CHAPTER 10 ALTERNATIVE ROUTE STUDY

10.1 Procedure of Alternative Route Study

The Study Team conducted initial route study using topographic map of 1:10,000 scale and information obtained through field investigations. Many alternative routes, which are referred to as the **"Conceivable Alternative Routes"** in this report, were identified by the initial route study. The procedure of alternative routes study, followed by the selection of an optimum route is a three-step process, as follows:

1) Step-1: Initial Route Study

2) Step-2: Screening of Conceivable Alternative Routes

   i) Initial screening (based on GIS and alignment data)
   ii) Further screening (based on tentative cost estimates)

3) Step-3: Optimum Route Selection

4) Step-4: Comparison with Existing Tribhuvan Highway improvement

10.1.1 Step-1: Initial Route Study

Based on the topographic map of 1:10,000 scale prepared from the existing topographic map of 1:25,000 scale, existing 1:50,000 scale aerial photographs, and information obtained through field investigations, the Study Team identified several Conceivable Alternative Routes. The Conceivable Alternative Routes were selected as having any of following advantages:

- To avoid steep slope zone
- To avoid (potential) disaster area
- To avoid built-up area
- To avoid critical objects such as temple and school
- To avoid cultivated land

10.1.2 Step-2: Screening of Conceivable Alternative Routes

At the beginning of this step, Land Use Map, Hazard Map with Geological Distribution, Slope Gradient Distribution Map and Soil production Map were prepared by satellite's remote sensing data and field information. All data of these maps are stored in digital form using the Geographical Information System (GIS).

Based on the digital maps, quantities of items shown in Table 10.1 for the respective Conceivable Alternative Routes were calculated using GIS.

Table 10.1 Quantified Items for Screening

No.	Item	Representing Factor
1	Road length by surface slope gradient	Construction cost
2	Road length through built-up area	Compensation cost
3	Road length through cultivated area	Land acquisition cost
4	Road length through forest area	Preservation of forest
5	Number of stream crossing and assumed bridge total length	Construction cost (bridge and culverts)
6	Road length through hazard area	Construction cost (disaster prevention/maintenance)
7	Number of crossing of stream with potential debris flow	Construction cost (disaster prevention/maintenance)
8	Horizontal alignment, deflection/km	Vehicle operating cost
9	Vertical alignment, absolute average gradient	Vehicle operating cost

Each quantified item represents a factor of project cost or benefit as mentioned in the table. The Project costs listed in the above table can be classified into following types:

1) Construction, maintenance and operation costs

2) Land acquisition cost and compensation cost for resettlement

The cost in the first category is related to the technical matters, whereas the second category is related to the socio-economical effects. The costs in these two categories cannot also be compared directly at one-to-one basis, the weight of the latter being higher. Hence, it was attempted to minimize the compensation cost as far as possible.

Using the quantities given in the table, all Conceivable Alternative Routes were evaluated in terms of cost and the inferior alternatives were screened out. The screening consists of the following two-step process:

i) Initial screening (Step 2i)

If an alternative has obviously less advantages against other alternatives in the construction, maintenance and operation costs, as well as the land acquisition costs, such alternative is eliminated.

ii) Further screening (Step 2ii)

If the comparison of different alternatives from the values of quantified items does not give clear answer, the rough estimates of construction cost and land acquisition costs are calculated. The comparison is then done with these estimated quantities.

Only those alternatives, which remain after this screening process, are carefully examined in the next step. The alternatives thus remained here are called the **"Possible Alternative Routes".**

10.1.3 Step-3: Optimum Route Selection

Project costs of the Possible Alternative Routes, including construction cost, maintenance cost and land acquisition cost, are roughly estimated. Economical benefits of the Possible Alternative Routes are estimated based on forecasted future traffic volume. The economical evaluation for the respective Possible Alternative Routes is then made. In parallel, magnitudes of environmental and social impact of the Possible Alternatives are evaluated, quantifying the impact as much as possible.

Based on the above estimation about the major project factors (costs, benefits, economic feasibility and environmental/social impact), the optimum route is finally selected. Significance of transfer of knowledge of new technologies for Nepal side will be considered simultaneously in the optimum route selection.

The above procedure is shown in Figure 10.1.

10.1.4 Step-4: Comparison with Existing Tribhuvan Highway Improvement

For the justification of the Project to construct a new alternate road in Kathmandu – Naubise Section, further comparison with other alternatives, which are 4-lane improvements of the existing Tribhuvan Highway, was conducted.

The comparison is carried out by estimating construction cost and land acquisition cost of each alternative.

