

**MINISTRY OF TRANSPORT
PROJECT MANAGEMENT UNIT 85 (PMU85)**

**Da Nang - Quang Ngai Expressway Project
Feasibility Study**



PART 1 - MAIN REPORT

April 2010

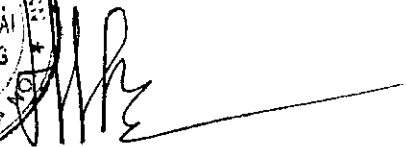
Da Nang – Quang Ngai Expressway Project Feasibility Study

PART 1 – MAIN REPORT

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Hanoi, April 2010

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Acronyms & Abbreviations

AADT	Annual Average Daily Traffic
ADB	Asian Development Bank
AN	Airport Network
CPCS	CPCS Transcom Limited
DA	Domestic Airport
DQE	Danang-Quang Ngai Expressway Project
DR	District Road
DWT	Deadweight Tonnage
EZ	Economic Zone
F/S	Feasibility Study
GDP	Gross Domestic Product
Ha	Hectare
ICAO	International Civil Aviation Organization
IMF	International Monetary Fund
IA	International Airport
IC	Interchange
IG	Industrial Group
IZ	Industrial Zone
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JETRO	Japan External Trade Organization
Km	Kilometer
Kph	Kilometer per hour
HH	Household
LGV	Large Goods Vehicle
M	Meter
min	minute
MOT	Ministry of Transport
NH	National Highway
NK	Nippon Koei
PMU	Project Management Unit
PR	Provincial Road
TCXDVN	Vietnam Construction Standard

TCVN	Vietnam Standard
TCN	Branch Standard
TEDI	Transport Engineering Design Inc.
VEC	Vietnam Expressway Corporation
VND	Vietnamese Dong
VO	Variation Order
VOT	Value of Time
V/C	Volume to Capacity Ratio
WB	World Bank

CHAPTER 1 - GENERAL INTRODUCTION

1.1 Background

The Pre-F/S and the F/S of the Da Nang - Quang Ngai Expressway Project in BOT form were approved to be implemented by the Vietnamese Ministry of Transport (MOT) according to Decision No. 2654/QD-BGTVT dated 11/09/2000 and Decision No. 134/QD-BGTVT dated 14/01/2004. The Pre-F/S of the above project prepared by TEDI was also approved by the Prime Minister in the Decision No. 493/CP-CN dated 21/04/2003. However, the F/S that was prepared by TEDI and submitted to MOT by PMU85 on May 2005 has not been approved due to the fact that investment funding source for the project has not been found.

For the purpose of supporting Vietnamese Government to find ODA, JETRO study has been conducted by association of Nippon Koei and Nippon Engineering (hereafter called JETRO Consultant) funded by Japanese Ministry of Economy, Trade and Industry (METI) based on the updated F/S of TEDI in 2005. The JETRO study was completed in April 2008.

At the same time, the World Bank (WB) has announced to the MOT regarding allocation of IDA and IBRD loan for the project. In April and June 2008, the WB's Work Team visited the site and determined preparation plan for the Da Nang - Quang Ngai Expressway Construction Project. According to the Memorandum of Understanding of WB on 14/7/2008, basically WB has agreed the study options proposed by the JETRO Consultant. However, WB also noted some issues to be further studied before making investment decision as follows:

- Based on resurvey result of the entire route, the alignment will be revised to avoid affecting the control points within the project area such as culture heritages, industrial zones and 500KV high-voltage transmission line...; reducing agricultural land acquisition area as well as number of intersections in Quang Ngai province. Location of the end point at the South should be selected so that the expressway is connected to the provincial road used as the planned Southern ring road of Quang Ngai city.

- Information from EIA, RAP Report, land acquisition compensation, as well as economic and financial analysis to be updated according to the WB's requirements.

To solve the above mentioned matters, WB has agreed with MOT on selecting a consulting service to update and finalize the F/S funded by WB before issuing the investment decision. The PMU85 under MOT is appointed to take charge of management of the Project, and the Nippon Koei - Japan is selected as the F/S Update & Finalization Consultant .

In the F/S updating and finalizing stage, the Nippon Koei Consultant implemented natural condition survey of re-alignment section with the following works:

(1) Updating the selection of alignment, and profile survey following the centerline for entire length of the main road and appropriate length of the connection road;

(2) Updating, field survey the design method of bridge, survey of river's cross-section at 8 large and medium bridges on the realignment route;

(3) Geological survey at 13 large and medium bridges on the realignment route, including viaduct area;

(4) Records of flood water level will be considered and updated for both F/S of TEDI in 2005 and the site survey of realignment route;

(5) Updating ITS;

(6) Updating drawings;

(7) Updating construction quantities;

(8) Updating cost estimate;

(9) Updating economic and financial analysis, operation and maintenance.

After Nippon Koei Consultant completed updated and finalized F/S, MOT has appointed TEDI to review this updated and finalized F/S. The main contents to be studied and added in CPCS Study are as follows:

- It is proposed to realign 2 sections (Km0-Km16 and Km112-Km129) and add 1 connection section to NH1A with 9.5km long according to the proposal of Quang Ngai PC;

- It is suggested to consider and select intersection locations and types to reduce profile elevation;

- It is required to survey and update survey data and hydrological calculation data;

- It is requested to review bridge width, seismic acceleration coefficient, pavement structure;

- It is required to analyze more carefully topographic, geological and hydrological conditions in order to arrange appropriately viaducts.

Concurrently, WB also selected an independent consultant (CPCS) to review the Updated and Finalized F/S of Nippon Koei. The following are main contents on the F/S of CPCS:

- It is required to analyze local transport demand to determine quantity underbridges and flyovers;

- It is proposed to increase design speed from 100km/h to 120km/h;
- Regarding alignment: it is suggested to arrange the horizontal curves in combination with vertical curves on the route;
- It is required to analyze more carefully hydrological conditions in order to consider finished design elevation and pay attention on railway effect;
- It is suggested to re-study locations and limits of viaducts; replacement by box culverts is also considered. Careful hydrological analysis and review of railway barrier effect;
- It is required to re-study intersection types;
- It is proposed to consider semi-hard pavement and cement concrete pavement for local roads;
- It is required to reduce width of emergency lane;
- It is required to explain more about the plan to prevent transport means from entering expressway;
- Regarding operation and maintenance: it is suggested to consider one unified management office in stead of the option of 2 offices at Da Nang and Tam Ky;
- Regarding toll system: It is proposed to consider manual toll system to reduce cost;
- It is required to update the cost estimate, unit price to match the time of setting total cost.

1.2 Existing situation of Project documents

(1) The F/S prepared by TEDI in 2005

The F/S of TEDI was prepared based on requirements and contents of the F/S preparation works according to Vietnamese Government's regulations in 2005 pursuant to Draft of Survey and Design approved by the MOT. However, the studies have not conformed to the Sponsors's request, especially in environmental and resettlement matters. In addition, due to limited funds, the proposed alignment and construction scale is not really appropriate to the technical requirements of the Expressway.

(2) Updated documents prepared by JETRO

The Documents prepared by JETRO is only Update and Supplementary Report for the Description section of the F/S prepared by TEDI without any site survey. The alignment proposed in JETRO's study is not revised at all against the F/S of TEDI in 2005 except addition of one 540m-long tunnel at Km22. In JETRO's study, traffic volume forecast is added, it adjusts some large bridges' structure,

adjusts some intersection types, adds some contents such as expressway management and operation, and the project financial analysis...

(3) Project updating and finalizing documents prepared by NIPPONKOEI

Updated and Final F/S of NIPPONKOEI with the tasks mentioned in article 2.1 is conforming to TOR approved by WB. The Report of NIPPONKOEI is inclusive of the following:

• Survey Reports

- Topographic Survey Report:

+ “Primary Control Survey (benchmark)” established by GPS technology.

+ Centerline profile document.

+ Profile of centerline of cross line

+ Cross section of river.

- Geological Investigation Reports: drilling at 13 bridges. Average drilling is 01 borehole for each bridge, drilling 02 boreholes for Tra Khuc and Tra Bong bridge.

- Hydrological Survey Report: water level investigation is carried out for the following sections:

+ Section Km0 - Km20.

+ Section Km65 - Km77.

+ Section Km101 - Km111.

+ Section Km124 - Km129.

+ Hydrological investigation at some bridge locations

• Design Documents

Design Documents consist of:

- General Report

- Drawings:

+ For road part: topo-map has scale of 1/25.000, profile with horizontal scale of 1/10.000, there is no cross section drawing,

+ Intersections: intersections are shown in topo-map scale of 1/25.000 only.

+ Bridge part: only general layouts and typical cross sections are shown.

+ Facilities: there are location drawings of centers, toll plazas and managements building, typical drawings of traffic management building and toll plaza.

(4) Comments on the project documents

With implementation process and existing documents mentioned above, it is recognized that Report prepared by TEDI in 2005 basically satisfies requirements

and regulations on content of F/S Report under Vietnamese rules. However, the documents have some limitations as discussed above.

For NipponKoei's Study, refer to Vietnamese standards on contents of F/S or Investment project preparation, survey and design works of NipponKoei has not met the requirements mentioned in the Decision No. 48/2008/QĐ-TTĐ dated 03/4/2008 of Prime Minister regarding general instruction of F/S Report preparation using official development support fund of 5 Bank group and requirements on document contents according to Vietnam standard, branch standard. Unqualified issues of the Report of NipponKoei are details of survey data as well as design solutions, construction quantity to prepare Total investment and agreement with relevant agencies..

The alignment proposed in the NipponKoei's Study consists of 6 sections with length of 52km/130km, distant from the alignment prepared by TEDI in 2005 about 0.8km - 1.5km, remaining sections are distant only tens to 100m. The proposed alignment is nice, appropriate to technical requirements of the expressway.

1.3 Scope of work of F/S Updating and Finalizing Consulting Service:

In accordance with Notice No. 422/TB-BGTĐT issued by MOT dated 23/9/2009 and the letter dated 22/9/2009 of WB in Vietnam, the scope of work proposed in Updating and Finalizing F/S Report are as follows:

(1) Site Survey: In order to assure progress and meet project completion works, the site survey will be conducted as bellows:

- Topographic survey: for 3 sections (Km0-Km16, Km58-Km68, Km109-Km129) and additional sections connecting to NH1A.
- Hydrological survey: collecting and surveying hydrological data for entire route.
- Geological investigation: only for Km 109-Km129 (because the proposed route is far away from the existing route) and additional section connecting to the NH1A (the new route). In stead of carrying out geological investigation for the other sections, geological investigation results of TEDI in 2003 and of NipponKoei in 2009 will be reused and referred..
- Carrying out traffic survey and traffic volume forecast.
- Working with local authorities on issues concerning the project.

(2) F/S Report: The Consultant will review the F/S of TEDI in 2005, the F/S of NipponKoei in combination with comments of the CPCS to finalize F/S Report of the Project. In which, Traffic demand forecast and Financial and Economic efficiency analysis of the project will be used and updated by the Consultant according to forecast and analysis results prepared by CPCS; EIA and resettlement will be conducted by other consultant.

(3) **Basic design:** Due to the fact that project progress is very urgent and implementation process underwent periods with many studies of different Consultants (local and foreign consultants), finalization of basic design of the project in accordance with Vietnamese requirements is very difficult. It is supposed to take time, large quantity of site survey and huge expense. Accordingly, the Consultant proposes to prepare Basic design of the project within scope of this consulting services as follows:

- Hydrological calculation for entire route.
- For realignment sections such as Km0-Km16, Km58-Km68, Km109-Km129 and additional section connecting to NH1A, basic design will be prepared and new design results will be updated.
- For remaining sections, design document of NipponKoei will be updated and adjusted with the following details:
 - + Topo-mapping scale 1/5000 from satellite photograph and preparing profile in the Updated and Final F/S Report of NipponKoei.
 - + Reviewing and adjusting the profile in the Updated and Final F/S Report of NipponKoei based on data from the Survey and Design Report prepared by TEDI in 2005; updating hydrological calculation results and working result with locals that the project passing by.
 - + Recalculating quantity and updating cost estimate.

1.4 Brief of Study Result

1.4.1. Brief of Nippon Koei' Study Result

(1) Alignment

The Da Nang - Quang Ngai Expressway has the beginning point intersecting with NH14B under Da Nang area, the ending point intersecting with the ring road of Quang Ngai City, Quang Ngai province. Its length is about 130.2Km (Da Nang: 7.9Km; Quang Nam: 91.7Km; Quang Ngai: 30.6Km)

The alignment runs towards the West of the existing North - South Railway.

(2) Scope and Technical standard:

Type A expressway, class 100. Scope of this expressway in the stage 1 is 4-lane expressway and 6-lane expressway in the final stage.

(3) Design results and main construction quantity (Proposed option):

- Route length : 130,2Km.
- In the stage 1, the expressway is constructed as 4 lanes, width is 26.0m; reserving for 6 lanes expressway.
- Length of soft soil treatment: about 22Km

- Soil excavation: 5.060.000 m³; backfill soil: 15.320.000 m³
- Bridges: 136 bridges with total length is 13,407m, in which there are 4 large bridges, 77 small bridges, 11 viaducts, 37 crossing overbridges.
- Tunnel: 01 tunnel with its length is 540m
- Underpass culvert: 122 culverts; drainage culverts: 276 culverts
- Operation and Management Works: 01 Traffic Management Center, 02 Management Station, 02 Toll plaza at the main road, 14 Toll gate, 04 Service Area, 10 Stopping Area, 14 Bus station.

(4) Total Investment

Total cost of the project is about USD 1.6 billion.

1.4.2. Brief of TEDI's Study Result

(1) Alignment

3 sections are realigned: Km0-Km16, Km60-Km73, Km109-Km129, in order to avoid multiple crossing the high-tension electrical poles, moving cultural, historical buildings, reducing the quantity of land acquisition, limiting the effects on social environment, increasing the stability of the alignment, so on. The other sections has the same route as in Nippon Koei study.

The alignment's length is about 131.5km (Danang: 8.0km, Quang Nam: 91.5km, Quang Ngai: 32km).

Besides, an additional connection section from the end of the Expressway to the NH1A in the South of Quang Ngai city is also considered to be added in the Project. The length of the connection road is about 8.02km.

(2) Scope and Technical standard:

- Type A expressway, class 120. Scope of this expressway in the phase 1 is 4-lane expressway and 6-lane expressway in the final stage.
- Connection road from the end of the Expressway to NH1A: class-III road on plain, width of roadbed $B_{roadbed} = 12m$.

(3) Design results and main construction quantity:

- Expressway length : 131,5Km, connection road linking to NH1A: 8.02km.
- The total length requiring soft soil treatment on the whole Expressway is 3,585m. In which, sand drain method combined with counterweight berm is applied for 03 sections with total length of 785m, the method of merely sand well is applied for 02 sections with total length of 1,100m, the method of soft soil excavation and replacement is applied for 02 sections of total length of 1,700m.
- Common soil excavation: 10,435,008m³; rock excavation: 1,114,329m³;

**Update and Finalization of the F/S
Da Nang - Quang Ngai Expressway Project**

backfill soil K95: 21,039,162m³; backfill sand K95: 1,389,314m³; backfill soil K98: 1,137,449m³;

- Bridges: 127 bridges on the Expressway with total length is 14,877lin.m, in which there are 97 bridges on the main road, 30 flyovers.

Connection road to NH1A with 03 bridges has the total length of 127.3m.

- Tunnel: 01 tunnel with its length is 540m

- Frontage roads: 59,67Km

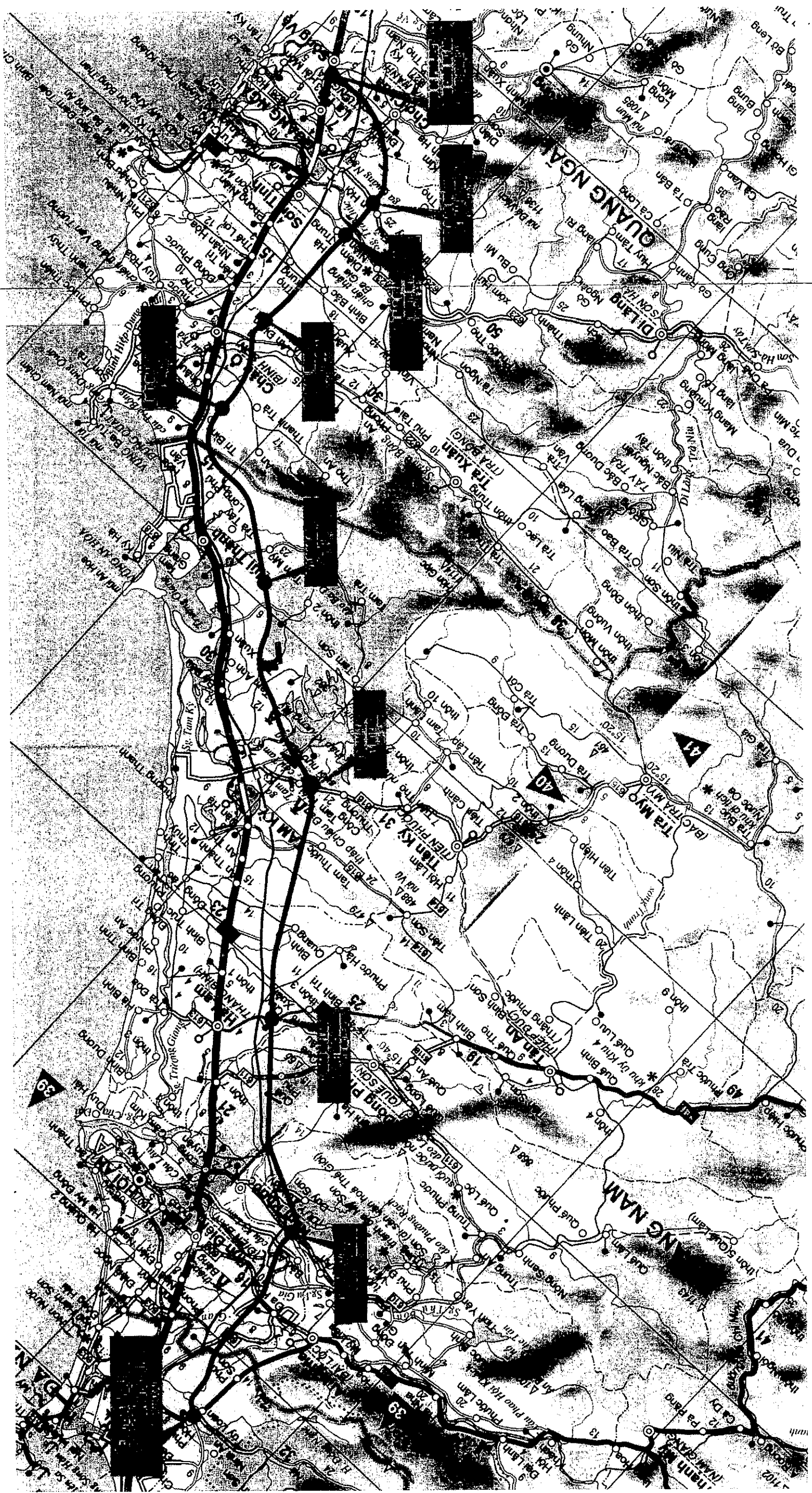
- Underpass culvert: 107 culverts; drainage culverts: 211 culverts on the Expressway and 43 culverts on the connection road to NH1A

- Operation and Management Works: 01 Traffic Management Center in Da Nang, 01 Operation & Maintenance Center in Tam Ky, 02 Toll plazas on the main road, 07 sub-toll gates, 02 service stations, 04 lay-by stations (for both sides).

(4) Total Investment

Total cost of the project is about VND 29,204 billion (equivalent with USD 1.537 billion at the exchange rate 1USD= VND19,000).

FIGURE 1.1 - GENERAL ALIGNMENT MAP DA NANG - QUANG NGAI EXPRESSWAY



CHAPTER 2 - BACKGROUND AND NECESSITY OF THE PROJECT

2.1 Overview

The Da Nang - Quang Ngai expressway is one section of the North South expressway at the East. It has the beginning point at Ha Noi and the ending point at Can Tho. The North South expressway is planned to cross 25 provinces and cities along the coastal of Vietnam.

The Da Nang - Quang Ngai expressway passes 3 among 5 provinces under Major economic area of Central region of Vietnam including: Thua Thien Hue, *Da Nang*, *Quang Ngai*, Binh Dinh.

2.2 Current conditions and Socio-economic development policies

2.2.1 Evaluation of current socio-economic conditions

a) *Current socio-economic conditions of Vietnam in the period of 2000-2008.*

- **Population and population growth rate:**

Vietnam population in 2008 accounts about 86.21 million; in which men accounts 49.16% and women accounts 50.84%. Urban population accounts about 24.18% (2000), and it increased to 28.11% (2008). Growth rate of population and urban population of overall country in the period of 2001-2008 is 1.32% and 3.24% respectively.

- **Economic growth rate:**

- GDP growth rate in the period of 1996-2000 increases 6.94%. In this period, due to the impact of the regional economic crisis, GDP growth rate in 1998 and 1999 declines to 5.8% and 4.8%, especially, in the period of 2001 -2008, GDP growth rate reached 7.55%. However, this world economic crisis is worse than the Asia financial crisis in 1997, and Vietnam was also affected more strongly due to deeper integration into the world economy.

- Growth rate: 6.91% in 2001, 7.79% in 2004, 8.47% in 2005, slightly reduces 8.22% in 2006, increases to 8.46% in 2007, 6.23% in 2008 due to impact of the world economic crisis.

- GDP per capita continuously increases as follows: 1.4 times in 1996-2000, 2.07 times in 2001-2007. GDP per capita rapidly increased through: 288 USD/per capita in 2000, 835 USD/per capita in 2007, over 1000USD/per capita in 2008. Although GDP per capita increases, the economy in Vietnam is still underdeveloped condition, income per capita in Vietnam compared with other countries in the region is still too low (in 2005 income per capita of Thailand is \$ 2721, Singapore is \$ 26,881, Malaysia is \$ 5009).

- Economic growth rate over the years is evaluated as the second highest economic growth rate in the region and after China, far exceeding the growth rate of

the world, the regions and many countries around the world.

- **Economic structure shift:**

Economic structure shift is the key content in the Vietnam economic innovation policies and they are shown in the three areas as follows:

- Area 1: Agriculture - forestry - fishery declined from 27.18% in 1995 to 24.53% in 2000; 20.3% in 2007 and increased to 22.1% in 2008.

- Area 2: Industry and construction increased from 28.76% in 1995 to 36.73% in 2000; 41.58% in 2007 and decreased down to 39.7% in 2008.

- Area 3: Services reduce from 44.06% in 1995 down to 38.74% in 2000; 38.12% in 2007 and 38.2% in 2008.

- **Import and Export turnover value:**

- Import and export turnover value continuously increased with high rate, accounting 21.59% in the period of 1996-2000; accounting 20.1% in the period of 2001-2008.

- Total import and export turnover value of Vietnam accounted 48561.4 mil USD in 2007; 62685.1 mil USD in 2008; it was increased to 29.08% compared with 2007. It shows that export activities of Vietnam are quite good. Import turnover is up to 80713.8 million USD in 2008, increased to 28.6% compared to 2007.

- **Cereal production:**

- Cereal production continuously and rapidly increases. In 1995, total cereal production of Vietnam reached 26.14 million tons; 34.53 million tons in 2004, average growth rate reached 5.73%; and up to 2007, total cereal production of Vietnam reached 40.25 million tons; 43.26 million tons in 2008, increased to 7.48% compared with 2007.

- Food per capita is continuously increasing, in 1995 reached 362.5 kg/person; in 2000 reached 444.9 kg/person; in 2007 reached 472.5 kg/person and in 2008 and reached 501.8 kg/person.

Table 2.2.1 - Some socio-economic targets of the whole country in the period of 1995-2008

No	Target	Unit	1995	2000	2005	2007	2008 (planning)	Growth rate	
								1996-2000	2001-2008
1	Population	10 ³ .per	71995.5	77635.4	83106.3	85154.9	86210.8	1.52	1.32
-	Urban people	Thousand people	14938.1	18771.9	22336.8	23370	24233.3	4.67	3.24
2	GDP (SS1994)	10 ³ .bil VND	195.6	273.6	393.1	461.4	489.8	6.94	7.55
-	Agriculture forestry - fishery	10 ³ .bil VND	51.3	63.7	76.9	82.4	86.1	4.42	3.84
-	Industry and Construction	10 ³ .bil VND	58.6	96.9	157.9	192.7	203.8	10.58	9.74
-	Services	10 ³ .bil VND	85.7	113.0	158.3	186.3	199.9	5.69	7.39
3	GDP (actual price)	10 ³ .bil VND	228.9	441.7	839.2	1144	1477.7	14.05	16.29
4	GDP/per (actual price)	1000 VND	3179	5689	10098	13435	17141	12.34	14.78
5	GDP/per	USD	288	402	639.1	835	1000		
6	Economic structure								
-	Agriculture forestry - fishery	%	27.18	24.53	20.97	20.3	22.1		
-	Industry and Construction	%	28.76	36.73	41.02	41.58	39.7		
-	Services	%	44.06	38.74	38.01	38.12	38.2		
7	Export turnover value (ETV)	Million USD	5448.9	14482.7	32447.1	48561.4	62685.1	21.59	20.1
8	Import turnover value	Million USD	8155.4	15636.5	36761.1	62682.2	80713.8	13.90	22.77
	ETV/per	USD	75.7	186.5	390.4	570.3	727.1	19.77	18.54
9	Cereal production/per	Kg	362.5	444.9	476.8	472.5	501.8	4.18	1.52

Source: Statistical Yearbook in 2008

b) Current conditions of key economic sectors

• **Agriculture - Forestry - Fishery**

Agriculture production value in the period of 1996-2000 accounted 6.4%; 4.24% in the period of 2001-2008. Agriculture production develops especially cereal production. In 2000, rice productivity reached 4240 kg/ha, maize reached 2750 kg/ha; rice productivity in 2007 reached 4980 kg/ha, maize reached 3930 kg/ha; in 2008 rice productivity reached 5220 kg/ha, maize reached 4020 kg/ha.

The value of forestry production in 2008 (1994 constant prices) reached 6752.0 billion, 1.14 times increase compared with 2000. Production of timber exploitation in 2007 reached 3562.3 thousand cubic meters and continuously increase in 8 years 2001-2008, the annual average growth rate reached 5.2% year.

The value of fisheries production increased rapidly in eight years (from 2001 to 2008). Annual average growth rate of total value of aquaculture production reached 11%. The total value of aquaculture production in 2008 reached 115.527 billion (actual cost). Aquaculture production in 2008 reached 4602.0 thousand tons, of which aquaculture production was 2465.6 thousand tons, production of mining is 2136.4 thousand tons.

**Table 2.2.2 - Production of major agricultures, forestry and fisheries
in the period of 1995 – 2008**

Unit: thousand tons, thousand m³

Product	1995	2000	2005	2007	2008	Growth rate (%)	
						1996-2000	2001-2008
Rice	24964	32500	35800	35942,7	38725,1	5,42	2,21
Maize	1177	2000	3800	4303,2	4531,2	11,19	10,76
Cotton	12,8	18,8	33,5	16,1	6,9	8,0	-11,78
Sedge	75,5	61,4	80,5	98,8	84,7	-4,05	4,1
Sugar-cane	10711,1	15044,3	14948,7	17396,7	16128,0	7,03	0,87
Peanut	334,5	355,3	489,3	510,0	533,8	1,21	5,22
Soybeans	125,5	149,3	292,7	275,2	268,6	3,53	7,62
Tea	0	314,7	570	705,9	760,5		11,66
Coffee	218	802,5	752,1	915,8	1055,8	29,78	3,49
Rubber	124,7	290,8	481,6	605,8	659,6	18,45	10,78
Pepper	9,3	39,2	80,3	89,3	98,3	33,34	12,18
Coconut	1165,3	884,8	977,2	1034,9	1086,0	-5,36	2,59
Cashew	0	67,6	240,2	312,4	308,5		20,9
Timber	2793,1	2375,6	2996,4	3461,8	3562,3	-3,19	5,19
Aquatic product	1584,4	2250,5	3465,9	4197,8	4602,0	7,27	9,35

Source: Statistical Yearbook 2008

- Industry and Construction

The value of industrial production (in 1994 constant prices) in 1996-2000 increased yearly on average by 13.9%, from 2001 to 2008 period increased early on average by 16%, the industries has established their positions firmly in the economic market and started to show clear effectiveness, increasing both in volume of products and in exports. See Table 2.2.3 of some products of main industries throughout the country in the period 1995-2008.

• **Services**

+ Trade: Total retail sales of goods and consumer services have annual growth period 2001-2008 is 20.56%.

+ Tourism: Total international tourists coming to Vietnam in 2008 is 4235.8 thousand people, of which:

Categorizing by purpose: travelers 2612.9 thousand people; business people 844.3 thousand people; visiting relatives 510.5 thousand people, the rest is for other purposes.

Categorizing by means of transport: by airways 3283.2 thousand people (accounting for 77.5%); by waterway 151.7 thousand people (accounting for 3.6%), by car 800.9 thousand people (accounting for 18.9%).

Table 2.2.3 - Produce of some major industries in over country
Period of 1995 - 2008

No	Produce	Unit	1995	2000	2005	2007	2008	Growth rate (%)	
								1996-2000	2001-2008
1	Clean coal	10 ⁶ ton	8,35	11,6	34,1	42,5	39,8	6,8	16,66
2	Crude oil	10 ⁶ ton	7,62	16,3	18,5	15,9	14,9	16,43	-1,12
3	Quarry stone	10 ⁶ m ³	10,66	22,2	70,8	92,8	101,6	15,8	20,94
4	Cement	10 ⁶ ton	5,83	13,3	27,1	37,1	40,0	17,9	14,76
5	Apatite	10 ³ ton	0	785,0	940	1222,7	2098,9		13,08
6	Chemical fertilizer	10 ³ ton	931	1209,5	2119,1	2499,4	2524,0	5,37	9,36
7	Rolled and wire steel	10 ⁶ ton	0,47	1,6	3,4	4,6	5,0	27,76	15,31
8	Ingot steel	10 ³ ton		36	473,5	890,5	935,0		50,35
8	Electricity	10 ⁹ kw/h	14,66	26,7	52,1	64,1	72,1	12,74	13,22
9	Honey	10 ³ ton	517	1208,7	1174,6	1558,2	1636,1	18,5	3,86
10	Rice for husking	10 ⁶ ton	15,58	22,2	28,4	30,8	31,5	7,34	4,47
11	Sand and gravel	10 ³ ton	33273	53210	66444	67060	66822	9,84	2,89
12	Salt	10 ³ ton		590	898	857	847		4,62
13	Canned vegetables	10 ³ ton		11,44	72,8	85,0	89,3		29,29
14	Sawn timber	10 ³ m ³		1744	3232	4441	5329		14,98

Source: Statistical Yearbook 2008

• **Import - Export**

Import-export turnover of Vietnam rapidly increased in both phases, in

1996-2000 increased 17.23%, from 2001 to 2008 period increased 21.54%, especially in 2006-2008 increased 30.1%.

Export turnover in 2008 was 62,685.1 million USD. Average growth rate of export turnover in 13 years (1996-2008) was 20.67% per year. In the most recent years (2007-2008) export turnover growth rate reached 29.08%.

Import turnover in 2008 was 80713.8 million USD. Average growth rate of import turnover in 13 years (1996-2008) was 19.28%/year, especially in 2008 import turnover value reached 28.6% compared with 2007.

A number of export products have high growth rate such as wood and wood products for export in the period of 2001-2008 increased 31.76%, coal increased 24.74%, textile may increase 21.63%, and cashews increased 21.77%.

Table 2.2.4 - Some major import export products in 1995-2007

Product type	Unit	1995	2000	2005	2007	2008	Growth rate	
							1996-2000	2001-2008
Export								
Crude oil	10 ⁶ Ton	7.65	15.4	18	15.1	13.75	15.02	-1.41
Coal	10 ⁶ Ton	2.82	3.3	18	32.1	19.35	3.19	24.74
Aquatic product ^a	10 ⁹ bill \$	0.62	1.5	2.7	3.76	4.51	19.33	14.75
Shoes	10 ⁹ \$	0.3	1.5	3.0	4.0	4.76	37.97	15.53
Textile	10 ⁹ \$	0.85	1.9	4.8	7.7	9.1	17.45	21.63
Rice	10 ⁶ ton	2.0	3.5	5.3	4.58	4.74	11.84	3.86
Coffee	10 ³ Ton	248.1	733.9	892.4	1232.1	1059.5	24.22	4.7
Rubber	10 ³ Ton	138.1	273.4	544.0	715.6	658.3	14.64	11.61
Cashew	10 ³ Ton	19.8	34.2	109	154.7	165.3	11.55	21.77
Pepper	10 ³ Ton	17.9	36.4	110	83.0	90.3	15.25	12.03
Tea	10 ³ Ton	18.8	55.7	92	115.7	104.5	24.26	8.18
Wood products	10 ⁶ \$	114.5	311.4	1561.4	2384.6	2829.3	22.15	31.76
Import								
Cars	10 ³ pcs		16.4	21.3	30.4	51.0		15.24
Motorcycles	10 ⁶ \$		787	541.4	725	763.8		-0.37
Steel, iron	10 ⁶ ton	1.12	2.8	5.5	8.1	8.26	20.11	14.48
Gas, oil	10 ⁶ ton	5.0	8.7	11.5	13.2	12.9	11.71	5.05
Fertilizers	10 ⁶ ton	2.32	4.0	2.9	3.8	3.0	11.51	-3.53
Clinker	10 ³ Ton	959.3	214.5	4375.5	3812.0	3694.5	-25.98	42.73
Medicine	10 ⁶ \$	69.1	325	507.6	714.2	864.2	36.3	13.0
Plastic	10 ⁶ \$	229.8	530.6	1456	2528.7	2945.1	18.22	23.89

Product type	Unit	1995	2000	2005	2007	2008	Growth rate	
							1996-2000	2001-2008
Pesticides and raw materials	10 ⁶ \$	100,4	143,5	243,5	401,1	473,8	7,4	16,1
Material for textile, garment, leather industries	10 ⁶ \$	488	1421	2282	2187	2355,1	23,83	6,52

Source: Statistical Yearbook 2008

c) Current socio-economic conditions of direct attractive area

• Population:

Total population of the project area in 2007 was 3578.6 thousand people; in which the urban population is 1139.4 thousand people (accounting for 31.8%), rural population is 2439.2 thousand people (accounting for 68.2%).

Table 2.2.5 - Population of direct attractive area during the pass years (2000-2007)

Unit: thousand people

Province	2000		2005		2007		Growth rate 2001-2007 (%)	
	Total	Urban	Total	Urban	Total	Urban	Total	Urban
Overall country	77635.4	18771.9	83106.3	22336.8	85154.9	23370.0	1.33	3.18
The project area	3293.0	914.8	3508.6	1101.3	3578.6	1139.4		
% of the project area compared with overall country	4.24	4.87	4.22	4.93	4.2	4.88		
Da Nang city	703.5	566.0	777.0	669.9	805.4	698	1.95	3.04
Quang Nam	1389.4	206.9	1462.9	249.2	1484.3	256	0.95	3.09
Quang Ngai	1200.1	141.9	1268.7	182.2	1288.9	185.4	1.02	3.89

Source: Statistical Yearbook 2007

• Economic growth rate and economic structure:

Recent years, accompany with innovation and integration and application of various investment preferential policies of in economic development, economic growth rate is always high and stable. High economic growth rate creates a lot of jobs for workers, besides, it promotes development of other social activities. Economic growth rate in the project area in 1996-2000 increased on average to 8.38%. In the period of 2000-2007, increased to very high rate, reaching

11.21%. GDP in 1995 reached VND102,079,608 million, in 2000 reached VND152,679,100 million and in 2007 reached VND321,175,720 million. The strong economic growth in the project area is created by the economic growth of all locals within the project area. All these local authorities achieved over 9% in the period 2000-2007. Some provinces and cities reach high growth rate such as 12.12% in Hanoi; 13.82% in Ninh Binh; 12.35% in Da Nang; 11.37% in Quang Nam; 11.36% in Phu Yen; 15.4% in Binh Thuan; 13.4% in Dong Nai; 11.38% in Hochiminh City.

Economic development and growth tightly associates with the development of agriculture, forestry and fisheries, industry, construction and services. With taking advantage from the available conditions and resources as well as promoting strengths of each sector, in the period 2000 - 2007 economic sectors has made huge strides not only for each sector has a sustainable development but also achieving high growth rate. Industry growth rate reached 14.43%, service sector growth rate reached 11.25%, agriculture, forestry, and fishery growth reached only 4.5% a year.

Table 2.2.6 - GDP of direct attractive area during pass years (in 1994 constant price)

Unit: Million dong

No.	Province	Sector	1995	2000	2005	2006	2007	Growth rate %	
								1996-2000	2001-2007
1	Da Nang City	Agriculture, forestry and fisheries	229,523	276,300	355,465	332,623	346,806	3.78	3.30
		Industry and construction	676,947	1,347,900	3,233,480	3,482,460	3,657,219	14.77	15.33
		Services	1,145,150	1,766,100	2,630,538	3,093,237	3,654,896	9.05	10.95
		Total	2,051,620	3,390,300	6,219,483	6,908,320	7,658,921	10.57	12.35
2	Quang Nam	Agriculture, forestry and fisheries	1,116,035	1,273,800	1,492,940	1,549,516	1,593,676	2.68	3.25
		Industry and construction	335,105	684,800	1,644,112	2,000,164	2,441,896	15.37	19.92
		Services	639,471	1,074,000	1,829,048	2,086,010	2,410,993	10.93	12.25
		Total	2,090,611	3,032,600	4,966,100	5,635,690	6,446,565	7.72	11.37
3	Quang Ngai	Agriculture, forestry and fisheries	775,033	1,012,800	1,404,700	1,463,600	1,525,000	5.50	6.02
		Industry and construction	232,752	498,500	1,040,300	1,299,500	1,648,200	16.45	18.63
		Services	504,881	811,900	1,272,000	1,417,000	1,591,400	9.97	10.09
		Total	1,512,666	2,323,200	3,717,000	4,180,100	4,764,600	8.96	10.81
Total of project area			5,654,897	8,746,100	14,902,583	16,724,110	18,870,086		
Overall country	Statistic data from provinces	186,101,090	288,062,600	485,228,295	545,278,989	592,610,587			
	Data from Statistical Yearbook	195,600,000	273,600,000	393,100,000	425,400,000	461,400,000			
<i>Compared with overall country</i>			<i>2.89</i>	<i>3.20</i>	<i>3.79</i>	<i>3.93</i>	<i>4.09</i>		

Table 2.2.7 - GDP of direct attractive area during previous years (current price)

Unit: Million dong

No	Province		1995	2000	2005	2006	2007	Growth rate	
								1996-2000	2001-2007
1	Da Nang	Agriculture, forestry and fisheries	262,445	388,600	509,793	578,158	616,155	8.17	6.81
		Industry and construction	750,611	2,041,100	5,867,509	6,927,569	7,124,984	22.15	19.55
		Services	1,327,825	2,522,300	5,139,716	6,363,336	7,460,639	13.69	16.76
		Total	2,340,881	4,952,000	11,517,018	13,869,063	15,201,798	16.17	17.38
2	Quang Nam	Agriculture, forestry and fisheries	1,153,910	1,762,300	2,724,161	3,072,535	3,393,276	8.84	9.81
		Industry and construction	375,468	1,074,200	2,994,477	3,766,336	4,928,223	23.40	24.31
		Services	675,724	1,407,000	3,083,730	3,757,694	4,684,354	15.80	18.75
		Total	2,205,102	4,243,500	8,802,368	10,596,565	13,005,853	13.99	17.35
3	Quang Ngai	Agriculture, forestry and fisheries	923,885	1,297,900	2,286,000	2,586,500	2,993,800	7.03	12.68
		Industry and construction	284,293	741,700	1,971,900	2,260,800	3,593,300	21.14	25.28
		Services	597,716	1,190,100	2,314,300	2,850,100	3,525,600	14.77	16.78
		Total	1,805,894	3,229,700	6,572,200	7,697,400	10,112,700	12.33	17.71
	Total of project area		6,351,877	12,425,200	26,891,586	32,163,028	38,320,351		
Overall country	Statistic data from provinces	212,672,346	394,078,100	879,396,193	1,062,237,384	1,209,537,948	13.13	17.38	
	Data from Statistical Yearbook	228,900,000	441,700,000	839,200,000	974,300,000	1,144,000,000	14.05	14.56	
<i>Compared with overall country</i>			<i>2,99</i>	<i>3,15</i>	<i>3,06</i>	<i>3,03</i>	<i>3,17</i>		

Source: Statistical Yearbook from provinces

Note: Error from the incremental GDP provided from provinces is higher than the GDP data published by GSO to between 4-8%

Economic structure changes towards gradual increasing of industry, construction gradual reduced the proportion of agriculture and forestry.

Table 2.2.8 - Economic structure (current price)

Unit: %

No	Province		1995	2000	2001	2002	2003	2004	2005	2006	2007
1	Da Nang	Agriculture, forestry and fisheries	11.21	7.85	7.38	6.72	6.39	5.96	4.43	4.17	4.05
		Industry and construction	32.07	41.22	42.05	43.53	45.32	49.07	50.95	49.95	46.87
		Services	56.72	50.93	50.57	49.75	48.29	44.97	44.63	45.88	49.08
		Total	100	100	100	100	100	100	100	100	100
2	Quang Nam	Agriculture, forestry and fisheries	52.33	41.53	39.34	38.17	35.66	33.27	30.95	29.00	26.09
		Industry and construction	17.03	25.31	26.38	28.38	30.19	32.11	34.02	35.54	37.89
		Services	30.64	33.16	34.28	33.45	34.15	34.63	35.03	35.46	36.02
		Total	100	100	100	100	100	100	100	100	100
3	Quang Ngai	Agriculture, forestry and fisheries	51.16	40.19	38.80	38.66	36.65	36.34	34.78	33.60	29.60
		Industry and construction	15.74	22.96	22.20	23.43	24.78	26.10	30.00	29.37	35.53
		Services	33.10	36.85	39.00	37.91	38.57	37.56	35.21	37.03	34.86
		Total		100	100	100	100	100	100	100	100

- Import and export turnover of the project area

- *Export.*

Total export turnover in the area continuously increase in recent years. Annual average growth rate in period of 2006-2007 reached 30.63% (higher than overall country) corresponding to the value in 2006 reached 26409018.2 thousand USD and in 2007 reached 34498030.7 thousand USD. The key export items of the region such as textiles, metals, agricultural products, tea, handicrafts, footwear, rice...

- *Import.*

Annually, the study area regularly imports goods such as machinery, metals, ores, fertilizers, wood, textile materials, chemical industry, materials for tobacco production, medicine ... Total import turnover in the past years also grew at high rate over 24%. Import value in 2006 was USD18,851,164.60 thousand and USD23,404,473.25 in 2007.

Table 2.2.9 - Import - export turnover value of the direct attractive area

Unit: 1000USD

No	Study area	2006	2007	Growth (%) (06-07)
I	Import export of overall country	84,717,300.80	111,243,600.00	31.31
	Export	39,826,200.00	48,561,400.00	21.93
	Import	44,891,100.00	62,682,200.20	39.63
II	Total import-export turnover value of the study area	1,089,073.00	1,307,864.00	20.09
	Export	565,136.00	684,505.00	21.12
	Import	523,937.00	623,359.00	18.98
	Compared with overall country	1.29%	1.18%	
12	Da Nang	761,700.00	910,100.00	19.48
	Export turnover	377,400.00	449,900.00	19.21
	Import turnover	384,300.00	460,200.00	19.75
13	Quang Nam	266,727.00	319,264.00	19.70
	Export turnover	141,388.00	176,123.00	24.57
	Import turnover	125,339.00	143,141.00	14.20
14	Quang Ngai	60,646.00	78,500.00	29.44
	Export turnover	46,348.00	58,482.00	26.18
	Import turnover	14,298.00	20,018.00	40.01

Source: Statistical Yearbook from provinces

2.2.2. Socio-economic development policies

a) Socio-economic development policies of overall country

• Population and its growth rate

Vietnam population is strived to keep at 88.2 million people in 2010 and 99 million people in 2020. Planned population growth rate for 2007-2010 is 1.18%, and about 1.16% in the period 2010-2020.

By 2010, creating jobs, solving more jobs for more than eight million workers, on average over 1.6 million workers each year; vocational training for 7.5 million workers, of which 25-30% longer-term. Urban unemployment rate is below 5%.

In 2010, agricultural labor accounts 50% of social workers. Average life expectancy of Vietnam reach 72 years.

Completely terminate the existence of hungry households, reducing poverty rate (according to the new standard equivalent to international standards) down to 15-16% in 2010.

• Economic growth rate

In accordance with socio-economic development of recent years and draft of Development Strategy Institute under Ministry of Plan and Investment, it is proposed 2 economic growth options:

Option 1

Growth rate of GDP reached 7.0% in the period of 2007-2010, and in the period of 2010-2020 will reach 8%. Making efforts so that the actual GDP 2010 will reach over 1443 thousand billion, GDP per capita over \$992, our country beyond the underdeveloped status; by 2020 actual GDP reached about 6674 thousand billion, GDP per capita is over \$ 3644, our country became industrialized countries, people live is improved basically.

Economic structure continuously changes according to focus of industrial development. In 2010, economic structure is expected: The proportion of agriculture, forestry and fishery reduce to 14.61%, industry and construction increase to 45.26%, service accounts 40.13%. Economic structure in 2020 are: Agriculture, forestry and fisheries continue to reduce to 9.19%, industry and construction continuously grow to 46.44%, service increase to 44.37%.

Export turnover value is expected to reach 72 billion 671 million USD in 2010 and 334 billion USD in 2020. Growth rate of export turnover reach 17.5% in 2006-2010 and 16.5% in 2010-2020.

Stable food production ensures enough for annual domestic consumption and export from 4-4.5 million ton of rice. Production of cereals in 2010 reach 42.5 million ton and expected to reach 48 million ton in 2020.

Option 2:

Promoting all good potential strengths, creating very high economic growth rate in the long term (2010-2020). Striving for growth rate of GDP of 7.5% on average in the period 2007-2010 and 8% on average in the 10 years from 2010 to 2020. By 2010 actual GDP of Vietnam will reach 1443 thousand billion dong, GDP per capita is over \$ 992, our country is taken out of the underdeveloped situation; by 2020 real GDP will reach 8000 thousand billion dong and GDP per capita reach about \$ 4000, our country will become industrialized countries.

Economic structure continuously changes towards positive direction: GDP of agriculture, forestry and fisheries declined from 20.3% in 2007 to 14.61% in 2010 and 7.61% in 2020; GDP of industry and construction increase from 41.58% in 2007 and to 45.26% in 2010 and to 47.2% in 2020; GDP of services increase from 38.12% in 2007 to 40.13% in 2010 and to 45, 15% in 2020

Value of export turnover is expected to reach \$ 72.67 billion in 2010 and reached \$ 334 billion in 2020. Growth rate of export turnover reaches 17.5% in

2006-2010 and 16.5% in period 2010-2020

Average Import growth rate in 2006-2010 period reach about 13.5-14.5% per year. Total import turnover of goods increase from 62.68 billion USD in 2007 to 72 billion USD in 2010; reach around 275-283 billion in the period 2010-2020.

Stable food production ensures enough for annual domestic consumption and export from 4-4.5 million ton of rice. Production of cereals in 2010 reached 42.5 million ton and in 2020 expected to reach 48 million ton.

- **Key economic sectors development policies**

- ✓ *Agriculture, forestry and fishery*

Creating change in quality of agricultural production and rural economy, meeting domestic requirements increasing export turnover. Restructuring of agriculture and rural economy towards increase of efficiency and technology level through application of science and technology in production, storage and processing. Promoting links of agriculture and industry to increase production efficiency.

Agriculture, forestry and fisheries growth rate is 3.8% in 2006-2010 and 3.5% in period 2010-2020.

- ✓ *Industry and construction*

Continuously maintain high growth accompany with improve product quality, industrial production efficiency, ensure industrial competitiveness to maintain and expand market share in domestic and international.

Ensure balance between supply and demand of the economy on the major industrial products such as electricity, coal, construction steel, petroleum, cement, fertilizers on the basis of promoting domestic production; satisfy domestic demand and industrial products consumption.

Strive to increase production value of industry and construction from 15 to 15.5% on average per year, the value of building an average to 11.5% a year in period from 2006 to 2010; on 9.2% / year in the period 2010-2020.

Table 2.2.10 - Development target of some basic products

No	Items	Unit	Planning in 2010	Planning in 2020
1	Apatite	Million Ton	2.4	2.4
2	Coal	Million Ton	41.0	51.0
3	Steel	Million Ton	6.5	18.1
4	Cement	Million ton	56.6	76.5
5	Gasoline	Million ton	6.5	18.3
6	Nitrogenous fertilizer	Million ton	2.5	3.3

No	Items	Unit	Planning in 2010	Planning in 2020
7	Phosphate	Million ton	1.5	1.6
8	NPK fertilizer	Million ton	3.2	3.3
9	DAP fertilizer	Million ton	0.7	0.7

✓ *Services*

They create great development of the service area. Approach to develop strongly trade and services corresponding to their potentials; improve capacity and quality, increase competitiveness of goods and services with the participation of many economic sectors, implement equality competitiveness and further enhance the role and effectiveness of state management on trade and services to meet diverse needs in production, business and social life, contribute to economic growth, expand market and effective international economic integration.

Added value of services increases to 7.4 % in period of 2006-2010 and near 8% in period of 2010-2020.

✓ *Import - export and international economic integration activities*

Export: Export development with high growth rate and sustainability as the driving force behind GDP growth. Promote production and export existing key goods as well as develop other potential commodities to become new export goods by improving export efficiency. Change export structure by promoting export goods having high added value; increase processing and manufacturing products, products having high technology content and grey matter, reducing gradually the proportion of raw materials. Trying to bring the total export turnover of goods reached USD72.6 billion in 2010 and about USD334 billion in 2020. Average growth rate in 2006-2010 is 17.5%, 16.5% in period 2011-2020 respectively.

The export structure will be changed towards increase of the export proportion of items with high added value; processing and manufacturing products, product technology content and high grey matter, and reduce the proportion of raw materials.

Import: to curb the trade deficit, trying to reach reasonable balance of export - import. Priority to import materials, equipments and advanced technologies; keep active in the import firm, focus on importing modern equipments from overseas technology sources; reduce quickly and proceed to limit import of outdated technology or intermediary technology equipments; limit import of goods and equipments as well as domestic consumption that can be produced.

Average import growth rate in 2006-2010 reaches about 13.5-14.5%/year. Total import turnover of goods increases from 62.68 billion USD in 2007 to 72 billion USD in 2010; accounts about 275-283 billion USD in 2007-2010.

Table 2.2.11 - Forecast of some key socio-economic elements

Items	Unit	2007	2010	2020	2030
Population	Thousand people	85154,9	88200	99000	110000
Population growth rate	%	1,33	1,18	1,16	1,06
GDP (current price)	Billion dong	1144015	1443898	6674510	13349020
GDP (in 1994 constant price)	Billion dong	461400	565237	1220225	2403378
GDP growth rate		2001-2007	2008-2010	2010-2020	2021-2030
General GDP (in 1994 constant price)	%	7,75	7,0	8,0	7,0
GDP/person (current price)	Thousand dong	13435	16371	67420	121355
	USD	835	992	3644	6068
Current exchange rate	VND/USD	16000	16500	18500	20000
Total export turnover value	Million USD	48561,4	72671,6	334675,9	937092,5

ii) Socio-economic development policies of direct attractive area

Development direction of major economic area of Center region toward 2010 and vision to 2020 implementing at 5 provinces, including: Thua Thien Hue, Da Nang, Quang Nam, Quang Ngai and Binh Dinh.

- Main development objective:

- Annual average GDP growth rate in 2006 – 2010 reached 1.2 times, in 2011 – 2020 reaches 1.25 times of average growth rate in over the country. Increase of region contribution in country's GDP from 5% at the moment to 5.5% in 2010 and to 6.5% in 2020.

- Increase of average export value per capita/year from 149 USD in 2005 to 375 USD in 2010 and 2530 USD in 2020.

- Increase of region contribution in state budget revenue from 4.6% in 2005 to 6% in 2010 and 7% in 2020.

- Striving to achieve 40% of region urbanization rate in 2010, reduce and does not increase unemployment workers down to 5% and continue to control to 4% of allowable level for 2020, striving to resolve more than 60-70 thousand new works each year.

- Reducing poor family rate from 15.5% in 2005 to fewer than 8.8% in 2010 and about 2% in 2020...

- Regarding new breakthrough tasks for developing key sectors:

- To speed up the construction investment of the Chu Lai Open Economic Zone (Quang Nam), Dung Quat Economic Zone (Quang Ngai) and the Chan May Economic - Commercial Development Encouragement Zone (Thua Thien - Hue), construction plan of the Nhon Hoi Economic Zone (Binh Dinh Province) to make those economic zones gradually become kernel and development center of the region after 2010.

- To promote central role of trade, services, international transactions of the Da Nang city, Hue, Quy Nhon functions to ensure trade, transaction, services, tourist center function of the Central region and Highland.

- To form tourist centers such as Hue, Da Nang, Quy Nhon and adjacent areas of Center region and Highland.

- To complete construction works of big infrastructure projects to connect these areas with the surrounding regions. Contribute to program the East - West corridor of the expansion Mekong sub-region, associated with the development of triangle borders of Vietnam - Laos - Cambodia. In which, Da Nang plays the role of the center of the region. Completing road construction through the Hai Van Pass and the bypass at the west of Hue city; complete Da Nang - Chu Lai - Quang Ngai expressway, Da Nang - Hue - Quang Tri expressway (in North - South Expressway) before 2007.

- To form multi disciplinary training center with high quality in Hue.

Table 2.2.12 - Forecast of some target developments of Key economic zone in Center region in 2000 - 2020

No	Target	Unit	2000	2005	2010	2020	Average growth rate (%)		
							2000-2005	2006-2010	2011-2020
1	Population	Thousand people	4356.5	4739.61	5105.9	5668.08	1.8	1.5	1.05
2	GDP (in 1994 constant price)	Billion dong	10576.7	15150.1	22329	57456	7.5	8.10	9.9
3	GDP/person	Thousand dong	2450.63	3196.5	4373.2	10136.0			
4	Economic structure	%	100	100	100	100			
	- Agriculture	%	22.55	18.61	15.0	7.83			
	- Industry construction	%	30.14	37.43	45.25	61.08			
	- Services	%	47.31	43.96	39.75	31.09			

5	Export turnover value	10 ⁶ USD	307.7	566.92	1140.27	4613.04	13	15	15
6	Export turnover value /person	USD	70.63	120	223	813			

Source: Draft of Socio-economic development of major regions - Development Strategy Institute - MPI

2.3 Plans relating to the project

2.3.1 Transport plans

Transport development plan in regions and overall country and development plans approved by the Prime Minister by the following Decisions:

- Decision No. 412/QĐ-TTg dated 11/4/2007 issued by the Prime Minister regarding approval of investment list of some important transport infrastructure projects toward 2020

- Decision No.1290/QĐ-TTg dated 26/9/2007 issued by the Prime Minister regarding issue of national calling list of foreign investment in 2006 – 2010.

- Decision No. 1734/QĐ-TTg dated 01/12/2008 issued by the Prime Minister regarding approval of Vietnam expressway network plan toward 2020 and vision to 2020.

- Decision No. 21/QĐ-TTg dated 08/01/2009 issued by the Prime Minister regarding approval of Airway transport development plan up to 2020

- Decision No. 35/2009/QĐ-TTg dated 03/3/2009 issued by the Prime Minister regarding approval of Vietnam transport development strategy up to 2020 and vision 2030.

- Decision No. 1327/QĐ-TTg dated 24/8/2009 issued by the Prime Minister regarding approval of Vietnam highway development plan toward 2020 and vision 2030

- Decision No. 136/QĐ-TTg dated 10/9/2009 issued by the Prime Minister regarding approval of amending Vietnam railway transport development strategy toward 2020 and vision 2030.

- Decision No. 1601/QĐ-TTg dated 15/10/2009 issued by the Prime Minister regarding approval of Vietnam Maritime transport development plan toward 2020 and vision to 2030.

- Decision No. 2190/QĐ-TTg dated 24/12/2009 issued by the Prime Minister regarding approval of Vietnam seaport system development plan toward 2020, vision to 2030.

- Decision No.140/QĐ-TTg dated 21/01/2010 issued by the Prime Minister regarding approval of Earthen North - South expressway detailed planning.

a) Road master planning

The Prime Minister has approved adjustment of Vietnam highway transport development plan. The bellow information on highway plans is updated information from this adjustment:

• National highway system

National highway system plan according to Decision No. 1327/QĐ-TTg dated 24/8/2009 issued by the Prime Minister regarding approval of Vietnam highway development plan toward 2020 and vision to 2030, of which the national highways under the North - South line and the Center region are summarized in the table 2.3.1

Table 2.3.1- National highway plans

No	Name of NH	The beginning point	The ending point	Length (km)	Class	Number of lane (lane)	Remark
I On the North - South line							
1	NH1	Huu Nghi Border (Lang Son)	Nam Can (Ca Mau)	2434	II-III	2-4	
2	Hochiminh Highway	Pac Bo (Cao Bang)	Đat Mui (Ca Mau)	3167		2	
II On the Center region							
34	NH217	Do Len (Thanh Hoa)	Na Meo (Thanh Hoa)	191	III-IV	2	
35	NH47	Nam Son (Thanh Hoa)	Muc Son (Thanh Hoa)	61	IV	2	
36	NH45	Ria (Ninh Binh)	Nhu Xuan (Thanh Hoa)	198	IV	2	
37	NH48	Yen Ly	Que Phong (Nghe An)	122	IV	2	
3	NH7	Dien Chau (Nghe An)	Nam Can (Nghe An)	227	IV	2	
39	NH46	Thanh Thuy	Cua Lo (Nghe An)	75	III	2	
40	NH8	Hong Linh	Cau Treo (Ha Tinh)	85.3	III	2	
41	NH8B	Hong Linh	Xuan Hai (Ha Tinh)	25	III	2	
42	NH12A	Ba Don	Cha Lo (Quang Binh)	138	III	2	
43	Vung Ang - Xom Sung	Vung Ang (Ha Tinh)	Xom Sung (Quang Binh)	63	III	2	
44	NH15	Tong Dau (Hoa)	Ngoc Lac	109	III	2	

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No	Name of NH	The beginning point	The ending point	Length (km)	Class	Number of lane (lane)	Remark
		Binh)	(Thanh Hoa)				
45	NH9	Cua Viet	Lao Bao (Quang Tri)	118	II-III	2-4	
46	NH49	Thuan An (Thua Thien Hue)	Lao boundary	92	IV	2	Routes under Major economic zone of the Center region
47	NH14B	Tien Sa (Da Nang)	Thach My (Quang Nam)	74	III	2	
48	NH14D	Giang	Ta Oc (Quang Nam)	75	III-IV	2	
49	NH14C	Ngoc Hoi (Kon Tum)	Buprang (Đak Nong)	387	IV	2	
50	NH14E	Hal-sam	Kham Duc (Quang Nam)	76	IV	2	
51	NH24	Thach Tru (Quang Ngai)	Kon Tum	169	III	2	
52	NH19	Quy Nhon (Binh Dinh)	Le Thanh (Gia Lai)	238	I-III	2-6	
53	NH25	Tuy Hoa (Phu Yen)	Chu Se (Gia Lai)	192	III	2	
54	NH26	Ninh Hoa (Ninh Thuan)	Buon Ma Thuot (Dak Lak)	165	II-IV	2-4	
55	NH27	Buon Ma Thuot (Dak Lak)	Phan Rang (Ninh Thuan)	277	IV	2	
56	NH28	Phan Thiet (Binh Thuan)	Gia Nghia (Đak Nong)	194	IV	2	
57	Truong Son Dong Road	Thach My (Quang Nam)	Da Lat (Lam Dong)	667	IV-V		
58	NH49B	Quang Loi	Chan May (Thua Thien Hue)	89	IV	2	
59	NH24B	Sa Ky port	NH1 section intersects with Quang Ngai	18	III	2	
60	NH40	Ngoc Hoi	Bo Y (Kon Tum)	21	III	2	
61	NH1D	Quy Nhon (Binh Dinh)	Cau river (Phu Yen)	35	III	2	
62	NH1C	NH1	Nha Trang (Khanh Hoa)	17		4	
63	NH27B	Ninh Binh (Ninh Thuan)	Hoa Dien (Khanh Hoa)	53	III	2	

- **Coastal roads**

Coastal road from Quang Ninh to Kien Giang is 3.127 km long. It has function for socio-economic, services development of the coastal area. Reduce and prevent natural calamity, assure national defense, eliminate hunger and reduce poverty. The route is formed based on using existing road and coastal dike system form improvement or renewal.

Gradually recover, upgrade and renew to meet two lanes scale; segments through urban areas, economic zones, tourist resorts ...have scale appropriate to approved plan.

The Prime Minister issued the Decision No. 129/QD-TTg dated 18/01/2010 regarding approval of the detailed coastal highway plan. The section of coastal highway in the studied area has minimum scale of the plain class-III highway. Planning coastal highway at the Project are is shown in Figure 2.3.1 and Table 2.3.2

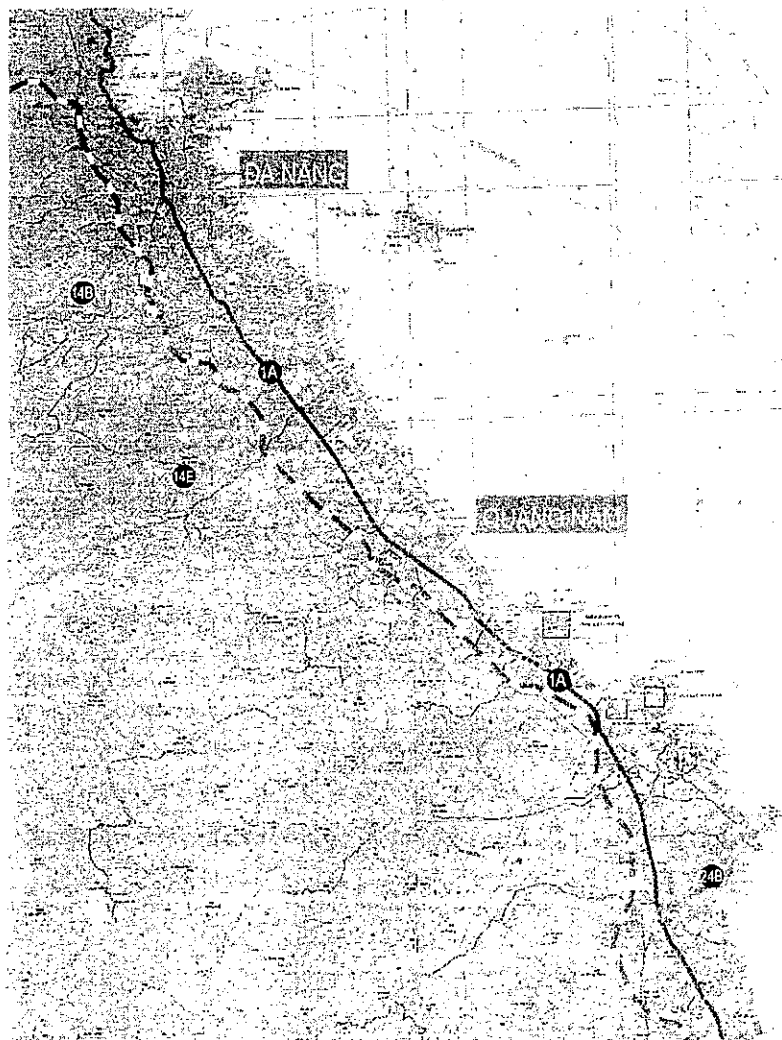


Figure 2.3.1- Coastal road plan of the study area

Table 2.3.2- Coastal road plan of the direct attractive area

No	Section	Length (Km)	Scale according to plan		Remark
			Class	Bm /Bn	
1	Section crossing Da Nang city	52.00			
	Boundary between Thua Thien - Hue and Da Nang - intersection between NH1A and Nguyen Tat Thanh road	17.00	III	11/12	
	Intersection between NH1A and Nguyen Tat Thanh road - Thuan Phuoc Bridge	11.00	Urban road		
	Thuan Phuoc Bridge - Son Tra - Dien Ngoc	6.00	Urban road		
	The beginning point of Son Tra - Dien Ngoc	18.00	Plan road	15/27	
2	Section crossing Quang Nam province	95.00			
	Boundary between Quang Nam and Quang Ngai province (Dien Ngoc) - end of Dien Ban district area (Ha My, Dien Duong commune)	8.00	Urban road class II	15/27	
	Dien Duong - Cam An	7.00	Urban road class II	15/27	
	Cam An - Cua Dai Bridge	6.00	4 lanes	10.5/14.5	
	Cua Dai Bridge - Binh Hai	20.00	III	11/12	
	Binh Hai - Tam Tien	23.00	III	11/12	
	Tam Tien - Tam Hoa (Village 2)	10.00	III	11/12	
	Tam Hoa (Village 2) - Village 4 (Tam Hoa)	2.00	III	11/12	
	Village 4 (Tam Hoa) - PR618	9.00	III	11/12	
	PR618 - Connection road between Ky Ha port and Dung Quat port	3.00	III	11/12	
	Connection road between Ky Ha port and Dung Quat port - boundary between Quang Nam and Quang Ngai province	7.00	III	11/12	
3	Section crossing Quang Ngai province	128.30			
	Boundary between Quang Ngai and Quang Nam (Trung An) - The beginning point of Coastal road Dung Quat - Sa Huynh	18.00	I (4 - 8 lanes)		
	The beginning point of coastal road Dung Quat - Sa Huynh - Km1116+000/NH1A	99.80	III DB. section crossing My Tra - My Khe (Km34-Km47) Urban main road class II	11/12 (III): B _n =36 (urban main road class II)	
	Km1116+000/NH1A - Km1121+000/NH1 (Chau Me)	5.00	III	11/12	
	Km1121+000/NH1 (Chau Me)- boundary between Quang Ngai and Binh Dinh	5.50	III	11/12	

- **Border corridor road**

Border corridor road is formed along boundary of China, Laos, Cambodia, from Quang Ninh to Kien Giang; its length is 4.432 km.

Construction of this road promotes socio-economic development, eliminate hunger and reduce poverty of the border area, protect national security sovereignty and social safety order.

Gradually connects and basically completes construction of the entire route. Basically qualifies standard of road class IV or V; for complicated sections, try to qualify standard of road class VI; for some sections crossing density area, reaching qualify standard road class III with 2 lanes.

- **Provincial road system development plan**

Improving the road to qualify standard of road class V at flat area, road class IV or V at mountainous area; for sections crossing urban area, it is complied with approved plan.

Improving some important provincial roads to national highways and important district roads to provincial roads. Realigning or constructing some new roads at necessary areas.

- **Urban road**

Developing urban road transport system to assure uniformity, balance and un-interruption with region, national and international transport network.

Constructing main access/exit routes, grade-separated at big intersection, bypass, and ring roads.

Constructing bus station and parking station to meet demand

- **Rural road**

- 100% of district roads and commune roads used all year round; hard roadbed rate accounts 95%, of which asphalt cement concrete accounts 50%.

- All district roads reach standard of road class IV and V, commune roads reach standard of rural road type A.

- 100% of district and commune roads are maintained.

- Removing monkey bridges of Cuu Long river delta.

- Developing field roads to meet production industrialization and agriculture product harvest.

- **Road transport development plan**

Passenger volume reaches 5,5 billion with 165,5 billion of rotation passenger, increase to 11,2%/year.

Transport goods reach 759,50 million ton with 34,6 billion ton of rotation goods, increase to 7,5%/year.

- **Transport means development plan**

- Automobiles

It is planned to reach 2,8 – 3 million vehicles in 2020, in which cars account 50%, coaches account 17%, and trucks account 33%.

- Motor bicycles

Limit increase of motorbike volume by administrative, economic and technical methods to control motorbikes volume in overall country. Motorbike is mainly used in rural or area without public transport service. It is planned that motor bicycles will reach about 34 - 36 million EAs in 2020.

- Stations and stopping areas

Complete bus station plan with scale appropriate to departing/arriving passenger volume, especially at traffic hubs. Prior investment of big bus stations at big cities such as Hanoi, Hochiminh, Da Nang, Hai Phong, Hue, Nha Trang and Can Tho...

Reserve appropriate land fund for developing parking; construct underground and elevated bus stations at big cities.

Complete plans and construction of stopping points on long-distance transport, especially on national highways; distance between stoppings points is about 200 – 300 km.

- **Expressway network plan**

Vietnam expressway network development plan toward 2020 and vision 2020 was approved by the Prime Minister in the Decision No. 1734/QĐ-TTg dated 01/12/2008. Main contents of the above plan are as follows:

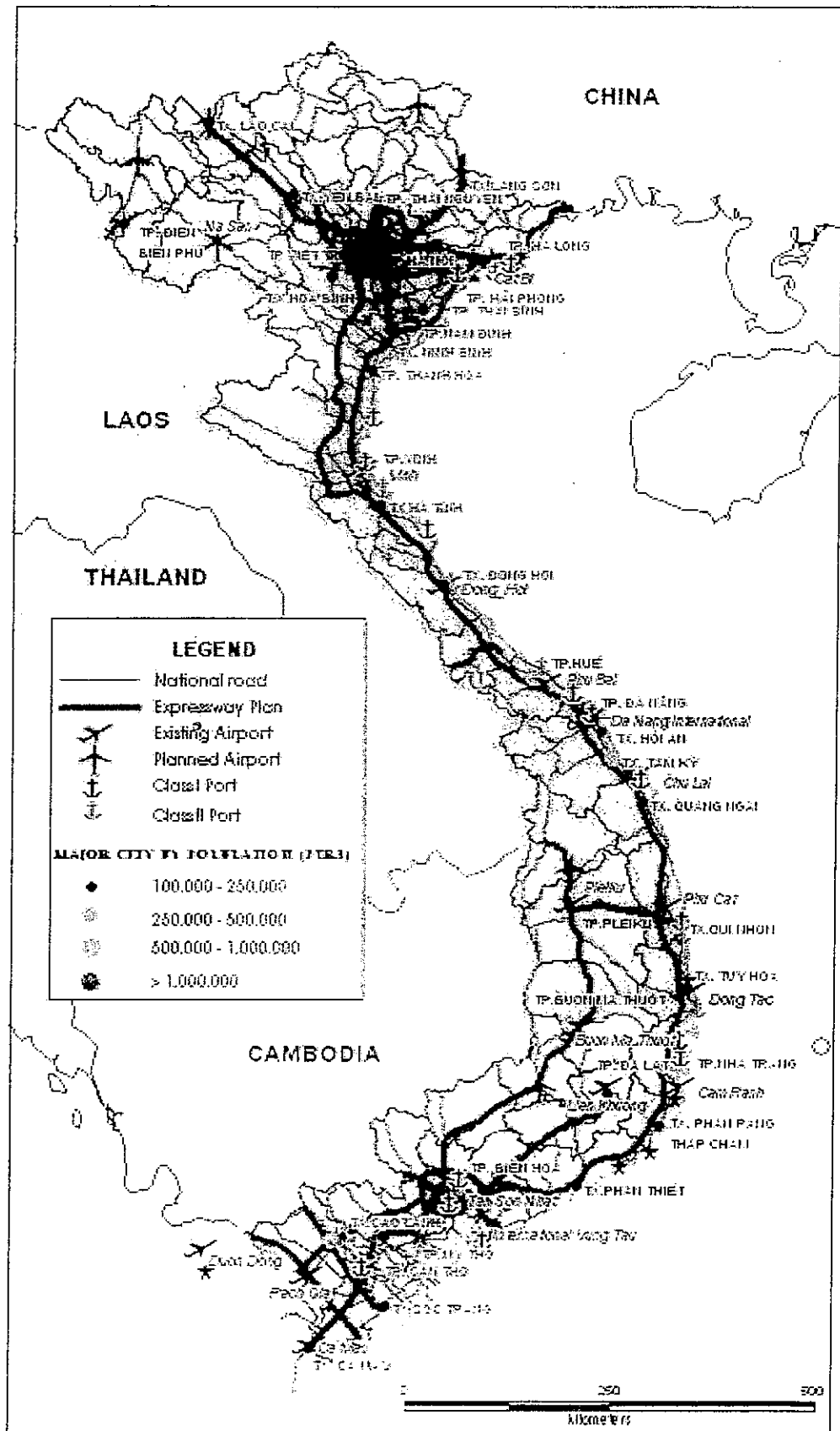


Figure 2.3.2 – Vietnam expressway network plan

- Vietnam expressway network is inclusive of 22 lines with total length is 5.873 km, including:

(a) The North - South expressway: including 2 lines with total length is about 3.262 km.

+ The North - South expressway at the East, its length is 1,941 km

+ The North - South expressway at the West, its length is about 1,321 km

(b) Expressway system at the North: consists of 7 centripetal lines connecting Hanoi with total length is 1099 km, details are as follows:

+ Lang Son - Bac Giang - Bac Ninh, 130 km long;

+ Ha Noi - Hai Phong, 105 km long;

+ Ha Noi - Viet Tri - Lao Cai, 264 km long;

+ Noi Bai - Ha Long - Mong Cai, 294 km long;

+ Ha Noi - Thai Nguyen - Cho Moi (Bac Kan), 90 km long;

+ Lang - Hoa Lac - Hoa Binh, 56 km long;

+ Ninh Binh - Hai Phong - Quang Ninh, 160 km long.

(c) Expressway system at Center region and Highland region: including 3 lines with total length is 264 km, details are as below:

+ Hong Linh (Ha Tinh) - Huong Son (Ha Tinh), 34 km long

+ Cam Lo (Quang Tri) - Lao Bao (Quang Tri), 70 km long

+ Quy Nhon (Binh Dinh) - PleiKu (Gia Lai), 160 km long

(d) Expressway system at the South: including 7 lines with total length is 984 km, details are as below:

+ Bien Hoa (Dong Nai) - Vung Tau (Ba Ria - Vung Tau), 76 km long;

+ Dau Giay (Dong Nai) - Da Lat (Lam Dong), 209 km long;

+ Ho Chi Minh City - Thu Dau Mot (Binh Duong) - Chon Thanh (Binh Phuoc), 69 km long;

+ Ho Chi Minh City - Moc Bai (Tay Ninh), 55 km long;

+ Chau Doc (An Giang) - Can Tho - Soc Trang, 200 km long;

+ Ha Tien - Rach Gia (Kien Giang) - Bac Lieu, 225 km long;

+ Can Tho - Ca Mau, 150 km long.

(đ) Ring road expressway system in Hanoi and Hochiminh City

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- + Hanoi City: the ring road 3, 56 km long; the ring road 4, 125 km long.
- + Hochiminh City: the Ring road 3, 83 km long.

