSED ROUTE (IMPROVEMENT)
- PROPOSED ROUTE (NEW CONSTRUCTION)
- PAVED ROUTE
- UNPAVED ROUTE
- INVENTORY SURVEY ROUTE
- (H) HOSPITAL
- (M) MEDICAL CENTER
- (S) SECONDARY SCHOOL

Table 5.5.1 CONSTRUCTION QUANTITIES AND COSTS IM-5 (29.1 km)

Items	Unit of Q'ty	Financial Unit Rate ฿	(DBST) Q'ty	(DBST) Financial Cost (10^3฿)	(DBST) Economic Cost (10^3฿)
DIRECT CONSTRUCTION COST					
Clearing and Grubbing	ha	15,000	67	1,005	914
Excavation - Soil	m^3	20	0	0	0
Excavation - Hard Rock	m^3	160	0	0	0
Embankment	m^3	45	132,140	5,946	5,411
Selected Material	m^3	80	61,700	4,936	4,393
Soil Aggregate Surface or Subbase	m^3	105	43,200	4,536	4,037
Crushed Stone Base	m^3	370	28,400	10,508	9,667
Soil Aggregate Shoulder	m^3	105	12,200	1,281	1,140
Prime Coat and DBST	m^2	55	160,000	8,800	7,920
Pipe Culvert	m	2,100	1,090	2,289	2,105
Box Culvert	m	16,000	0	0	0
Long Span Bridge	m	80,000	0	0	0
Short Span Bridge	m	40,000	141	5,640	5,019
Sub Total (a)				45,773	41,357
Miscellaneous Works (a) x 7%				3,204	2,895
Total (b)				48,977	44,252
PHYSICAL CONTENGENCY (b) x 15%				7,347	6,638
ENGINEERING AND ADMINISTRATION (b) x 10%				4,898	4,425
Sub Total				12,245	11,063
LAND ACQUISITION					
Highly Developed Land	ha	50,000	5	250	250
Less Developed Land	ha	15,000	0	0	0
Sub Total				250	250
GRAND TOTAL				61,472	55,565

Table 5.6.1 COST AND BENEFITS

(F4 STANDARD)

(1000 BAHT)

	COST	BENEFITS				DISCOUNTED(12%)	
YEAR	CONST. COST	AGRI. BENEFIT	VOC SAVING	RMC SAVING	TOTAL	COST	BENEFIT
1984	0	0	0	0	0	0	0
1985	22,226	0	0	0	0	27,880	0
1986	33,339	0	0	0	0	37,340	0
1987	0	331	10,487	85	10,903	0	9,735
1988	0	501	11,437	106	12,044	0	9,601
1989	0	670	12,387	127	13,185	0	9,385
1990	0	840	13,337	148	14,325	0	9,104
1991	0	1,009	14,288	169	15,466	0	8,776
1992	0	1,179	15,238	190	16,607	0	8,413
1993	0	1,348	16,188	211	17,747	0	8,028
1994	14,084	1,521	17,681	244	19,446	6,371	7,854
1995	0	1,694	19,174	276	21,144	0	7,625
1996	0	1,867	20,667	309	22,843	0	7,355
1997	0	2,041	22,159	341	24,541	0	7,055
1998	0	2,214	23,652	374	26,240	0	6,735
1999	0	2,387	25,145	406	27,938	0	6,403
2000	0	2,560	26,638	439	29,636	0	6,064
2001	-25,695	2,733	28,131	471	31,335	-4,694	5,725
TOTAL	43,954	22,893	276,609	3,898	303,400	66,896	117,857

DISCOUNTED ECONOMIC COSTS :	66,896
DISCOUNTED ECONOMIC BENEFITS :	117,857
AGRICULTURAL DEVELOPMENT BENEFIT	8,036
VOC SAVING	108,427
RMC SAVING	1,394
NET PRESENT VALUE :	50,961
BENEFIT COST RATIO :	1.76
INTERNAL RATE OF RETURN :	20.0 %

Table 5.7.1 SOCIAL INDICATORS

(Proposed Route IM-5)

Population (1,000)		
1982	:	27.2
1993	:	34.3
Average travelling speed, without (kph)	:	48
Isolation		
Access to Amphoe		
Average distance to Amphoe (km) 1/	:	7.9
Per capita time savings (10^{-4})	:	0.016
Score	:	47
Access to Artery Highway		
Average distance to highway (km) 1/	:	0
Per capita time savings (10^{-4})	:	0
Score	:	0
Impassability		
Impassable week a year	:	-
Impassability per year	:	0
Impassability per capita (10^{-4})	:	0
Score	:	0
Health		
Access to Hospital		
Average distance to Hospital (km) 1/	:	10.0
Per capita time savings (10^{-4})	:	0.020
Score	:	47
Access to Medical Facilities		
Average distance to facilities (km) 1/	:	3.8
Per capita time savings (10^{-4})	:	0.008
Score	:	32
Education		
Access to Secondary School		
Number of Student in 1993 (1,000) 2/	:	6.2
Average distance to school (km)	:	5.4
Per capita time savings (10^{-4})	:	0.060
Score	:	32
Teacher Intensity		
Number of teachers 3/		
University graduate	:	4
Total	:	15
Number of Student	:	365
Indicators		
E1 4/	:	11.0
E2 5/	:	41.1
E 6/	:	52.1
Degree of Improvement 7/	:	1.31
Score	:	84
Disparity		
G.P.V. in 1993 (Mn B) 8/		
With project	:	83.4
Without project	:	80.4
Per capita G.P.V. in 1993 (B)		
With project (W)	:	2,431
Without project (w)	:	2,344
Degree of Disparity		
(A/W) - (A/w) 9/	:	0.05
Score	:	89
Total Score	:	331

Note:

1/ ( ) shows the length or distance in without project case. Unless otherwise, lengthes are same both in with project case and without project case.

2/ Number of secondary school student estimated based on the projected population of the areas of influence applying ratios of secondary school students to the total population in the sample area.

3/ Numbers of the sample areas

4/ (Number of University Graduate Teachers)/(Total Number of Student) x 1,000

5/ (Total of Teachers)/(Total Number of Student) x 1,000

6/ Sum of 4/ and 5/

7/ Ratio of E value of each route to an average value of the same indicator E in case of the sample areas, 33 in number, along paved road near the proposed routes.
The average value of E in case of paved roads were calculated at 68.4 from the following data:

Number of university graduate teachers	438
Number of Teachers	1,285
Number of student	25,196

8/ Estimated gross value of crop production in the areas of influence

9/ "A" indicates an average per capita value of crop production in the Northeastern Region, which is estimated assuming that:
- GRP per capita of the Northeast is estimated at 11,897 Baht in 1993,
- Agricultural sector shares 40% of GRP, and
- Crop production shares 80% of agricultural production.