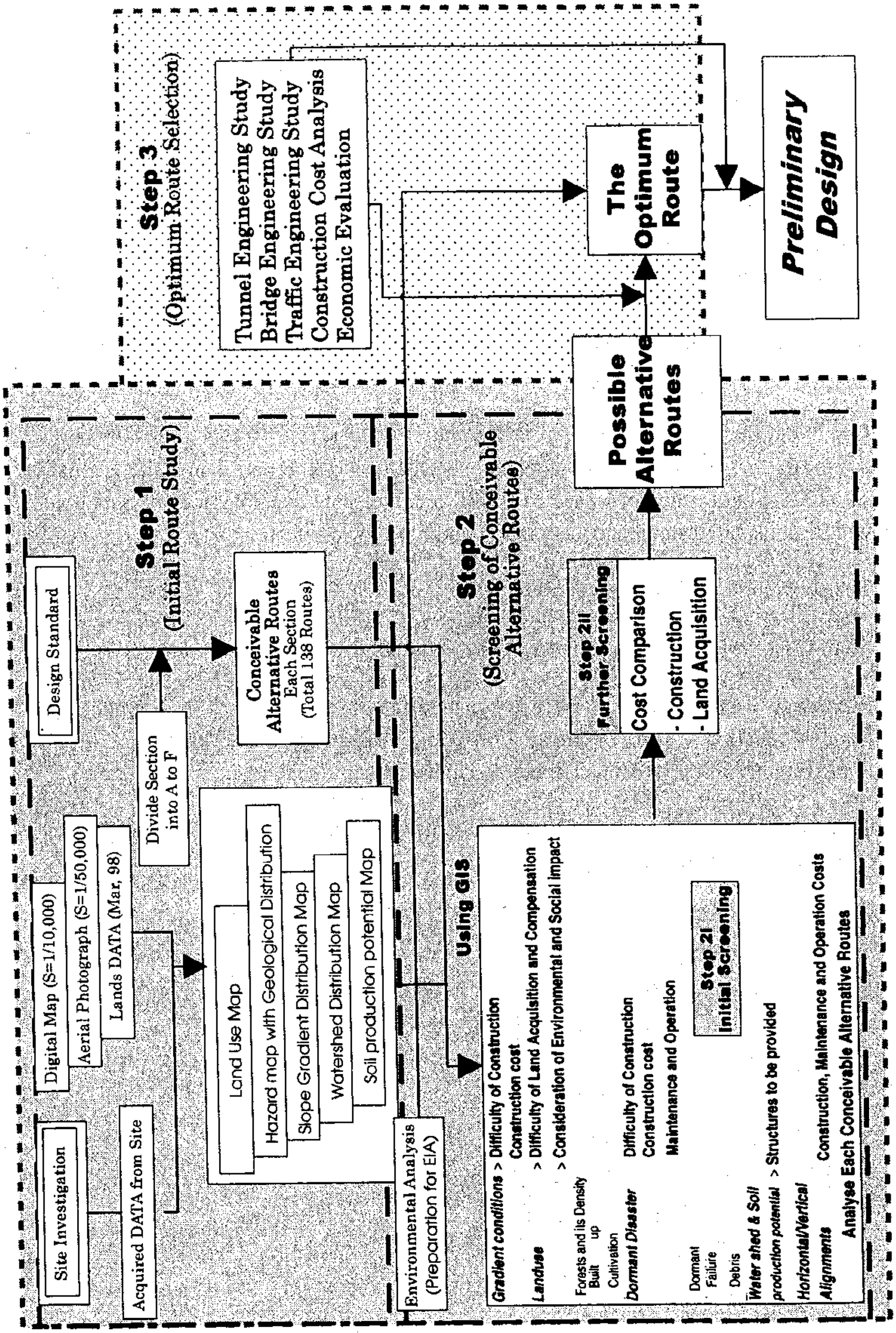


Figure 10.1 Outline Procedure of Alternative Route Study

10.2 Initial Route Study

The Study Team prepared several routes based on field investigation and by utilizing the existing topographic map of 1:25,000 scale. The topo-map was converted to digital 3-D data and a 1:10,000 scale digital-terrain-model (DTM) was prepared.

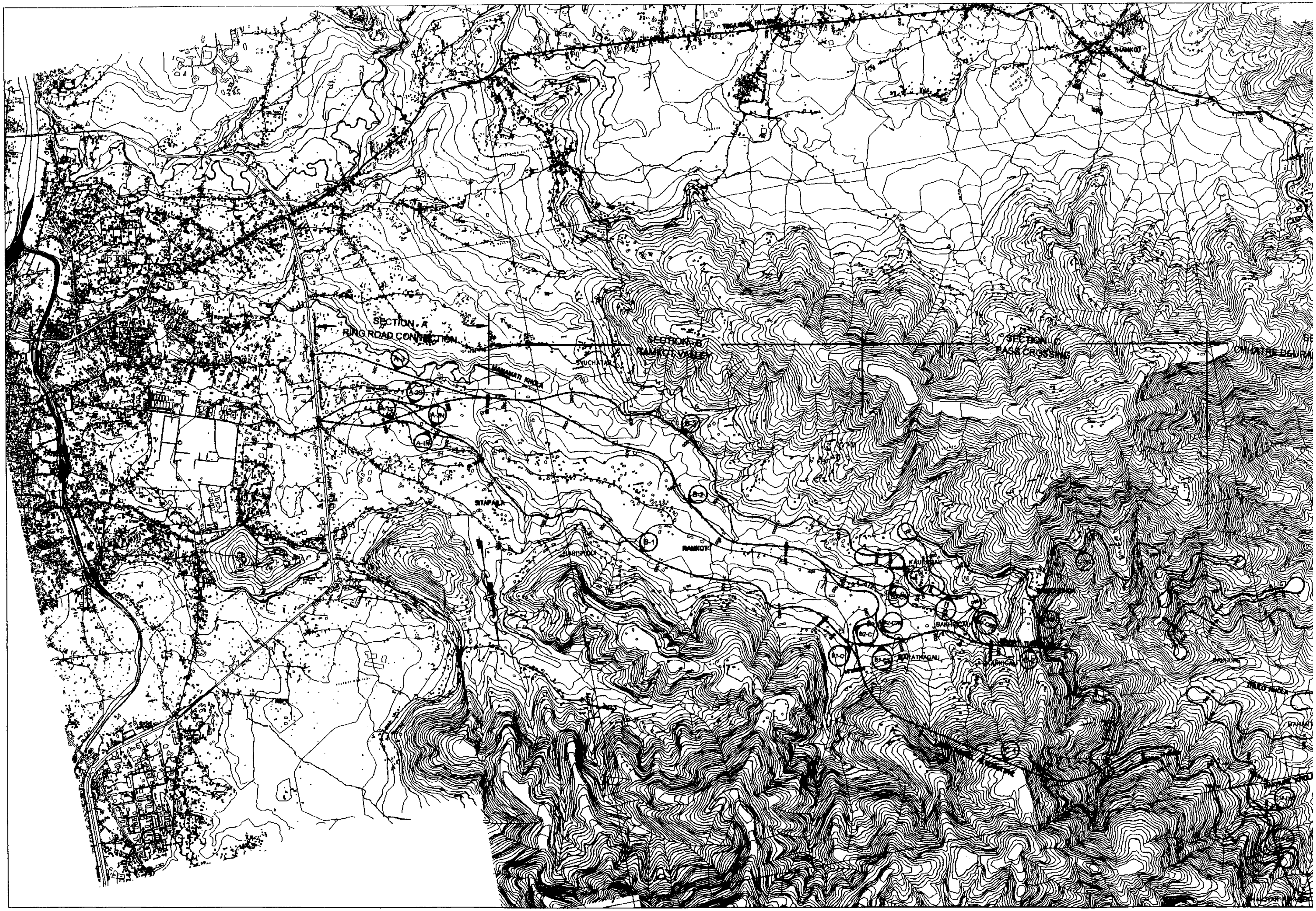
The Conceivable Alternative Routes were prepared by road design CAD and are given in Figure 10.2. The name and length of each section with their alternatives are given in Table 10.2.