Table 2.3.3 – Expressway network plans

No	Section/route	The beginning point	The ending point	Length (km)	Scale (lanes)	Total budget estimate (billion dong)	Investment stage
The North - South expressway at the East							
1	Cau Gie - Ninh Binh	Cau Gie, (existing extension Hanoi) Previous Ha Tay	Ninh Binh town	50	6	9.300	Under construction, Stage 1: 4 lanes
2	Ninh Binh - Thanh Hoa	Ninh Binh town	Quang Xuong district, Thanh Hoa	75	6	12.380	Before 2020
3	Thanh Hoa - Vinh	Thanh Hoa	Ben Thuy Bridge, Vinh City	140	6	22.120	Before 2020
4	Vinh - Ha Tinh	Vinh	Hong Linh town	20	4 - 6	2.580	Before 2020
5	Ha Tinh - Quang Tri	Bai Vot intersection	Cam Lo - Quang Tri	277	4	21.610	
6	Quang Tri - Da Nang	Cam Lo, Quang Tri	Tuy Loan, Da Nang	178	4	18.160	Before 2020
7	Da Nang - Quang Ngai	Da Nang City	Quang Ngai town	131	4	17.820	Before 2020
8	Quang Ngai - Quy Nhon	Quang Ngai town	An Nhon, Binh Dinh	150	4	23.700	Before 2020
9	Quy Nhon - Nha Trang	An Nhon, Binh Dinh	Nha Trang City	240	4	24.960	
10	Nha Trang - Dau Giay	Nha Trang City	Dau Giay, Dong Nai	378	4 - 6	55.940	
11	Hochiminh City - Long Thanh - Dau Giay	Hochiminh City	Dau Giay, Dong Nai	55	6 - 8	18.880	Before 2020
12	Long Thanh - Nhon Trach - Ben Luc	Long Thanh, Dong Nai	Ben Luc, Long An	45	6 - 8	12.340	Before 2020
13	Hochiminh City - Trung Luong	Cho Dem, Hochiminh City	Trung Luong	40	8	13.200	Under construction, Stage 1: 4 lanes
14	Trung Luong - My Thuan - Can Tho	Hochiminh City	Can Tho	92	6	26.250	Before 2020
The North - South expressway at the West							
15	Doan Hung - Hoa Lac - Pho Chau	Doan Hung, Phu Tho	Pho Chau, Ha Tinh	457	4 - 6	53.930	

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No	Section/route	The beginning point	The ending point	Length (km)	Scale (lanes)	Total budget estimate (billion dong)	Investment stage
16	Ngoc Hoi - Chon Thanh - Rach Gia	Ngoc Hoi, Kon Tum	Rach Gia town, Kien GIAG	864	4 - 6	96.770	
The North area							
1	Lang Son - Bac Giang - Bac Ninh	Huu Nghi border gate	Nhu Nguyet Bridge, new NH1A, Bac Ninh	130	4 - 6	12.220	Before 2020
2	Hanoi - Hai Phong	Hanoi	Hai Phong	105	4 - 6	16.800	Before 2020
3	Hanoi- Lao Cai	Noi Bai, Hanoi	Lao Cai City	264	4 - 6	15.580	Before 2020
4	Hanoi- Thai Nguyen	Hanoi	Thai Nguyen City	62	4 - 6	4.220	Before 2020
5	Thai Nguyen - Cho Moi	Thai Nguyen city	Cho Moi	28	4 - 6	2.940	
6	Lang - Hoa Lac	Lang	Hoa Lac	30	6	7.650	Under construction
7	Hoa Lac - Hoa Binh	Hoa Lac K	Hoa Binh City	26	4 - 6	2.550	
8	Bac Ninh - Ha Long	Bac Ninh City	Ha Long City	136	6	19.040	Before 2020
9	Ha Long - Mong Cai	Ha Long City	Mong Cai town	128	4 - 6	13.820	Before 2020
10	Ninh Binh - Hai Phong - Quang Ninh	Ninh Binh town	Ha Long	160	4	13.760	
Center region							
1	Hong Linh - Huong Son	Hong Linh town	Huong Son Town	34	4	2.450	
2	Cam Lo - Lao Bao	Cam Lo town, Quang Tri	Lao Bao border gate	70	4	4.900	
3	Quy Nhon - PleiKu	An Nhon, Binh Dinh	PleiKu City	160	4	12.000	
The South							
1	Dau Giay - Da Lat	Dau Giay	Da Lat City	189	4	19.280	Before 2020
2	Bien Hoa - Vung Tau	Bien Hoa City	Vung Tau City	76	6	12.160	Before 2020
3	Hochiminh City - Thu Dau Mot - Chon Thanh	Binh Phuoc junction	Chon Thanh	69	6 - 8	20.010	

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No	Section/route	The beginning point	The ending point	Length (km)	Scale (lanes)	Total budget estimate (billion dong)	Investment stage
4	Hochiminh City - Moc Bai	Ring road 3 Hochiminh City	Moc Bai border gate	55	4 - 6	7.480	
5	Soc Trang - Can Tho - Chau Doc	Soc Trang town	Chau Doc town	200	4	24.200	
6	Ha Tien - rach Gia - Bac Lieu	Xa Xia border gate, Ha Tien town	Bac Lieu Town	225	4	27.230	
7	Can Tho - Ca Mau	Can Tho city	Ca Mau City	150	4	24.750	
The ring roads system in Hanoi							
1	Ring road 3	Noi Bai, Hanoi	Coincide with the beginning point	56	4 - 6	17.990	Before 2020
2	Ring road 4	Soc Son, Hanoi	Coincide with the beginning point	125	6 - 8	34.500	
The ring road system in Hochiminh City							
1	Ring road 3	Nhon Trach - Dong Nai	Binh Chanh, Hochiminh City	83	6 - 8	20.750	Before 2020
Total				5.753		766.220	

• **Detailed plan of the North - South expressway at the East**

The Prime Minister issued the Decision No.140/QD-TTg dated 21/01/2010 regarding approval the Eastward North - South expressway detailed plan. According to this decision:

- *The beginning point:* at Phap Van IC (between the ring road 3 of Hanoi city).

- *The ending point:* at Can Tho. In the imminent time, connect the expressway and Cha Va IC at the North of the Can Tho Bridge Project. In the next stage, the expressway connects to Quan Lo - Phung Hiep road to continuously run towards Ca Mau.

The entire expressway from Hanoi to Can Tho (excluding Can Tho Bridge) is 1.811Km long.

Based on transport demand forecast, socio-economic development, planned investment time of sections under the North South Expressway at the East is shown in the table 2.3.4

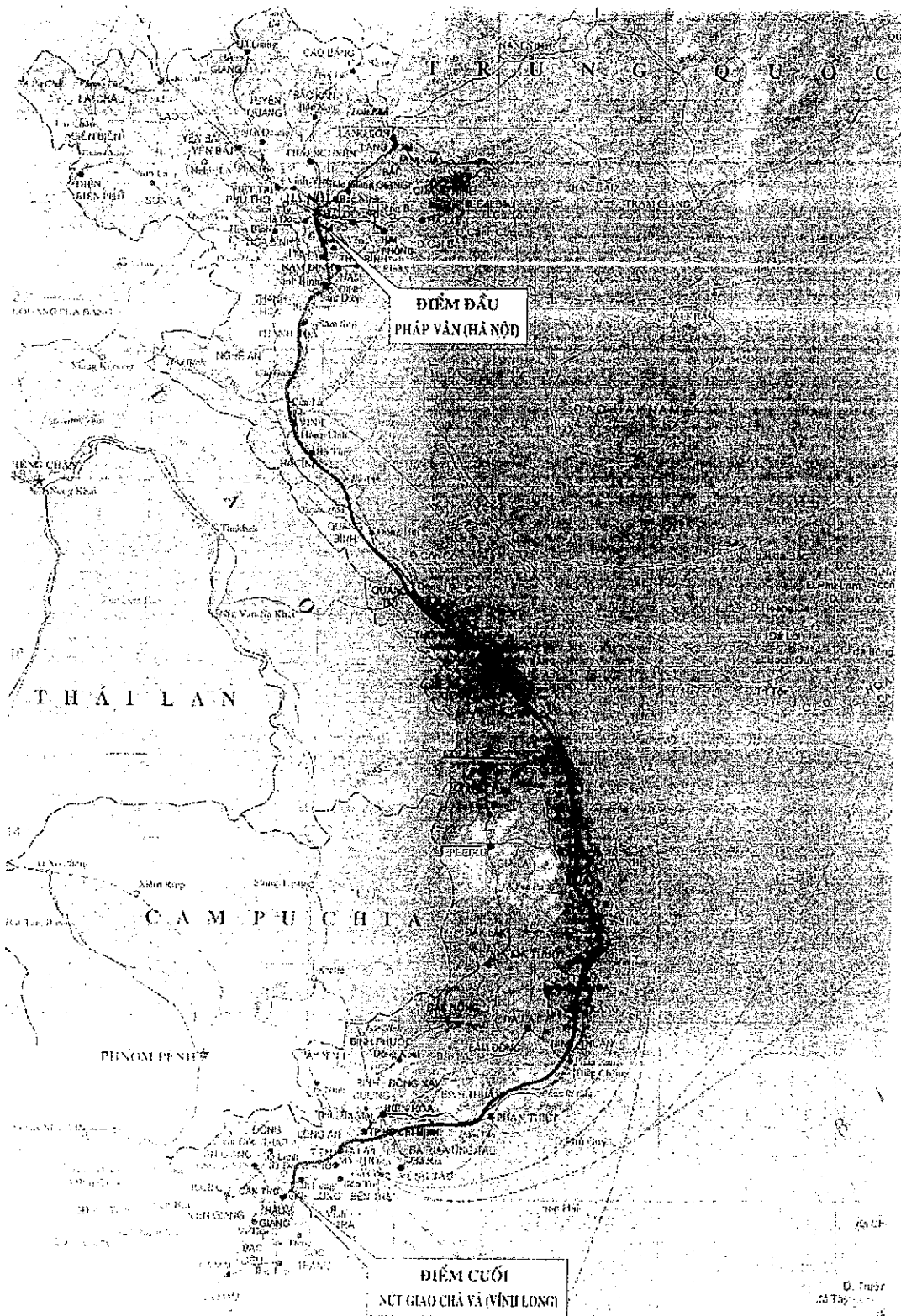


Figure 2.3.3 – Location map of the North - South Expressway

Table 2.3.4 - Construction plan of the North - South Expressway at the East

No	Section	Length (km)	Construction plan											Remark				
			Tow rd 2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020		After 2020			
1	Phap Van - Cau Gie	30																Will be expanded Under construction
2	Cau Gie - Ninh Binh	50																2011-2014
3	Ninh Binh -- Thanh Hoa	121																2012-2015
4	Thanh Hoa - Ha Tinh	97																2019-2023
5	Ha Tinh - Quang Binh	145																2019-2023
6	Quang Binh - Quang Tri	117																2015-2019
7	Quang Tri - Da Nang	182																2011-2014
8	Da Nang - Quang Ngai	130																2016-2019
9	Quang Ngai -- Binh Dinh	170																2017-2020
10	Binh Dinh -- Nha Trang	215																2014-2017
11	Nha Trang -- Phan Thiet	226																2011-2014
12	Phan Thiet - Dau Giay	98																Will be expanded after 2020
13	Dau Giay - Long Thanh	43																2012-2016
14	Long Thanh - Ben Luc	58																Will be expanded after 2020
15	Ben Luc - Trung Luong	37																2011-2015
16	Trung Luong - My Thuan - Can Tho	92																
	Total	1811																

b) Railways

The Prime Minister has issued Decision No. 136/QĐ-TTg dated 10/9/2009 regarding amendment of Vietnam Railway Transport Development Strategy towards 2020 and vision to 2030. According to this Decision:

- By 2020, the following will be completed:

+ Improvement of existing railways.

+ Some sections of the North - South High speed Railway, Yen Vien - Pha Lai
0 Ha Long - Cai Lan railway, Bien Hoa - Vung Tau, Lao Cai – Hanoi– Hai Phong railway, Dong Dang - Hanoi railway, railway for exploiting bauxite (DakNong - Binh Thuan), Di An - Loc Ninh railway, Vung Ang - Mu Gia railway; improvement of Thap Cham - Da Lat railway; construction of Dong Ha - Lao Bao railway; railways connecting with seaports, industrial zones, economic zones, new mining...such as Hai Phong International Port, Van Phong International Terminal Port, Cai Mep - Thi Vai Port, Thach Khe Iron Pit, Bauxite Tay Nguyen...; hub railway network such as Hanoi (the ring road at the East), Hochiminh City (the ring road at the West), Hai Phong, Da Nang, Diêu Trì; construction of some main routes of urban railways, inter-region railways in Hanoi and Hochiminh City.

- By 2030, the following will be completed:

+ Tay Nguyen railway network including main railway: Da Nang – Kon Tum – Dak Lak – Buon Ma Thuot – Chon Thanh – Hochiminh City and ramps Buon Ma Thuot – Tuy Hoa, Dak Nong – Binh Thuan.

+ Remain sections of the North - South High speed Railway;

+ Urban railway network of Hanoi, Hochiminh City;

+ Coastal railway corridor Nam Dinh – Thai Binh – Hai Phong – Quang Ninh, Ha Long – Mong Cai;

+ Lang Son – Quang Ninh (Mui Chua), Nam Dinh – Thinh Long, My Ly – Tan Ky ...

Currently, Vietnam - Japan Association Consultant is appointed by the MOT to prepare F/S Report of Hanoi- Hochiminh City Express Railway. According to the Final Report of the Project, the North - South Express Railway has the following features:

- The beginning point is Hanoi city and the ending point us Hochiminh City with total length is 1.555km.

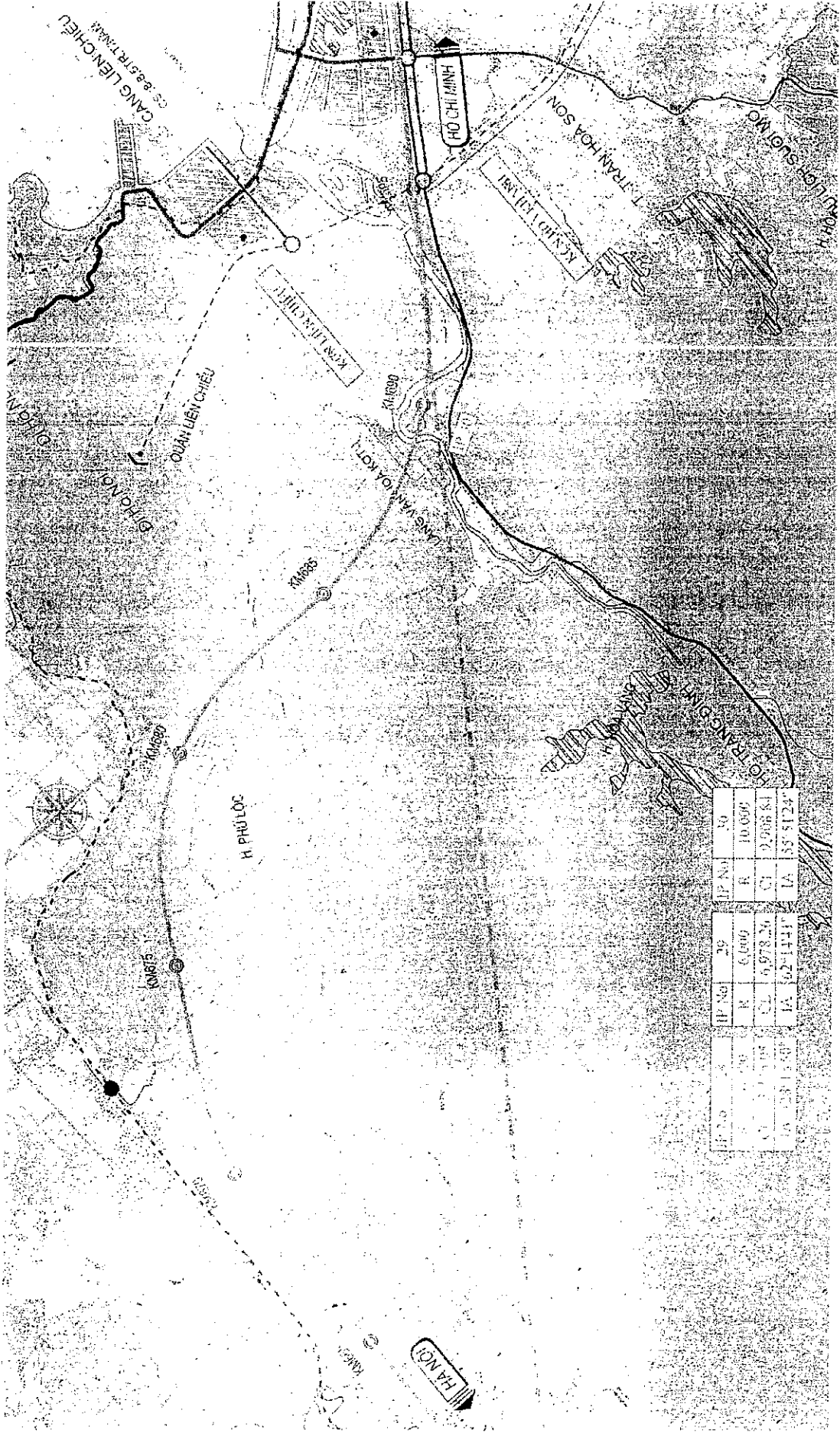
- Main design standards: gauge is 1435mm, double track, design speed is

350km/h, design load P16, rail: ballast less, track:60kg/m, supply power source AC25kV 50Hz and automatic transmission, signal system ATC, digital automatic control.

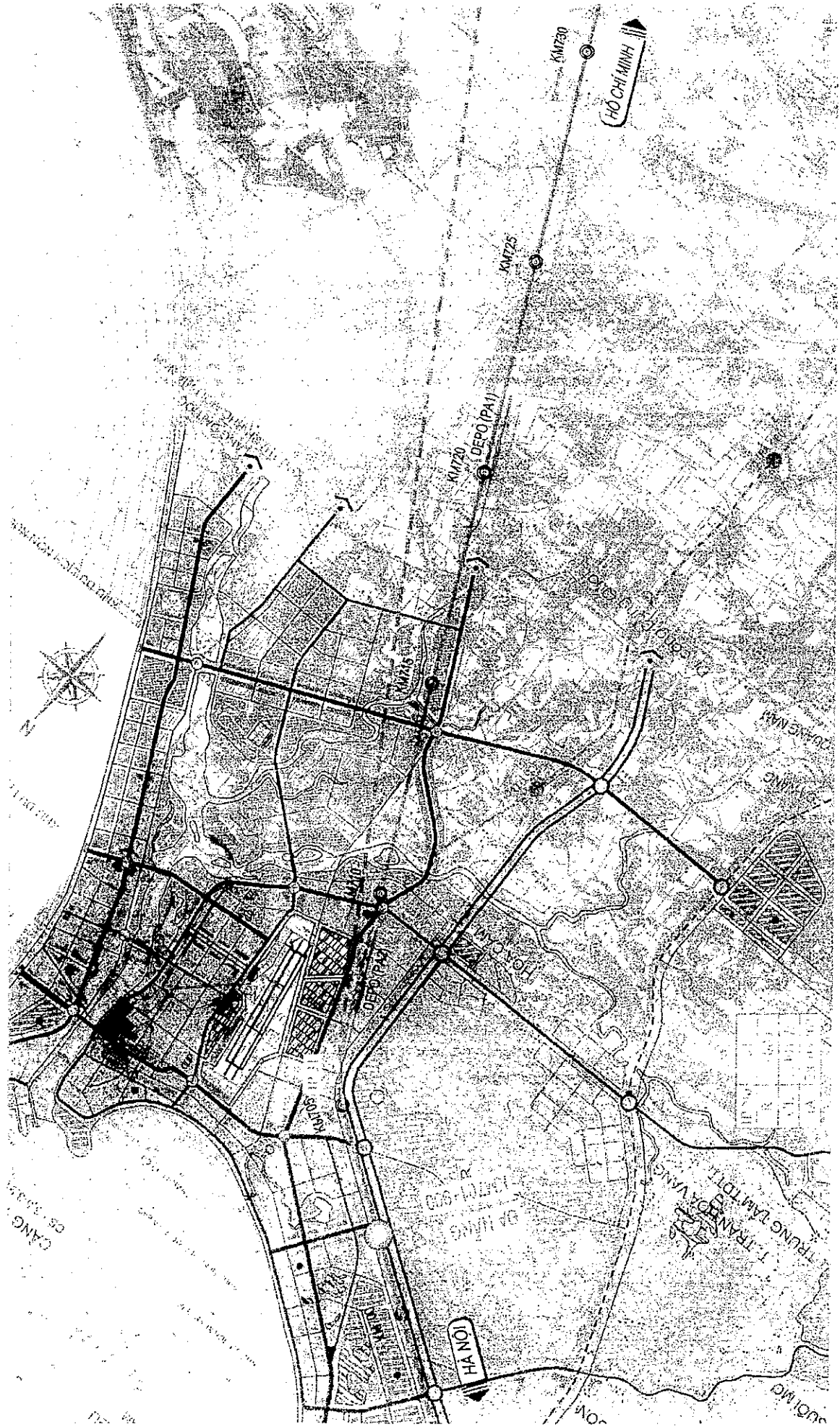
- Stations on the rail route: total 25 stations, of which 3 stations will be located in the existing locations, 12 stations will be located close to existing locations and 10 stations will be located at planned locations.

- Construction plan: Hanoi- Vinh and Nha Trang - Hochiminh city section will be constructed and operated by 2020; Vinh- Da Nang section will be operated by 2030; Da Nang - Nha Trang section will be operated in 2035.

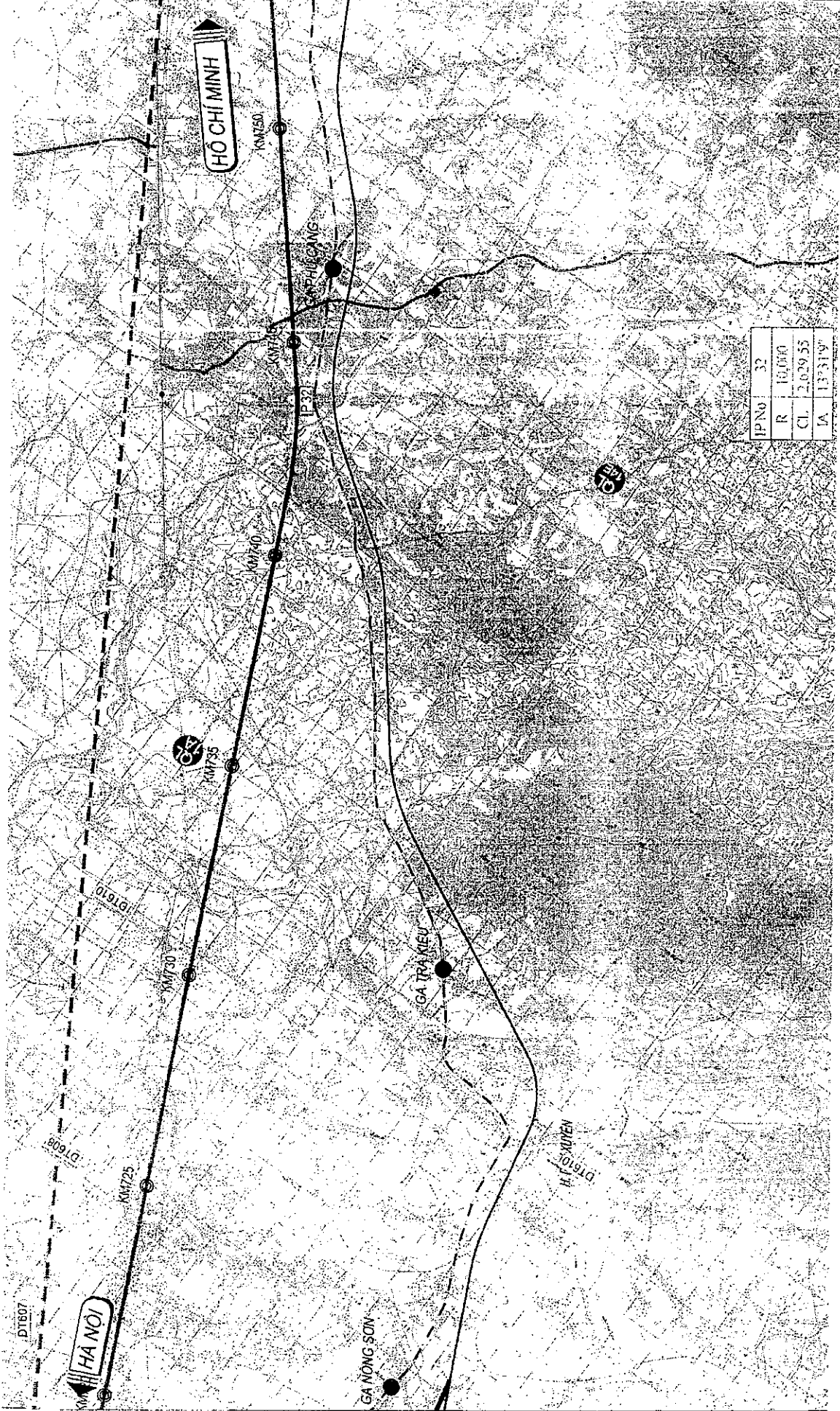
Figure 2.3.4- Alignment of Hanoi - Hochiminh City High speed Railway, section from Da Nang to Quang Ngai



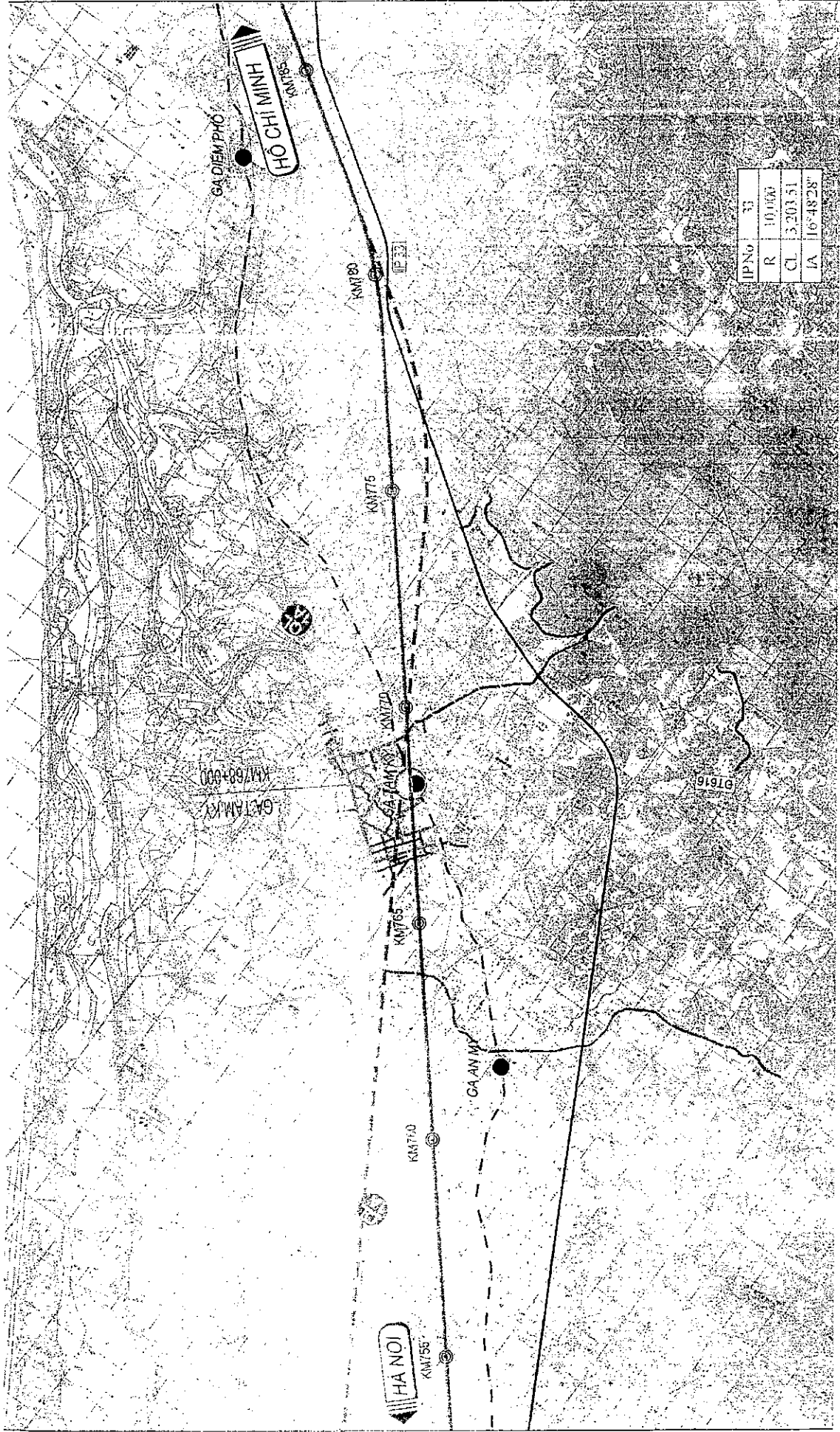
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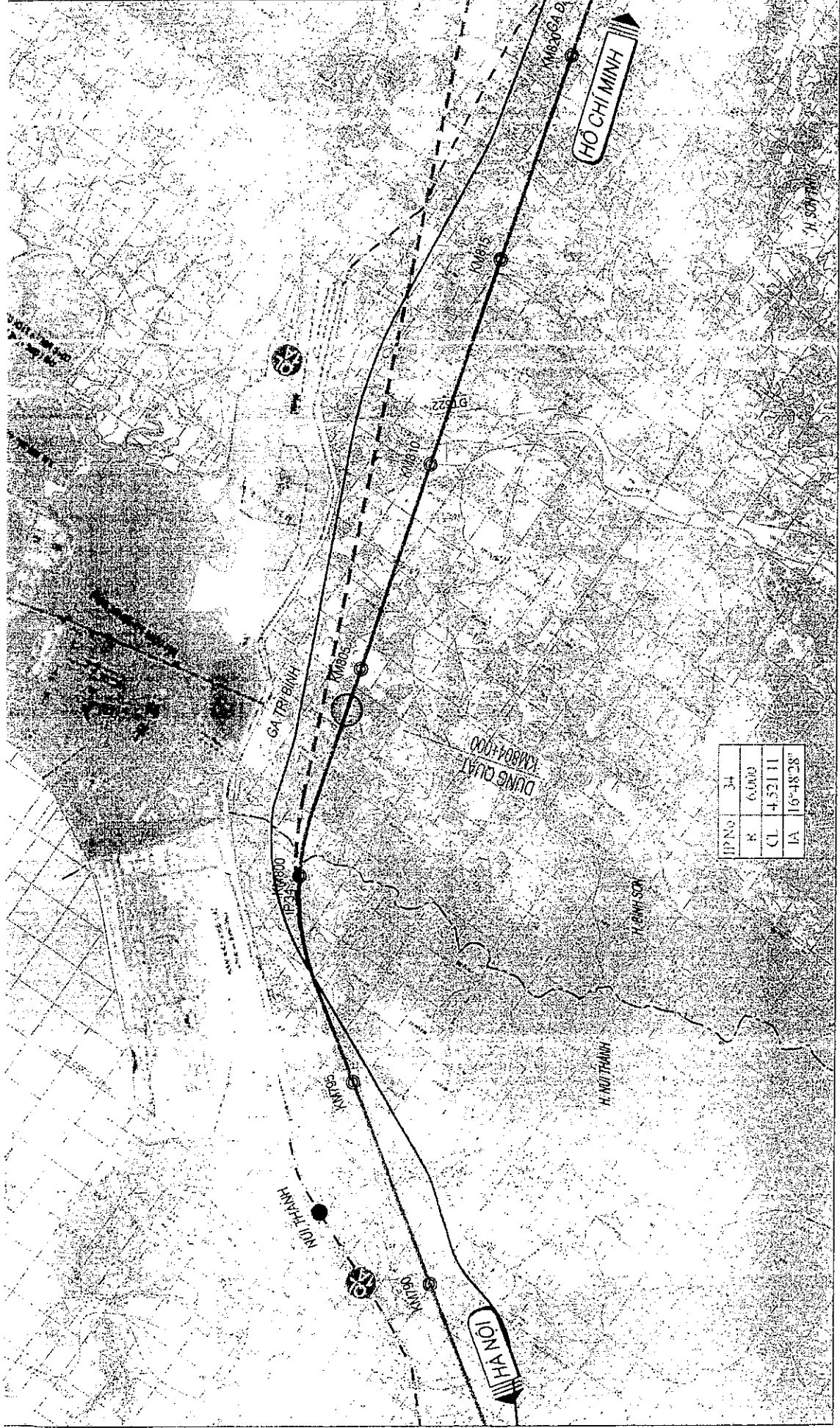
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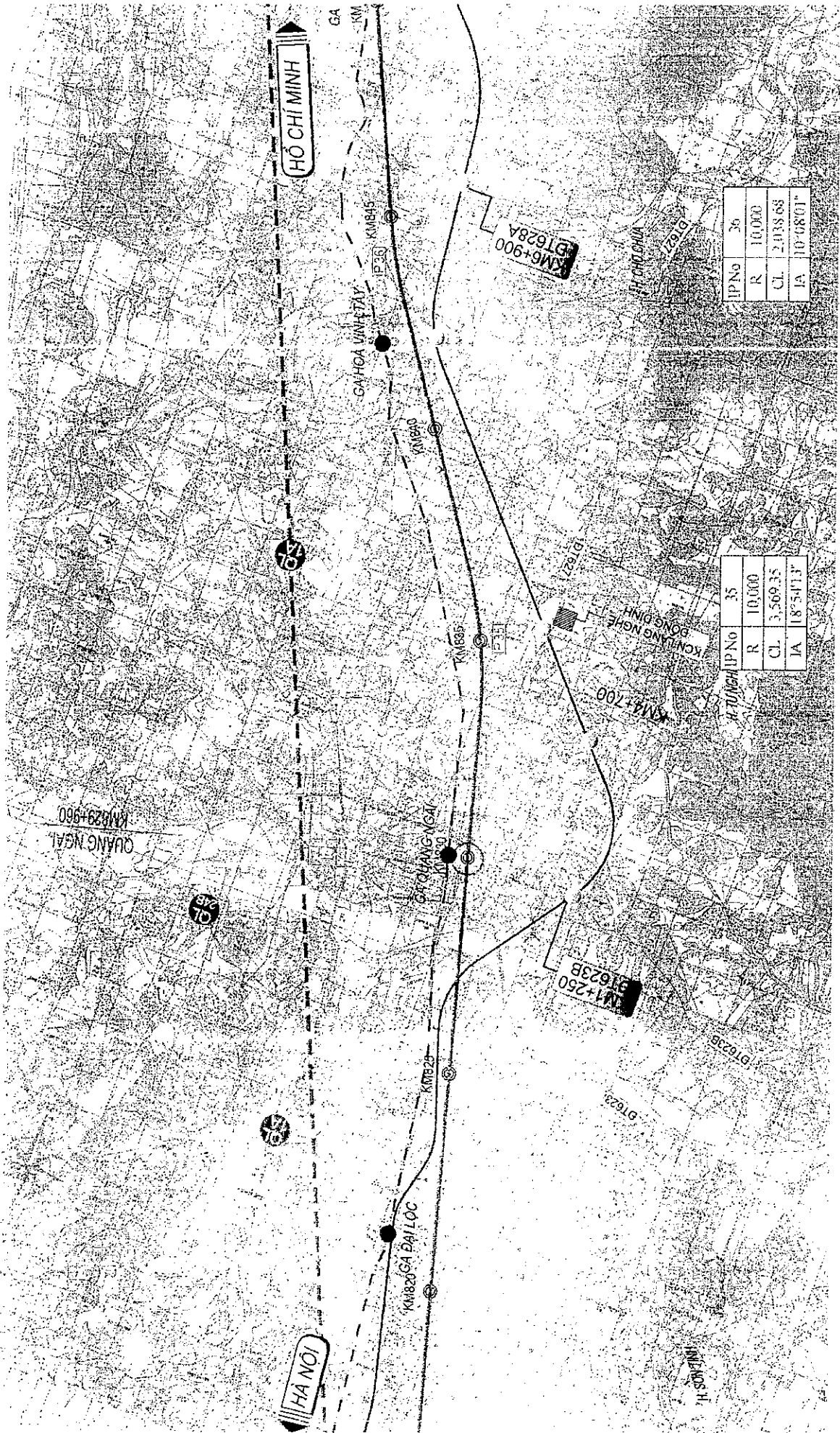
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IPNo	35
R	10,000
CL	3,569.35
JA	18°54'13"

IPNo	36
R	10,000
CL	2,038.68
JA	10°08'01"

c) Ports

In accordance with Vietnam Seaports System Development Plan towards 2020 and vision to 2030 approved by the Prime Minister by the Decision No. 2190/QD-TTg dated 24/12/2009, main seaports in the Major economic zone of the Center region from Thua Thien Hue to Binh Dinh are inclusive of:

Table 2.3.5 –Development plans of seaports under Major economic zone of the Center region

No	Name of seaports	Clarification	Development plans			
			Towards 2015		Towards 2020	
			Capacity (Mill. Ton/year)	Dimension (thousand DWT)	Capacity (Mill. Ton/year)	Dimension (thousand DWT)
1	Thua Thien Hue port	Synthetic Locals type II				
	Chan May	Synthetic, local, for foreign tourist	1.5-1.7	10-30 100 GRT (cruise)	2.5-3.0	30-50 100 GRT (cruise)
	Thuan An	Satellite locality	0.2-0.3	1-3	0.2-0.3	1-3
2	Da Nang port	Synthetic nation, region hub type 1				
	Tien Sa - Son Tra	Synthetic, container, for foreign tourist	4-4.2	10-30 100 GRT (cruise)	4.5-5	10-50 100 GRT (cruise)
	Han River - Tho Quan	Synthetic, special purpose	0.6-1.0	1.0-20	0.6-1.0	1.0-20
	Lien Chieu	special purpose Synthetic, container	1.5-1.7	5.0-20	4.5-6.0	5.0-80
3	Ky Ha Port	Synthetic local type II	1.5-5.0	5-20	3.0-3.5	5-20
4	Dung Quat Port	Synthetic nation, region hub type I				
	Dung Quat I	Synthetic, container and special purpose	10-11	10-70	14.5-15.5	10-70
	Dung Quat II (*)	special purpose Synthetic		Grain, liquid: 100-300 Synthetic: 30-50		Grain, liquid: 100-300 Synthetic: 30-50
	Sa Ky	Satellite locality	0.2-0.3	1	0.2-0.3	1
5	Quy Nhon Port	Synthetic nation, region hub type I				

No	Name of seaports	Clarification	Development plans			
			Towards 2015		Towards 2020	
			Capacity (Mill. Ton/year)	Dimension (thousand DWT)	Capacity (Mill. Ton/year)	Dimension (thousand DWT)
	Quy Nhon – Thi Nai	Synthetic, container, special purpose station	5.0-5.5	10-30	6.0-6.5	10-30
	Nhon Hoi (*)	special purpose Synthetic	1.5-2.0	20-50	2.0-3.2	20-50
	Dong Da, De Gi, Tam Quan, ... (*)	Satellite locality	0.5-1.0	2-10	1.0-1.5	2-10

Note: (*) are ports that have been constructed

d) Airways

Pursuant to Decision No. 21/QĐ-TTg dated 08/01/2009 issued by the Prime Minister:

- By 2020:

Airport network (AN) by 2020 is planned based on taking Hanoi, Da Nang and Hochiminh City as 3 points of goods and passenger gathering in order to connect with domestic and international airways.

By 2020, 26 AN will be operated, of which, there are 10 international AN (IA) such as Noi Bai, Cat Bi, Phi Bai, Da Nang, Chu Lai, Cam Ranh, Tan Son Nhat, Long Thanh, Can Tho, Phu Quoc and 16 domestic airport (DA) such as Dien Bien Phu, Na San, Lao Cai, Quang Ninh, Gia Lam, Vinh, Dong Hoi, Phu Cat, Tuy Hoa, Pleiku, Buon Ma Thuot, Lien Khuong, Rach Gia, Ca Mau, Con Son, Vung Tau.

Total area of AN towards 2020 is about 23.000 ha, in which, land area under civil aviation management accounts 11.200 ha, land area under civil and military management accounts 6.500 ha, land area under military management accounts 5.300 ha.

Based on region development plan, local plans in the period of 2020, studies and plans airports serving common aviation activities, air taxi by helicopter and small wing aircraft at far provinces and provinces have no airport.

Airport clarification according to regions:

- The North region consists of 9 airports: 02 IA (Noi Bai, Cat Bi), 07 DA (Dien Bien, Na San, Lao Cai, Gia Lam, Quang Ninh, Vinh, Dong Hoi).

- The Center region consists of 7 airports: 04 IA (Da Nang, Chu Lai, Phu Bai, Cam Ranh), 03 DA (Phu Cat, Tuy Hoa, Pleiku).

- The South region consists of 10 airports: 04 IA (Tan Son Nhat, Long Thanh, Can Tho, Phu Quoc), 06 DA (Buon Ma Thuot, Lien Khuong, Rach Gia, Ca Mau, Con Son, Vung Tau).

- Small airports, dedicated airports and helipads:

- By 2030:

- Airport network:

+ Continuously develop existing airports including 10 IAs (Noi Bai, Cat Bi, Phi Bai, Da Nang, Chu Lai, Cam Ranh, Tan Son Nhat, Long Thanh, Can Tho, Phu Quoc) and 16 DAs (Dien Bien Phu, Na San, Lao Cai, Quang Ninh, Gia Lam, Vinh, Dong Hoi, Phu Cat, Tuy Ha, Pleiku, Buon Ma Thuot, Lien Khuong, Rach Gia, Ca Mau, Con Son, Vung Tau). To study location, scale of the second IA in Hanoi area while airway passenger demand exceeds 50 million passengers/year. In case market demand is large enough, it can develop some airports such as Lai Chau, Cao Bang, Phan Thiet to be big airports in this stage.

+ Total land area of airports towards 2030 is about 25.000 ha.

+ In this stage, keep studying, planning and constructing more small airports for helicopters, air taxi, common aviation activities at provinces and cities having no airports.

- International Airports:

+ Keep investing and expanding the next stages of Long Thanh International Airport in order to assure the replacement international airport of Tan Son Nhat IA and become the most important IA of the South, the biggest IA of overall country and region terminal center according to international standard. Long Thanh IA reaches grade 4F according to standard ICAO with total capacity from 80 to 100 million passengers/year.

+ Expand Noi Bai IA towards the North with construction of the third taking off/landing line; parallel and connection rolling road system; aircraft parking area system; station T3 with its capacity is 20-25 million passengers/year; cargo station with capacity 0.5 - 1 ton/year; repair and maintenance area of large fuselage aircraft together with synchronous infrastructure system. After 2020, Noi Bai IA will reach grade 4F according standard ICAO and military airport class I. Total capacity will reach 50 million passengers/year.

+ Expand passenger and cargo serving area at Cat Bi IA to meet capacity 4 - 5 million passengers/year and 80 - 100.000 ton cargo/year. Strengthen navigation equipments qualifying standard CAT - II of ICAO.

+ Keep expanding and improving operation ability of the Da Nang IA appropriate to political, socio-economic development requirements of Da Nang city in particular and of Center region in general. Capacity of the Da Nang IA reach 10 - 15 Million passengers/year and 250.000 - 300.000 ton cargo/year in 2020 - 2030.

+ Expand passenger service area at Phu Bai IA to meet capacity 4 - 5 Million passengers/year and 200.000 - 300.000 ton cargo/year. Strengthen navigation equipments qualifying standard CAT - II of ICAO.

+ Keep expanding and developing Chu Lai IA to become cargo terminal center of region with construction of the second taking off/landing line (4.000m x 60m), cargo station system with capacity 5 Million ton/year, passenger station with capacity 4 Million passengers/year.

+ Expand passenger service area at Cam Ranh IA with capacity 4 - 5 million passenger/year and 200.000 - 300.000 ton cargo/year. Strengthen navigation equipments qualifying standard CAT - II of ICAO.

+ Expand passenger service area at Can Tho IA to meet capacity 5 Million passengers/year and 400.000 - 500.000 ton cargo/year. Strengthen navigation equipments qualifying standard CAT - II of ICAO.

+ Priority to develop Phu Quoc IA to become airport of tourism and trade center, assuring operation of aircraft B747 or equivalent to capacity 6 Million passengers/year and 300.000 ton cargo/year.

- Domestic Airports:

Keep expanding and strengthening DA operation capacity. Especially, it is necessary to focus on investment and expansion of airport operation capacity located in areas with tourism and economic development potential, has an important role on national defense such as Quang Ninh, Cam Ranh, Lien Khuong Phu Quoc, Con Son, Ca Mau ...as motivation for socio-economic and national defense development of locals and overall country.

2.3.2. Plans of urban and economic zones

Until now, Vietnam has had 15 economic zones along the sea according to Decision No. 1353/QĐ-TTg dated 23/09/2008 of the Prime Minister regarding approval of Vietnam coastal economic zone development plan project towards year 2020. Those economic zones are inclusive of: *Van Don Economic Zone (Quang Ninh)*, *Dinh Vu - Cat Hai Economic Zone (Hai Phong)*, *Nghi Son Economic Zone (Thanh Hoa)*, *Dong Nam Economic Zone (Nghe An)*, *Vung Ang Economic Zone (Ha Tinh)*, *Hon La Economic Zone (Quang Binh)*, *Chan May - Lang Co Economic Zone (Thua Thien - Hue)*, *Chu Lai Open Economic Zone (Quang Nam)*, *Dung Quat Economic Zone (Quang Ngai)*, *Nhon Hoi Economic Zone (Binh Dinh)*, *Nam Phu Yen Economic Zone (Phu Yen)*, *Van Phong Economic Zone (Khanh Hoa)*, *Phu Quoc Economic Zone (Kien Giang)*, *Dinh An Economic Zone (Tra Vinh)*, *Nam Can Economic Zone (Ca Mau)*.

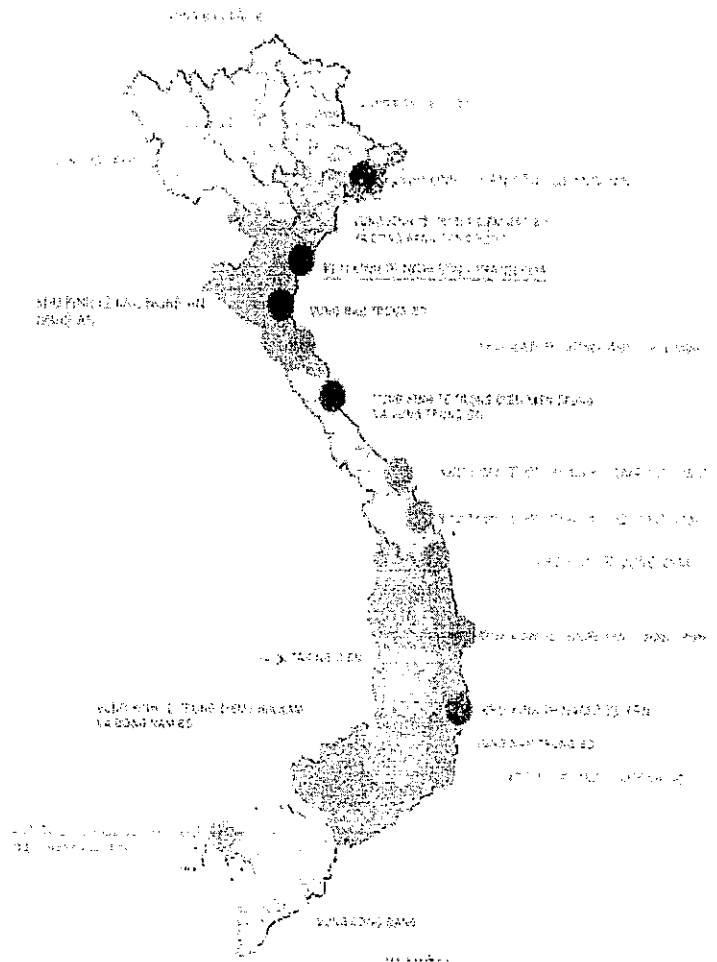


Figure 2.3.5 – Vietnam Coastal Economic Zone

- Due to the fact that those economic zones are located in the potential tourism regions that is taken interest in by the Government such as marine tourism, island tourism, eco-tourism....., they have lot of advantages and development opportunities.

- Development of major economic zones and coastal economic corridor will promote development of economic zones with general region development.

- Technical infrastructure system of economic zones have been interested and invested.

There are 2 important economic zones (EZ) within the project area: Chu Lai Open EZ and Dung Quat EZ.



Figure 2.3.6 – Plans of Chu Lai Open EZ and Dung Quat EZ

- **Chu Lai Open Economic Zone**

Chu Lai Open EZ will be industrial - tourism - service center of Major EZ of the Center region, promotion of industrialization & modernization of the Center region and overall country. It connects the Tay Nguyen, Dung Quat EZ and Cambodia, Laos, Thailand.

By 2020, it is planned to formed and develop major EZ such as North Chu Lai (630ha), Truong Hai Automobile Mechanic EZ (243ha), Tam Anh EZ (1.915ha)...; construct and develop Tam Thang high technology zone (300 ha).

In social field, by 2020, the Chu Lao Open EZ will have 650.000 people of population limit, form education - training institutions such as 295ha of Vocational Center, Chu Lai International High School, Private Universities, and vocational schools with high quality. Besides, Central Polyclinic Hospital will be constructed here...

Up to 2020, the Tam Phu (2.000ha) and Tam Hoa (1.640ha) Urban Areas will be formed; Nui Thanh Urban Area will be improved into type III urban...

Regarding development direction, with 32,040 ha, Chu Lai Open EZ will be gradually expanded towards the West and the North.

- **Dung Quat Economic Zone**

Dung Quat is synthetic EZ with multi-sectors and multi-fields development.

- Develop heavy industry; including oils filter industry, rolling steel industry, and shipbuilding, cements production, mechanical and heavy equipment manufacturing, automobile assembly...

- Develop light industry, mainly electrical and electronic industry, high-tech materials, textiles, footwear, processed commodities, export...

- Develop industrial services; financial and banking services; insurance, education and training; housing, entertainment, travel ... (associated with the Van Tuong modern city with urban industrial - service).

- Till 2010: Complete Oil Refinery Plant, Polypropylene Petrochemical Plant; develop oil and gas port and container cargo for 30,000 DWT of ships; develop Van Tuong Urban in an area of about 200 hectares, Shipbuilding Phase 1, Steel Rolling Plant, clinker grinding plant, Heavy Equipment Manufacturing Plant, light industry projects and service - auxiliary projects....

- Phase II (2010-2015): Expand the Dung Quat Economic Zone area to 46 thousand ha. To construct Dung Quat Economic Zone following the model of special economic zone or industrial city. Improve Oil Refinery Plant to 10 million ton/year, attract more new Oil Refinery Plant and develop petrochemical respectively; complete two steel rolling plants with 10 million tons/year, complete other heavy industry plants (thermal power, shipbuilding, heavy equipment manufacturing ...), develop ports phase II for 50,000 DWT of tanker, 50,000 DWT of cargo ships; gradually develop high-tech projects ...; develop Van Tuong Urban in an area of about 500 ha....

2.3.3 Industrial Zones under Major Economic Area of the Center region

According to the Decision No. 29/2007/QD-BCN dated 11/7/2007 issued by the Ministry of Industry, Major Economic Zone of the Center region has the following Industrial Zones:

Table 2.3.6 - List of planned Industrial Zones toward year 2015
Major Economic Zone of the Center region

No	Name of Industrial Zone	Area (ha)	Location
1	Phu Bai IZ (old, including phase 1, 2, 3)	300	Huong Thuy, Thua Thien - Hue
2	Phu Bai IZ (Extension - phase 4)	600	"
3	Chan May 1 IZ	398	Chan May - Lang Co EZ
4	Chan May 2 IZ	346	"
5	Chan May 3 IZ	164	"
6	Tu Ha IZ	300	Huong Tra, Thua Thien - Hue
7	Phong Dien IZ	400	Phong Dien, Thua Thien - Hue
8	28 Industrial Groups – Industrial centers and 4 Industrial Groups trade village under Thua Thien - Hue	1.427	Hue City and districts of Huong Tra, Huong Thuy, Phu Vang, Huong Dien, Phu Loc, Quang Dien, Nam Dong, A Luoi
9	Planned total area of Izs of Da Nang, including: Hoa Khanh, Extension Hoa Khanh, Da Nang, Lien Chieu, Hoa Cam, Da Nang Aquatic Product Service, Thanh Vinh	1.357	Da Nang City
10	Hoa Khanh IZ expanding to the North	110	Lien Chieu District, Da Nang
11	Hoa Khuong IZ	400	Hoa Khuong, Hoa Vang, Da Nang
12	Hoa Minh IZ	200	Hoa Minh, Hoa Vang, Da Nang
13	6 Industrial Groups at some districts of Da Nang	316	Districts of Hoa Van, Ngu Hanh Son, Thanh Khe, Lien Chieu, Son Tra - Da Nang
14	Dien Nam - Dien Ngoc IZ	418	Dien Ban District – Quang Nam
15	Thuan Yen IZ	130	Tam Ky Town – Quang Nam
16	Tam Hiep IZ	120	Nui Thanh district –

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No	Name of Industrial Zone	Area (ha)	Location
			Quang Nam
17	Bac Chu Lai IZ	120	Nui Thanh district – Quang Nam
18	Tam Thang IZ	292	Thang Binh district - Quang Nam
19	Dong Que Son IZ	381	Que Son district - Quang Nam
20	An Hoa - Dong Son IZ	300	Duy Xuyen District – Quang Nam
21	Phu My Xuan IZ	550	Phu Ninh district – Quang Nam
22	Phu My Xuan IZ (Phase 1)	350	Huyện Phú Ninh – Quang Nam
23	157 Industrial Groups located in Quang Nam district	3.096	Districts of Tay Giang, Dong Giang, Nam Giang, Dai Loc, Que Son, Phuoc Son, Nam Tra My, Hiep Duc, Tien Phuoc, Dien Ban, Quy Xuyen, Hoi An, Thang Binh, Tam Ky, Phu Ninh, Nui Thanh – Quang Nam
24	IZ at the East (Dung Quat EZ)	5.054	Dung Quat EZ – Quang Ngai
25	IZ at the West (Dung Quat EZ)	2.100	Dung Quat EZ – Quang Ngai
26	Tinh Phong IZ	350	Quang Ngai
27	Quang Phu IZ	147	At the west of Quang Ngai town
28	Pho Phong IZ	138	Duc Pho – Quang Ngai
29	IZ at the West of Son Tinh	80	Quang Ngai
30	Industrial Groups (300 billion dong) at some districts – Quang Ngai	25	Quang Ngai town. Nghia Hanh dist
31	Phu Tai IZ	348	Quy Nhon – Binh Dinh
32	Long My IZ	210	Quy Nhon City – Binh Dinh

No	Name of Industrial Zone	Area (ha)	Location
33	Nhon Hoa IZ	272	An Nhon – Binh Dinh
34	Binh Nghi IZ	150	Binh Dinh
35	Nhon Hoi IZ	1.077	Binh Dinh
36	Hoa Hoi IZ	300	Cat Hanh, Phu Cat – Binh Dinh
37	Cat Khanh IZ	150	Phu Cat – Binh Dinh
38	Bong Son IZ	100	Hoai Nhon – Binh Dinh
39	33 IG at districts – Binh Dinh	670	At districts, cities
	<i>Total area of planned IZ towards 2015 (ha)</i>	<i>16.476</i>	
	<i>Total area of planned IG towards 2015 (ha)</i>	<i>5.534</i>	
	<i>Capital of planned IZ towards 2015 (billion dong)</i>	<i>23.000</i>	
	<i>Capital of planned IG towards 2015 (billion dong)</i>	<i>5.500</i>	
	Total construction land for Iz and IG towards year 2015 (ha)	22.010	
	Total investment capital for IZ and IG towards 2015 (billion dong)	28.050	

(Source: Decision No. 29/2007/QĐ-BCN dated 11/7/2007 issued by MOI).

2.4. Necessary for investment of Da Nang - Quang Ngai Expressway

A developing economy requires a strong infrastructure. Transport works, transportation network and modes is one of infrastructure plays an important role in the industrialization - modernization of the country. In different transportation modes, road transport plays an important role in transporting goods and passengers. This is due to the flexibility of road transport to facilitate services to each house, unlike other transport modes.

Economic development countries in Europe such as England, Germany, Finland has developed high-speed road from the early 20th century and it has really contributed significantly to the economic development of these countries. In Asia, expressways began to appear from the second half of the 20th century in developing

loans of ADB, WB, JBIC (OEFC). However, because transport demand has been gradually growing, some sections of the NH1A have been expanded or expressways and bypass will be constructed in densely populated areas, cities, towns within the initial time such as : the Bac Giang - Hanoi section, Phap Van - Cau Gie - Ninh Binh section, Quang Ngai bypass, Hue City Bypass, the Hochiminh City - Trung Luong - My Thuan, etc.



Figure 2.3.7- The AH1 in the Asia Road Network

Ho Chi Minh Road is the longitudinal route at the West that was connected from Hoa Lac to Chon Thanh with scale of two lanes. However, because the route goes through areas that socio - economic conditions still poorly develop, service system is mostly not invested, transport volume is not attracted as the NH1A.

With the above importance, the North - South expressway at the West should be invested to meet requirements of national life-line route and conform to region and international requests.

Currently, the North - South expressway at the East has 30km under operation (section Phap Van - Cau Gie); other sections of the North - South expressway at the East are under construction such as Cau Gie - Ninh Binh, Dau Giay – Long Thanh, Hochiminh City – Trung Luong; the remaining sections are under investment preparation, in which, Da Nang expressway is one of them.

Major Economic Area of the Center region consists of Da Nang city and provinces such as: Thua Thien Hue, Quang Nam, Quang Ngai, Binh Dinh. It motivates socio-economic development for the Center region and Tay Nguyen with decisive sea economy together with industry and services. It has lot of culture heritage, revolutionary historical monuments and beautiful nature landscape. It is forecasted that by 2025 region population will reach 8.15 million people of which,

over 6 million people in working age; urban construction land will reach 60.000 - 65.000 ha, 120 - 140 m²/person.

Region will have the sub-region for the main motivation. The sub-region will be development space for development of marine and coastal economy, free international economic and trade corridor along the coast, based on the NH1A, national railway and seaport system.

Urban chain system will be developed to motivate the development. The system of industrial parks, export processing zones, exploiting is near the port; national and international warehouse system will connect with the international synthetic ports and inter-regional, trans-nation traffic hubs.

Coastal tourism will be formed in the region to connect with mountainous tourism, culture heritage and ocean discovery tourism.

In order to develop Major economic area at the Center region, it is necessary to develop infrastructure. Border gates through Myanmar, Thailand and Laos will be connected to seaport system and economic zone of Vietnam based on improving some national highways and provincial roads in the region.

The region will form 4 urban groups, in which Da Nang city will be center capital. It is planned that in 2025 there are 86 urban (43 new urban) in the entire region.

For the purpose of shortening the travel time between major ports in the region and nationwide, expressway corridor on the sea following North - South direction and a route linking with international will be constructed.

The following projects is priority invested: technical infrastructure investment for Hue - Lang Co - Non Nuoc synthetic tourism chain; formation of high quality multidisciplinary training center in Hue and Da Nang; construction of Da Nang as a coastal city - the largest synthetic service center of the region; construction of Hue city to become a tourism and culture center of the country; construction of Quy Nhon city to become economic growth center of the south and the road transport and sea port center directly serving for Tay Nguyen.

Currently, the economy of the Central region's key economic is growing strongly. Projects invested by domestic and abroad private investors is being implemented nation-wide; land demand using for economic sectors is gradually growing. The NH1A is the life-line route of in the area which is regularly flooded during the heavy rainy season. So completion of transportation network, including region expressway network, needs to early implementation as the basis for the construction of the involved projects.

The Da Nang - Quang Ngai expressway will be an important transport infrastructure to promote connection and support socio-economic development of the large area in central region. In addition, the route will play an important role in ensuring a smooth traffic, emergency relief for people in the region which frequently flooded during heavy rainy season.

The Da Nang - Quang Ngai Expressway (one part of the North - South expressway) will shorten the travel distance and price from the provinces to the tourism central areas in Da Nang, Quang Nam, Quang Ngai - which is attracting increasing number of tourists, opening investment opportunities in the central region and creating conditions to promote the establishment and development of industrial parks and tourism along the route, eco-tourism along the coast of Da Nang, Quang Nam, Quang Ngai. Therefore, the investment in construction of the expressway is an urgent requirement for key economic of the Central region.

CHAPTER 3 SURVEY AND TRAFFIC FORECAST DEMAND

The survey and traffic forecast demand implemented by CPCS and collected in the following items:

3.1. Base Traffic Model

3.1.1 Overview

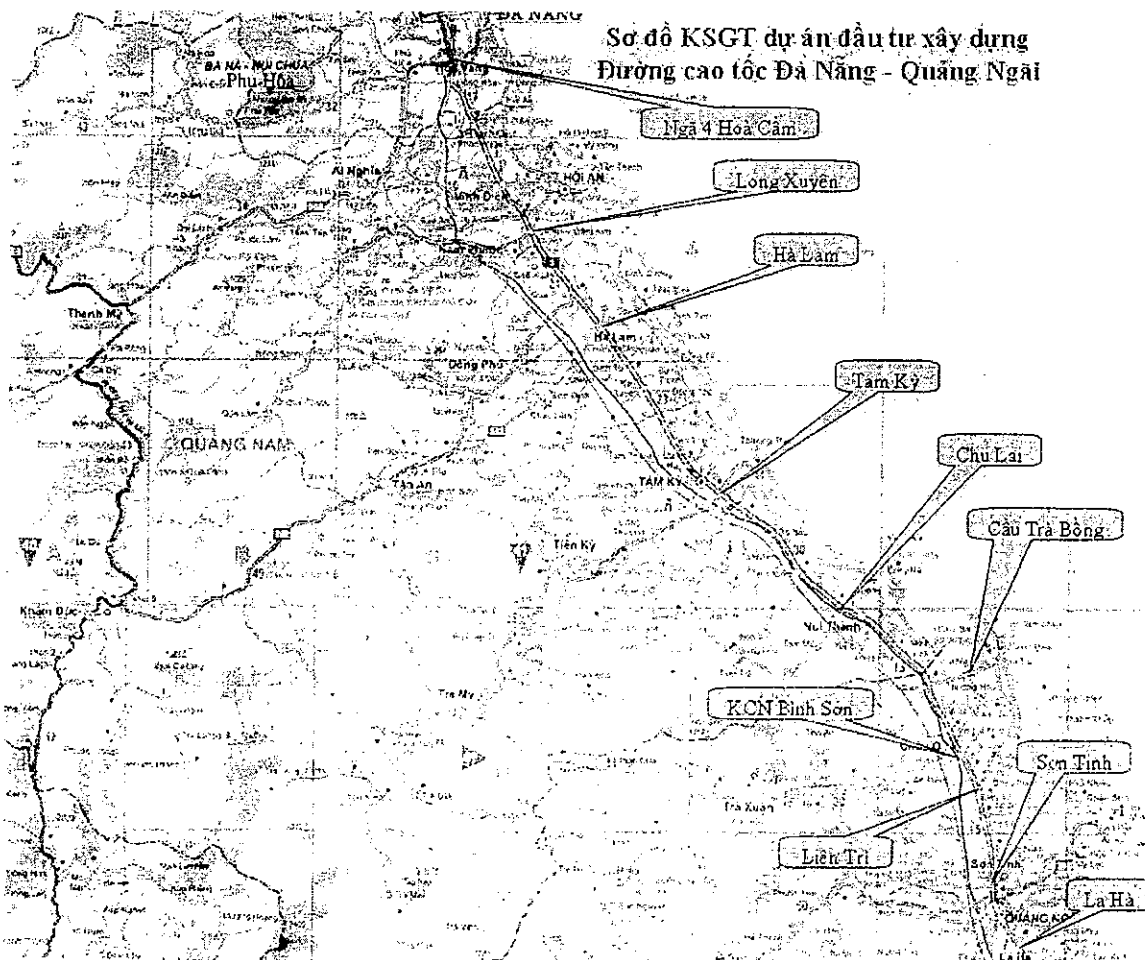
The key components of the traffic model consist of:

- A road network;
- A set of trip matrices predicated upon the 25-zone system, which was previously elaborated in the Traffic Survey Review; and
- A set of route-choice parameters.

3.1.2 Road Network

The road network for the base traffic model includes the National Highway 1 (NH1) from Hoa Cam in the north to La Ha in the South as illustrated in Figure 3.1.1. It also includes the east-west road from Phu Hoa to Hoa Cam, which will serve as the link road to junction 1 of the DQE. Other east-west roads which will act as link roads to the DQE at Long Xuyen, Ha Lam, Tam Ky, Chu Lai, Binh Son and Son Tinh are also included in the base traffic model network.

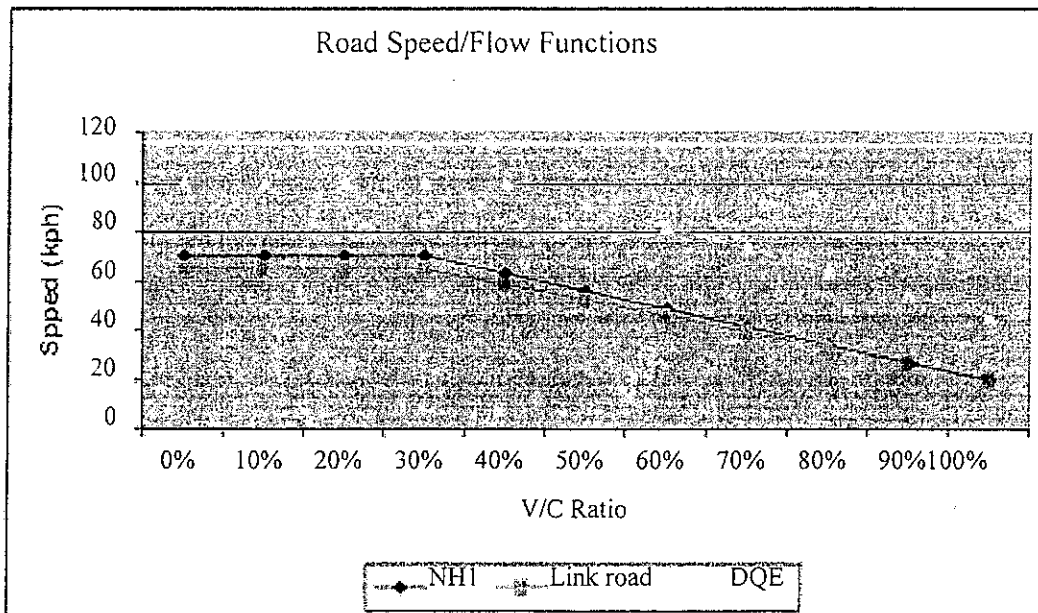
Figure 3.1.1: Road Network



Source: TEDI.

Each of the NHI and DQE connecting road links is given a speed/flow function as shown in Figure 3.1.2. However, Phu Hoa-Hoa Cam connecting road is allocated the same speed/flow function as for the NHI road links. The NHI and Phu Hoa-Hoa Cam road links are given a capacity of 30,800-44,800 PCU [passenger car unit] per day. Other connecting road links have a capacity of 26,400 PCU per day.

Figure 3.1.2- Speed-flow Functions



Source: CPCS.

3.1.3 Trip Matrices

The 2009 trip matrices by vehicle type reported in the Traffic Survey Review formed the trip matrices for the base year traffic model. Two adjustments were made prior to their allocation to the road network. First, the long-distance bias of trucks with three axles, highlighted in the Traffic Survey Review, was ameliorated by factoring down the 3-axle truck matrix to better reflect the number of these trucks crossing the southern roadside interview station; resulting in a reduction of 132 three-axle truck trips per day (about -5%). Second, the 25-zone matrices were compressed to 14 assignment zones; this principally involved combining the zones to the north of Danang with that of Danang city and grouping the zones south of Quang Ngai into a single southern zone.

3.1.4 Route Choice Function

The route choice function is predicated upon a generalised cost function consisting of travel time, motorway bonus and toll payable. Only the first parameter is theoretical applicable for the base model. However, as there is no alternative route in the base year the route choice function is redundant in practice. The motorway bonus will be elaborated in the next section on forecasting model inputs.

3.1.5 Model Calibration

The calibration of the base traffic model principally involved refining the adopted speed-flow functions; only the capacity was adjusted and not the shape of the function.

3.1.6 Model Quality

In addition to demonstrating the quality of the input trip matrices, which was included in the Traffic Survey Review, the quality of the base traffic model can be demonstrated in two ways:

- Comparing modelled link flows against observed traffic flows; and
- Comparing modelled journey times against observed times.

The link flow comparisons are shown in Figure 3.1.3. With two exceptions all modelled flows are within 10% of the observed traffic. The exceptions relate to heavy trucks at the northern end of the DQE corridor and reflect our minimalist approach to ameliorate the three-axle truck bias and will have minimal impact in forecasting. These link flow comparison results reinforce the matrix comparison results previous reported and underpin the pattern and quantity of traffic across the DQE corridor.

Figure 3.1.3 - Link Flow Comparisons

Link	Hoa Cam/Cam Le (RSI North)	Long Xuyen North	Lien Tri (RSI South)
Observed			
Car	2,124	2,147	1,549
Bus	1,906	1,803	1,606
Light Truck	3,933	3,533	2,474
Heavy Truck	2,080	1,464	1,119
Total	10,043	8,947	6,748
Modelled			
Car	2,093	2,107	1,523
Bus	1,841	1,857	1,652
Light Truck	3,781	3,798	2,640
Heavy Truck	1,781	1,709	1,096
Total	9,496	9,471	6,910
Modelled/Observed			
Car	99%	98%	98%
Bus	97%	103%	103%
Light Truck	96%	107%	107%
Heavy Truck	86%	117%	98%
Total	95%	106%	102%

Source: CPCS calculations.

The journey time comparisons are shown in Figure 3.1.4. Again the results are impressive, particularly from a strategic (i.e. medium to long distance) basis. Only two links, i.e. Chu Lai Dung Quat and Dung Quat-Binh Son, are outside the exceptional results of within 10% of the recorded average times. As previously indicated in the Traffic Survey Review the large variance for these two links may be due to inappropriate input road lengths as when considered together their combined modelled time and observed time are very close (i.e.

within 2% of each other). These journey time comparison results provide strong support that the adopted speed/flow functions are sensible.

Figure 3.1.4- Journey Times Comparisons

Link	Description	Length (km)	Observed speed (kph)	Observed time (min)	Modelled time (min)	Modelled/Observed time (%)
0	Phu Hoa - Hoa Vang	5.6	30.0	11.2	11.2	100%
1	Hoa Vang - Long Xuyen	24.2	49.8	29.2	29.5	101%
2	Long Xuyen - Ha Lam	13.9	32.3	25.8	23.6	92%
3	Ha Lam - Tam Ky	24.5	56.2	26.2	28.6	109%
4	Tam Ky - Chu Lai	18.9	44.2	25.7	25.8	101%
5	Chu Lai - Dung Quat	17.4	79.1	13.2	19.2	145%
6	Dung Quat - Binh Son	9.3	36.2	15.4	9.0	58%
7	Binh Son - Quang Ngai	16.2	65.5	14.9	15.6	105%
8	Quang Ngai - La Ha	6.1	55.0	7.9	6.8	102%
Σ	Phu Hoa - La Ha	136.1	48.6	169.3	169.2	101%
5-6	Chu Lai-Binh Son	26.7	56.0	28.6	28.2	98%
1-3	Hoa Vang-Tam Ky	62.6	46.3	81.1	81.7	101%
4-7	Tam Ky-Quang Ngai	61.8	53.7	69.1	69.5	101%
1-8	Hoa Vang-La Ha	130.5	50.0	156.9	158.0	101%

Source: TEDI, CPCS calculations.

The Base Year modelled traffic flows and link volume to capacity ratios (V/C ratios) for the NH1 and the important Phu Hoa-Hoa Cam road are highlighted in Figure 3.1.5. The table shows that NH1 is not as overused as many observers would like to believe. Nevertheless, there are various local bottlenecks, primarily caused by poorly controlled frontage activities and roadworks. However, Phu Hoa-Hoa Cam road with a V/C ratio of 68% could soon be saturated as well as making DQE less attractive.

Figure 3.1.5 - Base Year Modelled Flows and V/C Ratios

Link	Car	Bus	Light Truck	Heavy Truck	All Vehicle	All PCU	V/C
Phu Hoa - Hoa Cam	2,102	1,745	4,913	2,850	11,610	21,865	68%
Hoa Cam - Ho An	2,093	1,841	3,781	1,781	9,496	17,604	42%
Hoi An - Long Xuyen	2,107	1,857	3,798	1,709	9,471	17,470	42%
Long Xuyen - Ha Lam	2,155	1,866	3,860	1,718	9,600	17,676	57%
Ha Lam - Tam Ky	2,199	1,885	3,950	1,736	9,769	17,966	40%
Tam Ky - Chu Lai	1,525	1,589	3,371	1,278	7,762	14,335	47%
Chu Lai - Dung Quat	1,570	1,538	3,431	1,264	7,804	14,378	38%
Dung Quat - Binh Son	1,523	1,652	2,640	1,096	6,910	12,654	33%
Binh Son - Quang Ngai	1,463	1,627	2,655	1,097	6,841	12,602	33%
Quang Ngai - La Ha	1,359	1,416	2,647	1,052	6,474	11,780	38%

Source: CPCS calculations

The superior validation results provide strong comfort that the base traffic model and its input data form the necessary foundation for traffic forecasting.

3.2. Forecasting Model Inputs

3.2.1 Overview

The forecasting model inputs essentially relate to the three components of the traffic model, viz.:

- 1) Trip matrices;
- 2) Road network; and
- 3) Route-choice parameters.

The modelled forecast years for this exercise are 2015, 2020, 2025, 2030, 2035 and 2040.

3.2.2 Trip Matrices

Trip matrix growths are assumed to be driven by economic growths. Two economic growth scenarios are assumed as shown in Figure 3.2.1.

Figure 3.2.1- Economic Growth Scenarios (% per annum)

Year	Base case	Low case
2010	6.5%	6.5%
2011	7.0%	6.5%
2012-2015	7.5%	6.5%
2016-2020	7.0%	6.0%
2021-2025	6.5%	5.5%
2026-2030	6.0%	5.0%
2031-2035	5.5%	4.5%
2036-2040	5.0%	4.0%

Source: World Bank.

Often travel demand increases faster than economic growth, particularly in fast growing developing countries. An analysis of historic cross-sectional traffic of NHI within the DQE corridor confirms such a phenomenon for some vehicle types as indicated in Figure 3.2.2.

Figure 3.2.2: Traffic and GDP Growth Relationships

Station	Vehicle type	Vehicles per day			Growth % p.a.		
		2003	2007	2009	2003-07	2007-09	2003-09
RSI North (Danang-Vinh Dien)	Car+Van	632	2,136	4,059	35.6%	37.9%	36.3%
	Bus	847	1,426	1,803	13.9%	12.4%	13.4%
	Truck	1,878	2,301	3,085	5.2%	15.8%	8.6%
	Total	3,357	5,863	8,947	15.0%	23.5%	17.7%
RSI South (Tam Ky Quang Ngai)	Car+Van	544	1,306	2,342	39.6%	39.5%	39.6%
	Bus	544	1,227	1,606	22.5%	14.4%	19.8%
	Truck	1,712	2,087	2,600	5.1%	11.6%	7.2%
	Total	2,600	4,620	6,748	15.5%	20.9%	17.2%
GDP					8.2%	5.7%	7.4%
Traffic:GDP Multiplier (times GDP growth)							
RSI North (Danang-Vinh Dien)	Car+Van				4.3	6.0	4.9
	Bus				1.7	2.2	1.8
	Truck				0.6	2.7	1.2
	Total				1.8	4.1	2.4
RSI South (Tam Ky Quang Ngai)	Car+Van				4.8	6.7	5.3
	Bus				2.7	2.5	2.7
	Truck				0.6	2.0	1.0
	Total				1.9	3.6	2.3

Source: TEDI, Nippon Koei, World Bank, CPCS calculations.

Going forward the assumed traffic:GDP growth multipliers are presented in Figure 3.2.3. The slightly greater than unity multipliers for trucks are to reflect traffic generation effect of DQE. Some may argue that the traffic multipliers for cars could be higher in the early years, given the low starting base and recent past rates. This could be less than prudence; more in the next paragraph.

Figure 3.2.3: Traffic Growth Multipliers (times GDP Growth)

Vehicle type	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
Car	3.0	2.0	1.75	1.5	1.35	1.2	1.1
Bus	1.75	1.5	1.4	1.3	1.2	1.1	1.0
Truck	1.0	1.0	1.05	1.1	1.1	1.05	1.0

Source: CPCS calculations.