PROPOSED ROUTE NO. IM-6

Changwat : Udon Thani / Khon Kaen

B. Sok Chan (J.R.2146) - Ubolrattana Dam (J.R 2109)

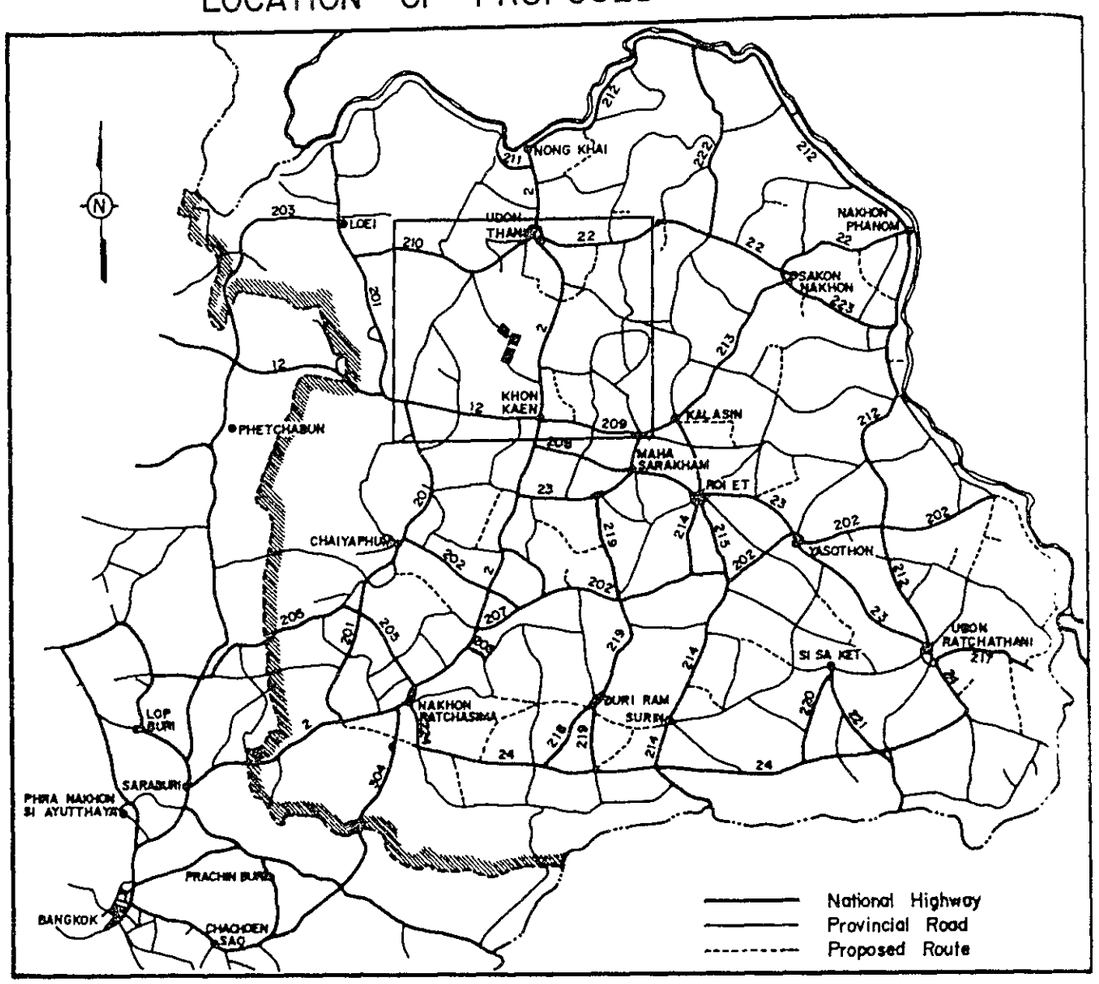
Length : 20.3 KM.

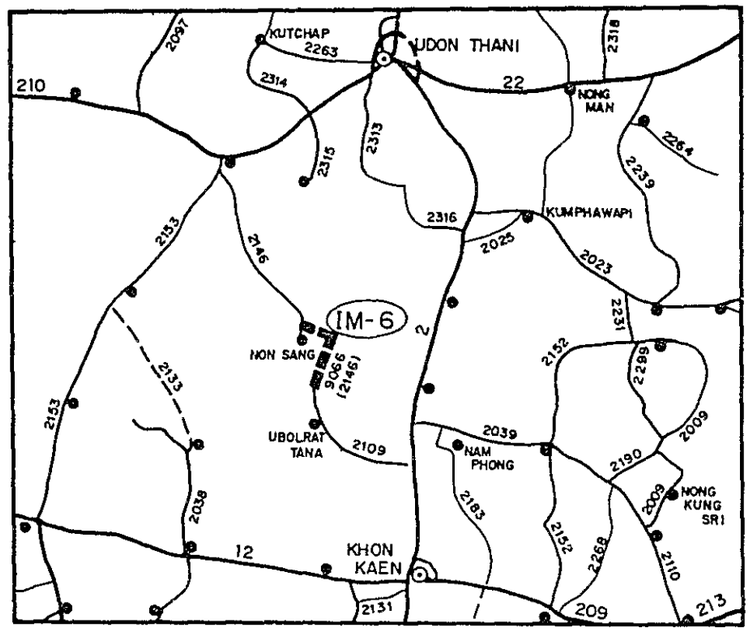
SUMMARY

PROPOSED ROUTE IM-6

Item	Description
Changwat	Udon Thani/Khon Kaen
Origin	B. Sok Chan (J.R. 2146)
Destination	Ubolrattana Dam (J.R. 2109)
Length	
Total	20.3 km
Improvement Section	20.3 km
DOH Road	R.2146 20.3 km
ARD Road	0 km
Others	0 km
New Alignment Section	0 km
Surface Type and Condition	Soil Aggregate, Poor
Terrain	Flat, Rolling and Mountainous
Influence Area	
Area	67 km^2
Population (1982)	4900
Principal Crops	Paddy
Traffic (ADT)	
Existing	102
1993	405
2001	543
Proposed Standard	F4 (DBST)
Construction Cost	
Financial	52,407 . 10^3 ฿
Economic	47,423 . 10^3 ฿
IRR	4.0 %
B/C	0.44
Social Impact	High
Recommendation	For further consideration

LOCATION OF PROPOSED ROUTE





1. GENERAL

1.1 Characteristics of the Route

The proposed route is extended in two Changwat, Udon Thani and Khon Kaen. The route starting at Ban Sok Chan on Route 2146 runs southward passing through Ban Tha Sila, Ban Pa Kung and Ban Kho and ends at Ubolrattana Dam, the termination of Route 2109. Its total length is 20.3 km (Figure 6.5.2).

The terrain is almost flat and rolling, while there is a steep mountainous section. In the influence area, there exist a few villages with total population of 4,900. There is only one medical center along the proposed route. But, at Amphoe Nong Sang and Ubolrattana near the proposed route, two secondary schools, one medical center and one hospital exist.

The proposed route, upon completion, will form an important part of road network to connect two agriculturally developed area isolated by a steep mountain range.

1.2 Condition of Existing Road

Condition of existing roads to be utilized for the proposed route is summarized in Table 6.1.1. The details are shown as the results of inventory survey in Table 6.1.2.

2. TRAFFIC

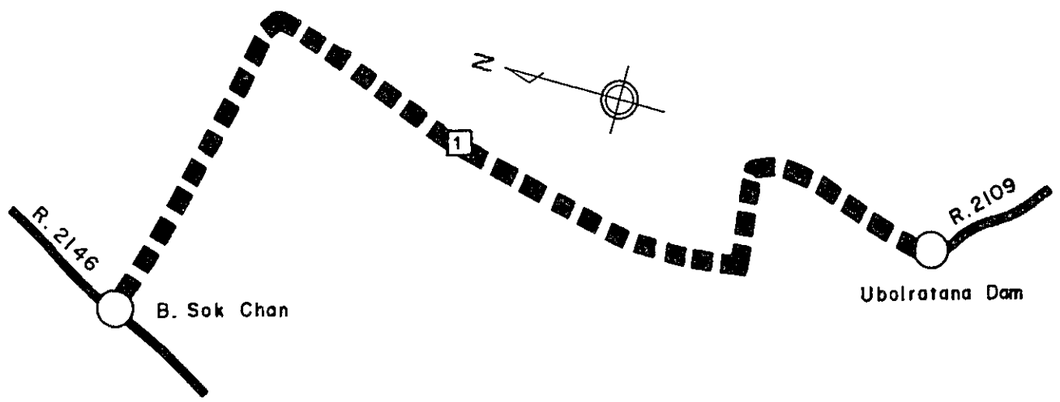
2.1 Method

Growth Rate Method was employed for traffic forecasting as no diverted traffic is expected after improvement of the proposed road.