Table 10.2 Length of Alternatives in Each Section

Section Name	Alternatives	Length (m)
Section A (Ring Road Connection)	A-1(N)	1318.382
	A-1(S)	1307.633
	A-2(N)	1405.542
	A-2(S)	1320.065
	A-3	1372.128
Section B (Ramkot Valley)	B-1	3051.064
	B-2	2627.739
	B-3	3817.912
Transition B-C	B1-C1	457.764
	B1-C2	1342.692
	B2-C1	1444.371
	B2-C2N	1940.064
	B2-C2S	2926.377
	B2-C3	1779.813
	B3-C2	1312.348
Section C (Pass Crossing)	C-1	2733.233
	C2	2343.566
	C-3(N)	6424.552
	C-3(S)	9349.627
Transition C-D	C12-D3	1821.484
	C3N-D3	1160.106
Section D (Chhatre Deurali Mountain Approach)	D-1	5928.083
	D-2	6142.709
	D-3	4637.705
	D-4	6187.971
Transition D-E	D123-E2	959.364
Section E (Mahesh Khola Plain)	E-1	9180.083
	E-2	7711.153
Section F (Dharke Connection)	F-1	1466.599
	F-2	1652.973
	F-3	898.436

Note: transition sections are required to define each alignment numerically in CAD.

Numerous alignments from the beginning to the end of the Project Road are possible with various combinations of alternatives in each section. A total of 138 different alternative alignments are possible for various combinations.


SECTION - A
RING ROAD CONNECTION
SECTION - B
RAMKOT VALLEY
SECTION - C
PASS CROSSING
MAHAMATI KHOLA
SYUCHATAR
RAMKOT

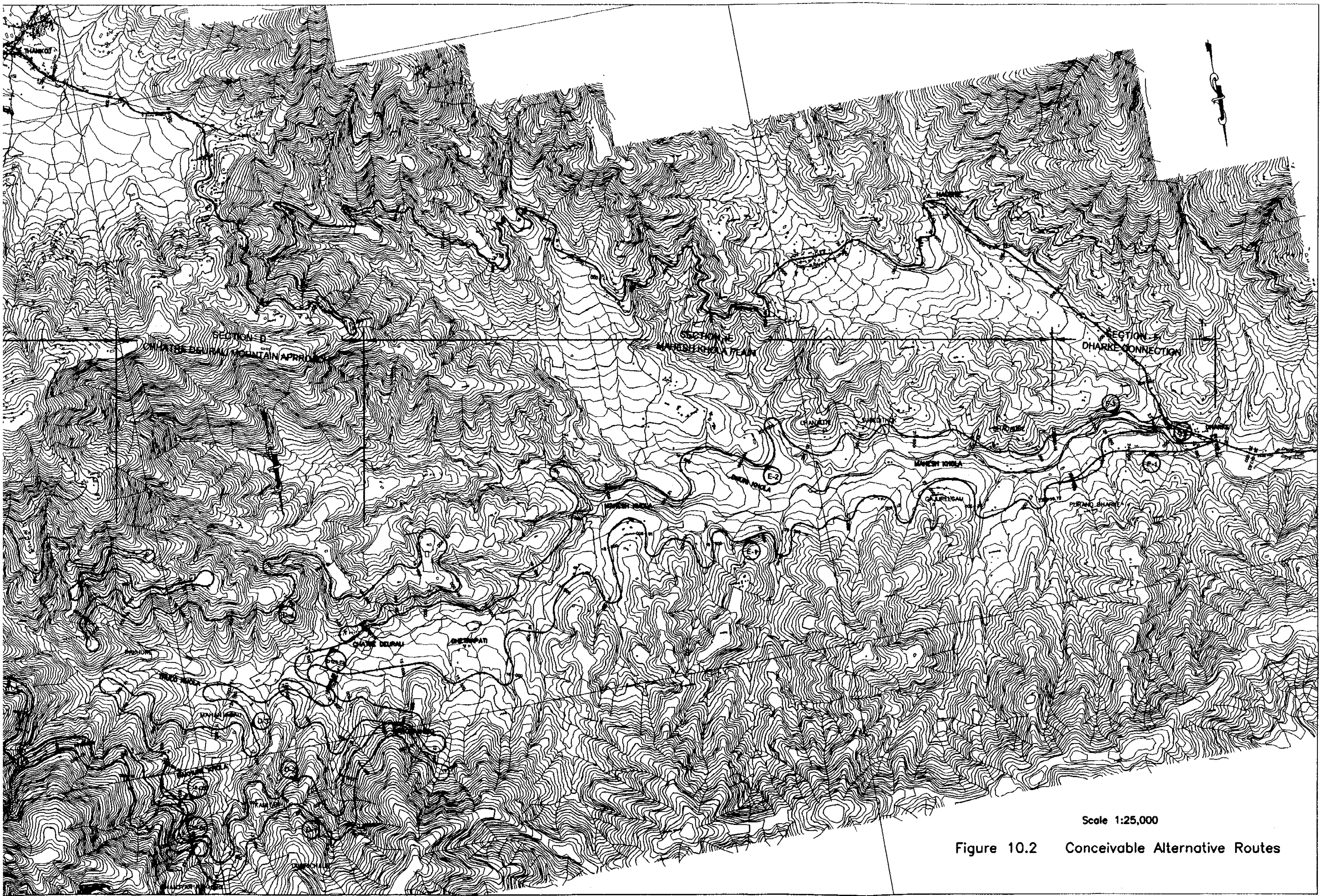


Figure 10.2 Conceivable Alternative Routes

Comparison of each alignment in such case will be complicated. The comparison gets complicated further due to the presence of transition sections. So, the procedure is simplified by doing the comparison section-by-section for the corresponding alternatives inside the section only.