Combining the assumed GDP growths and the traffic:GDP multipliers yields the travel growth indices as in Figure 3.2.4. The figure shows that for the Base case car travel is projected to grow by 18 folds in just over 30 years (i.e. equivalent to 9.8% per annum). Any higher and the projection will start to appear unreasonable. Although car travel and car ownership are not the same thing, Dargay, Gately and Sommer showed in 2007 that between 1960 and 2002 Thai vehicle ownership grew by 8.7% per annum whereas starting from a much higher base Malaysian vehicle ownership grew by 6.7% per annum between 1967 and 2002⁴. They also indicated that Chinese vehicle ownership grew at a very robust 9.8% per annum between 1962 and 2002 but that was from an extremely low base of less than 0.5 vehicle per 1,000 population. A 2008 news digest suggests that Vietnamese car ownership was 8 cars per 1,000 population by the end of 2007.

Figure 3-4: Traffic Indices

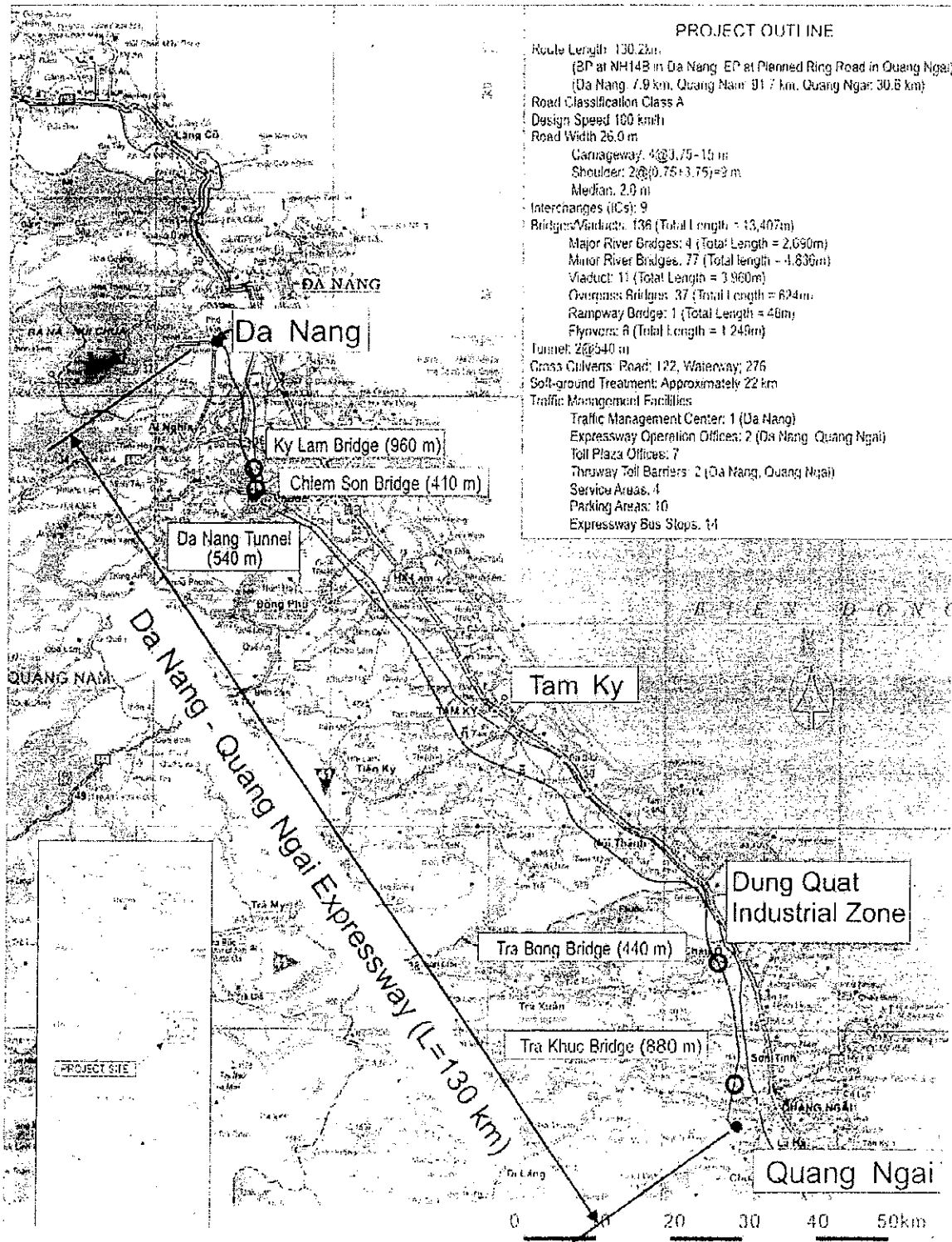
Year	Base case			Low case		
	Car	Bus	Truck	Car	Bus	Truck
2009	1.000	1.000	1.000	1.000	1.000	1.000
2015	2.383	1.885	1.522	2.202	1.773	1.459
2020	4.246	3.009	2.170	3.627	2.654	1.980
2025	6.761	4.513	3.064	5.392	3.749	2.657
2030	9.980	6.390	4.218	7.474	5.017	3.472
2035	13.738	8.571	5.585	9.722	6.388	4.374
2040	17.955	10.939	7.128	12.057	7.772	5.321

Source: CPCS calculations.

3.2.3 Road Network

The proposed DQE will be a 2x2-lane tolled expressway connecting Phu Hoa in the north to Quang Ngai West in the south (i.e. 129.3 kilometres long) and from there a single carriageway road to NH1 at La Ha. The proposed expressway will have seven intermediate junctions at Long Xuyen, Ha Lam, Tam Ky, Chu Lai, Dung Quat, Binh Son and Quang Ngai North. It will have a design speed of up to 120 kph and slow moving traffic will not normally be allowed. Figure 3.2.5 presents the DQE alignment.

Figure 3.2.5: Alignment of Proposed DQE



Project Location Map

Updating and Finalizing the Feasibility Study Report

for Da Nang - Quang Ngai Expressway Construction Project

Source: Nippon Koei,
 Construction Project

"Updating and Finalizing the Feasibility Study Report for Da Nang-Quang Ngai Expressway

In essence, nine additional road sections (i.e. eight DQE sections plus the southern link road) were added to the Base Year (existing) road network to form the Do-Something road network. The speed/flow function of DQE sections is as given in Figure 3.5 and a daily capacity of 96,000 PCUs per day is assumed.

While there are still ample NH1 road capacities as indicated in Figure 3.2.5, the very high travel demand growths projected for the corridor (above) mean that the NH1 would likely be very heavily trafficked after 2020. By then average journey times from Hoa Cam (just south of Danang) to Quang Ngai could take 6 hours or more. As such corridor travel demand projections beyond 2020 could be suppressed without additional road capacity, whether in the form of a do-something DQE or do-minimum widening of NH1.

Hence it is assumed that the existing NH1 will be widened by an extra lane in each direction to form the Do-Minimum road network. In that case the widened NH1 will add additional daily capacity of 39,200 PCUs per day. It is assumed that NH1 widening will take place in 2021 for the Base case and two years later for the Low case. The proposed DQE is added to the Do-Minimum network to form the DO-Something with NH1 widening network. (This employment of a Do-Minimum and a Do-Something with NH1 widening networks is to prevent over-estimating the economic benefits of DQE.)

For incremental analysis an alternative DQE was also considered. This will involve constructing a shorter DQE from Phu Hoa in the north to Quang Ngai North in the south. In other words there will be no DQE Section 8.

3.2.4 Route-choice Parameters

The route-choice parameters for car, LGV and trucks with two axles consist of travel time, motorway bonus and toll. And these are combined to form generalised costs of travel.

Three toll scenarios were assumed for traffic and revenue forecasting. They were VND 400, 800 and 1,200 per kilometre in constant 2009 prices. Figure 3.2.6 shows the toll rates by vehicle type. These toll rates are equivalent to car tolls between Danang and Quang Ngai of roundly VND 50,000, 100,000 and 150,000, respectively. Bus and truck tolls will be higher.

Figure 3.2.6: Toll Rates (VND 2009 per kilometre)

Scenario	Car	Mini Bus	Large Bus	LGV	Truck 2 axles	Truck 3 axles	Truck >3 axles
400	400	600	1,000	600	800	1,000	1,200
800	800	1,200	2,000	1,200	1,600	2,000	2,400
1,200	1,200	1,800	3,000	1,800	2,400	3,000	3,600

Source: CPCS.

Expressway development and use in Vietnam is in its infancy. Experience elsewhere suggests that road users have a preference to using expressways for reasons other than higher speed. Factors such as safety, reliability, ride quality etc have been mentioned. These superior expressway characteristics are captured as “motorway bonus”. Essentially the perceived cost of using an expressway is lower than a non-expressway alternative. For DQE, it is assumed that Vietnamese road users will also exude similar preference for expressway and Figure 3.2.7 indicates the motorway bonus assumed for traffic forecasting. The figure shows that truck motorway bonuses are a third of that for cars. This is because trucks typically benefit less than cars from the higher permissive expressway speed.

Figure 3.2.7: Motorway Bonus (% expressway travel times)

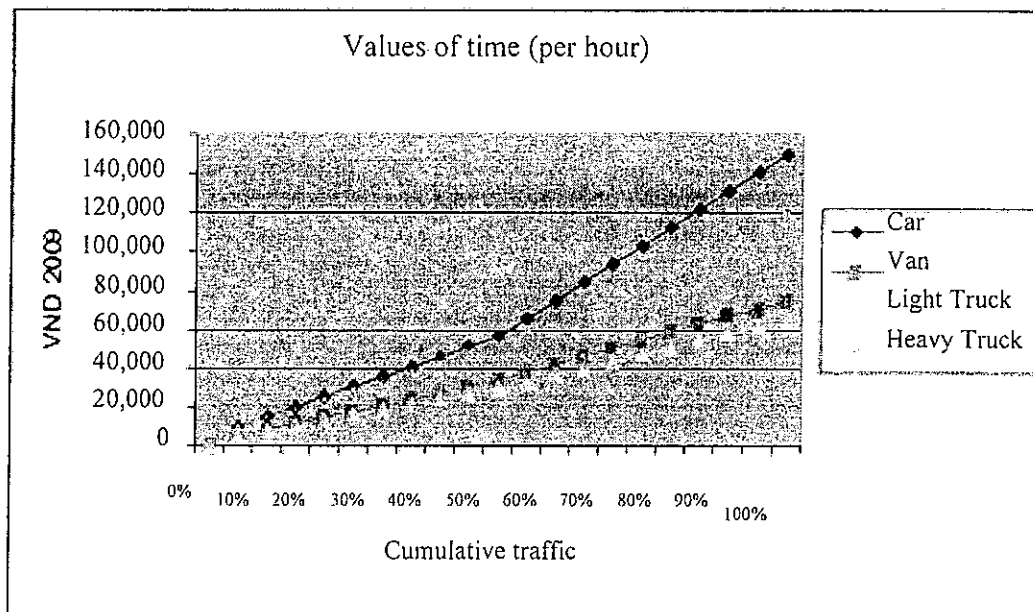
Car	Mini Bus	Large Bus	LGV	Truck 2 axles	Truck 3 axles	Truck >3 axles
-15%	-10%	-10%	-5%	-5%	-5%	-5%

Source: CPCS.

Travel time costs are determined by values of time. The Traffic Survey Review presented the surveyed values of time for cars and trucks and noted that 1-2 values were suspiciously high. For traffic forecasting these higher survey values have been excluded to err on the side of prudence. Figure 3.2.8 presents the “trimmed” value of time (VOT) distributions for cars and trucks.

In line with many toll road studies the values of times employed were assumed to rise with per capita GDP growth. For the purpose of computing per capita GDP growths the Vietnamese population is assumed to increase by 1% per annum throughout the appraisal period. Figure 3.2.9 gives the per capita growth indices for the Base and Low cases.

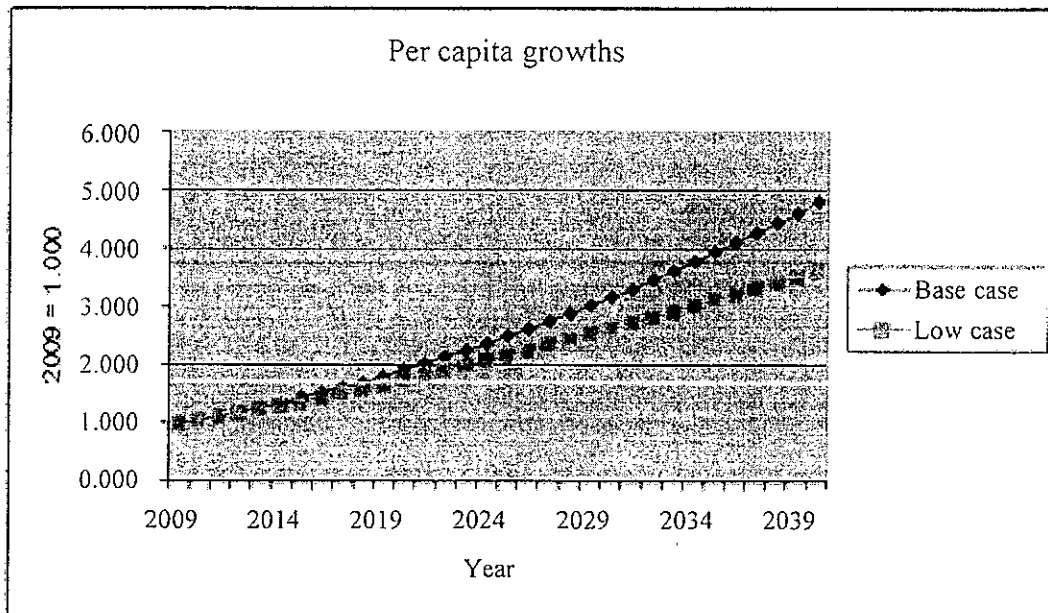
Figure 3.2.8: Value of Time Distributions



Source: CPCS calculations.

Given that heavy trucks (i.e. trucks with three axles or more) will be mandated to use the DQE6 to protect weak NHI structures all but 10% of heavy trucks is assumed to use the DQE. The small proportion not assigned to DQE is for local access/egress and less than total enforcement. (This assumption is a significant departure from that employed by previous studies.)

Figure 3.2.9: Per Capita Growth Indices



Source: CPCS calculations

Analysis of the bus trip matrices suggests that local bus movements (i.e. intra-Quang Nam and intra-Quang Ngai provincial trips) formed quite small but significant proportions of total bus trips (i.e. about 9% for both mini buses and large buses). These can be expected to continue plying the NHI with a parallel DQE in the future. However, during the survey site visits many longer-distance buses of both categories were observed to slow down at “population points” to tout for passengers. Essentially these buses operated as stop anywhere services. With a DQE longer-distance bus operators will be confronted with a service operation challenge, namely: 1) to ply the NHI as a stop anywhere service (as now), 2) to operate as a premium express service (i.e. using the DQE and non-stop, say, between Danang and Quang Ngai), or 3) to offer an intermediate quality, limited-stop service (such as Danang-Tam Ky-Quang Ngai and using the DQE). Detailed modelling of how bus operators will react in the future is beyond the scope of this study. What is clear is they will have to react and under a pre-defined service type umbrella. It is thus pragmatically assumed that with a DQE 30% of all mini-buses will switch to a limited-stop or non-stop operation whereas 70% of all large buses will do so.

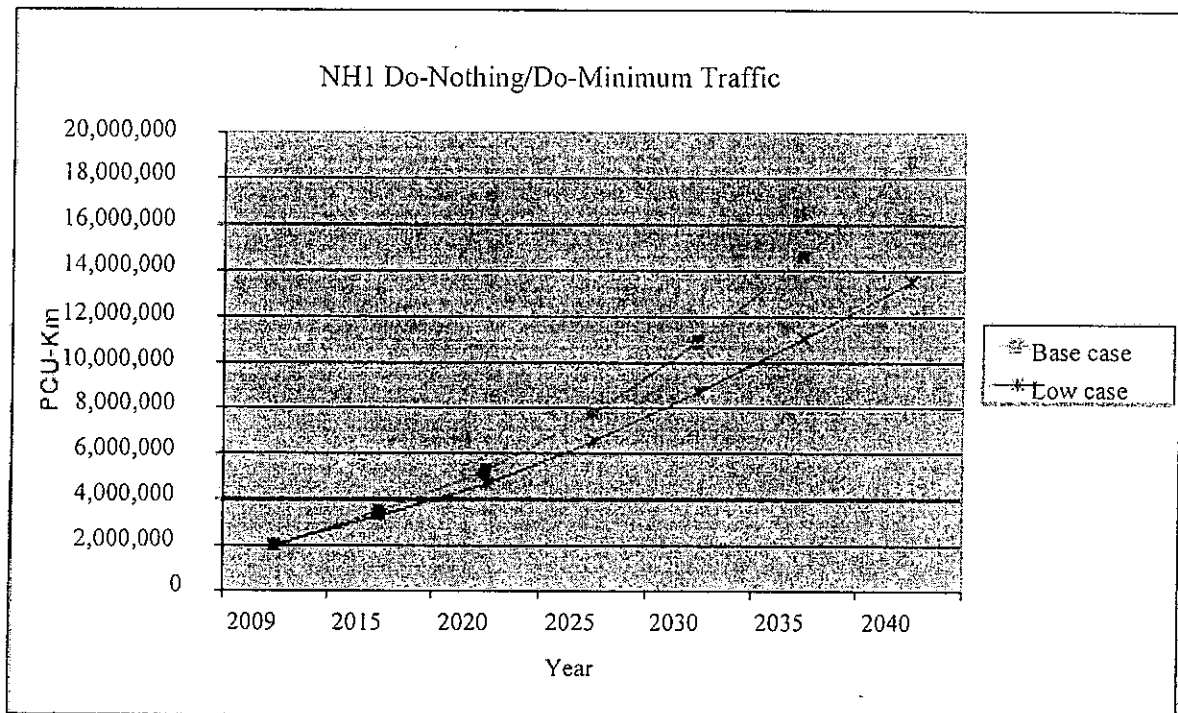
For subsequent economic and financial appraisals it is assumed that there will be traffic ramp-up effect as previously reported in the Interim Report; a five-year traffic ramp-up period (60%, 67%, 75%, 85%, 100%) will be assumed.

3.3. Traffic and Revenue Forecasts

3.3.1 Forecasts Carried Out

A total of twelve Do-Nothing (i.e. with NH1 widening) forecasts (for forecast years 2015, 2020, 2025, 2030, 2035 and 2040 and Base and Low macro-economic cases), and excluding 2015 forecast year, ten Do-Minimum (i.e. with NH1 widening) forecasts were carried out. The Do-Minimum forecasts have the same forecast links flows as both road networks consist of only one north-south road, i.e. NH1. They differ in the NH1 link speeds, travel times and V/C ratios. Figure 3.3.1 shows the Do-Nothing/Do-Minimum NH1 traffic forecasts. The figure indicates that NH1 traffic is projected to grow by 2040 by five times for the Low case and by eight folds for the Base case. Also, given that NH1 has current V/C ratios of around 40% it can be seen that NH1 will run out of capacity for further traffic growth some time after 2020. Hence the need for Do-minimum forecasts.

Figure 3.3.1: NH1 Traffic



Source: CPCS calculations.

In total 138 Do-Something sets of traffic forecasts were generated predicated upon five forecasting drivers as summarised in Figure 3.3.2

Figure 3.3.2: Modelling Scenarios and Number of Model Runs

Macro	Toll	DQE alignment	NH1 capacity	Forecast Year	Number of model runs*
2	3	2	2	7	138

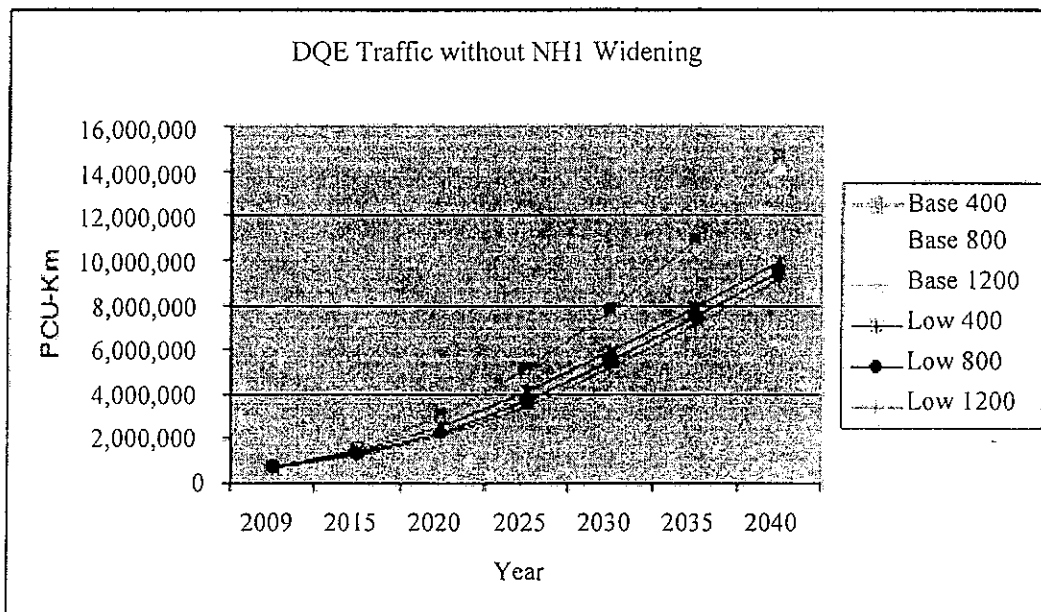
Appendix presents the Do-Something forecast results drawing on all 138 model runs. Each set of traffic forecasts (without application of traffic ramp-up effects) includes the annual average daily traffic (AADT)

flows by DQE section by vehicle type (i.e. car, bus, and light and heavy trucks) by route (i.e. DQE and NH1) for the seven forecast years, including the pro-forma 2009. Also shown are the V/C ratios and traffic market shares. Readers should note that that the rest of this report is on the basis of without application of traffic ramp-up effects. The traffic ramp-up effects will be applied at the economic and financial appraisal stage.

3.2.2 DQE Traffic without NH1 Widening

Figure 3.3.3 presents the forecast traffic for the full length DQE without NH1 widening. This shows that DQE traffic will grow from about just over 700,000 PUC-kilometres in 2009 (if DQE were in place) to about 14 million PCU-kms for the Base case but to only over 9 million PCU-kms by 2040. The figure shows that the higher the toll the lower the forecast DQE traffic. Also the Low case forecasts are significantly lower than those for the Base case; due in large part to the power of compound growth effect.

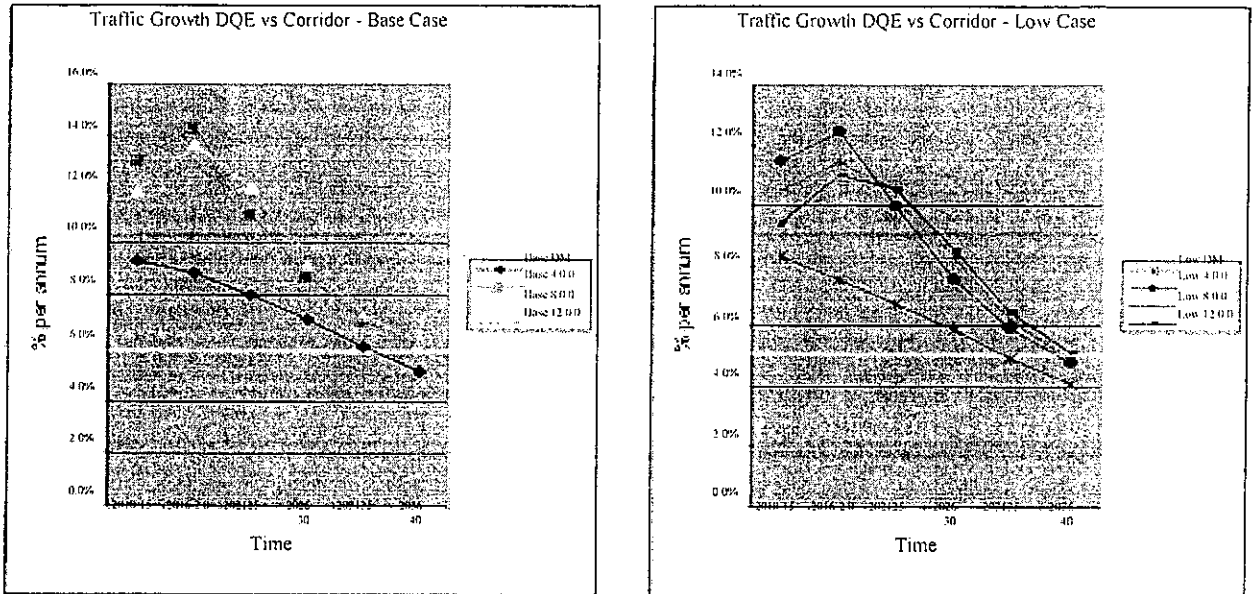
Figure 3.3.3: DQE Traffic Forecasts



Source: CPCS calculations

Figure 3.3.4 demonstrates the annual growths in Project corridor and DQE traffic over the appraisal period. This presents higher DQE traffic growths as can be expected - DQE provides the capacity for traffic to grow, as VOTs are relatively low vis-à-vis tolls in the early years DQE traffic starts with a low base (as highlighted in Figure 3.3.3) but grows fast with increasing VOTs and in later years DQE growth slows as it too becomes congested.

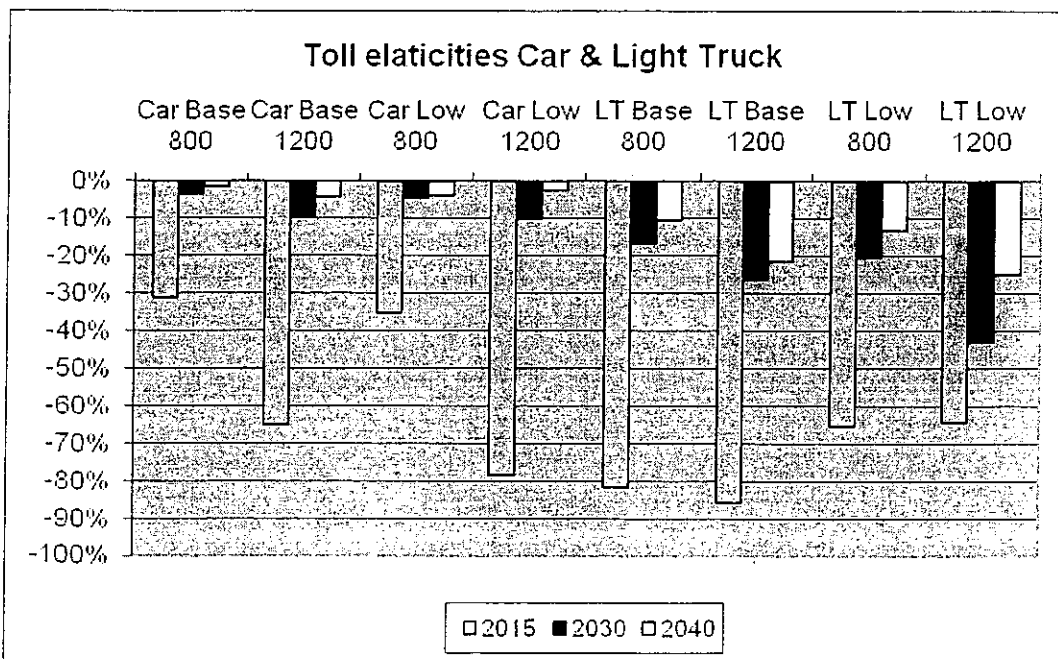
Figure 3.3.4: Project Corridor and DQE Traffic Growths



The toll elasticities for cars and light trucks (i.e. LGVs and trucks with 2-axes) for selected forecast years are highlighted in Figure 3.3.5. Equivalent toll elasticities for buses and heavy trucks are not presented as the routing of these vehicle types are pre-determined as discussed in Section 3. The figure shows that toll elasticities sensibly decreases with time and equally reasonably increases with toll payable.

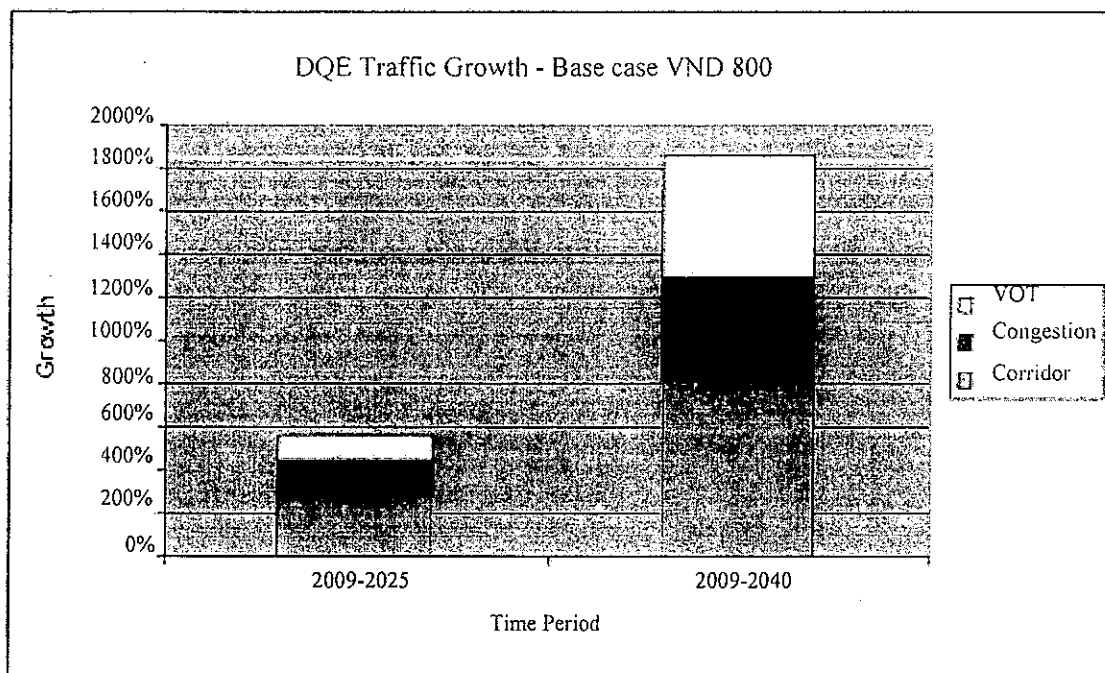
Figure 3.3.6 presents the quantity and quality of DQE traffic growth for the Base case with VND 800 per km car tolls to further demonstrate the realism of the traffic forecasting process and results. This shows that DQE traffic is forecast to increase 5.6 and 18.6 times 2009 pro forma traffic by 2025 and 2040, respectively. More importantly, in both cases corridor traffic growth contributes the greatest share of DQE traffic growth. Further, with minimum speed cut-off, the speeds of NHI and link roads are not allowed to fall below 20 kph, the importance of increasing VOTs shines through as time progresses. These forecast characteristics are most reassuring.

Figure 3.3.5: Toll Elasticities for Car and Light Truck



Source: CPCS calculations.

Figure 3.3.6: DQE Traffic Growth - Base Case VND 800 Toll



Source: CPCS calculations.

Figure 3.3.7 summarises the DQE traffic growths to 2040 for the various Base and Low cases and toll rates.

Figure 3.3.7: DQE Traffic Growths, 2009-2040

Macro	Base			Low		
Toll rate (VND)	400	800	1,200	400	800	1,200
Traffic growth	1,870%	1,857%	1,783%	1,239%	1,212%	1,163%

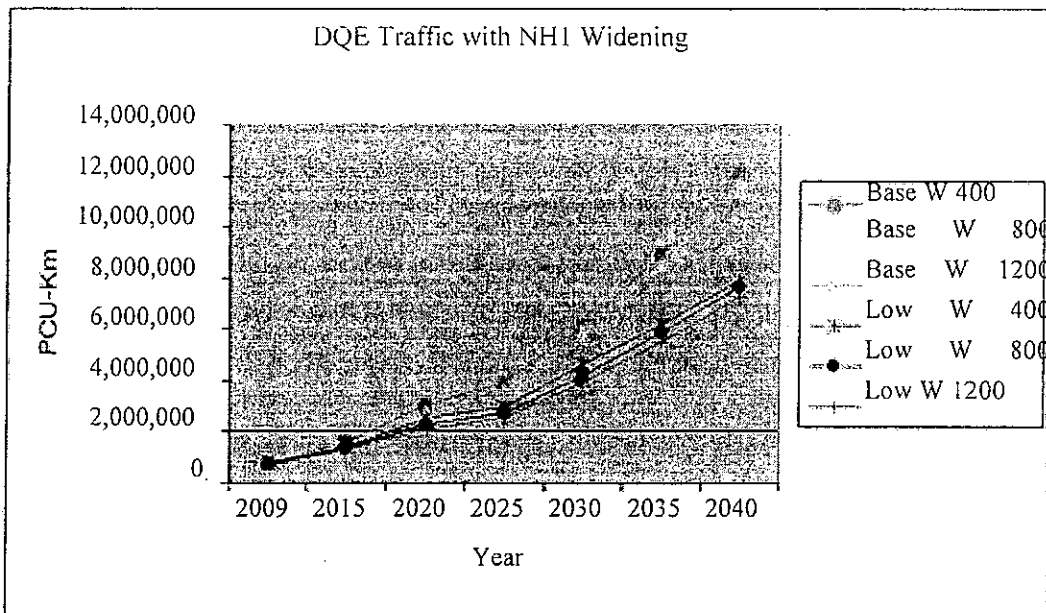
Source: CPCS calculations.

The above DQE traffic forecasts were carried out predicated upon a Do-Nothing NH1. This is not unreasonable for financial appraisal as DQE is timed to open to traffic just before NH1 will become seriously congested and consequently suppress corridor traffic growth. However, for economic appraisal the benefits of DQE are derived by comparing a with DQE option against a without DQE option. A without DQE option predicated upon a Do-Nothing NH1 would attenuate the poor performance of such an option - assuming corridor traffic growth is not suppressed - and on the other hand will exaggerate the economic benefits of the DQE. To ensure a level playing field in economic appraisal a set of model runs with NH1 widening were carried out - hence the two NH1 scenarios in Figure 3.3.2.

3.3.3 DQE Traffic with NH1 Widening

As indicated above, NH1 is projected to reach capacity in 2021 and 2023 for the Base and Low cases respectively. Thus, Do-Something and Do-Minimum model runs with a widened NH1 were carried out for 2020, 2025, 2030, 2035 and 2040. Figure 3.3.8 shows the forecast traffic for the full length DQE with NH1 widening after 2020. The figure shows that DQE is forecast to respectively grow to up to 12 million PCU-kms for the Base case and to under 7 million PCU-kms for the Low case by 2040. These 2040 traffic projections are some 2 million PCU-kms less than those presented in Figure 3.3.3 (i.e. no NH1 widening).

Figure 3.3.8: DQE Traffic Forecasts with NH1 Widening



Source: CPCS calculations.

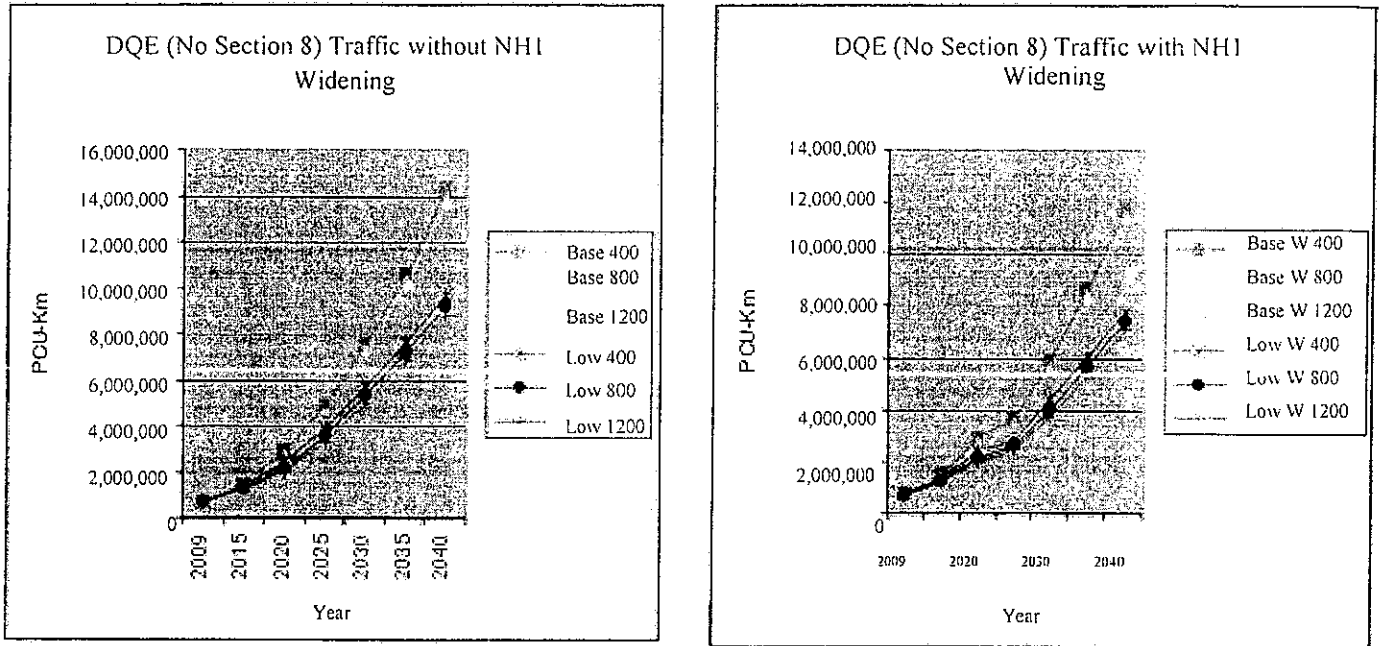
Figure 3.3.9 summarises the traffic growths to 2040 for DQE with NH1 widening for the Base and Low cases and various toll rates. Not surprisingly the traffic growths to 2040 are significantly lower than with a Do-Nothing NH1 (cf Figure 3.3.7).

Figure 3.3.9: DQE (with NH1 Widening) Traffic Growths, 2009-2040

Macro	Base			Low		
Toll rate (VND)	400	800	1,200	400	800	1,200
Traffic growth	1,526%	1,527%	1,467%	968%	963%	913%

Figure 3.3.10 presents the traffic forecasts for a shortened DQE (i.e. without Section 8) with and without NH1 widening. Again the forecasts exude similar characteristics as those for the full length DQE (cf Figure 3.3.3 and Figure 3.3.8). Their traffic growths to 2040 are summarised in Figure 4-11 and compare favourably with those for the full length DQE (cf Figure 3.3.7 and Figure 3.3.9).

Figure 3.3.10: Shortened DQE Traffic Forecasts



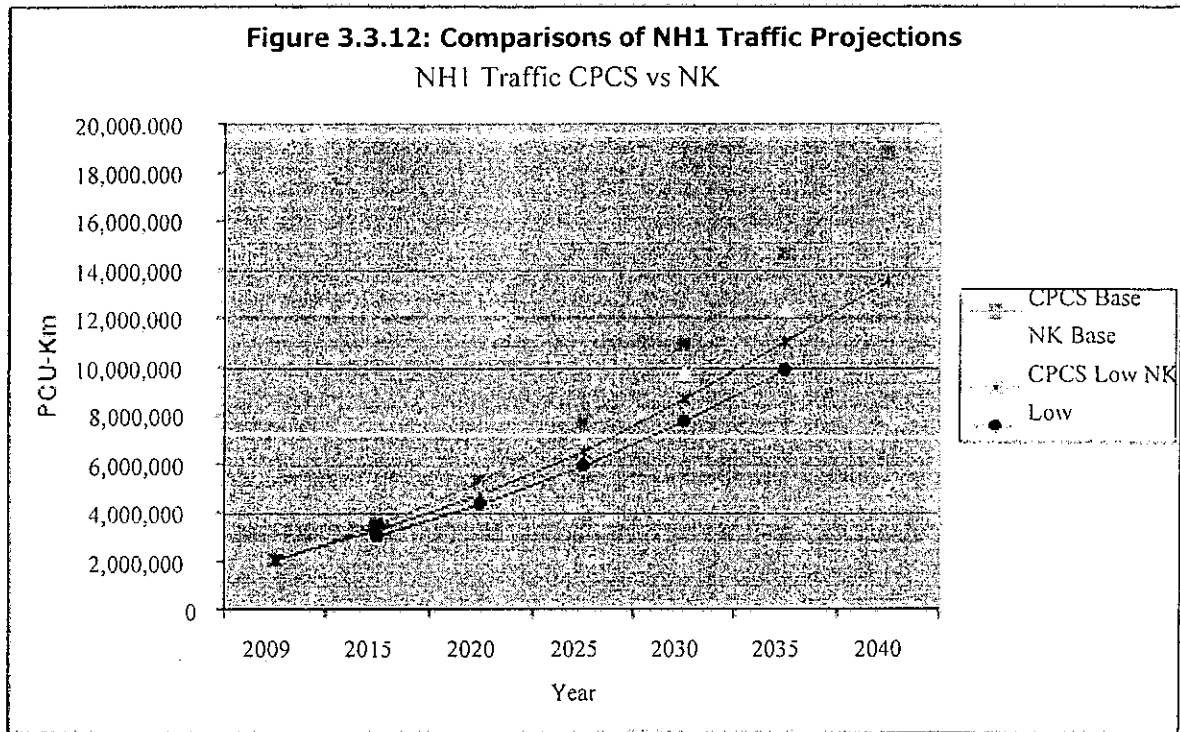
Source: CPCS calculations

Figure 3.3.11: Shortened DQE Traffic Growths, 2009-2040

Macro %	Base			Low		
Toll	400	800	1,200	400	800	1,200
Traffic without NHI widening	1,883%	1,873%	1,799%	1,242%	1,220%	1,172%
Traffic with NHI widening	1,533%	1,532%	1,476%	982%	962%	915%

3.3.4 Nippon Koei Feasibility Study

Figure 3.3.12 highlights the different NHI traffic projections by this exercise and Nippon Koei (NK). NK analysis is completely silent on its Base Year and its last forecast year is 2035. These NK Do-Nothing traffic projections are reconstituted from their Do-Something forecasts, and they and make detailed comparisons by vehicle type impractical.



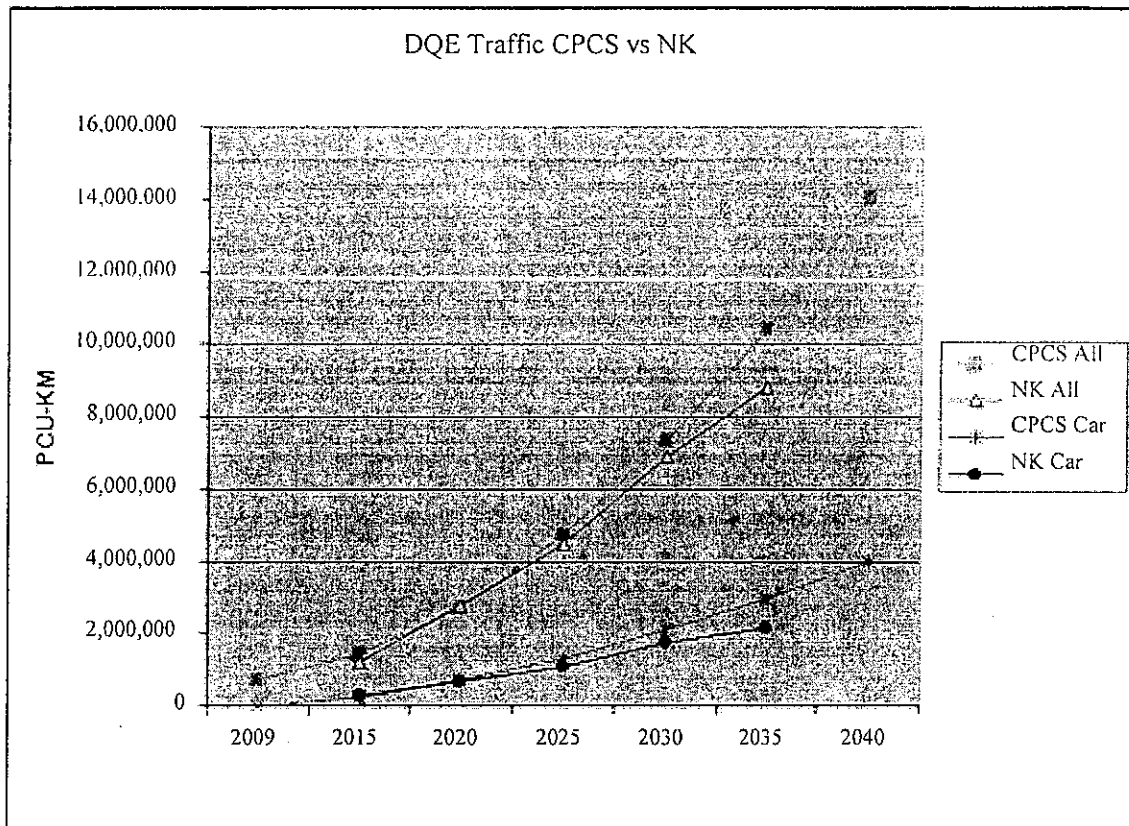
Source: Nippon Koei, CPCS calculations.

The figure shows that NK's NH1 traffic will start at marginally lower levels, which by themselves need careful handling because NK trip matrices are lumpier and contain fewer intra-corridor trips. However, of particular interest are the lower NK traffic growths as the CPCS and NK projections diverge through time. Given that the macro-economic growth assumptions between 2015 and 2035 are the same, NK's slower growths are due to differences in trip:GDP growth multipliers and, possibly, differences in vehicle compositions too.

For Do-Something forecasts, it is even more challenging to compare and contrast the forecasts of the two studies in a meaningful manner. The principal difficulty relates to the assignment process. In NK's case all vehicle types decide to use (or not use) the DQE on the basis of their relative generalised costs by NH1 and DQE. How in this exercise buses' and heavy trucks' usages of DQE are pre-determined outside of the route-choice modelling process, as previously discussed above.

Nevertheless, Figure 3.3.13 compares the forecast DQE traffic of this exercise for the Base case with VND800 per km toll with that by Nippon Koei for the Base case with US\$0.04 toll. It should be noted that VND 800 is about 7% more than US\$0.04 at current market exchange rate. The profiles of traffic projections are most interesting feature demonstrated by Figure 3.3.13. Although they start at roughly similar levels, again their growths diverge. Differences in trip:GDP multipliers and vehicle mix were given as plausible explanation for corridor traffic comparisons above. These are potentially as valid here. However there are other possibilities at work. First, NH1 congestion in the early years could possibly be more important to the NK projections than for this analysis and is consistent with NK's forecasts show DQE having a higher market share of the corridor traffic for the early years. Second, the benefit of rising VOTs becomes clearer and clearer in the later years for this exercise; this is consistent with Figure 3.3.6 and NK did not employ rising VOTs.

Figure 3.3.13: DQE Traffic Comparisons



The preceding discussion lends further support to the CPCS traffic projections. Not only are the CPCS traffic forecasts carried out in a transparent manner, which itself is extremely important to judge a feasibility study, but the traffic projections are driven steadily higher through time by growth drivers in a timely manner.

3.4. Conclusions

CPCS has developed, calibrated and validated a spreadsheet traffic model for the DQE. The validation results of link flow and journey time comparisons are very impressive. This is further augmented by the matrix comparisons reported in the Traffic Survey Review. These suggest that the base traffic model provides a suitable foundation for traffic forecasting.

A set of forecasting inputs was also developed. These include two GDP growth scenarios, traffic:GDP growth multipliers, motorway bonuses, refined values of time and two different DQE configurations.

One hundred and thirty-eight do-something model runs were carried out for the six forecast years (i.e. 2015, 2020, 2025, 2030, 2035 and 2040) and the 2009 pro forma scenario. Also twelve do-nothing and 10 do-minimum model runs were generated. With a 2009 pro forma traffic of about 700,000 PCU-km DQE traffic is forecast to grow to up to 14 million PCU-kms by 2040. The traffic forecasts have been analysed for consistency and reasonableness. Analyses included examining the traffic growth rates, quantifying the amount and source of traffic growths, and selectively computing toll elasticities.

Further checks were carried out by comparing the results of this exercise with those produced for the Feasibility Study by Nippon Koei. This comparative exercise was more limited due to poor transparency of the Feasibility Study. Nevertheless, it adds an extra layer of comfort.

These various analyses and comparisons suggest that the traffic modelling process, assumptions and results are sensible and suitable for use in further analyses, including highway design, and economic and financial appraisals.

Summary of forecast results regarding transport demand on the Expressway for the years: 2015, 2020, 2025, 2030, 2035, 2049 in different scenarios are represented in the below appendices.

**Appendix 3.1 : Forecast of Transport Demand
Base Case - Toll VND 400/Km - No NH1A Widening**

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6675	13659	26228	44096	67166	94410	127807
2	NG 2 – NG 3	6566	13705	26869	45587	69457	97649	132132
3	NG 3 – NG 4	6738	14170	27630	46693	70979	99654	134691
4	NG 4 – NG 5	5135	11127	21806	36718	55808	78664	104391
5	NG 5 – NG 6	5072	10954	21632	36730	55994	78749	105073
6	NG 6 – NG 7	4819	9932	19873	33666	50706	70433	93778
7	NG 7 – NG 8	4773	9728	19305	32473	48584	67336	89645
8	NG 8 – NG 9	3657	6788	12349	20144	29792	41341	54071

**Appendix 3.2: Forecast of Transport Demand
Base Case - Toll VND 800/Km - No NH1A Widening**

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	12555	23456	41126	63687	90348	122700
2	NG 2 – NG 3	6391	12488	23871	42340	65702	93243	126707
3	NG 3 – NG 4	6505	12820	24555	43394	67203	95255	129253
4	NG 4 – NG 5	4961	9991	19067	33773	52537	74957	100604
5	NG 5 – NG 6	4899	9893	18877	33673	52602	75237	101195
6	NG 6 – NG 7	4619	9107	17493	63333	47697	67573	90870
7	NG 7 – NG 8	4583	8953	17076	30176	45979	64821	87349
8	NG 8 – NG 9	3588	6467	11093	18842	28055	39413	52429

**Appendix 3.3: Forecast of Transport Demand
Base Case - Toll VND 1200/Km - No NH1A Widening**

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11914	21693	38739	60754	88872	117897
2	NG 2 – NG 3	6391	11814	21931	39757	62535	89467	121626
3	NG 3 – NG 4	6486	12089	22525	40746	63970	91524	124284
4	NG 4 – NG 5	4954	9413	17441	31430	50044	72082	96535
5	NG 5 – NG 6	4894	9334	17257	63275	50058	72336	97072
6	NG 6 – NG 7	4619	8527	16166	29031	45725	65191	87688
7	NG 7 – NG 8	4583	8398	15848	28266	44280	62765	84636
8	NG 8 – NG 9	3588	6284	10514	17807	27061	38164	50668

**Appendix 3.4 : Forecast of Transport Demand
Low Case - Toll VND 400/Km - No NH1A Widening**

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6675	12553	22169	35560	50985	68045	86186
2	NG 2 – NG 3	6566	12550	22619	36654	52676	40337	89074
3	NG 3 – NG 4	6738	12981	23304	37597	53909	71872	90942
4	NG 4 – NG 5	5135	10192	18377	29295	42401	56635	71575
5	NG 5 – NG 6	5072	10033	18156	29211	42468	56811	71896
6	NG 6 – NG 7	4819	9056	16653	26821	38725	51274	64305
7	NG 7 – NG 8	4773	8882	16180	25968	37296	49141	61504
8	NG 8 – NG 9	3657	6288	10611	16348	23107	30298	37916

**Appendix 3.5 : Forecast of Transport Demand
Low Case - Toll VND 800/Km - No NH1A Widening**

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11663	19739	32313	47746	64654	81873
2	NG 2 – NG 3	6391	11583	19965	33108	49166	66653	84435
3	NG 3 – NG 4	6505	11879	20542	33979	50359	68166	86291
4	NG 4 – NG 5	4961	9281	15989	26343	39452	53302	67875
5	NG 5 – NG 6	4899	9191	15790	26170	39426	53361	68086
6	NG 6 – NG 7	4619	8343	14603	24235	36140	48263	61209
7	NG 7 – NG 8	4583	8207	14293	23599	35011	46526	58845
8	NG 8 – NG 9	3588	6069	9522	15022	21734	28493	35973

**Appendix 3.6 : Forecast of Transport Demand
Low Case - Toll VND 1200/Km - No NH1A Widening**

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11020	18373	30102	45005	61468	78860
2	NG 2 – NG 3	6391	10908	18492	30708	46225	63224	81110
3	NG 3 – NG 4	6486	11152	18966	31516	47345	64676	82954
4	NG 4 – NG 5	4954	8733	14626	24227	36791	50694	65296
5	NG 5 – NG 6	4894	8646	14479	24020	36689	50698	65406
6	NG 6 – NG 7	4619	7894	13563	22395	33893	46191	58945
7	NG 7 – NG 8	4583	7782	13303	21867	32930	44741	56889
8	NG 8 – NG 9	3588	5899	9063	14039	20537	27468	34796

Appendix 3.7 : Forecast of Transport Demand
Base Case - Toll VND 400/Km - With NH1A Widening from 2021

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6675	13659	26228	33871	52793	77123	105328
2	NG 2 – NG 3	6566	13705	26869	34806	54670	79957	109135
3	NG 3 – NG 4	6738	14170	27630	36197	56564	82297	112142
4	NG 4 – NG 5	5135	11127	21806	27624	43909	63795	85488
5	NG 5 – NG 6	5072	10954	21632	27232	43719	63699	85339
6	NG 6 – NG 7	4819	9932	19873	25260	40175	57778	77012
7	NG 7 – NG 8	4773	9728	19305	24536	39653	55477	73734
8	NG 8 – NG 9	3657	6788	12349	15794	24906	36102	48094

Appendix 3.8 : Forecast of Transport Demand
Base Case - Toll VND 800/Km – With NH1A Widening from 2021

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	12555	23457	31084	50166	73826	102091
2	NG 2 – NG 3	6391	12488	23871	31685	51704	76228	105601
3	NG 3 – NG 4	6505	12820	24555	32896	53459	78492	108454
4	NG 4 – NG 5	4961	9991	19067	24853	41129	60604	82854
5	NG 5 – NG 6	4899	9893	18877	24506	40826	60396	82784
6	NG 6 – NG 7	4619	9107	17193	23015	38063	55360	74841
7	NG 7 – NG 8	4583	8953	17076	22465	36801	53290	71849
8	NG 8 – NG 9	3588	6467	11093	14932	23438	34084	46952

Appendix 3.9 : Forecast of Transport Demand
Base Case - Toll VND 1200/Km – With NH1A Widening from 2021

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11914	21693	29366	47506	70832	98265
2	NG 2 – NG 3	6391	11814	21931	29733	48789	72911	101372
3	NG 3 – NG 4	6486	12089	22525	30805	50478	75131	104185
4	NG 4 – NG 5	4954	9413	17441	23158	38388	57488	79773
5	NG 5 – NG 6	4894	9334	17257	22866	39030	57193	79641
6	NG 6 – NG 7	4619	8527	16166	21591	35757	52753	72508
7	NG 7 – NG 8	4583	8398	15848	21130	34652	50866	69709
8	NG 8 – NG 9	3588	62844	10514	14382	22173	32374	45018

Appendix 3.10 : Forecast of Transport Demand
Low Case - Toll VND 400/Km – With NH1A Widening from 2023

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6675	12553	22169	25778	40027	53654	68450
2	NG 2 – NG 3	6566	12550	22619	26245	41248	55516	70834
3	NG 3 – NG 4	6738	12981	23304	27478	42744	57419	73162
4	NG 4 – NG 5	5135	10192	18377	21087	32707	44529	56813
5	NG 5 – NG 6	5072	10033	18156	20718	32359	44321	56629
6	NG 6 – NG 7	4819	9056	16653	19289	29958	40668	51457
7	NG 7 – NG 8	4773	8882	16180	18811	29046	39161	49400
8	NG 8 – NG 9	3657	6299	10611	12555	18701	25284	32003

Appendix 3.11 : Forecast of Transport Demand
Low Case - Toll VND 800/Km – With NH1A Widening from 2023

No.	Section	Traffic Flow (PCU/ day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11663	19739	23779	36667	50996	66406
2	NG 2 – NG 3	6391	11583	19965	23956	37529	52515	68467
3	NG 3 – NG 4	6505	11879	20542	24949	38909	54277	70577
4	NG 4 – NG 5	4961	9281	15989	18984	29361	41650	54396
5	NG 5 – NG 6	4899	9191	15790	18722	28969	41629	54129
6	NG 6 – NG 7	4619	8343	14603	17414	27180	38575	49720
7	NG 7 – NG 8	4583	8207	14293	17062	26439	37314	47928
8	NG 8 – NG 9	3588	6069	9522	11989	17248	23875	30552

Appendix 3.12 : Forecast of Transport Demand
Low Case - Toll VND 1200/Km - NH1A Widening from 2023

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11020	18373	22650	34537	48209	63532
2	NG 2 – NG 3	6391	10908	18492	22649	35122	49459	65269
3	NG 3 – NG 4	6486	11152	18966	23472	36381	51158	67302
4	NG 4 – NG 5	4954	8733	14626	17852	27456	38933	51507
5	NG 5 – NG 6	4894	8646	14479	17674	27083	38559	51176
6	NG 6 – NG 7	4619	7894	13563	16565	25561	36179	47295
7	NG 7 – NG 8	4583	7782	13303	16252	24951	35103	45690
8	NG 8 – NG 9	3588	5899	9063	11765	16605	22504	29133

Appendix 3.13 : Forecast of Transport Demand
Base case - Toll VND 400/Km - No NH1A Widening No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6681	13647	26144	44199	67003	94236	127807
2	NG 2 – NG 3	6571	13692	26799	45688	69293	97472	132132
3	NG 3 – NG 4	6744	14157	27562	46799	70812	99484	134691
4	NG 4 – NG 5	5142	11122	21596	36459	55707	78146	104430
5	NG 5 – NG 6	5080	10944	21400	36448	55878	78555	105091
6	NG 6 – NG 7	4835	9770	18655	31473	49438	70095	93719
7	NG 7 – NG 8	7489	9566	17985	30031	47156	66948	89589
8	NG 8 – NG 9							

Appendix 3.14 : Forecast of Transport Demand
Base Case - Toll VND 800/Km - No NH1A Widening No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	12555	23355	41062	63805	90348	122700
2	NG 2 – NG 3	6391	12488	23770	42277	65717	93240	126707
3	NG 3 – NG 4	6505	12820	24458	43332	67315	95253	129253
4	NG 4 – NG 5	4961	9995	18888	33368	52404	74925	100595
5	NG 5 – NG 6	4899	9897	18670	33233	52441	74194	101176
6	NG 6 – NG 7	4619	8991	16784	29313	46882	67460	90820
7	NG 7 – NG 8	4583	8836	16260	28109	44839	64646	87293
8	NG 8 – NG 9							

Appendix 3.15 : Forecast of Transport Demand
Base Case - Toll VND 1200/Km - No NH1A Widening No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11914	21716	38610	60689	86872	117892
2	NG 2 – NG 3	6391	11814	21954	39633	62474	89467	121621
3	NG 3 – NG 4	6486	12089	22549	40625	63909	91524	124279
4	NG 4 – NG 5	4954	9411	17351	31181	49918	71997	96523
5	NG 5 – NG 6	4894	9332	17159	30997	49925	72248	97061
6	NG 6 – NG 7	4619	8497	15722	27639	44851	64973	87647
7	NG 7 – NG 8	4583	8368	15317	26604	43008	62479	84613
8	NG 8 – NG 9							

Appendix 3.16 : Forecast of Transport Demand
Low Case - Toll VND 400/Km - No NH1A Widening No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6681	12553	22044	35577	50727	68177	86052
2	NG 2 – NG 3	6571	12550	22504	36665	52416	70463	88936
3	NG 3 – NG 4	6744	12981	23187	37612	52640	71997	90792
4	NG 4 – NG 5	5142	10190	18155	29143	42094	56656	71357
5	NG 5 – NG 6	5080	10030	17915	29018	42137	56809	71652
6	NG 6 – NG 7	4835	8970	15741	24847	36830	50163	63633
7	NG 7 – NG 8	4789	8796	15219	23783	35142	47876	60783
8	NG 8 – NG 9							

Appendix 3.17 : Forecast of Transport Demand
Low Case - Toll VND 800/Km - No NH1A Widening No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11663	19655	32208	47543	64543	81869
2	NG 2 – NG 3	6391	11573	19888	33008	48963	66542	84434
3	NG 3 – NG 4	6505	11879	20471	33873	50144	68044	86290
4	NG 4 – NG 5	4961	9277	15812	26085	39028	53184	67929
5	NG 5 – NG 6	4899	9187	15603	25876	36974	53204	68121
6	NG 6 – NG 7	4619	8314	14122	22999	34432	47411	60772
7	NG 7 – NG 8	4583	8178	13745	22163	32999	45356	58167
8	NG 8 – NG 9							

Appendix 3.18 : Forecast of Transport Demand
Low Case - Toll VND 1200/Km - No NH1A Widening No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11019	18277	29764	44950	61526	78848
2	NG 2 – NG 3	6391	10908	18396	30370	46168	63282	81098
3	NG 3 – NG 4	6486	11151	18869	31184	47286	64734	82947
4	NG 4 – NG 5	4954	8732	14461	23854	36557	50701	65221
5	NG 5 – NG 6	4894	8645	14309	23610	36425	50703	65329
6	NG 6 – NG 7	4619	7893	13190	21275	32628	45555	58712
7	NG 7 – NG 8	4583	7782	12891	20575	31333	43722	56451
8	NG 8 – NG 9							

Appendix 3.19 : Forecast of Transport Demand
Base Case - Toll VND 400/Km - With NH1A Widening from 2021, No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6681	13647	26144	33516	52978	77280	105491
2	NG 2 – NG 3	6571	13692	26799	34483	54851	80109	109311
3	NG 3 – NG 4	6744	14157	27562	35870	56744	82455	112306
4	NG 4 – NG 5	5142	11122	21596	26964	43673	63806	85391
5	NG 5 – NG 6	5090	10944	21400	26575	43482	63751	85265
6	NG 6 – NG 7	4835	9770	18655	22623	37441	55609	76407
7	NG 7 – NG 8	4789	9566	17975	21803	35695	53055	73077
8	NG 8 – NG 9							

Appendix 3.20 : Forecast of Transport Demand
Base Case - Toll VND 800/Km - With NH1A Widening from 2021, No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	12555	23355	30837	49993	73827	101950
2	NG 2 – NG 3	6391	12488	23770	31442	42441	76219	105456
3	NG 3 – NG 4	6505	12820	24458	32637	53309	78488	108309
4	NG 4 – NG 5	4961	9995	18888	24522	40878	60567	82633
5	NG 5 – NG 6	4899	9897	18670	24167	40539	60362	82532
6	NG 6 – NG 7	4619	8991	16784	20934	34534	53097	73874
7	NG 7 – NG 8	4583	8836	16286	20318	33154	50868	70809
8	NG 8 – NG 9							

Appendix 3.21 : Forecast of Transport Demand
Base Case - Toll VND 1200/Km - With NH1A Widening from 2021, No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11914	21716	29290	47471	70916	98449
2	NG 2 – NG 3	6391	11814	21954	29658	48757	72998	101551
3	NG 3 – NG 4	6486	12089	22579	30734	50439	75211	104369
4	NG 4 – NG 5	4954	9411	17351	22869	38190	57454	79706
5	NG 5 – NG 6	4894	9332	17159	22577	37794	47148	79544
6	NG 6 – NG 7	4619	8497	15722	19982	32257	51154	71779
7	NG 7 – NG 8	4583	8368	15317	19500	31084	49125	68929
8	NG 8 – NG 9							

Appendix 3.22 : Forecast of Transport Demand
Low Case - Toll VND 400/Km - With NH1A Widening from 2023, No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6681	12553	22044	25602	39810	53757	69557
2	NG 2 – NG 3	6571	12550	22504	26071	41046	55623	72012
3	NG 3 – NG 4	6744	12981	23187	27305	42526	57525	74255
4	NG 4 – NG 5	5142	10190	18155	20719	32095	44495	57405
5	NG 5 – NG 6	5080	10030	17915	20350	31747	44285	57277
6	NG 6 – NG 7	4835	8970	15741	17519	26994	37945	50116
7	NG 7 – NG 8	4789	8796	15219	17047	25926	36202	47804
8	NG 8 – NG 9							

Appendix 3.23 : Forecast of Transport Demand
Low Case - Toll VND 800/Km - With NH1A Widening from 2023, No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11663	19655	23828	36452	50860	66386
2	NG 2 – NG 3	6391	11583	19888	24003	37330	52378	68464
3	NG 3 – NG 4	6505	11879	20471	24995	39721	54147	70584
4	NG 4 – NG 5	4961	9277	15812	18701	28960	41514	54319
5	NG 5 – NG 6	4899	9187	15603	18444	28558	41150	54033
6	NG 6 – NG 7	4619	8314	14122	16448	24580	35124	47257
7	NG 7 – NG 8	4583	8178	13745	16095	23764	33732	45294
8	NG 8 – NG 9							

Appendix 3.24 : Forecast of Transport Demand
Low Case - Toll VND 1200/Km - With NH1A Widening from 2023, No DQE Section 8

No.	Section	Traffic Flow (PCU/day-night)						
		2009	2015	2020	2025	2030	2035	2040
1	NG 1 – NG 2	6523	11019	18277	22613	34293	48116	63600
2	NG 2 – NG 3	6391	10908	18396	22613	34888	49367	65330
3	NG 3 – NG 4	6486	11151	18869	23436	36147	51056	67366
4	NG 4 – NG 5	4954	8732	14461	17645	27132	38765	51522
5	NG 5 – NG 6	4894	8645	14309	17468	26777	38351	51166
6	NG 6 – NG 7	4619	7893	13190	15997	23309	32951	45586
7	NG 7 – NG 8	4583	7782	12891	15684	22637	31780	43859
8	NG 8 – NG 9							

Note:

- NG1 –Phu Hoa/ Tuy Loan interchange
- NG2 –My Son interchange
- NG3 –Ha Lam interchange
- NG4 –Tam Ky interchange
- NG5 –Chu Lai interchange
- NG6 –Dung Quat Interchange
- NG7 –Binh Son Interchange
- NG8 –Quang Ngai Interchange
- NG9 –La Haà Interchange (crossing NH1A)

CHAPTER 4 - NATURAL CONDITIONS SURVEY

4.1 Topographic survey

The Da Nang - Quang Ngai Expressway has 130km long, towards North - South direction, the same direction with the NH1A and the North - South Railway, crossing Da Nang city area and Quang Nam, Quang Ngai provinces.

Generally, terrain tends to tilt to the east. Because the route stretches through the area mixing between plains, plains before mountains and low to high mountains, terrain constantly changes throughout the length of route.

In order to update and finalize the F/S to meet required progress, the Consultant has carried out additional topographic survey.

4.1.1 For realignment sections and additional section connecting to the NH1A:

Topographic survey has been carried out for 03 sections Km0-Km16, Km60-Km73, Km109-Km129 on the expressway and for additional section connecting to the NH1A. The topographic survey consists of the following works:

- Establishment of primary control network (according to VN2000 system, meridian 108° , projection 3° , Hon Dau National Elevation System) including: Primary control network class IV, secondary control point.

- Route survey: topo-mapping (scale 1/5000); profile (scale 1/5000, 1/500); cross section (scale 1/200)

- Survey and measurement of culverts: measurement of profile of culvert centerline at slot locations and crossing the road at culvert centerlines with scale 1/200; measurement of intersection angle between culvert centerline and road centerline.

- Survey of intersections and crossing roads: conducted for main intersections. Plans, profiles and cross sections of crossing roads are also conducted.

- Survey for bridges and structures: staking bridge centerline, measuring profiles of large bridges crossing rivers, viaducts, bridges on intersections.

- Survey and investigation of intersection points with other works such as intersection with high voltage and low voltage transmission line and all types of communication, telephone wire, lighting wire, post office cable and underground works...within the project area.

4.1.2 For non-realignment sections

Non-realignment sections are including: section Km16-Km60, Km73-Km109. For these sections, plans (scale 1/5000), profiles (scale 1/5000, 1/500) and cross

sections (scale 1/200) are prepared based on satellite photos, cadastral map and profile designed by Nippon Koei.

All topographic data are processed by appropriate software and transfer to electronic file for design works.

4.2 Climate features

According to National Standard on natural condition data for construction, the project area is in *Region II_A - South Centre Coastal Climate*, including entire plain and low mountain (under 100m) areas of Quang Nam, Quang Ngai, Binh Dinh, Phu Yen, Khanh Hoa, Ninh Thuan, Binh Thuan provinces. The climate is tropical monsoon, without cold winter (except the north with cool winter). The lowest temperature usually not less than 10°C. The highest temperature can exceed 40°C. Because the influential of the sea, temperature amplitude of day as well as year is small. Coastal parts are directly affected by hurricane.

Meteorological elements of the project area can be summarize as follows:

- **Temperature:**

The annual average temperature is approximately 26°C. Months in the middle of the winter are quite cool. There are 3-4 months (from December to March) that the temperature falls below 20°C. The coldest month is December and January with 20°C of average temperature. During summer months (from April to September), the average temperature exceeds 27°C. The highest absolute temperature exceeds 40°C. June and August are the hottest month with average temperature is 29°C. Fluctuation amplitude within day and night of average temperatures is around 7 ÷ 8°C.

Table 4.2.1 - Temperature feature (°C)

Features	Da Nang	Tam Ky	Quang Ngai
Average temperature per year	25.7	25.6	25.8
Highest monthly average temperature/ in month ____	29.2/ June	28.8/ August	29.0/ August
Lowest monthly average temperature / in month:	21.3/ January	21.1/ January	21.7/ January
The highest absolute temperature	40.9	40.0	41.4
The lowest absolute temperature	10.2	13.7	12.4
Average daily amplitude	7.2	7.0	8.0

- **Rainfall**

Annual average rainfall within the area is about 2000 ÷ 2500mm. Average number of rainy days of the whole year are about 140 days. The rainy season begins from July, August and ends in December or the next January. The three months of heavy rain are October, November and December. Maximum monthly rainfall is in October, and November is the month having the most storms in the region. Less rainy season begins in February and ends in June. The less rain month is on March, the average rainfall is about 10 ÷ 40mm.

Raining parameters varies very widely in both rainy season and dry season. Rainfall fluctuation limit of whole year is up to ± 1000mm around the average value.

Table 4.2.2 - Rainfall system features

Features	Da Nang	Tam Ky	Quang Ngai
Annual average rainfall (mm)	2044.5	2531.5	2290.5
Lowest monthly average rainfall (mm/ - in Month:)	612.8/ October	693.1/ October	586.7/ October
Lowest monthly average rainfall (mm/ - in month:)	22.4/ March	8.0/ March	37.5/ March
Daily average rainfall	144.0	140.3	139.4

- **Wind, storm**

Vietnam has two main wind seasons; each season has a distinct wind direction - the northeast wind in the summer and southwest monsoon and in winter. Average wind speed variation from 1 - 5 m/ s....

In summer, northeast monsoon blows from May to September. Properties here are necessarily the dominance of the winds from Bengal Gulf and the South Pacific during the rainy season. Last season was marked by heavy rain and storms as the convergence of the tropical motion to their northernmost point.

In winter, the southeast blows from October to the next April. The weather rarely changes and it is considered to be stability. However, it causes humidity in the Centre.

Vietnam is usually affected by storms from the East Sea (South China sea) or the Pacific (sometimes they are tropical low-pressure forming from typhoons). Stormy season of project area is from September to December. The maximum wind speed in stormy weather can reach 30 - 40m/s. Storms always go with heavy rain; it can reach 600mm/24 hour during stormy weather. Due to this reason, storm and

flood often go together, causing serious flood in the project area.

- **Humidity**

Annual average relative humidity is quite high; it can reach 82 - 85%. The most humid months are the last winter months; average relative humidity is approx. 90%. The driest time is the end of summer, especially at the north of the project area. Average humidity then is about 75%.

- **Cloud, sun**

The changing of the cloud thickness is consistent with that of humidity. The annual cloud thickness is at about 6.5 ÷ 7.5/10 the sky. In general, the period of clouds especially on the middle or end of winter with average amount at about 9/10.

Total full-year average observed sunny hours is 2100 - 2300. The less sunny period is late winter months, on July, May I, the number of sunshine hours in about 100 hours per month. Period of sunshine from May to December III VIII, number of sunny hours per month will exceed 200 hours

4.3 Hydrographic features

With features of the monsoon tropical climate, every year there are two main monsoon seasons: North - East monsoon in winter and South - West monsoon in summer. The South - West monsoon goes through the sea to the land with moisture. In the summer there usually are storms and tropical low pressures causing heavy rain on a large scale. Every year, there are 4 to 5 and even 12 to 13 typhoons landing or direct affecting Vietnam. Due to effect of the terrain, as storm or tropical low pressure happens, flood appears at every area and river. Flood of the rivers are not identical allocated upon space, early and late in some places, fierce and mild in other places. At each small area, because of terrain impacts so formation and features of flood present the private characteristics. The most serious situation caused by storm is the rising of sea level and water penetrates through estuary at some areas flooding widely. On the other hand, rain due to storm at the time water level in rivers is high will result in extremely devastating flood threatening dykes, lives of the people and the economy. Those disasters are getting worse because of unreasonable activities of the human. At the forest and mountain, deforestation increases erosion, sediment yield and surface run-off so floods happen at higher level and earlier than usual. Rainstorms and floods are becoming the most serious disasters in our country.

River and stream network of the project area there are below characteristics:

- + Many rivers gathered at the upstream before running down to the plain

+ River runs very fast at the high mountainous region and slows down prior to running to the sea

+ Two distinctive seasons of the current are in dry season and rainy season

Heavy rain at the project area is always concentrated from September to December. In general, flood season is usually shorter than the rainy season about 1 month. During flooding period in rainy season, flow volume made up 70÷80% total annual water flow, while only 20÷30% in dry season. In dry season, river is narrow, current speed is reduced with higher tidal influences and salt water level than in rainy season.

Flashflood appears on the small and slope valleys at the project area as well as mountain stream of the main rivers, caused damages in human and assets. Sometimes, the flood current takes mud rock and grits with it may bury the houses and infrastructural works

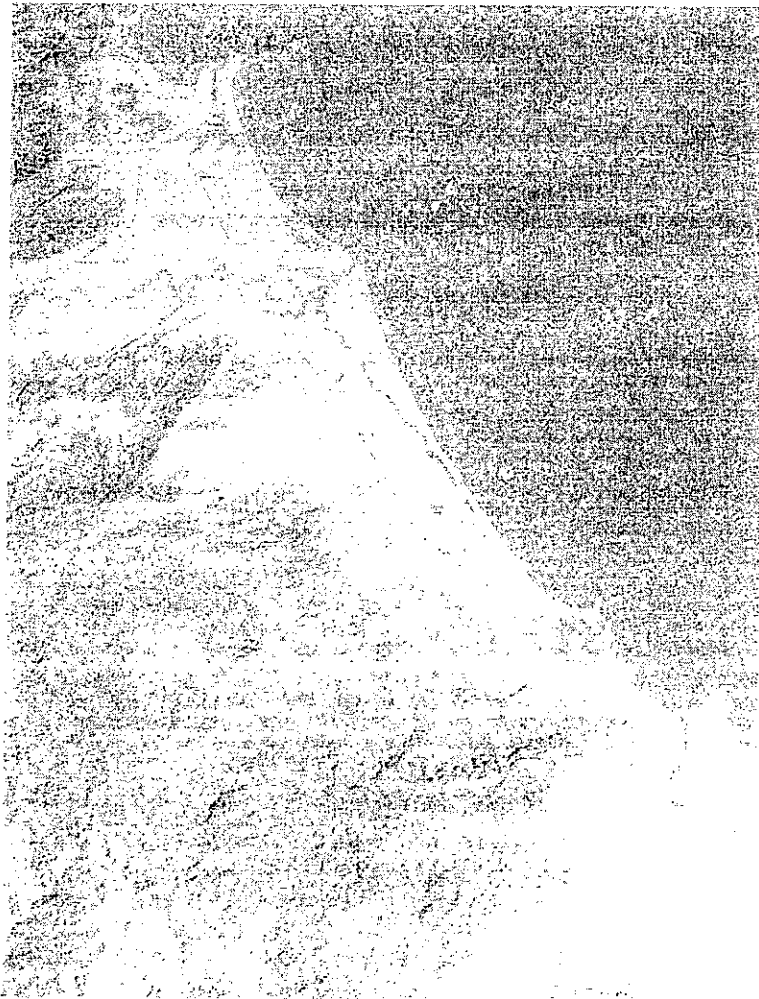


Fig. 4.3.1 – Project area terrain creating forms of long and short rivers and streams before running to the plain

Aside from the climate factors, the land surface (forest, soil etc), terrain factors and economic activity of the human also affect the formation of currents at each region and small area. Comprehensive study of the meteorology and hydrographic factors is to obtain proper solutions and guarantee durability of the works against impacts of the nature plays a very important role in preliminary design studies of the transport works.