2.2 Base Year Traffic

The base year traffic by road link by vehicle type was estimated referring to the DOHs traffic records and manual classified counts as shown below:

Proposed Road Link



Traffic Volume in Base Year

Source (base year)	Link No /1	Vehicle Type P/C	P/P	L/B	M/B	H/B	P/T	4/T	6/T	10/T	ADT
DOH (1981)	1	14	19	9	11	2	3	9	-	-	67
Manual Counts (1982)	1	1	69	10	14	-	8	24	3	2	131
Estimated	1	8	44	10	13	1	6	17	2	1	102

Note: /1 Route 2146, Section 0200, Station km 3 + 000

2.3 Transport Movement

Passenger movement in terms of trips per day and freight movement in terms of tonnage per day on the proposed road links were estimated multiplying traffic volume in base year by the occupancy or average load obtained from roadside interview, as shown below:

PASSENGER MOVEMENT (1982)

PROPOSED ROAD LINK	TRIPS PER DAY
1	643

FREIGHT MOVEMENT (1982)

PROPOSED ROAD LINK	TONAGE PER DAY		
	NON-AGRI.	AGRI.	TOTAL
1	20	9	29

2.4 Future Growth of Transport Movement

The growth rates of passenger and freight movements for the periods of 1981 - 1987, 1987 - 1993 and 1993 - 2001 were predicted by the formula described in 7.3.3-2) of the Main Report. The basis for the prediction is shown in the following tables:

GROWTH RATE OF PASSENGER MOVEMENT

ITEM	GROWTH RATE (% P.A.)		
	1981 - 1987	1987 - 1993	1993 - 2001
PER CAPITA INCOME	4.2	4.5	4.7
TRANS. PRICE INCREASE	4.5	4.5	4.5
POPULATION	1.6	1.4	1.3
PASSENGER MOVEMENT	5.7	5.8	5.9

GROWTH RATE OF FREIGHT MOVEMENT

ITEM	GROWTH RATE (% P.A.)		
	1981 - 1987	1987 - 1993	1993 - 2001
NON-AGRI.	7.3	7.5	7.6
AGRICULTURE	0.0	0.0	0.0
FREIGHT	5.1	5.2	5.3

2.5 Induced and Developed Traffic

The following ratios are used for the estimation of induced and developed traffic described in 7.3.3-3) of the Main Report:

RATE OF INDUCED AND DEVELOPED TRAFFIC

(%)

ITEM	YEAR		
	1987	1993	2001
INDUCED	15.0	15.0	15.0
DEVELOPED	0.0	0.0	0.0

2.6 Future Traffic

1) Traffic Composition

The movements of passenger and freight transport were transformed into traffic volume by vehicle type applying future traffic composition as shown in the following table:

TRAFFIC COMPOSITION

(UNIT : %)

LINK NO.	YEAR	PASSENGER					FREIGHT			
		P/C	P/P	L/B	M/B	H/B	P/T	4/T	6/T	10/T
1	1982	10.5	57.9	13.2	17.1	1.3	23.1	65.4	7.7	3.8
	1987	12.3	56.2	12.7	16.3	2.6	21.5	52.4	14.9	11.3
	1993	14.3	54.1	12.1	15.3	4.1	19.6	36.8	23.5	20.1
	2001	17.1	51.3	11.4	14.0	6.1	17.0	16.0	35.0	32.0

2) Forecasted ADT

The average of the forecasted traffic on proposed road link is shown in the following table and details by road link by traffic type are shown in Table 6.2.1.

AVERAGE FUTURE TRAFFIC ON PROPOSED ROUTE

YEAR	TYPE OF VEHICLE								ADT	M/C	TOTAL
	P/C	L/B	M/B	H/B	P/P&T	4/T	6/T	10/T			
1987	14	14	18	3	68	12	4	3	136	197	332
1993	22	18	23	6	86	8	5	4	174	231	405
2001	39	26	32	14	122	4	8	8	254	290	543

3. AGRICULTURAL DEVELOPMENT

3.1 Present Condition

Because of steep topography and the Nam Phong reservoir, the area of influence is limited. The influenced area divided into two parts, Amphoe Non Sang side and Ubolrattana side. Paddy fields cover almost 100% of the cultivated land of Amphoe Nong Sang and nearly 80% of Amphoe Ubolrattana. There is no unused cultivable land. Cassava ranks first in the upland fields followed by sugar cane and kenaf. These commercial crops are shipped out via Route 2109 to the processing plants in Amphoe Nam Phong or along Route No. 2 near Khon Kaen.

Land use and capability conditions in the area of influence are shown in Table 6.3.1 and Figure 6.3.1. Typical cropping calendars in both Udon Thani and Khon Kaen area are shown in Figure 6.3.2.

3.2 Development Projection

Future agricultural development in the area of influence was projected for both cases of without project and with project. The projected planted area, unit yields by crop, and the consequent production volumes are shown in Table 6.3.2.

Farmgate prices and production costs of the selected crops are estimated as follows, referring to the Changwat data and field survey information as shown in Table 6.3.3.

Based on the above projected production volume, farmgate prices, production costs and land preparation cost estimated separately, net production value (NPV) was obtained as shown in Table 6.3.4. The difference between NPV of with project case and NPV of without project case is deemed to be the development benefit of the subject road.

4. VOC SAVINGS

In accordance with the concept and basic data given in Chapter 7 of Vol. 1 Main Report, VOCs on each road link concerned were calculated in both cases of with project and without project.

Elements of road condition, which affect the calculation of additional costs of VOC of each link, are shown below.

Road Condition

Link No.	Terrain	Without Project: Length (km)	Road Class[1]	Nos. of Wooden Bridge	Nos. of Narrow C.Bridge	With Project: Length (km)	Road Class[1] Case 1	Case 2	Nos. of Wooden Narrow Bridge
1	Flat, Rolling & Mount-anious	20.3	3	3	0	20.3	1(F4)	2A(F5)	0

Road 1: Paved Road

Road 2A: Laterite Road with good surface condition and alignment

Road 2B: Laterite Road with good surface condition but poor alignment

Road 3: Laterite Road with poor surface condition and alignment

Road 4: Earth Road

VOC savings, obtained from the difference of total link VOCs in the cases of with project and those of without project case, were calculated as follwos.

Vehicle Operating Cost Saving

(unit: 1,000 Baht)

Road Class	1987	1993	2001
1 (F4)	2,353	3,462	5,623
2A (F5)	1,738	2,670	4,470

5. ENGINEERING

5.1 Preliminary Design

Preliminary design was carried out based on the following design criteria.

Design Standard : F4 (if not feasible, F5)

Geometric Design : AASHTO (Rural Highways)

Typical Cross Section : as shown in Figure 6.5.1

Minimum Height of Embankment

- Ordinary Section : 1.0m
- Approach of Bridge in Flat Area : 2.0m
- Flood Section : 0.7m (above flood level)

Pavement Structure

In case of F4 Standard

- DBST : 2.5cm
- Crushed Stone Base CBR≥80% : 15.0cm
- Soil Aggregate Subbase CBR≥20% : 15.0cm
- Selected Material CBR≥ 6% : 20.0cm

In case of F5 Standard

- Soil Aggregate Surface CBR≥20% : 15.0cm
- Selected Material CBR≥ 6% : 20.0cm

Pipe Culvert

- Standard Size : ø 100cm
- Standard Interval
  - Paddy Area : 200 m
  - Others : 500 m

Box Culvert

- Standard Size : 2.4m x 2.4m
- Location : as required

Bridge

Standard Type (width 7.0m)

Short Span Bridge	:	RC - Slab
Long Span Bridge	:	PC - Girder
Location	:	as shown in Bridge List in Figure 6.5.2

Alignment of the route is shown in Figure 6.5.2.

5.2 Work Quantity and Construction Cost

Work quantities based on the preliminary design and construction cost together with unit rate by work item are shown in Table 6.5.1.

Total financial and economic construction costs by applied road class are as given below:

Financial and Economic Construction Cost

Road Class	Length (km)	Construction Cost (10^3 ฿) Financial Cost	Economic Cost	Remark
F4 (DBST)	20.3	52,407	47,423	
F5 (Soil Aggregate)	20.3	24,199	21,903	

6. ECONOMIC EVALUATION

Yearly distribution of the economic costs and benefits and the calculated economic indicators for evaluation are given in Table 6.6.1 and 6.6.2. The result indicates that the proposed project seems to be not feasible under F4 Standard and F5 Standard in case the opening year is 1987.