To simplify the procedure further, it is desirable to exclude the transition sections (e.g. Transition B-C, Transition C-D etc), while comparing. However, due to the presence of longer lengths of transition sections, a fair comparison may not be obtained. So, a representative value of any alternative **within a section**, is derived by adding the average of all possible alternative transitions for **that section**.

The comparative lengths of alternatives, calculated as explained above, are given in Table 10.3. It is to be noted that the lengths of transitions are already included and are not needed to add further.

Table 10.3 Comparative Lengths of Alternatives in Each Section

Section Name	Alternatives	Length (m)	Remarks
Section A (Ring Road Connection)	A-1(N)	1318.382	
	A-1(S)	1307.633	
	A-2(N)	1405.542	
	A-2(S)	1320.065	
	A-3	1372.128	
Section B (Ramkot Valley)	B-1	3787.752	including average of transitions
	B-2	4567.803	including average of transitions
	B-3	4198.732	including average of transitions
Section C (Pass Crossing)	C-1	2733.233	
	C2	2343.566	
	C-3(N)	6424.552	
	C-3(S)	9349.627	
Section D (Chhatre Deurali Mountain Approach)	D-1	5928.083	
	D-2	6142.709	
	D-3	6128.500	including average of transitions
	D-4	6187.971	
Section E (Mahesh Khola Plain)	E-1	9180.083	
	E-2	8670.517	including average of transitions
Section F (Dharke Connection)	F-1	1466.599	
	F-2	1652.973	
	F-3	898.436	

10.3 Screening of Conceivable Alternative Routes

As mentioned earlier, the Land Use Map, the Hazard Map with Geological Distribution, the Slope Gradient Distribution Map and the Soil Production Map were prepared by satellite remote sensing data, aerial photographs and field information. All data from these maps were stored in digital format using the Geographical Information System (GIS).

In parallel, the existing topographical map of 1:25,000 scale was converted to digital three dimension topographic map of 1:10,000 and the digital terrain model was generated. The Conceivable Alternative Routes were studied and defined numerically in CAD. From these studies, quantified items for screening as mentioned in Table 10.1 were estimated which are the representative factors of the total Project costs. The results are summarized in Table 10.4.

From the values of the results in Table 10.4, the screening is done through the following two steps of screening process,

i) Step-2i Initial screening

ii) Step-2ii Further screening

10.3.1 Initial screening of Conceivable Alternative Routes

The comparison is done for each alternative, section-by-section, considering the advantages and disadvantages of each alternative. The results of the first step of the screening process are given in Table 10.5. Brief discussions are given below.

Table 10.4 Results of the Quantified Items for Screening

Section	Route	Length (m)	Slope gradient (m)									Built-up area (pixel)	Cultivated Area (pixel)	Forest area (pixel)	No. of structure stream cross.				Dormant Landslide		Slope Failure		Slope Failure trace		Dangerous stream of debris flow		Hz.Algn Deflection (deg/km)	Profile AvgGrade (%)
			0≤i<10	10≤i<15	15≤i<20	20≤i<25	25≤i<30	30≤i<35	35≤i<40	40≤i<45	45≤I				Total No.	Culvert	Minor Bridge	Major Bridge	(m)	No.	(m)	No.	(m)	No.	(m3)	No.		
A	A-1N	1,320	1140	150	30							54	87	6	2	1	0	1	—	—	—	—	—	—	—	—	108	3.3
	A-1S	1,310	1280	30								47	88	6	3	2	1	0	—	—	—	—	—	—	—	—	38	2.9
	A-2N	1,410	1260	120	30							68	76	9	2	1	0	1	—	—	—	—	—	—	—	—	90	1.7
	A-2S	1,320	1320									67	66	6	3	2	1	0	—	—	—	—	—	—	—	—	72	1.5
	A-3	1,380	1380									72	79	4	2	1	1	0	—	—	—	—	—	—	—	—	30	1.7
B	B-1	3,790	2660	770	370							19	342	78	11	5	5	1	155	8					—	—	97	1.6
	B-2	4,570	3630	610	230	30	30					60	396	66	7	6	1	0	10	1					—	—	128	2.0
	B-3	4,200	2320	970	310	290	160	120	20			27	418	181	17	16	1	0	0	0	50	2	120	1	—	—	208	2.3
C	C-1	2,730	150	80	150	300	380	1360	300			0	79	10	1	0	0	1	70	1	—	—	80	2	0	0	81	2.4
	C-2	2,340	0	50	130	130	250	890	530	280	80	0	141	39	6	0	2	4	30	1	—	—	70	3	24,000	6	291	4.3
	C-3N	6,420	550	430	530	910	1390	1060	1010	410	120	4	395	202	22	10	8	4	140	1	—	—	120	6	17,300	14	411	4.9
	C-3S	9,350	740	600	950	1380	1880	1810	1360	500	120	11	474	303	29	18	6	5	160	5	—	—	270	10	17,900	15	538	4.1
D	D-1	5,930	420	530	830	1150	1290	1320	370	20		0	422	89	26	12	12	2	170	2	30	1	120	5	29,800	20	384	4.5
	D-2	6,140	260	260	700	1070	1540	1980	330			2	402	166	26	13	7	6	90	2	67	1	130	3	38,400	18	459	4.8
	D-3	6,130	950	1240	870	1090	1170	720	100			2	531	118	17	9	8	0	-	-	40	2	2	2	50,050	24	480	4.6
	D-4	6,190	440	390	580	1220	1640	1430	490			9	387	246	21	17	2	2	180	4	—	—	80	1	22,900	26	481	4.0
E	E-1	9,180	4590	2300	1260	580	390	70				13	942	39	24	17	7	0	110	2	80	3	—	—	175,800	47	384	2.0
	E-2	8,670	1680	2250	1540	1560	1020	450	140	20		5	727	152	27	16	8	3	200	7	30	1	60	1	374,600	52	329	2.3
F	F-1	1,470	960	330	180							14	138	2	4	3	0	1	—	—	—	—	—	—	92,300	10	124	3.3
	F-2	1,650	850	180	300	130	130	80				14	159	3	4	3	0	1	—	—	—	—	—	—	5,962,600	13	262	2.9
	F-3	900	140	160	210	230	70	90				4	40	23	1	0	0	1	—	—	—	—	—	—	27,600	8	239	3.9