Large rivers in the region are the system of Thu Bon, Tra Bong and Tra Khuc rivers.

+ *Thu Bon River System:*

Thu Bon River system includes Thu Bon, Cai and Bung rivers, the major slope direction of the valley is southwest - northeastern. The average density of rivers and streams in river system is $0.40\text{km}/\text{km}^2$.

Main current of Thu Bon originates from Ngoc Linh mountain area and runs to the sea in Hoi An. Before running to the sea, the main current of Thu Bon river system combines with Vu Gia river formed by Cai and Bung rivers. At lower section of the river where crossed by Thong Nhat railway and Highway 1A, the river network interlacing develops with many river branches running to the sea as Ngang, Vinh Dien and Tinh Yen rivers, which run to Da Nang Bay through Han, and Truong river run to An Hoa Bay. Aggradations and erosion of the river bed at the lower section area is very complex, which is an important issue for production and life.

+ *Tra Bong River*

The lower section of Tra Bong River includes almost Tra Bong and Binh Son districts, Quang Ngai province. The valley area is about 697km^2 .

Located at the North of the province and originated from the West of Tra Bong district, the river runs to the sea through Binh Son district at Sa Can estuary. The river is about 45km long, basic running direction is from West to East. The estuary section turns South-North. Almost river is running through the forest and mountain terrain at altitude of 200 - 1.300m high, the rest is running inside the plain mixed with bare hills and sand banks. At the upper reaches of Tra Bong river there is many estuaries including many rivers and streams, especially Nun stream, Ca Du stream and Tra Boi river at Tra Thuy and Tra Giang communes. Coming back to the lower section at the East of Binh Son district, the ground position here is so high, therefore, Tra Bong river is not running very fast as at above section. Next to the estuary, there are areas at 10 - 40m height. At the lower section there are also effluent branches of the rivers and streams combining with the main river prior running to the sea..

+ *Tra Khuc River*

Tra Khuc River is about 135km long, valley is about 3.240km² in area, including territories of Son Ha and Tu Nghia districts, a part of Ba To, Minh Long, Son Tinh, Tra Bong and Tay Tra districts. There is a small source belongs to Kon Tum province. On the surface of river valley half of the area from the source is primitive forest, the rest is thin forest in highland style and bushes; lower section is farming land and rice cultivating plain has a relative large area

In Thach Nham, a river crossing dam has been built for backwater by two Northward - Southward channels to irrigate the plains in Quang Ngai.

Flood season always synchronous happens on rivers in valley. The flow volume in flood season is about 65%, in which the largest flow volume presents in October or November made up 25 - 35% flow volume of the whole year. The proportion between largest and smallest flow volume may reach more than 700 times. Floods happens at the same time in the region endangered seriously the plain and flood many road sections of Highway A1. The historical floods happened in the region in the years of 1964, 1999, 2004, 2007 and 2009.



Flooding due to affects of the 9th storm (September 2009)
in project area



Many track sections flooded unit its bottom

The highest flood level on the local basin of rivers in the historical floods in recent period, see table 4.3.1

Table 4.3.1 - Altitude of flood peak at some major hydrographic stations in project area

Hydrographic stations	Altitude of flood peak H (m)			
	1999	2007	2009	Note
Cam Le (Han River)	4.28	3.98	3.16	
Cau Lau (Thu Bon River)	5.23	5.39	5.29	Flood peak in 1999 was lower than the historical flood peak in 1964 by 0.25m.
Châu O (Tra Bong River)	5.15	5.23	6.28	Flood peak in 1999 was lower than the historical flood peak in 1964 by 0.54m.
Tra Khuc (Tra Khuc River)	8.36	7.31	8.12	Flood peak in 1999 was higher than the historical flood peak in 1964 by 0.35m

The flood hydrogram in 1999 indicated that flooding period is lasted during 5 - 6 days. The local hydrographic stations were apparent affected by tide and serrated

flood peak.

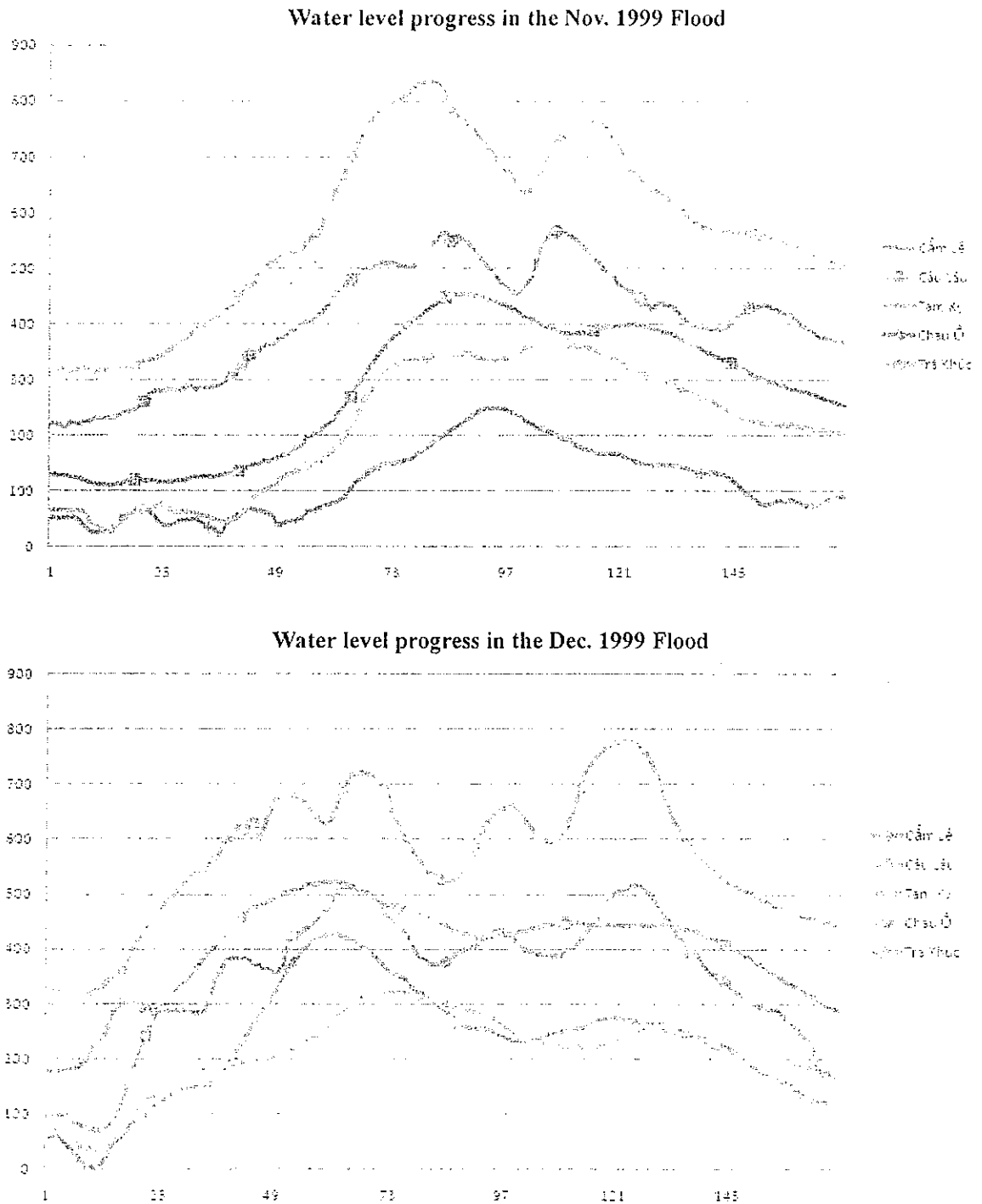


Fig. 4.3.2 – Flood level hyrogram in November and December 2009 at the gauging stations in project area

Due to narrow terrain, slope and short river bed (Fig. 4.3.1) so forming and changing process of the flood flow of the rivers coming from the upper reaches to Thong Nhat railway now may be divided into 3 stages:

- Stage 1:

This is a forming and accumulation process of the flow in upstream (from the source to the mountain gorge). Flood characteristics during this stage are sharp peak of flood, high density and rapid rise and decrease of flood. Before running to the plain from the mountain gaps, flood flow energy is rather plentiful and swept with a large quantity of alluvium including grains.

- Stage 2:

This is a stage for changing the flow from mountain foot to the railway. Due to low terrain and sudden expansion made maximum load of mud and sand of the river is rapid reduced. On the way to lower section, a remarkable quantity of alluvium has been left behind by the flow forming the grounds at the middle or on both sides. As a result, it is forming the bent and meander lobes (as Thu Bon river section in upstream of Ky Lam bridge). For this reason, ability to drain flood of the rivers is significantly limited, overflowing to the grounds to drain into lower sections. Due to characteristics of the flow, principle of happenings inside riverbed and river ground is different. Inside the riverbed, because the alluvium is taken with the flow so the principle of happening is the principle of imbalance transporting mud and sand. And on the ground, because there is no or a little of alluvium is taken with the flow so principle of happening depends on interrelation between the current velocity with the allowable current velocity of the river ground materials. As the current velocity is larger than the allowable current velocity, erosion would happen.

- Stage 3:

This is the final stage when the current goes through the high way and railway to downstream. Because the alignment blocks the entrance of the flow as a dyke, so the flow has influences on the alignment. As a result, during more than 100 years of existence many track sections of Thong Nhat Railway have been destructed by flood. Reason for destruction is because these track sections are opposite with the mountain gaps, where the largest flow energy source existed. At this time, running state is changed from fast running at the mountain gaps to smooth running at the plain. This change created slanting flow and swirls on the ground. As coming to the railway they eroded the pavement foundation and bridges and roads. In addition to, because railway just like a blocking dyke so water level at the railway upstream also rises increasing potential energy of the flow and almost is turned into kinetic energy as running through the bridges and roads. The flow behind the works increased suddenly, its flow velocity is so much larger than allowable non-corrosive flow velocity of the river bank geology (soft clay sand) eroded river-bed under the bed at lower section creating wide and depth dug holes so called "Heaven abyss hole" on

the bridges on Thong Nhat railway as: Lo, Chau Lau, Bau Thinh, Ky Long, Xa Duyet, Bau Tai etc

The shortcomings of the draining works on Thong Nhat railway indicated the necessity to study more carefully about hydrographic and hydraulic issues to put forward solutions to arrange properly the construction works of the expressway in sections subject to damage by flood.

During study and updating for Da Nang - Quang Ngai Expressway project, the consultant collected the observational documents at the hydrographic stations in region, hydrographic surveying and observational documents at the bridges on Thong Nhat railway for calculation of the water level, discharge, designing speed and aperture of the spillway works. For details of the calculation results, see the Hydrographic calculation document along the alignment and engineering hydrology for each specific location. The calculation results shall be reckoned up in **Chapter 5 - Basic Engineering** of this report.

4.4 Engineering geological condition and building materials

4.4.1 Features of engineering geological condition

Da Nang - Quang Ngai Expressway is running along the west of the central coastal provinces. Because it is running along with the edge of countryside and complex geology conditions along the alignment in gravelly soil components, distribution area and depth.

Based upon:

- Total direction of project alignment;
- Geologic map sheets Hoi An (D-49-I), Quang Ngai (D49-VII, D-49-VIII);

and

- Exploratory boring results along the alignment,

It is possible to divide into alignments with below specific geologic features:

i) Section km0 ~ km20

The alignment is running on the plain strip within the valley in the mountain and valleys of the large local rivers are Cau Do, Tuy Loan, Yen, La Tho, Qua Giang, Thu Bon and Ba Ren Rivers. Because located in active area of many large rivers, the sedimentary formations are rather complex composed of clay formation, clay sand, sand, gravel sand, gravel mixed with each other through the sediment strata and allocated until the depth over 50m and covering on the sandstone, aleurolite and argillaceous slate.

Soft soil is absolutely gathered at this alignment. Nevertheless, at this

alignment soft soil is limited distributed mostly concentrated at the head of the bridge as Tuy Loan bridge, bridge of Yen river, Bau Sau bridge and La Tho bridge. Soft soil element is not identical including clay sand, soft clay loam, flow-plastic and particular clay mud, organic mixed clay mud (Bridge on Yen River, Bau Sau bridge). The allocation depth is also not identical, changing from 7m (Bridge on Yen River) to 28m (La Tho Bridge). In addition to, there are some sections where soft clay loam layer was allocated along the alignment to 3~5m depth may be affected to stabilization of the filling embankment, expected up to 7-9m of this section.

In general, soft soil is not popular and allocated not too depth. Nevertheless, it is located within valleys of many large rivers, usually deeper flooded so filling embankment is so high (7m - 9m in popular). Furthermore, filling embankment quality here is unstable in saturated condition (see contents of building materials). These are inconvenient conditions for soft soil treatment at this section

The bearing layer for the bridges is not depth allocated and it is a convenient condition for design, construction of the bridgeworks at this section. Composition of the bearing layer includes two types: most popular is gravel, gravel mixed with clay is allocated in the depth over 50m and local layer is aleurolite is allocated in 20~30m depth (bridge section of Yen River) and argillaceous slate is allocated in 15m depth (section Km7+500).

ii) Section km20 ~ km35 (including all Chiem Son Bridge – Ba Ren River)

The alignment runs closely to the west edge of the plain includes the short alignment sections are crossing low mountain/hill and the valleys in the mountain are alternating with each other in low thickness, particular 5~10m. This is equal to the bearing layer is shallow allocated even emerged on the surface

The major covering is (1) sediment: Clay loam in rigid-plastic state, sand and gravel and (2) remains of clay loam mixed with grit break stone in rigid-plastic, semi rigid and clay sand states.

The source-bed is allocated from 5~10m in popular depth; particular emerged on the surface (on right bank of Ba Ren River - Chiem Son bridge) or in 15m deeper (section ~km33+500). The source-bed includes 2 main types are sedimentary rocks (almost sandstone) is allocated at section ~km26+000 and granite is allocated from the section ~km26+000 until the end of this section.

In general, the engineering geological condition is rather convenient at this section. The section from ~km26+000 until the end of this line with the source-bed is granite, in basically, open excavation or pit excavation (if any) is convenient. However, due to the covering is the weathering product from granite, usually unstable with erosion activity of the surface water. Therefore, it is necessary to

attach special importance to the solution to reinforce prevention of digging section in the coating (both bents and portal of tunnel).

iii) Section km35 ~ km67

The alignment is running on rather flat terrain alternating some low hills (lost mountain). The sedimentary formations and remains are alternating allocated to each other in low thickness, usually 5~10m; equal to the bearing layer is shallow distributed.

Soft soil at this section all is insignificant, only in both sections ~km57+600 (about 300m length) and ~km64+300 (about 200m length), 4~5m thickness. Almost elements are clay, fluid-plastic clay loam. In general, it is not much affecting to stabilization of the pavement foundation and may be settled with the simple solutions as digging and changing the soil.

All bearing layers are weathered granite in different levels, in general, very convenient for foundations of the bridgeworks. There are many bridges, particular overpass for welfare of the people (not river bridge) absolutely may use the shallow foundation.

iv) Section km67 ~ km80

The alignment embraces the eastern mountain sides so coverings are very thin and bearing layer is shallow allocated, even emerged on surface.

At the valley in the mountain, almost covering is clay loam, clay sand and gravel sand from 5~15m depth, alternating with the sections are running on low hill mountain sides with the coatings as clay remains, clay loam mixed with grit break stone from 3~5m depth. There is no soft soil at this section.

Bearing layer includes 2 kinds of xerixit schist and granite is alternating allocated at 3~15m depth.

v) Section km80 ~ end of alignment

The alignment is running on rather flat terrain alternating some low hills (lost mountain). The sedimentary formations and remains are alternating allocated to each other in low thickness, usually 5~10m; equal to the bearing layer is shallow allocated, some sections emerging on surface.

Almost has no soft soil at this section.

The clay coating and rigid-plastic to rigid clay loam, sediment and remains originated sand are alternating with each other along the alignment, from 3 to more than 5m depth.

The bearing layer includes quartz schist and granite are alternating with each other along the alignment, shallow depth is allocated, particular 5~10m. Some sections are emerging on surface as km90+00 ~ km91+00 (quartz schist),

km92+500 ~ km93+500 (granite), km96+00 ~ km 99+00 (granite) and 103+500 ~ 104+500 (quartz schist). As for Tra Khuc and Tra Bông Rivers, basement rock layer is deeper allocated from 15~25m.

4.4.2 Construction materials

To serve for construction of Da Nang - Quang Ngai Expressway, 48 mines among building occurrence units have been investigated and surveyed in different levels. In which, there 28 filling soil mines, 10 sand mines and 10 rock mines are spreading along the alignment (see diagram of building occurrences).

The filling soil along the alignment is very plentiful, meeting all requirements in reserves. Nevertheless, quality of materials is not good. It is necessary to pay attention to some things:

- The basic elements of materials are Gravel clay, rather high index of plasticity (16/20 occurrences are $I_p > 17$). Therefore, it is inconvenient for compacting;

- Elastic module is common in level of 300~350 KG/cm² particular at so slow saturated state. Therefore, it is almost impossible to be used for the subgrade at the sections that are always being flooded (beginning of the section). At the design development, it is necessary to carry out additional investigation of materials for the subgrade.

- Shear resistance of soil is sharp reduced when saturated, in average C reduced to 75% and ϕ reduce to 25%. This would be inconvenient to cover the area where is often flooded. These sections are rather popular on the alignment, particular at beginning of the section and within valleys of the large rivers. During design development process, should survey more materials of filling soil through this section. In case without other materials, it is probable to consider improvement of materials by mixing with coarse aggregate (grave, crushed stone).

Sand and building stone materials are also very plentiful and in high quality. Nevertheless, it is irregular allocated on the alignment. Therefore, regulation of the materials along the alignment shall meet with certain difficulties.

Below is the survey results summary table of the occurrences.

Table 4.4.1 - List of the borrow pits

No	Pit symbol	Locations	Reserves (10 ⁶ m ³)	Transportation distance (km)	Descriptions
1	B1	Phuoc Nhon Hill, Phuoc Nhon, Hoa Khuong, Hoa Vang, Da Nang	1	5	Gravel clay
2	B2	Bo Bo Hill, Hamlets 5, 6 and 7, Dien Tien, Dien Ban, Quang Nam	2	1.5	Gravel clay
3	B3	Co grave Hill, Hamlet 5, Duy Son, Duy Xuyen, Quang Nam	2	1	Gravel clay
4	B4	Vang Mountain, Hamlet 1, Que Cuong, Que Son, Quang Nam	0.5	1	Gravel clay
5	B4A	Hon Gia Hill, Que Cuong, Que Son, Quang Nam	0.5	2	Gravel clay
6	B4B	Hon Ly Hill, Que Cuong, Que Son, Quang Nam	0.5	2.5	Gravel clay
7	B4C	Hon Mo Hill, Que Cuong, Que Son, Quang Nam	0.5	2.5	Gravel clay
8	B4D	Hon Hoanh Hill, Que Cuong, Que Son, Quang Nam	0.5	3.5	Gravel clay
9	B5	Huong Mao Hill, Hamlet 3, Phu Tho, Que Son, Quang Nam	1	0.1	Gravel clay
10	B6	Do Mound, Hamlet 3, Binh An, Thang Binh, Quang Nam	0.5	0	Gravel clay
11	B7	Go Cao Hill, Hamlet 2, Tam Thanh, Tam Ky, Quang Nam	1	1	Clay
12	B7A	Nong Gieng Hill, Tam Thanh, Tam Ky, Quang Nam	1	1	Clay
13	B7B	Nong Gieng Hill, Tam Thanh, Tam Ky, Quang Nam	1	0.2	Clay
14	B7C	Nong Gieng Hill, Tam Thanh, Tam Ky, Quang Nam	1	1	Clay
15	B7D	Nong Gieng Hill, Tam Thanh, Tam Ky, Quang Nam	1	0.5	Clay
16	B8	Deu So Hill, Trung Dam Hamlet, Tam Thai, Tam Ky, Quang Nam	0.5	0.5	Gravel clay
17	B9	Mieu Mountain, Ly Tran 1 Hamlet, Tam Anh, Nui Thanh, Quang Nam	0.5	1	Gravel clay
18	B10	Tra Cam Hill, Ly Tran 1 Hamlet, Tam Anh, Nui Thanh, Quang Nam	0.5	1	Gravel clay
19	B11	Ray Bom Hill, Xuyen Ngac Hamlet, Tam Anh, Nui Thanh, Quang Nam	1	0.5	Clay
20	B12	Rocky Mountain, Hamlet 4, Tam	1	0.5	Clay

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No	Pit symbol	Locations	Reserves (10 ⁶ m ³)	Transportation distance (km)	Descriptions
		Hiep, Nui Thanh, Quang Nam			
21	B13	Ham Rong Hill, Dong Binh Hamlet, Binh Chanh, Binh Son, Quang Ngai	1	0.2	Gravel clay
22	B14	Cay Lim Hill, Nam Binh Hamlet, Binh Nghia 1, Binh Son, Quang Ngai	2	0	Gravel clay
23	B15	Ba Ta Hill, Phu Le 2 Hamlet, Binh Trung, Binh Son, Quang Ngai	1	0	Gravel clay
24	B16	Go Son Hill, An Dien 1 Hamlet, Binh Chuong, Binh Son, Quang Ngai	0.5	4	Clay
25	B17	Rung Ham Hill, Tho Bac Hamlet, Tinh Tho, Son Tinh, Quang Ngai	1	0.2	Gravel clay
26	B18	Ngang Mountain, Tho Trung Hamlet, Tinh Tho, Son Tinh, Quang Ngai	0.5	0.2	Gravel clay
27	B19	Thop Mountain, Tho Dong Hamlet, Tinh Tho, Son Tinh, Quang Ngai	0.5	1	Gravel clay
28	B20	Cam Mountain, Hoa Binh Hamlet, Tinh An Dong, Son Tinh, Quang Ngai	0.5	3	Gravel clay

(Source: Construction materials survey report performed by TEDI-RECO in December 2003)

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Table 4.4.2 - Basic targets of filling soil materials

No	Signal	Ip (%)	γ_{cmax} (t/m ³)	W _{op} (%)	Prepared E (Kg/cm ²)	Saturated E (Kg/cm ²)
1	B1	14.6	1.87	13.8	487	311
2	B2	28.8	1.75	17.6	507	311
3	B3	27.6	1.83	15.0	504	327
4	B4	20.2	1.57	22.6	519	341
5	B5	24.5	1.53	23.8	527	391
6	B6	18.3	1.67	19.8	520	357
7	B7	20.5	1.47	27.9	435	321
8	B8	19.5	1.89	13.7	379	271
9	B9	26.0	1.51	26.1	475	349
10	B10	24.1	1.82	15.0	474	348
11	B11	24.2	1.43	27.3	511	343
12	B12	25.9	1.49	26.5	429	321
13	B13	18.5	1.72	17.5	419	328
14	B14	20.4	1.81	15.5	511	341

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No	Signal	Ip (%)	γ_{max} (t/m ³)	W _{op} (%)	Prepared E(Kg/cm ²)	Saturated E(Kg/cm ²)
15	B15	22.4	1.81	17.4	507	327
16	B16	27.6	1.81	22.0	528	323
17	B17	17.3	1.83	15.9	529	341
18	B18	14.5	1.85	14.7	508	349
19	B19	12.0	1.87	13.9	421	312
20	B20	11.6	1.86	13.0	462	247

(Source: Construction materials survey report performed by TEDI-RECO in December 2003)

Table 4.4.3 - List of the sand pits

No	Signal	Locations	Ability to provide (m ³ /date)	Transporting distance (km)	Descriptions
1	C1	Tuy Loan sand pit: Tuy Loan Hamlet, Hoa Phong, Hoa Vang, Da Nang	200	1	Medium sand
2	C2	Cau Do sand pit: Km934+590 QL1A, Nuoc River, Do Bridge lower section 200m.	200	11	Medium sand
3	C3	Truong Giang sand pit: Nhi Dinh 1 Hamlet, Dien Phuoc, Dien Ban, Quang Nam	By request	2	Medium sand
4	C4	Ngoc An sand pit: Ngoc An Hamlet, Dien Hong, Dien Ban, Quang Nam	By request	2	Medium sand
5	C5	Duy Dong sand pit: Cam Ha Hamlet, Dien Phong, Dien Ban, Quang Nam	By request	3	Medium sand
6	C6	Vinh Dien sand pit, km948+380 QL1A, left bank of Thu Bon River (Vinh Dien, Dien Ban, Quang Nam)	200	9	Medium sand
7	C7	Cau Lau sand pit: Km954+300 QL1A, Ba Ren River, lower section of Cau Lau Bridge 100m	200	14	Medium sand
8	C8	Tam Ky sand pit: Km996+100 QL1A, Tam Ky River, Lower section of Tam Ky Bridge 100m	200	8	Gravel sand
9	C9	An Tan Bridge: Km1018+600 QL1A, An Tan River, Upstream of An Tan bridge	200	10	Gravel sand
10	C10	Chau O bridge: Km1036+400, QL1A, Tra Bong River, Upstream of Chau O bridge 200m	200	6	Medium sand

(Source: Construction materials survey report performed by TEDI-RECO in December 2003)

Table 4.4.4 - List of the quarries

No	Signal	Locations/Governing bodies	Ability to provide (m ³ /day)	Transporting distance (km)	Descriptions
1	R1	Phuoc Tuong Hamlet, Hoa Phat, Hoa Vang, Da Nang/ Transport Materials Enterprise	By request	13	Granite
2	R1A	Hoa Nhon, Hoa Vang, Da Nang	By request	1.5	Granite
3	R2	Hon The, Hamlet 5, Duy Xuyen, Duy Son, Quang Nam/ Company Limited	By request	2	Granite
4	R3	Huong Mao, Hamlet 3, Phu Tho, Que Son, Quang Nam/ Company Limited	By request	0.8	Granite
5	R4	Phu Hue, Dinh Phuoc Hamlet, Tan Ngha, Nui Thanh, Quang Nam/ Chu Lai JSC	By request	2	Granite
6	R4A	Nui Tra, Quang Nam, Quang Ngai/ Nui Tra Quarrying Company	By request	0	Granite
7	R4B	Vn Tuong, Quang Nam, Quang Ngai/ Van Tuong Quarrying Company	By request	0	Granite
8	R4C	High Command of the 5th Military Zone, Quang Nam, Quang Ngai/ Quarrying Company of the High Command of the 5th Military Zone	By request	0	Granite
9	R4D	Hoa Van, Quang Nam, Quang Ngai/ Hoa Van Quarrying Company	By request	0	Granite
10	R4E	Hung Long, Quang Nam, Quang Ngai/ Hung Long Quarrying Company	By request	0	Granite

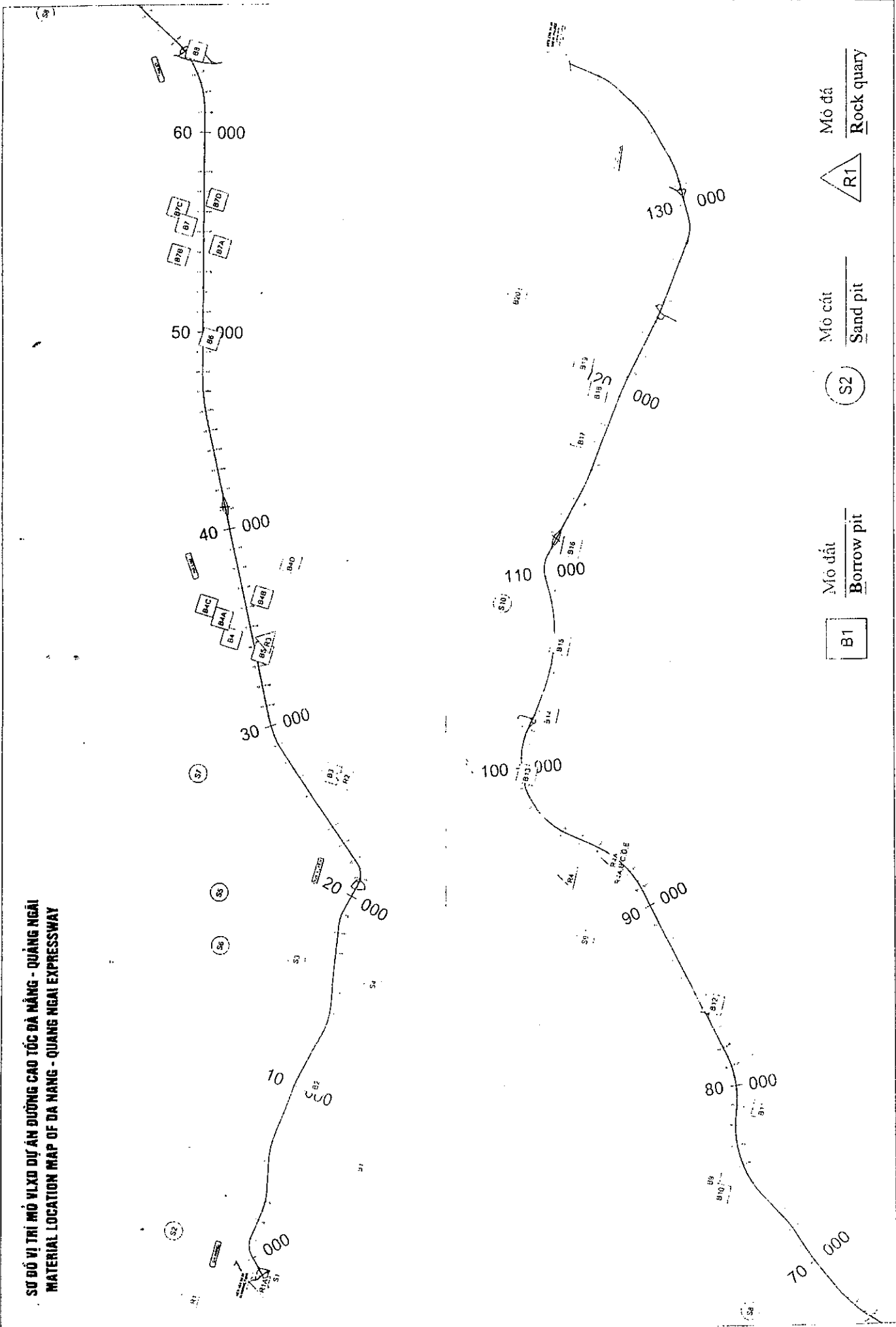
(Source: Construction materials survey report performed by TEDI-RECO in December 2003)

Table 4.4.5 - Basic targets of the rock materials

No	Signal	Abrasivity L. A. (%)	Drying qu (Kg/cm ²)	Saturated qu (Kg/cm ²)
1	R1	20.3	1138	1090
2	R2	19.7	1506	1441
3	R4	20.3	1666	1616

(Source: Construction materials survey report performed by TEDI-RECO in December 2003)

SƠ ĐỒ VỊ TRÍ MỎ VẬT TƯ DỰ ÁN ĐƯỜNG CAO TỐC ĐÀ NẴNG - QUẢNG NGÃI
MATERIAL LOCATION MAP OF DA NANG - QUANG NGAI EXPRESSWAY



- B1 Mỏ đất / Borrow pit
- S2 Mỏ cát / Sand pit
- R1 Mỏ đá / Rock quarry

The geometric design standards of the route shall be reckoned up in conformity with design standards of expressway TCVN 5729 -97 and according to the below table:

Table 5.1.1 – Geometric design standards

No.	Standards	Unit	Class 100	Class 120
1	Calculated speed V _{tt}	Km/h	100	120
2	Maximum super elevation gradient (isc)	%	7	7
3	Respectively minimum radius isc=+7%	m	450	650
4	Respectively normal minimum radius isc=+5%	m	650	1000
5	Radius correlative to isc=+2%	m	2000	3000
6	Radius not requiring one-slope gradient isc=-2%	m	3000	4000
7	Length of transitional curve corresponsive to R _{min}	m	210	210
8	Length of transitional curve corresponsive to ordinary minimum radius	m	150	150
9	Length of transitional curve corresponsive to radius with numeric value in bracket	m	100(900)	125 (1125)
10	Breaking Length or stopping vision	m	160	230
11	Gradient up maximum slope	%	5	4
12	Gradient down maximum slope	%	5.5	5.5
13	Radius of standing curve with minimum convex	m	6000	12000
14	Radius of standing curve with minimum concave	m	3000	5000

5.2 Design of the alignment and utilities on the route

5.2.1 Scope of cross-section

The typical cross-section of the route shall be proposed according to design standard of expressway TCVN 5729 – 97 and considered on a basis of the road's function.

i) Cross-section of the main route:

According to the traffic demand forecast results presented in Chapter 3, in the Base Case, with 4-lane expressway, toll of VND1200/km and without NH1A widening, in 2035 the section from Ha Lam interchange to Tam Ky interchange has the highest traffic volume on the route, reaching 91,524 PCU/day night so the V/C (Volume to Capacity) ratio is 95% ; the section from Binh Son interchange to Quang

Ngai interchange has the lowest traffic flow on the route, reaching 62.765 PCU/day-night, V/C ratio is 70%. Up to 2040, the section from Ha Lam interchange to Tam Ky interchange has the flow reaching 124,284 PCU/day night so V/C ratio is 129%; the section from Binh Son interchange to Quang Ngai interchange has the lowest flow on the route, 84,636 PCU/day night, and then V/C ratio is 88%. Thus in 2035 it is necessary to widen the Expressway into 6-lane road to meet the transport demand.

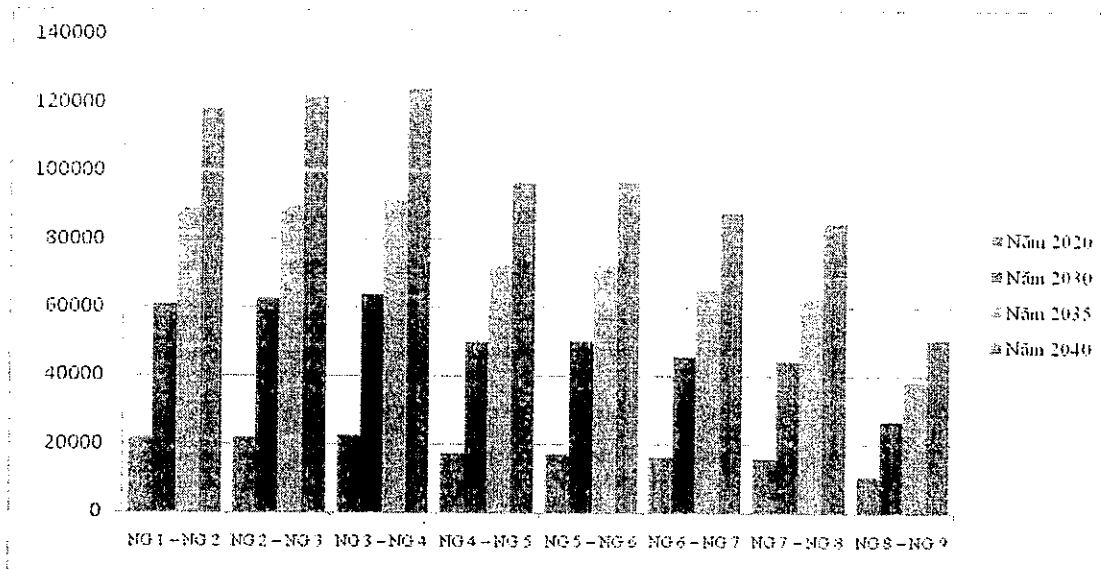


Figure 5.2.1 – Traffic forecast on the Expressway, base case, toll VND1200/km, no NH1 widening (in PCU/day night)

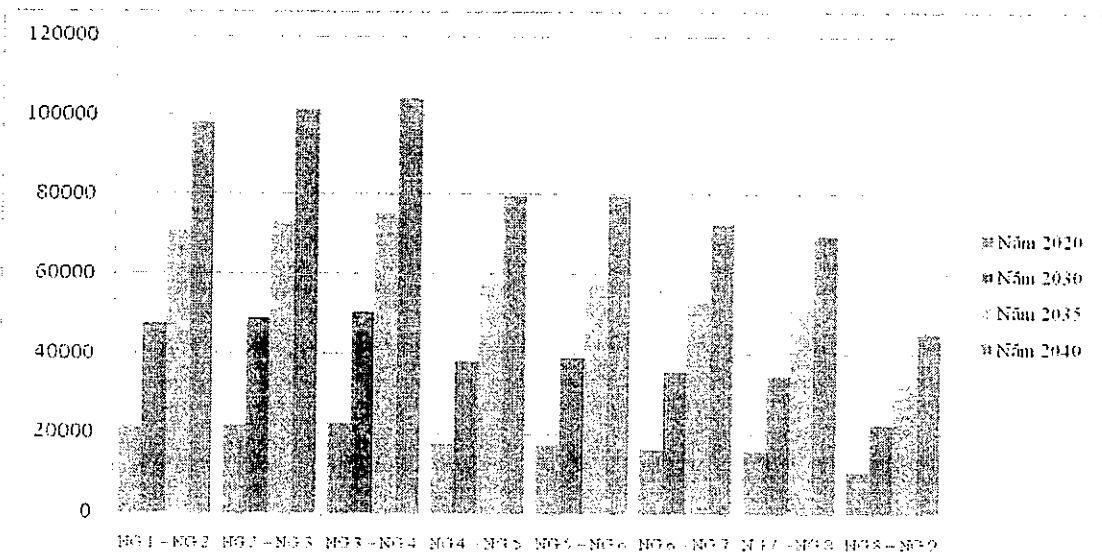


Figure 5.2.2 – Traffic forecast on the Expressway, base case, toll VND1200/km, with NH1 widening (in PCU/day night)

Also in the Base case, with 4-lane expressway, toll VND1200/km with NH1A widening from 2021, in 2035 the section from Ha Lam interchange to Tam Ky interchange has the lowest traffic flow on the route, 75,131 PCU/day night, then the V/C ratio is 78% ; the section from Binh Son to Quang Ngai interchange has the lowest traffic flow, 50,866 PCU/day night, V/C ratio is 53%. In 2040 the section from Ha Lam interchange to Tam Ky interchange has traffic flow at 104,185 PCU/day night, V/C ratio is 109% ; the section from Binh Son interchange to Quang Ngai interchange has the lowest traffic flow on the route, reaching 69,709 PCU/day night, then the V/C ratio is 73%. Thus in 2040 it is necessary to widen the Expressway section from Danang to Tam Ky into 6-lane road to meet the traffic demand, and Tam Ky – Quang Ngai section will be still 4-lane.

According to the Decision no. 140/QD-TTg dated 21/01/2010 issued by the Prime Minister on approval for the Detailed planning of the North-South expressway in the East, Da Nang – Quang Ngai section has 4 to 6-lane.

According to the above Decision and the traffic forecast, it is recommended that construction will be phased: completion phase will be 6-lane expressway, while the initial phase is 4-lane expressway.

The typical cross-section factors of the project are chosen in accordance with TCVN 5729 - 97 standard as follows:

Table 5.2.1 - Cross-section of main route

Cross-section factor	Quantity	Width (m)	Total (m)
Expressway lane	4	3.75	15.0
Emergency lane	2	3.0	6.0
Soil shoulder (*)	2	0.75	1.5
Safety strip	2	0.75	1.5
Median	1	2.0	2.0
Total (m)			26.0

Note ()*: According to TCVN 5729-97, width of soil shoulder is 0.75m for class 100 and 1.00m for class 120. However, 3.00m width of emergency lane is too wide. Therefore, it should be recommended to use 0.75m width of soil shoulder for both classes.

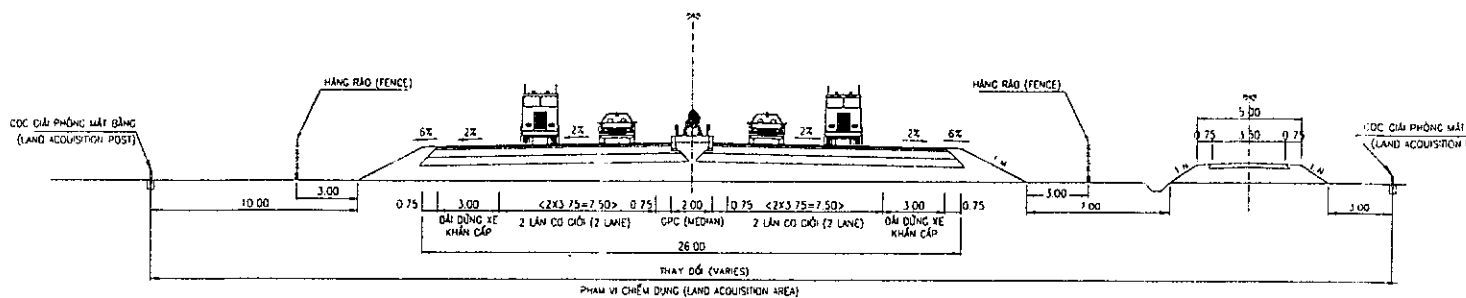


Figure 5.2.3 – Typical cross-section of main route

ii) Cross-section of frontage road

Table 5.2.2 – Cross-section of frontage road

Cross-section factor	Quantity	Width (m)	Total (m)
Carriageway	1	3.5	3.5
Soil shoulder	2	0.75	1.5
Total (m)			5.0

iii) Cross-section of part connecting from the expressway end to NH1A

The road class of part connecting from the expressway end to NH 1A shall be class III delta with scope of cross-section as below:

Figure 5.2.4 – Typical cross-section of part connecting to NH 1A

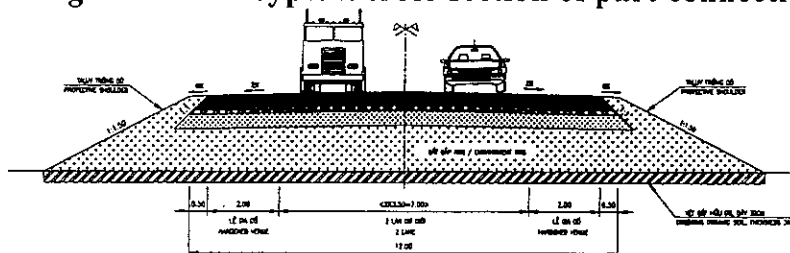


Table 5.2.3 - Cross-section of part connecting from the expressway end to NH 1A

Cross-section factor	Quantity	Width (m)	Total (m)
Carriageway	2	3.5	7.0
Reinforced roadside	2	2.0	4.0
Soil shoulder	2	0.5	1.0
Total (m)			12.0

5.2.2 Design of route and intersection

(1) Principle to determine alignment:

In order to create favorable conditions to determine the route location, the project shall set out some principles in selecting the alignment as follows:

- The expressway shall be established separately, ensuring link with the available road network. The route should be near NH 1A (the major highway for the region and the nation) which have the demand for using the highway in future;

- The route shall not go through the urban zones, populous areas and industrial zones planned; avoid violating safe landmark of other works (irrigational works, tourism zones, historical relics, industrial zones, military areas ...), at the same time ensure landscape and environment of that project area that the route passes by.

- The expressway must ensure favorable link with the key economic centers in the region; creating high connection with other means of transport through important transport intersection with large transport demand (seaport, railway station and airport ...);

- Securing sustainability and minimize impact on environment.

(2) Alignment

i) Expressway

- **Beginning point:**

The beginning point cross NH 14B at Km23+908/QL14B in Hoa Vang district, Da Nang city.

- **End point:**

The end point cross the planning road in West of Quang Ngai city at Km131+129.26.

- **Main control points:**

The main control points are towns, cities, economic zones and industrial zones ... along the expected alignment; tunnels and intersections with highways, provincial roads (control on topography and population); electric works, irrigational works, cultural and historical relics These locations are reviewed on each specific section.

- **The alignment direction**

- ✓ *The alignment proposed by Nippon Koei*

The alignment of expressway is towards the West of the existing Thong Nhat railway, in particular:

- + From Km23+908/QL14B under Hoa Vang district, Da Nang city, the road

will pass through the low field areas with highly-concentrated 500kV and 35kV power transmission lines in Phu Hoa commune, Hoa Vang district. Then, the road will cross Tuy Loan River and Yen River in the 3km distance from Do Bridge on NH 1A upstream. It will continue along Yen River bordering the residential area of Le Son 2 in Tien Hoa commune, Hoa Vang district, Da Nang city, and then parallels for about 750m from Thong Nhat railway westwards to boundary between Da Nang city and Quang Nam province (Km8+000).

+ From the boundary between Da Nang city and Quang Nam province, the road will continue to run in parallel for about 800m from Thong Nhat railway westwards and crosses Cam Son industrial complex; PR.605 (road to Bo Bo Mountain) residential area under Dien Tien commune, Dien Ban district, Quang Nam province. The road will run towards the East for about 2.2km from Bo Bo Mountain and across La Tho River through the fields of Duc Ky and La Trung communes to DT609, residential area of Chau Thuy, Bi Nhai and Ky Lam communes and across Thu Bon River at the 250m distance of Thong Nhat railway westwards.

+ Across Thu Bon River, the route will run in parallel for about 250m from Thong Nhat railway westwards, through the floodplain and the resident area of Xuan Dai and Den Bong river wharf under Dien Son commune, Dien Ban district, Quang Nam province. After that, the road will cross Ba Ren River about 250m away from Thong Nhat railway bridge westwards and PR.610 at Km20+500 with about 10.5km distant from NH 1A westwards (along PR.610) in Hamlet 1, Duy Trinh commune, Nam Phuoc district (Duy Xuyen), Quang Nam.

+ Across PR.610, the road then will turn left, crosses Eo Mountain by about 540m tunnel, goes straight through the local road and thinly populated area of Duy Son commune and then parallels with about 250 from Thong Nhat railway westwards intersecting PR.611 at Km 25+500 under Que Thuan commune, Dong Phu district (Que Son), Quang Nam.

+ Across PR.611, the route will go straight for about 800m from Thong Nhat railway through the fields and thinly populated areas and cross NH14E at about 5km from NH1A westwards in Quy Thach hamlet, Binh Quy commune, Ha Lam district, Quang Nam.

+ Across NH14E, the road will go straight and westwards in parallel with Thong Nhat railway for about 370m, through Tu Tra hamlet to Binh Hoi hamlet, Binh Que commune, Ha Lam district, Quang Nam. From there, the road will continue running straight and be distant far from Thong Nhat railway westwards about 1.5-2.5km through the residential areas interweaving with the fields under Binh Que commune, Ha Lam district, Tam Thanh and Tam Phuoc communes, Tam

Ky town, Quang Nam province and crosses PR.616 at Km64+300 with about 6.5km from NH 1A westwards (along PR.616) in Tam Thai commune, Tam Ky town, Quang Nam province.

+ After crossing PR.616, the road will turn left, cross Tam Ky river at the position 4.5 km away from Tam Ky bridge on the existing NH1 upstream. Then the road will go through hilly and mountainous area alternative with the thinly populated areas, about 2.5km away from Thong Nhat railway in the west and directing to the east of shooting gallery controlled by army force. Going along the foot mountain to the intersection of the planned access road of Chu Lai industrial zone at the about Km84+000, about 2.7km from NH1 in the west.

+ The road will continuously go straight through hamlet 4, Da Phu hamlet, under Tam My commune, then comes to the downstream of Ho Ca dam, Hoc Co dam, and Ngo May dam. Next, it shall turn left to Hoa Dong of Tri Binh commune, Chau O district, Quang Nam province. From there, the route is parallel and 0.5 km from the west of Thong Nhat railway and NH1A to the intersection with the access roads into Dung Quat industrial zone at Km102+000 belonging to Binh Nguyen commune, Son Tinh district, Quang Nam province.

+ After crossing the planned road accessing Dung Quat industrial zone, the road shall turn right toward the west of Cau mountain and come into fields, pass through the population area of Binh Nguyen and Binh Trung communes and intersecting Tra Bong river at the position 2.2 km from the existing Tra Bong bridge on NH1 upstream in Phuoc Thuan hamlet, Binh Trung commune, Chau O district, Quang Nam province

+ Crossing Tra Bong river, the road will cut the connection road accessing Dung Quat industrial zone in progress at station Km112+000 (Binh Son intersection). Then it turns left and runs in parallel and about 200-300m far away from the west of Thong Nhat railway through the hamlets like Tho Bac, Tho Trung, Phu Tho of Tinh Tho and the submerged area of Tra Khu valley under Lam Loc hamlet, Tinh Ha commune. The road will cross PR. 623 at the point of 4.2km from NH1A in the west, then it will cross Tra Khuc river at station Km126+000 far 5kms from the current Tra Khuc bridge on NH1A upstream under Ngan Gian hamlet, Tinh Ha commune, Son Tinh district, Quang Nam province.

+ After crossing Tra Khuc river, the road will turn left and cross PR.625 and the ring road in the west of Quang Ngai City at station of Km131+000 in Dien An hamlet, Quang Phu commune and ends the expressway at Km131+129.36.

✓ *Analysis and comments on the alignment of Nippon Koei*

After studying the alignment in Update and Finalization of the F/S Report prepared by Nippon Koei together with inspection results of alignment in the field,

the investigation report and the conclusion announcement of leaders of Ministry of Transport on the project, The consultant would like to give some comments on the alignment as follows:

- Regarding geometric standards: the alignment prepared by Nippon Koei in straight, with very good technical requirements, minimum radius of horizontal curve $R=4000m$.

- Control points: The alignment mainly eliminates main control points in Bo Bo mountain area, shooting garelly of army force, crowded population areas, big industrial zones, irrigational dams, etc. However, at the sections of the beginning area at Km0-Km16, Km60-Km73, there are a lot of electrical poles of the 500KV electrical network and other electrical networks, therefore, the consultant prioritized for geometric guarantees of the alignment and accepted to remove as well as raise the pole of 500KV and other poles. Moreover, on the section Km0+000 – Km16+000, the route also crosses some villages and Cam Son industrial area. On the section Km109-Km129, the alignment of Nippon Koei also comes into crowded population areas and heavily flooded areas of Tra Khuc valley.

With the comments stated above, the consultant studied carefully in the field 03 sections at Km0-Km16, Km60-Km73 and Km109-Km129. Their topography features as follows:

- **Section Km0-Km16**

Section Km0-Km10, the topography of the route is low field, anually submerged due to floods. It has a heavy network of transmission poles of 500KV and 35KV electrical networks. The electrical transmission lines as follows:

- Electrical transmission line of 35Kv*

- + In Section Km0-Km1 about 130m-200m away from the left of the road there exists the 35kv electrical network in parallel the centerline. In this scope, there are 04 poles.

- + at Km1+750, there is the electrical line of 35Kv crossing the centerline, in which the centerline ifself crosses 01 and 02 nearest poles of 100m and 190m in turn.

- + Section Km2+500-Km7+000, there is a electrical line of 35kv in parallel the left of the centerline and 440 m from the centerline.

- + At Km7+700, the electrical line of 35kv crosses the centerline. The centerline goes through 01, 02 nearest poles with 100 and 128m respectively.

+Section

Km7+700 – Km10+500:
the electrical line of 35kv
run in parallel the right of
the center line and 300m
far from the centerline.

+ At Km11+000:
the electrical line of 35kv
crosses the center line in
which it is 40m far from
the nearest pole

+ From Km11 to
Km13, the electrical line
goes toward the left of the
route, and goes away the
center line 185m.

+ At Km13+400, the electrical line cuts the centerline, in which the nearest pole is far from the centerline of 30m

+ Section Km13+400 – Km16+00, the electrical line directs to the right of the route

+ At Km16+000, the electrical line cuts the centerline in which there is 01 pole is exactly on the centerline.

+ At Km14+950, the electrical line of 35kv of the other electrical line of 35kv cuts the centerline.

To sum up, the section Km0-Km14, the centerline of Da Nang- Quang Ngai Expressway prepared by Nippon Koei crosses 01 electrical line of 35KV 04 times and crosses other two 35KV lines.

Electrical transmission line of 500Kv

+ At Km0+800, it exists an electrical line of 500Kv crossing the centerline, in which the centerline goes through the positions of 02 poles, the nearest pole is 190m

+ Section Km2+500-Km4+500, there is an electrical line system of 500Kv in parallel in the left of the centerline and 360m far from the centerline.

+ At Km4+300, there is an electrical line of 500Kv crossing the road, in which the 02 nearest poles are far from the centerline of 77m and 263m respectively. The vertical clearance of electrical cable at the intersection via the centerline is 15,95m.

- For Section Km8-Km10, the centerline crosses Cam Son industrial area and

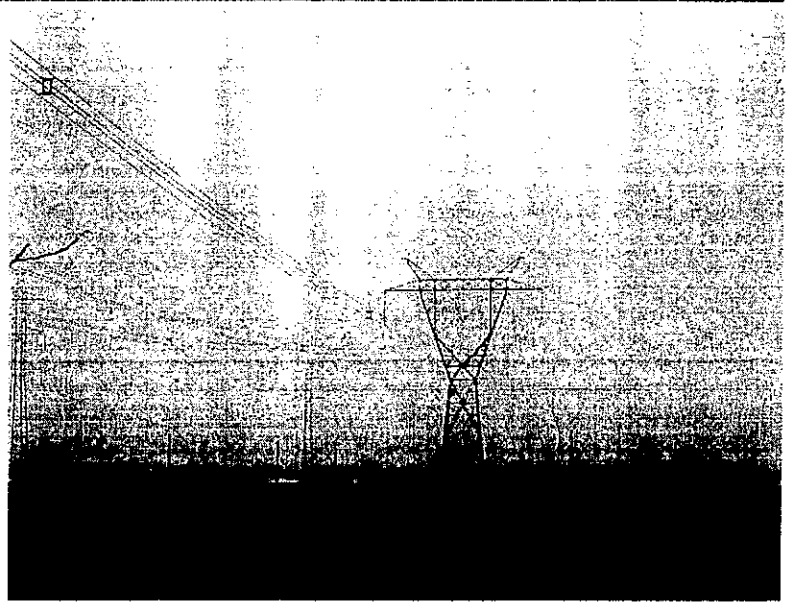


Figure 5.2.5 -

Electrical line in the section of Km0-Km16

population area of Thai Cam hamlet.

Based on the features mentioned above, the consultant finds that:

- Area of section Km0+00 - Km16+000, the route goes through the hollow area, therefore, the road-bed is filled in height to ensure the calculated flood frequency. It is difficult to avoid raising the height of poles of 500Kv at the two intersections. In particular, toward the 35KV of transmission line, the centerline is crossed many times, should study carefully to adjust the route to minimize the intersection with the electrical system.

- In case of section Km8-Km10, the route goes in the center of Cam Son industrial area and population area of Thai Cam hamlet. In order to limit the GPMB volume, and avoid separating this industrial area, adjustments should be studied.

- Section Km60+000 – Km73+000

This section is in the area of mountains mixing fields. Together with the standing feature of topography, geophysics of the area appears transmission line of 500KV and some pagodas, temples, martyrs' cemetery near the selected alignment.

On 500Kv of high voltage transmission line :

+ At Km60+500, the transmission line crossing the centerline, 02 poles near the centerline at the distances of 128m and 172m. The zero-statics of electrical cable crossing the centerline is 10.35m.

+ Section Km66-Km70, the electrical line is in the left of the centerline.

+ At Km67+400, the centerline is only 30m from the 500Kv pole of high voltage transmission line.

+ At Km71+000, the centerline cross the transmission line.

On the pagodas, churches along the route:

+Section Km63+000 – Km64+000, there are 03 pagodas and 01 martyrs' cemetery near the two sides of centerline. In this area, the 02 nearest pagodas place in the two sides and distant the centerline 160m and 190m respectively.

+ At Km65+000 – Km66+100, there is a Phan worship house next to the left of the route and Phap Dam pagoda in the right. The worship house and the pagoda is in distance of 30m from the centerline.

Hence, on the section Km58+000 – Km73+000, the alignment proposed by Nippon Koei shall cross the 500kv of high voltage transmission line in two times and the route is too near the Phan worship house and Phap Dan pagoda. Therefore, on this section, should study thoroughly to minimize the intersections with the 500KV of high voltage transmission line in many times and avoid the works like pagodas and worship –houses.



Figure 5.2.6– Positions of the 500 Kv poles near Km67+400

- Section Km109 – Km129

Section Km109 - Km129, the topographic features is mainly hollow fields, anually flooded by Tra Khuc river. Section 109-Km115, the route goes through high mountains. Section Km115 - Km129, it comes over the population areas alternative with rice & crop fields. Along the alignment of the expressway, there are many local roads in which crowded population areas are existing. The alignment is only in the distance of 100m from the local roads, so the volume of land acquisition is large under this plan.

Section Km121 - Km129 is in the flooded area due to Tra Khuc river. The alignment proposed by Nippon Koei goes through the depressed area, so the construction of the highway according to this alignment shall raise some problems in the stability of the work, appropriate scope, and construction quantity.

Therefore, toward the section Km109-Km129, the re-alignment is studied to reduce the volume of land acquisition, increase the stability for the road.

✓ Alignment proposed by TEDI

- Section Km0-Km16

Based the above analysis and resurvey results in the field, maps as well as other collected results, the consultant indicates that on the section Km0+000 - Km16+000, the alignment should be adjusted to avoid crossing the 500KV poles and intersecting in many times with the 35KV tranmission line, minimizing the intersections through Cam Son industrial area, population area of Thai Cam hamlet,

Dien Tien commune, Dien Ban district, Quang Nam province.

Re-alignment of section Km 0+000 – Km16+000 in details as follows:

+ From Km0+000 on the alignment proposed by Nippon Koei (hereinafter called the old centerline), the route slopes to the east of the centerline to avoid clearing the 500 KV poles at Km0+800. The adjusted centerline crosses Tuy Loan river and Yen river at the waterway crossing points of the old centerlines of 233m and 48m respectively downstream. Up to Km3+000, the re-alignment is in the same position of the old one.

+ From Km3+000 to Km 6+000, the route is nearly in parallel the old one and in the distance of 100m from the old to avoid removing of the 500kv poles at Km 4+500.

+ At Km6+000, the route crosses and goes to the west of the old centerline to reach the edge of the west of the population area under Thai Cam hamlet, the route cuts the angle of the planned Cam Son industrial area, and goes through the Bo Bo footmountain, in distance of 392m toward the west.

+ Section Km 13+000 – Km16+000, the route is nearly in the same position with the old centerline to tape to the old one at Km16+000.

Re-alignment of section Km0+000 - Km16+000 shall restrict the removal of 02 poles of 500Kv and the intersections through the population areas of Thai Cam hamlet as well as going through Cam Son industrial area.

- Section Km60+000 – Km73+000

Section Km60-Km73 should be adjusted the alignment toward the east to avoid the removal of 01 pole of 500kv at Km67+400 and 01 intersection with the transmission line of 500 kv at Km71+000. Moreover, re-alignment helps to avoid land acquisition of Phap Dan pagoda and Phan worship house.

Re-alignment of the section Km60+000 – Km73+000 in details as follows:

+ From Km60 +000 on the alignment proposed by Nippon Koei, the route goes straight and toward the west of the old centerline in the distance of 84m. Then the route turns left and crosses PR.616 at the same position of the old centerline.

+ Upon crossing PR.616, the route turns left and goes toward the east of the old centerline, goes through the east edge of the population area of hamlet 3. The route goes straight through the empty area including some brick-kilns between the two population areas of hamlet 3 and hamlet 4. The re-alignment at the furthest point is 530m far from the old centerline in the east.

+ The route in its way continue to goes straight and intersects Tam Ky river at the position away from Tam Ky bridge of 483m downstream. Upon Tam Ky river, it comes to the eastern foot of 02 hills and integrates into the old centerline at

Km73+000.

- Section Km109+000 – Km129+000

On section Km109-Km129, the alignment is adjusted toward the west to reduce the land acquisition quantity and avoid the heavily submerged area. However, in order to reduce the land acquisition quantity due to the old alignment coming into population area of An Thuan hamlet, re-alignment should be made from Km107+000.

Re-alignment of section Km107 – Km129 as follows:

- From Km107+000 on the alignment proposed by Nippon Koei, the route is directed toward the east in comparison with the old one of 100m. It crosses Tra Bong at waterway crossing point of the old one in 260m far away downstream. As cross of Tra Bong river, it goes through the eastern edge of An Thuan population area.

- Then, the route crosses the old one at Km111+500 and turns into the gently sloped hills of the west old centerline. It comes over Van Hoa, Lam Loc of Tinh Tho commune, Son Tinh district, Quang Nam province.

- The route is on the straight way and crosses Tra Khuc river at the position far from Tra Khuc river along the old one of 700m upstream. Then it goes along and meets the old at Km129+000.

The re-alignment cuts down the times of intersections through An Thuan's population area, reduces the land acquisition quantity of the section Km115-Km129 because the route passes through the mountainous topography not fertilized fields. The population of adjusted areas is thin, which helps for the ground clearance decrease sharply in comparison with in the old one. On the other hand, the alignment toward the west is higher in topography than that of the old, hence it restricts the disadvantages of stability, construction quantity of the work.

The total length of the alignment proposed by the consultant is 131,490km.

ii) Connection section from the end of the route with NH1A

Pursuant to the notice No. 146/TB-BGTVT dated April 08, 2009 and No. 486/TB-BGTVT dated October 30, 2009 by Ministry of Transport, the official document No. 720/UBND-CNXD dated March 26, 2009 by Quang Ngai People's Committee on agreement upon alignment and technical scale of Da Nang – Quang Ngai Expressway and study results on maps and in the fields, the consultant proposes the connection section from the end of the expressway to NH1A as follows:

- Beginning point: the end point of the expressway is the end of intersection with the planned road in the west of Quang Ngai province, about Km131+129.26..

- End point: joints with the bypass in the east of La Ha town, at Km1063+700 on NH1A.

- The alignment in details:

+ From the end of intersection with the planned road of the Western Quang Ngai (the end point of the highway), the route goes straight through the western edge of Dieu An population area, the eastern edge of the Dien An belonging to Nghia Dien commune, Tu Nghia district, Quang Ngai province.

+ The route turns right at Km131+894.86 with a small turning angle ($16^{\circ}44'09''$), radius of horizontal curve $R=5000\text{m}$; It is on the straight way, then crosses and in the same line with AC B=5.0m with a distance of 280m (from Km132+100 to Km132+380); cuts the large stream (the upstream of Bau Giang river) at Km132+934.27; intersects the provincial road PR.624 (asphalted road B=6.0m) at Km133+371.32, comes nearer to Xom Xiec bridge under Phu Dinh hamlet, Hanh Thuan commune, cuts channel N8 at Km133+696.12 and on the way to Km135+000.

+ The route turns left at Km135+121.40 with a small turning angle ($16^{\circ}34'09''$), radius of horizontal curve $R=5000\text{m}$; It is on the straight way, then crosses with the North- South railway at Km135+269.93 under Phu Van hamlet, Nghia Trung commune, Tu Nghia district, intersects the district road DR.59 AC at Km135+415.13, B=5.0m, at the intersection point without asphalted surface, crosses the district road DR.55 AC (B=5.0m) at Km137+215.42 belonging to Phu Van 2 hamlet, Nghia Trung commune, Tu Nghia district.

+ The route turns left at Km137+545.63 with a small turning angle ($17^{\circ}50'08''$), radius of horizontal curve $R=3000\text{m}$. It continuously goes through the fields, passes the population area of Phu Van 2 hamlet, and comes over the southern edge of population area of Dien Trang hamlet, Nghia Trung commune, Tu Nghia district, Quang Ngai province. Then it goes straight, and intersects with NH1A at Km1063+700.

iii) Conclusion on alignment.

The re-alignment of 03 sections and the added section linking NH1A is studied and resurveyed by the consultant in the field. The alignment is reported meets the technical requirements of design speed of 120km/h and satisfies the topographic conditions, and practical geophysics, plans if relative and ensures the economic-technical features as well as meets the suggestion of Ministry of Transport, World Bank, People's Committee of the province. With the remaining sections, the alignment keeps compliance with the old one proposed by Nippon Koei without any adjustments.

iv) 500KV Electric Line

Designed alignment cuts the 500KV line at some positions with respective high clearance as follow:

- Km0+797: Htn=5.32m (ground level); Htk=10.46m (finished grade); High clearance H=11.86m (comparing with the finished grade).
- **Km4+431.65**: Htn=3.35m (ground level); Htk=8.08m (finished grade); High clearance H=3.27m (comparing with the finished grade).
- Km60+560: Htn=20.61m (ground level); Htk=22.98m (finished grade); High clearance H=12.63m (comparing with the finished grade).
- **Km65+959.97**: Htn=5.19m (ground level); Htk=11.22m (finished grade); High clearance H=7.81m (comparing with the finished grade).

The safe distance against electric discharge according to the voltage class stipulated in the Law of Electric Power, Provision 51, Items 5, 6 and 7 is the minimum distance from the line, which is maximum in sagging status, to the highest point (4.5m) of the vehicles and, accordingly, is 5.5m corresponding to the voltage class of 500KV. Therefore, the minimum requirement of the high clearance for highway is 10m from the finished grade. That mean, the electric poles at km4+431.65 and km65+959.97 shall be heightened.

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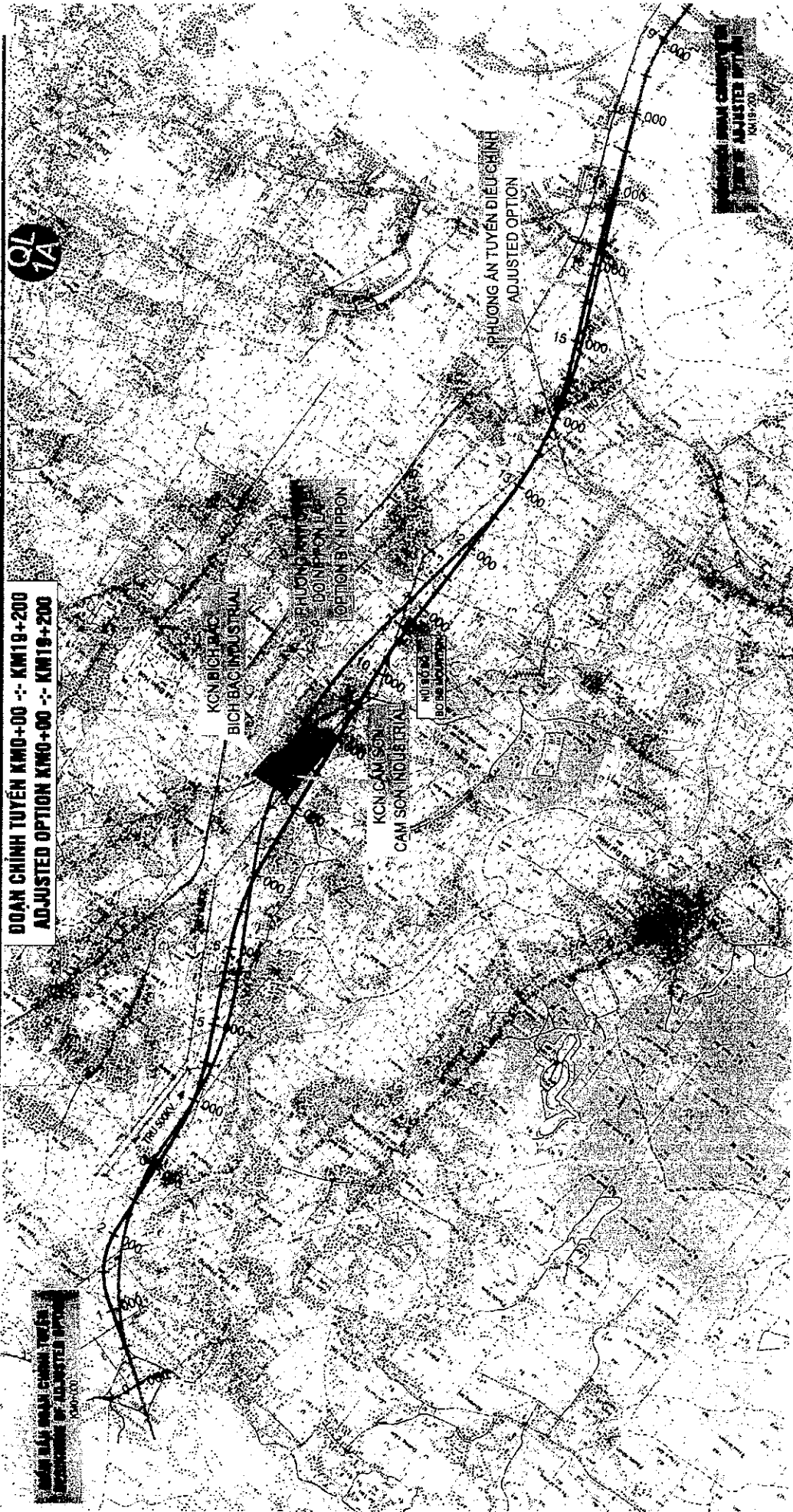


Figure 5.2.7 – Plan of the adjusted section Km 0+000 – Km 16+000

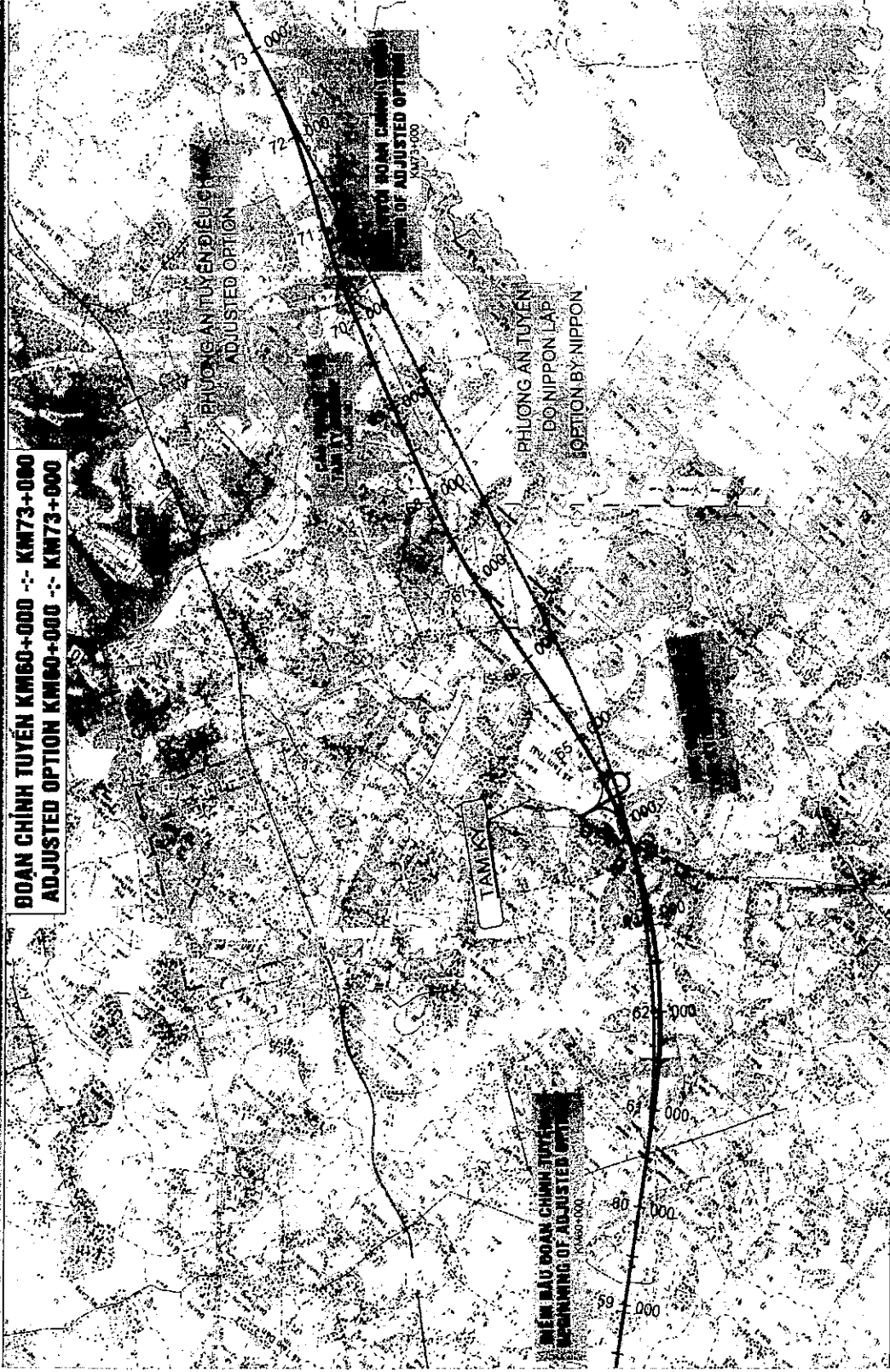


Figure 5.2.8 – Plan of the adjust section Km 60+000 – Km 73+000

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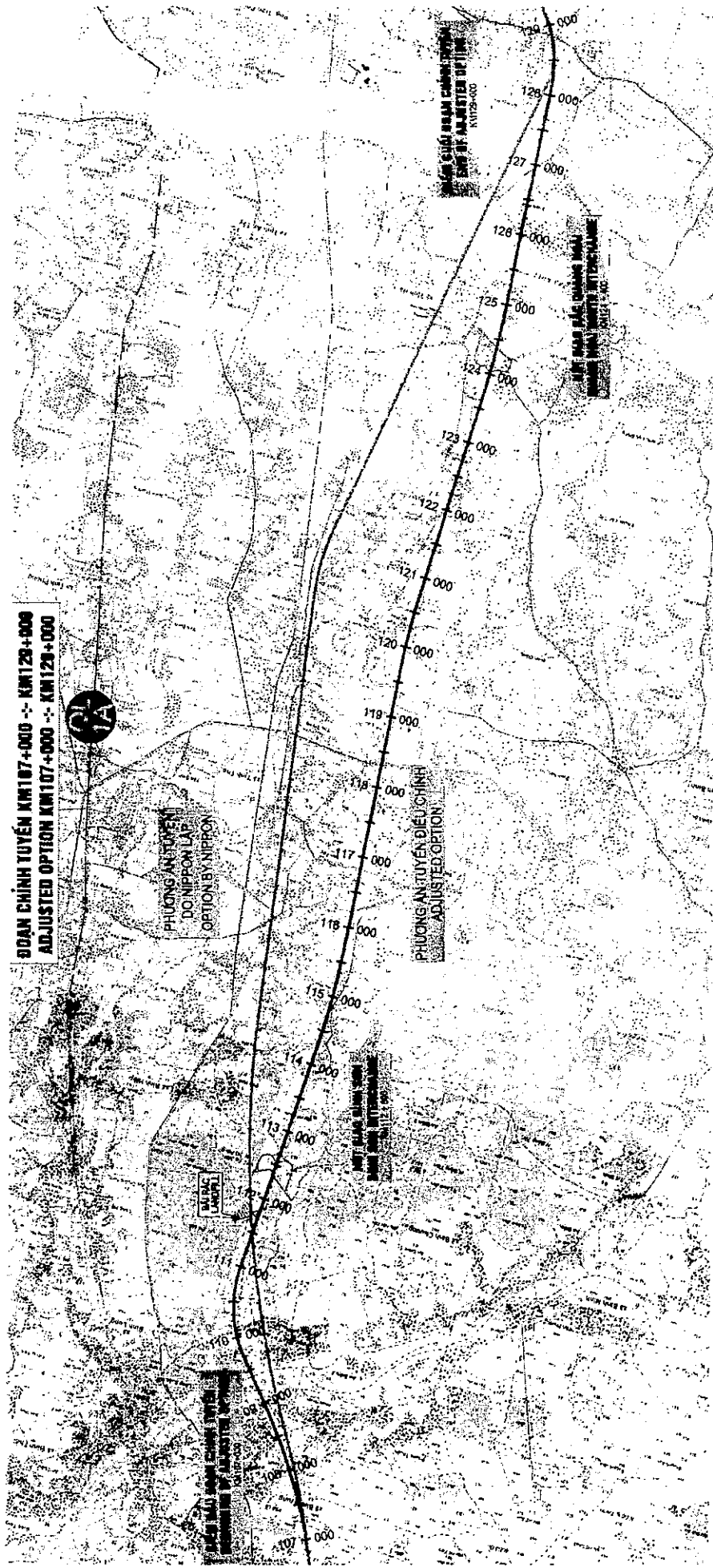


Figure 5.2.9 – Plan of the adjusted section Km 107+000 – Km 129+000

(3) Designing the plan of the alignment

Design results of geometric aspects as follows:

i) The expressway

The entire route is arranged with 26 horizontal curves (average 5km/curve). In which the minimum radius is 1000m, the maximum one is 15,000m. The detailed result for designing the alignment plan is shown in the following table:

Table 5.2.4 – Result of designing the horizontal alignment

Section Km0 – Km35

No.	Peak	Co-ordinate X	Co-ordinate Y	Station	R(m)	Turning	Lct(m)	K(m)	T(m)	p(m)	Turning direction
1. Km0-Km19+200											
1	D1	1769097.460	516947.090	Km1+593	1000	2333'56"	130	1056.17	564.64	118.51	right
2	D2	1766651.100	517147.910	Km4+4.82	3000	159d19'17"	340	1422.73	717.59	51.15	left
3	D3	1764293.510	518265.950	Km6+602.85	3000	199d11'2"	340	1344.47	677.23	44.16	right
4	D4	1760641.420	518661.910	Km10+270.79	5000	187d20'5"	560	1200.08	600.61	12.88	right
5	D5	1757215.710	518593.320	Km13+681.42	4000	154d37'46"	450	2221.20	1125.81	102.24	left
6	D6	1754935.630	519619.160	Km16+166.42	15000	181d49'22"	250	727.20	363.62	2.07	right
7	D7	1752515.610	520616.624	Km18+778.10	2000	203d24'23"	223	817.05	414.30	42.46	right
2. Km19+200-Km35											
8	D6	1750000.493	520571.972	Km21+161.90	1000	116d06'00"	112	1115.09	623.56	178.51	left
9	D7	1746213.437	527963.740	Km29+389.00	5000	157d47'00"		1939.20	981.93	95.49	right

Section Km35 – Km73

No.	Peak	Co-ordinate Y	Co-ordinate X	station	R(m)	Turning angle	Lct (m)	K(m)	T(m)	p (m)	Turning direction
1	D1	539239.076	1733038.283	46+742.35	10000	12°30'0"		2183.08	1095.89	59.83	Left
2	D9	547295.970	1718925.410	63+017.52	5000	133° 11'16"	550	4,635.14	2,440.39	451.08	Left
	ND9	545864.410	1720724.020	60+699.96							
	TD9	546132.640	1720243.950	61+249.96							
	TC9	548843.830	1718091.140	64+785.09							
	NC9	549372.200	1717938.670	65+335.09							
3	D10	551399.480	1717366.360	67+442.25	5000	168° 47'24"	550	1528.26	765.91	26.55	right
	ND10	550669.190	1717590.040	66+678.12							
	TD10	551197.560	1717437.570	67+228.12							
	TC10	551598.180	1717286.580	67+656.38							
	NC10	552095.750	1717052.420	68+206.38							
4	D11	553929.700	1716125.310	70+261.64	7300	172° 18'33"	810	1789.88	895.89	20.23	right
	ND11	553136.380	1716539.130	69+366.69							
	TD11	553855.960	1716167.490	70+176.69							
	TC11	554002.940	1716082.280	70+346.59							
	NC11	554683.040	1715642.530	71+156.59							
5	D12	555463.660	1715150.920	72+079.58	4900	168° 16'34"	540	1542.64	773.3	28.25	left
	ND12	554808.860	1715557.830	71+308.27							

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		TD12	555262.230	1715264.600	71+848.27							
		TC12	555670.240	1715046.880	72+310.90							
		NC12	556166.23	1714833.53	72+850.90							

Section Km73 – Km131+500

No.	peak		Co-ordinate Y	Co-ordinate X	station	R(m)	Turning angle	Lct (m)	K(m)	T(m)	p(m)	Turning direction
1	D1		556461.925	1714712.737	73+112.900		0d00'02"					
2	D2		559552.787	1713449.956	76+294.511	5000	50d45'48"		4429.94	2372.217	534.204	Right
		TD2	557356.775	1714347.14	74+079.552							
		TC2	560246.913	1711181.564	78+509.493							
3	D3		560708.999	1709671.476	80+039.122	5000	35d03'23"		3059.258	1579.205	243.462	Left
		TD3	560246.913	1711181.564	78+509.493							
		TC3	561954.627	1708700.754	81+568.751							
4	D4		570538.966	1702010.947	92+384.550	5000	38d43'39"		3379.614	1757.224	299.796	Left
		TD4	569152.923	1703091.096	90+694.743							
		TC4	572296.02	1702035.423	94+074.357							
5	D5		577935.401	1702113.982	99+086.487	4000	91 54'47"		6416.73	4135.83	1753.7	Right
		TD5	574909.273	1701915.514	96+700.336							
		TC5	577854.933	1697978.88	102+294.85							
6	D6		577789.681	1694625.817	105+441.035	4000	33d15'43"	450	1872.119	1420.412	176.834	Left
		ND6	577817.317	1696045.959	104+054.975							
		TD6	577816.998	1695596.023	104+504.975							
		TC6	578313.25	1693808.552	106+377.095							
		NC6	578545.474	1693423.176	106+827.095							
7	D7		580540.525	1690248.589	110+558.445	1600	36d23'56"	180	836.448	616.303	85.143	Right
		ND7	580212.593	1690770.404	109+960.221							
		TD7	580305.483	1690616.253	110+140.221							
		TC7	580504.808	1689813.68	110+976.669							
		NC7	580494.832	1689633.982	111+156.669							
8	D8		580210.796	1685813.412	114+986.507	10000	7d39'07"	1100	235.513	1219.033	27.389	Left
		ND8	580301.174	1687029.09	113+768.750							
		TD8	580239.752	1685930.954	114+868.750							
		TC8	580238.002	1685695.453	115+104.263							
		NC8	580283.095	1684596.525	116+204.263							
9	D9		580516.73	1680664.185	120+142.882	10000	6d09'43"	850	225.483	963.397	17.49	Right
		ND9	580459.592	1681625.887	119+180.141							
		TD9	580497.976	1680776.822	120+030.141							
		TC9	580499.232	1680551.347	120+255.624							
		NC9	580470.308	1679701.907	121+105.624							
10	D10		580314.593	1676474.111	124+336.530	10000	6d07'08"	850	217.957	959.622	17.288	Left
		ND10	580360.833	1677432.618	123+377.552							
		TD10	580331.909	1676583.179	124+227.552							
		TC10	580333.04	1676365.229	124+445.509							
		NC10	580370.786	1675516.136	125+295.509							

11	D11		580576.118	1672015.665	128+780.644	2000	35d44'10"	220	1027.424	755.065	102.417	Left
		ND11	580531.903	1672769.474	128+046.932							
		TD11	580548.807	1672550.114	128+266.932							
		TC11	580916.692	1671602.881	129+294.356							
		NC11	581052.248	1671429.643	129+514.356							
12	D12		582556.661	1669578.008	131+894.857	5000	16d44'39"	70	1391.204	770.853	53.898	Left
		ND12	582070.575	1670176.284	131+129.255							
		TD12	582114.842	1670122.059	131+199.255							
		TC12	583136.671	1669184.583	132+590.459							
		NC12	583194.5	1669145.14	132+660.459							

ii) Connection section from the end of the expressway to NH1A

Table 5.2.5 – Result of designing the horizontal alignment

No	peak		Co-ordinate X	Co-ordinate Y	Station	R(m)	Turning	Let(m)	K(m)	T(m)	p(m)	Turning direction
		ND7	582070.581	1670176.288	131+129.26							
		TD7	582114.848	1670122.063	131+199.26							
1	D7		582556.667	1669578.015	131+894.86	5000	16°44'39"	70	1531.20	770.85	53.90	left
		TC7	583136.676	1669184.592	132+590.46							
		NC7	583194.505	1669145.149	132+660.46							
		ND8	584603.631	1668188.85	134+363.44							
		TD8	584661.644	1668149.678	134+433.44							
2	D8		585235.018	1667760.362	135+121.40	5000	16°34'09"	70	1515.93	763.05	52.77	left
		TC8	585895.704	1667551.035	135+809.37							
		NC8	585962.380	1667529.721	135+879.37							
		ND9	587074.573	1667177.053	137+046.14							
		TD9	587141.380	1667156.154	137+116.14							
3	D9		587556.736	1667024.162	137+545.63	3000	17°50'18"	70	1004.01	505.83	36.79	left
		TC9	587992.555	1667026.296	137+980.15							
		NC9	588062.555	1667026.323	138+050.15							
		CDA	589534.420	1667032.611	139+522.02							

(4) Designing the profile

The profile is designed on the principles of well-combined between horizontal and vertical curves ensuring the design standards according to the currently effective regulations, ensuring the stability during the vehicle transportation and minimizing the filling and cutting quantity as well as facilities.