7. SOCIAL IMPACTS

Detailed data and results of quantification of indicators of social impacts are tabulated in Table 6.7.1. Social impacts of the proposed route are considerably high.

Table 6.1.1 SUMMARY OF ROAD INVENTORY

Item	Description		
Origin	B. Sok Chan (J.R. 2146)		
Destination	Ubolrattana Dam (J.R. 2109)		
Length			
Total			20.3 km
Improvement Section			20.3 km
DOH Road	R. 2146		20.3 km
ARD Road			0 km
Others			0 km
New Alignment Section			0 km
Terrain	Flat, Rolling and Mountainous		
Alignment (Hori./Vert.)	Poor		
Formation Width	6.0 m - 7.0 m, 6.5 m (Weighted average)		
Embankment Section			
Length			19.3 km
Height	0.3 m - 1.0 m		
Cut Section			
Length			1.0 km
Depth	1.5 m - m		
Surface Type and Condition			
SBST or DBST	Poor		1.0 km
Soil Aggregate	Poor		19.3 km
Earth			0 km
Pipe Culvert	23 each		
Box Culvert	0 each		0 m
Bridge			
Permanent Bridge	0 each		0 m
Narrow Concrete Bridge	0 each		0 m (4m)
Wooden Bridge	3 each		59.0 m
Overflow Section	0 place		0 km

Table 6.1.2 ROAD INVENTORY

PROPOSED ROUTE NO. IM-6 ROUTE NO. 9066 (2146) B. SOK CHAN (J.R. 2146) ∿ UBOLRATANA DAM (J.R. 2109) L = 20.3 km

UDON THANI/KHON KAEN

STATION (Km)		0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
VILLAGE - Name - Household (H) - Population (P)		B. SOK CHAN H = 220 P = 880; B. PA KUNG H = 70 P = 350; B. THA SILA H = 32 P = 200; B. NONG KUNG H = 1500 P = 12000
TERRAIN		Flat | Rolling | Mountainous | Rolling
CROSS SECTION	Formation Width (m)	7.00 | 6.00 | 7.50 | 4.00 | 6.00 | 7.00
	Embankment Height (m)	0.50 | 0.30 | 1.00 | 0.50 | 0.40 | 0.20
	Cutting Depth (m)	1.50
PAVEMENT	Type/Length	DT | Laterite
	Condition	Poor
FLOODING	Overflow Length(Km)/Height(m)	
LAND USE	Left	Paddy | Bush | Forest
	Right	Paddy | Bush | Forest
PIPE CULVERT	Total Number	23 Pipes
BOX CULVERT & BRIDGE	Station (Km)	0.7; 1.7; 2.2
	Dimension	W-Br. 4.00 x 10.50; W-Br. 4.00 x 28.50; W-Br. 4.50 x 20.00
RIGHT OF WAY (m)		18.0
ALIGNMENT	Horizontal	Fair | Poor | Fair
	Vertical	Fair | Poor | Fair
ROUTE NO., AGENCIES		DOH 9066 (2146)

Table 6.2.1 TRAFFIC VOLUME ON ROUTE IM - 6

YEAR		1987		1993		2001	
LINK		1	AVR.	1	AVR.	1	AVR.
P/C	N+D	12	12	19	19	34	34
	I	2	2	3	3	5	5
	DV	0	0	0	0	0	0
	TOTAL	14	14	22	22	39	39
L/B	N+D	12	12	16	16	23	23
	I	2	2	2	2	3	3
	DV	0	0	0	0	0	0
	TOTAL	14	14	18	18	26	26
M/B	N+D	16	16	20	20	28	28
	I	2	2	3	3	4	4
	DV	0	0	0	0	0	0
	TOTAL	18	18	23	23	32	32
H/B	N+D	3	3	5	5	12	12
	I	0	0	1	1	2	2
	DV	0	0	0	0	0	0
	TOTAL	3	3	6	6	14	14
P/P&T	N+D	59	59	75	75	106	106
	I	9	9	11	11	16	16
	DV	0	0	0	0	0	0
	TOTAL	68	68	86	86	122	122
4/T	N+D	11	11	7	7	3	3
	I	2	2	1	1	0	0
	DV	0	0	0	0	0	0
	TOTAL	12	12	8	8	4	4
6/T	N+D	3	3	5	5	7	7
	I	0	0	1	1	1	1
	DV	0	0	0	0	0	0
	TOTAL	4	4	5	5	8	8
10/T	N+D	2	2	4	4	7	7
	I	0	0	1	1	1	1
	DV	0	0	0	0	0	0
	TOTAL	3	3	4	4	8	8
ADT	N+D	118	118	151	151	220	220
	I	18	18	23	23	33	33
	DV	0	0	0	0	0	0
	TOTAL	136	136	174	174	254	254
M/C	N+D	179	179	211	211	267	267
	I	18	18	20	20	23	23
	DV	0	0	0	0	0	0
	TOTAL	197	197	231	231	290	290
TOTAL	N+D	297	297	363	363	488	488
	I	35	35	42	42	56	56
	DV	0	0	0	0	0	0
	TOTAL	332	332	405	405	543	543