Table 10.5 Results of Initial Screening of Conceivable Alternative Routes

Section	Route	Advantages	Disadvantages	Remarks	Result
A	A-1N	Continuation of road from Chauni	through highly built-up area	These alternatives pass through highly built-up area along existing road, the construction and other costs are almost same in all alternatives.	Screened Out
	A-1S	Continuation of road from Chauni	through highly built-up area		
	A-2N	Continuation of road from Chauni, avoids cutting	through highly built-up area		
	A-2S	Continuation of road from Chauni, avoids cutting	through highly built-up area		
	A-3	Comparatively less built-up area.	along Manamati River	Smooth future connection to Kathmandu city.	Remains
B	B-1	1) shorter length (-800m to B-2 and -400m to B-3 2) a little less land acquisition 3) less horizontal deflection angle 4) less average profile gradient	1) 1-major and 5-minor bridges 2) No. and length of dormant landslide is higher 3) though total area of land acquisition is less the 4) slope gradient in higher range is more	Disadvantages are more both in terms of construction, maintenance and operation costs as well as land acquistion costs compared to other alternatives.	Screened Out
	B-2	1) least slope gradient 2) least stream crossing and only 1-minor bridge 3) no slope failures and landslides 4) moderate horizontal and vertical alignment	1) longer length 2) a little higher land acquisition area	Though the length is little longer and land acquisition area is more, the construction cost is reduced drastically. The horizontal and vertical alignments are good.	Remains
	B-3	1) only one minor bridge 2) less built-up area 3) less unit cost for land acquisition	1) 16-culverts, highest number 2) slope gradient in higher range is highest 3) several slope failures 4) higher deflection and profile gradient	Though no. of culverts are more, passes through some slope failure areas, construction cost is lower than of B-1, whereas land acquisition cost may be lower than of B-2 and shall be compared in detail.	Remains
C	C-1	**Long tunnel option, detailed investigation needed**			Remains
	C-2	**Short tunnel optioin, detailed investigation needed**			Remains
	C-3N	1) among no tunnel option, short length 2) less slope gradient 3) less land acquisition 4) less stream crossing 5) only 4-major bridges 6) less horizontal deflection angle	1) a little higher average profile gradient 2) 8-minor bridges	Comparing two alternatives with no tunnel, the construction and maintenance costs, land acquisition costs are considerably lower.	Remains
	C-3S	1) a little less average profile gradient 2) 6-minor bridges	1) longer length 2) higher slope gradient 3) higher land acquisition 4) more stream crossings 5) 5-major bridges 6) higher horizontal deflection angle	Comparing two alternatives with no tunnel, the construction and maintenance costs, land acquisition costs are considerably higher.	Screened Out
D	D-1	1) a little shorter length 2) moderate land acquisition 3) least deflection angle 4) only 2-major bridges	1) highest stream crossings 2) highest number of minor bridges 3) two dormant landslides 4) slope failures	Tentative estimate of construction and land acquistion cost is required.	Remains
	D-2	1) moderate land acquisition 2) moderate number of minor bridges	1) highest slope gradient 2) 6-major bridges 3) two dormant landslides 4) slope failures 5) highest profile gradient	Tentative estimate of construction and land acquistion cost is required.	Remains
	D-3	1) least and most favorable slope gradient 2) least stream crossings 3) no major bridge	1) highest land acquisition 2) higher debris flow	Tentative estimate of construction and land acquistion cost is required.	Remains
	D-4	1) least average profile gradient 2) less cultivated area	1) higher slope gradient 2) highest forest area 3) 4-dormant landslides 4) Highest built up area 5) moderate stream crossings 6) 2-major bridges 7) highest deflection angle	Comparing alternatives from north hillside of Thulo khola, higher construction and land acquisition costs.	Screened Out
E	E-1	1) less slope gradient 2) less unit cost for land acquisition 3) less stream crossing 4) less minor bridge and no major bridge 5) less dormant landslides 6) less debris flow 7) less average profile gradient	1) higher land acquisition area 2) a little higher horizontal deflection angle	Though the land acquistion area is higher, the total land acquisition cost is less than in the other alternative, because the unit cost is much less. Other construction cost is drastically less mainly because of no major bridges.	Remains
	E-2	1) less land acquisition area 2) less horizontal deflection angle	1) higher slope gradient 2) higher unit cost for land acquisition 3) more stream crossings 4) 2-major bridges 5) high debris flow from Dhuni River	Though the land acquistion area is less, the total land acquisition cost is higher, because the unit cost is high. Other construction cost is drastically increased because of 2-major bridges.	Screened Out
F	F-1	1) protected from debris flow in ubise khola 2) least slope gradient	1) 4-culverts	The main point is, the alignment will not be affected by the debris flow in Naubise khola.	Remains
	F-2	1) least profile gradient	1) high slope gradient 2) very high debris flow	Affected by the debris flow in Naubise khola.	Screened Out
	F-3	1) less debris flow 2) less built-up area	1) highest horizontal deflection 2) highest profile gradient 3) longer bridge length	Higher construction cost, and if E-2 is screened out, automatically screen out too.	Screened Out

Section A (Ring Road Connection)

The selection of the optimum route in this section needs detailed investigation of the area. The biggest issue in this section is the land acquisition that will become the major control point in selecting the optimum route. Since the area is densely built-up, and is close to the Kathmandu city, fixing of alignment in any of the alternatives will need careful investigation to minimize the land acquisition cost. The total length of this section is not very significant to produce a large difference in the construction, maintenance or operating cost between each alternative.