Control points during the profile design stage.

- According to the calculated water level: the designed water level is calculated with the flood frequency of $p=1\%$ applied in normal road-beds and bridges in the route.

- According to the height of the construction structure: the designed altitude should match the zero-statics for boat travel and the zero-statics of passing the horizontally access road.

- The longitudinal section of the route in the first stage shall be the foundation to design one in the planned stage.

Statistics of calculation results of designed water level along the route with the design frequency $P = 1\%$.

Table 5.2.6 – Statistics of calculation results of designed water level along the expressway

Section Km0 – Km35

No.	station	Water level (m)		Remarks
		P=1%	The max. of Observed water level/ years appeared	
1. section Km0 – Km19+200				
1	Km0+61.99	7.64	5.68/1999	
2	Km0+775.00	7.08		
3	Km1+158.8	6.98	5.52/1999	
4	Km1+610.22	6.57	5.55/1999	Tuy Loan bridge
5	Km2+510.13	6.68	5.45/2000	Song Yen bridge
6	Km3+0.00	6.77	5.33/1964	
7	Km4+117.98	6.97	5.45/1964	
8	Km5+0.00	7.13	6.16/1964	
9	Km5+623.00	7.24	6.25/1964	Yen Ne bridge
10	Km6+104.19	7.33	5.97/1964	
11	Km7+5.39	7.53		
12	Km8+104.65	7.69	6.55/1964	
13	Km8+844.33	7.85	6.38/1999	
14	Km9+870.00	8.03	7.68/1964	Bau Sau bridge
15	Km10+442.04	8.16		
16	Km10+882.00	8.28	7.68/1964	La Tho bridge
17	Km11+904.48	8.51	7.62/1964	Bau Duc bridge
18	Km12+639.09	8.69	7.61/1964	My Yen bridge
19	Km13+210.09	8.87		Bridge Km13+210.01
20	Km13+500.61	8.96	8.55/1964	
21	Km14+027.36	9.09	8.63/1964	Phong Thu bridge
22	Km14+501.09	9.23		
23	Km14+826.05	9.52		
24	Km14+873.45	9.52		Bau Thinh 1 bridge

No.	station	Water level (m)		Remarks
		P=1%	The max. of Observed water level / years appeared	
25	Km15+171.40	9.49	8.56/1964	Bau Thinh bridge
26	Km16+052.81	9.42		
27	Km16+497.27	9.39		Ky Long bridge
28	Km17+650.00	8.66		Ky Lam bridge
2.Section Km19+200 – Km35+00				
29	Km20+150.00	8.66		Chiem Son bridge
30	Km23+350.00	6.77		Bridge Km23+350.00
31	Km24+648.00	6.24		Bridge Km24+648.00
32	Km25+720.00	11.97		Bridge Km25+720.00
33	Km27+000.00	16.81		Bridge Km27+000.00
34	Km27+900.00	17.79		Bridge Km27+900.00
35	Km29+500.00	13.28		Bridge Km29+500.00
36	Km32+440.00	16.55		Bridge Km32+440.00
37	Km34+120.00	20.35		Bridge Km34+120.00

Section Km35 – Km73

No	Km - Km	Water level (m)		Remarks
		P=1%	The max. of observed water level/ years appeared	
1	Km37+300 – Km38+450	15.70	15.14	Cầu Km38+300
2	Km38+900 – Km39+950	16.40	15.94	Cầu Km39+550
3	Km43+400 – Km44+500	13.60	13.60	Cầu Km44+350
4	Km44+500 – Km46+800	13.50	13.29	Cầu Km45+775
5	Km46+850 – Km48+350	13.10	12.95	Cầu Km47+850
6	Km54+783	8.20	7.73	Cầu Km54+783
7	Km55+100 – Km56+135	8.00	7.97	Cầu Km55+510
8	Km57+750 – Km58+650	9.50	9.44	Cầu Km58+120
9	Km62+040 – Km63+080	11.27	10.89	Cầu Km62+337
10	Km66+200 – Km67+700	8.63	8.57	Cầu Km66+350
11	Km68+200 – Km68+900	6.70	6.67	Cầu Km68+308

Section Km73 – Km131+500

No.	Km + Km	Height of water level (m)		Remarks
		P=1%	The max. of observed water level	
1	Km74+300	8.00	7.49	Ba Tuc river Overpass
2	Km79+200		Not flooded	
3	Km80+000	10.40	9.90	sewer
4	Km81+600	10.65	10.15	bridge
5	Km82+545	6.95	6.20	Trau river Overpass
6	Km84+160	13.32	12.82	bridge
7	Km85+460	13.20		
8	Km86+915	5.29	4.29	
9	Km87+892	5.61	5.11	bridge
10	Km88+200	5.60	5.04	Mu Cua river Overpass
11	Km90+670	4.12	3.62	bridge
12	Km92+658	4.00	3.50	bridge
13	Km92+750	4.00	3.50	bridge
14	Km94+330	16.51	16.01	bridge
15	Km95+720	7.28	6.78	bridge
16	Km97+813	10.17	9.67	bridge
17	Km99+400	8.15	7.65	sewer
18	Km100+600	6.50	6.00	sewer
19	Km101+700	4.21	3.51	
20	Km102+400	4.05	3.35	
21	Km102+900	Section from Km103+350 - Km104+850, the route passes through the mountainous areas and not submerged		
22	Km103+300			
23	Km105+500	4.59	3.89	
24	Km106+400	5.15	4.45	
25	Km107+000	5.2	4.50	
26	Km109+169	7.32	6.85	Tra Bong bridge
27	Km110+147	8.16	7.66	
28	Km116+269	10.66	10.16	bridge
29	Km117+030	10.01	9.51	bridge

30	Km118+317			bridge
31	Km124+470	11.49	10.99	bridge
32	Km125+279	11.79	11.29	Tra Khuc bridge
33	Km127+340	11.99	11.49	Viaduct area
34	Km128+00	12.17	11.67	
35	Km129+980	9.02	8.72	
36	Km131+010	9.02	8.72	

Connection section to NH1A

Table 5.2.7 – Statistics of calculation results of designed water level along the connection road to NH1A

No	Station	Height of water level (m)		Remarks
		P=4%	The max. of observed water level/ years appeared	
1	Km132+000.00	8.34	8.30 / 2009	
2	Km132+934.27	8.02	7.98 / 2009	
3	Km134+160.5	7.56	7.50 / 2009	
4	Km134+726.12	7.35	7.29 / 2009	
5	Km135+859.27	6.46	6.35 / 2009	
6	Km137+150.30	6.27	6.22 / 2009	
7	Km137+825.13	5.92	5.83 / 2009	
8	Km138+599.32	5.46	5.36 / 2009	

Based on the control points mentioned above, designing the profile, and the design results are shown in the following table:

Table 5.2.8 – Result of profile design along the expressway route

No.	Gradient (%)	Length of ramp (m)				Ratio
		Km0-Km35	Km35-Km73	Km73-Km131+500	Total	
1	0 - 1	27,566.30	34,077.44	46,935.63	108,579.37	82.58%
2	>1 - 2	5,793.48	3,658.90	6,868.29	16,320.67	12.41%
3	>2 - 3	800.00	0.00	2,605.44	3,405.44	2.59%

4	>3 - 4	900.00	320.98	1,963.97	3,184.95	2.42%
5	>4			0.00	0.00	0.00%
	Total	35,059.78	38,057.32	58,373.33	131,490.43	100.00%

Table 5.2.9 – Result of profile design along the part linking with NH 1A

No.	Gradient (%)	Length of slope (m)	Ratio (%)
		6772.73	84.43
2	>1 - 2	1249.17	15.57
3	>2 - 3	0.00	0.00
4	>3 - 4	0.00	0.00
5	>4	0.00	0.00

(5) Designing road-bed

i) Principles of designing road-bed

- Road-bed must always remain the stability of the whole block, road-bed form should satisfy the requirements of vehicle movement during the exploitation.

- Road-bed should achieve the strength facing the load stress of vehicle movement through the pavement structure.

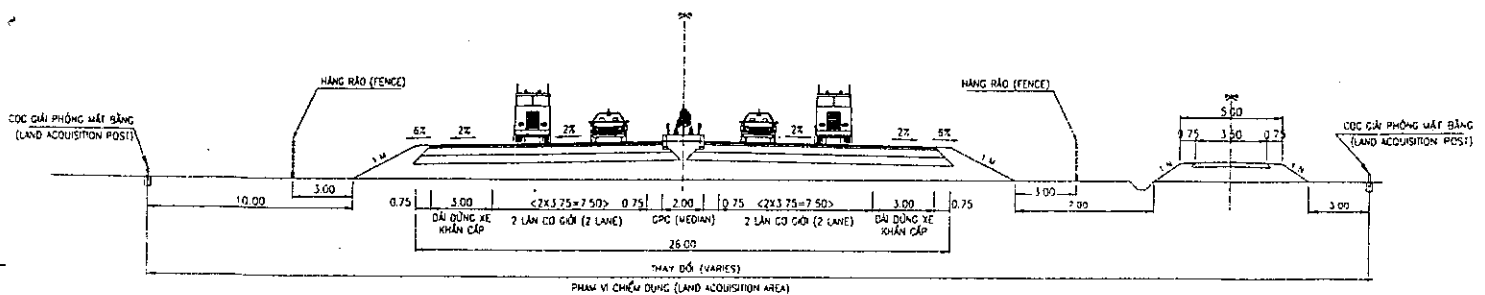
ii) Filling Embankment

• Filling slope:

- $H \leq 6,0m$: slope 1/2;

- $H > 6,0m$: the embankment is benched (the maximum of each bench is 0.6m slope 1/2), between the bench, there is a supporting ditch with the width of 2.0m)

Figure 5.2.10 – The typical cross-section of filling embankment



iii) Earth cut

Based on the geological features of each section and the stability of the previous earth-cut slope to design gradient of the new slope when expanding the earth-cut.

- **Digging through the earth (the coat):**

- $H \leq 6,0\text{m}$: slope 1/1,0

- $H > 6,0\text{m}$: each 6,0m sets a slope bench 1/1,0; between the benches there is a supporting ditch with the width of 2.0m.

- **Digging through stone:**

- $H \leq 8,0\text{m}$: slope 1/0,75 (stone class 4).

- $H > 8,0\text{m}$: every 6.0m set a slope bench 1/0,75 (stone class 4); between the benches there is a supporting ditch with the width of 2.0m.

In case the earth-cut is deep, excavation fully for 6 lanes to reduce construction cost and ensure safe operation in the later period.

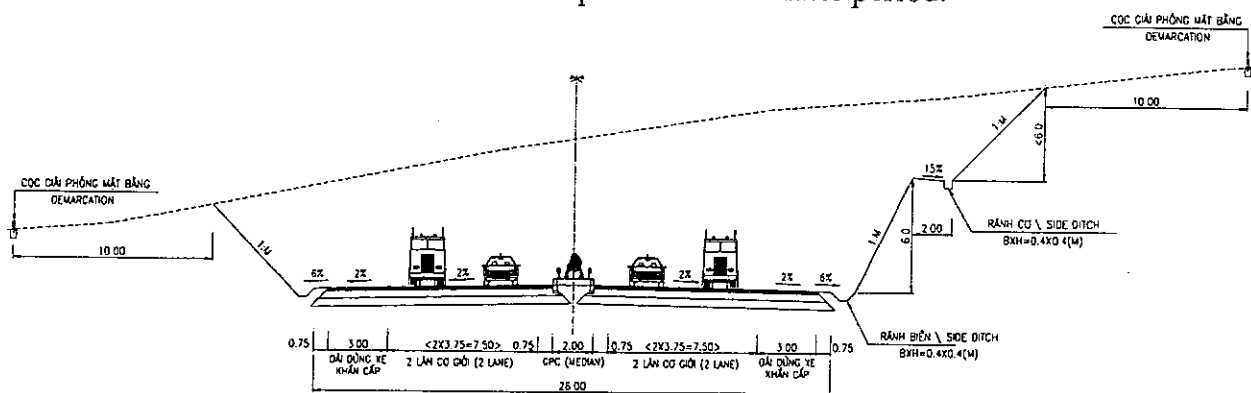


Figure 5.2.11 – The typical cross-section of earth cut

iv) Solutions for filling and cutting road-bed

With the filling embankment, from the large bottom of stone combination for macadam grade II down to at least 30cm it is necessary to ram with $K \geq 0.98$. With the earth cut not meeting the requirements on the press, the bottom of pavement should be raked and re-compacted to ensure that the top 30cm surface density has $K \geq 0.98$.

Filling slope is sodden to protect, which is beautiful, easy to care and maintain.

The new filling embankment or the added one should remove the organic soil layer with at least 50cm.

v) *Solutions for soft soil*

- **Common features**

In general, soft soil belonging to the area of the project is not complex: only scattered in initial 20km of the route, collected in the bridgeheads such as Tuy Loan Bridge, Song Yen Bridge, Bau Sau Bridge and La Tho; the depth of allocation is not high and in the range of 7m to 28m. However, hydrological characteristics are complex: the soft soil allocates at the beginning of the route mostly in the valleys of big rivers, often flooded and deeply submerged, hence filled at height (mostly from 7m to 9m) and often flooded and the filling materials is not good: the cutting resistance decreases sharply in saturated conditions and affects solutions for soft soil in this section.

- **General solutions and processing principles**

- ✓ Vertical drainage solution

In order to stabilize the sinking grade: redundant depression and unity as required, vertical drainage solutions such as absorbed wick, sand drain can be applied.

However, due to the soft soil is not identical, the sand lens and/or good soil intermixed in the land, the hard cover mostly allocates in soft soil section, hence it is difficult to insert absorbed wick and in some cases, the stage cannot be implemented.

Moreover, due to the height, and soft soil collection in the bridgehead with the requirement of small redundant settlement ($S_r < 10\text{cm}$), it demands a short time for processing (because abutments are built after the soft soil process), so the application of absorbed wick is not guaranteed.

Therefore, sand drain is considered the most feasible solution and suggested carrying out in this case.

- ✓ Solutions for enhancing the stability

There are many applicable solutions to strengthen the stability of the filling embankment such as cement- land stakes, pressed sand stakes, high intensity geotextile, counterweight berm, etc. However, the two first solutions require foreign technologies including machines. Although both of them in the first step are applied in Vietnam, there are no official processes or procedures on designing, executing and checking. Therefore, with the process quantity of soft soil as in the project, domestically popular solutions and successful ones in many projects have focused on using geotextile with high intensity or counterweight berm which is preferentially considered.

The main advantage of using woven geotextile is not to extend the used area. Nevertheless, in often submerged, the cutting resistant of filling material for the section decreases sharply which causes the disadvantages in technical aspect toward this solution. Moreover, due to flooded often, the quality of the geotextile is reduced which can cause some risks for this solution itself.

On the other hand, the major disadvantage of counterweight berm is to increase the area as well as filling material quantity. However, due to the collection of soft soil in the bridgehead with a small allocation scale, and a plenty of filling materials, counterweight berm is easy to apply.

In summary, together with raising the shearing resistance of soft soil by the vertical drainage solution, for the purpose of stabilizing the filling embankment, counterweight berm is suggested in this case.

✓ General principles in soft soil treatment filling embankment

Based on the analysis set above and allocation feature of soft soil in the route, the principles in soft soil treatment filling embankment in this project as follows:

- Only use sand drains to speed the unity of soft soil. Sand drains are applied for sections with the allocation depth of 5m or more.

- With the section with soft soil less than 5m, digging and replacing soil by sand is considered.

- Counterweight berm is combined to enhance the stability of the filling embankment if necessary. In order to reduce the width of counterweight berm, soft soil is considered to process and to raise the processing effect, the height of counterweight berm is increased (it can create counterweight berm at different level)

Moreover, the hydrological conditions and climate features at the initial route, viaduct spreading to the end of allocation scale can be considered.

• **Recommended option of soft soil treatment in the expressway**

The typical section and processing solutions are suggested as follows:

- Section of approach embankment next to abutment A1 of Song Yen bridge: 2-step counterweight berm, the width of : 10~15m, the 1st layer: height: 3,5m, the 2nd layer: height: 3m; sand drain forms the square network, distance: 1.7~2.0m, depth 14m (up to the end of soft soil) and covering all the scale of cap concrete layer 1 Figure 5.2.12).

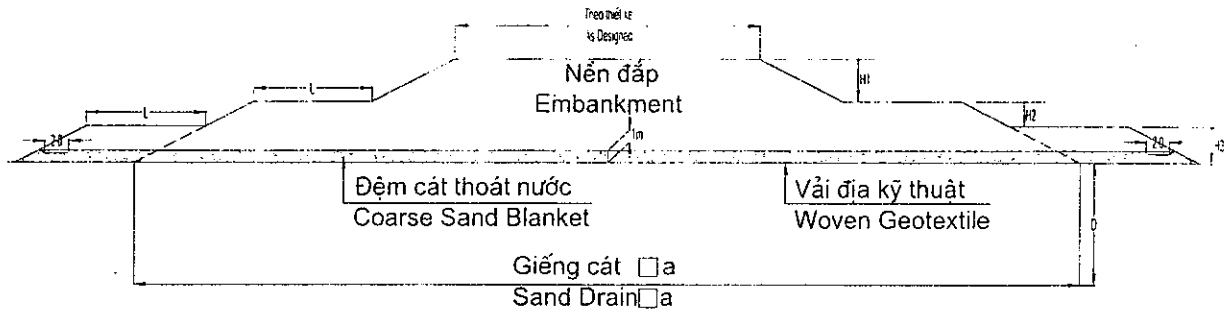


Figure 5.2.12 – 2-step Counterweight berm and processing sand drain out of the scale of counterweight berm step 1

- Section of approach embankment next to abutment A2 of Song Yen bridge: the counterweight berm with the width of 12m, the height of 4m; sand drain forms the square network, distance of 1.6-2.0m, depth of 7m (up to the depth of soft soil) and out of the scale of counterweight berm (Figure.5.2.13).

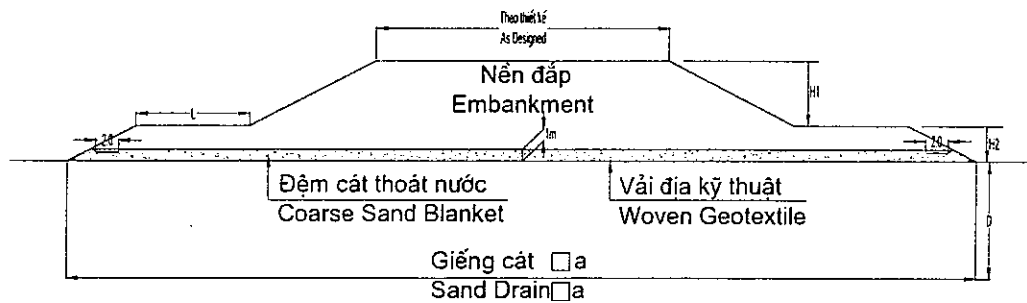


Figure 5.2.13 – Treatment with sand drain out of the scale of counterweight berm

- Section km4+100 ~ km4+600 and km9+950 ~ km10+100: the counterweight berm with the width of 10~15m the height of 2.5~3.0m; sand drain forms the square network, distance of 2.0m, depth of 13.0m ~ 25.0m (up to the depth of soft soil), and out of the scale of counterweight berm (Figure 5.2.14).

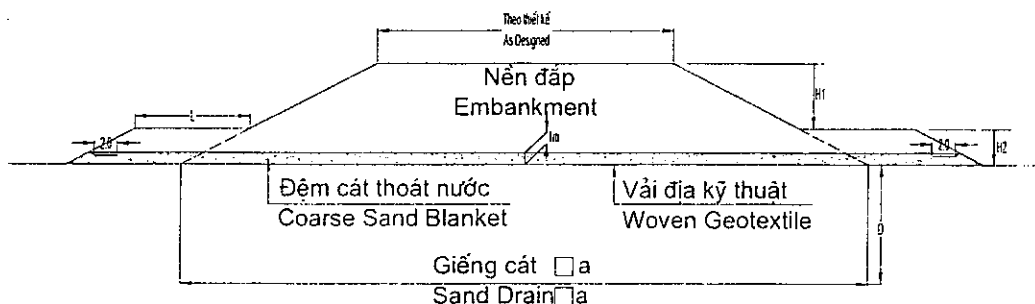


Figure 5.2.14 - Treatment with sand drain in the scale of the main road

- Section km10+750 ~ km11+350: sand drain forms the square network, distance of 2.0m, depth of 25 ÷ 28m (to the full depth of soft soil) (Figure 5.2.15).

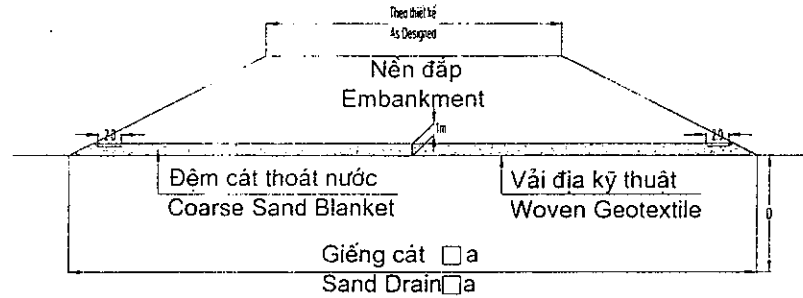


Figure 5.2.15 – Treatment with sand drain

- Section 4+600 ~ km6+00 and km13+00 ~ km13+300: dig and replace soil 3~4m, especially the section Km 4+600 ~ km6+00 dig and replace the soft soil (figure 5.2.16).

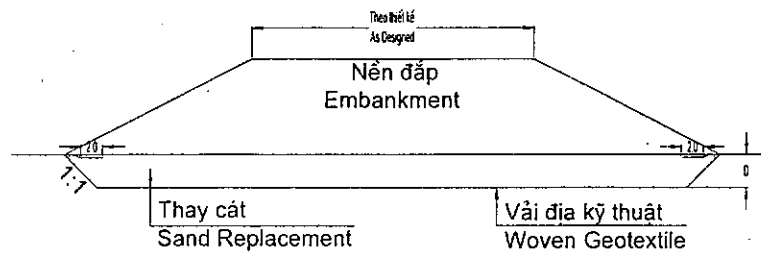


Figure 5.2.16- Soil Replacement

Table 5.2.10 – Detailed technical specifications of measures

Section (km)	a (m)	D ^(a) (m)	L (m)	H1 (m)	H2 ^(b) (m)	H3 ^(c) (m)	Depth replaced soil (m)	Length (m)
Main road:								
2+000 – 2+427 ^(d)	1.7	14.0	15.0	3.5	2.0	3.0		427
2+592 ^(e) – 2+800	2.0	7.0	10.0	4.5	4.0			208
4+100 – 4+600	1.6	25.0						500
4+600 – 6+00		25.0					4.0 ^(f)	1400
9+950 – 10+100	2.0	13.0	12.0	4.0	3.0			150
10+750 – 11+350	2.0	28.0						600
13+00 – 13+300							4.0 ^(f)	300
Total								3585

Notes:

(a): Dig the entire soft soil

(b): $H_2 = \text{Design height} - H_1$ (applied for filling embankment with one layer cap concrete)

(c): $H_3 = \text{Design height} - H_1 - H_2$ (applied for filling embankment with two layer cap concrete)

(d): abutment A1 of SongYen bridge

(e): abutment A2 of SongYen bridge

(f): Replace all soft soil

Thus, the total length requiring soft soil treatment on the whole Expressway is 3,585. In which, sand drain method combined with counterweight berm is applied for 03 sections with total length of 785m, the method of merely sand well is applied for 02 sections with total length of 1,100m, the method of unsuitable soil excavation and replacement is applied for 02 sections of total length of 1,700m.

vi) Slope treatment

- Embankment slope: In the position 10m behind the abutment, the slope is treated with cement mortared stone 25 cm thick or small sized concrete slab. For other ordinary filling positions, the slope is sodden or paved with concrete tile with holes for sodding to prevent erosion.

- Earth cut slope: Using the concrete frame system together with mortared stone, sodding to protect the slope, on the supporting ditches there are water collecting gutters in concrete C15 15cm thick.

(6) Designing pavement

i) Principles in designing and selecting pavement structure

- The surface layer should have the durability enough during the exploitation. It should be plain, roughness, anti-deformation, anti-broken, and anti-peeling off.

- Using combined solutions to enhance the intensity of bottomland, making favorable conditions for the bottom can bear force as the pavement at the maximum level;

- Utilizing all available materials at site.

- Matching the factual construction capacity, speeding up the construction in line to reduce the construction price.

Based on the estimated traffic data, the hydrological situation, the local material, the consultant suggests using the soft pavement structure for the project. The calculation standard for design is 22 TCN 211 – 06.

ii) Solutions for pavement structure

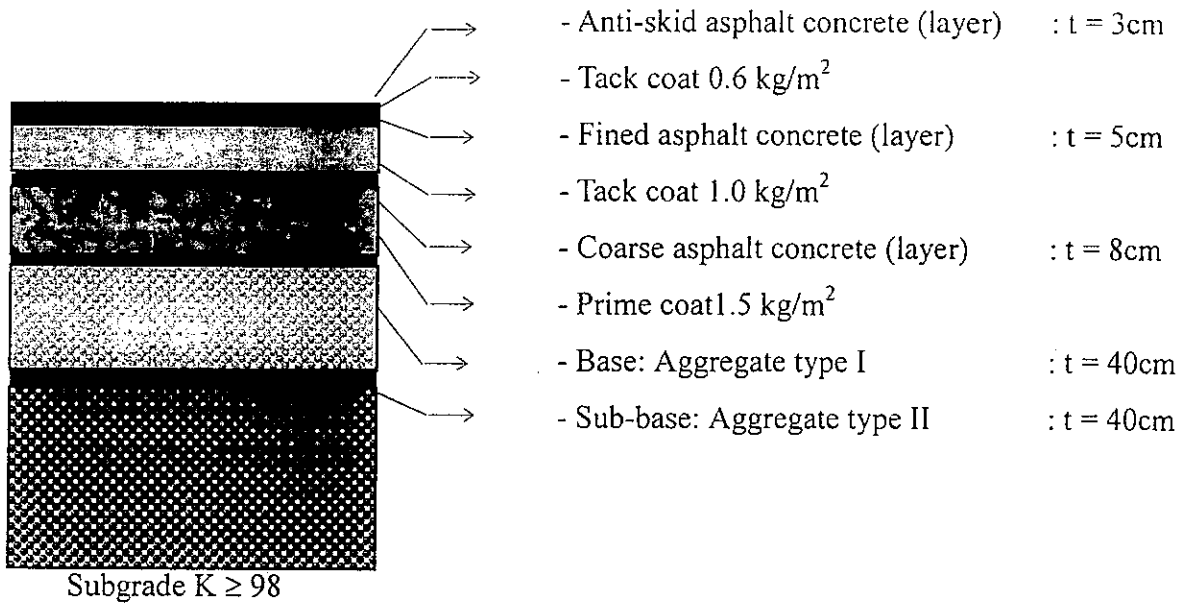
- Carriage pavement: High class pavement A1, the surface layer is made of asphalt concrete, according to the traffic, the minimum elasticity modulus $E_{yc} \geq 210$

Mpa, the load of the designed spindle of 12 ton.

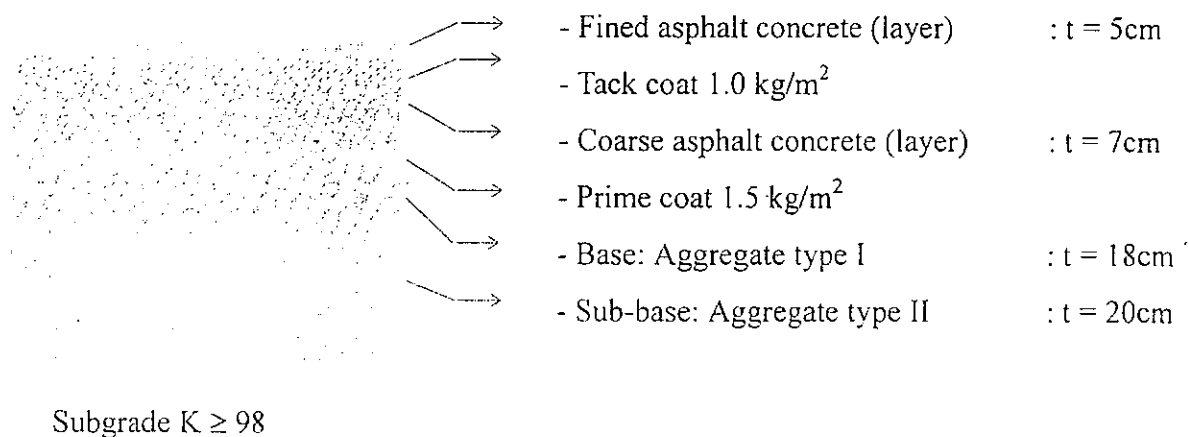
- Connection road from the end of the expressway to NH1A: the class III plain road, using the high class pavement A1, the minimum elasticity modulus $E_{yc} \geq 140$ MPa, the load of the designed spindle of 10T.

- Emergency lane: using the structure as used in the main road to make favorable to expand the finalization stage.

Basing on the elasticity modulus required and the local materials, the consultant suggests the solution for pavement structure as follows:

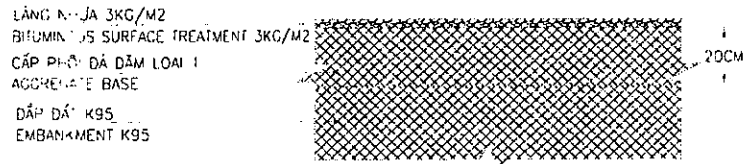


Pavement structure of the connection road from the end of the expressway to NH1A

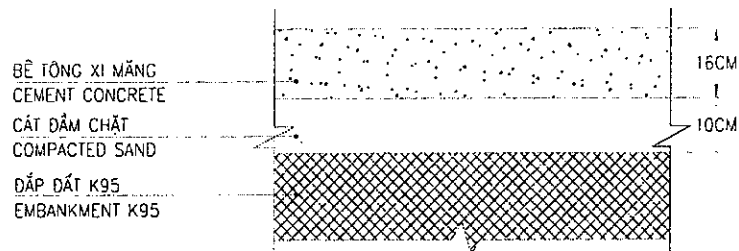


Pavement structure for collector road

KẾT CẤU MẶT ĐƯỜNG GOM LOẠI 1
PAVEMENT OF COLLECTOR ROAD TYPE 1



KẾT CẤU MẶT ĐƯỜNG GOM LOẠI 2
PAVEMENT OF COLLECTOR ROAD TYPE 2



(7) Designing drainage

i) Principles in designing, selecting aperture of culverts, type of culverts

- The aperture ensures the drainage as required in hydrography and irrigation, at the same time, it ensures to comply with the process and procedures.
- The length of designed culverts meets the cross-section.
- The height of culverts meets the profile of the whole route to ensure the filling height, and make favorable for maintenance in the exploitation.
- Meeting other plans along the route.
- Considering the aesthetic requirements toward certain works.
- To simplify the execution of the work, make the quality management easier, and to reduce the execution time.

ii) *Traverse culvert*

Based on the topography, profile, hydrography and principles in selecting the aperture of culverts, the consultant designs 211 culverts for the expressway and 43 ones for the connection road from the end point of the expressway to NH1A. The following table shows culverts in details:

Table 5.2.11 – Statistics of drainage works on the main route

Section Km0 – Km35

No	station	aperture	No	station	aperture
I Drainage culverts for the valley					
1	Km0+095.96 ✓	2D1.5m	13	Km27+200.00 ✓	2□(3.0x3.2)m
2	Km0+431.00 ✓	1D1.5m	14	Km27+550.00 ✓	1D1.5m
3	Km0+775.00 ✓	1D1.5m	15	Km27+950.00 ✓	2D1.5m
4	Km0+900.00 ✓	1D1.5m	16	Km28+200.00 ✓	2D1.5m
5	Km2+099.82 ✓	1□(5.0x3.5)m	17	Km28+850.00 ✓	1D1.5m
6	Km6+718.88 ✓	2D1.5m	18	Km29+000.00 ✓	1D1.5m
7	Km7+775.44 ✓	2D1.5m	19	Km29+650.00 ✓	1D1.5m
8	Km8+632.13 ✓	2D1.5m	20	Km32+750.00 ✓	1D1.5m
9	Km19+059.82 ✓	2□(5.0x3.2)m	21	Km33+100.00 ✓	2D1.5m
10	Km24+200.00 ✓	1D1.5m	22	Km33+400.00 ✓	1D1.5m
11	Km26+100.00 ✓	2□(3.0x3.2)m	23	Km33+850.00 ✓	1D1.5m
12	Km26+480.00 ✓	2□(3.0x3.2)m	24	Km34+500.00 ✓	1D1.5m
II Drainage culverts for irrigation					
25	Km01+158.80 ✓	1□(2.0x2.0)m	39	Km12+011.94 ✓	1D1.5m
26	Km03+210.64 ✓	1D1.5m	40	Km12+253.89 ✓	1D1.5m
27	Km03+512.05 ✓	1D1.5m	41	Km12+426.61 ✓	1D1.5m
28	Km04+926.42 ✓	1D1.5m	42	Km12+752.96 ✓	1D1.5m
29	Km05+519.67 ✓	1D1.5m	43	Km13+028.24 ✓	1□(2.0x2.0)m
30	Km05+681.41 ✓	1D1.5m	44	Km13+162.13 ✓	1D1.5m
31	Km05+761.18 ✓	1D1.5m	45	Km13+460.21 ✓	1D1.5m
32	Km08+219.68 ✓	1D1.5m	46	Km14+269.00 ✓	1□(2.0x2.0)m
33	Km08+737.94 ✓	1D1.5m	47	Km14+699.96 ✓	1□(2.0x2.0)m
34	Km09+391.28 ✓	1□(2.0x2.0)m	48	Km14+946.30 ✓	1D1.5m
35	Km09+773.69 ✓	1D1.5m	49	Km15+409.19 ✓	1D1.5m
36	Km10+762.94 ✓	1D1.5m	50	Km15+592.67 ✓	1D1.5m
37	Km11+088.18 ✓	1□(2.0x2.0)m	51	Km15+848.08 ✓	1D1.5m

No	station	aperture	No	station	aperture
38	Km1(+27).58	1D1.5m			

Section Km35 – Km73

No	station	aperture	No	station	aperture
1	Km35+050 ✓	1D1.5m	32	Km62+900 ✓	1D1.5m
2	Km35+480 ✓	1D1.5m	33	Km53+400 ✓	1D1.5m
3	Km35+860 ✓	2□(3x3)m	34	Km53+800 ✓	1D1.5m
4	Km36+600 ✓	1D1.5m	35	Km54+300 ✓	2D1.5m
5	Km37+600 ✓	1D1.5m	36	Km55+200 ✓	1D1.5m
6	Km37+900 ✓	1D1.5m	37	Km55+800 ✓	1D1.5m
7	Km39+950 ✓	1D1.5m	38	Km56+900 ✓	1D1.5m
8	Km40+550 ✓	1D1.5m	39	Km56+500 ✓	1D1.5m
9	Km40+800 ✓	1D1.5m	40	Km57+300 ✓	1D1.5m
10	Km41+750 ✓	1D1.5m	41	Km58+500 ✓	1D1.5m
11	Km42+700 ✓	1D1.5m	42	Km59+100 ✓	1D1.5m
12	Km42+880 ✓	1D1.5m	43	Km59+500 ✓	1D1.5m
13	Km43+680 ✓	1D1.5m	44	Km59+800 ✓	1D1.5m
14	Km43+900 ✓	1D1.5m	45	Km62+216 ✓	1D1.5m
15	Km44+700 ✓	2□(3x3)m	46	Km62+400 ✓	1D1.5m
16	Km46+300 ✓	1D1.5m	47	Km62+720 ✓	1□(3x3)m
17	Km46+550 ✓	1D1.5m	48	Km62+982.34 ✓	1□(2x2)m
18	Km46+900 ✓	1D1.5m	49	Km65+486.61 ✓	2D1.5m
19	Km47+130 ✓	1D1.5m	50	Km67+188.42 ✓	1D1.5m
20	Km48+100 ✓	1D1.5m	51	Km68+640 ✓	1D1.5m
21	Km48+420 ✓	1D1.5m	52	Km69+236.7 ✓	1D1.5m
22	Km48+900 ✓	1D1.5m	53	Km70+245	2□(3x3)m
23	Km49+400 ✓	1D1.5m	54	Km71+236 ✓	1D1.5m
24	Km49+640 ✓	1D1.5m	55	Km72+937.76 ✓	1D1.5m
25	Km50+160 ✓	1D1.5m	56	Km72+315.90 ✓	1D1.5m
26	Km50+340 ✓	2D1.5m	57	Km72+528.37 ✓	1D1.5m

27	Km50+600 ✓	1D1.5m		58	Km72+707.45 ✓	1D1.5m
28	Km51+000 ✓	1D1.5m		59	Km72+831.48 ✓	1D1.5m
29	Km51+500 ✓	1D1.5m		60	Km72+954.95 ✓	1D1.5m
30	Km51+850 ✓	1D1.5m				
31	Km52+490 ✓	2D1.5m				

Section Km73 – Km131+500

No	Station	Aperture	No	Station	Aperture
1	Km73+200 ✓	1□(3.0x3.0)m	51	Km103+400 ✓	1D1.5m
2	Km73+800 ✓	1□(3.0x3.0)m	52	Km104+700 ✓	1D1.5m
3	Km74+080 ✓	1□(3.0x3.0)m	53	Km105+000 ✓	1D1.5m
4	Km74+500 ✓	1□(3.0x3.0)m	54	Km105+900 ✓	1D1.5m
5	Km75+750 ✓	1D1.5m	55	Km106+300 ✓	1D1.5m
6	Km76+000 ✓	1D1.5m	56	Km107+100 ✓	1D1.5m 0
7	Km76+400 ✓	1D1.5m	57	Km108+000 ✓	1D1.5m
8	Km77+000 ✓	1D1.5m	58	Km109+663 ✓	2□(3.0x3.0)m
9	Km77+400 ✓	1D1.5m	59	Km110+200 ✓	1□(2.0x2.0)m
10	Km78+200 ✓	1D1.5m	60	Km110+400 ✓	1□(2.0x2.0)m
11	Km78+800 ✓	1D1.5m	61	Km110+567 ✓	1□(2.0x2.0)m
12	Km79+800 ✓	2D1.5m	62	Km112+310 ✓	1D1.5m
13	Km80+600 ✓	1□(2.0x2.0)m	63	Km113+447 ✓	1D1.5m
14	Km81+100 ✓	1□(2.0x2.0)m	64	Km114+180 ✓	1D1.5m
15	Km82+341 ✓	2□(3.0x3.0)m	65	Km114+975 ✓	1D1.5m
16	Km82+679 ✓	2□(3.0x3.0)m	66	Km116+44 ✓	1D1.5m
17	Km83+400 ✓	2□(3.0x3.0)m	67	Km116+892 ✓	1D1.5m
18	Km84+400 ✓	1□(2.0x2.0)m	68	Km117+356 ✓	1D1.5m
19	Km84+800 ✓	1□(2.0x2.0)m	69	Km118+547 ✓	1D1.5m
20	Km85+941 ✓	1D1.5m	70	Km118+958 ✓	1D1.5m
21	Km86+300 ✓	2D1.5m	71	Km119+23 ✓	1D1.5m
22	Km86+800 ✓	2D1.5m	72	Km119+481 ✓	1□(3.0x3.0)m
23	Km87+000 ✓	1D1.5m	73	Km119+687 ✓	1D1.5m
24	Km87+500 ✓	1D1.5m	74	Km120+687 ✓	1D1.5m
25	Km88+500 ✓	1D1.5m	75	Km120+985 ✓	1D1.5m
26	Km89+000 ✓	1D1.5m	76	Km121+144 ✓	1D1.5m

27	Km89+674	1D1.5m	77	Km121+287	1D1.5m
28	Km90+400	1(2.0x2.0)m	78	Km121+555	1D1.5m
29	Km91+162	1D1.5m	79	Km121+946	1D1.5m
30	Km91+500	1D1.5m	80	Km122+029	1D1.5m
31	Km92+334	1D1.5m	81	Km122+580	1D1.5m
32	Km93+100	1D1.5m	82	Km123+096	1(3.0x3.0)m
33	Km93+399	2(2.0x2.0)m	83	Km123+131	1D1.5m
34	Km93+629	2(2.0x2.0)m	84	Km123+281	1(2.0x2.0)m
35	Km94+500	1(2.0x2.0)m	85	Km123+647	1D1.5m
36	Km95+000	1(2.0x2.0)m	86	Km123+920	1D1.5m
37	Km95+200	1D1.5m	87	Km127+847	1(2.0x2.0)m
38	Km95+579	1D1.5m	88	Km128+402	1(2.0x2.0)m
39	Km96+118	1(2.0x2.0)m	89	Km128+746	1(2.0x2.0)m
40	Km96+600	1(2.0x2.0)m	90	Km129+246	1D1.5m
41	Km97+400	1(2.0x2.0)m	91	Km129+339	1(2.0x2.0)m
42	Km98+300	1(2.0x2.0)m	92	Km129+905	1D1.5m
43	Km99+227	2(2.0x2.0)m	93	Km130+246	1D1.5m
44	Km99+400	1D1.5m	94	Km130+394	1D1.5m
45	Km100+000	1D1.5m	95	Km130+482	3(3.5x3.5)m
46	Km100+600	1D1.5m	96	Km130+680	1(2.0x2.0)m
47	Km101+200	1D1.5m	97	Km131+000	1D1.5m
48	Km101+846	1D1.5m	98	Km131+436	1(2.0x2.0)m
49	Km102+500	1(2.0x2.0)m	99	Km131+605	1(2.0x2.0)m
50	Km103+000	1D1.5m	100	Km131+835	1D1.5m

**Table 5.2.12 – Culverts on the connection road
from the end point of the expressway to NH1A**

No	station	aperture	Remarks
1	Km131+605.12	1D150	Small valley culverts in the two sides of fields
2	Km131+867.72	1(150x150)	Earth canal B = 0,7m x 1.0m slope 1/0.4
3	Km132+440.32	1(150x150)	Culverts on the old road upstream 70 x70
4	Km133+265.12	1D100	Earth canal B = 0,5m x 0.4m
5	Km133+342.92	2(250x250)	Streams with natural flows B = 4.5m x 2.0m slope 1/0.8
6	Km133+393.52	1D150	Irrigational canals for fields B = 0,7m x 0.5m

7	Km133+599.62	1[]200X200	Streams with natural flows upstream are 1,5 x 1,5m
8	Km133+696.12	2[]200X200	Irrigational canal (N8), B = 2.2m x 1.6m, slope 1/1.5
9	Km133+898.12	1D100	Ditch BT driving water for fields B = 0.7m x 0.6m
10	Km134+225.62	1[]150X150	Earth canal B = 1,0m x 0.9m slope 1/0.4
11	Km134+391.12	2[]150X150	Valley flows
12	Km134+686.12	1D150	Earth canal B = 1,0m x 0.5m
13	Km134+828.12	1[]200X200	Earth canal B = 2,0m x 1.0m
14	Km134+880.12	1D150	Earth canal B = 0,6m x 0.5m
15	Km134+969.12	1D150	Earth canal B = 1,0m x 0.6m
16	Km135+142.35	2[]250x250	Streams with natural flows B = 2,8m x 1.4m slope 1/0.5
17	Km135+456.13	1D150	Earth canal B = 1,0m x 0.6m
18	Km135+645.63	1[]100x100	Earth canal B = 1,0m x 0.8m
19	Km135+698.63	1[]100x100	Earth canal B = 0,7m x 0.8m
20	Km135+969.33	1[]100x100	Earth canal B = 0,5m x 0.4m
21	Km136+076.63	1[]100x100	Earth canal B = 0,7m x 0.5m
22	Km136+217.53	1[]150X150	Earth canal B = 1,5m x 0.5m
23	Km136+355.83	2[]200X200	Earth canal B = 2,0m x 1.3m slope 1/0.5
24	Km136+469.03	1[]100x100	Earth canal B = 0,7m x 0.4m
25	Km136+738.03	2[]250x250	Earth canal B = 1,0m x 1.2m slope 1/0.3
26	Km136+974.93	2[]100X100	Earth canal B = 2,0m x 0.6m
27	Km137+094.86	2[]100X100	Earth canal B = 1,5m x 0.6m
28	Km137+228.92	2[]200X200	Earth canal B = 3,0m x 0.8m slope 1/0.5
29	Km137+360.92	1D100	Canal driving water for fields BT B = 0,7m x 0.6m
30	Km137+460.62	1D100	Earth canal B = 0,6m x 0.4m
31	Km137+728.83	1D100	Earth canal B = 0,8m x 0.5m
32	Km137+825.15	2[]300X300	Earth canal B = 0,8m x 0.5m
33	Km138+265.12	1D100	Earth canal B = 0,6m x 0.3m
34	Km138+353.32	1D100	Earth canal B = 0,5m x 0.3m
35	Km138+421.62	1[]250X250	Streams with natural flows B = 2,5m
36	Km138+672.12	2[]150X150	Canal driving water for fields B = 2,0m x 2.0m slope 1/0.5
37	Km138+803.22	1D100	Earth canal B = 0,7m x 0.4m
38	KM138+903.32	1D100	Earth canal B = 0,7m x 0.4m
39	Km139+005.72	1D100	Ditch driving water for fields B = 0,5m, upstream culvert Ø20

iii) Design of side-ditch, catch water drain and drain of high embankment:

The routes of excavation and embankment of less than 0.6m must design the surface water drain and slope. The drains dug in the ground has trapezium section of 40x40cm reinforced by 20cm-thick stone. The drains dug in the hard stone has triangle section and cement mortar surface to create plane surface.

The longitudinal gradient of the drain bottom is designed under the gradient along the centerline to ensure soil and stone to not deposit in the drain. The longitudinal gradient of the drain is greater that 0.3%.

The highly embankment routes >4m to avoid overflow on the slope shall design a system carrying water into the concrete drains on two roadsides and according to the water slopes down the slope foot.

Table 5.2.14 - Statistic table of design routes of side-ditch

From Km0 to Km35

From Km ...	To Km ...	Side-ditch Class I	Side-ditch class II	Drain of excava.	Drain of embank.	Catch- water drain	Location
1. Section Km0 - Km19+200							
Km0 + 00	Km0 + 28.11	28.11					2
Km0 + 28.11	Km0 + 130.82		102.71				2
Km0 + 130.82	Km0 + 177.50	46.69					2
Km0 + 219.50	Km0 + 305.00		85.50				R
Km0 + 219.50	Km0 + 400.00		180.50				L
Km0 + 466.00	Km0 + 729.00	263.00					L
Km0 + 466.00	Km0 + 623.20	157.20					R
Km0 + 540.00	Km0 + 590.00			50.00			R
Km0 + 540.00	Km0 + 623.20			50.00			
Km0 + 775.00	Km0 + 823.50		48.50				2
Km0 + 823.50	Km0 + 875.00	51.50					2
Km1+00	Km2+00		816.70				2
Km2+00	Km3+00		816.70				2
Km3 + 00	Km3 + 104.82		104.82				2
Km3 + 187.82	Km3 + 506.72		318.90				2

From Km ...	To Km ...	Side-ditch Class I	Side-ditch class II	Drain of excava.	Drain of embank.	Catch- water drain	Location
Km3 + 517.90	Km3 + 1000.00		482.10				2
Km4+00	Km5+00		926.42				2
Km5+00	Km6+00		865.50				2
Km6+00	Km7+00		1000.00				2
Km7+00	Km7 + 359.39		359.39				2
Km7 + 700.50	Km7 + 1000.00		299.50				2
Km8+00	Km8 + 557.66		557.66				2
Km8 + 557.66	Km8 + 614.22	56.56					L
Km9 + 416.64	Km9 + 450.04	33.40					R
Km9 + 526.11	Km9 + 759.59	233.48					2
Km9 + 759.59	Km9 + 1000.00		57.11				2
Km10+00	Km11+00		792.60				2
Km11+00	Km12+00		849.75				2
Km12+00	Km13+00		913.80				2
Km13+00	Km14+00		819.60				2
Km14+00	Km15+00		769.60				2
Km15+00	Km16+00		886.80				2
Km16+00	Km17 + 00		886.80				2
Km16 + 962.36	Km17 + 00				37.64		2
Km17 + 00	Km18 + 00		29.40				2
Km17 + 00	Km17 + 116.24				116.24		2
Km18+00	Km19+00		765.45				2
2. Section Km19+200 - Km35+00							
Km19 + 00	Km19 + 1000		926.80				2
Km19 + 800.00	Km19 + 1000				200.00		2
Km20 + 500.00	Km20 + 604.36			258.72			L
Km20 + 500.00	Km20 + 604.36			208.72			R
Km20 + 500.00	Km20 + 750.00	250.00					2
Km20 + 750.00	Km21 + 00		250.00				2
Km21 + 00	Km21 +		180.95				2

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From Km ...	To Km ...	Side-ditch Class I	Side-ditch class II	Drain of excava.	Drain of embank.	Catch- water drain	Location
	180.95						
Km21 + 300.00	Km21 + 400.00	100.00					2
Km21 + 500.00	Km22 + 00		452.90				2
Km22 + 00	Km22 + 150.00	150.00					2
Km22 + 150.00	Km22 + 250.00		100.00				2
Km22 + 250.00	Km22 + 300.00	50.00					2
Km23+00	Km24+00		637.85		700.00		1
Km24+00	Km25+00		926.80				2
Km25+00	Km26+00		673.90				2
Km26 + 100.00	Km26 + 200.00		100.00				2
Km26 + 400.00	Km26 + 550.00		150.00				2
Km26 + 550.00	Km26 + 700.00	150.00					2
Km26 + 900.00	Km27 + 00		100.00				2
Km27 + 00	Km27 + 300.00		280.00				2
Km27 + 600.00	Km27 + 800.00	200.00					2
Km28 + 00	Km28 + 100.00	100.00					2
Km28 + 300.00	Km28 + 500.00	200.00					L
Km28 + 300.00	Km28 + 700.00	400.00					R
Km28 + 800.00	Km29 + 00		200.00				L
Km29 + 00	Km30 + 00		919.85				L
Km29 + 00	Km29 + 600.00		519.85				R
Km30 + 100.00	Km30 + 500.00		400.00		400.00		2/L
Km30 + 900.00	Km31 + 00		100.00		100.00		2/L
Km31 + 00	Km31 + 300.00		300.00				L
Km31 + 400.00	Km31 + 900.00	500.00					2
Km31 + 700.00	Km31 + 800.00			200+300			2

From Km ...	To Km ...	Side-ditch Class I	Side-ditch class II	Drain of excava.	Drain of embank.	Catch-water drain	Location
Km32+00	Km33+00		873.90				2
Km33 + 200.00	Km33 + 600.00	400.00					2
Km33 + 200.00	Km33 + 500.00			300.00			R
Km33 + 700.00	Km34 + 00		300.00				L
Km34 + 00	Km34 + 400.00		337.85		800.00		2/L
Km34 + 500.00	Km34 + 800.00			1200+300 0		300.00	2/R
Km34 + 400.00	Km35 + 00	600.00					2

Note: 2 – two sides, L – left side, R – right side, 2/L: location correlative to poles

From Km35 to Km73

No.	From Km ...	To Km ...	Note
1	Km49+50.00	Km49+250	Side-ditch
2	Km49+650.00	Km50+50.00	Side-ditch
3	Km50+750.00	Km50+850.00	Side-ditch
4	Km52+50.00	Km52+446.50	Side-ditch
5	Km52+950.00	Km53+150.00	Side-ditch
6	Km53+450.00	Km53+550.00	Side-ditch
7	Km54+450.00	Km54+650.00	Side-ditch
8	Km59+250.00	Km59+350.00	Side-ditch
9	Km60+300.00	Km60+420.00	Side-ditch
10	Km60+780.00	Km61+60.00	Side-ditch
11	Km61+420.00	Km61+540.00	Side-ditch
12	Km64+680.00	Km64+820.00	Side-ditch
13	Km67+820.00	Km67+940.00	Side-ditch
14	Km69+0.00	Km69+100.00	Side-ditch
15	Km69+740.00	Km69+940.00	Side-ditch
16	Km70+0.00	Km70+188.35	Side-ditch
17	Km70+333.30	Km70+608.00	Side-ditch
18	Km69+820.00	Km69+900.00	mechanical ditch

19	Km70+420.00	Km70+580.00	mechanical ditch
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From Km73 to Km131+500

No.	From Km	To Km	Side-ditch	Peak drain	Location
1	Km77+450.00	Km77+550.00	100.00		L
2	Km77+450.00	Km78+050.00	600		R
3	Km77+650.00	Km77+950.00	400.00		L
4	Km78+350.00	Km78+450.00	100		R
5	Km78+554.80	Km78+650.00	95.2		R
6	Km78+750.00	Km79+050.00	300		R
7	Km79+250.00	Km80+572.80	1322.8		R
8	Km79+350.00	Km79+750.00	400.00		L
9	Km79+850.00	Km79+950.00	100.00		L
10	Km80+069.62	Km80+245.00	175.38		L
11	Km80+282.50	Km80+572.80	290.30		L
12	Km80+350.00	Km80+522.80		864.00	2
13	Km80+650.00	Km81+050.00	400.00		L
14	Km80+650.00	Km81+050.00	400		R
15	Km81+750.00	Km82+150.00	400		R
16	Km81+950.00	Km82+150.00	200.00		L
17	Km82+670.85	Km83+050.00	379.15		R
18	Km82+674.30	Km82+966.25	291.95		L
19	Km82+724.35	Km82+966.25		1451.40	2
20	Km83+650.00	Km83+850.00	200.00		L
21	Km83+650.00	Km83+850.00	200		R
22	Km84+550.00	Km84+750.00	200		R
23	Km84+950.00	Km85+150.00	200		R
24	Km85+550.00	Km85+971.35	421.35		R
25	Km85+650.00	Km85+971.35	321.35		L
26	Km86+350.00	Km86+750.00	400.00		L
27	Km86+550.00	Km86+650.00	100		R
28	Km87+050.00	Km87+450.00	400.00		L
29	Km87+050.00	Km87+450.00	400		R
30	Km87+150.00	Km87+350.00		1200.00	2
31	Km88+650.00	Km88+950.00	300		R
32	Km88+750.00	Km88+850.00	100.00		L
33	Km89+050.00	Km89+550.00	500.00		L
34	Km89+050.00	Km89+550.00	500		R
35	Km90+722.50	Km90+985.75	263.25		L
36	Km90+722.50	Km90+985.75	263.25		R
37	Km90+772.50	Km90+956.20		1010.35	2
38	Km91+650.00	Km92+250.00	600.00		L
39	Km91+650.00	Km92+250.00	600		R
40	Km91+750.00	Km92+250.00		2400.00	R

No.	From Km	To Km	Side-ditch	Peak drain	Location
41	Km91+820.00	Km92+250.00		1806.00	L
42	Km93+850.00	Km94+087.24	237.24		L
43	Km93+850.00	Km94+087.24	237.235		R
44	Km93+950.00	Km94+056.54		735.09	2
45	Km94+550.00	Km94+950.00	400.00		L
46	Km94+550.00	Km94+950.00	400		R
47	Km95+021.50	Km95+150.00	128.50		L
48	Km95+021.50	Km95+150.00	128.5		R
49	Km95+250.00	Km95+450.00	200.00		L
50	Km95+250.00	Km95+450.00	200		R
51	Km95+720.00	Km95+977.50	257.50		L
52	Km95+720.00	Km95+977.50	257.5		R
53	Km97+150.00	Km97+350.00	200.00		L
54	Km97+150.00	Km97+350.00	200		R
55	Km97+550.00	Km97+740.85	190.85		R
56	Km98+150.00	Km98+250.00	100.00		L
57	Km98+150.00	Km98+250.00	100		R
58	Km98+350.00	Km98+750.00	400		R
59	Km98+450.00	Km98+750.00	300.00		L
60	Km99+450.00	Km99+750.00	300.00		L
61	Km99+450.00	Km99+750.00	300		R
62	Km100+150.00	Km100+300.00	150.00		L
63	Km100+150.00	Km100+300.00	150		R
64	Km100+750.00	Km100+950.00	200.00		L
65	Km100+750.00	Km100+850.00	100		R
66	Km103+550.00	Km104+552.48	1002.48		L
67	Km103+550.00	Km104+552.48	1002.48		R
68	Km104+027.48	Km104+350.00		1935.12	2
69	Km107+450.00	Km107+750.00	300.00		L
70	Km107+450.00	Km107+750.00	300		R
71	Km108+050.00	Km108+250.00	200.00		L
72	Km108+050.00	Km108+250.00	200		R
73	Km108+450.00	Km108+650.00	200.00		L
74	Km108+450.00	Km108+650.00	200		R
75	Km109+650.00	Km109+980.11		825.28	L
76	Km109+860.00	Km110+060.00	200.00		L
77	Km109+860.00	Km110+020.00	160		R
78	Km110+260.00	Km110+340.00	80.00		L
79	Km111+436.82	Km112+146.72	709.90		L
80	Km111+476.82	Km112+146.72	669.9		R
81	Km111+561.77	Km112+107.72		1910.82	L
82	Km111+561.77	Km112+009.91		1568.49	L
83	Km112+218.72	Km112+281.22	62.50		L
84	Km112+300.72	Km113+426.72	1126		R

No.	From Km	To Km	Side-ditch	Peak drain	Location
85	Km112+359.22	Km112+411.77	52.55		L
86	Km112+439.02	Km113+066.72		4205.59	2
87	Km112+439.02	Km113+386.72	947.70		L
88	Km113+386.72	Km113+426.72	40.00		L
89	Km113+501.72	Km113+948.60	446.88		L
90	Km113+501.72	Km113+948.60	446.875		R
91	Km114+238.91	Km114+709.04	470.13		L
92	Km114+238.91	Km114+670.64	431.73		R
93	Km114+318.78	Km114+519.58		1124.48	2
94	Km114+709.04	Km114+936.83	227.79		R
95	Km114+749.16	Km114+936.83	187.67		L
96	Km115+147.26	Km116+186.99	1039.74		L
97	Km115+187.70	Km115+381.62	193.915		R
98	Km115+421.67	Km116+186.99	765.32		R
99	Km116+581.22	Km117+060.47	479.25		L
100	Km116+581.22	Km117+060.47	479.25		R
101	Km117+175.72	Km117+255.72	80.00		L
102	Km117+175.72	Km117+255.72	80		R
103	Km117+445.72	Km118+098.79	653.07		L
104	Km117+445.72	Km118+098.79	653.07		R
105	Km118+686.72	Km118+926.72	240.00		L
106	Km118+726.72	Km118+952.34	225.615		R
107	Km118+962.34	Km119+219.13	256.79		L
108	Km118+962.34	Km119+219.13	256.795		R
109	Km119+310.04	Km119+408.04	98.01		L
110	Km119+310.04	Km119+386.72	76.685		R
111	Km119+428.04	Km119+469.28	41.235		R
112	Km119+473.82	Km119+477.80	3.98		L
113	Km119+483.62	Km119+489.19	5.565		R
114	Km119+493.19	Km119+496.03	2.84		L
115	Km119+496.03	Km119+499.43	3.405		R
116	Km119+519.89	Km119+676.22	156.33		L
117	Km119+519.89	Km119+676.22	156.33		R
118	Km119+724.94	Km120+271.17	546.23		L
119	Km119+724.94	Km120+271.17	546.23		R
120	Km120+300.28	Km120+320.28	20		R
121	Km121+346.72	Km121+386.72	40.00		L
122	Km121+346.72	Km121+386.72	40		R
123	Km122+146.72	Km122+576.41	429.69		L
124	Km122+186.72	Km122+557.15	370.425		R
125	Km122+571.23	Km122+576.41	5.185		R
126	Km122+660.84	Km122+946.72	285.88		L
127	Km122+706.74	Km122+946.72	239.98		R
128	Km123+089.59	Km123+116.39	26.80		L

No.	From Km	To Km	Side-ditch	Peak drain	Location
129	Km123+089.59	Km123+102.90	13.31		R
130	Km128+502.37	Km128+622.38	120.01		L
131	Km128+502.37	Km128+622.38	120.01		R
132	Km128+662.38	Km128+771.51	109.13		L
133	Km128+662.38	Km128+822.38	160.005		R
134	Km128+791.51	Km128+822.38	30.87		L
135	Km128+902.38	Km129+022.38	119.995		R
136	Km128+926.66	Km129+022.38	95.71		L
137	Km131+255.38	Km131+417.62	162.245		R
138	Km131+282.62	Km131+382.62	100.00		L

(8) Design of intersections

Capacity of the expressway depends on arrangement of interchanges. Arrangement and planning of interchanges must be based on traffic flow predicted and separable to build up and supplement in case of increased traffic flow.

The frontage road between the interchange needs to be considered carefully and in generally must use the available road systems to the interchanges. It should not build the frontage road system for the mechanical vehicles in road landmark of the expressway.

Da Nang – Quang Ngai Express intersects with the Highways, the provincial roads and the road for local people. The expected locations to build the interchanges is mainly listed in the following table.

Table 5.2.15 – Statistic table of main interchanges

No	Name of interchange	Project station	Distance between interchange (km)	Connect to	Note
1	Tuy Loan intersection	Km0+000.00	0.00	NH14B	
2	Chiem Son intersection	Km20+200.00	19.990	Route 610A	
3	Ha Lam intersection	Km41+121	20.921	NH14E	
4	Tam Ky intersection	Km64+200	23.079	Route 616	
5	Chu Lai Intersection	Km83+800	19.600	Chu Lai Industrial Zone	
6	Dung Quat Intersection	Km102+325	18.525	Dung Quat Industrial Zone	
7	Binh Son Intersection	Km112+400	10.075	Tra Bong – Binh Long road	

8	North Quang Ngai Intersection	Km124+400	12.000	TL623	
9	Quang Ngai Intersection	Km130+750	6.350	Quang Ngai city	

i) Selection of design standards

Standards applied in designing interchanges under Da Nang – Quang Ngai Expressway Project include:

- **Vietnamese standards**
 - Standard 22 TCN 273-01
 - Standard TCVN 5729 -1997
- **Standard AASHTO 2004.**

ii) Design standard of ramps of interchanges

- It mainly applies Vietnamese Standards; in case of Vietnamese Standard not regulated, Standard AASHTO shall be applied and then compared, selected and propose suitable standard.

- If there is difference between standard 22TCN 273-01 and TCVN 5729 -1997, they shall be compared with standard AASHTO and then propose suitable standard.

iii) Standard proposal

- **Design velocity**

Table 5.2.16 – Selecting design velocity for interchanges

Classification	TCVN 5729-97	TCVN 4054-05	22TCN 273-01	AASHTO 2004	Proposal	Note
Interchange at the route head	80~50	50	70	60	80	
Interchange with the highways and the main roads in the region	70~40	50	70	60	50	
Other Interchanges	60~35	50	70	40	40	
Interchange at the route end	60~35	50	70	40	40	

Selecting the design velocity on the ramps of intersection shall be based on

technical standard, design experience, total investment and traffic safety.