NOTE

N : NORMAL TRAFFIC D : DIVERTED TRAFFIC

DV : DEVELOPED TRAFFIC I : INDUCED TRAFFIC

Figure 6.3.1 LAND USE AND CAPABILITY OF INFLUENCE AREA PROPOSED ROUTE NO. IM – 6

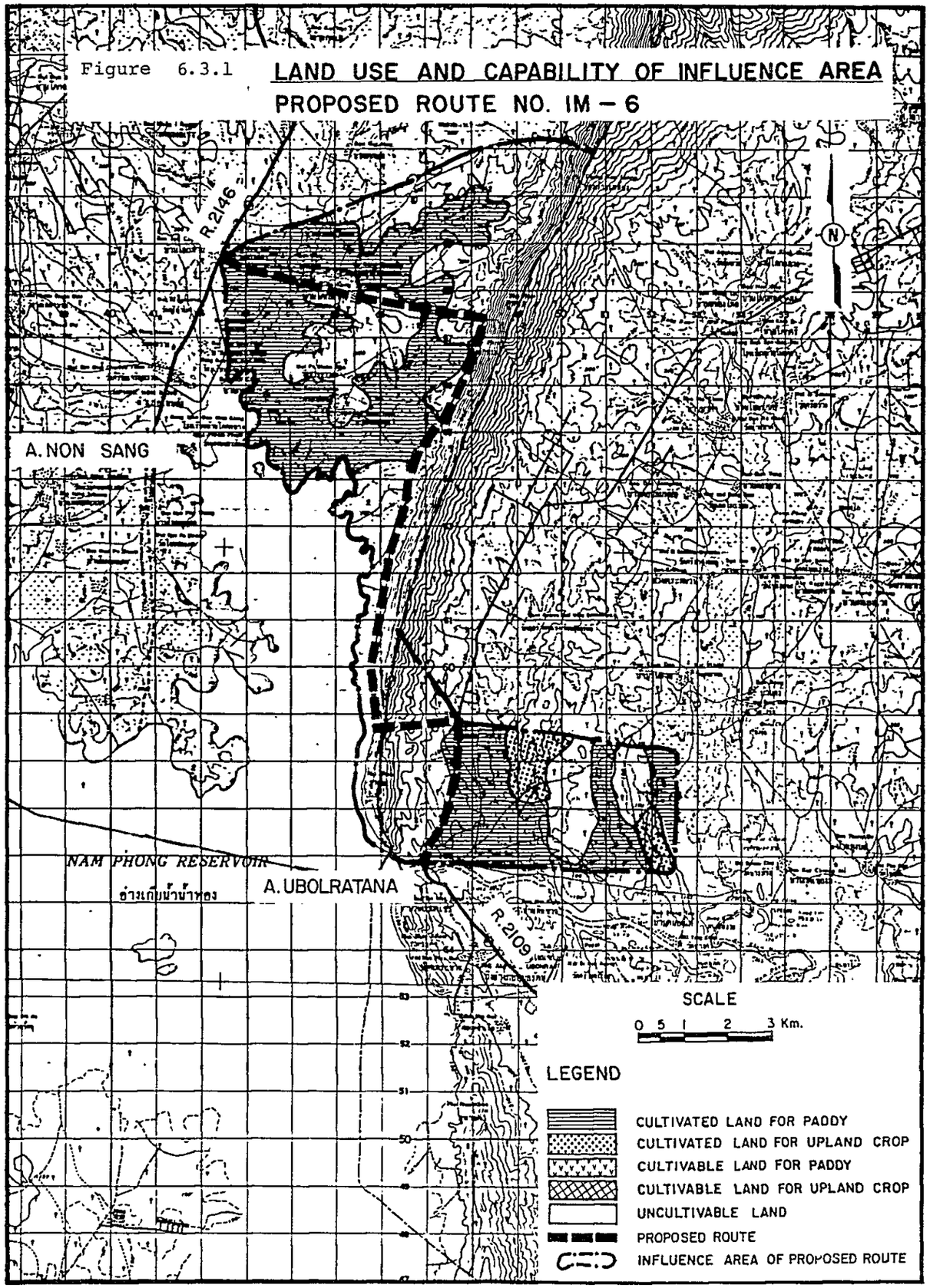
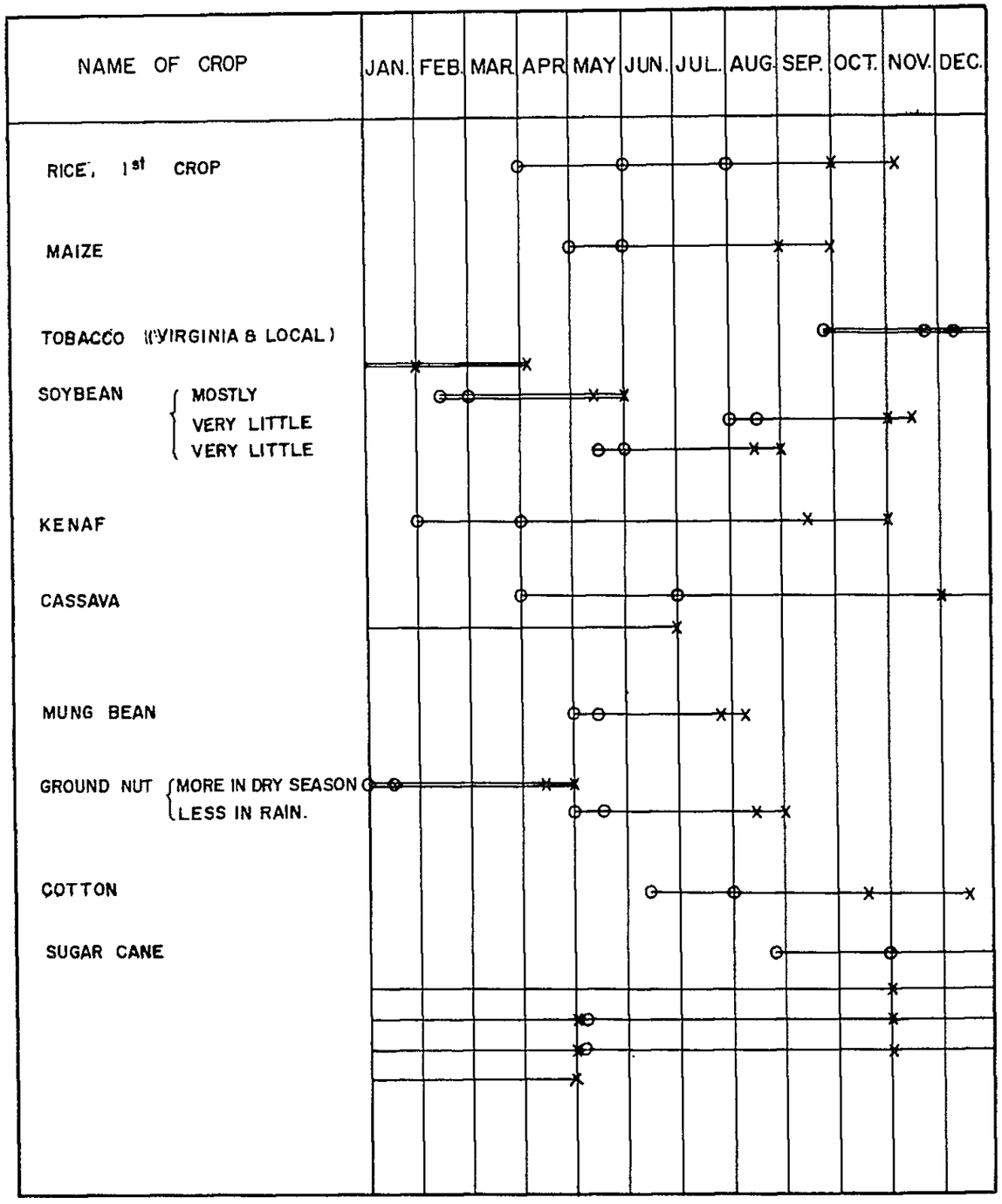


Figure 6.3.2 CROPPING CALENDAR (1)

0200 CHANGWAT UDON THANI



CROPPING CALENDAR (2)