So, the selection of optimum route in this section was done after detailed survey was completed, that was after the Interim Report presentation. During the Progress Report presentation, the alternative B-1 in section B was screened out and hence the alternatives A-1 (N) and A-2 (N) were also automatically screened out.

The location of the starting point of A-1 (S) and A-2 (S) were selected in view that the road coming from Chauni will be improved to provide smooth connection to the city. However, after the examination, the widening of the Chauni road seems very difficult due to urbanized area of Kathmandu core city. After the detailed survey, it was concluded that alternative A-2 (S) should be screened out because it passes through the center of built-up area in Sitapaila. The main objective of the alternative A-1 (S) was to minimize the land acquisition cost (presumed from existing 1:25,000 scale map). However, after the detailed survey, it was found that the number of affected houses was more mainly because this alternative crosses the existing road twice. Besides, due to the existing road, the unit cost of land adjacent to the road is comparatively higher than along the Manamati river (Alternative A-3). In view of these reasons and that the Chauni road cannot also be improved, this alternative was also screened out.

Alternative A-3 utilizes the alluvial deposit along the Manamati river. The construction and maintenance costs are not significantly different in any of the alternatives, due to shorter length of this section.

The road coming out from Kathmandu city, Kalimati-Kalanki road is already operating near to capacity. The widening of this road may require large compensation to houses on both sides of the road. Planning of road from Soaltee Mod along Manamati River to Ring road is another alternative for this access, which is out of the scope of this Study. However, careful examination of this possibility is recommended in future. In view of this possibility, it is desirable to establish the connection point of this Project road on Ring Road as that of alternative A-3. The unit cost of land along this alternative is also relatively less because it is far from the existing road.

So, the alternative A-3 has been recommended as the optimum route in Section A and thus the remaining alternative in this Section is,

1) Alternative A-3

Section B (Ramkot Valley)

Comparing the advantages and the disadvantages of each alternative, it was concluded that Alternative B-1 has high construction cost as well as land acquisition cost and hence was screened out.

The construction cost of Alternative B-2 seems less than that of Alternative B-3, but the land acquisition cost may be reversed for the two cases. So the estimates of the remaining alternatives were done and were compared against the land acquisition costs that will be described in the next step (further screening process) of this Study.

Thus the remaining alternatives in this section are:

1) Alternative B-2

2) Alternative B-3

Section C (Pass Crossing)

The long tunnel option and the short tunnel options will be compared in the next stage of this study that needs consideration of various aspects of the construction, maintenance and the operation costs.

The option without tunnel has two alternatives, one from the north (C-3N) and the other from the south (C-3S) hillside of Thulo Khola.

When these two alternatives are compared, the alternative from the south hill side, C-3(S) seems to have obviously high construction and maintenance cost as well as land acquisition cost. So this alternative is also proposed to be screened out from further comparison. The remaining alternatives in this section are:

1) Alternative C-1; Long Tunnel Option

2) Alternative C-2; Short Tunnel Option

3) Alternative C-3 (N); open option without tunnel

Section D (Chattre Deurali Mountain Approach)

Among the four of the alternatives in this section, it was concluded that the construction, maintenance and the operation costs as well as the land acquisition costs in Alternative D-4 is high compared to other options and is also proposed to be screened out from further comparison process.

However, though the construction and maintenance cost of the Alternative D-3, which utilizes the most gentle slope of the terrain is low, the land acquisition seems to be higher as it passes through agricultural land for longer length than other alternatives. So rough estimates of the remaining alternatives were done and compared against the land acquisition cost. This will be described in the Second Step of the screening process, later in this section. The remaining alternatives from first screening process in this section are:

1) Alternative D-1

2) Alternative D-2

3) Alternative D-3

Section E (Mahesh Khola Plain)

The construction cost of the Alternative E-2 is obviously higher because of presence of two major bridges. Besides, the terrain condition is also not good comparatively in this section. Though the land acquisition area is lesser in this alternative, the total land acquisition cost was found to be higher than the other alternative. The land price along E-2 is higher because it is closer to the existing Trivuban Highway and has better access to it. So, the Alternative E-2 is also screened out from further comparison. The remaining alternative in this section is,

1) Alternative E-1

Section F (Dharke Connection)

The alternatives F-2 and F-3 were found to be more expensive because consideration to the debris flow of Naubise Khola is required. The locations of these two alternatives are affected by the debris flow of Naubise Khola and hence are proposed to be screened out. The remaining alternative in this section is;

1) Alternative F-1

10.3.2 Further screening of Conceivable Alternative Routes

From the results of the initial screening process, it was concluded that the remaining two alternatives in Section B and three alternatives in Section D should be further compared from the rough estimates of the construction cost and the land acquisition cost.

Section B (Ramkot Valley)

The quantities of major work items and land acquisition were calculated for each remaining Alternatives B-2 and B-3 and, the approximate cost estimate was done. The result of the cost estimate is given in Table 10.6.

Table 10.6 Approximate Cost Estimate of Remaining Alternatives in Section B

	Alternative B-2	**Alternative B-3**
Total Construction Cost (NRs)	231,364,000	288,937,000
Total Land Acquisition Cost (NRs)	7,827,960	4,336,500

From the above results, the difference in construction cost of the Alternative B-2 is 58 million NRs. less than that of Alternative B-3, whereas the increase in Land Acquisition Cost in Alternative B-2 is only about 3.5 million NRs. more than that of Alternative B-3. Besides, Alternative B-3 passes through difficult terrain conditions and the effect on forest area is considerably large in this alternative. So it was concluded to screen out Alternative B-3 from further comparison.