- Typical cross-section under TCVN 5729 – 1997


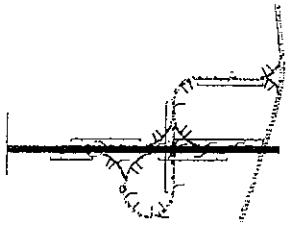
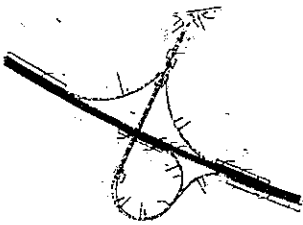
Table 5.2.17 – Typical cross-sections of ramps

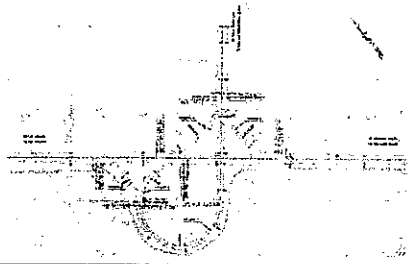

Classification	Lane width (m)	Width of safe band (m)	Width of road shoulder (m)	Width of separator (m)	Total (m)	Note
1 direction - 1 lane	$4.0 \times 1 = 4.0$	$1 \times 2 = 2.00$	$1 + 0.75 = 1.75$	-	7.750	+50/R (expansion)
1 direction - 2 lanes	$3.50 \times 2 = 7.0$	$1 \times 2.0 = 2.00$	$1 + 0.75 = 1.75$	-	10.75	+50/R (expansion)
2 directions - 2 lanes	$4.0 \times 2 = 8.0$	$(1.0 + 2.0) \times 2 = 6.0$	$0.75 \times 2 = 1.5$	1.0	16.50	+50/R (expansion)
2 directions - 4 lanes	$3.50 \times 4 = 14.0$	$(1.0 + 2.0) \times 2 = 6.0$	$0.75 \times 2 = 1.5$	1.0	21.50	+50/R (expansion)

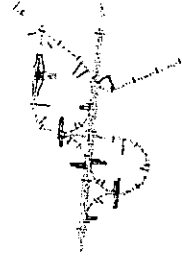


iv) Selecting methods of interchanges

Table 5.2.18 – Methods of Interchange

No	Name of Interchange	Topographic conditions of Interchange area	Method and plan of kind of Interchange	Note
1	Tuy Loan interchange (Km0+00)	<p>(1) Traffic flow: The interchange lies in the section with the third highest traffic flow in the whole route as expected.</p> <p>(2) Traffic features: Intersecting with NH 14B and being a road to Da Nang city southwards.</p> <p>(3) Topographic features: The intersection has rather empty topography. However, the area is rather low and deeply submerged by annual flood and has a dense number of electric poles.</p>	<p>Other interchange is inter-traffic and shaped as a complete cloverleaf. The bridge on NH 14B is across the expressway with expected outline of spans, bridge width:</p> <p>$B = 0.5 + 10.5 + 0.5 + 10.5 + 0.5 = 22.5\text{m}$</p> 	

No.	Name of Interchange	Topographic conditions of Interchange area	Method and plan of kind of Interchange	Note
2	My Son interchange (Km20+200)	<p>(1) Traffic flow: The interchange lies in the section with the second highest traffic flow in the whole route as expected.</p> <p>(2) Traffic features: Intersecting with PR. 610 and being a road connecting Long Xuyen on NH 1A with My Son Holy Land.</p> <p>(3) Topographic features: The topography of the interchange area is rather limited in the North with Ba Ren River across the expressway, the martyrs' ceremony in the east and the royal tomb of Madam Doan Quy Phi in the west.</p>	<p>The interchange is trumpet interchange with bridge on the ramps across expressway</p> 	<p>Change is compared with Document FS of NipponKoei. Method of NP is Cloverleaf Interchange with 2 ramps of cloverleaf located at the south of Ba Ren river.. Change of intersection shaped as trumpet model is more advantageous to collect fees.</p>
3	Ha Lam interchange Km41+ 121.00	<p>(1) Traffic flow: The interchange lies in the section with the highest traffic flow in the whole route as expected.</p> <p>(2) Traffic features: Intersecting with NH 14E and being a road connecting from NH 1A (Ha Lam) to Ho Chi Minh Highway (Kham Duc)</p> <p>(3) Topographic features: The topography is gently hilly from the right route to the left route. The population density is thin with about 5 households scattered in the scope of interchange. North - South railway parallels with about 600m from the expressway westwards.</p>	<p>The interchange is trumpet interchange with bridge on the expressway across NH 14E, span outline 1x24 and bridge width 26m.</p> 	<p>Change is compared with Document FS of NipponKoei. Method of NP is Diamond Interchange with 2 ramps of cloverleaf located at the south of Ba Ren river.. Change of intersection shaped as trumpet model is more advantageous to collect fees.</p>
4	Tam Ky interchange Km64+200	<p>(1) Traffic flow: The interchange lies in the section with the average traffic flow in the whole route as expected.</p> <p>(2) Traffic features: Intersecting with PR. 610 and being a road connecting Tam Ky town on NH 1A to Tra My.</p> <p>(3) Topographic features: At the intersection between Highway and Route 616, there are a high density of population and some works such as martyrs' ceremony and several pagodas along the PR. 616, The topography in the South of the intersection between the expressway and PR.616 is field with thinly populated.</p>	<p>Trumpet interchange with bridge on the PR. 616 (across the expressway), expected outline of spans 8x35m and bridge width 12m</p> 	<p>Change is compared with Document FS of NipponKoei. Method of NP is Cloverleaf Interchange with 2 ramps of clover-leaf located at the south of the intersection in combination with improvement of Route 616. However, the traffic flow on PR 616 is little. Existing capacity of Route 616 still well meets such traffic flow. Therefore, it is unnecessary to improve this PR.616. Besides,</p>

No.	Name of Interchange	Topographic conditions of Interchange area	Method and plan of kind of Interchange	Note
				method of intersection shaped as trumpet model is more advantageous to collect fees.
5	Chu Lai interchange Km 83+812	(1) Traffic flow: The interchange lies in the section with the average traffic flow in the whole route as expected. (2) Traffic features: Intersecting with the planned road from the expressway, NH 1A and Chu Lai Industrial Zone. (3) Topographic features: The topography is rather empty and thinly populated.	Trumpet interchange with overpass on the transversal road (across the expressway), expected outline of spans 3x35 and bridge width 17.5m 	
6	Dung Quat interchange Km102+255	(1) Traffic flow: The interchange lies in the section with the average traffic flow in the whole route as expected. (2) Traffic features: Intersecting with the planned road from the expressway, NH 1A and Dung Quat Industrial Zone. (3) Topographic features: The topography is rather limited. North - South railway parallels with about 600m from the expressway eastwards.	Trumpet interchange with overpass on the transversal road across the expressway, North - South railway and NH 1A. Outline of spans and bridge width is - From North - South railway to Dung Quat 4x35, width 22.5m - From North - South railway to west of the expressway: 14x35(17.5), bridge width 17.5m. - Joined branch: 3x35 bridge width 7.5m 	Change is compared with Document FS of NipponKoei. Method of NP is to improve a route of entrance of Dung Quat Industrial Zone with design of Trumpet interchange, bridge on the express but route intersecting between Dung Quat Port and NH 1A and North-South railway. Due to route connecting from the expressway to Dung Quat Industrial Zone in the future with very high traffic flow, transition with North - South railway and NH 1A of this connection route is unreasonable.
7	Binh Son interchange Km111+832	(1) Traffic flow: The interchange lies in the section with the average traffic flow in the whole route as expected. (2) Traffic features: Intersecting with Tra My - Tra Bong - Binh Long road and connecting with Dung Quat Industrial Zone. (3) Topographic features: The topography is rather difficult and limited about surface due to high mountain surrounded.	Other intersection is semi-Cloverleaf Interchange with 02 ramps in South of the intersection, bridge on Tra My - Tra Bong - Binh Long road (across the expressway), outline of spans 3x35. Bridge width 12m.	Change is compared with Document FS of NipponKoei. Method of NP is a diamond model. However, due to the expressway route at the interchange adjusted in comparison with method of NP in accordance with topographic conditions of the intersection with Binh Son intersection and advantageous to collect

No.	Name of Interchange	Topographic conditions of Interchange area	Method and plan of kind of Interchange	Note
				fees. Design Consulting is adjusted as a trumpet Interchange
8	North Quang Ngai interchange Km130+710	(1) Traffic flow: The interchange lies in the section with the lowest traffic flow in the whole route as expected. (2) Traffic features: Intersecting with PR. 623 and being a road from North of Quang Ngai city to West and Viet – Laos border (3) Topographic features: The area has rather dense population at 02 quarters of the intersection. On other hand, the area is heavily flooded in annual flood.	The interchange is trumpet interchange with bridge on the ramps of PR.623 across expressway. 	Change is compared with Document FS of NipponKoei. Method of NP is designed as Cloverleaf Interchange with 02 symmetric ramps at quarters I and III of the intersection. However, due to advantageous to collect fees and reduce the volume of ROW, Design Consultants is adjusted as a trumpet Interchange
9	Quang Ngai interchange Km131+000	(1) Traffic flow: The intersection lies in the section with the lowest traffic flow in the whole route as expected. (2) Traffic features: Intersecting with the planned ring road of Quang Ngai city. At the same time, this is the ending point of the expressway. The immediate period of this intersection is designed at the same rate and connecting with NH 1 A by the joined route. In the period upon continuing construction of the expressway from Quang Ngai, this intersection shall become other inter-traffic intersection. (3) Topographic features: The topography of the area is mainly fields and thinly populated.	Trumpet interchange, bridge on the planned ring road of Quang Ngai city (across the expressway) 	

(9) Intersection design for the route joining from the expressway to NH 1A

The interchange between the existing road and the route joining the ending point of the express with NH 1A is designed with intersections. The design velocity at these intersections is 50km/hr. The design solution at these intersections is mainly tapers from the design expressway to the existing road. Ramps with high traffic flow may be classified by the traffic islands and the paint line. The locations of intersection are listed in the following table:

Table 5.2.19 – Intersections in the route from the ending point of the expressway to NH1A

No	Name of Intersection	Project station	Distance between interchanges (m)	Connect to	Notes
1	District road	132+125.12 (right) 132+380.32 (left)	0	PR. 624	District road
2	Provincial road 624	133+371.32	1.0	NH 1A	Provincial road
3	District road 59	135+415.13	2.0	PR. 624	District road
4	District road 55	137+215.42	1.8	NH 1A, PR.624	District road
5	NH 1A	139+522.02	2.2		Ending point of project

5.2.3 Design of lighting on the Expressway

(i) Overview

The lighting system helps to improve traveling capability on the Expressway. The requirements on lighting need to ensure safety transport at night or in bad weather condition. The system needs to have high quality and low operation cost during operation period. The lighting principles are as follows:

- To keep the vision of the driver continuous by lighting the areas of toll plazas, interchanges, tunnels, etc.
- To provide sufficient luminance to recognize the roadside utilities.

(ii) Areas need lighting

Lighting will be installed in the following areas:

- Toll plazas
- Service stations and lay-by stations
- Expressway Management Center and Operation, Maintenance Center and other buildings
- Large bridges (L > 500m)
- Interchange
- Tunnel

According to the Expressway standard (TCVN 5729: 2007), lighting is not required for bridges. However, the Consultant recommends lighting for bridges over 500m length for following reason:

- To minimize accidents caused by bad weather such as strong wind or thick fog.

- To help the drivers to keep a safe distance to avoid accident

- The width of the pavement and road shoulder of the large bridges will be narrower than the embankment after 6-lane is constructed in the future.

iii) Design standard

Below are the design standard for lighting:

- + TCXDVN 333: 2005 – Artificial lighting outside the public and urban technical infrastructure utilities- Design standard

- + TCXDVN 259: 2001 – Design standard of artificial lighting for roads, streets, urban square.

- + TCVN 5729: 2007 – Design standard of expressway

iv) General of the lighting design

Distance between the light poles is preliminarily arranged as follows:

- For toll plazas: 35 – 40m/pole in each roadside.

- Large bridges ($L > 100\text{m}$): Bridge on the main route has light poles at interval of 30m/pole in both sides; for expressway crossing flyovers light poles are on one side or alternative on two sides.

- Interchanges: Distance: 30m/ 1 pole.

5.3 Construction of the road and interchanges

5.3.1 Construction of the road

i) Preparation

The preparation is carried out to serve for construction. The suitable preparation works shall make a good contribution to progress and quality of construction. Thus, it needs to apply the most suitable method upon carefully considering content of construction. The main items are stated as follows. It is necessary to study thoroughly in the period of technical design. For evaluation of construction time, it is expected to prepare for 6 months.

- Exploration of project site and surrounding area

The work shall determine obstacles (underground works, buildings, graves, tombs ...), meet with the line departments in charge of the works across the road, waterway, railway, drains and electric lines), soil survey (exploration, drilling, soil mine and park) and consider environment (surrounding works, underground water, fresh water and water for agriculture) in this item.

- Survey to preparation

Before construction, it needs to plan the co-ordinate datum points, stake out centerline and reference. It should consider ability of survey and supplementation upon adjusting route, especially at the bridge and tunnel with complicated topography.

- Mission road for construction

The mission road shall be constructed with materials from excavation. It must be built with materials and well drained to avoid damaging the road. It may use the drainage pipeline or bridge for the existing drainage.

ii) Design of temporary facilities

The temporary facilities are facilities, equipment is transported to the site in the construction process. Because they are temporary, they shall be installed as simple as possible but must ensure safety and efficiency for the project. The below is profile about the facilities.

- Site office, lab and warehouse

Location and quantity shall be determined under the construction conditions and the tender package. It is essential to optimal by coordinating different functions. In general, a necessary area shall be from twice to 3 times as area of the building.

- Accommodation

The accommodation of worker needs to be provided under the mobilized plan. It needs to follow local laws on location, structure, use area and safety.

- Aggregate and concrete mixture station

In case concrete, aggregate and other materials are provided in the tents, it needs to be installed in order to be suitable to power supply source.

- Power and water supply and drainage handling for the construction area

It should ensure power, light and water supply for construction ... Water supply needs to be checked subject to purposes of use. It should treat water rationally.

- Material and machine warehouse

Materials such as aggregate, concrete ... need to be covered in the tent. It is necessary to ensure transport materials to the construction area. Materials need to be stored under the slope or by plastic sheet if necessary.

iii) Safety equipment

Safe equipment is necessary items for construction. For example, safe equipment/ materials include signboard, fence, traffic control equipment, lamps,

water and dust handling equipment and grit basin.

5.3.2 Organization of interchange construction

- Temporary road

The temporary road needs to be considered in construction of intersections that occupy a lot of area and needs to move a large volume of soil. Time to construct the temporary road is a key to avoid conflicts between the construction vehicles and one of the local people.

- Construction at the different level

Sequence to construct structures and excavation needs to be carefully considered to construct effectively structures at the different level.

5.3.3 Construction of the connection road

- Traffic management

Some existing routes used as the internal roads or the road for the local people need to pay special attention in construction to maintain their functions. Traveling and circulating must be maintained to transfer the temporary roads and take construction measures and well organized.

- Encounter with obstacles

The obstacles determined in the construction process must be informed and coordinated with the line departments. The underground works needs to determine by exploratory holes and database if any in order to check whether it is necessary to remove or protect. The connection road needs to be built to access to the construction area of the main route. This means that determining and proposing solution are important to avoid delay of the project implementation.

- Environment

Expanding the connection road shall be carried out in the routes with densely populated area. The negative impacts such traffic jam, noise, vibration and dust as well as traffic accidents with the construction means of transport are expected. It needs to take strict measures of construction and organization, at the same time inform the local people to minimize such bad impacts.

CHAPTER 6 – SOLUTION AND RESULT OF WORKS DESIGN

6.1 Principles of designing works

Traffic construction works proposed on main alignment includes: bridgework on major alignment (overflow works, drainage viaducts, crossroad over bridge...), highway tunnels, crossroad over bridges, expressway over bridges, grade-separated intersection bridges, underpasses are designed according to following principles:

- Works are designed permanently and in accordance with the scale of alignment.
- Meet requirements of planning and development of irrigation.
- Guarantee calculated flood sewage with a frequency of 1%.
- For bridges requiring navigation clearance, ensure Navigation Clearance in accordance with respective river, channel levels or local requirements of boats clearance.
- Intersection bridges, road over bridges must ensure vertical clearance and horizontal clearance for paths below in current period as well as extension in future
- Tunnel works must ensure clearance for vehicles clearance; cross section meets the scale of construction of alignment; arrange roadside for exploitation and maintenance. Structure of tunnel and manner of execution agree to geologic conditions of execution area.
- Promote capability and use of execution tools of domestic contractors as well as apply scientific and technical progress reasonably for construction of traffic works.
- Execute conveniently and mechanically.
- Ensure convenience for exploitation and maintenance;
- Pay attention to aestheticism of construction works and suitability with landscape of construction area.
- Ensure economic criteria reasonably.

In addition to above requirements, each specific kind of construction works must ensure following requirements:

- *Viaducts:*

Viaducts are designed for areas of frequently suffering from serious floods, high embankment or costly means of land treatment. And they are used to avoid social separation when a highway separates residential areas along two sides of the road.

- **Road and railway clearance:**

According to design standards of highway TCVN 5729-97 and design standard TCVN 4054-2005 as well as agreements with local government. Vertical clearance is designed for main alignment and access roads as shown in the following table.

Table 6.1.1 - Road and railway vertical clearance

Type	Vertical clearance	Standard
Minimum highway	4,75m	TCVN 5729: 1997
Provincial road and district road	4,50m	TCVN 4054:2005
Inter-communes road, inter-village road	-	Agree with local government
Railway	6,00m	

- **Non-navigation clearance for river over bridge:**

According to investigation of flood water level in study and comparison of 1 % of high water level calculated among previous studies, higher water level is applied to design bridges.

According to previous studies and at current designed high water level (DHWL) is calculated from hydrologic analysis based on flood trace investigation, and flood water level investigation carried out on some paragraphs in the study. Bridge opening is defined based on hydraulic discharge calculated from daily rainfall and flow data of water of headwater lakes.

To define clearance below bridge, add to unsafe static design high water level depending on whether rivers have drifting trees or not according to the standard TCN 272 - 05

Table 6.1.2 – Required vertical clearance for below bridges calculated from altitude of design high water level

Item	Clearance (m)
Without drifting trees	0.500
With drifting trees	1.000

- **River overbites clearance requiring boats clearance:**

Requirements of Navigation Clearance is shown in TCVN 5664-1992 and statistic in following table. Design water level with a frequency of 5% is applied to define Navigation Clearance. Required Navigation Clearance including vertical

clearance and horizontal clearance are defined according to requirements of Local Waterway Bureau and Transportation Department.

Unless otherwise agreed, clearance will meet requirements in the following table, extracted from TCVN 5664 - 1992.

Table 6.1.3 – Waterway technical gradation table TCVN 5664-1992

River class	Canal size (m)					Navigation vertical clearance		
	Natural river		Dug canal		Curve radius	Horizontal		Vertical clearance
	Water depth	Riverbed width	Water depth	Bed width		River	Canal	
I	>3.0	>90	>4.0	>50	>700	80	50	10
II	2 ÷ 3.0	70 ÷ 90	3.0 ÷ 4.0	40 ÷ 50	500 ÷ 700	60	40	9
III	1.5 ÷ 2.0	50 ÷ 70	2.5 ÷ 3.0	30 ÷ 40	300 ÷ 500	50	30	7
IV	1.2 ÷ 1.5	30 ÷ 50	2.0 ÷ 2.5	20 ÷ 30	200 ÷ 300	40	25	6(5)
V	1.0 ÷ 1.2	20 ÷ 30	1.2 ÷ 2.0	10 ÷ 20	100 ÷ 200	25	20	3.5
VI	<1.0	10 ÷ 20	<1.2	10	60 ÷ 150	15	10	2.5

Note: Numeric values (...) are allowed to be used upon receipt of approval from authorities.

Highway alignment goes to the West of Thong Nhat railroad. Except for major bridges that require Navigation Clearance such as Ky Lam, Chiem Son, Tra Bong and Tra Khuc, there is notary requirement for clearance for small bridges and median bridges on alignment.

Consultants only consider design of altitude of roads according to standards applied for river with drifting trees and without drifting trees as shown above, except for big bridges that need clearance such as Ky Lam, Chiem Son, Tra Bong and Tra Khuc.

Parts as follows uses documents made by NIPPON KOEI consultant.

6.2 Design solution for bridges, underpasses

6.2.1 Review of the previous studies

The purpose of this study is to update and complete the study of NIPPON KOEI consultant completed on August/2009 (this study is based on the study of JETRO and feasibility previously implemented by TEDI).

As presented above, some sections of main alignment have been re-aligned compared to direction of alignment studied by NIPPON KOEI consultant.

Design of bridges on the alignment is studied mainly for major bridges (04 bridges are Ky Lam, Chiem Son, Tra Bong and Tra Khuc) that affect the cost of the Project as well as small bridges and median bridges arranged on realigned sections. In the study of NIPPON KOEI consultant, the ideas of using steel bridge for superstructure has been abandoned because: "Vietnam Bank and Government has an

opinion that steel bridge is costly compared with concrete bridge and concrete bridge is more popular” (Extraction in the final report of NIPPON KOEI consultant).

6.2.2 Approach and design

- To review the design standards established in the Study of NIPPON KOEI consultant.

- Update and re-design some bridges on realigned sections.

- Revise other bridges on the alignment including viaducts in flooded areas.

- Note to following issues:

- + Length of bridges on non-realigned sections, basically, are updated by using data of NIPPON KOEI consultant in connection with survey data and hydrographical calculations.

- + For non-realigned sections and without new geological, topographical survey, the geological data are updated from previous studies.

- + For realigned sections: On the basis of field survey, additional stratum drilling survey and in combination with previous studies, the data are updated and calculated, and used for designing.

- + For realigned sections, length of bridges and bridge span arrangement will be studied more thoroughly.

- +The Project Update Consultant has discussed with the local government to define the scale of over bridges and highways and underpasses in accordance with local planning.

- + Big bridges which are basically considered in the study of NIPPON KOEI consultant in this stage are basically considered to be used with conditions as follows: Over bridges of the same river in the case that the alignment goes through a position far from that proposed of NIPPON KOEI consultant, combined with new topographical survey data and latest hydrographic investigation, calculation data showing that this realignment is necessary.

6.2.3 Standard and design load

Branch standard 22TCN 272-05 is applied in consideration of updating and referencing standard AASHTO LRFD 2007.

Design load is similar to previous studies, as in following table:

Table 6.2.1 – Load design

Items		Applied values
Specific weight	General structural steel	76.9 kN/m ³
	Reinforced concrete	25.0 kN/m ³
	unreinforced concrete	23.5 kN/m ³
	Asphalted concrete	22.1 kN/m ³
	Compacted soil	18.9 kN/m ³
Design live load (HL-93), Pedestrian live load under 22TCN 272-05		
Thermal Force	Structural elements	Average temperature: 20°C - 25°C Increase in temperature: +20°C Decrease in temperature: -20°C
	Expansion joint, bearing, etc.	Temperature range: +/-35°C
Seismic Force	Design standard of construction works subject to earthquake TCXDVN 375-2006	

6.2.4 Review of positions and conditions of designing bridges

The alignment of the project in the stage is revised and re-aligned in three sections as in the chapter of design conception of the alignment as above mentioned.

Items		Km0-Km35	Km35-Km73	Km73-131+500	Connection to NH1A	Total
Bridges of main road	each	37	34	26		97
	lin.m	4653.6	2105	4243		11001.6
Expressway overbridges +interchanges	each	4	2	22		28
	Lin.m	565.0	475	2730		3770.0
Other Bridges	each	2			3	5
	Lin.m	106.3			117	223.3
Box culvert	each	49	44	14		107

Details in the summary of quantity of bridges, construction works.

Viaduct is considered to be re-arranged in accordance with topographic and hydraulic conditions. Viaducts are not only used for flood discharge but also for minimizing social separation when a highway runs through.

Basically, in the whole of the alignment positions of bridges, cross over bridges, underpasses are considered and updated from the report of NIPPON KOEI consultant. In addition on the base of agreement with local government to advise and update the project and re-adjust construction works as follows:

i) Section: Km000+000 - Km35+000

This alignment section is divided into two sections:

- Section 1: Km 0 – Km 16+000 : Based on results of checking field and map details as well as collected information, alignment section from Km0+000 to Km16+000 must be re-aligned so as not to cross 500KV electric pole and is restricted to cross Cam Son industrial park, residential areas of Thai Cam village, Dien Tien commune, Dien Ban district, Quang Nam province.

- Section 2: From Km 16+000 to Km 35+000

Alignment section is not re-aligned compared with that in the proposal of NIPPON KOEI consultant.

- The result of update and design of Km0+000 – Km35 + 000 section:

+ 29 bridges crossing rivers, streams, irrigation canals and drains;

+ 08 flyovers on national highway/provincial road/ access road;

+ 04 expressway-crossing over bridges;

+ 02 bridges at interchanges;

+ 49 underpasses;

ii) Alignment section: Km35+000 –Km73+000

The whole section Km35 – Km73 has total 36 bridges; 44 underpasses, in which the updated section in the F/S by Nippon Koei from Km35 – Km60 has 30 bridges and 26 underpasses, the adjusted section from Km60 – Km73 has 6 bridges and 18 underpasses.

- The bridges are categorized into 3 types:

+ 22 bridges crossing rivers, streams, irrigation canals and drains;

+ 12 flyovers on national highway/provincial road/ access road and the interchanges;

+ 2 expressway-crossing over bridges;

+ 44 underpasses;

- The second adjusted section: Km60+000 ~ Km73 + 000.

The section is re-aligned compared with the proposal by NIPPON KOEI consultant, and undergoing topographical survey, more thoroughly hydrographic calculation, the result are bridges: Km60+600, Km61+566, Km65+700, Km66+035, Km66+650, Km66+950, Km67+730, Km69+350, Km70+151, Km72+860 are removed or replaced with underpasses.

While the bridges at Km62+113 (bridge over Hoa Binh river, 3x24 PCI

girder), Km66+268 (3x24 PCI girder Flyover), Km68+275 (Tam Ky 2 bridge, 12 x 40 Super-T girder) on the old alignment, after realignment, have following stations and span structure:: Hoa Binh bridge Km62+337,77 (3x21, PCI girder), Km66+200 (3x21, PCI girder), Tam Ky 2 bridge at Km68+308 (8x33, PCI girder).

iii) Section alignment Km 73+000 – Km131+500

Section alignment is divided into two sections:

- Section 1: The alignment has the same direction as proposal by NIPPON KOEI consultant from Km 73+000 to 107+000;

- Section 2: The section is realigned compared with the proposal by NIPPON KOEI consultant from Km 107+000 to Km 131+500; realigned section restricts intersection of residential areas of An Thuan village, reducing quantity of land acquisition for section Km 115-Km131+500 because intersected area is hilly not as plain as agricultural land. Population in realigned areas is sparse so land acquisition quantity is considerably reduced in comparison with old centerline. Otherwise the direction of the alignment goes to the West where topography is higher than that of the old centerline, which reduces a lot of disadvantages involved in stability, construction quantity of works.

Quantity of construction works in this section is planned, calculated on following basis:

- To review and update the utilities on the alignment in the section Km 73+000 to 107+000 proposed by NIPPON KOEI consultant;

- Field visit of the whole section;

- Implementing agreements with local government on intersected area (negotiation is carried out in detail in this stage because previous studies hasn't had any agreement with local government);

- Results:

On the section at Km 110+000 due to high filling embankment, It is necessary to design one more viaduct with span diagram of 12 @Super T.

+ 23 bridges crossing rivers, streams, irrigation canals and drains;

+ 03 flyovers on national highway/provincial road/ access road and the interchanges;

+ 22 expressway-crossing over bridges;

+ 14 underpasses;

iv) Connection road from the end point of the expressway to National Highway No. 1A

Bridges on section connecting the end point of the expressway to Highway

1A in the vicinity of Quang Ngai province.

No	Name of bridges	Province	Expected span diagram (m)	Expected bridge length (m)	Note
1	Bridge no 1	Quang Ngai	1 x 33	47.10	B=12 m
2	Bridge no 2	Quang Ngai	1 x 33	47.10	B=12 m
3	Bridge no 3	Quang Ngai	1 x 24	33.10	B=12 m

Bridges are designed according to the standard of road on plain class III.

6.2.5 Typical cross section

- **Width of typical cross section of bridge on main alignment:**

The bridge's width in the project is equal to the width of road.

According to design standard of highway, the width between the two rails is equal to that of embankment B=26.0 m

Table 6.2.2 – The width of bridge on main alignment

Factors	Width (m)
Parapet	2x 0.50m = 1.0 m
Safety strip	1x 0.75m = 0.75 m
1 emergency lane	1x 3.25m = 3.25 m
2 lanes	2x 3.75m = 7.50 m
Total width of one direction	B = 12.50 m
Clearance between two bridges	1x 1.0m = 1.0 m
Total width of bridge	B = 12.50+1.0+12.50=26.0 m

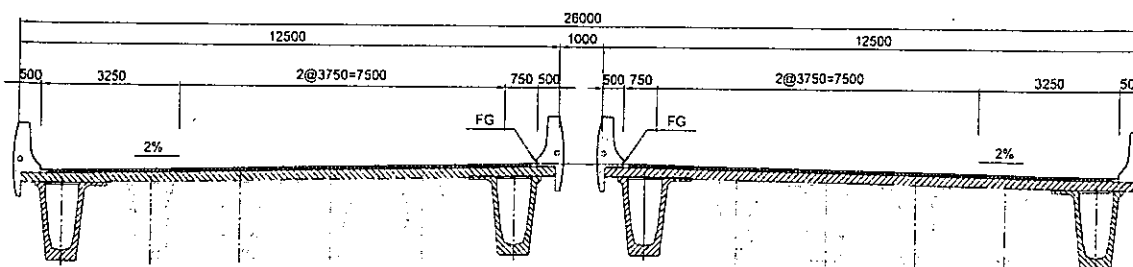


Figure 6.2.1 – The width of typical cross section of a bridge on main alignment

- **Cross section for bridges over highway**

Typical cross section of connection roads, highways are designed based on agreements with local government and design standard TCVN 4054:2005.

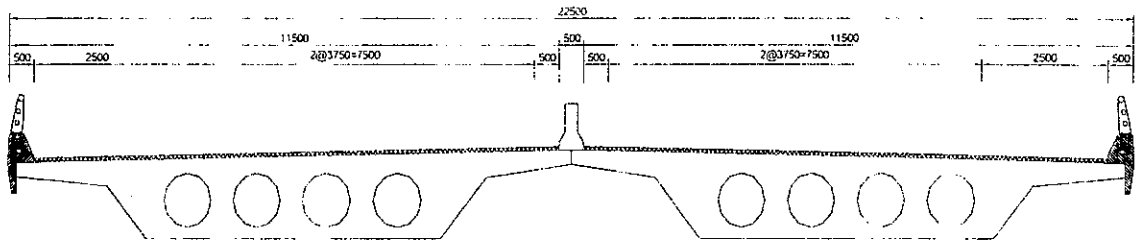


Figure 6.2.2 – Cross-section of bridge on road class II, $B=22.5\text{ m}$
 (used for 14B Highway over expressway)

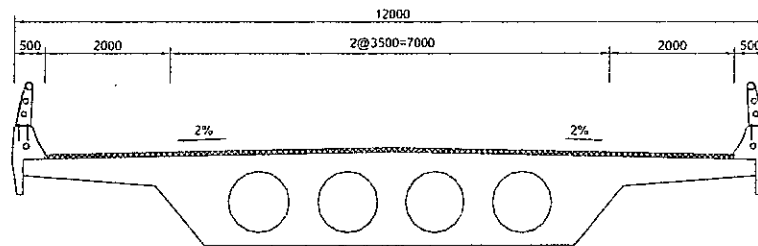


Figure 6.2.3 – Cross-section of bridge on road class III, $B=12.0\text{ m}$

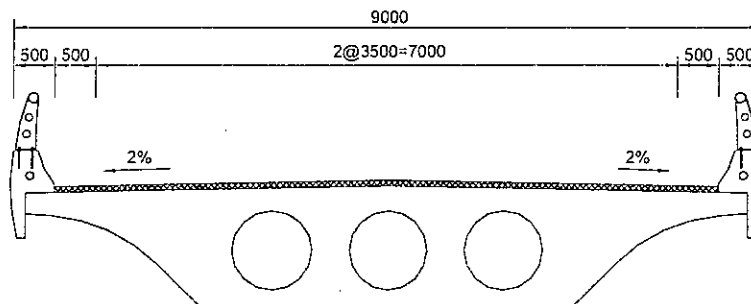


Figure 6.2.4 – Other roads with cross-section, $B=9.0\text{ m}$.

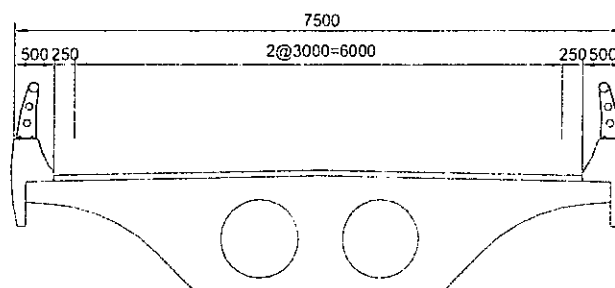


Figure 6.2.5– Cross-section of over bridge crossing inter-commune roads, $B=7.50\text{m}$.

- Cross-section of overpasses/underpasses

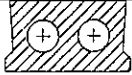
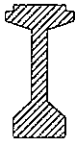
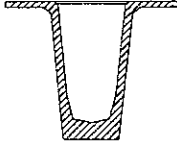

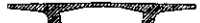
Use underpasses for some positions with clearance sizes as follows:

- Minimum vertical clearance 4.75 m used for roads of classes I, II, III
- Minimum vertical clearance 4.50 m used for other classes of road
- Minimum vertical clearance 3.50 m used for rural roads.
- Width of a underpass is usually 5.0 meters, in some special positions >5.0 meters

6.2.6 Superstructure

Alternate designs of superstructure are compared as in following table:

Table 6.2.4 – Comparison of alternate designs of superstructure

Content of comparison	Slab beam (PC-S)	PC I girder (PC-I)	Super T girder (Super T)	Hollow slab girder (PC-HS)	Box girder (Box)
Cross section					
Description	Slab beam is made of normal reinforced concrete and prestressed reinforced concrete, with a size from 9-24m. Width of each slab beam B=1.0m.	- Structure of PC I girder is made of post-stressing prestressed reinforced concrete, with a size from 24-33m	Structure of Super T girder is made of prestressed reinforced concrete, with a maximum size of 38.3m. The distance between two centerline of 2 piers is 40 meters	Structure of hollow slab girders made of prestressed reinforced concrete, casted on scaffolding with an size of span is from 24-35m	Structure of continuous box girder is made of prestressed reinforced concrete, casted on scaffolding (immobile or mobile) length of each span 40-50 m, or balance cantilever with a size of from 75-150m.
Advantage	Height of structure is small, girder is precasted on casting platform, time of erection is short, motorization capability is	Girder is precasted, time of erection is short, motorization capability is high, able to extend bridge in	Box girder is thin-walled, twisting hardness is good, and material-saving, erection of precasted girder is short and quick,	The length of structure is small, aesthetic value is high, especially applied for bending bridges in intersections.	Twisting hardness is good, aestheticism is high, especially applied for bending bridges in intersections,

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Content of comparison	Slab beam (PC-S)	PC I girder (PC-I)	Super T girder (Super T)	Hollow slab girder (PC-HS)	Box girder (Box)
	high, able to extend bridge in future	future	motorization capability is high, able to extend bridge in future. Economical for multispan bridges		size is big, reduce number of piers, compared with using other girders
Disadvantage	Costly, execute casting platform on site. Restriction in size.	Aestheticism is not high. Restriction in size.	Costly, execute casting platform on site	Weight of structure is big, cost is high, manner of execution requires plane (use immobile scaffolding), and ability to extend bridge in future is difficult.	Cost is high, length of structure is big, manner of execution requires plane (when using immobile scaffolding), or specialized equipment (when using mobile scaffolding), ability to extend bridge in future is difficult.
Proposal for application	Small and median bridges from 1-3 spans that are over streams, rivers. Total length of a bridge (calculated to the end of wing wall) $L < 100m$.	- Small and median bridges from 1-3 spans, length of a bridge $L < 100m$.	Possible to apply to all kinds of median and big bridges requiring vertical clearance $< 40m$. However, it is economical when applied to big bridges and multispan viaduct	Flyovers in intersections, bending bridges.	Flyovers in intersections, bending bridges, bridges intersecting with highway with big skew angle, viaduct has great length and high piers. Bridges over rivers must casted with cantilever.

Table 6.2.5 - Principle of applying superstructure

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	Erecting slab beam (PC-S)	PCI girder (PC-I)	Super T girder (Super T)	Hollow slab girder (PC-HS)	Box girder (Box)
Bridge of main alignment	OK	OK	OK	OK (in intersection)	OK
Highway Flyover (*)	N/A	N/A	N/A	OK	N/A

Note:

OK – Applicable;

N/A – Not applicable;

(*) – For agreement, only use cast-in-place hollow slabs for expressway flyovers.

6.2.7 Sub-structure

To review the proposal of NIPPON KOEI consultant for balance cantilever bridges with one-column wall-typed pier, T-cap above which is placed on two box girders. In theory, this pier is appropriate for boats clearance and water blocking reduction. However this solution is restricted and impractical:

- Cantilever box girders casting have large static load so cap is very cumbersome. Therefore It is necessary to arrange big prestress as girders are put on cantilever wing.

- Construction works is in seismic zones so calculation of body of abutments is difficult to meet seismic conditions.

- In cantilever construction, it is impossible to execute both boxes simultaneously then the load causing lengthwise and widthwise bending load negatively affects the pier body.

- Designing steel for cap is very difficult

Based on above analysis, the Project Updating Consultant recommends:

i) Abutment

For selecting type of abutment, characteristic of 3 types of abutment is described as follows:

- Gravity abutment: applied in places that have good stratum structure, applied height is from 5m to 6m.

- Reverse-T-shape abutment: Reversed T-shape abutment is light in weight. This type of abutment is cost-saving due to stabilizing load of filling soil. The execution of filling soil is simple. The appropriate height reaches 12 m and is

applied in places that have normal natural surface conditions.

Wall abutment: Wall abutment is a type of abutment that has a height of more than 12 m. The execution of reinforcing and concrete is complex and soil filling is difficult when using bulky machinery.

Most of bearing strata in bridge positions observed are at from 5 m to 10 m in depth. Because pile foundation is applied for most of bridges, lightweight structures are preferentially selected. The height of abutment is designed between 8-10m, Inverse T abutment is normally used in designs.

ii) Pier

The selection of pier, characteristics of 2 types of pier are described as follows:

- Wall pier and T pier: Wall pier and balanced cantilever girders are widely used for river crossing bridges, plains, mountains and cities. If the stability of high piers is in perpendicular angle, the balanced piers will be chosen by girder erection to reduce cross-section area. Applied elevation can reach up to 50 meters.

- Cylindrical pier: This pier is used in positions that have flows diagonal with the diagonal angle compared to the bridge centerline and expressway Flyovers, piers of the bridges in interchanges.

iii) Bridge foundation

For selection of foundation for small bridges, characteristic and criteria of selection of foundations is basically described as follows:

Shallow foundation: Shallow foundation is a type of foundation directly applied to stratum. This type of foundation will be applied when the depth of stratum is below 5 m.

Driven piles and bored piles can have appropriate diameters depending on actual situations. However, in places near residential areas, sensitive zones, areas near construction works, bridges that require large load impacting on piles or inaccessible road to the site, do not apply piles in these situations.

6.2.8 Bridges in interchanges:

The alignment is crossed by many roads including national highways, provincial roads, inter-district roads, etc. The Interchanges are arranged to have large cross roads and in line with local or planning sector. For cross roads at important positions, arrange grade-separated intersections connecting the Expressway. The principle of designing bridges in intersections:

- Structure is slender, aesthetic.
- Suitable with topography of areas of intersection and types of

intersections.

- It guarantees geometric factors in intersections.
- Manner of execution is suitable, guaranteeing continuous traffic of current roads during construction.
- For cross roads with a small scale or canal roads designed below highway Flyovers or gathered or concentrated with a lot of cross roads passing one intersection.
- In the case the pier is located on the median, or is necessary to design a further steel shell with a thickness of 12 to 16 mm covering the outside of the pier body of 1.8 m above the pavement before casting concrete for the pier body to protect against vehicle collision.

6.2.9 Viaduct of the main alignment:

In positions where terrain changes suddenly, filling height is too high, and at positions where floods frequently occur or have high frequency of floods, to guarantee criteria on stable construction and to restrict influences on environmental landscape, Consultant studies alternate design of a viaduct according to following principles:

- Study for construction of viaducts in places having average filling embankment >12m or in places road base is embanked on deeply flooded, overflow areas and places road base of bridge ends are in soft soil.
- Structure is aesthetic, suitable with topography and landscape.
- Standardization of the structures for high motorization ability.
- Simple, convenient construction, limiting the supporting facilities.

It is recommended to use of Super-T, PCI girder for structure of viaduct and respective sub-structure.

6.2.10 Flyovers and box culverts:

Because the alignment intersects a lot of existing access roads, to ensure demand for traveling of people living along the two sides of highway, it is necessary to design Flyovers and box culverts in combination with frontage roads in the two sides. Positions of a bridge or a box culvert are projected based on existing cross roads according to investigation and agreements with the local government. The Principle of designing works for local people's traveling is as follows:

- * Access Over bridges:
 - + Suitable with current road class with consideration of extending, upgrading, enhancing access road elevation in the future.
 - + Span plans and structures are suitable with topography, ensuring to save

construction expenses.

+ Structure is slender, various, contributing to creating architectural landscape for highway.

Note that for piers of over bridges located on the median, it is necessary to design a further steel cover with a thickness of 12 to 16 mm for outside pier body which is 1.8 m high above the pavement before casting concrete for the pier body to protect against vehicle collision.

Box culverts:

+ Design in positions of filling embankment to limit volume and reduce construction expenses.

+ Conform to current road level with consideration of extending, upgrading in the future.

+ Ensure vertical clearance for means of transportation such as cars, light trucks with loads for rural road as discussed above.

6.2.11 Statistic of hydrographic data of main alignment's bridges over rivers/streams

Based on collected and calculated hydrographic data, calculation of hydrographic data and hydraulic power will be statistic by Consultant in the final report.

6.2.12 Design of big river bridges

Ky Lam and Chiem Son in Quang Nam province and Tra Bong and Tra Khuc in Quang Ngai province are classified as big bridges over rivers in this study.

The final report by NIPPON KOEI consultant shows that: The localities through which the project goes through have basically agreed with the consultant on applying concrete bridges in the meetings with Quang Nam province on November 5th 2008 and with Quang Ngai on November 6th 2008 and other meetings with PMU85.

i) Principle of arranging spans for main bridges:

Based on the study of NIPPON KOEI consultant in connection with further studies shows that regime of rivers and flowing direction of rivers, especially in bridges of Ky Lam, Chiem Son and Tra Khuc are not stable. Therefore It is necessary to propose standard span length for the whole span between the two river banks to ensure bridge opening for each river when its flow changes.

ii) Sub-structure of bridges:

The piers are designed in so that the effect on the flow of river is minimum, hence minimize erosion in piers. As above mentioned, the flow of river intersecting

with main bridges will change in future.

The study of NIPPON KOEI consultant uses one cylindrical pier for two cantilever box girders placed on the cap, which is infeasible because :

- In theory, this pier seems to be suitable for boat clearance and water blocking reduction; however it is necessary to clarify some points:

- Balanced cantilever box girder has a very large static load → cap is extremely bulky and it is a must to design a large prestress because the girder is put on cantilever wing.

- The Works is located in the seismic, strongly windy area, therefore, in the calculation the pier body is difficult to meet requirements.

- In execution of cantilever, it is impossible to execute both boxes simultaneously, then the load causing horizontal bending and vertical bending along the pier's body negatively affect the pier body.

- It is difficult to arrange steel for this cap.

- Aestheticism is not high.

A consultant recommends that cantilever span piers over rivers would use two separate pier bodies for each bridge (left and right). At position of rivers, the centerline is slanted much over the running current, thus it is necessary to study so that the pier has a shape which minimizes water blocking.

iii) Design of Ky Lam bridge

Ky Lam bridge crosses Thu Bon river at Km17+700. The alignment is in the section that is not realigned compared to the alignment of NIPPON KOEI consultant. In this area, the width of river-bed is about 950m. On the downstream side 200 m is a railway bridge of 500 m, arrangement of 10 steel truss spans of 50 m built in 2002 also crosses Thu Bon river. 200 kV high voltage line crossing is parallel to the alignment which is 100 m on the upstream side. Characteristics of the river are shown as follows:

Table 6.2.6 –Requirements for Ky Lam bridge

No	Bridge name	Vertical clearance for boat clearance			DHWL	
		River class	Vertical	Horizontal	H (1%)	H (5%)
			m	m	m	m
1	Ky Lam	IV	6	40	8.66	-

- Option of crossing river

The Intersection point is a junction of rivers and it is shown on the map that

with a span length of 50 meters. new bridge must have a span of at least 50 m or more so as not to affect flow of the river. For navigation clearance, this river is classified as IV class so vertical and horizontal clearance must be 6m and 40m respectively. Therefore Super Tee girder should be applied. Length of each span for PC extra-dosed girder, precasted girder/cable strayed bridge and suspension bridge is too long compared to the requirement. Therefore, precasted concrete box girder bridge and steel plate bridge are selected. Results of selecting types of bridge are shown in following table:

Table 6.2.7 –Result of selecting Ky Lam bridge

Type of bridges		Applicable span length	Evaluation	
Concrete	Super-T girder	35 m - 40 m	Not sufficient vertical Navigation Clearance	NG
	Prestressed box girder (Height of girder does not change)	40 m - 60 m	Total length of bridge is too long to execute	NG
	Prestressed box girder (Height of girder changes)	60 m - 100 m	Applicable	OK
	Prestressed Extra-dosed girder	100 m - 180 m	In term of economic aspect, the length of each span is too long than necessary.	NG
	Prestressed cable strayed bridge	180 m - 300 m		NG

The final option (without change compared to proposal by NIPPON KOEI consultant). Because the flow of river can change in future as above mentioned so the necessary length of span will be arranged for cross section of river suitably.

Span diagram: 4@40+65+5@100+65+4@40, Main pier: C30 RC wall pier, bored pile foundation D1500. – Approach span pier: BCTC C30 T pier, bored pile foundation D1000. - Abutment: C30 RC inverse T abutment, bored pile foundation.

iv) Design of Chiem Son bridge

Chiem Son bridge crosses Ba Ren river at Km20+200 at Duy Trinh commune, Duy Xuyen district, Quang Nam province;

The alignment is in section that is not realigned compared to section of NIPPON KOEI consultant.

In the area, width of river-bed is about 350 meters. On the downstream side 350 m away is railway with a length of 400 meters, arrangement of 80 steel spans of 50 meters built in 2002 also crosses this Ba Ren river.

Table 6.2.8 –Requirements for Chiem Son river

No	Name of bridge	Vertical clearance for boat clearance			Designed level water	
		River class	Vertical	Horizontal	H(1%)	H(5%)
			m	m	m	m
2	Chiem Son	V	3.5	25	8.68	-

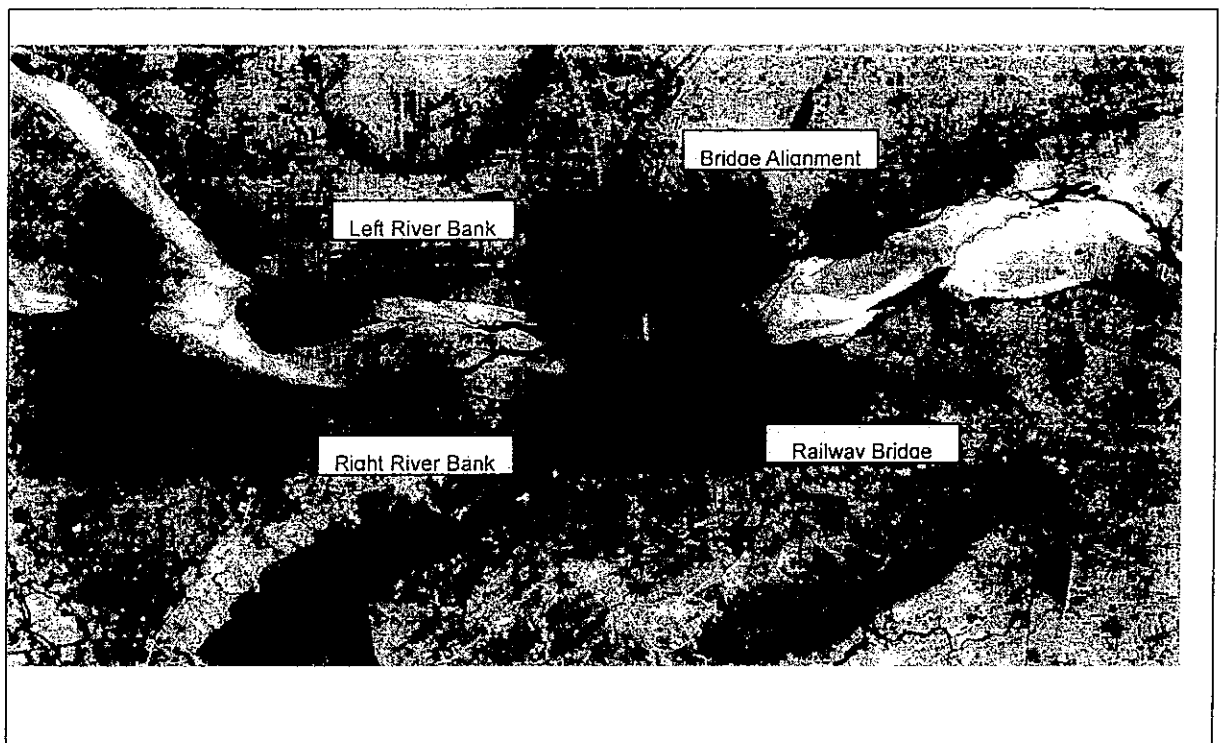


Figure 6.2.7 –Some pictures of a position of Chiem Son bridge

- Option of crossing river:

Alignment does not change compared to the proposal by NIPPON KOEI consultant. Cross section of the river including alluvial ground is 400 meters.

The river is classified as class V that requires horizontal navigation clearance of 25 meters for boats. Otherwise, on the downstream side is a railway bridge with a length of 50 meters. Therefore applicable span length is extra-dosed girder, PC/cable-strayed bridge or suspension cable these bridges have span length too long for necessary requirement. The result is that precasted box girder is considered for selection.

Table 6.2.9 –Results of selecting design option of Chiem Son bridge

Type of bridge		Applicable span length	Evaluation	
Concrete	Super Tee girder	35 m - 40 m	Not enough for minimum span length	NG
	Prestressed girder (Girder elevation does not change)	40 m - 60 m	Total length of bridge is too long to execute	NG
	Prestressed box girder (Girder elevation changes)	60 m - 100 m	Applicable	OK
	PC Extra-dosed girder	100 m - 180 m	The required length of each span is longer than	NG
	Cable-strayed bridge	180 m - 300 m	required economically.	NG

- Results of design:

Because the main flow of the river can change in future as mentioned in previous section. In fact, the main flow of river moves to the right of river-bed according to observation carried out (10/2008). Therefore the necessary length of each span must be arranged for cross section of the river suitably. Select span diagram: 3@33+55+90+55+3@33; cross section of main span includes 2 single box girder with a width of 12.5 meters; Cross section of approach span includes 10 PCI girders; width of bridge cross section B=26.0m; Main pier: C30 reinforced concrete, bored pile foundation D1500; Approach span pier: C30 RC T-pier, bored pile foundation D1000; Abutment: C30 RC Reverse-T abutment, bored pile foundation

v) Design of Tra Bong bridge

- Selection of a position for crossing river

Basically, the centerline through Tra Bong bridge does not change compared with the centerline proposed by NIPPON KOEI consultant at Km109+300. The point which bridge passes is upstream of Tra Bong river intersection and a small branch. Based on field study, river banks are fairly stable because a lot of high trees grow on the two banks of the river.

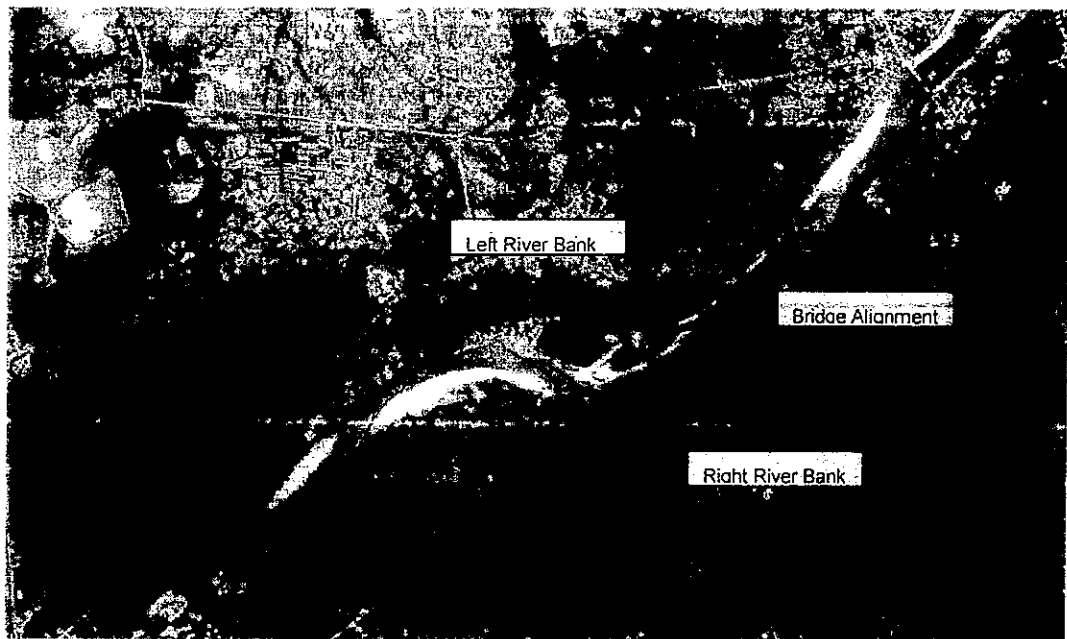


Figure 6.2.8 –Some pictures of a position of Tra Bong bridge

Official Letter no 1752/SGTVT-KHTĐ dated November 17th 2003 of Quang Ngai Department of Transport shows that: According to detailed planning on waterway transportation of Quang Ngai province approved at the decision no 169/2003/QĐ/-UB dated September 25th 2003, Tra Bong river is classified as V class river.

Basic hydrographic data is shown in following table:

Table 6.2.10 –Requirements for Tra Bong bridge

Name of bridge	Navigation Clearance			Designed water level	
	River class	Vertical	Horizontal	H(1%)	H(5%)
		m	m	m	m
Tra Bong	V	3.5	25	7.32	-

- Design of superstructure:

Based on principles, hydraulic calculation and results of measurement of upstream cross section at selected positions, following alternate designs are considered:

Table 6.2.11 – Selection of option for Tra Bong bridge

Type of structure	Applicable span length	Evaluation	Selection
Super T girder	n@ 40 m	Meet clearance for navigation clearance. Construction cost is the cheapest	OK
Balance cantilever	60- 100 m	Meet clearance for navigation clearance. Construction cost is higher than use of Super T girder	N.G
PC Extra-dosed girder	100- 180 m	Meet clearance for navigation clearance. Construction cost is high.	N.G
Cable-Strayed girder	180- 300 m	Meet clearance for navigation clearance. Construction cost is the highest.	N.G

On the basis that, the width between the two river banks is 330 meters and the further arrangement for better drainage for flooded area on the right bank, total length of Tra Bong river is expected to be (11@40m= 440 m span SuperT).

- Solution for sub-structure:

For pier foundation, use bored piles with a diameter of 1.0 meter.

vi) Design of Tra Khuc river

- Selection of a position for crossing river

Previous study of NIPPON KOEI consultant shows that alignment is greatly diagonal to the flow of river, on that basis, re-align the alignment to the west/upstream of Tra Khuc river 800 meters far from the alignment of NIPPON KOEI consultant.

Alternate design of Tra Khuc bridge: Tra Khuc bridge crosses Tra Khuc river at the position where the alignment passes is wider than surrounding areas and the alignment a bit deflects compared with the flow of the river. However, designed alignment meets other conditions of topography, social environment and minimum curve radius.

The main flow and flowing direction of river change between the two banks as observed in pictures photographed from satellite and other studies. The minimum

length of bridge is 880 meters.

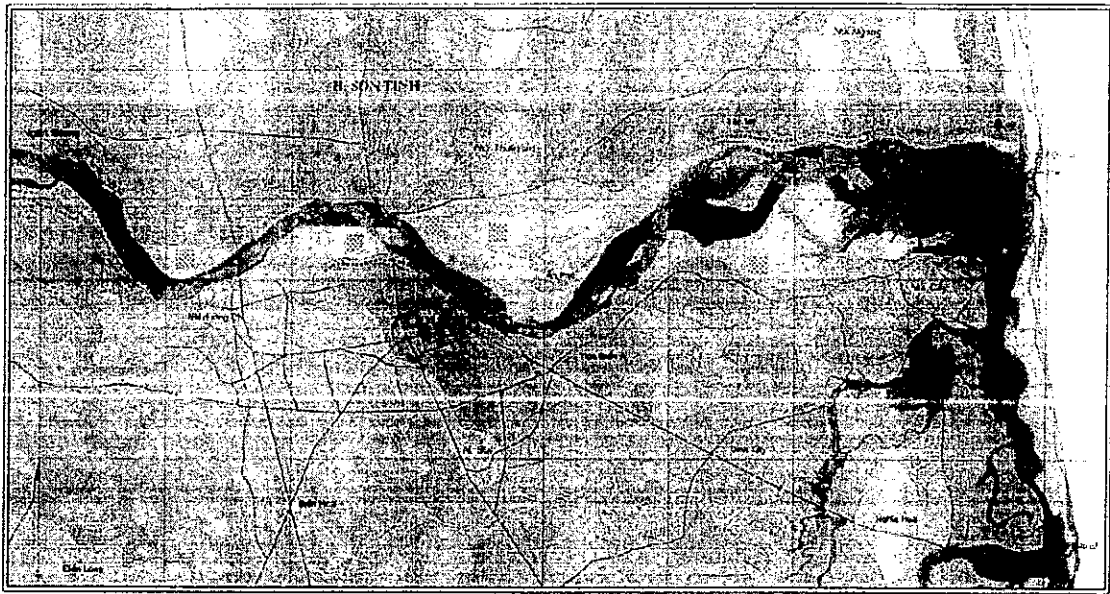


Figure 6.2.9 –Change of the main flow of Tra Khuc river.

The figure shows the change of flow of Tra Khuc river chronologically. The flow in 1965 is expressed in red color and flow in 1993 is expressed in blue color. Flooded area of Tra Khuc river shows flow of water at position of the bridge. The whole bank of the river in Da Nang has been embanked.

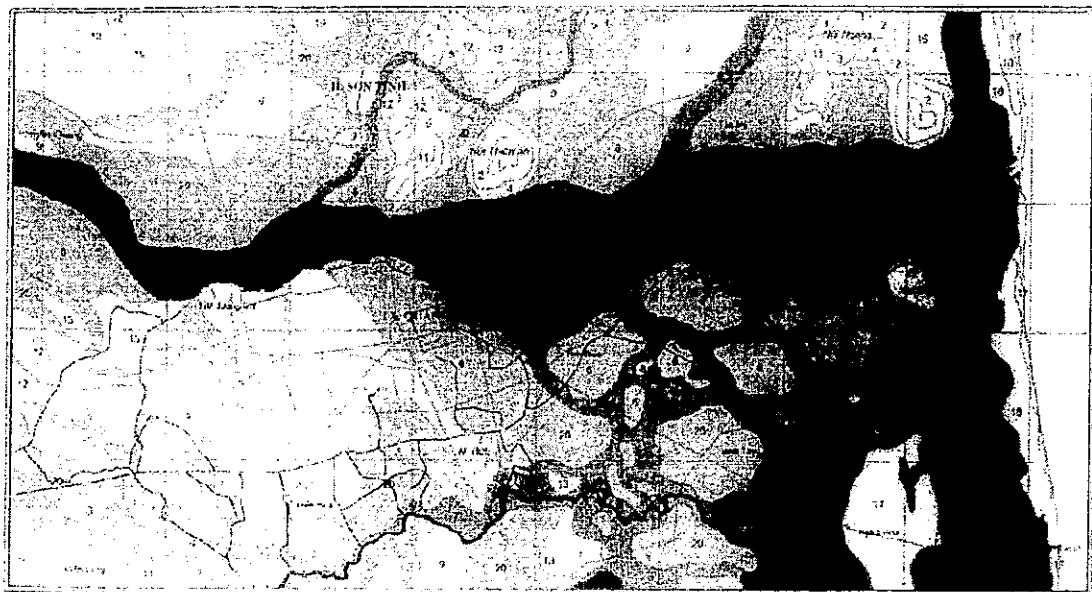


Figure 6.2.10 –Flood area of Tra Khuc bridge.

According to documents of Center for Studies and Evaluations of Natural Conditions to Enhance Capability of Warning and preventing natural Calamities & Flood in Some Southern Areas, the flood basin of Tra Khuc river is shown in the above figure.

Selection of alignment: The alignment crossing the river is shifted to the

upstream about 800 meters compared with previous study of NIPPON KOEI consultant.

Official Letter no 1752/SGTVT-KHTĐ dated 17th November 2003 of Quang Ngai Department of Transport shows:” According to detailed planning on waterway transportation of Quang Ngai province approved at the decision no 169/2003/QĐ/-UB dated September 25th 2003, Tra Bong river is classified as river class VI.

Table 6.2.12 –Requirements for Tra Khuc bridge

No	Name of bridge	Navigation Clearance			Designed water level	
		River class	Vertical	Horizontal	H(1%)	H(5%)
			m	m	m	m
1	Tra Khuc	VI	2.5	15	-	-

- Structure option

For hydrographic requirement of the river, length of each span, topographic condition, arrangement of span for alternate design of the bridge is selected as follows:

Table 6.2.13 –Results of selecting alternate design for Tra Khuc bridge

Type of structure	Applicable span length	Evaluation	Selection
Super T girder	n@ 40 m	Meet requirements for navigation clearance. However, for Tra Khuc river, flood discharge is large. Therefore the arrangement of a lot of piers won't be appropriate, resulting in lack of clearance in the flow of the river. Construction cost is the lowest.	N.G
Balance cantilever	60- 100 m	Meet requirements for navigation clearance, flood draining and clearance for the flow. Moderate construction cost.	OK
PC Extra-dosed girder	100- 180 m	Meet requirements for navigation clearance, flood draining and clearance for the flow. Construction cost is high	N.G
Cable-Strayed girder	180- 300 m	Meet requirements for navigation clearance, flood draining and clearance for the flow. Construction cost is highest.	N.G

Based on the width between the two banks and the length of the bridge calculated according to hydrographic requirement: Total length of Tra Khuc bridge:

It is projected that structure of superstructure is made of concrete box girder, prestressed balance cantilever with an arrangement of span 65m+7@100m+65m.

Design solution for the sub-structure: For pier foundation, use bored piles with a diameter of 1.5 m.

6.2.13 Structure of other works

- RC retaining wall: At the two ends of the bridge in intersection, to solve elevation difference between bridge approach roads and ramps in two sides, use reinforced concrete retaining wall in the form of L on precasted reinforced concrete pile foundation or shallow foundation on natural foundation. The surface of retaining wall is slotted for decoration.

- Handrail: Parapet is designed with a height in accordance with requirements of bridge design Standard 22TCN 272-05; handrail of the bridge are made of galvanized steel (for bridge that is not in main alignment).

- Coating layer: Wearing coat is 74mm thick including following layers: Neutral particle asphalt layer: t=70mm and water-proof layer of specialized material with a depth of 4mm.

- Drainage: Water is collected to drainage pipes on deck, and concentrate on drainage pipes along the deck. These pipes run to the pier and then down to via pipes along the vertical surface outside of the pier.

- Traffic safety: Traffic safety on bridge is done by drawing lines in paint breadth wise according to applicable regulations. The road mark line at the foot of guardrail is solid line. Road mark line between carriage-way and emergency lane are solid lines with reflective nails. Median strips between lanes are broken lines.

6.2.14 Materials for construction of bridge and works

- **Concrete:**

Types of concrete used for structures of works in the project are as in the following table (strength of concrete at twenty-eight days)

Table 6.2.14 - Concrete used for structure

Concrete level	Intension f _c (MPa)	Used structures
C45	45	Super T girder
C40	40	Prestressed reinforced concrete girders: cantilever prestressed concrete, box girder, scaffolding box girder, Prestressed cap

C30	30	Bridge deck and transverse girders of type I, erecting plate girders, abutments, shafts, bored piles, underpasses, box culvert.
C25	25	Parapet, median, transition slab, retaining wall.
C10	10	Foundation base blinding concrete, bottom seal concrete

• **Ordinary reinforced steel and prestressed steel:**

Ordinary reinforced steel conforms to the standard TCVN1651-85 or equivalent.

Prestressed steel: prestressed steel is a type of steel which included 7 steel wires, uncoated, low relaxation, and meet the standard AASHTO M 203/M 203M (ASTM A 416/A).

Prestressed bar steel meets the standard AASHTO M 275/M 275M (ASTM A 722/A 722M).

Table 6.2.15 – Standard of steel

Steel	TCVN1651-85 or equivalent		Yield point: 400MPa
	Es elasticity modulus		Es = 200,000MPa
Prestressed steel	strand	Level	Grade 270 low relaxation
		Nominal diameter	12.7mm or 15.2 mm
		Breaking strength (fpu)	1,860MPa
		Yield point (fpy)	90% x fpu
	bar	Intensity	Type 1, plain
		Diameter	19mm to 35mm
		Breaking strength (fpu)	1,035MPa
		Yield point (fpy)	85% of fpu

6.2.15 Organization for construction of the bridge

i) Location of site

For big bridges, a site hut is located at the two ends of the bridges. For small bridges or viaducts, the position of a site hut depends on topography or distance to place of execution but it should be located in a way convenient for managing each bridge or many bridges effectively.

ii) Construction of abutment

- *The foundation is bored piles*
- Sand filling and grading, and define center of abutment and position of piles.
- Install earth drilling equipment.

- Drill holes, reinforce boreholes by using pipe casing and clay mortar, wash drilled holes, install and lower steel ring by crane, fix piles by moving termite pipes vertically.

- Excavate foundation pit to designed elevation, hammer the concrete pile cap, cast and smooth the concrete, install formwork, lay reinforcement for foundation, hold foundation firmly, cast concrete, fill soil up to the top surface of the foundation.

- Install scaffolding and formwork, reinforce for abutment body, retaining wall, wing wall..., cast and treat the concrete, remove scaffolding and formwork.

- Execute quarter-cones, install transition slab and finish abutment.

- *Execute abutment with concrete pile driving*

- Sand filling & grading, define center of abutment and location of piles.

- Install devices for driving piles and drive piles down to designed elevation

- Excavate foundation pit to designed elevation, hammer the concrete pile cap concrete, cast and smooth the concrete, install formwork, lay reinforcement for foundation, hold foundation firmly, cast concrete, fill soil to the top surface of the foundation.

- Install scaffolding and formwork, install reinforcement for abutment, retaining wall, wing wall..., cast and treat the concrete, remove scaffolding and formwork.

- Fill, execute quarter-cones, install transition slab on approach road and finish abutment.

- *Shallow-foundation abutment:*

- Define position of abutment.

- Excavate to the design elevation by digging machine and Excavate by hand, cast concrete to line foundation.

- Install formwork, install reinforcement for foundation, hold foundation firmly, cast concrete, fill soil to the top surface of foundation.

- Install scaffolding and formwork, install reinforcement for abutment, retaining wall, wing wall..., cast and treat the concrete, remove scaffolding and formwork.

- Fill, execute quarter-cones and loose rocks, install transition slab on approach roads and finish the abutment.

iii) Construction of pier

- *Pier on land*

- Pier on bored piles:

- + Sand filling & grading, and define centers of the piers and position of piles.

- + Install earth drilling equipment.

- + Drill holes, reinforce drilled holes by using casing and clay mortar, wash drilled holes, install and lower steel ring by crane, fix piles by moving the termite pipes vertically.

- + Excavate the foundation pit to designed elevation, hammer the concrete pile cap, cast and smooth the concrete, install formwork, lay reinforcement for foundation, hold foundation firmly, cast concrete, fill soil to the top surface of the foundation.

- + Install scaffolding and formwork, arrange reinforcement for the body, pier cap, remove scaffolding and formwork.

- Piers on driven concrete pile foundation:

- + Skim ground plan and define centerline of pier and position of piles.

- + Install devices to drive piles and drive piles down to designed elevation.

- + Excavate the foundation pit to designed elevation, hammer the concrete pile cap, cast and smooth the concrete, install formwork, lay reinforcement for foundation, hold foundation firmly, cast concrete, fill soil to the top surface of the foundation.

- + Install scaffolding and formwork, reinforce for pier bodies, pier cap, remove scaffolding and formwork.

- + Fill soil to natural ground and finish pier.

- Pier on shallow foundation

- + Sand filling & grading, and define centers of the piers and position of piles.

- + Excavate to designed elevation by digging machines and Excavate by hand, cast concrete to line foundation.

- + Install formworks, reinforce for foundation, hold foundation firmly, cast concrete, fill soil to the top surface of foundation..

- + Install scaffolding and formwork, arrange reinforcement for the body, pier cap, remove scaffolding and formwork.

- + Fill to natural ground and finish the pier.

- *Underwater pier*

- Pier on bored piles:

- + Define center of pier and positions of piles.

- + Install steel cofferdam.

- Install flying buttress.
 - Install bearing shoe and temporary structure.
 - Execute the Ko block of the section above the top of the pier and install temporary anchor to fix to the pier.
 - Prepare casting vehicle.
 - Execute box girder by method of casting fragmented balance cantilever. Install steel reinforcement, cladding, prestressed cable, cast concrete, tighten prestress.
 - Execute girders casted on scaffolding, closure.
 - Water-proofing, spreading asphalt concrete, finish bridge.
 - *PC-S slab and Super T girder*
 - Prepare girder casting yard, mobilize equipment and materials.
 - Execute casting platform/formwork.
 - Install reinforcement for girder and prestressed cable and install formwork.
 - Cast and cure the concrete.
 - Stretching prestressed cable.
 - Move the girders to the site.
 - Erect girders by crane and install.
 - Execute bridge deck and concrete edge.
 - Water-proofing, pours asphalt concrete, finish the bridge.
 - *Prestressed hollow slab girder (casted in factories or other locations)*
 - Convey girders from foundry to the field.
 - Erect girders by crane and locate girders.
 - Cast concrete to joint girders.
 - Execute concrete edge strip, proof for bridge deck, spreading asphalt concrete, finish bridge.
- Post-tensioned Hollow slab girder
- Move materials out of casting yard
 - Install scaffolding and flying buttress.
 - Arrange reinforcement and prestressed cable and protecting cover of girders, install formwork.
 - Cast and cure concrete.
 - Stretching prestressed cable.
 - Remove formwork and execute next stage.

- Waterproofing for bridge deck, spreading asphalt concrete, finish bridge.

v) Time of execution of prestressed box girder

Time for execution of prestressed box girder and balance cantilever for Ky Lam bridge and Tra Khuc bridge, the two big bridges using method of casting balance cantilever. Both the two bridges are expected to be completed within 42 months with 6 scaffoldings, formwork for each bridge.