0600 CHANGWAT KHON KAEN

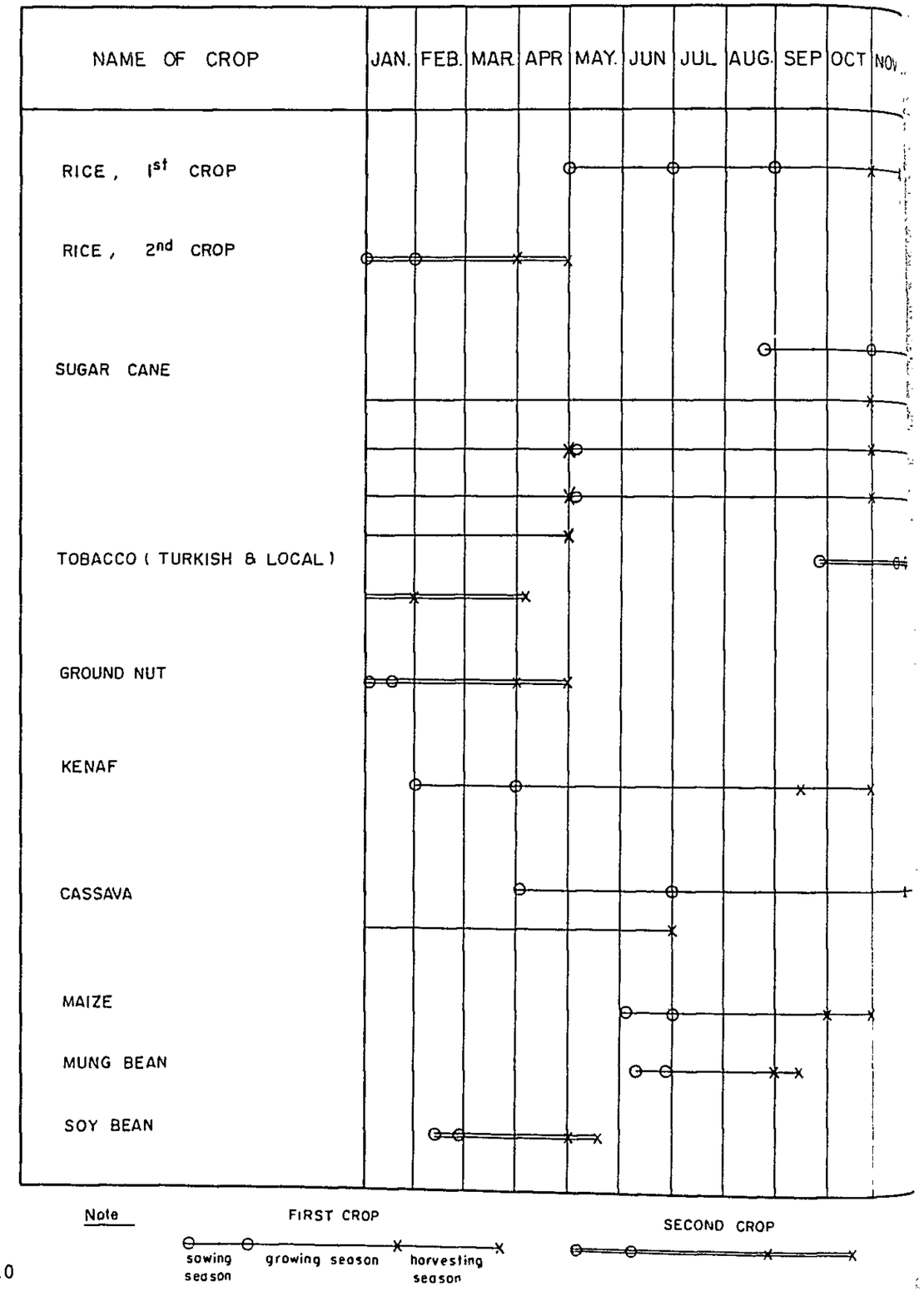


TABLE 6.3.1 CULTIVATED & CULTIVABLE LAND

(1979)

[UNIT : 1000 RAI (KM^2)]

AMPHOE CODE	AMPHOE NAME	CULTIVATED LAND			UNUSED CULTIVABLE LAND		
		PADDY	UPLAND	TOTAL	PADDY	UPLAND	TOTAL
		14.375 (23.0)	1.250 (2.0)	15.625 (25.0)	-	-	-
0213	NON SANG	10.000 (16.0)	-	10.000 (16.0)	-	-	-
0607	UBOLRATANA	4.375 (7.0)	1.250 (2.0)	5.625 (9.0)	-	-	-

TABLE 6.3.2 CROP PRODUCTION

ITEM			PADDY	MAIZE	BEANS	GRUND NUTS	CASSAVA	SUGAR CANE	KENAF	COTTON	UPLAND TOTAL	TOTAL
PLANTED AREA (1000 RAI)												
1981			16.45	-	-	-	0.80	0.18	0.24	-	1.25	17.70
1987			16.45	-	-	-	0.83	0.17	0.22	-	1.25	17.70
1993	WITHOUT	PROJECT	16.45	-	-	-	0.86	0.16	0.20	-	1.25	17.70
	WITH	PROJECT	16.45	-	-	-	0.86	0.17	0.19	-	1.25	17.70
2001	WITHOUT	PROJECT	16.45	-	-	-	0.90	0.14	0.18	-	1.25	17.70
	WITH	PROJECT	16.45	-	-	-	0.90	0.15	0.17	-	1.25	17.70
CROP YIELD (KG/RAI)												
1981			261.7	-	-	-	2200.0	7117.5	294.0	-		
1987			263.3	-	-	-	2200.0	7160.3	294.0	-		
1993	WITHOUT	PROJECT	264.9	-	-	-	2200.0	7203.4	294.0	-		
	WITH	PROJECT	268.1	-	-	-	2213.2	7246.7	294.0	-		
2001	WITHOUT	PROJECT	267.0	-	-	-	2200.0	7261.2	294.0	-		
	WITH	PROJECT	274.6	-	-	-	2231.0	7363.4	294.0	-		
CROP PRODUCTION (TON)												
1981			4,304	-	-	-	1,755	1,277	69	-	3,107	7,411
1987			4,330	-	-	-	1,825	1,208	64	-	3,102	7,433
1993	WITHOUT	PROJECT	4,356	-	-	-	1,892	1,139	59	-	3,095	7,451
	WITH	PROJECT	4,409	-	-	-	1,913	1,201	56	-	3,175	7,584
2001	WITHOUT	PROJECT	4,391	-	-	-	1,977	1,049	53	-	3,083	7,475
	WITH	PROJECT	4,516	-	-	-	2,014	1,114	50	-	3,183	7,698

NOTE : SYMBOL "-" MEANS ZERO OR NEGLIGIBLE SMALL

TABLE 6.3.3 FARMGATE PRICE AND PRODUCTION COST

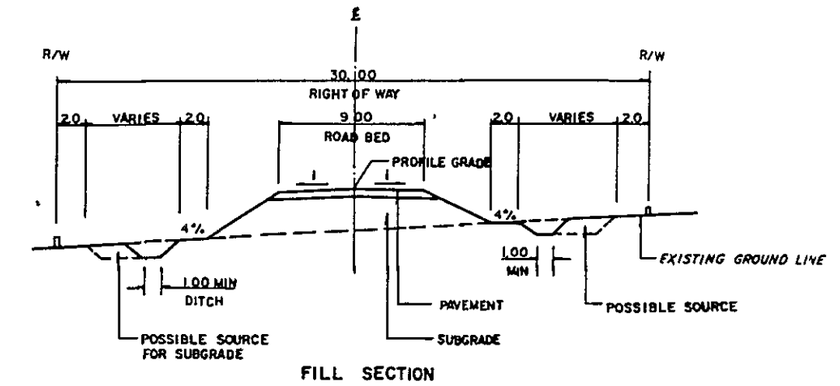
ITEM	PADDY	MAIZE	BEANS	GRUND NUTS	CASSAVA	SUGAR CANE	KENAF	COTTON
FARMGATE PRICE (BAHT/TON)								
WITHOUT PROJECT (1981 - 2001)	3,799	-	-	-	608	652	4,625	-
WITH PROJECT (1987 - 2001)	3,894	-	-	-	623	652	4,741	-
CROP PRODUCTION COST (BAHT/RAI)								
WITHOUT PROJECT (1981 - 2001)	608	-	-	-	724	2,879	845	-
WITH PROJECT (1987 - 2001)	628	-	-	-	744	2,929	845	-

TABLE 6.3.4 NET PRODUCTION VALUE

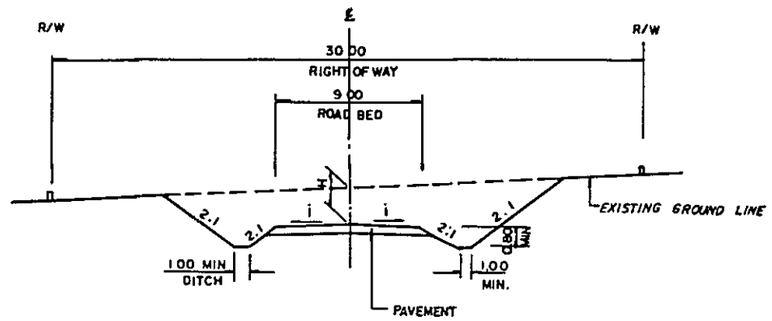
(1000 BAHT)

YEAR	WITHOUT PROJECT			WITH PROJECT		
	PADDY	UPLAND	TOTAL	PADDY	UPLAND	TOTAL
1987	6,448	926	7,374	6,530	936	7,466
1993	6,547	924	7,471	6,836	955	7,791
2001	6,680	916	7,596	7,253	965	8,218

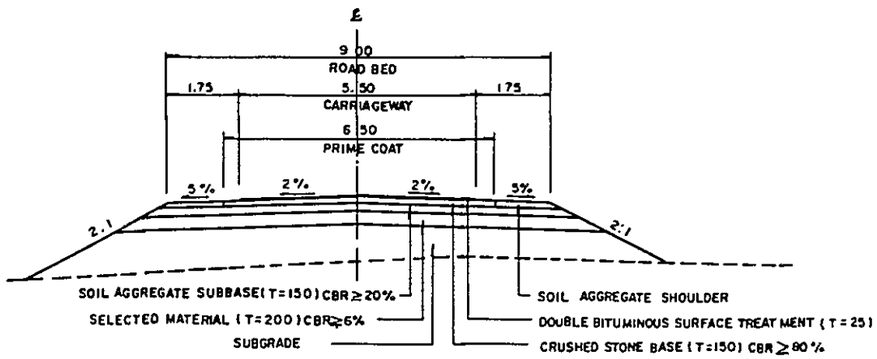
Figure 6.5.1 TYPICAL CROSS SECTION AND TYPICAL PAVEMENT STRUCTURE