Section D (Chattre Deurali Mountain Approach)

From the results of the initial screening process, it was concluded that the remaining three alternatives in Section D should further be compared from the rough estimates of the construction cost and the land acquisition cost.

The quantities were calculated for each Alternative D-1, D-2, and D-3 and the estimate was done. The result of the cost estimate is given in Table 10.7.

Table 10.7 Approximate Cost Estimate of Remaining Alternatives in Section D

	D-1	**D-2**	**D-3**
Total Construction Cost (NRs)	1,980,033,000	1,771,302,000	1,079,433,000
Total Land Acquisition Cost (NRs)	4,542,000	3,978,000	6,862,000

From the above results, the difference in construction cost of Alternative D-3 is almost half the construction cost of Alternatives D-1 and D-2. The construction cost of the Alternative D-3 is about 800 million Nepalese Rupees less in average than other two alternatives, where as the increase in Land Acquisition cost in this alternative is only about 2.6 million Nepalese Rupees, on average. So it has been concluded that substantially lower construction cost of this alternative will be considered as the major factor for selecting this alternative and the other two alternatives; Alternative D-1 and Alternative D-2, will be screened out from further comparison.

The remaining alternative in this section is thus,

1) Alternative D-3

10.3.3 Results of the Screening of Conceivable Alternative Routes

The remaining alternatives after the screening of Conceivable Alternative Routes are given in Table 10.8. These remaining alternatives are compared in the next step of the Alternative Route Study process.

Table 10.8 Remaining Alternatives after Screening

Section Name	Alternatives
Section A (Ring Road Connection)	A-3
Section B (Ramkot Valley)	B-2
Transition B-C	B2-C1
	B2-C2S
	B2-C3
Section C (Pass Crossing)	C-1
	C2
	C-3(N)
Transition C-D	C12-D3
	C3N-D3
Section D (Chhatre Deurali Mountain Approach)	D-3
Section E (Mahesh Khola Plain)	E-1
Section F (Dharke Connection)	F-1

10.4 Optimum Route Selection

10.4.1 Possible Alternative Routes

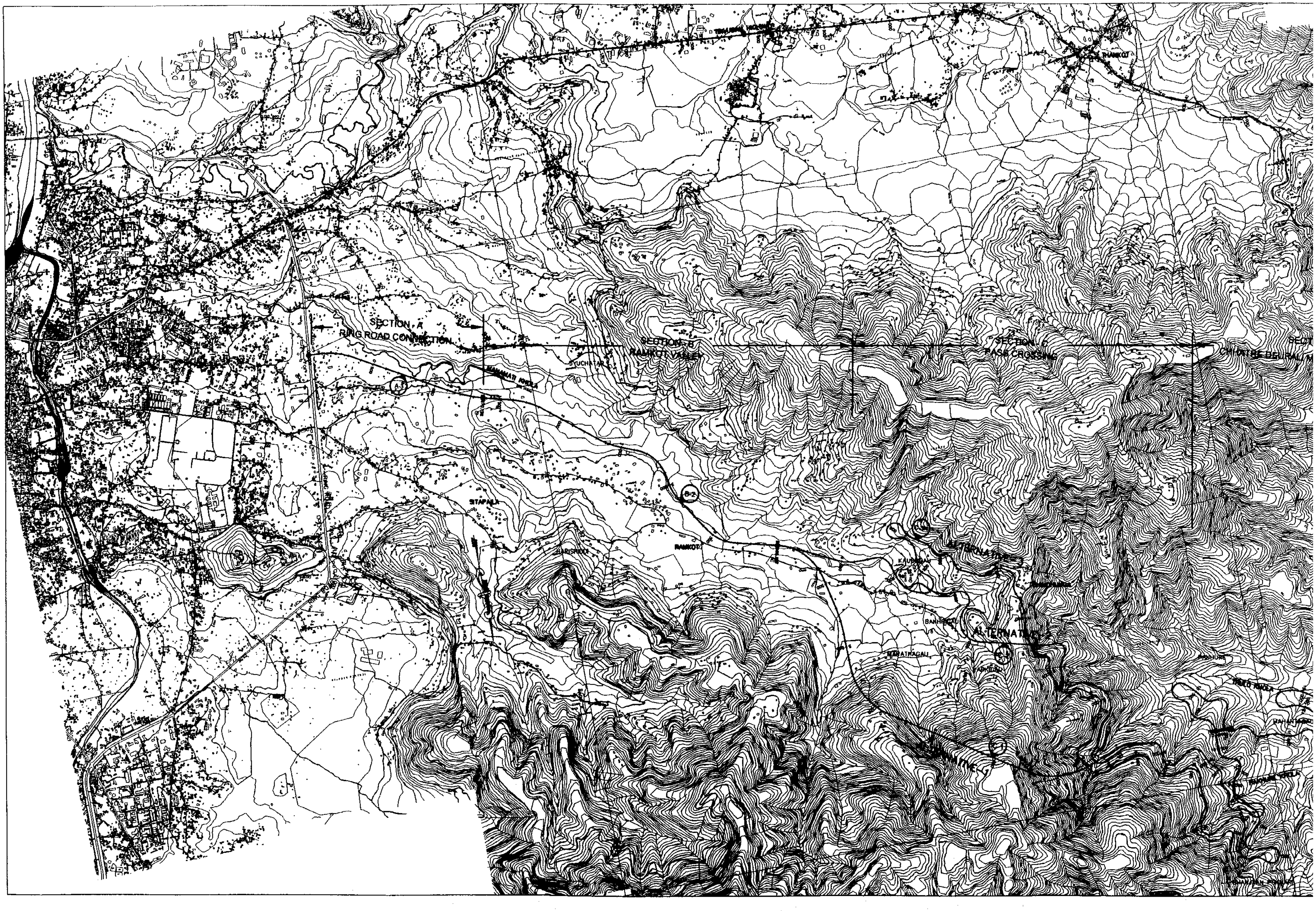
From the above study, only one route alternative is selected in each Sections of A, B, D, E, and F. Selection of the optimum alternative route in Section C requires further detailed study.