6.2.16 Results of design of works

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Table 6.2.16 - SUMMARY CHART OF BRIDGES ON MAIN ALIGNMENT

Section Km 0+000- Km 35+000

No.	Position	Crossing		Bridge length (m)	Span diagram	Deck area (m ²)	Girder type	Foundation		
		Name						Type	Pile size (cm)	Pile length (m)
1	2	3		4	5	6	7	8	9	10
1	Km0+000.00	✓ Drain	Tuy Loan	49.1	1 @33	1276.6	PC-I	Driven pile	40	16
2	Km1+618.66	✓ River	Tuy Loan river	743.15	22 @33	19321.9	PC-I	Driven pile	40	14
3	Km2+510.13	✓ River	Yen river	181.3	5 @33	4713.8	PC-I	Bored pile	100	32
4	Km5+623.00	✓ River	Yen Ne	113.2	3 @33	2943.2	PC-I	Driven pile	40	26
5	Km5+750.16	✓ Road		26.1	1 @12	678.6	PC-S	Driven pile	40	26
6	Km7+926.01	✓ Road		23.1	1 @9	600.6	PC-S	Driven pile	40	26
7	Km9+870.00	✓ River	Bau Sau	183.3	5 @33	4765.8	PC-I	Driven pile	40	15
8	Km10+270.79	✓ Drain	Bau khe	90.2	3 @24	2345.2	PC-I	Driven pile	40	28
9	Km10+882.00	✓ River	La Tho	117.2	3 @33	3047.2	PC-I	Driven pile	40	26
10	Km11+940.48	✓ Drain	Bau Duc	150.25	4 @33	3906.5	PC-I	Driven pile	40	15
11	Km12+639.09	✓ River	My Yen	86.2	3 @24	2241.2	PC-I	Driven pile	40	15
12	Km13+210.09	✓ Drain		138.3	5 @24	3595.8	PC-I	Driven pile	40	25
13	Km13+625.83	✓ Road	PR609	42.1	1 @24	1094.6	PC-S	Driven pile	40	15
14	Km14+027.36	✓ River	Phong Thu	117.2	3 @33	3047.2	PC-I	Driven pile	40	20
15	Km14+873.45	✓ Drain	Bau Thinh 1	117.2	3 @33	3047.2	PC-I	Driven pile	40	12
16	Km15+171.40	✓ Drain	Bau Thinh 2	117.2	3 @33	3047.2	PC-I	Driven pile	40	12
17	Km16+497.27	✓ River	Ky Long	117.2	3 @33	3047.2	PC-I	Driven pile	40	12
18	Km17+661.91	✓ River	Ky Lam	962	4@40+65+5@100+65+4@40	25012	Box	Bored pile/CIP	100-150	40
19	Km18+319.01	✓ Drain	Xa Duyet	86.2	3 @24	2241.2	PC-I	Driven pile	40	24
20	Km18+612.04	✓ Drain	Roc	62.15	2 @24	1615.9	PC-I	Driven pile	40	24

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✓	21	Km18+830.80	✓	Drain	Bau Tai	86.2	3 @24	2241.2	PC-I	Driven pile	40	24
✓	22	Km19+209.44	✓	Road	PR610B	26.1	1 @12	678.6	PC-S	Driven pile	40	15
✓	23	Km19+350.00	✓	Drain	Cau Lau	47.1	1 @33	1224.6	PC-I	Driven pile	40	26
M	24	Km20+185.00	✓	River	Chiem Son	410	3@33+55+90+55+3@33	10660	Box	Bored pile/CIP	100-150	31-34
✓	25	Km21+900.00	✓	Drain		47.1	1 @33	1224.6	PC-I	Driven pile	40	26
	26	Km23+350.00	✓	Stream		62.15	2 @24	1615.9	PC-I	Driven pile	40	24
	27	Km24+430.00	✓	Road		26.1	1 @12	678.6	PC-S	Driven pile	40	15
	28	Km24+648.00	✓	River		77.65	2 @33	2018.9	PC-I	Bored pile	100	9
	29	Km25+062.00	✓	Road		26.1	1 @12	678.6	PC-S	Driven pile	40	15
	30	Km25+720.00	✓	Stream		36.1	1 @24	938.6	PC-I	Bored pile	100	13
✓	31	Km27+000.00	✓	Drain		34.1	1 @24	886.6	PC-I	Bored pile	100	13
✓	32	Km27+900.00	✓	Drain		26.1	1 @12	678.6	PC-S	Bored pile	100	15
	33	Km28+778.00	✓	Road		26.1	1 @12	678.6	PC-S	Driven pile	40	15
	34	Km29+500.00	✓	Stream		77.65	2 @33	2018.9	PC-I	Bored pile	100	6
	35	Km31+950.00	✓	Road		26.1	1 @12	678.6	PC-S	Driven pile	40	15
✓	36	Km32+440.00	✓	Drain		26.1	1 @12	678.6	PC-S	Driven pile	40	15
✓	37	Km34+120.00	✓	Drain		70.15	2 @24	1823.9	PC-I	Bored pile	100	6

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Section Km 35+000- Km 60+000

No.	Position		Crossing		Bridge parameters						
	Km	Name	Bridge length (m)	Span diagram	Deck area (m2)	Girder type	Foundation		Pile length (m)		
							Type	Pile size (cm)			
1	2	3	4	5	6	7	8	9	10		
1	Km35+353.00	Road ✓ PR611	35	1 @21	910	PC-S	Shallow foundation				
2	Km36+200.00	River ✓	60	2 @24	1560	PC-I	Bored pile/CIP	100	8		
3	Km36+780.00	Stream ✓	24	1 @12	624	PC-S	Bored pile/CIP	100	8		
4	Km38+287.00	River ✓ Ru Ri	142	4 @33	3692	PC-I	Bored pile/CIP	100	17		
5	Km38+787.00	Road ✓	19	1 @9	494	PC-S	Bored pile/CIP	100	17		
6	Km39+550.00	River ✓ Ly Ly	176	5 @33	4576	PC-I	Shallow foundation				
7	Km39+995.00	Canal ✓	22	1 @12	572	PC-S	Bored pile/CIP	100	8		
8	Km40+776.00	Road	38	1 @24	988	PC-S	Shallow foundation				
9	Km41+121.00	Road ✓ NH 14E	38	1 @24	988	PC-S	Shallow foundation				
10	Km42+058.00	Canal ✓	58	2 @24	1508	PC-I	Bored pile/CIP	100	6		
11	Km42+596.00	Road ✓ NH 14E	34	1 @21	884	PC-S	Shallow foundation				
12	Km43+520.00	Canal ✓	23	1 @12	598	PC-S	Bored pile/CIP	100	6		
13	Km44+300.00	River ✓ Bau Veau	58	2 @24	1508	PC-I	Bored pile/CIP	100	6		
14	Km45+306.00	Stream ✓ Binh Chanh 1	21	1 @9	546	PC-S	Shallow foundation				
15	Km45+525.00	Canal ✓	25	1 @15	650	PC-S	Bored pile/CIP	100	24		
16	Km45+775.00	River ✓ Binh Chanh 2	142	4 @33	3692	PC-I	Bored pile/CIP	100	6		
17	Km46+121.00	Road ✓	19	1 @9	494	PC-S	Shallow foundation				
18	Km46+750.00	Stream ✓	25	1 @15	650	PC-S	Bored pile/CIP	100	10		
19	Km47+012.00	Road ✓	19	1 @9	494	PC-S	Shallow foundation				
20	Km47+850.00	River ✓ Chau Long	142	4 @33	3692	PC-I	Shallow foundation				
21	Km51+120.00	Road ✓	19	1 @9	494	PC-S	Shallow foundation				
22	Km54+222.00	Road ✓	19	1 @9	494	PC-S	Shallow foundation				
23	Km54+783.00	River ✓ Tam Thanh	45	1 @33	1170	PC-I	Shallow foundation				

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24	Km55+500.00	River	✓	Nha Ngu	142	4 @33	3692	PC-I	Bored pile/CIP	100	10
25	Km56+300.00	Canal	✓		22	1 @12	572	PC-S	Shallow foundation		
26	Km56+370.00	Road	✓		19	1 @9	494	PC-S	Shallow foundation		
27	Km56+940.00	River	✓	Tam Phuoc	45	1 @33	1170	PC-I	Shallow foundation		
28	Km57+378.00	Road	✓	PR 615	32	1 @21	832	PC-S	Bored pile/CIP	100	8
29	Km58+120.00	River	✓	Tam Dan	142	4 @33	3692	PC-I	Shallow foundation		
30	Km59+167.00	Road	✓		22	1 @12	572	PC-S	Shallow foundation		

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Section Km 60+000 – Km 73+000

No.	Position		Crossing		Bridge parameters						
	Km		Name		Bridge length (m)	Span diagram	Deck area (m2)	Girder type	Type	Pile size (cm)	Pile length (m)
1	2		3		4	5	6	7	8	9	10
31	Km62+337.00	✓	River	Hoa Binh	73	3 @21	1898	PC-I	Shallow foundation		
32	Km66+200.00	✓	Stream		73	3 @21	1898	PC-I	Bored pile/CIP	100	10
33	Km68+308.00	✓	River	Tam Ky 2	307	9 @33	7982	PC-I	Bored pile/CIP	100	13
34	Km71+000.00	✓	Canal		25	1 @15	650	PC-S	Bored pile/CIP	100	15

Section Km 73+000- Km 131+500

No.	Position		Crossing		Bridge parameters						
	Km		Name		Bridge length (m)	Span diagram	Deck area (m2)	Girder type	Type	Pile size (cm)	Pile length (m)
1	2		3		4	5	6	7	8	9	10
1	Km74+311.50	✓	River	Ba Tuc river	144	4 @33	3744	PC-I	Bored pile	100	15
2	Km74+879.31	✓	Canal	N28 canal	24	1 @12	624	PC-S	Driven pile	40	15
3	Km79+211.50	✓	Canal		33	1 @21	858	PC-I	Bored pile	100	15
4	Km81+555.50	✓	Canal	Thai Xuan canal	45	1 @33	1170	PC-I	Bored pile	100	15
5	Km82+527.40	✓	River	Trau river	84	3 @24	2184	PC-I	Bored pile	100	15
6	Km85+460.00	✓	Canal	Canal of Ho Trau dam	24	1 @12	624	PC-S	Driven pile	40	15
7	Km87+892.00	✓	Canal		36	1 @24	1170	PC-I	Bored pile	100	15

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Table 6.2.17 – SUMMARY CHART OF BOX CULVERTS (UNDERPASS)
OF THE MAIN ALIGNMENT

Section Km 0+000- Km 35+000

No.	Position	Crossing		Dimensions BxH
	Km	Type	Name	
1	2	3	4	5
1	Km1+162.00	Road	Frontage road	5.0x3.5
2	Km3+049.47	Road	Frontage road	5.0x3.5
3	Km3+691.84	Road	Frontage road	5.0x3.5
4	Km4+280.86	Road	Frontage road	5.0x3.5
5	Km4+527.84	Road	Frontage road	5.0x3.5
6	Km4+928.96	Road	Frontage road	5.0x3.5
7	Km5+239.42	Road	Frontage road	5.0x3.5
8	Km5+517.35	Road	Frontage road	5.0x3.5
9	Km5+678.41	Road	Frontage road	5.0x3.5
10	Km6+030.59	Road	Frontage road	5.0x3.5
11	Km7+469.94	Road	Frontage road	5.0x3.5
12	Km9+027.61	Road	Frontage road	5.0x3.5
13	Km9+299.89	Road	Frontage road	5.0x3.5
14	Km9+434.39	Road	Frontage road	5.0x3.5
15	Km9+761.80	Road	Frontage road	5.0x3.5
16	Km10+165.90	Road	Frontage road	5.0x3.5
17	Km11+270.30	Road	Frontage road	5.0x3.5
18	Km11+319.13	Road	Frontage road	5.0x3.5
19	Km12+255.89	Road	Frontage road	5.0x3.5
20	Km14+107.70	Road	Frontage road	5.0x3.5
21	Km14+375.78	Road	Frontage road	5.0x3.5
22	Km14+457.59	Road	Frontage road	5.0x3.5
23	Km16+192.65	Road	Frontage road	5.0x3.5
24	Km16+775.07	Road	Frontage road	5.0x3.5
25	Km16+942.77	Road	Frontage road	5.0x3.5
26	Km18+061.93	Road	Frontage road	5.0x3.5
27	Km18+211.36	Road	Frontage road	5.0x3.5
28	Km19+094.95	Road	Frontage road	5.0x3.5
29	Km19+380.00	Road	Frontage road	5.0x3.5
30	Km19+570.00	Road	Frontage road	5.0x3.5
31	Km19+680.00	Road	Frontage road	5.0x3.5
32	Km21+000.00	Road	Frontage road	5.0x3.5
33	Km21+150.00	Road	Frontage road	5.0x3.5
34	Km21+500.00	Road	Frontage road	5.0x3.5
35	Km22+000.00	Road	Frontage road	5.0x3.5
36	Km23+310.00	Road	Frontage road	5.0x3.5
37	Km24+000.00	Road	Frontage road	5.0x3.5

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38	Km24+600.00	Road	Frontage road	5.0x3.5
39	Km24+760.00	Road	Frontage road	5.0x3.5
40	Km25+200.00	Road	Frontage road	5.0x3.5
41	Km26+000.00	Road	Frontage road	5.0x3.5
42	Km29+260.00	Road	Frontage road	5.0x3.5
43	Km30+020.00	Road	Frontage road	5.0x3.5
44	Km30+610.00	Road	Frontage road	5.0x3.5
45	Km30+800.00	Road	Frontage road	5.0x3.5
46	Km30+740.00	Road	Frontage road	5.0x3.5
47	Km31+600.00	Road	Frontage road	5.0x3.5
48	Km32+000.00	Road	Frontage road	5.0x3.5
49	Km34+280.00	Road	Frontage road	5.0x3.5

Section Km 35+000 – Km 73+000

No.	Name of utility	Station	Structure type	Box culvert length (m)	Box culvert width (m)
Quang Nam province					
1	Box culvert	Km36+580	RC box		BxH=5x4.5
2	Box culvert	Km37+560	RC box		BxH=5x3.5
3	Box culvert	Km38+880	RC box		BxH=5x3.5
4	Box culvert	Km40+360	RC box		BxH=5x4.5
5	Box culvert	Km41+560	RC box		BxH=5x4.5
6	Box culvert	Km42+380	RC box		BxH=5x3.5
7	Box culvert	Km45+060	RC box		BxH=5x3.5
8	Box culvert	Km46+440	RC box		BxH=5x3.5
9	Box culvert	Km47+840	RC box		BxH=5x4.5
10	Box culvert	Km48+500	RC box		BxH=5x4.5
11	Box culvert	Km48+900	RC box		BxH=5x3.5
12	Box culvert	Km49+420	RC box		BxH=5x3.5
13	Box culvert	Km50+300	RC box		BxH=5x3.5
14	Box culvert	Km50+700	RC box		BxH=5x3.5
15	Box culvert	Km50+900	RC box		BxH=5x3.5
16	Box culvert	Km52+500	RC box		BxH=5x4.5
17	Box culvert	Km52+950	RC box		BxH=5x3.5
18	Box culvert	Km53+300	RC box		BxH=5x3.5
19	Box culvert	Km53+700	RC box		BxH=5x3.5
20	Box culvert	Km54+700	RC box		BxH=5x3.5

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21	Box culvert	Km55+260	RC box		BxH=5x3.5
22	Box culvert	Km55+940	RC box		BxH=5x3.5
23	Box culvert	Km56+890	RC box		BxH=5x3.5
24	Box culvert	Km57+960	RC box		BxH=5x3.5
25	Box culvert	Km58+700	RC box		BxH=5x3.5
26	Box culvert	Km59+940	RC box		BxH=5x3.5
	Quang Nam province	<i>Adjusted option 2 (Km60 - Km73)</i>			
1	Box culvert	Km60+480	RC box		BxH=5x3.5
2	Box culvert + TL	Km61+645.30	RC box		BxH=5x3.5
3	Box culvert	Km62+829.30	RC box		BxH=5x3.5
4	Box culvert Provincial road no. 616	Km63+656.41	RC box		BxH=5x3.5
5	Box culvert	Km64+089.78	RC box		BxH=5x3.5
6	Box culvert	Km64+240	RC box		BxH=5x3.5
7	Box culvert	Km64+432.38	RC box		BxH=5x3.5
8	Box culvert	Km65+338.59	RC box		BxH=5x3.5
9	Box culvert	Km65+680	RC box		BxH=5x3.5
10	Box culvert	Km66+678	RC box		BxH=5x3.5
11	Box culvert	Km67+467.65	RC box		BxH=5x3.5
12	Box culvert	Km68+100	RC box		BxH=5x3.5
13	Box culvert	Km68+470	RC box		BxH=5x3.5
14	Box culvert	Km69+178.50	RC box		BxH=5x3.5
15	Box culvert	Km70+275.03	RC box		BxH=5x3.5
16	Box culvert	Km70+616	RC box		BxH=5x3.5
17	Box culvert	Km71+900	RC box		BxH=5x3.5
18	Box culvert	Km72+705.34	RC box		BxH=5x3.5

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Section Km 73+000 – Km 131+500

No.	Position	Crossing		Culvert parameter			
	Km	Type	Name	Dimensions BxH (m)	Foundation		
					Type	Pile size (cm)	Pile length(m)
1	2	3	4	5	6	7	8
1	KM73+627.66	Road	Frontage	5.0x3.5	Driving pile	40x40	12
2	KM74+640.00	Road	Frontage	5.0x3.5	Driving pile	40x40	12
3	KM75+643.81	Road	Frontage	5.0x3.5	Driving pile	40x40	12
4	KM87+794.72	Road	Frontage	5.0x3.5	Driving pile	40x40	12
5	KM91+859.47	Road	Frontage	5.0x3.5	Driving pile	40x40	12
6	KM92+866.60	Road	Frontage	5.0x3.5	Driving pile	40x40	12
7	KM93+896.22	Road	Frontage	5.0x3.5	Driving pile	40x40	12
8	KM96+900.00	Road	Frontage	5.0x3.5	Driving pile	40x40	12
9	KM98+920.13	Road	Frontage	5.0x3.5	Driving pile	40x40	12
10	KM101+848.51	Road	Frontage	5.0x3.5	Driving pile	40x40	12
11	KM104+953.67	Road	Frontage	5.0x3.5	Driving pile	40x40	12
12	KM106+020.66	Road	Frontage	5.0x3.5	Driving pile	40x40	12
13	KM116+275.16	Road	Frontage	5.0x3.5	Driving pile	40x40	10
14	KM130+000.00	Road	Frontage	5.0x3.5	Driving pile	40x40	15

Table 6.2.18 – SUMMARY CHART OF OVERBRIDGES (INCLUDING OVERBRIDGES IN INTERCHANGES)

Section Km 0+000 – Km 35+000

No.	Position		Crossing			Bridge parameters						
	Km	Type	Name of Interchange	Length of Bridge(m)	Width of Bridge (m)	Span Arrangement	Area of Bridge(m ²)	Girder Type	Foundation			
									Type	Pile size (cm)	Pile length (m)	
1	2	3	4	5	6	7	8	9	10	11	12	
1	KM00+000.00	NH		220	12.00	6 @ 35	2640	PC-HS	Bored pile/CIP	100	18	
2	KM00+590.00	NH		45	9.00	1 @ 35	405	PC-HS	Driven pile	40	14	
3	KM09+584.65	PR	605	45	12.00	1 @ 35	540	PC-HS	Driven pile	40	15	
4	KM20+185.00	Other road	My Son LC Ramp	255	12.00	7 @ 35	3060	PC-HS	Driven pile	40	15	

Section Km 35+000 – Km 73+000

No	Station		Crossing			Bridge Parameter						
	Km	Type	Name of Interchange	Length of Bridge(m)	Width of Bridge (m)	Span Arrangement	Area of Bridge(m ²)	Girder Type	Foundation			
									Type	Pile size (cm)	Pile length (m)	
1	2	3	4	5	6	7	8	9	10	11	12	
1	KM64+200.00	Interchange	PR616	290	12.00	8 @ 35.	3480	PC-HS	Bored pile	100	15	
2	KM66+333.78	Other road	Dai Ngoc	185	12.00	5 @ 35	2220	PC-HS	Bored pile/CIP	100	15	

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Section Km 73+000 – Km 131+500

No	Position		Crossing		Bridge parameters							Foundation	
	Km	Type	Name of Interc hange		Length of Bridge(m)	Width of Bridge (m)	Span Arrangement	Area of Bridge(m2)	Girder Type	Type	Pile size (cm)	Pile length (m)	
1	2	3	4		5	6	7	8	9	10	11	12	
1	KM78+480.68	Other road			187	7.50	5 @ 35	900	PC-HS	Bored pile/CIP	100	15	
2	KM80+070.76	Other road			117	7.50	3 @ 35	900	PC-HS	Bored pile/CIP	100	15	
3	KM85+942.83	Other road			117	7.50	3 @ 35	900	PC-HS	Bored pile/CIP	100	15	
4	KM89+334.57	Other road			47	7.50	1 @ 35	900	PC-HS	Bored pile/CIP	100	15	
5	KM99+709.68	Other road			47	9.00	1 @ 35	1080	PC-HS	Bored pile/CIP	100	18	
6	KM108+477.72	District road	DR. 01		117	12.00	3 @ 35	1440	PC-HS	Bored pile/CIP	100	20	
7	KM114+754.55	Other road			117	7.50	3 @ 35	900	PC-HS	Bored pile/CIP	100	15	
8	KM115+242.12	Other road			117	7.50	3 @ 35	900	PC-HS	Bored pile/CIP	100	15	
9	KM116+887.69	Other road			117	7.50	3 @ 35	900	PC-HS	Bored pile/CIP	100	15	
10	KM118+065.14	Other road			117	7.50	3 @ 35	900	PC-HS	Bored pile/CIP	100	15	
11	KM119+494.42	Provincial road	PR622 C		187	12.00	5 @ 35	1440	PC-HS	Bored pile/CIP	100	20	

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12	KM120+315.89	Other road	117	7.50	3 @ 35	900	PC-HS	Bored pile/CIP	100	15
13	KM122+567.85	Other road	117	7.50	3 @ 35	900	PC-HS	Bored pile/CIP	100	15
14	KM128+947.88	Provincial road	187	12.00	5 @ 35	1440	PC-HS	Bored pile/CIP	100	28

Bridges in interchanges

No.	Position Km	Crossing		Length of Bridge(m)	Width of Bridge (m)	Span Arrangement	Area of Bridge(m ²)	Girder Type	Foundation		
		Type	Name of Interchange						Type	Pile size (cm)	Pile length (m)
1	KM100+000	Interchange	Tay Son	5	6	2x24m	8			12	
2	KM109+000	Interchange	Chu Lai	119	17.50	3 @ 35.	2082.5	PC-HS	Bored pile	100	18
3	KM102+323.00	Interchange	Dung Quat over H1+RW	154	22.50	4 @ 35.	3465	PC-HS	Bored pile	100	20
4	KM102+323.00	Interchange	Over Highway	224	17.50	6 @ 35.	3920	PC-HS	Bored pile	100	20
5	KM102+323.00	Interchange	Turn 1	119	7.50	3 @ 35.	892.5	PC-HS	Bored pile	100	20
6	KM102+323.00	Interchange	Turn 2	119	7.50	3 @ 35.	892.5	PC-HS	Bored pile	100	20
7	KM111+832.00	Interchange	Binh Son 1	49	12.00	1 @ 35.	588	PC-HS	Bored pile	100	7
8	KM111+832.00	Interchange	Binh Son 2	49	13.50	1 @ 35.	661.5	PC-HS	Bored pile	100	7
9	KM120+400.00	Interchange	North Quang Ngai	189	13.50	5 @ 35.	2551.5	PC-HS	Bored pile	100	18

6.3 Design of tunnel

6.3.1 Requirements of design:

- Tunnel is designed to ensure permanent requirements as well as other requirements of exploitation, safety, environmental hygienic conditions.
- Ensure continuous traffic, lowest repair and maintenance expenses.
- Design on the basis of economic, technical characteristic of alignment in public and tunnel works in private.
- Design on the basis of investigation, measurement, engineering and geological conditions, hydrologic data.
- Design to ensure quick execution and high motorized traveling capacity.

6.3.2 Position and description of tunnel area:

On the alignment at Km 22+656 which passes through Eo mountain near Duy Son commune, Duy Xuyen district, Quang Nam province. This mountain is ~ 140 m high. Section of alignment that is designed with a tunnel does not belong to re-aligned sections, consultant updates to complete the project and carry out the design on the following basis:

- Because there is not investigation, survey, further test in this stage, data of previous investigation, evaluation and report are used.
- On the basis of final report of NIPPON KOEI consultant; combine revised field survey to adjust the cross section of tunnel in accordance with the alignment..

In the final report of NIPPON KOEI consultant, arrange a tunnel with a length $L=540$ m which is projected at Km 22+656. In the place of the North tunnel, topography of the mountain has a sloped roof which is flatter while in the place of the South tunnel, topography of the mountain is abrupt.

According to previous evaluation and field survey this area is basically stable and engineering and geological conditions are good. The crossing location of tunnel is nearly square to sloping roof.

6.3.3 Applicable standard

Applicable and reference standards:

- Highway design standard TCVN 5729-1997;
- Road and railway tunnel design standard TCVN 4527:1988;
- Reference:
 - + Design standard - Section 3 - Tunnel NEXCO the East, Middle, West 2005.7).
 - + Japanese standard for mountain tunnel (Japan Society of Civil Engineer).

+ Highway tunnel design standard – Ministry of Transportation (draft).

6.3.4 Materials

- **Concrete**

Table 6.3.1 - Concrete used for tunnel structure

Type of concrete	Intensity f'c 28 days (Mpa)	Use
Concrete spraying C35	35	supporting structure, crown, mirror surface, inverted arch
C 30	30	Tunnel coat, tunnel pavement
C 25	25	Absorption pit concrete construction foundation, supporting construction foundation.
C 10	10	Blinding concrete

- **Steel reinforcement**

Use as bridge steel and some types of steel such as net steel, air-placed axial steel,...

- **Rock anchor**

Rock anchor use type of anchor in cement mortar, method of anchoring and installing in accordance with design:

- Type SN (Ground Rock Bolt): Basically in accordance with standard ASTM A 615 M Grade 400, this type is recorded with a limit of breaking thread head that is protected by PVC.

- Type IBO (Injection Boring Outside): Basically in accordance with standard ASTM A 615 M Grade 400 that is recorded with a limit of breaking.

- Immediate load bearing anchor Swellex type meeting the standard ASTM A 615 M Grade 400 – 600 is a set of anchor, buffered steel plate, bolter washer nut in drilled holes and is pumped high pressure mortar into anchor body, body expansion anchor and load bearing anchor.

6.3.5 Geometric standard:

- **Classification of tunnel:**

It is expected to classify as tunnel class III with a length of $100 \text{ m} < L \leq 1000 \text{ m}$.

Design vehicle flow: Year for calculating the design vehicle flow is 2035;
 34,496 vehicle/day (57,010 PCU/day) V/C=0.92 (17,248 vehicle/day)

In consideration of alignment and traffic flow:

- Classification of road : Class 100/120
- Design speed : 100 km/hr (120 km/hr)
- Traffic lane : 4 lanes / 2 lanes per tunnel

Breadth of each tunnel 12.75m=(1.25+3.25+3.75+3.75+0.75)m, including
 1.25 m of roadside for repair and maintenance; 2 traffic lanes 2@ 3.75 m + 01
 emergency parking lane + safety lane 0.75 m.

Tunnel location:

Alignment	Starting point (Km)	End point (Km)	For and aft tilt (%)	Cross fall	Length (m)
Right	22+656	23+196	0.3	2.0%	540
Left	22+656	23+196	0.3	2.0%	540

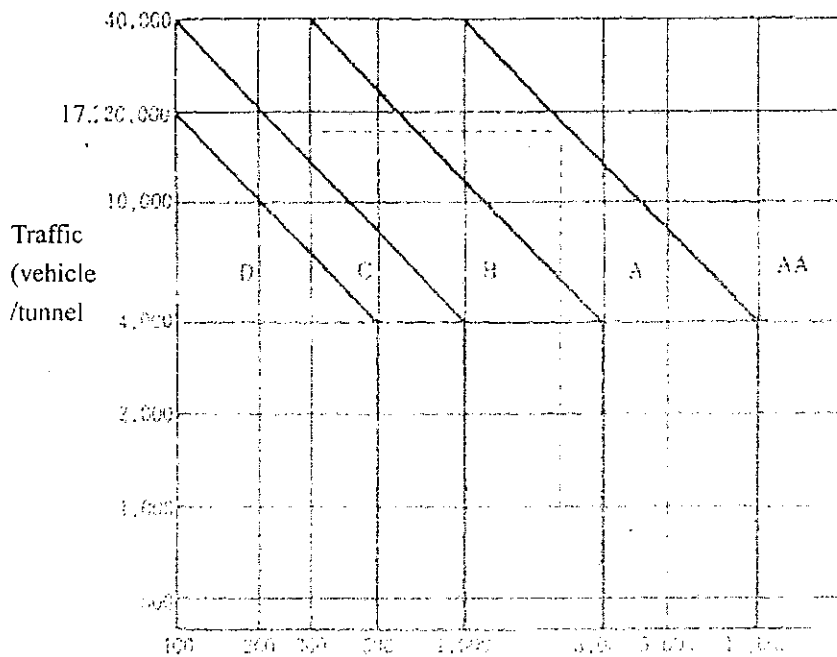
Percentage of large vehicles: 53.6%

Traffic characteristic: K=18% (internal)

D=100 % (Two-way traffic)

60 % (One-way traffic)

Casualties prevention level: Level B



Casualties prevention level of tunnel (According to Nexco document)

Tunnel is located in straight section. The position of the two alignments (two tunnels) are expected to be 2.5 D distant from each other (D~ 16 m – tunnel diameter). So the distance between the two tunnel centers is =40 meters.

- **Cross section of tunnel:**

General dimension of cross section of tunnel is designed in accordance with general standard of alignment, depending on design speed of traffic flow, types of vehicle and number of traffic lanes, width of traffic lane, field of view, air ventilation system, illumination system.

The tunnel is designed into 2 tunnels with different direction of moving. The width of each carriage-way is 11.50 meters (exclusive of edge and roadside for repair and maintenance of tunnel). The cross section of tunnel will be designed suitably, it is arranged with air ventilation system, lighting system, emergency warning system and traffic safety signal system, etc. In the scope of execution and prepare allowance of error of execution in accordance with design standard.

- **Breadth of pavement and vertical clearance**

Breadth of tunnel is equal to breadth of embankment outside of alignment, therefore geometric design of tunnel is established on geometric data of main alignment. Level 100 (design speed 100km/h) is applied. Typical cross section and vertical clearance is shown in following specification:

- Breadth of carriageway:
- Breadth of road $B=11.5\text{m}$ includes: $3.25\text{ m}+2@3.75\text{m}+0.75\text{m}$
- Clearance: $h = \text{Minimum } 4.9\text{ m}$
- Arrange walkway for repair and maintenance:
- Minimum breadth of 1.25m and safety vertical clearance: $h = \Delta h+2.5\text{m}$;
Of which: $\Delta h = 0.40\text{ m}$ Elevation between carriage-way and walkway inside tunnel.

- Cross fall: $i = \pm 2.0\%$

Drainage ditch: use one-sided drainage system.

Cross section inside tunnel:

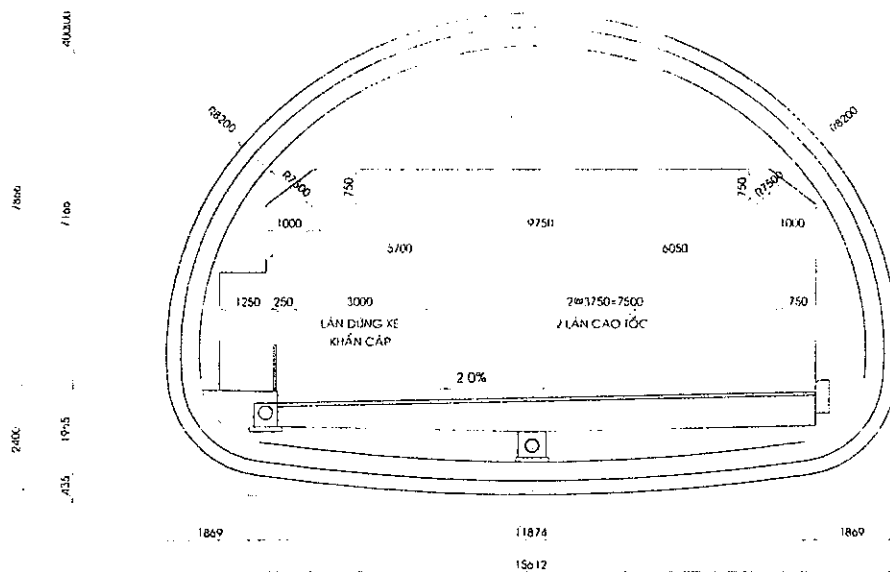


Figure 6.3.1 – Cross section of each tunnel

6.3.6 Structure of tunnel coat

Tunnel coat made of concrete or designed by cast-in-place (with concrete pump) concrete or assembled with joints which should be calculated on the basis that does not interrupt longitudinal force in Tunnel coat and in positions bearing minimum moment of force.

6.3.7 Structure of pavement inside tunnel

The depth of pavement concrete inside tunnel is usually 24 cm. Concrete is arranged in longitudinal and a horizontal joint, longitudinal joint is arranged with steel pins.

For transverse contraction joints with a distance of 6 meters and expansion joint are arranged in a distance of 120 meters. These joints are arranged with steel pins.

6.3.8 Design of drainage system and water-proof system

- **Drainage system**

Drainage system ensures to discharge ground water flowing from mountains, rock and discharge pavement water inside tunnel to outside. Drainage system is designed with a sloped roof as pavement inside tunnel. Structure of drainage system is divided into following levels depending on arrangement of positions.

- Water catching materials: $\Phi 75\text{mm}$ made of HDPE plastic material.
- Central drainage pipe: $\Phi 300\text{mm}$ punched reinforced concrete pipe
- Transverse drainage pipe: $\Phi 100\text{mm}$ punched plastic pipe

- Side ditch: round ditch $\Phi 200\text{mm}$

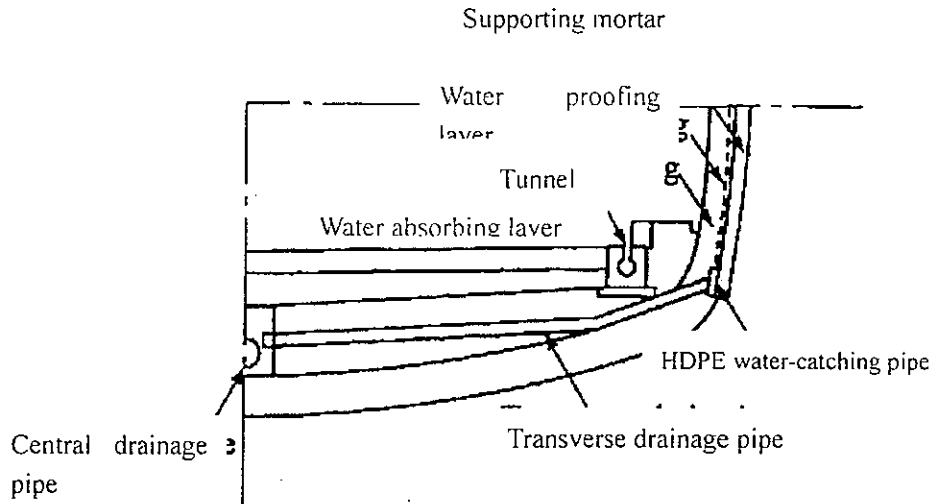


Figure 6.3.2 - Tunnel water proofing and drainage system

- **Water proofing**

It is expected that there is not groundwater in tunnel. However water proofing activities are still considered to enable favorable conditions for repairing and maintaining tunnel whether it has ground water or not.

Ground level	Materials	Depth
DI	EVA	t = 0.8 mm
DIII+C	EVA	t = 0.8 mm

Note: EVA= Ethylene Vinyl Acetate

6.3.9 Air ventilation design

Because tunnel has a length > 400 m and it is necessary to design an artificial air ventilation system that is expected on the basis of calculation:

- Natural ventilation:

$$\Delta\text{PMT} = (1 + \xi_e + \lambda_r (L/D)) \rho/2 U_n^2$$

Of which:

$\xi_e = 0.6$ – Inlet loss factor

$\lambda_r = 0.025$ – Inside-tunnel loss factor

L= tunnel length = 540 m

D= 15.5 m – tunnel diameter

$\rho = 1.2 \text{ kg/m}^3$

$U_n = 2.5 \text{ m/s}$

$$\Delta\text{PMT} = (1 + \xi_e + \lambda_r (L/D)) \rho/2 U_n^2 = 9.3 \text{ Pa}$$

- Ventilate air for traffic means of transportation (vehicle piston effect):
Because tunnel is one-way traffic

$$\Delta Pr = (A_m/A_r) (\rho/2)(n+)(V_{i+}-U_r)^2$$

A_r – tunnel air ventilation section: 42 m²

A_m - vehicle equivalent blocking section

Proposed $A_m/A_r = 0.3$

$n+$ = number of vehicles/hour = 500 vehicles/hour

U_r = air velocity in tunnel = 2.5 m/s

Vehicle velocity plus wind direction $V_{i+} = 80$ km/h = 22 m/s

$$\Delta Pr = (A_m/A_r) (\rho/2)(n+)(V_{i+}-U_r)^2 \sim 26\,000 \text{ Pa}$$

- Jet fan expected to ventilate air longitudinally:

With conditions:

+ Maximum wind velocity = 10 m/s.

+ Maximum exit road length from danger area

$$X \leq 800 * H/5 \sim 800 \text{ m.}$$

When there is a fire, wind velocity must obtain 1.5 m/s and suction force must obtain at least 200 m³/s. normally air current must at least obtain 80 m³/s.

Air ventilation system must be equally shared along the length of the tunnel to ensure safe operation even there is a fire

After analyzing project, use two fans of a diameter from 0.9÷1.0m. The minimum wind velocity caused by fans is 30 m/s.

6.3.10 Design of lighting system

Lighting concentrated on areas along tunnel must be minimum as follows:

Mode of lighting	Distance from tunnel gate (m)				
	0	25	50	75	>100
Day-time (Illumination -Lux)	300	175	80	40	20
Night (Illumination -Lux)	10				

6.3.11 Signaling information system

See details in control system, signaling information of the whole project.

6.3.12 Service system for safety of exploitation

Fire chamber, smoke alarming chamber are designed within 50 meters, telephone and information are arranged across public road with the largest distance of 250 meters.

It is necessary to select information system, signal system, warning devices

and tunnel locking devices-these devices must be operated continuously and frequently 24/24 h.

6.3.13 Geologic conditions and classification of tunnel rock

(i) Geologic conditions and topographic conditions in tunnel

Field studies show that natural mountains are rocky mountains and weathered rock. Geologic conditions in tunnel are complex, which include heavy weathered rock, batch stone and sandstone (according to updates and studies of NIPPON KOEI consultant). Rock of tunnel that is classified based on field studies and available data in connection with classification table of rock and analyses of NIPPON KOEI consultant shows that its elastic wave speed is low. Rock is classified as DI type although most of it is fissured rock, batch stone and sandstone.

(ii) North Tunnel portal

Topography of this tunnel portal shows that roof is sloped about 300, based on topographic map (1/25.000) soil foundation is perpendicular to tunnel axis. For adjacent geologic area, field studies show that there is orphan rock. It is geologically projected that tunnel has fissured weathered rock, batch stone and sandstone.

Based on analysis and evaluation of NIPPON KOEI consultant done by observation, rock is classified as D III type. Tunnel arch action is projected to be 1.5 D thick because rock is strongly weathered.

(iii) Tunnel portal in the South

Topography of this tunnel portal shows that roof is sloped about 350-450. Soil foundation is perpendicular to tunnel axis. For adjacent geologic area, according to geologic predictions there's fissured weathered rock, batch stone and sandstone in tunnel.

Based on analysis and evaluation of NIPPON KOEI consultant done through observation of naked eyes, rock is classified as DIII type. Tunnel arch action is projected to be 1.5 D thick because rock is strongly weathered.

Position	Type of rock	Supporting type	Length (m)	Geologic conditions	Characteristic of rock	Geologic conditions of tunnel	
KM 22+656- 22+656.7 22+721 23+146 23+181 23+195.3- 23+196		Tunnel portal	0.7	- Topography of this tunnel portal shows that roof is sloped about 35°. Soil foundation is perpendicular to tunnel axis.	Fissured weathered rock Batch stone		
							Size of tunnel portal is defined in consideration of current weathered rock on the spot. Length of 1.5 D is selected for tunnel portal because with this size tunnel portal nearly does not suffer any acting force that results in instability
	DIII	DIII	64.3			DI supporting structure is designed mainly for geologic conditions of weathered rock.	
	DI	DI	417			Length of 1.5 D is selected for tunnel portal because with this size tunnel portal nearly does not suffer any acting force that results in instability.	
	DIIIA-DIIIA	DIIIA-DIIIA	49.3	- Topography of this tunnel portal shows that roof is sloped about 35°-45°. Soil foundation is perpendicular to tunnel axis.		DIIIA supporting structure is selected with axis to avoid collapse of superstructure section of tunnel because a thick layer of material that is poured instable is found at section between tunnel portal and KM23+195.	
		Tunnel portal	0.7				

Figure 6.3.3 - Classification of rock along the tunnel

6.3.14 Execution of facilities - Projected types of supporting structure

In this stage, there is not adequate specification to evaluate details of rock according to RMR. Based on evaluation in final report of NIPPON KOEI consultant, types of supporting structure are projected to be used.

To define a type of supporting structure for a tunnel, there must have experience, technology and data related to execution of a tunnel. This enables favorite and practical conditions to decide to select which tunnel supporting structure, based on standard supporting models defined through relevant data of execution of a tunnel. In this study, classification of supporting types of NEXCO is applied and shown in the following table:

Table 6.3.2 –Classification of supporting structure

Model of digging	Length of digging cycle	Rock anchor			Depth of air-placed concrete	Supporting by steel supporting frame	Inverted crown concrete
		Length	Crown stress	Circle			
	m	m	KN	m	Cm		cm
C	2.0	4.0	170	1.5	10-20	—	40
DI	1.0	6.0	170	1.0	20	H-150	40-60
DIII	1.0	6.0	170	1.0	30	H-250	45-70

Standard tunnel supporting structure: To define a supporting structure for a tunnel there must have experience, technology and data related to execution of a tunnel. Supporting structure, based on standard supporting models defined through relevant data of execution of a tunnel.

Basically, a supporting structure includes air-placed concrete, rock anchor, steel supporting system. This system combines with surrounding environment of tunnel for permanent operation. It is designed to ensure stability of a tunnel after each stage of execution and guarantee safety and effectiveness during exploitation.

Auxiliary measures: At the beginning point of the tunnel, it is discovered that there's weathered rock on surface. It is unnecessary to consider any auxiliary measures because tunnel surface will be stable with a standard supporting system.

At the ending point of the tunnel, geologic conditions are not stable: there are sloped roofs, fault or there is not adhesion in land. These conditions make tunnel crown unstable. Combining rock anchor with steel frame will reinforce soil

foundation to minimize deformation prior to mirror and to stabilize digging mirror.

6.3.15 Design of tunnel portal region

(i) Tunnel portal region

Tunnel portal region is generally defined as a region having coating thickness from $1.5 D$ or below compared to tunnel diameter. And this is also a place that arch action of land hardly occurs, as shown in the following figure.

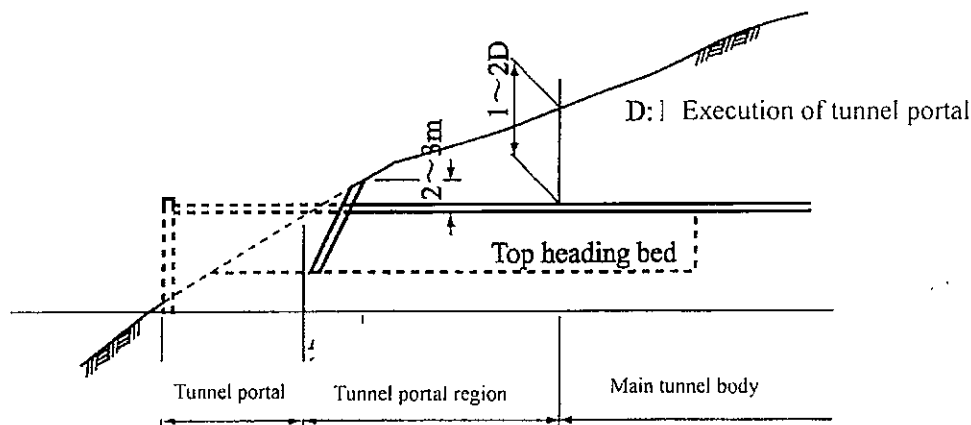


Figure 6.3.4 – Tunnel portal region

(ii) Types and positions of tunnel portal

Each type of tunnel portal with general characteristic shown as in the above figure, which is used to select a type of tunnel.

- *Tunnel portal in the North*

- Topographic and geologic conditions: According to topographic map (1:25,000), topography of the tunnel portal shows that it slopes about 300 and soil foundation is perpendicular to tunnel axis. Geologic conditions surrounding tunnel portal region include mud rock or batch stone or sandstone as expected.

- Type of tunnel portal: a type of tunnel portal will be selected according to following factors:

- + Type of structure can protect pavement from impacts of falling rock or collapse of sloped roofs above tunnel portal.

- + Type of structure that allows vehicles to be driven into tunnel the most conveniently.

- + Type of wings is selected based on above criteria and results of field inspection. On site it is likely that serious landslides and existence of water won't occur and type of retaining wall won't bear non-symmetric pressure because surface materials are mud rock and batch stone. As tangent line is horizontal, it is not

difficult to go into tunnel.

- Positions of tunnel portal are selected according to following factors:

- + Tunnel axis must be perpendicular to topography to avoid nonsymmetrical pressure.

- + Avoid narrow valleys and rivers.

- + Consider position of other structures such as bridge before going into tunnel and office building used for maintenance operation.

Based on field inspection and contour lines on map, position of tunnel portal is located at Km 22+656 for both tunnels: right tunnel and left tunnel

- *Tunnel portal in the South*

- Topographic and geologic conditions: According to topographic map (1:25,000), topography of the tunnel portal shows that it slopes about 30° and soil foundation is perpendicular to tunnel axis. Geologic conditions surrounding tunnel portal region include mud rock or batch stone or sandstone as expected.

- A type of tunnel portal will be selected according to following factors:

- + Type of structure can protect pavement from impacts of falling rock or collapse of sloped roofs above tunnel portal.

- + Type of structure that allows vehicles to be driven into tunnel the most conveniently.

- + Type of wings is selected based on above criteria and results of field inspection. On site it is likely that serious landslides and existence of water won't occur and type of retaining wall won't bear non-symmetric pressure because surface materials are mud rock and batch stone. As tangent line is horizontal, it is not difficult to go into tunnel.

- Positions of tunnel portal are selected according to following factors:

- + Tunnel axis must be perpendicular to topography to avoid nonsymmetrical pressure.

- + Avoid narrow valleys and rivers

- + Consider position of other structures such as bridge before going into tunnel and office building used for maintenance operation.

Based on field inspection and contour lines on map, position of tunnel portal is located at Km 23+196 for both tunnels: right tunnel and left tunnel.

6.3.16 Status of tunnel portals

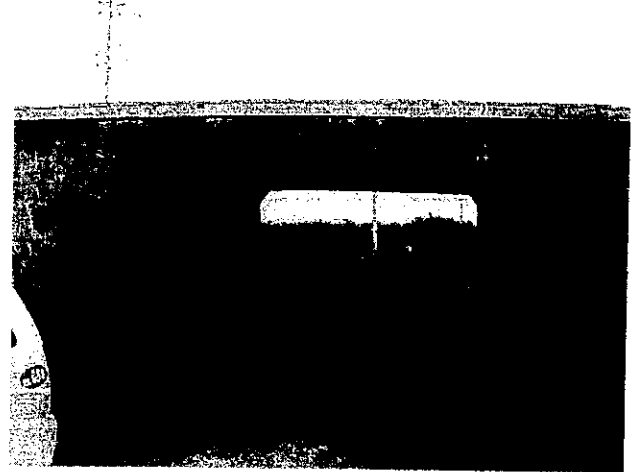
- **North**

The beginning point of tunnel portal will be located on a lane up to the

mountain. Before going into the tunnel, there is a deep valley. Haul road (B=3.0m)



Starting point of tunnel portal in the North



Haul road (B=3.0m)

will be designed to be gone into from new intersection because current road intersects below a railroad (clearance 3.1 m) and It is difficult for execution vehicles to enter.

- **South**

At present at place of designing South tunnel portal, there is a small access road with a breadth of 2.5 m. This road may be used as a service road during execution or it is possible to build a new service road.



Photograph-5

Figure 6.3.5 - Some pictures of a position of projected tunnel

6.3.17 Organize to execute tunnel

Tunnel construction program includes progress and temporary structures based on available information such as surrounding conditions of construction site.

- **Method of excavation**

Natural geologic conditions as expected include batch stone and sandstone. It is projected to use mechanical method of digging in combination with stepped method of excavation although single-axle compressive strength of rock and bed rock hasn't been tested.

Figure 6.3.4 – Execution of tunnel

	In general	Note
Execution	Execute for each tunnel from portal of tunnel inside	
Method of excavation	Stepped excavation	NATM
Length of tunnel	Right tunnel: 540m Left tunnel: 540m	Right tunnel: excavate second Left tunnel: excavate first
Method of drilling	Mechanical excavation	
Movement in tunnel	Movement on pavement	
Expected time of excavation	21.0 months	Excluding pavement and houses

- **Works and equipment for execution**

Temporary building should be designed in consideration of quantity of construction works, geologic conditions, manner of execution and construction site.

Table 6.3.5 - List of equipment and facilities for execution

No	Name	Size (m)	Area (m ²)	Note
1	Electronic plate	5.00×8.70	43.5	
2	air-placed concrete mixing plant	10.0×20.0	200.0	
3	Sewage treatment	6.00×15.0	90.0	
4	Water absorption equipment	3.00×5.00	15.0	
5	Temporary waste water repository		200.0	
6	Materials repository	7.00×20.0	140.0	
7	Maintenance yard	5.46×7.28	39.7	
8	Accessories stock	5.46×7.28	39.7	
9	Rest-house for workers	5.46×7.28	39.7	
10	Inspection office	5.46×7.28	39.7	
11	Ventilating equipment	2.50×5.00	12.5	
12	Water suction equipment	2.00×2.00	4.0	Water pump

- Execute conveniently and mechanically.
- Ensure convenience for exploitation and maintenance;

CHAPTER 7 – OPERATION AND MAINTENANCE PLAN

Operation and maintenance of the Da Nang - Quang Ngai Expressway includes three major categories:

- Management and operation of the highway;
- Maintenance;
- Management of toll collection.

7.1 Organization of operation and maintenance

7.1.1 Service and management, operation buildings

As traffic characteristics on highway is running with the high speed, continuously, high traffic capacity hence a synchronous traffic management system should be built for a safety, convenient and order on the expressway. Main purposes of the traffic management system are:

- Monitoring traffic conditions and roads on highway;
- Managing and controlling traffic for safety and convenient travel;
- Providing correct and rapid information on highway for the road users;
- Planning and applying the countermeasures early to minimize the unexpected problems;
- Monitoring operation and maintenance of the different equipments installed along with highway to secure its good working conditions.

The service and management, operation buildings for the expressway are arranged as follows:

- 01 Expressway Management Center at Km0+950
- 01 Operation and Maintenance Center at Km64+750
- 02 Main tollgates: Beginning Point Tollgate at Km4+750 and end-point toll gate at Km129+600
- 07 sub-tollgates and toll buildings:
 - + My Son interchange, Km20+200: 01 tollgates
 - + Ky Lam interchange, Km41+121: 01 tollgate
 - + Tam Ky interchange, Km64+200: 01 tollgate
 - + Chu Lai interchange, Km84+000: 01 tollgate
 - + Dung Quat interchange, Km102+400: 01 tollgate
 - + Binh Son interchange, Km112+620: 01 tollgates
 - + North Quang Ngai interchange, Km124+200: 01 tollgates
- 04 lay-by stations at Km29+130 and Km98+800 (02 stations each side)
- 02 service stations at Km 69+600 (01 station each side).

Update and Finalization of the F/S
Da Nang - Quang Ngai Expressway Project

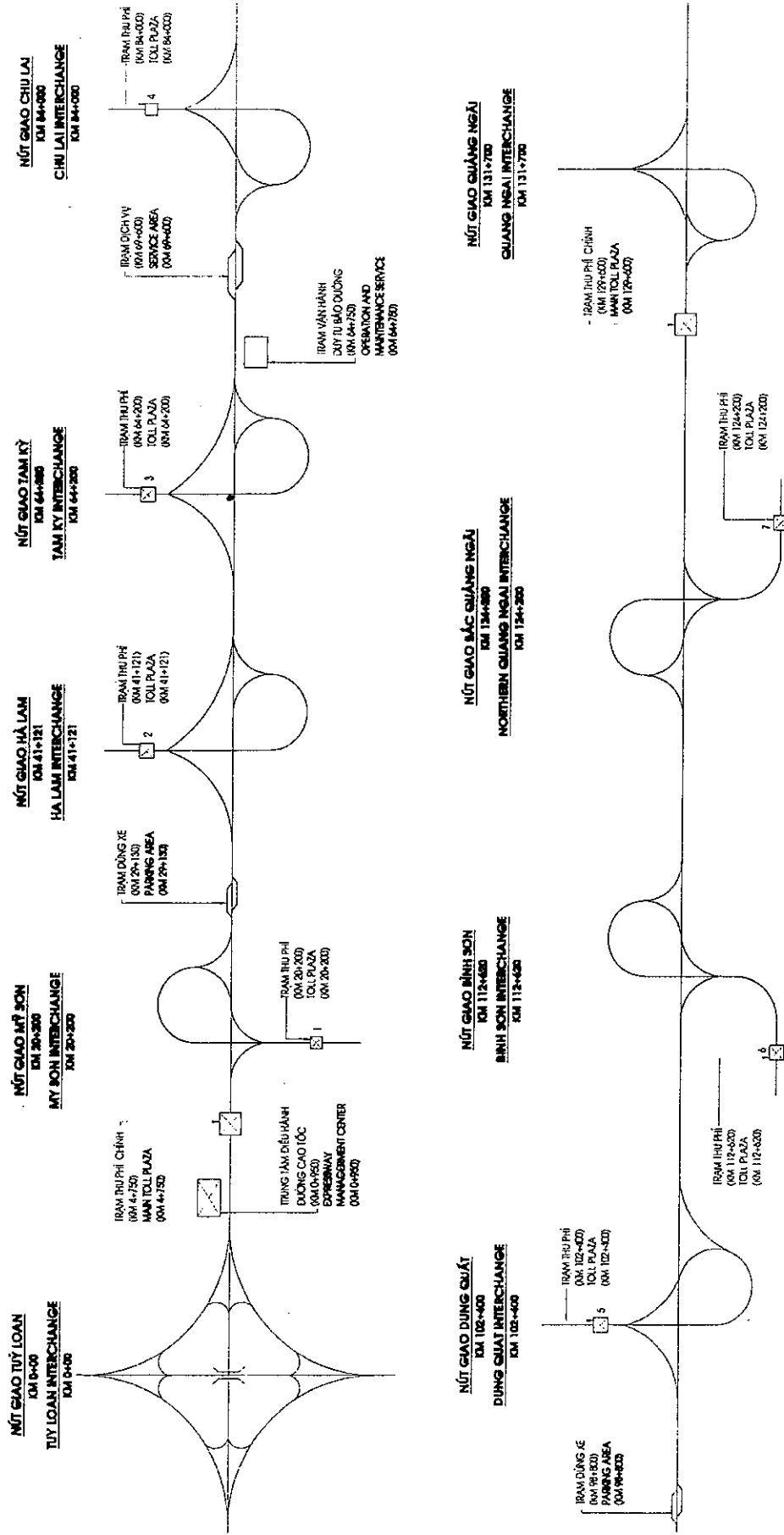


Figure 7.1.1 – Layout of the service and management, operation buildings

Design results of the management and operation, service buildings is as follow:

i) Main tollgate:

- Tollgate:

- Overall toll plaza includes :

- + Toll gate, island and toll lanes (12 lanes).

- + Miscellaneous facilities;

Total Construction area 3220m².

- Toll gate:

- + Designed as steel complex and large space span steel roof, the lowest point of the roof is 5.5m above the toll lane.

- + Internal traffic system (service tunnel) is underground system, connecting the service area for the toll plaza in order to avoid crossing the toll lane, the tunnel size is 2.5m wide, 2.5m high, 88m long and there are 12 entrances, the wall is RC , the tunnel floor is lower than the pavement of the toll plaza by 3.75m.

- + The toll island has 2mx30m size, made of RC.

- + Toll lane

- Lane for sedans is 3.5m wide.

- Lane for vehicles exceeding 4.5m.

- Miscellaneous facilities:

The architectural option ensures the requirements of harmony with the landscape and architectural space, synchronously linking to the technical infrastructure, meeting environmental and fire prevention requirements.

- 2-storey office building:

- + Construction area is 235m

- + Constructed floor area is 470m².

- 2-storey canteen and accommodation building for staff.

- + Construction area is 350m²

- + Constructed floor area is 700m²

- Guard house 30m².

- 2-wheel vehicle shed 60m².

- Water tank pump station

- Transformer 150KVA.

- Gate 7m.

- Protecting fence (brick fence combined with iron grillwork fence).

ii) Sub-tollgate:

- Sub-tollgate

- Total layout of a sub-tollgate includes:

- + Toll gate, island and toll lanes (07 lanes).

- + Miscellaneous facilities:

Total construction area is 1020m².

- Toll gate:

- + Designed as steel complex and large space span steel roof, the lowest point of the roof is 5.5m above the toll lane.

- + The toll island has 2mx30m size, made of RC.

- + Toll lane

Lane for sedans is 3.5m wide.

Lane for vehicles exceeding 4.5m

- + Miscellaneous facilities;

The architectural option ensures the requirements of harmony with the landscape and architectural space, synchronously linking to the technical infrastructure, meeting environmental and fire prevention requirements.

- 2-storey office building:

- + Construction area is 93m²

- + Constructed floor area is 186m².

2-storey canteen and accommodation building for staff.

- + Construction area is 135m²

- + Constructed floor area is 270m²

- 2-wheel vehicle shed 24m².

- Water tank pump station

- Transformer 150KVA.

- Gate 5m.

- Protecting fence (brick fence combined with iron grillwork fence).

iii) Expressway Management Center:

- Construction scale: Total construction area is 9,450m².

The architectural option ensures the requirements of harmony with the landscape and architectural space, synchronously linking to the technical infrastructure, meeting environmental and fire prevention requirements, including:

- 3-storey office building: Constructed floor area is 1870m².
- 2-storey accommodation building for staff: Constructed floor area is 700m²
- 1-storey garage + store: 180m² floor.
- 1-storey entertainment house: 450m² floor.
- Guard house: 1 storey, 12m² floor.
- 2-wheel vehicle shed 36m².
- Water tank pump station
- Transformer 320KVA.
- Gate 10m.
- Protecting fence (brick fence combined with iron grillwork fence).

iv) Service station:

- Construction scale: 2 service stations are constructed on 2 road sides. The total construction area of one station is 37,000m²

The architectural option ensures the requirements of harmony with the landscape and architectural space, synchronously linking to the technical infrastructure, meeting environmental and fire prevention requirements, each service station includes:

- + Service house: Constructed floor area 870m²
- + Motel: 945m² floor
- + Toilet: 115m² floor.
- + Supermarket: 470m² floor.
- + Office: 520m² floor
- + Accommodation building for staff: 350m² floor.
- + Repair garage: 300m² floor.
- + Petrol station: 258m² floor.
- + Guard house: 8m² floor.
- + Water tank, pump station
- + Transformer 560KVA (2 stations).
- + Car-washing
- + Fence.

v) Lay-by station:

- Construction scale: 02 lay-by stations, in each station there are 2 lay-by zones on 2 roadsides. Total construction area of each zone is 5980 m².

The architectural option ensures the requirements of harmony with the landscape and architectural space, synchronously linking to the technical infrastructure, meeting environmental and fire prevention requirements, each station includes:

- + Service house (1 storey): Constructed floor area 445m²
- + Public toilet (1 storey): 175m² floor
- + Large vehicle parking lot: 1,860m².
- + Sedan parking lot: 600m².
- + Fence.

vi) Operation and Maintenance Station:

- Construction scale: The total construction area of one station is 3,100m²
- The architectural option ensures the requirements of harmony with the landscape and architectural space, synchronously linking to the technical infrastructure, meeting environmental and fire prevention requirements, including:
 - + 1-storey office building: Constructed floor area 149m²
 - + 1-storey Accommodation building for staff: 121m² floor
 - 1-storey garage + store: 113m² floor.
 - 1-storey entertainment house: 450m² floor.
 - 1-storey canteen for working shifts: 90m² floor.
 - 1-storey Bathroom, toilet: 22m² floor.
 - 2-wheel vehicle shed 16m².
 - Water well, yard, tank.
 - Transformer 320KVA.
 - Entrance gate
 - Protecting fence (brick fence combined with iron grillwork fence).

7.1.2 Intelligent Traffic System:

The Intelligent Transportation System (ITS) is used to manage the Expressway, including some below subordinate systems. These systems shall support each other for the purpose of the whole system as mentioned above.

- **CCTV System includes:**
 - + Camera, Monitor, DVR & Converter
 - + Central control software
- **Vehicle Detection System (VDS)**

Controlling circulation of the vehicles and detect timely problems happen on highway.

- + Applied technology: Video image detector

- + Including cameras and software

- ***Weather Observation System (WOS)*** and Master Clock System (MCS)

It is used to monitor weather on the whole alignment, including

- + Temperature sensor, pluviometer, Inspection of wind direction and time synchronization

- + Control software

- ***Variable Message Sign System (VMS)***

Providing traffic information for the road users, including:

- + Display panel

- + Control software

- ***Digital Transmission System (DTS)***

Providing signal line for the whole alignment, including

- + Fiber optic cable system

- + Network unit

- ***Emergency Telephone System (ETS)***

Providing emergency communication from the rescue center to the road users. Including:

- + Outdoor emergency phone

- + Center control system

- ***Internal Telephone System (ITS)***

Providing the internal communication system for the whole system, including:

- + Telephone switch IP, Cell phone IP

- + Control software

- ***Walkie-Talkie System (WTS)***

Providing communication system with walkie-talkie system so as to serve for repair and rescue. Including

- + 01 Transmitting and Receiving antenna

- + 120 sets on the vehicles and 120 hand-held sets

- + Control software

- ***Weight in Motion (WIM)***

Providing 01 dynamic balance system to control loading capacity of the trucks going into highway, including:

+ Low speed dynamic balance system. Not including static weighing machine.

+ Installation position for the truck lane at entrance of the toll station.

- Toll collection system (TCS)

Providing the close toll collection system for the highway system in the form of close toll collection. It is including equipment at the lane and center equipment

Quantity of the equipments in traffic management system is summarized in table 7.1.1 as follows:

Table 7.1.1 – Quantities of the equipment in traffic management system

No	Equipment type	Unit	Quantity	Location
1	CCTV system	Pcs	34	At the intersection
2	Vehicle Detection System	Set	300	Along with the highway, installed for each 2km to monitor 4 lanes and at the intersections
3	Weather sensor system	Set	01	At the Management Center
4	Variable Message Sign System	Paces	12	05 signals on major alignment and 01 signals at the intersections
5	Communication system	Whole	1	Installed for the whole alignment
6	Emergency Telephone System	Pcs	130	01 piece installed for each 2Km on each way
7	Internal Telephone System	Pcs	1 switchboard and 240 phones	On the whole management systems
8	Walkie-talkie system	Set	01 receiving and transmitting antenna, 120 vehicle-installed sets and 120 hand held sets	
9	Weight in Motion	Set	09	At entrance of the toll collection stations
10	Toll collection system	Station	12	02 stations on the alignment and 10 substations
11	Center operating system	Whole	01	At the Operating Center
12	Maintenance and emergency installation	Whole	01	At the Maintenance Center

7.2 Management responsibility of the organizations

7.2.1 Expressway Management Center in Da Nang

Administrative management for highway is just management of the road assets upon law regulations, State statutes on protection of road and strip of land reserved for the road, corridor on both roadsides, equipments on the road and protection safety, convenient for the road users, protection of road assets is under control by the management organizations or authorized to manage by the State based upon "Highway traffic laws", "Highway traffic management statutes", Circulars and Decrees of the Government on highway traffic management.

Contents of administrative management of the highway, including:

- Office management;
- Patrolling and managing the expressway;
- Managing and controlling the expressway;
- Managing safety corridor of the expressway;
- Law management on the expressway.

7.2.2 Maintenance center in Tam Ky

Management of expressway maintenance is management of the maintenance activities for highway and equipments along the alignment, local and timely repair of the unexpected damages on the road. Management of the Expressway includes below contents:

- Minor maintenance and repairs to maintain road quality and its perfect image;
- Periodic preventive maintenance and repair of the works and equipments along the alignment;
- Improving and enhancing using functions of the present alignments;
- Giving the first aid to the problems happening so as to recover traffic activities as soon as possible;
- Maintaining land, water supply within strip of land for road, growing and taking care verdure and landscape along the alignment.

7.2.3 Toll Collection Offices at every intersection

It is used to direct management toll collection at the intersections and support the highway management Center, Maintenance Center in administrative management, management of maintenance, settlement of problems and traffic rescue at the neighboring areas if necessary.

7.2.4 Service station:

This takes responsibility for general business at the service area.

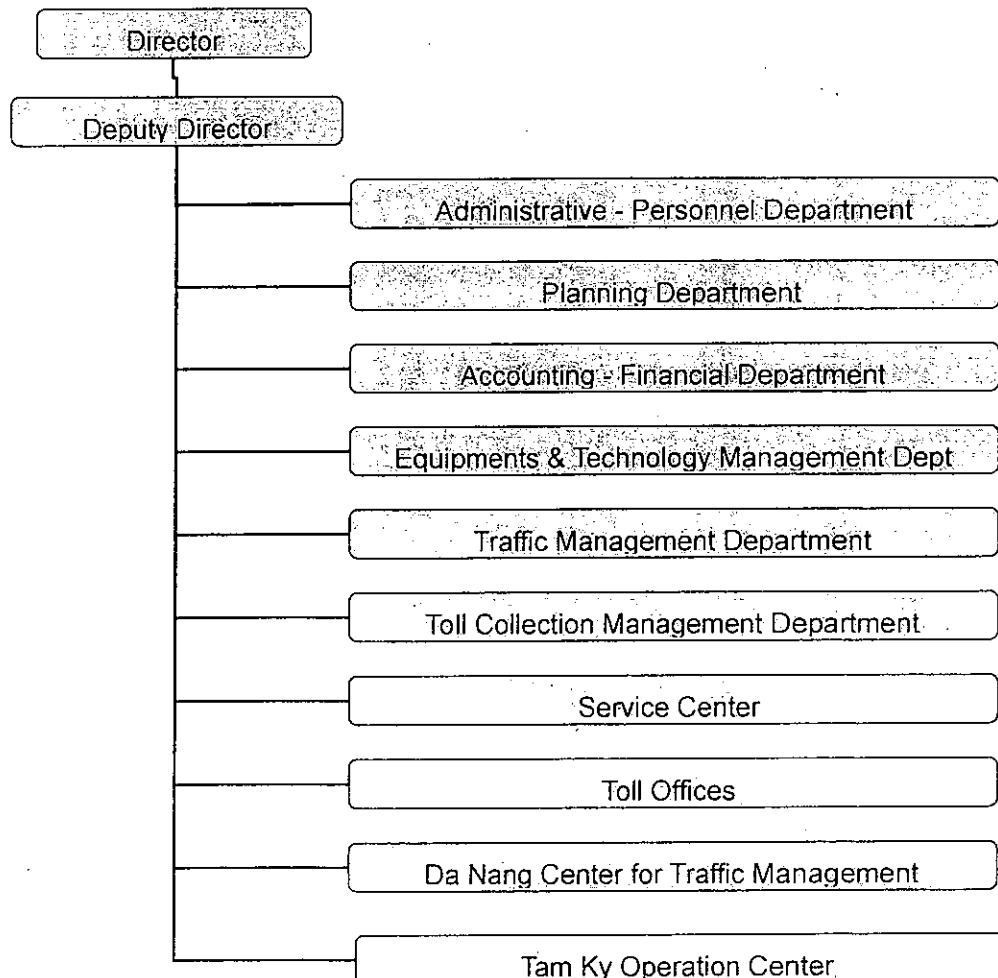
7.3 Proposal for organization model of maintenance and operation unit

The expected model of the operation, development and maintenance Management Company is shown in figure 7.3.1

Aside from divisions and functions as described above, the other working departments of the company take responsibility for general management on development, operation and maintenance of the Expressway, planning management of medium-term or long-term operation and maintenance, planning management of budget/expenditures, planning and management of customer care and traffic operation etc, including below major contents:

- Administrative management (assets protection management) of highway;
- Management of toll collection;
- Traffic management on the Expressway;
- Maintenance management on the Expressway;
- Management of developing general business of the service areas;

Fig 7.3.1 - Expected organization model of the maintenance and operation management company



7.4 Toll Collection System

7.4.1 Selection of the toll collection system:

There are two types of toll collection system: open and closed system. For the open system, there is one toll gate at each tolled section and fee is collected at the toll gate. The toll gate is located on the major alignment or two entrances and exits of each section. This fee collection manner is applying Marjory in Vietnam. The toll collection ticket of each vehicle type shares the same par value regardless of the long or short trip.

For close toll collection system, the toll gate is located at all entrances and exits. The basic toll collection process such as: ticket is issued at the entrance and fee is paid at the exit. Toll is depending on direction of vehicle, distance and vehicle type.

The major technical factors of two kinds of toll collection are compared in below table.

Table 7.4.1 - Comparison of open and close toll collection system

	Close system	Open system
• Arrangement of tollgate	Tollgate at all entrances and exits	Tollgate at every toll plaza
• Toll level system	Flexible and depending on the distance	Fixed toll for all trips
• Toll collection method	Tickets are received at entrance, toll is paid at exit	Toll is paid at each toll plaza
• Management of toll collection	Toll collection is absolute guaranteed (against loss of revenue)	Unable to absolutely guarantee toll collection (may loss of revenue)
• Management of use	Road use may be managed strictly	Unable to prevent illegal road use and difficult to control if accident, traffic jam or disaster happens.
• Traffic jam on the road	Traffic jam may happen but minimized at entrance and exit	Traffic jam may happen at the toll gate on main alignment
• Occurring crossroads	Locating one more tollgate at entrance/exit of each occurring intersections	Locating one tollgate on major alignment or creating toll-free areas
• Management of data of point of departure, point of arrival data	Point of departure, point of arrival data is available	Available at the toll plaza but very difficult to obtain point of departure, point of arrival data
• Applicable road system	Suitable with long and wide highway system	Suitable with short and one-way highway system

The close toll collection system is usually applied into toll collection on highway due to below reasons:

- Variety of tolls may be applied;
- Toll collection may be closely controlled;
- Road use without payment of toll may be prevented (illegal use);
- Traffic jam on major alignment may be minimized;
- Possible to check point of departure - point of destination data (very useful for study and reference for expansion scheme or road maintenance planning).

7.4.2 Proposed toll collection system model

Toll collection system on Da Nang - Quang Ngai Expressway shall be a closed toll collection system and expected to arrange the completing period as follows:

- 09 toll offices; 09 toll plazas: 02 major plazas, 07 sub plazas (as proposals at management of operation, development and maintenance);
- Using automatic devices to support toll collection and traffic control:
 - + Entrance control system: vehicle counting device, pilot-light, lane signal, lane control device, control panel, magnetic ticket writing/reading device, display, information electronic tablet...;
 - + Entrance control system: automatic vehicle sorting unit, pilot-light, lane signal, lane control device, bar code reading/writing device, information electronic tablet, bill printer...;
 - + CCTV system at the toll collection lane
 - + Control computer system stores all toll collection data, effective with query reporting model, connection among the toll collection lanes, toll collection operating office and Traffic management center.

7.4.3 Structure of toll office

The management system at the toll office undertakes to operate toll collection brings effects in management and saving operation costs. The electronic operation system plays central role in toll plaza system, communities with the equipments on the lane, manages and stores all toll collection data at the plaza.

This system includes data processing and managing devices for each toll plaza. These are main functions:

- Grasp and store transaction data from the toll plazas and controls through images at the office at the same time.
- Data processing and managing through images, printers, subordinate storage medium and data transmission devices.

- Display operation status of the devices at the toll collection lane (pilot-light, automatic barrier. connection status, ect.);

- Manage working shift and toll collectors, manage system logon, manage cash amount, receipts of the day, manage revenue, balance of revenue at toll plaza and issued ticket quantity;

- Management the device parameters, traffic flow query report, toll collection sales query report, upload transaction information, download parameters of the toll plaza, data backup saving and data reconstruction, synchronous time management for the system.

Major elements of the system of the toll collection office include:

- Server manages toll collection information and processes transaction information of toll collection

- Monitoring server is used to process images from camera, vehicle identifier and monitoring information manager

- Toll collection configure at entrance: (i) Barrier; (ii) lane sign; (iii) Vehicle detection system; (iv) Pilot-light; (v) Terminal unit (monitor, control panel); (vi) Ticket issuer; (vii) Lane control device; (viii) Internal phone; (ix) Lighting protections and (x) network units: Switch, optical fiber...etc

- Toll collection configure at exit: lane signal; Barrier; Electronic table; automatic vehicle identifier; Pilot-light; Terminal; ticket writing/reading device; bill printer; lane controller; Internal phone; Lighting protections; Network units: switch, optical fiber,...

- Toll plaza's computer (terminal unit) is used for accounting, ticket registration and operation monitoring

- Ordinary printer

- LAN Networking unit

Operational control center system manages the whole toll collection activities.

Below are major functions:

- Operating and managing every toll collection office

- Managing the whole toll collection activities

- Managing all toll collection tickets

- Managing advance payment cards

The toll collection center system includes below equipments:

- Data server manages toll collection data with functions such as: managing all data of toll collection transactions are transmitted from the toll collection offices on the principle of concurrence.

- Data server manages advance payment cards are used to manage all information of advance payment cards such as: card number, user's name, remaining amount and paid amount of the advance payment card. The terminal unit controls and displays all information of the server.

- Plaza computer (Terminal unit is used to monitor and operate)
- Plaza computer (Terminal unit serves for accounting work)
- Plaza computer (Terminal unit for registration of cards)
- Printing machine
- LAN Networking units.

For close toll collection system, data is transmitted between toll collection lanes and toll collection operating Office, between toll collection operating Office and Management Center. Toll collection lane → Toll collection operating Office:

- Vehicle discharge goes through plaza;
- Information of working shift;
- Operation status of the equipments at the toll collection lane.

Managing Center (Da Nang) → Toll collection operating Office → toll collection lane

- List of the operators, personnel at each tour of duty;
- Face value of toll collection ticket;
- List of the violating vehicles

Toll collection operating Office → Managing Center (Da Nang)

- Vehicle discharge goes through plaza;
- Information of working shift;
- Operation status of the equipments at the toll collection lane.
- Revenue data

7.4.4 IC card used in toll collection

IC Card is getting applied widely in many fields with the effective facilities and rapid replaced the magnetic card or bar-coded thanks to its reliance and high durability card as well as readers. There are two forms of IC card:

- Contact card: it is activated and uses energy as chip contacts with the reader. Therefore, after a period of use, accuracy and durability of the ID card contact is reduced;

- Non-contact card is activated and uses energy of the radio wave emitting from the reader, so data writing/reading period takes a lot of time.

It is suggested to use the non-contact ID card for toll collection at the Da

Nang - Quang Ngai Expressway, because of its advantages as below:

- Data management in high degree of safety, anti-counterfeiting and high reliance.
- Usable in the long time or reusable during the certain period (life service is 50.000 times of reading and writing or longer).
- Flexible applicability for many purposes, easy to use with high processing speed.
- Applicable for expansion as it is applied for the automatic toll collection system in the future.
- Saving cost because of long life service.

Advance payment in use of ID card is also introduced to reduce transaction time at exit and better serve the frequent users.

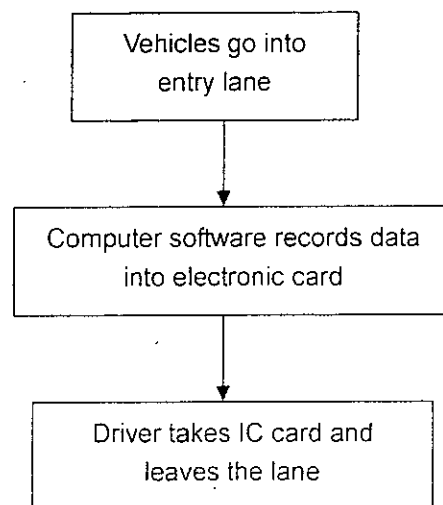
7.4.5 Toll collection model of close toll collection system

- At present, toll collection based upon the finished stretch of road is the first toll collection form in Vietnam, therefore, application of proper toll collection (ticket type, face value... etc) monitoring and suggestions of the relevant parties and ministries such as Ministry of Transport, Ministry of Finance and toll collection units are very necessary ... etc

- Upon reference to some close toll collection systems in region, the Consultant puts forward a close toll collection model for the Da Nang - Quang Ngai Expressway as below:

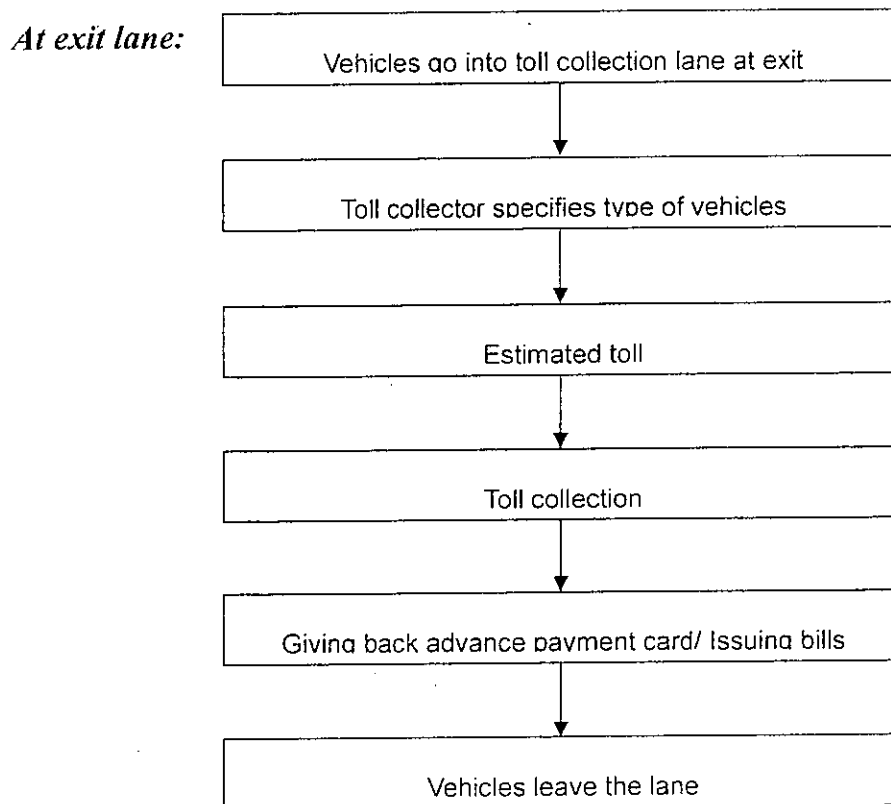
Fig. 7.4.1 - Block diagram describes operation of ENTRY LANE

At Entry Lane:



- (i) The computer system records data into IC card; as vehicles go into lane, toll collector presses "ENTER" button to control the IC card issuance system, below information are recorded into card:
 - Entry time code;
 - Toll plaza code;
 - Entry code;
- (ii) The vehicle receiving device shall count correctly vehicle quantity goes through the lane. This figure shall compare with quantity of issued IC cards.
- (iii) All data at the entrance is saved in the system. Vehicle quantity at the entrance shall be automatic reckoned up and compared by the system with vehicle quantity at exit.

Fig 7.4.2 - Block diagram describes operation at exit lane



- (i) Specification of vehicle type:
 - As vehicles go into toll collection lane, the toll collector specifies vehicle type by pressing the correlative buttons on control panel.
 - If it free vehicles, pressing "free" button on control panel.
 - If it is commutation ticker vehicle, pressing "commutation ticket" on control panel.

- If it is necessary to specify vehicle type, pressing "Cancel" button and specify vehicle type.

(ii) Estimated transport charges:

- At ticket checking office, the driver gives the toll collector received IC card at the entrance.

- The officer inserts IC card into IC card reader:

- The system estimates charges based upon input parameters of the IC card.

- The equipment shall store card in drawer, simultaneously information on card shall be deleted to reuse in the future.

- Electronic LED displays vehicle type and charges.

- Officer collects charges equal to correlative face value.

At the first period, manual toll collection with IC card may be used.

CHAPTER 8 – ENVIRONMENTAL IMPACT

This chapter is summary of the study results on environmental impact assessment (Final Report, February 2010) had done by The Environment and Construction Consultant Service Joint Stock Company (ENCOSE.JS.CO).

8.1 Environmental Baseline

8.1.1 Ecological Environment

The current ecological environment in the assessment scope of the proposed highway is good. The highway will take up a permanent land size of about 10,062,798 m². The land occupation type includes forestland, paddy field, non-irrigated field, wasteland, etc.

There are a natural reserve, 14 rare and endangered animals and plants distributed within the assessment scope of the proposed highway. The animal species are mostly domestic animals, poultry and some common little wild animals that are few in population and are not very demanding for living environment and are adaptable to human activity.

8.1.2 Socio-economy

Except for Da Nang city, it is obvious that the economy in the two provinces is under-developed, with the GDP per capita lower than that of the national average. The GDP per capita varies large between different provinces, in Da Nang it is about one and a half times higher than the provincial average but in Quang Nam and Quang Ngai it is as low as 60% of the national average.

Most villages in the project areas rely on agriculture as their main income source. In particular, the income of the region comes from paddy and cash crops such as fruits and vegetables.

People in the project area suffer severe limitation of access to social infrastructures in general.

There are several cultural heritages as Sa Huynh culture in Duy Trung commune, Madam Chiem Son palace, Mac Thi Giai temple (Ngoc Han princess), Cham archaeological site, Huong temple, Tra Kien Tay communal house in Duy Son commune, Duy Xuyen district and Quang Nam province. Such cultural heritage is about 1-2 km from the expressway alignment so it is evaluated as no direct impact by the project.

8.1.3 Acoustic Environment

There is no important noise source at most of the sampling points. The primary noise source is the daily activity of human beings. Although there are several sensitive receptors are being affected by traffic, the acoustic environment quality is fairly good since the traffic flow is very low. In general, the acoustic quality along the

project is quite good.

8.1.4 Water Quality

The surface water environments in project area reaches conform to class B1 of QCVN 08-2008/BTNMT basically except for the contents of SS at Thu Bon river, BOD5 at Thu Bon, Ba Ren and Tra Bong rivers and COD at Thu Bon and Ba Ren rivers. In general, the water quality of major rivers and reservoir in the study area is fairly good and these rivers achieve the water quality statutory compliance levels for their classification.

The underground water in project area is good. Parameters of underground water quality generally meet with the request of QCVN 09: 2008/BTNMT.

8.1.5 Ambient Air

Each concentration parameter for ambient air assessment does not exceed standard in the project area, thus complying with the enforced environmental standard and with 100% standard satisfaction. The ambient air quality within the assessment scope is relatively good.

8.2 Environmental Impact

8.2.1 Impact on Eco-environment

The construction of the highway will cause certain agricultural economic losses, but will not produce remarkable influence on the distribution pattern of the land and vegetation.