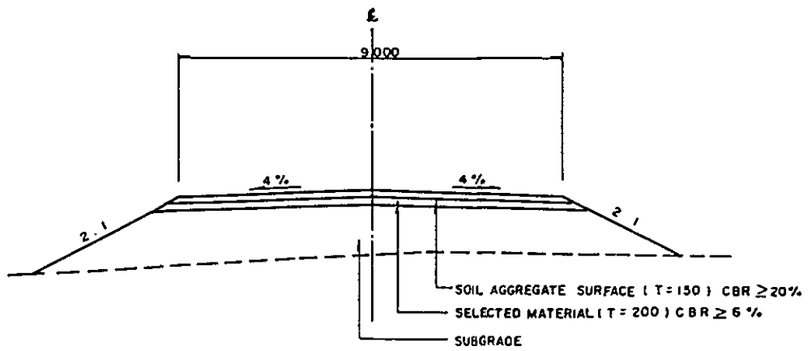
FILL SECTION



CUT SECTION



DOUBLE BITUMINOUS SURFACE TREATMENT (DBST) ROAD (Class F4)

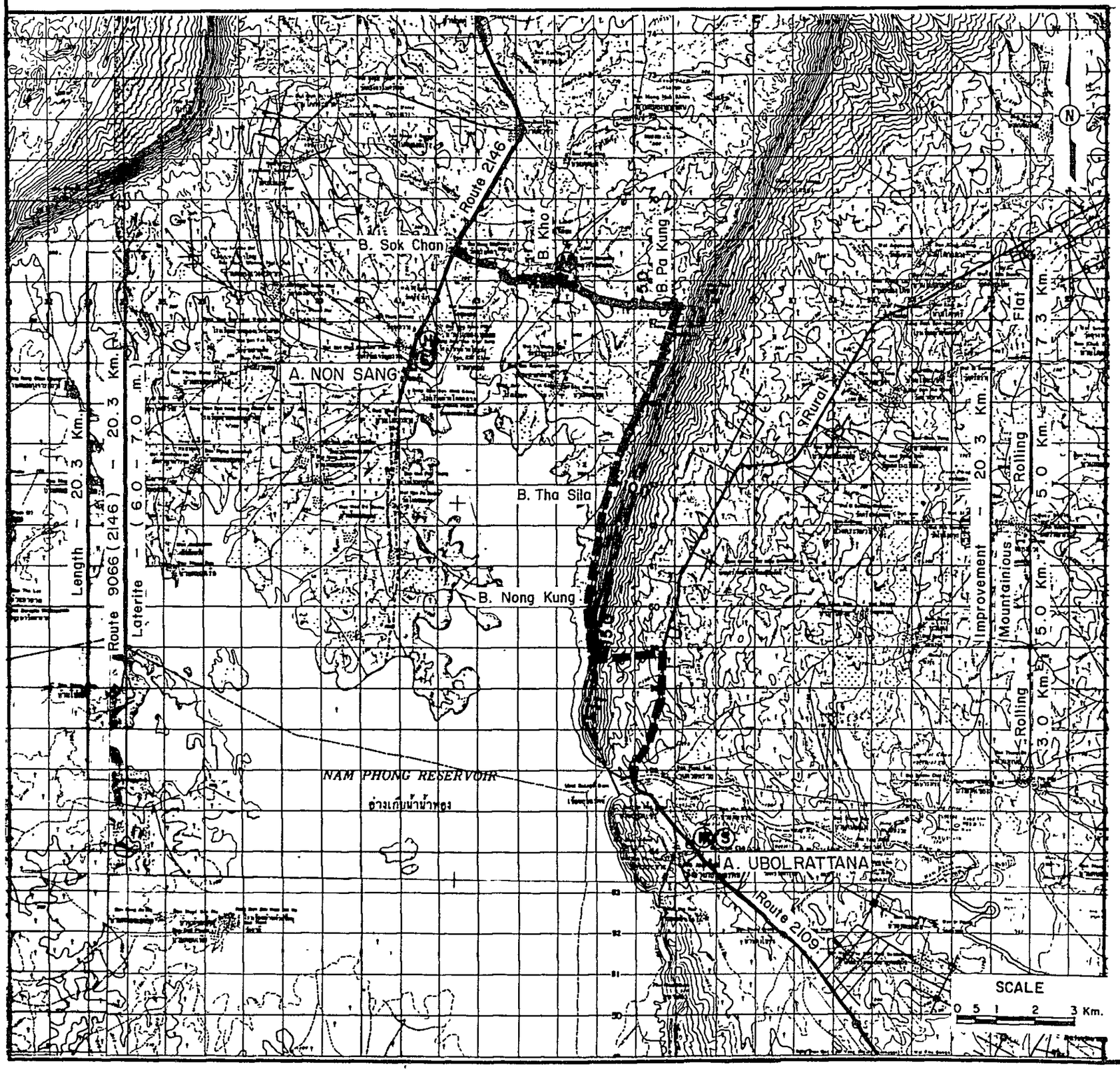


SOIL AGGREGATE SURFACED ROAD (Class F5)

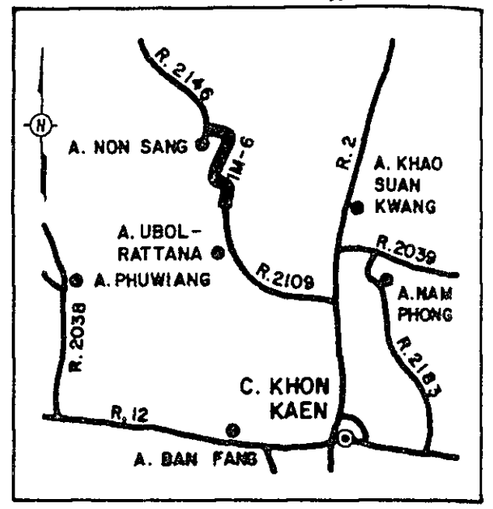
Figure 6.5.2

PROPOSED ROUTE NO. IM-6 **C. UDON THANI / KHON KAEN** **B. SOK CHAN (J.R. 2146) – UBOLRATTANA DAM (J.R. 2109)**

ROUTE NO. 9066 (2146) L = 20.3 Km.



LOCATION MAP



BRIDGE LIST

No.	Station Km.	Proposed Bridge	Existing Bridge
1	0.7	C-7.00 x 14.00	W-4.00 x 10 50
2	1.7	C-7.00 x 30.00	W-4.00 x 28 50
3	2.2	C-7.00 x 21.00	W-4.50 x 20 00

LEGEND

- PROPOSED ROUTE (IMPROVEMENT)
- PROPOSED ROUTE (NEW CONSTRUCTION
- PAVED ROUTE
- UNPAVED ROUTE
- INVENTORY SURVEY ROUTE
- (H) HOSPITAL
- (M) MEDICAL CENTER
- (S) SECONDARY SCHOOL

Table 6.5.1 CONSTRUCTION QUANTITIES AND COSTS IM-6 (20.3 km)