Alternative C-1 and C-2 include tunnels, so that the construction costs of these alternatives are expected to be higher than that of Alternative C-3 naturally. Therefore it is proposed to evaluate each alternative in Section C by calculating EIRR. Furthermore, calculation of EIRR should not be based on the quantities of alternatives is Section C alone, but overall of the Project. In order to do the comparison among the alternatives for the whole project length, alternatives (Possible Alternative Routes) are re-composed for the whole project length and are shown in Table 10.9 and Figure 10.3. These possible alternative routes are renamed as Alternative 1, 2 and 3. For comparison purposes the horizontal and vertical alignments have been fine-tuned to provide better alignment against topography.

Table 10.9 Composition of New Alternatives (Possible Alternative Routes)

Section	Possible Alternative Routes			Remarks
	Alternative 1	Alternative 2	Alternative 3	
A	A-3	A-3	A-3	Selected after detailed survey
B	B-2	B-2	B-2	Selected in interim report
C	C-1	C-2	C3-N	
D	D-3	D-3	D-3	Selected in progress report
E	E-1	E-1	E-1	Selected in progress report
F	F-1	F-1	F-1	Selected in progress report

The vertical profiles of each alternative in Section C are shown in Figure 10.4. The boundary of Section C has been re-adjusted such that all the alternatives in this section starts and ends at same points and includes all the required transitions from Section B to C and Section C to D. The geological profiles along the tunnel routes are also given in Figure 10.5.


SECTION - A
RING ROAD CONNECTION
SECTION - B
RAMKOT VALLEY
SYUCHATAR
SECTION - C
PASS CROSSING
SITAPAILA
RAMKOT

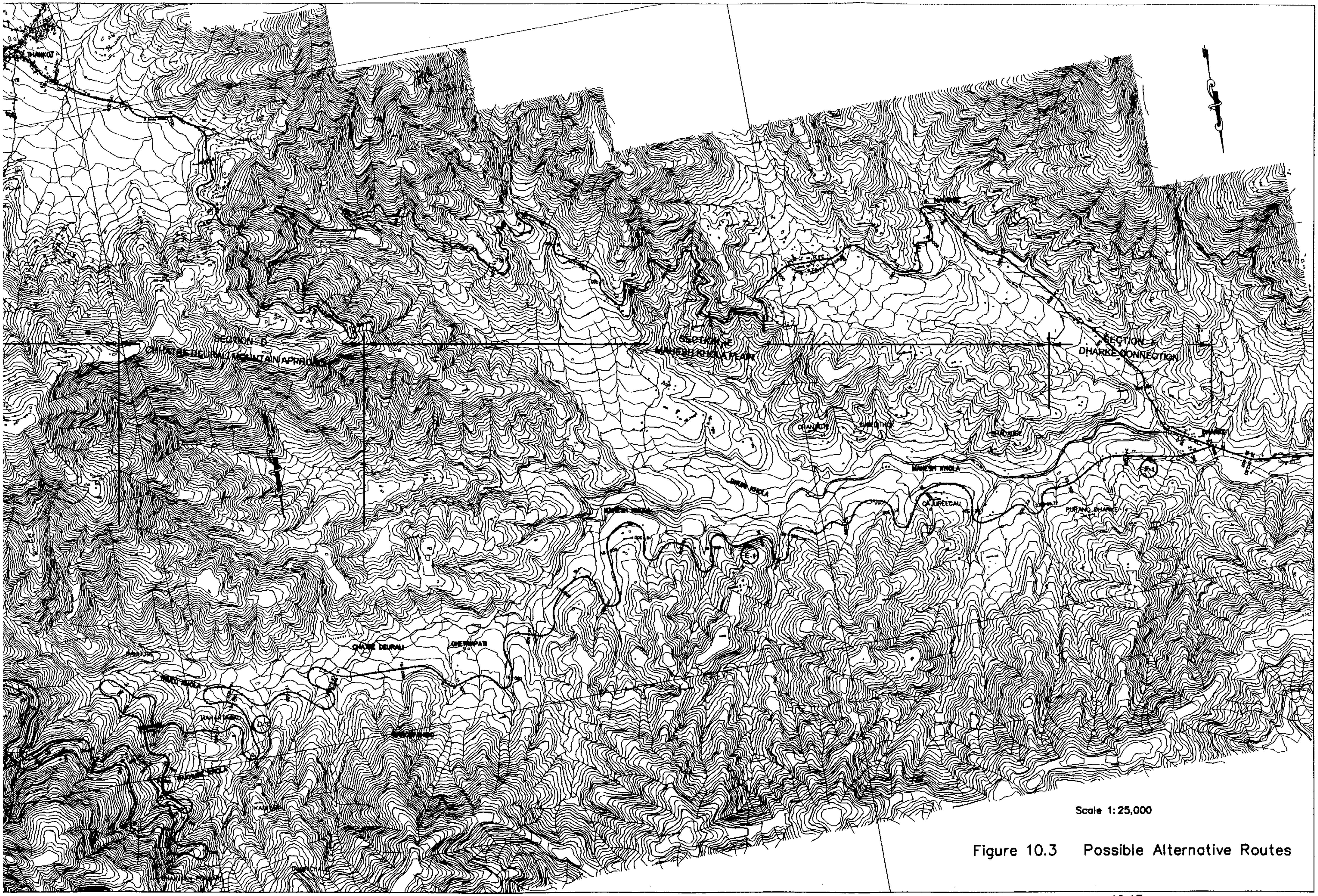


Figure 10.3 Possible Alternative Routes