Subgrade excavation and earth/stone filling of the proposed highway construction will change the landform and topography of some areas to a certain extent. But corresponding engineering protection measures taken during the design, construction and operation stages of the highway can minimize such adverse effects on vegetation, land utilization and farmland change.

The engineering construction's impact on vegetation is mainly the cutting, rooting, burying and trampling of trees, fruit trees, flowers and plants, bush and farmland crops in the acquired lands during construction stage. Some small animals living there will be threatened to some degree during the whole construction stage of the highway. The above impact can be compensated for to a certain degree through the greening and planting measures.

This road construction has not caused and changed their habitat environment greatly, will not interfere their normal life, which can still continue surviving in the areas along the route.

This project construction will disrupt and damage the original landform, land and vegetation, the possibly created soil erosion will produce adverse impact on the project construction, production and life along the route, as well as nearby ecological

environment. But because the protection works will be designed, constructed and accepted simultaneously with the main works of the project, the actually occurred water and soil erosion will be far smaller than the forecasted value. The earth borrow pits, waste banks, embankments, cutting slopes, service areas and construction sites are the main places where soil erosion occurs.

8.2.2 Impact on Socio-environment

Construction of the proposed highway will exert a positive influence in promoting social and economic development, in promoting rational adjustment of industrial sectors in areas along the route, in fostering the social and economic development and tourist resource development in areas along the route.

This project will permanently take up lands with a total size of 10,062,798 m², of which 3,206,274 m² for cultivated lands. Land allocation and use value transformation could mitigate land occupation's impact on agricultural economy.

It is required to do good removal and resettlement work, to conscientiously enforce local government's removal and resettlement policy. Because reasonable number of frontage routes, overpasses and underpasses will be set up, impact on life convenience of residents along the route is not big.

Operation of the proposed highway will alleviate the traffic pressure imposing on original existing roads, will improve traffic environment, and will reduce traffic accidents.

The construction unit will strengthen publicity on historical relic protection, protective measures shall be made available to underground historical relic being found during construction, which shall be traced and monitored.

8.2.3 Impact on Acoustic Environment

Construction phase: The information obtained from field investigation indicates that there are a number of sensitive receptors along the route of the road. Although the noise impact is to be encountered in construction stage, it is a temporary impact versus that in operation stage. Several mitigation measures can be used on the sections where sensitive receptors are located to reduce the noise impact to an acceptable level.

Operation phase: the noise modeling results indicate that the project in operation phase will have severe impact on acoustic quality in the receptors along the road. The noise level at 31 sensitive receptors is predicted to exceed the standard in middle term, thus mitigation measures are suggested to be adopted.

8.2.4 Impact on Surface Water

The impact on surface water quality arising from construction of road mainly created by domestic wastewater discharged from construction camp and sediment

disturbance and oil spillage caused by construction of bridges. In addition, construction materials which rushed by surface runoff during heavy rainfall into river nearby would be one of primary concerns in water pollution.

The wastewater generated in the operation phase is mainly from the service zone and the parking yard and the initial storm water. The surface runoff on bridges although may increase the pollutant load where it is discharged into the surface, the dispersion of the wastewater may decrease quickly the pollutant load in the whole water area.

Presence of vehicles hauling hazardous materials may present the risk of water pollution accidents. If such accidents occur on the bridges over Thu Bon, Ba Ren, Tam Ky, Tra Bong, Tra Khuc rivers which are zoned for drinking water supply, the impact of such leakage may be significant, resulting in devastating effect to the eco-system and the health of the people living downstream.

8.2.5 Impact on Ambient Air Quality

Construction phase: the major source for air pollution during construction phase is the construction site, unpaved road, material stockpile site, and access road. The air-borne dust from the site, waste gas from the asphalt pavement operation, and the end gas from the operational equipment will cause significant impact on environment.

Operation phase: Exhaust gas from vehicles and boiler flue gas in service zones are the major source for air pollution during operation phase. The volume of emission will proportionately increase with the increase of traffic flow. The type and performance condition of vehicles are another controlling elements for exhaust gas pollution.

According to the prediction results, the EA team predicts that the impact on ambient air quality in short term through medium term is small; while with increased traffic flow expected in the long term, NO₂ concentration may exceed the standard in the area near the road. However this impact can be mitigated by ordinary measures such as planting and adoption of cleaner technology and fuel to an acceptable level.

8.2.6 Impact on Landscape and cultural relics

The project owner has actively cooperated with the local cultural department in contracting Quang Nam, Quang Ngai Provincial Relics and Viet Nam Archeological Research Institute to prepare a cultural heritage protection plan.

The reporting procedure will be followed once cultural relics are discovered at construction site. In the construction phase, the professionals from provincial cultural department will assist the contractor in the protection of cultural properties. If valuable or invaluable relics are discovered, the local related departments will be

notified immediately. The excavation will be stopped until authorized department identifies relics.

8.3 Mitigation Measures

8.3.1 Design Stage

The project owner has contracted institutes to carry out field investigation and prepare reports for soil conservation, cultural property, geological disaster and mineral resource with the major findings to be considered in the design stage by the design institute;

In the pre-feasibility study stage, the proposed road will cross the planning flooding area of Da Nang city, Quang Nam and Quang Ngai province (Km 0-Km 20; Km 109-Km 129). In the feasibility study stage the road section has been altered to avoid the planning flooding area;

In the field investigation, the road is suggested to aligned so as to avoid the electric wires 500KV, 35KV

Flood prevention consideration has been taken in the design of bridges and roadbed.

8.3.2 Construction Stage

On the road sections where sensitive receptors are located, speed limits will be set, and the whistle blowing is banned. The road surface will be regularly maintained to reduce the noise with the vehicle movement. The new residential houses will be planned 200 m from the proposed road. The sensitive receptors, such as hospital and school, will be constructed at least 250 m from the road central line. If Cam Son, Bich Bac, Chu Lai and Dung Quat industrial zone decide to modify their development planning in which they tend to extend toward the proposed road, it is suggested that in the area within the distance of 200 m from the road will be constructed with storehouse, plant and greening works.

Low noise machines and noise windows for sensitive receptors including Phi Hoax, Thatch Bo, Le Son 2, Thai Cam, Duck Key, Chua They, Bi Nay, Xian Dai, Key Lam, Ben Den Dong hamlet 4 and 5 of Day Son village and Nguyen Thatch Han primary school, Pap Dan pagoda, temple Pham..... At these locations, night time (22:00 pm- 6:00 am) construction will be strictly restricted. The day time construction will also take measures to minimize the noise operations near the sensitive receptors where possible. Other sensitive receptors, such as residential areas near a bridge site, piling construction can be very noisy. The transportation routes will also be carefully planned to make sure the noise, dust and safety impacts will be minimized.

During the construction of bridges, advanced environmental measures will be adopted, and site of construction camps, material stockpiling site will be carefully

selected. The wastewater from the construction sites will be collected and treated in septic tanks. The wastewater from material washing will be treated through settling tanks prior to being discharged into surface water bodies.

Water spray operation will be scheduled twice a day (each in morning and afternoon) on the unpaved road surface, loose material stockpiles. The frequency of water spray will be increased in the dry day or windy day. The asphalt and cement mixing station will be located as far as 200 m from the resident's blocks. And the mixing station will be enclosed. The access roads will be as far as possible from the resident's blocks. The stockpiles for cements, sand and limes will be covered.

8.3.3 Operation Stage

There are 66 sensitive receptors along the road. Various noise control measures will be designed and implemented to mitigate the noise impact from the road project. The main mitigation measures are installation of noise barrier, noise window and relocation. The considerations for the selection of these measures are:

The noise barrier is to be used in the sensitive receptors where: the projected noise level exceeds the standard, most of the affected residents are living within 70 m from the road curb, and the road bed is high (more than 3 m), and the affected houses are dense.

The noise window will be used where the project noise level exceeds the standard, most of the affected residents are far from the road, or the affected houses are scattered and the population to be affected is small.

Two service areas and two parking areas as well as Da Nang, Quang Ngai toll station/maintenance depot will all have secondary wastewater treatment stations. The vehicle washing effluent from the service areas will be recycled and reused after proper treatment. The five ramp and one main line toll stations will have septic tanks for wastewater treatment. The supernatant will be used for landscape spray and sediment will be regularly cleared.

In order to mitigate the impacts from hazardous material transportation accident to Thu Bon river, Ba Ren river, Tra Bong river and Tra Khuc river, the major bridges on these rivers will have liquid collection system and strong guard rails. The spills, if any, will be collected in holding tanks for later hauling and disposal, to avoid direct discharges in case of an accidents on the bridges. The collection system will also collect the first flush from rain water to minimize the water quality impacts. The bridge and expressway company will take lead for an emergency plan to handle promptly and properly accidents and environmental emergency. The emergency will be equipped with appropriate equipment and staffed with proper people.

8.4 Public Consultation and Information Disclosure

The results of the first round public consultation indicate that most of the people affected are supportive to the road project and have a good understanding of the potential impacts arising from the road; most of the people affected are concerned about the policies concerning land acquisition, relocation and house demolition and thus expect a reasonable compensation for the loss due to land acquisition.

8.5 Conclusions

In general, the proposed Da Nang –Quang Ngai project fits into the legal framework, and the road network development planning of Da Nang, Quang Nam and Quang Ngai Province and Viet Nam. Environmental considerations dominate the alignment selection process. One of such example is that the road route is carefully designed to mitigate the flooding along the roads.

So far, agreements from the regulatory departments have been granted for these road sections. With implementation of environmental measures, the potential adverse impacts on these sensitive sites can be mitigated and compensated effectively. In addition, to ensure successful implementation of these measures, an EMP will be developed to cover all the relevant aspects such as institutional arrangement for environmental management and supervision, environmental monitoring and training. This road project is environmentally feasible provided that the EMP is carefully implemented.

CHAPTER 9 –SOCIAL DIMENSIONS

9.1 Objects and Methodology

The overall objective of the social study is to provide relevant social information on the following: (i) impact of the project on the affected people, (ii) extent of land acquisition and resettlement (iii) legal policy requirements and (iv) mitigation measures.

Several methods were employed to collect social base information. Several methods were employed to collect the social base information. These include key informant's interview, structured surveys, community consultations and informal dialogues with various stakeholders. The information derived from these methods provided the basis to establish the perceptions, needs, socio-economic trends of the local community, and in getting recommendations to improve the road design.

9.2 Minimizing Land Acquisition and Resettlement Impacts

A lot of efforts have been made by technical and social teams as well as local authorities to minimize impacts on land acquisition through different phases of the project study. The consultation with relevant parties was also held, based on their feedback, the alignment was adjusted to avoid the negative impacts on environment and land acquisition. As the result of alignment adjustment, number of households have to be relocated is reduced significantly compared to the original alignment proposed by TEDI in its Feasibility Study. The changes made to reduce impacts on land acquisition, especially to reduce the number of households that have to be relocated, are summarized as below:

The original alignment was proposed by TEDI in its Feasibility Study (TEDI F/S 2005) with due examination in order to reduce negative social impacts as well as to realize technical feasibility.

The JETRO Study and then with the WB Supplemental Study which basically applied the alignment proposed by TEDI in its F/S for the section of Quang Nam province. From December 10, 2009, the TEDI design consultant (DC) has started adjustment alignment at sections: Km8+00 to Km16+00 and Km 58+00 to km 68+00 basing on the Circulars No 422/TB-BGTVT signed on September 23, 2009 and 594/TB-BGTVT signed on December 25, 2009 by MOT in order to reduce negative social impacts. As a result of re-examination under WB Supplemental Study, the following major modifications at six sections (from Km0+00 to Km16+00, Km21 to Km26, Km35 to Km43, Km 58+00 to km68+00, Km67 to Km80, and Km83 to Km97) are proposed in order to reduce adverse environmental and social impacts.

- *Section from Km8 to Km16*

An alignment is proposed to avoid 2 poles of 500kV high voltage transmission

lines relocation, Thai Cam industrial zones, and Thai Cam residential area. By adjusting alignment in this area, it reduces significantly the number of the affected houses. Total affected house in these sections are 141, of which the relocated households are 89.

- *Section from Km 21 to Km 26*

With TEDI F/S, the proposed alignment passes through the residential areas by curving along the national railways. The WB Supplemental Study proposed to adjust the route by straightening the alignment and providing a tunnel through a mountain. By adjusting alignment in this area, it reduces significantly the number of the affected houses. Total affected house in these sections are 77, of which the relocated households are 38.

- *Section from Km 35 to Km 43*

This section is proposed to be straightened and therefore, several populated areas are avoided compared to the alternative proposed in the F/S of TEDI such as Hamlet 3, Hamlet 4, and Hamlet 5 of Phu Tho commune; Quy Thanh village; Quy Xuan village; and Hamlet 1 of Binh Quy commune.

- *Section from Km 58 to Km 73*

This section is proposed to avoid cutting many 500kV high voltage transmission lines, and relocation of temples.

- *Section from Km67 to Km80*

The World Bank Supplemental Study, an alignment is proposed to be between TEDI F/S and JETRO Study to avoid military facilities.

- *Section from Km83 to Km97*

The alignment proposed by TEDI F/S and JETRO Study in this area runs parallel with the Chu Lai Open Economic Zone. During the course of discussions among relevant parties, it was confirmed that future expansion of the zone would be secured. Therefore, adjustment of the alignment is proposed in the World Bank Supplemental Study for securing future expansion of the zone.

9.3 Socio-economic characteristics of affected Province

The IOL and socioeconomic survey was done during the period of December 2008 to March 2009 and then the data processing, analysis on the socioeconomic conditions of the project affected households is based on the results of (i) Inventory of loss (IOL) for 100% of affected households of 3 provinces section of the DQEP; (ii) in Da Nang City, socioeconomic household survey of the DPs, accounting to 23.2 % of the affected households, including 114 of HHs; in Quang Nam Province socioeconomic household survey of the DPs, accounting to 32 % of the affected households, including 1436 of HHs; in Quang Ngai Province, socioeconomic

household survey of the DPs, accounting to 29 % of the affected households, including 838 of HHs who lose more than 10 % of agricultural land, households who have to relocate and households who lose business premises; and (iii) Formal and informal meetings and group discussions with local authorities and other stakeholders including local NGOs.

At the time of survey and information gathering as mentioned above, only the F/S was available. The affected area has not yet identified and marked on the ground. Hence the socioeconomic characteristics of the communities and potential DPs presented below will necessarily be updated after the final detailed designs are completed and the bench marks demarcating for the project site are put on the ground and officially declared to local authorities and local people. The results of survey from a sample of the project affected households are as follows.

9.3.1 Demographic characteristics of DPs

According to the results of census and IOL for 2,388 affected households (HHs) (9,571 persons) who are located in the project affected areas, all respondents are Kinh people. The socioeconomic survey also did not indicate presence of any ethnic minorities in the study areas.

The average HH size is 4 persons for the whole section. The average age of the total surveyed population is 36 years old with the average proportion of males is 48 % and females is 52 %.

Table 9.3.1 – Demographic Characteristics of DPs

Provinces	Total affected HHs surveyed with census and IOL	Affected Persons		Gender Ratio		Ethnic composition	
		Population	Average household size (per/HH)	Male (%)	Female (%)	Kinh (%)	Others (%)
Da Nang	114	461	4	48.3	51.7	100	0
Quang Nam	1,436	5,811	4.125	48.25	51.75	100	0
Quang Ngai	838	3,299	4	48	52.0	100	0
Total	2,388	9,571	4.04	48.27	51.82	100	0

Table 9.3.2 – Distribution by HH's size of survey DPs

Provinces	Total affected HHs surveyed	Population	Average HH Size (Per/HH)	Household Size (%)		
				Less than 4 per/HH	From 5-8 per/HH	More than 8 per/HH
Da Nang	114	461	4.0	75.6	23.8	0.7
Quang Nam	1,436	5,811	4.1	55.7	40.3	4.0
Quang Ngai	838	3,299	3.9	47.8	44.0	8.0
Total	2,388	9,571	4.0	59.7	36.0	4.2

Table 9.3.3 – Age structure of surveyed population

Provinces	Total affected HHs surveyed	Population	Average age of surveyed population	Percentage of age group (%)				
				Less 7 years old	From 7 to 17 years old	From 18 to 35 years old	From 36 to 55 years old	Over 55 years old
Da Nang	114	461	35.3	8.5	15.6	33.5	26.6	15.8
Quang Nam	1,436	5,811	36.4	5.5	14.0	36.6	28.8	15.5
Quang Ngai	838	3,299	33.1	6.0	15.4	38.3	24.3	16.3
Total	2,388	9,571	34.93	6.7	15.3	36.1	26.6	15.9

9.3.2 Education status

The illiteracy rate among survey HHs is 3.9 %, 32.8 % of the total surveyed population has reached at least primary or lower education level. 39.1% has reached at secondary education, the survey found encouraging percentage of the surveyed population (about 19.3%) achieving high school level and just very small portion (2.0%) got college or university degree.

As for the HHs' Head, the illiteracy rate is very low, just 1.8 %, 42.4 % of the surveyed HHs Heads has reached primary of lower education. More than 36.5% has got basic secondary education, and just 3% has got college or university degree. The details of educational status of analysis on the heads of households and surveyed

affected persons are described as in tables 9.3.4 and 9.3.5 below.

Table 9.3.4 – Education of the heads of households

Provinces	Total Surveyed HH Heads	Education Level of DP Households Heads				
		Illiterate (%)	Primary or Lower Education (%)	Basic Secondary Education (%)	High Education (%)	College and University (%)
Da Nang	114	4.3	39.3	34.9	18.6	6.0
Quang Nam	1,436	0.8	47.7	37.5	12.0	2.0
Quang Ngai	838	0.3	40.3	37.0	19.6	1.1
Total	2,388	1.8	42.4	36.5	16.7	3.0

Table 9.3.5 – Education level of surveyed DPs

Provinces	Total surveyed population	Education Level of DP Population				
		Illiterate (%)	Primary or Lower Education (%)	Basic Secondary Education (%)	Higher Secondary Education (%)	College and University (%)
Da Nang	461	4.7	32.0	37.3	18.8	7.2
Quang Nam	5,811	3.65	31.6	42.6	19.3	2.2
Quang Ngai	3,299	3.6	34.7	37.4	19.7	4.6
Total	9,571	3.98	32.8	39.1	19.3	4.7

9.3.3 Employment and incomes

More than 58 % of the surveyed DPs are engaged in the agricultural sector. Around 17.5 % of the surveyed DPs are students of local colleges and university. From these, it is identified that the primary income of the DPs comes from agricultural activities.

The average monthly income of the surveyed HH in affected communes is about VND 474,300. Some 28.7 % of the HHs surveyed fall within the group having per capita monthly income over VND 500,000. However, findings from the survey shows that a relatively high proportion (16.3%) of HHs monthly income is less than VND 200,000 and would need a special care through the relocation process. The results of survey on the employment and incomes are shown as in tables 9.3.6 and 9.3.8 below.

Table 9.3.6 – Types of employment

Provinces	Survey population	Office Servant (%)	Doctor (%)	Soldier and policemen (%)	Teacher (%)	Worker (%)	Agriculture (%)
Da Nang	461	1.6	0.2	1.0	0.7	10.2	57.2
Quang Nam	5,811	1.9	0.3	0.34	0.9	5.2	61.8
Quang Ngai	3,299	2.8	0.4	0.2	1.1	5.0	55.2
Total	9,571	2.1	0.3	0.51	0.9	6.8	58.1

Table 9.3.7 – Types of employment (continued)

Provinces	Engineer (%)	Trade (%)	Student (%)	Housewife (%)	Handicraft (%)
Da Nang	1.8	10.1	10.6	4.7	1.9
Quang Nam	0.6	4.2	20.4	2.9	2.0
Quang Ngai	0.5	8.5	21.4	3.7	1.0
Total	1.0	7.6	17.5	3.8	1.6

Table 9.3.8 – Monthly income

Provinces	Total Surveyed HHs	Per capita income (1000VND/Per/Month)	Less than VND 200,000		VND 200,000 to 500,000		More than VND 500,000	
			HHs	%	HHs	%	HHs	%
Da Nang	114	520.3	5	5.3	55	51.3	52	41.2
Quang Nam	1,436	481.3	281	23.1	821	52.1	328	24.7
Quang Ngai	838	421.4	103	13.6	431	50.8	302	35.5
Total	2,388	474.3	389	16.3	1307	54.8	682	28.7

9.3.4 Living facilities

Hundred percent (100%) of the affected communes are connected to the national power grid with private meter. All have access to basic social infrastructure, including primary school, post office and health care centers. However, it was learned that there is just about 29.3 % of the HHs experience with periodic health check. None of surveyed HHs is connected to safe water system and all HHs have to use drinking water derived from wells. Some 45.5 % of the DPs have latrine with semi-septic tank

and 40.3 % use latrine with septic tank. Most of the population has access to telecommunication systems, for instance more than 84.9% of the HHs has TV, and about 48.4 % of the HHs has telephones. The detailed results of survey are shown in tables 9.3.9, 9.3.10 and 9.3.10 below.

Table 9.3.9 – Living conditions of surveyed households

Provinces	Total Surveyed HHs	Running water (%)	Wells (%)	Latrine with septic tank (%)	Latrine with semi septic tank (%)	Latrine over pond or river (%)
Da Nang	114	15.1	84.9	84.7	12.5	2.8
Quang Nam	1,436	0	100	32.3	66.0	1.8
Quang Ngai	838	0	100	4	58	38
Total	2,388	5.0	95	40.3	45.5	14.2

Table 9.3.10 – Living conditions of surveyed households

Provinces	Total Surveyed HHs	Connected to power grid (%)	Disabled/permanent illness problems (%)	Periodic health care check (%)	No Periodic health care check (%)
Da Nang	114	100	9.6	31.7	68.3
Quang Nam	1,436	100	6.8	26.3	74.1
Quang Ngai	838	100	11.6	30	70
Total	2,388	100	9.3	29.3	70.7

Table 9.3.11 - Living conditions of surveyed households

Provinces	Surveyed HH	HH with telephone (%)	HH with motorbike (%)	HH with TV (%)	HH with Video Player (%)	HH with washing machine (%)
Da Nang	114	64.0	61.7	89.0	38.0	10.7
Quang Nam	1,436	28.3	62.7	86.9	20.9	1.1
Quang Ngai	838	53.0	51.5	78.9	57.9	11.0
Total	2,388	48.4	58.6	84.9	38.9	7.6

9.4 Land acquisition

Approximately 140 km length of the road alignment crosses through thirty eight communes of the districts namely Hoa Vang of Da Nang City; Duy Xuyen, Que Son, Thang Binh, Nui Thanh, Phu Ninh and Tam Ky city of Quang Nam Province and Binh Son, Son Tinh, Tu Nghia, Nghia Hanh of Quang Ngai Province. The right of way is

70m wide. The impacts on land acquisition for this RP are surveyed based on the design of the route of feasibility studies and the cadastral maps of affected communes. The impacts on land acquisition will be updated with detailed measurement survey (DMS) after the detailed engineering design is made available and the demarcation of the affected area is marked by the bench marks on the ground by local authorities and PMU 85.

9.4.1 Land acquisition impact

There are a total of 7,825 households of 38 communes will be impacted by land acquisition for the project; of which:

- 1,210 Households will be impacted on residential land either partially or fully with the total affected area is 716,385 m²
- 4,506 Households will be impacted on agricultural land with the total area of 3,776,230 m².
- 791 Households will be impacted on other land with the total area of 2,989,595 m².
- About 1,191,544 m² of forestry land (public land) will be impacted.
- 1,380 Households will be impacted on either partially or fully on houses with the total affected area of houses is 343,349 m², from these 839 households have to relocate to new places.
- There are 39 collective or public institutions will be affected on their assets.

Details of land acquisition impacts on the households with different categories of impacts are analyzed as in tables from 9.4.1 to below.

Table 9.4.1 – Number of households and heads affected by land acquisition in 3 provinces

Provinces	Number of affected HH	Number of affected people
Da Nang	491	1,964
Quang Nam	4,486	18,222
Quang Ngai	2,848	11,079
Total	7,825	31,265

(a) Impact on types of land

Impacts on the different types of land by communes are described as in table

9.4.2 below

Table 9.4.2 – Number of affected area of different land types

Provinces	Loss of residential land (m ²)	Loss of agricultural land (m ²)	Loss of forestry land (m ²)	Loss of other types of land (m ²)	Total (m ²)
Da Nang	38,498	446,447	9,075	67,716	561,736
Quang Nam	347,138	2,686,623	1,700,762	1,690,761	6,425,283
Quang Ngai	340,749	1,376,653	128,415	998,021	2,843,838
Total	726,385	4,509,723	1,838,252	2,756,498	9,830,857

The number of households who are severely affected by the loss of agricultural land (losing more than 10% of the total area of the agricultural land their holding) by communes is shown as in table 9.4.3.

Table 9.4.3 – Severely affected on agricultural land

Provinces	Number of HH affected from 10% to 30% of the total agricultural land holding	Number of HH affected from 30% to 70% of the total agricultural land holding	Number of HH affected more than 70% of the total agricultural land holding
Da Nang	59	102	221
Quang Nam	929	1,151	667
Quang Ngai	348	480	549
Total	1,336	1,733	1,437

Number of households which fully affected on residential plot (fully affected or the remaining areas are less than 100 m² in the rural area and less than 40 m² in the urban area) and residential landless households are identified by communes as in table 9.4.4 below

Table 9.4.4 - Number of households fully affected on residential plot and number of residential landless households by provinces

Provinces	Number of HH fully affected on residential plot	Number of residential landless HH
Da Nang	24	55
Quang Nam	329	693
Quang Ngai	216	462
Total	569	1,210

ii) Legal status on land use right:

(a) For residential land: It is identified that there are 592 households have LURC. 441 households have not granted with LURC, but are legalizable to be granted with LURC and 171 households will not be eligible to have LURC.

(b) For agricultural land: there are 2,852 households have red book, 1,111 households have not granted with red book, but are legalizable to be granted with red book and 543 households will not be eligible to have red book.

(c) Impact on house and other substructures

Fully impacted houses and other substructures are described as in the following tables.

Table 9.4.5 - Fully affected houses by provinces (fully affected area or partially acquired by the project but the remaining area cannot be remained or not convenient for living)

Provinces	Total No. of HHs who are fully affected on houses	Number of fully affected houses	Classes				
			Class 1	Class 2	Class 3	Class 4	Temporary house
Da Nang	29	29	2	3	4	15	5
Quang Nam	556	556	30	173	12	269	72
Quang Ngai	254	254	32	32	56	115	19
Total	839	839	34	212	72	399	96

Table 9.4.6 - Area of fully affected houses according to each house class

Provinces	Affected area (m ²)				
	Class 1	Class 2	Class 3	Class 4	Temporary house
Da Nang	231	303	337	930	147
Quang Nam	3666	19430	839	18,493	2,138
Quang Ngai	4,229	3,183	4,561	6,585	496
Total	8,126	22,916	7,637	26,008	2,781

There is not any house on non-residential land.

Partially impacted houses and other substructures are described as in tables 9.4.7 and 9.4.8.

Table 9.4.7 - Partially affected houses by provinces

Provinces	Total No. of HHs who are partially affected on houses	Number of partially affected houses	Classes				
			Class 1	Class 2	Class 3	Class 4	Temporary house
Da Nang	44	44	4	6	6	23	5
Quang Nam	976	976	66	280	40	445	72
Quang Ngai	360	360	38	66	96	141	19
Total	1,380	1,380	108	352	142	609	96

Table 9.4.8 - Area of partially affected houses according to each house class

Provinces	Affected area (m ²)				
	Class 1	Class 2	Class 3	Class 4	Temporary house
Da Nang	517	516	487	1,123	147
Quang Nam	5,966	28,426	2,422	31,498	2,138
Quang Ngai	4,704	5,916	7,821	7,840	496
Total	11,187	34,858	10,730	40,461	2,781

Number of households who are affected by loss of existing houses (houses class 4 or temporary houses) in areas smaller than 30 m² (considered in poor living condition) need assistance to improve the house to a minimum standard as proposed in the entitlement policy.

Table 9.4.9 - Number of households who are with the area of existing house is smaller than 30 m²

Provinces	Class 4		Temporary house	
	Number of houses	Area (m ²)	Number of houses	Area (m ²)
Da Nang	5	143	5	147
Quang Nam	129	3,418.5	72	2,138
Quang Ngai	37	1,194	19	496
Total	171	4,755.5	96	2,781

Impacts on the substructures are shown as in table 9.4.10 below

Table 9.4.10 – Loss of other structures

Provinces	Kitchen (m ²)	Houses for poultry (m ²)	Sub house with Fibro cement font cover (m ²)	Cement Playgr-ound (m ²)	Brick wall fence (m ²)	Iron Gate (m ²)	Graves (m ²)	No. of Well	No. of Plants
Da Nang	1,315	596	990	1,274	764	255	1	34	1,133
Quang Nam	7,927	5,114	5,077	11,949	4,552	1,429	3,047	404	26,765
Quang Ngai	10,498	7,935	4,706	10,704	4,998	241	1,112	407	18,831
Total	19,740	13,645	10,773	23,927	10,314	1,925	1,116	845	19,991

iii) Impacts on annual crops and trees

Annual crops and trees (wooden trees and perennial tress) are described as in table 9.4.11 below.

Table 9.4.11 - Impacts on annual crops and trees by provinces

Provinces	Rice (m ²)	Maize (m ²)	Sugar cane (m ²)	Acacia (m ²)	Eucalyptus (m ²)	Other tree (m ²)
Da Nang	33,146	55,452	78,324	9,075	0	12,525
Quang Nam	2,283,630	349,261	53,732	731,328	963,734	18,598
Quang Ngai	1,101,322	206,498	523,128	75,765	52,650	165,198
Total	3,418,098	644,211	655,184	816,168	1,016,384	196,321

iv) Impacts on Collective assets and public works

Impact on collective assets and public works by province are identified as in table 9.4.12 below.

Table 9.4.12 - Impact on collective assets and public works

Provinces	Names of affected assets	Names of Owners	Unit and Quantity	Remark on the technical specification
Da Nang	Roads	Local state	m ²	3,092.9
Quang Nam	Roads	Local state	m ²	25,010.2
Quang Ngai	Roads	Local state	m ²	14,970.3
Total	Roads	Local state	m²	43,073.4

v) Impact on vulnerable people

Impacts on the vulnerable groups and severely affected by land acquisition (family with disable persons, female headed HH, poor households who are severely affected, Ethic Minorities, HH who are eligible to the social policy of the Government, HH of all member are elderly and no one support) is described as in table 9.4.13 below.

Table 9.4.13 - Affected vulnerable households

Provinces	Number of HH with disable person	Number of HH is under the poverty line set forth by MOLISA	Number of Ethnic Minority HH	Number of HH with social policy	Number of female HH	Number of HH with all members are old and no one support
Da Nang	0	17	0	36	137	0
Quang Nam	0	1,225	0	290	1,562	0
Quang Ngai	0	169	0	193	1,187	0
Total	0	1,411	0	519	2,886	0

9.5 Relocation arrangement

9.5.1 Households and constructions in surveyed area

There are a total of 7,825 households of 38 communes will be impacted by land acquisition for the project; Of which:

- 1,210 Households will be impacted on residential land either partially or fully with the total affected area is 716,385 m²
- 4,506 Households will be impacted on agricultural land with the total area of 3,776,230 m².
- 791 Households will be impacted on other land with the total area of 2,989,595 m².
- About 1,191,544 m² of forestry land (public land) will be impacted.
- 1,380 Households will be impacted on either partially or fully on houses with the total affected area of houses is 343,349 m², from these 839 households have to relocate to new places.
- There are 39 collective or public institutions will be affected on their assets.

9.5.2 Relocation arrangement

Fully affected residential plot with house (households have to be relocated): Plot no longer viable for continued use and the entire property to be acquired. The DPs would be entitled to relocation if in the urban area, the non-affected residential area is

less than 40 m² and in the rural area, non-affected residential area is less than 100 m². This will be finally determined by the DCSCC and concurred with by the affected household during the DMS.

DPs who are fully affected on residential plot and house have an option on either:

(i) Cash compensation at replacement cost (free from taxes and transaction costs) for the entire land plus with bonus for self-relocation, or

(ii) Plot at the resettlement site which will be constructed by PMU 85

Table 9.5.1 – The households have to relocate by provinces

Provinces	Relocated HHs	Estimated area per lot (m ²)	Total areas of resettlement area (m ²)	No. of resettlement area required
Da Nang	23	500	11,500	2
Quang Nam	280	500	140,000	11
Quang Ngai	151	500	75,500	8
Total	454	500	227,000	21

A Resettlement Plan has been prepared as a separate document accompanying this project documents

CHAPTER 10 – TOTAL COST INVESTMENT

10.1 Basis of Total cost investment

- Construction law no.16/2003/QH11 date 26 Nov.2003 that was adopted by Vietnam National Assembly.
- Law on Land on 26 Nov. 2003.
- Law on Value Added Tax of National Assembly Legislature XII, 3rd Session, No.13/2008/QJ12 dated 3 June 2008.
- Decree no.209/2004/NĐ-CP dated 16-Dec-2004 about quality control of construction Projects.
- Government Decree 112/2009/NĐ-CP dated 14-Dec-2009 about management of project construction investment cost.
- Government Decree No. 205/2004/NĐ-CP dated on December 14, 2004 regulates the salary and allowances system in the state company.
- Government Decree no.97/2009/NĐ-CP dated 30-Oct-2009 regulating the minimum zone salary level of the labor working in factories, enterprises, co-operatives, farms, households, individual and other organization of Vietnam employing labor.
- Circular No.05/2007/TT-BXD dated on 25-Jul-2007 by the Ministry of Construction about the guideline on project cost establishment and management;
- Decision No.957/QĐ-BXD dated 29-Sept-2009 of Ministry of Construction of about promulgating norms of project management cost and construction investment consultancy of projects.
- Letter ref.2615/BXD-VP dated 30-Nov-2009 of Ministry of Construction promulgating the price index in quarter 3 in 2009.
- Letter ref.292/BXD-KTXD of Ministry of Construction promulgating project construction investment fund in 2008.
- Norms of project construction cost estimate for construction part promulgating in Letter ref.1776/BXD-VP dated 16-8-2007 of Ministry of Construction.
- Norms of project construction cost estimate for installation portion promulgating in Letter ref.1777/BXD-VP dated 16-Aug-2007 of Ministry of Construction.
- Cost estimate norms of urban drainage system maintenance and public lighting system maintenance attached in Decision No. 37/2005/QĐ-BXD and Decision No. 38/2005/QĐ-BXD dated 2-Nov-2005 of Ministry of Construction.
- Decision No. 18/2007/QĐ-UBND dated 19-Jul-2007 promulgating Project

Construction Unit Price – Installation Part in Quang Ngai Province.

- Decision No. 19/2007/QĐ-UBND dated 19-Jul-2007 promulgating construction survey unit price in Quang Ngai Province.
- Decision No. 20/2007/QĐ-UBND dated 19-Jul-2007 promulgating construction unit price – Construction part in Quang Ngai Province.
- Decision No. 70/2006/QĐ-UBND dated 28-Nov-2006 of People’s Committee of Quang Ngai Province regarding promulgating estimated pricelist of machine shift and construction equipment for construction works in Quang Ngai Province.
- Regulation on price of types of soils in Quang Ngai Province promulgating enclosed Decision No. 468/2008/QĐ-UBND dated 26-Dec-2008 of Quang Ngai Province.
- Decision No.39/2007/QĐ –UBND dated 31-Dec-2007 regarding promulgation of regulation on compensation, support and resettlement when the Government withdraws land applying in Quang Ngai Province.
- Decision No. 177/2008/QĐ-UBND dated 11-Jul-2008 of People’s Committee of Quang Ngai Province promulgating regulation on unit price of compensation for house and architecture works when the Government withdraws land applying in Quang Ngai Province.
- Decision No. 24/2005/QĐ-UB dated 23-Feb-2005 of People’s Committee of Quang Ngai Province promulgating regulation on density of plant ; unit price and rules of compensation, support damage of plant and farm produce when the Government withdraws land applying in Quang Ngai Province.
- Decision No. 35/2009/QĐ-UBND dated 24-Dec-2009 of People’s Committee of Da Nang Province promulgating regulation on price of types of land in Da Nang Province.
- Decision No. 71/2007/QĐ-UBND dated 20-Dec-2007 of People’s Committee of Da Nang Province promulgating regulation on compensation, support and resettlement.
- Decision No. 18/2008/QĐ-UBND dated 13-Mar-2008 of People’s Committee of Da Nang Province regarding adjustment and supplementation of regulation on compensation, support and resettlement when the Government withdraws land applying in Da Nang Province promulgating enclosed Decision No. 71/2007/QĐ-UBND dated 20-Dec-2007 of People’s Committee of Da Nang Province.
- Construction unit price – Construction and installation part, No.89/2006/QĐ-UBND, Construction survey part No.90/2006/QĐ-UBND dated 14-Oct-2006 of People’s Committee of Da Nang Province.

- Decision No. 36/2009/QĐ-UBND dated 20-Dec-2009 of People's Committee of Da Nang Province regulating regulation on compensation, support and resettlement when the Government withdraws land applying in Da Nang Province.
- Decision No. 46/2009/QĐ-UBND promulgating regulation on determination price of land and price bill of types of land in 2010 in rural districts and city of Quang Nam Province.
- Construction unit price of survey part promulgating enclosed Decision No.3398/QĐ-UBND dated 24-Nov-2006 of People's Committee of Quang Nam Province.
- Construction unit price of construction and installation part promulgating enclosed Decision No. 3399/QĐ-UBND dated 24-Nov-2006 of People's Committee of Quang Nam Province.
- Declaration on material price No.1530/CB-LS dated 14-Oct-2009 of People's Committee of Quang Nam Province promulgating construction material price Quang Nam Province.
- Declaration on material price No.1212/SXD-KHKTT Đ dated 15-Dec-2009 of People's Committee of Quang Nam Province promulgating construction material price Quang Nam Province.
- Declaration on material price in December 2009 of interdepartmental of Finance – Construction in Da Nang City.

10.2 Structure of Total Cost Investment

Component of Total cost investment is calculated based on Circular No.05/2007/TT-BXD dated 25-Jul-2007 of Ministry of Construction regarding guidance and management of construction investment cost included :

- Construction cost is established based on norm, machine shift unit, material price and other above mentioned Circulars and Documents for implementing establishment of general unit price of each installation item in order to estimate for each item such as road-bed, pavement, bridge and works on this line ...
- Project management costs, construction investment cost and other cost of the Project estimate about 12% of total construction cost.
- Cost for land acquisition and resettlement includes compensation of farm produce and land. Compensation of house and compensation of utilities, which must relocate on this line.
- Contingency:
 - + Contingency cost for quantity factor of additional works is calculated by 5% of total

construction cost, compensation cost for land acquisition and resettlement, project management cost, construction investment consultant cost and other costs.

- + Contingency cost for price escalation factor is calculated by 15% of total construction cost, compensation cost for land acquisition and resettlement, project management cost, construction investment consultant cost and other costs.

10.3 Total cost investment

Total cost investment of the whole project is summarized in the following tables

Table 10.3.1 – Total investment summary

No.	Work items	Description	Amount (VND)
A	Construction cost		20,076,547,598,759
I	Road part		11,410,814,741,630
I.1	Main road		10,338,142,146,933
I.2	Frontage road		406,387,403,752
I.3	Service road		666,285,190,945
II	Bridge part		6,552,300,316,079
III	Tunnel part		442,668,529,849
IV	Management and Operation Works		1,670,764,011,200
B	Project's overhead, project construction consulting services, investment , others	12%*(A)	2,409,185,711,851
C	Cost for land acquisition		2,380,353,532,873
D	Contingency	20%*(A+B+C)	4,973,217,368,696
	Contingency for quantity	5%*(A+B+C)	1,243,304,342,174
	Price escalation Contingency	15%*(A+B+C)	3,729,913,026,522
E	Total Investment		29,839,304,212,179

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Table 10.3.2 – Detailed total investment

No.	Work items	Description	Volume (km)	Road section connects (km)	Amount (VND)
A	Construction cost		19,885,613,125,391	190,934,473,367	20,076,547,598,759
I	Road Part		11,525,534,752,502	158,279,989,128	11,410,814,741,630
I.1	Main road		10,186,176,640,500	151,965,506,433	10,338,142,146,933
1	Road bed	Attached cost estimate	4,216,537,349,127	49,999,350,053	4,266,536,699,180
2	Pavement	ditto	3,534,697,469,220	67,031,609,046	3,601,729,078,266
3	Soft soil treatment	ditto	429,143,939,248	8,575,708,307	437,719,647,556
4	Other Items	ditto	1,112,923,699,695		1,112,923,699,695
5	Traffic safety	ditto	104,848,485,537	6,968,970,302	111,817,455,839
6	Drainage	ditto	488,025,697,672	19,389,868,725	507,415,566,397
7	Lighting	Estimate	200,000,000,000		200,000,000,000
8	Planting	Estimate	100,000,000,000		100,000,000,000
I.2	Frontage road		405,072,921,057	1,314,482,695	406,387,403,752
1	Road bed	Attached cost estimate	246,259,276,601	864,107,389	247,123,383,989
2	Pavement	ditto	137,669,058,863	400,980,635	138,070,039,498
3	Drainage	ditto	21,043,836,593		21,043,836,593
4	Other Items	ditto	100,749,000	49,394,671	150,143,671
I.3	Service road		661,285,190,945	5,000,000,000	666,285,190,945
1	Road bed	ditto	357,037,054,755	2,900,000,000	359,937,054,755
2	Pavement	ditto	290,718,513,921	2,100,000,000	292,818,513,921
3	Drainage	ditto	13,529,622,269		13,529,622,269
II	Bridge part		6,519,645,831,840	32,654,484,239	6,552,300,316,079
III	Tunnel part		442,668,529,849		442,668,529,849
	Tunnel at Km22+656	Attached cost estimate	442,668,529,849		442,668,529,849

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No.	Workitems	Description	Manpower (Person)	Personnel Expenses (USD)	Material (USD)
IV	Management and operation works		1,670,764,011,200		1,670,764,011,200
1	Construction cost	Attached cost estimate	565,695,269,000		565,695,269,000
2	Facilities expenses	ditto	445,136,673,000		445,136,673,000
3	Management Center	Estimate	250,000,000,000		250,000,000,000
4	ITS	Attached cost estimate	409,932,069,200		409,932,069,200
B	Other expenses	12%*(A)	2,386,273,575,047	22,912,136,804	2,409,185,711,851
D	Land acquisition	Attached cost estimate	2,380,353,532,873		2,380,353,532,873
1	Da Nang		141,699,190,545		141,699,190,545
2	Quang Ngai		1,351,260,759,418		1,351,260,759,418
3	Quang Nam		792,393,582,909		792,393,582,909
4	Management and operation works		95,000,000,000		95,000,000,000
D	Contingency	20%*(A+B+C)	4,930,448,046,662	42,769,322,034	4,973,217,368,696
E	Total budget		29,582,688,279,973	256,615,932,206	29,839,304,212,179

Notes: Total investment excluding interest during construction

CHAPTER 12 – PROJECT IMPLEMENTATION

12.1 Project implementation mechanism

12.1.1 Project implementation mechanism

Following Notice No.594/TB-BGTVT dated 25-Dec-09 regarding Conclusion of Vice Minister Ngo Think Duc at the closing meeting with preparation delegation of World Bank on Quang Ngai Expressway Project, the Project implementation mechanism as follows:

- MOT is the Governing Body, makes a decision.
- Vietnam Expressway Corporation is the Employer of the Project.
- Project Management Unit 85 is the project implementation agency.

12.1.2 Organization structure and capacity of project implementation agencies

(i) Vietnam Expressway Company (VEC)

- *Current Structure and Organization of VEC*

Vietnam Expressway Corporation (VEC) is a state owned company established, being formed under Ministry of Transportation's decision number 3030-QD-BGTVT on October 6th 2004 based on approval of the Government in document number 1245/CP-ĐMDN on September 1st 2004.

VEC operates in the fields of investment fund absorbing, construction management, operation, toll fee collection, maintenance and reinvestment into other construction works from collected tolls in the future, and will actively cooperate with financial institutions and cooperative partners to get invest fund for nominated projects as well as to find out the most suitable model for toll expressways.

Organization structure of VEC is shown in Figure 12.1.1

- *Funding Mechanism of VEC is allowed model application*

Following Decision No. 1202/QĐ-TTg, dated 10 September 2007 of the Prime Minister on Piloting some Mechanisms, Policies to Highway Investment and Operation Projects of the Employer – Vietnam Expressway Corporation, the content of mechanisms, the policy is allowed model application for funding of VEC including:

1) For expressway project appraised by the authorized agencies which is effectiveness and has reimbursement ability that is applied the re-borrowing mechanism from ODA loan of the Government; from normal borrowed funds or commercial borrowed funds from Governments and International Credit Organizations; from the fund by issuing the long term international bond of the Government.

2) Depend on each expressway project, VEC is allowed to issue domestic and internal works bonds following regulation guaranteed by the Government. The case in the reimbursement time of the Project, VEC does not collect enough funds from income of the Project and other incomes to pay the loans, VEC is allowed to issue bond more for returning. Ministry of Finance considers, submits to Prime Minister each specific case.

3) VEC is allowed development investment credit funding following regulation at the Decree No. 151/2006/ND-CP dated December 20, 2006, on the State's investment credit and export credit, to invest expressway projects.

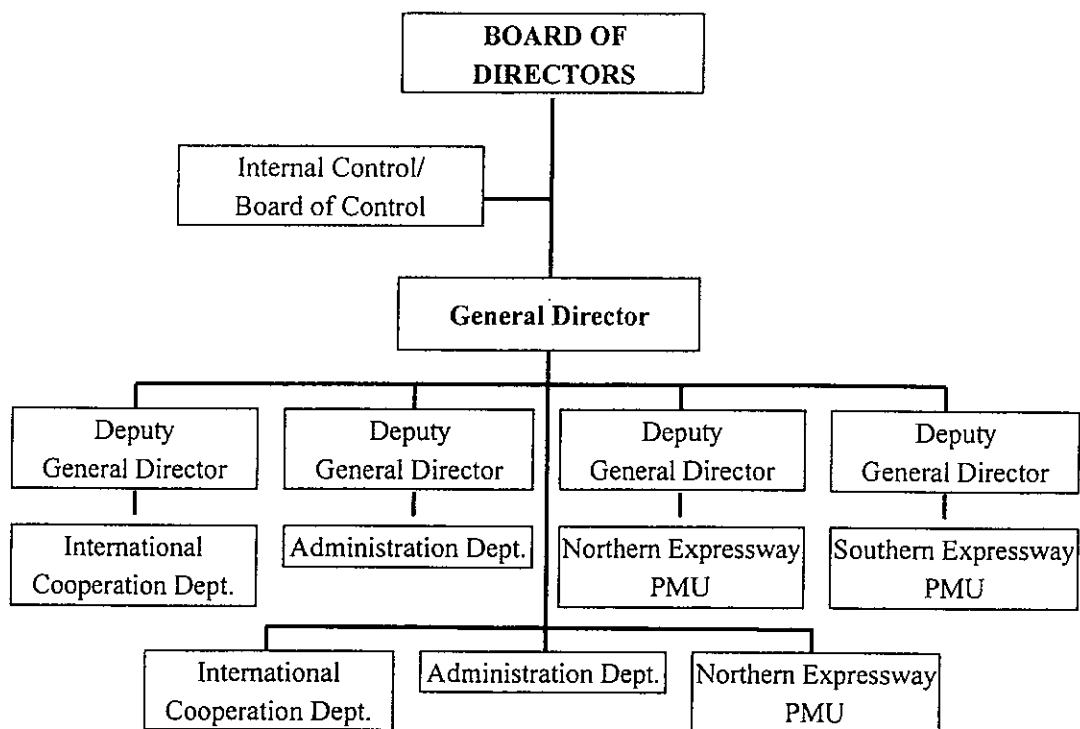


Figure 12.1.1 – Organization structure of VEC
(Source: Research TA 4695-VIE, 2007)

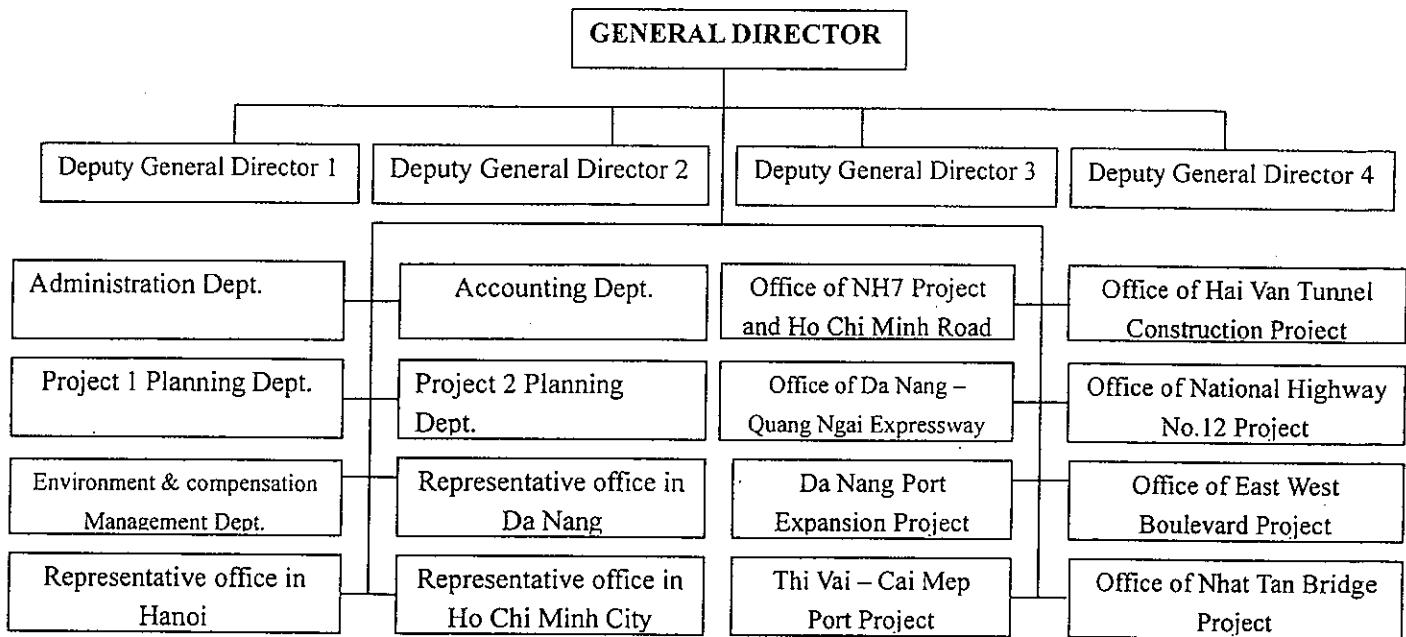
(iii) Project Management Unit 85 (PMU85)

- *Organization structure*

PMU85 which was established in 1985, is one of Project Management Units under MOT.

Figure 12.2.2 - Organization structure of PMU85

(Source: Research JETRO, 2008)



- *Projects is managed by PMU85.*

PMU85 has had a lot of experiences in management of international, JBIC and ADB Projects. Projects which are managed by PMU85 in recent time, are stated in Table 12.1.1

Table 12.1.1 – List of Projects managed by PMU85

Name of Project	Funds	Scope	Expenditure (VND million)	Completion time
Projects utilizing ODA loan				
1. Hai Van Tunnel Construction Project	JBIC	Total is 12.5km	3465	June-2005
2. Tien Sa Da Nang Port Expansion Project	JBIC	Port improvement. Approach road into the Port Da Nang by-road	1932	Being implemented
3. National Highway No.9 Improvement Project (Phase 2)	ADB	Total is 102km	546	November - 2006
4. Cai Mep - Thi Vai International Port Construction Project	JBIC	Cai Mep Port: 2@300m Thi Vai Port: 2@300m Road into the Port	6073	Being implemented
5. Nhat Tan Bridge Construction Project	JBIC	Total is 4.4km. Nhat Tan Bridge: 3.9km (Cable-stayed bridge)	7529	Being implemented
Projects utilizing local funds				
1. Cua Lo Port Construction Project	-	Length of whaft: 420m	No data	1984
2. Ben Thuy Bridge Construction Project	-	Length of Bridge: 650m	No data	1990
3. National Highway No.8A Improvement Project	-	Length of Road: 85.3km	167	1995
4. Danh River Bridge Construction Project	-	Length of Bridge: 750m	239	1998
5. Hien Luong Bridge Construction Project	-	Length of Bridge: 242m	45	1999
6. National Highway No.9 Improvement Project (Phase 1)	-	Length of Road: 67km	100	1999
7. Quan Hau Bridge Construction Project	-	Length of Bridge: 521m	149	2000
8. Vung Ang Port Construction Project (Phase 1)	-	Length of whaft: 185m	94	2000
9. National Highway No.8B Construction Project	-	Length of Road: 90km	USD 48.5 million	2006
10. Khe Khoi – Nam Can Road Improvement Project	-	Length of Road: 105km	750	Being implemented
11. National Highway No.1 Improvement Project (Vung Ang – Lao Port)	-	Length of Road: 54km	692	Being implemented
12. Vung Ang Port Construction Project (Phase 2)	-	Length of Bridge: 153m	532	No information

(Source: Research JETRO, 2008)

12.2 Division of construction packages

12.2.1 Principle of construction package division

Construction packages are divided according to the following principles:

- Conformity with construction organization from knots following recent road system, suitable transport interval.

- Noticing major and focus knots, specifically 04 bridges flying over river: Cau Lau, Chiem Son, Tra Bong, Tra Khuc, Tunnel Km22+656, main intersections and technical matters about soft soil treatment which may influence on construction schedule of expressway.

- Considering division following administrative boundary (if possible) for conformity with land acquisition work according to each region.

- To ensure uniformity over whole route during construction and operation process, the following items can be established into separated construction packages implemented by special authorities:

- + Tollgate, operation management house, expressway operation control management centre, service station and other equipments.

- + Lighting system.

- + Traffic safety system.

- + Intelligent traffic system.

Based on the above mentioned principles, 2 alternatives of construction packages are expected as follows:

(i) Alternative 1:

It is divided into 07 packages following location of main intersections and bridge works; and 01 package about works for serving management and operation.

Table 12.2.1 - Expectation of package division for Alternative 1

Package	Section/ Works	Region	Main items	Road crossing is mainly used for construction	Notice
1	Km0-Km22	Hoa Vang rural district – Da Nang City, Dien Ban rural district and Duy Trinh commune, Duy Xuyen rural district – Quang Nam province	- Construct 17.68km road. - Construct 4,139 md bridge on main road, in which there are Cau Lau Bridge and Chiem Son Bridge and 63 lmd overpass bridge. - Construct 02 interchanges: Tuy Loan and My Son.	NH No.14B PR No.605, PR No.609, PR No.610	

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Package	Section/ Works	Region	Main items	Road crossing is mainly used for construction	Notice
2	Km22-Km42	Duy Xuyen rural district, Que Son rural district and Binh Quy Commune, Thang Binh rural district – Quang Nam province	- Construct 18.93km road; - Construct 1,068.4 md bridge; - Construct 01 tunnel, L=540md. - Construct 01 interchange: Thang Binh.	PR No.610, PR No.611, NH No.14E	
3	Km42-Km65	Thang Binh rural district, Phu Ninh rural district – Quang Nam province	- Construct 21.854km road; - Construct 1,146 md bridge on main road and 290md overpass bridge; - Construct 01 interchange: Tam Ky	NH No.14E, PR No.615, PR No.616	
4	Km65-Km85	Phu Ninh rural district, Tam Ky City, Nui Thanh rural district – Quang Nam province	- Construct 19.27km road; - Construct 735 md bridge on main road and 608md overpass bridge; - Construct 01 interchange: Chu Lai.	PR No. 617	
5	Km85-Km103	Nui Thanh rural district - Quang Nam province and Binh Nguyen Commune, Binh Son rural district – Quang Ngai province	- Construct 17.58km road; - Construct 420 md bridge on main road and 827md overpass bridge; - Construct 01 interchange: Dung Quat.	PR No.617	
6	Km103-Km123	Binh Son rural district, Son Tinh rural district – Quang Ngai province	- Construct 18.71km road. - Construct 1,291 md bridge on main road and 1,293md overpass bridge; in which there is Chau O Bridge; - Construct 01 interchange: Binh Son	PR No.622 PR No.623	
7	Km123-Km131+500 expressway and 8.02km section connecting NH No.1	Son Tinh rural district – Quang Ngai province, Tu Nghia rural district.	- Construct 6.3km of main road and 7.89 km of connection road - Construct 2,202 md bridge on main road and 127md bridge on	PR No.623, PR No.623B, PR No.627	

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Package	Section/Works	Region	Main items	Road crossing is mainly used for construction	Notice
			connection road, in which there is Tra Khuc Bridge. - Construct 01 interchange: North Quang Ngai.		
8	Works for serving management and operation	Whole route	Construct 09 tollgates, 01 operation office, 01 Traffic management centre, 01 service station and equipments, ITS, lighting, traffic safety...		

(ii) Alternative 2:

It is divided into 13 packages considered location of main intersections, bridge works and boundary among regions... and 01 package about works serving management and operation.

Table 12.2.2 - Expectation of package division for Alternative 2

Package	Section/Works	Region	Main items	Road crossing is mainly used for construction	Notice
1	Km0-Km8	Hoa Vang rural district – Da Nang City	- Construct 6.864km road; - Construct 1,136md bridge on main road and 371md bridge at interchange; - Construct 01 interchange: Tuy Loan	NH No.14B, PR No.605	
2	Km8-Km22	Dien Ban rural district and Duy Trinh Commune, Duy Xuyen rural district – Quang Nam province	- Construct 10.997km road - Construct 3,003md bridge on main road and 300md bridge at interchange; in which there are Cau Lau Bridge and Chiem Son Bridge. - Construct 01 interchange: My Son.	PR605, PR609, PR610	
3	Km22-Km32	Duy Xuyen rural district, Que Son	- Construct 9.582km road;	PR No.610,	

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Package	Section/Works	Region	Main items	Road crossing is mainly used for construction	Notice
		rural district – Quang Nam province	- Construct 418md bridge on main road; - Construct 01 tunnel, L= 540md.		
4	Km32-Km42	Queue Son rural district, and Binh Quy Commune, Thang Binh rural district – Quang Nam province	- Construct 9.35km road; - Construct 650md bridge on main road; - Construct 01 interchange: Thang Binh	PR No.615, NH No.14E	
5	Km42-Km52	Thang Binh rural district – Quang Nam province	- Construct 9.415km road; - Construct 585md bridge;	NH No.14E	
6	Km52-Km65	Phu Ninh rural district– Quang Nam province	- Construct 12.439km road. - Construct 561md bridge on main road and 290md bridge at interchange; - Construct 01 interchange: Tam Ky.	PR No.615 PR No.616	
7	Km65-Km77	Phu Ninh rural district, Tam Ky City, Nui Thanh rural district – Quang Nam province	- Construct 11.427km road. - Construct 573md bridge on main road and 185md bridge at interchange.	PR No.617	
8	Km77-Km88	Nui Thanh rural district – Quang Nam province	- Construct 10.78km road; - Construct 222md bridge on main road and 540md bridge at interchange; - Construct 01 interchange: Chu Lai.	PR No.617	
9	Km88-Km100	Nui Thanh rural district - Quang Nam province	- Construct 11.68km road; - Construct 324md bridge on main road and 94md bridge at interchange; - Construct 01 interchange: Dung	PR No.617	

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Package	Section/Works	Region	Main items	Road crossing is mainly used for construction	Notice
			Quat.		
10	Km100-Km111	Binh Son rural district – Quang Ngai province	- Construct 9.75km road; - Construct 1,250md bridge on main road and 733md bridge at interchange; in which there is Chau O Bridge.	PR No.622	
11	Km111-Km123	Binh Son rural district, Son Tinh rural district – Quang Ngai province	- Construct 11.92km road. - Construct 77md bridge on main road and 1,176md bridge at interchange; - Construct 01 interchange: Binh Son	PR No.622, PR No.623	
12	Km123-Km131+500	Son Tinh rural district – Quang Ngai province, Tu Nghia rural district.	- Construct 6.3km road. - Construct 2,202md bridge on main road and 187md bridge at interchange; in which there is Tra Khuc Bridge. - Construct 01 interchange: North Quang Ngai	PR No.623, PR No.623B,	
13	8.02km section connecting NH No.1A		- Construct 7.903km road. - Construct 127md bridge.	PR 627	
14	Works for serving management and operation	Whole route	Construct 09 tollgates, 01 operation office, 01 Traffic management centre, 02 service stations and equipments, ITS, lighting, traffic safety...		

In conformity with the construction schedule as well as capability of contractors, alternative 2 will be recommended.

12.2.2 Proposal on Source of Capital

Following is the proposal for partition of sources of capital and scope of work respectively according to the memorandum in the meetings with World Bank (WB), Japan International Corporation Agency (JICA) and Ministry of Transport of Vietnam (MOT):

- **Loan from Japan:** Executing 6 packages of the expressway construction (package 1 to package 6) belong to section Da Nang – Tam Ky (section from Km0 to Km65) and 01 Management-Operation-Service package (package 14) with total cost of about 14,149 billion.VND (equivalent to 744.710 million USD; 48.5% of total investment

- **Loan from WB:** Executing 6 packages of the expressway construction (package 7 to package 12) belong to section Tam Ky – Quang Ngai (section from Km65 to Km131+500) and the road section connects with NH.1A (package 13) with total cost of about 11,133 billion VND (equivalent to 585.980 million USD; 38.12% of total investment).

- **Local capital:** Executing for land acquisition and for tax with total cost of about 3,920 billion.VND (equivalent to 206.350 million USD; 13.4% of total investment).

12.3 Implementation program

The implementation program which is prepared following agreement between MOT and World Bank and the implementation schedule of the Employer and PMU85, and expected in Table 12.3.1.

Table 12.3.1 - Expectation of implementation program

No.	Item	Implementation program	Notice
1000	Funding Bank		8 months
1010	Project pre-appraisal	May-2010	
1020	Project appraisal	October-2010	
1030	Agreement negotiation	January-2011	
1040	Agreement approval	March-2011	
2000	Selection of detailed design consultant		9 months
2010	Issuance of proposed bidding document	January-2010	
2020	The Contractor submits proposal document and evaluation of proposal document	March-2010	
2030	The Bank and the Employer approve result on the consultant selection	July-2010	

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No.	Item	Implementation program	Notice
2040	Negotiation and signing contract	August-2010	
3000	Detailed design and preparation of bidding document		16 months
3010	Consultant mobilization	September-2010	
3020	Detail design completion	December-2011	
4000	Land acquisition		20 months
4010	Starting time	May-2010	
4020	Ending time	December-2012	
5000	Selection of the Consultant for checking detailed design, supporting bidding and supervising construction		
5010	Issuance of proposed invitation document	January-2011	
5020	The Contractor submits proposal document and evaluation of proposal document	March-2011	
5030	The Bank and the Employer approve result on the consultant selection	May-2011	
5040	Negotiation and signing contract	June-2011	
5050	Consultant mobilization for checking detailed design, supporting bidding and supervising construction	July-2011	
6000	Construction bidding		18 months
6010	Advertisement, prequalification	May-2011	
6020	Selection of short list	July-2011	
6020	Issuance of bidding document and bids		
6030	Preparation of contract and negotiation	August-2011	
6040	Notice of selected bidder and contractor mobilization	January-2012	
7000	Construction		42 months
7010	Starting time	January-2012	
7020	Ending time	July-2016	

In project implementation process, PMU85 shall construct and submit the following reports to the Project Owner for submitting to MOT, Ministry of Planning and Investment, Ministry of Finance and the Provincial People's Committee where the Project is implemented:

- a) Monthly report, the latest is 10 days after ending of month;
- b) Quarterly report, the latest is 15 days after ending of quarter;

- c) Yearly report, the latest is on 31st December of the next year;
- d) Completion report, the latest is 6 months after finishing project implementation;
- e) Report on changes (if any) in comparison with the contents of the signed particular Agreement on the Project.
- f) Reports for the Sponsors are implemented following agreement in the signed particular Agreement on the Project.

CHAPTER 13 – CONCLUSIONS AND RECOMMENDATIONS

13.1 CONCLUSIONS

1) Name of the Project:

Da Nang – Quang Ngai Expressway

2) Type of the Project:

Group A - Transport Works Project

3) The Employer:

Vietnam Expressway Corporation (VEC)

4) Project management:

Project Management Unit No. 85 (PMU85)

5) Objective of works construction investment:

The construction investment of Da Nang – Quang Ngai Expressway is to reach the following objectives:

- Solve the transport demand of passenger and goods among the central clue area of the major economic regions of Central zone and other economic regions over the Country.
- Shorten moving time from provinces to the central tourism regions in Da Nang, Quang Nam and Quang Ngai.
- Create good condition for pushing up establishment and development of industrial zones, ecological tourism zones along coastal of Da Nang, Quang Nam and Quang Ngai.
- Overcome traffic jam situation in diluvia rain season and minimize traffic accident which regularly happens on NH No.1A.
- Create good condition for each step of completion of Vietnam expressway network system development plan up to 2020 and overview after 2020, specialty is the early establishment of North and South expressway axle to the East.

6) Scope of the Project and location of construction:

- The Expressway, which is located in the West of NH No.1 and Thong Nhat Railway, passes land of Da Nang City, Quang Nam Province and Quang Ngai province.
- The staring point of the route: Crossing with NH No.14B at about Km23+908/QL14B under land of Hoa Vang rural district, Da Nang City.
- The ending point of the route: Crossing with the planning road of the West of Quang Ngai City.

Besides, the Project is still studied the route connecting from the ending point of the Expressway with NH No.1A in the South of Quang Ngai City.

7) Scale of the Project:

7.1 Type of the works class

Type A Expressway, design speed $V_{TK} = 120\text{Km/h}$ according to Vietnam Standard TCVN 5729-1997: Expressway – Design requirement.

- Works Class: Special.

7.2 Cross section

a) Scale of cross section of the Expressway

Planning cross section is 6 carriageway lanes. Phase 1 is constructed with scope of 4 carriageway lanes (empty at 2 sides).

b) Scale of cross section of road crossing

- Cross with road crossings including National Highway and provincial roads which are designed following standard of Class III flat road with width of roadbed $B=12\text{m}$. For NH14B alone, the existing size will be unchanged $B_{\text{roadbed}} = 23\text{m}$.

- The connection road from the end-point to NH1A is class-3 plain road.

- Road crossings are designed according to standard of Type A rural road with width of roadbed $B=5.0\text{m}$.

c) Scale of cross section of frontage road

Frontage road is constructed close the Expressway (except the case making the most of the neighboring existing roads) following standard of Type A rural road. Width of roadbed is $B=5.0\text{m}$.

8) Applicable specifications

The Consultant will prepare technical frame applying for the Project for the Project Owner submitting to MOT to approve.

9) Design measurements:

9.1 Route alignment:

◆ Expressway

The starting point is at Tuy Loan Town and Hoa Vang rural district, Da Nang City, the route totally goes through the West of NH No.1A and Thong Nhat Railway, flies over Tuy Loan River and Yen River, avoids Dien Tien – Dien Ban Industrial Zone and Bo Bo Mountain. The Route flies over Thu Bon River at the upstream of Ky Lam Bridge on Thong Nhat Railway. After flying over Thu Bon River, the Route continues flying over Ba Ren River and Provincial Road 610.

After passing My Son Intersection, the route passes Eo Mountain, then, it goes straight to the crossing location with provincial road No.616, goes along hill ranges and goes to the West of Nui Thanh Town, goes downstream of Ho May Dam,

then goes parallel towards the West of Thong Nhat Railway to Dung Quat Intersection.

From Dung Quat Intersection, the route will turn right, fly over Tra Bong River to Binh Son Intersection then goes to the West area of the communes of Tinh Tho and Tinh Ha, cross with provincial road No.623, Tra Khuc River and provincial road No.623B, then connects to planning ring road of Quang Ngai City.

Total length of the route is about 131.5Km.

◆ Section connecting NH No.1A

- The starting point of the route: The ending point of the expressway is the ending point of intersection with the planning road of the West of Quang Ngai City, at about Km131+129.26..

- The ending point of the route: Joint with the byroad of the West of La Ha Town, about Km1063+700 on NH No.1A.

The length of the route is about 8.02Km.

9.2 Plan:

Diameter of lied curve is ensured bigger or similar to minimum diameter of road Class ($R_{min}=250m$ for connection section out NH No.1A).

9.3 Profile:

- Design frequency of embankment is $P=1\%$ for expressway and $P=4\%$ for the connection route to NH No.1A.

- Expressway is been priority to go under National highways and provincial roads. Arrangement of direct through flyovers or interchanges among the National highways and the provincial roads with expressway.

- Local roads and internal roads of the region may be arranged local passing culvert or overpass combining with frontage road for connecting 2 sides of expressway.

9.4 Pavement structure:

- Pavement structure of the Expressway: ensures minimum elastic module $E_{yc} \geq 210Mpa$. To be advantage for expansion in completion stage, pavement structure of emergency lane is similar to pavement structure of carriageway lane but without anti-skid asphalt concrete layer.

- Pavement structure of the road connecting to NH No.1A: ensures minimum elastic module $E_{yc} \geq 140Mpa$.

- Pavement structure of frontage road: Cement concrete pavement for the sections subject to flooding and double BTS for the sections non-subject to flooding.

9.5 Drainage system:

9.5.1 Pavement drainage:

- Water surface freely drains at the low embankment sections by horizontal pavement slope through the roof slopes down both sides.

- At the position where the embankment is higher than 4m and slope is larger than 2% of surface water that is concentrated in the concrete gutters arranged at both sides and drains through water slopes and gutter system on the bent roof.

- In the scope of the curves, which are arranged super-elevation, water from the pavement to the back curve is collected in grooves arranged in vertical distribution between solution, flowing along the trench and gas collection system to escape outside.

9.5.2 Traverse drainage

The bridge and culvert apertures are determined based on the hydrologic and hydraulic power calculation with $P=1\%$ of design frequency. Culverts relating to irrigation channel have agreement of the local management authorities.

9.6 Design of flyover, local crossing culvert and frontage road.

- Flyover: Flyover on National Highway and provincial road are designed according to plan depending on each particular route, width of flyover is $B=9-22.5m$.

Flyover on inter-commune road has $B=7.5m$.

- Local crossing culvert has $B \times H=5.0 \times 3.5m$.

- Frontage road sections are suitably arranged, combined flyover and local crossing culvert to meet the traveling demand of the people passing the expressway.

9.7 Interchanges

- Eight interchanges connecting with the existing National highways and provincial roads are arranged on the whole expressway. Particularly, intersection at the ending expressway of phase I is at-grade intersection and connects the expressway endpoint to NH No.1A.

- Roads crossing with the connecting section to NH No.1 are designed as at-grade intersection.

- Bridge structure in intersection is conformity with conditions of topography, geology and landscape of the region.

9.8 Bridge design

9.8.1 Scale and grade of works

- Construct permanent bridges by RC and Pre-stressed concrete

- Design load: HL 93, passenger $300kg/cm^2$

- Flood frequency: $P=1\%$.

Width of bridge:

+ B=26m for bridge on the expressway; B=12m for bridge on the alignment of way out NH No.1A

+ B= 9-22.5m for the flyovers of the National highway and provincial road.

+ B=7.5m for local flyover

9.8.2 Span structure solution

a) Superstructure

- River crossing bridge: Using built-up slab girder, I-Beam, Super-T Beam, PC box girder.

- Bridge in the Interchange: Hollow slab girder structure

b) Substructure

- RC abutments and piers on shallow foundations or bored pile foundations depending on geotechnical conditions at each bridge position.

- Detailed design of bridge shall be following basic design.

9.9. Tunnel design:

At Km22+656, construct 02 separate tunnels for each vehicle direction, respectively. Width of one tunnel B=12.75m, including: 1.25m side used for maintenance; 2 carriageway lanes 2@3.75m and 01 emergency lane 3.25m; Safety strip 0,75m. Expected tunnel length is L=540m

9.10. Traffic safety utilities

- The system of road marking lines, traffic signs shall be following the Regulations of road signal 22TCN273-01 and 22TCN331-05 to instruct and organize traffic on the roads.

- Installation of wire net fence on two sides of roads to prohibit non-motorized vehicles, pedestrians, cattle entering the expressways.

9.11. Landscape and Lighting Design

- Landscape: At the interchange position, planting is designed following architectural landscape.

- Lighting: Lighting at the tollgates, service stations, interchanges and bridges L>500m.

9.12. The works serving management and operation.

9.12.1. Tollgates

Tolling shall be in an enclosed mode. Tollgates are located at all incoming and outgoing ramps of the expressway. Each tollgate has one Electronic Toll Collection/ ETC; for the remaining gates, tolling shall be following one-stop mode. In Stage 1, 09 of tollgates shall be constructed (including 2 main tollgates and 07 sub-tollgates). For the intersection crossing the planned road of Quang Ngai city at the end of the expressway, it is a at-grade intersection.

9.12.2. Lay-by along the route

04 lay-bys are located on both sides at stations Km29+130 and Km98+800

9.12.3. Service stations.

One service station shall be constructed on both sides of the road at station Km69+600.

9.12.4. Management and Operation Building – Control Center

One Control Center shall be constructed on the expressway at Km0+950 in Da Nang; One Operation and Maintenance Center shall be constructed at station Km64+750 in Tam Ky.

9.12.5. Traffic Control System

The Traffic Control System includes some sub-systems as follows:

- Vehicle counting system.
- Weather Observation System
- CCTV system
- Weight-in-motion system
- Wireless Radio System
- Variable Message Sign System
- Traffic Control Center System

10) Land acquisition and resettlement Plan

In accordance with Vietnam's rules and guidelines of the sponsors.

Land acquisition phase 1: construction of 4 lanes (with emergency lane) and clearing the site from scope of occupancy of the Works (slope footing, edge of the road or viaduct) 10cm outwards each side so that in phase 2 there will be enough space for 6 lanes as planning.

11) Environmental Impact Assessment.

The EIA is made in a separate report according to Vietnam's regulation and the sponsors' guidelines.

12) Total cost

Total cost of the project is about VND 29,204 billion (equivalent to USD 1.537 billion at the exchange rate 1USD= VND19,000).

No.	Work items	Description	Amount (VND)
A	Construction cost		20,692,948,142,668
I	Road part		11,366,657,277,503
I.1	Main road		10,101,899,078,217
I.2	Frontage road		445,209,339,466
I.3	Service road		819,548,859,820
II	Bridge part		7,363,620,910,926
III	Tunnel part		432,373,423,228
IV	Management and Operation Works		1,530,296,531,012
B	Project's overhead, project construction consulting services, investment , others	12%*(A)	2,483,153,777,120
C	Cost for land acquisition		1,160,265,758,650
D	Contingency	20%*(A+B+C)	4,867,273,535,688
	Contingency for quantity	5%*(A+B+C)	1,216,818,383,922
	Price escalation Contingency	15%*(A+B+C)	3,650,455,151,766
E	Total Investment		29,203,641,214,126

13) Investment funding source and financial option of the Project

Funding structure and cost of funds utilization will be corrected after completion of funding procedures.

14) Project implementation period

- Commencement: January 2012
- Finish: May 2016

13.2 RECOMMENDATIONS

1) The updated, completed Project on Da Nang – Quang Ngai Expressway basically complies with the rules on contents, appearance and quality of the steps of construction investment project establishment. However, the documents still has following problems:

- Because some sections are not adjusted but take full advantage of the studied sections (km16-Km60 section and Km73-Km109 section) without additional geological, topographical surveys; for realigned sections from Km16, Km60-Km73 only topographical, hydrological, geological materials referring to implemented researches, so the documents still have some limits regarding calculation of width, layout of drainage system, depth of abutment, pier, layout of the interchanges, so on;

- The alignment runs through the most heavily flooded area of the Center, especially the sections go through Thu Bon and Tra Khuc basins, so hydrographic and hydraulic studies should be studied, surveyed more thoroughly and more detailed calculations should be made in the technical design.

2) The Consultant would like to recommend the Ministry of Transport and competent authorities to review, and approve the project so that the next stages can be done.