Items	Unit of Q'ty	Financial Unit Rate ฿	(DBST)			(Soil Aggregate Surface)		
			Q'ty	Financial Cost (10^3฿)	Economic Cost (10^3฿)	Q'ty	Financial Cost (10^3฿)	Economic Cost (10^3฿)
DIRECT CONSTRUCTION COST								
Clearing and Grubbing	ha	15,000	48	720	655	48	720	655
Excavation - Soil	m^3	20	27,900	558	502	27,900	558	502
Excavation - Hard Rock	m^3	160	65,200	10,432	9,388	65,200	10,432	9,388
Embankment	m^3	45	62,200	2,799	2,547	62,200	2,799	2,547
Selected Material	m^3	80	42,000	3,360	2,990	42,000	3,360	2,990
Soil Aggregate Surface or Subbase	m^3	105	29,400	3,087	2,747	29,400	3,087	2,747
Crushed Stone Base	m^3	370	19,300	7,141	6,569	2,400	888	816
Soil Aggregate Shoulder	m^3	105	8,300	871	775	1,100	115	102
Prime Coat and DBST	m^2	55	108,900	5,990	5,391	13,800	759	683
Pipe Culvert	m	2,100	520	1,092	1,004	520	1,092	1,004
Box Culvert	m	16,000	0	0	0	0	0	0
Long Span Bridge	m	80,000	0	0	0	0	0	0
Short Span Bridge	m	40,000	65	2,600	2,314	65	2,600	2,314
Sub Total (a)				38,651	34,886		26,410	23,753
Miscellaneous Works (a) x 7%				2,706	4,884		1,849	1,663
Total (b)				41,357	39,770		28,259	25,416
PHYSICAL CONTENGENCY (b) x 15%				6,204	5,966		4,239	3,812
ENGINEERING AND ADMINISTRATION (b) x 10%				4,136	3,977		2,826	2,542
Sub Total				10,340	9,943		7,065	6,354
LAND ACQUISITION								
Highly Developed Land	ha	50,000	10	500	500	10	500	500
Less Developed Land	ha	15,000	14	210	210	14	210	210
Sub Total				710	710		710	710
GRAND TOTAL				52,407	47,423		36,034	32,480

Table 6.6.1 COST AND BENEFITS

(F4 STANDARD)

(1000 BAHT)

YEAR	COST	BENEFITS				DISCOUNTED(12%)	
	CONST. COST	AGRI. BENEFIT	VOC SAVING	RMC SAVING	TOTAL	COST	BENEFIT
1984	0	0	0	0	0	0	0
1985	18,969	0	0	0	0	23,795	0
1986	28,454	0	0	0	0	31,868	0
1987	0	92	2,353	-91	2,354	0	2,101
1988	0	130	2,538	-82	2,586	0	2,061
1989	0	168	2,723	-73	2,817	0	2,005
1990	0	206	2,907	-64	3,049	0	1,938
1991	0	244	3,092	-55	3,281	0	1,862
1992	0	282	3,277	-46	3,513	0	1,780
1993	0	320	3,462	-37	3,745	0	1,694
1994	9,825	358	3,732	-23	4,067	4,444	1,642
1995	0	396	4,002	-9	4,388	0	1,582
1996	0	433	4,272	4	4,710	0	1,516
1997	0	471	4,543	18	5,031	0	1,446
1998	0	509	4,813	32	5,353	0	1,374
1999	0	547	5,083	45	5,675	0	1,300
2000	0	584	5,353	59	5,996	0	1,227
2001	-23,578	622	5,623	72	6,318	-4,308	1,154
TOTAL	33,670	5,361	57,773	-251	62,883	55,800	24,685

DISCOUNTED ECONOMIC COSTS : 55,800

DISCOUNTED ECONOMIC BENEFITS : 24,685

AGRICULTURAL DEVELOPMENT BENEFIT 1,913
VOC SAVING 23,045
RMC SAVING -274

NET PRESENT VALUE : -31,115

BENEFIT COST RATIO : 0.44

INTERNAL RATE OF RETURN : 4.0 %

Table 6.6.2 COST AND BENEFITS

(F5 STANDARD)

(1000 BAHT)

YEAR	COST	BENEFITS				DISCOUNTED(12%)	
	CONST. COST	AGRI. BENEFIT	VOC SAVING	RMC SAVING	TOTAL	COST	BENEFIT
1984	0	0	0	0	0	0	0
1985	12,992	0	0	0	0	16,297	0
1986	19,488	0	0	0	0	21,827	0
1987	0	92	1,738	-19	1,811	0	1,617
1988	0	130	1,893	-12	2,012	0	1,604
1989	0	168	2,049	-5	2,212	0	1,574
1990	0	206	2,204	2	2,412	0	1,533
1991	0	244	2,359	9	2,612	0	1,482
1992	0	282	2,515	16	2,812	0	1,425
1993	0	320	2,670	22	3,012	0	1,363
1994	1,210	358	2,895	32	3,285	547	1,327
1995	0	396	3,120	42	3,558	0	1,283
1996	0	433	3,345	53	3,831	0	1,233
1997	0	471	3,570	63	4,104	0	1,180
1998	0	509	3,795	73	4,376	0	1,123
1999	0	547	4,020	83	4,649	0	1,066
2000	0	584	4,245	93	4,922	0	1,007
2001	-15,324	622	4,470	103	5,195	-2,800	949
TOTAL	18,366	5,361	44,888	554	50,803	35,871	19,765

DISCOUNTED ECONOMIC COSTS : 35,871

DISCOUNTED ECONOMIC BENEFITS : 19,765

AGRICULTURAL DEVELOPMENT BENEFIT 1,913
VOC SAVING 17,719
RMC SAVING 133

NET PRESENT VALUE : -16,106

BENEFIT COST RATIO : 0.55

INTERNAL RATE OF RETURN : 6.2 %

Table 6.7.1 SOCIAL INDICATORS

(Proposed Route IM-6)

Population (1,000)	
1982	: 4.9
1993	: 5.8
Average travelling speed, without (kph)	: 40
Isolation	
Access to Amphoe	
Average distance to Amphoe (km) 1/	: 4.2
Per capita time savings (10^{-4})	: 0.0086
Score	: 253
Access to Artery Highway	
Average distance to highway (km) 1/	: 0
Per capita time savings (10^{-4})	: 0
Score	: 0
Impassability	
Impassable week a year	: -
Impassability per year	: 0
Impassability per capita (10^{-4})	: 0
Score	: 0
Health	
Access to Hospital	
Average distance to Hospital (km) 1/	: 4.2
Per capita time savings (10^{-4})	: 0.086
Score	: 200
Access to Medical Facilities	
Average distance to facilities (km) 1/	: 4.2
Per capita time savings (10^{-4})	: 0.086
Score	: 344
Education	
Access to Secondary School	
Number of Student in 1993 (1,000) 2/	: 1.0
Average distance to school (km)	: 4.2
Per capita time savings (10^{-4})	: 0.467
Score	: 252
Teacher Intensity	
Number of teachers 3/	
University graduate	: -
Total	: 10
Number of Student	: 152
Indicators	
E1 4/	: -
E2 5/	: (51.0)
E 6/	: 51.0
Degree of Improvement 7/	: 1.34
Score	: 85
Disparity	
G.P.V. in 1993 (Mn B) 8/	
With project	: 19.4
Without project	: 18.7
Per capita G.P.V. in 1993 (B)	
With project (W)	: 3,345
Without project (w)	: 3,224
Degree of Disparity	
(A/W) - (A/w) 9/	: 0
Score	: 0
Total Score	: 1,134

Note:

1/ ( ) shows the length or distance in without project case. Unless otherwise, lengthes are same both in with project case and without project case.

2/ Number of secondary school student estimated based on the projected population of the areas of influence applying ratios of secondary school students to the total population in the sample area.

3/ Numbers of the sample areas

4/ (Number of University Graduate Teachers)/(Total Number of Student) x 1,000

5/ (Total of Teachers)/(Total Number of Student) x 1,000

6/ Sum of 4/ and 5/

7/ Ratio of E value of each route to an average value of the same indicator E in case of the sample areas, 33 in number, along paved road near the proposed routes.
The average value of E in case of paved roads were calculated at 68.4 from the following data:

Number of university graduate teachers	438
Number of Teachers	1,285
Number of student	25,196

8/ Estimated gross value of crop production in the areas of influence

9/ "A" indicates an average per capita value of crop production in the Northeastern Region, which is estimated assuming that:
- GRP per capita of the Northeast is estimated at 11,897 Baht in 1993,
- Agricultural sector shares 40% of GRP, and
- Crop production shares 80% of agricultural production.