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Ministry of Communications
The Islamic Republic of Pakistan

PAKISTAN TRANSPORT PLAN STUDY IN THE ISLAMIC REPUBLIC OF PAKISTAN (Phase II)

Final Report
(Volume I)

January 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD. & ALMEC CORPORATION

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PREFACE

In response to a request from the Government of Pakistan, the Government of Japan decided to conduct the Pakistan Transport Plan Study in the Islamic Republic of Pakistan, and entrusted the study to the Japan International Cooperation Agency (JICA).

The study consists of two phases and the Phase I study was completed in March 2006. This final report presents the study result of the Phase II study conducted from April 2006 to September 2006.

JICA selected and dispatched a study team headed by Mr. Minoru Shibuya of Nippon Koei Co., Ltd. and consisted of Nippon Koei Co., Ltd. and Almec Corporation. The team conducted field surveys and analysis in the study area and held a number of discussions with and made presentations to the officials concerned of the Government of Pakistan.

I hope that this report will contribute to the development of Pakistan and to the enhancement of friendly relationship between the two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Pakistan for their close cooperation and friendship extended to the study.

January, 2007

Kazuhisa Matsuoka
Vice President
Japan International Cooperation Agency

January, 2007

Letter of Transmittal

We are pleased to submit herewith the Final Report of the Pakistan Transport Plan Study in the Islamic Republic of Pakistan (Phase II). This study was entrusted to Nippon Koei Co., Ltd. in association with Almec Corporation, under a contract with Japan International Cooperation Agency (JICA), during the period from April 2005 to January 2007.

The report contains the advices and suggestions of the concerned authorities of the Government of Japan and your agency as well as the comments made by the concerned authorities of the Government of Pakistan.

We would like to take this occasion to express our sincere gratitude to JICA and the Ministry of Communications for providing an opportunity to conduct this Study. We are also the most grateful for the cooperation, guidance and assistance of the National Highway Authority, the National Transport Research Center, the Embassy of Japan in Pakistan and the JICA Pakistan office.

We hope that this report will contribute to the development of Pakistan.

Yours Faithfully,

Minoru SHIBUYA
Team Leader, JICA Study Team for
the Pakistan Transport Plan Study
in the Islamic Republic of Pakistan

Location	Distance (m)
Kohat Toi (Start Point)	
Kohat Pindi IC (N-80)	9,658
Kohat Link Road IC	5,930
South Portal of Kohat Tunnel	5,019
North Portal of Kohat Tunnel	1,885
Sanda Basta IC (NWF Road)	936
Dara Adam Khel (End Point)	6,843
Total Project Length	30,271

To Peshawar

DARA ADAM KHEL (End Point)

NWF Road (Old N-55)

Sanda Basta IC

Kohat Pass

KOHAT TUNNEL

(L=1,885m)

Kohat Link Road

Kohat Link Road IC

KOHAT City

Kohat Pindi IC

Pakistan Railway

National Highway N-80

To Rawalpindi

To Bannu

KOHAT TOI (Start Point)

0 5km

2ND KOHAT TUNNEL AND ACCESS ROADS PROJECT

LOCATION MAP

Abbreviations /Acronyms

AADT	Annual Average Daily Traffic
AAQA	Ambient Air Quality Standards
AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
ADT	Average Daily Traffic
B/C	Benefit/Cost Ratio
CAD	Computer aided design system
CBR	California Bearing Ration
CCTV	Close Circuit Television
CDWP	Central Development Working Party
CESA	Cumulative Equivalent Single Axle Load
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
COMSAK	Committee for Safety Action for Kohat Tunnel
D.G.	Director of General
D/D	Detailed Design
DBST	Double Bituminous Surface Treatment
DFO	District Forest Officer
EA	Engineering Associate
ECNEC	Executive Committee of the National Economic Council
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EL	Elevation
EMMP	Environment Management & Monitoring Plan
EMP	Environmental Management Plan
EPA	Environment Protection Agency
ESA	Equivalent Single Axle
F	Fluorine
FATA	Federally Administered Tribal Areas
FONSI	Finding of Non-Significant Impact
FR	Frontier Region
FRL	Finished Road Level
FY	Fiscal Year
GDP	Gross Domestic Product
GoP	Government of Pakistan
GOP	Government of Japan
GPS	Global Positioning System
HAZCHEM	Hazardous Chemical Material
HCM	Highway Capacity Manual
HGVs	Heavy Goods Vehicles
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immune Deficiency Syndrome
HPS	high-pressure sodium
I.E.C.	International Electro-Technical Commission
IBRD	International Bank for Reconstruction and Development
IC	Interchange/Intersection
IEE	Initial Environmental Examination
IUCN	International Union for the Conservation of Nature and Natural Resources

JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
KPT	Karachi Port Trust
LOS	Level of Service
MC&O	Management Contractor & Operator
MOC	Ministry of Communication
MOE	Ministry of Environment
MR	Resilient Modules
MTDF	Medium Term Development Framework
NATM	New Austrian Tunneling Method
NESPAK	National Engineering Services Pakistan
NHA	National Highway Authority
NO2	Nitrogen dioxide
NOx	Nitrogen Oxide(s)
NPV	Net Present Value
NTC	National Trade Corridor
NTRC	National Transport Research Center
NWFP	North West Frontier Province
O/D	Origin/Destination
OECF	Overseas Economic Cooperation Fund
PC	Precast Concrete
PCC	Portland cement concrete pavement
PCI	Pacific Consultants International
PCUs	Passenger Car Units
PDA	Post Decision Analysis
PEPA	Pakistan Environment Protection Agency
PGA	Peak Ground Acceleration
pH	hydrogen-ion concentration (pH is Germany)
PIA	Pakistan International Airlines
PIARC	Permanent International Association of Road Congress
PMD	Pakistan Meteorological Department
POL	Petroleum, Oil and Lubricants
PR	Pakistan Railways
PSDP	Public Sector Development Program
PTPS	Pakistan Transport Plan Study
RH	Relative Humidity
RMA	Road Maintenance Account
ROW	Right of Way
S/S	Sub Station
SCF	Standard Conversion Factor
SE	SuperElevation
SEA	Strategic Environmental Assessment
SO2	Sulphur dioxide
SOP	Standard Operation Procedures
SOP	Survey of Pakistan
SOx	Sulphur Oxide(s)
SPM	Suspended Particulate Matter
STD	Sexually Transmitted Disease
SVC	Supervisory and Control
SWH	Surface Water Hydrology

TCM	Travel Cost Method
TPM	Total Particle Matter
TRB	Transportation Research Board
TTC	Travel Time Costs
UPS	Un-interrupt able power supply
US-SCS	U.S. Soil Conservation Services
VOC	Vehicle Operating Costs
W/O	Without
WAPDA	Water and Power Development Authority
WHO	World Health Organization
WPCHB	West Pakistan Code of Practice for Highway Bridges

Executive Summary

1. The Final Report of Pakistan Transport Plan Study (Master Plan) was submitted in March 2006. In the report, the 2nd Kohat Tunnel Construction Project was recommended as one of the priority projects to be selected for the next Medium Term Development Framework (MTDF), or in parallel with the current MTDF, in view of their contribution to national economy, alleviation of traffic congestion and safety improvement.

The Condition of the Existing Kohat Tunnel and Access Road

2. The existing tunnel (1st Kohat Tunnel) and both access roads were completed and became operational in June, 2003. Up to now, no accident has been recorded in the tunnel by the severe vehicle checking by NHA monitoring and management. Traffic volume at the Kohat tunnel was increased by 12.4% from 2004 to 2005. For the period from January to May, the increase rate was 21.8% from 2005 (Jan-May) to 2006 (Jan-May).

3. The existing tunnel was constructed as a 2-lane (single carriageway road) at 2.2% up grade to the north. The design speed of the Kohat tunnel is 60 km/hour. Vehicle running speed has been controlled at 40km/hour and overtaking is not allowed in the tunnel for safety. However, the actual travel speed is 16.7 km/hour and it takes 7-8 minutes for the northbound traffic forming platoons behind slow-moving trucks, which cannot be broken up since passing maneuvers are not possible. The travel speed for the south bound traffic is 30.9 km/hour, that is less than the controlled speed, even though down-grade traffic.

4. Taking the above situation into consideration, the feasibility study of 2nd Kohat Tunnel Construction Project was selected by JICA as the most appropriate priority project in view of urgency, technical complexity, and the fact that the 1st Kohat Tunnel is named as the Pakistan-Japan friendship tunnel.

5. The feasibility study was commenced from the end of April, 2006. Hereinafter, major conclusions and recommendations of the study are introduced.

Traffic Analysis

6. The current traffic passing through the Kohat tunnel is 7,370 veh/day and it will continue to increase at high percentage. Future traffic volume was forecast based on the analysis of the PTPS traffic survey, NHA's toll collection data, and supplemental traffic surveys carried out in the study. The future tunnel traffic is estimated to be 14,050 veh/day in 2015 and 24,340 veh/day in 2025.

7. The capacity analysis based on Highway Capacity Manual (Transportation Research Board, National Research Council, USA) revealed that the level of service of the existing Kohat Tunnel is already LOS of "D" level in a peak hour, and will experience LOS of "E" level within a few years.

8. The traffic on the Access Road in the south of the Kohat Link Road IC, located 4.6 km south of the tunnel (nearly the mid point of the entire Project length), will be 80% of the tunnel traffic and experience LOS of "D" level in 2013.

Preliminary Design

Access Road

9. New 2-lane access road is designed beside the existing two lane access road within the already acquired ROW. Northern access road is 7,780m in length and southern access road is 20,607m in length.

10. In the design of southern access road, transition curves are employed in its horizontal alignment. Four intersections and ten bridges are planned.

Tunnel

11. The location of south portal is shifted from the original plan proposed in the design stage of the 1st tunnel, to the western direction by 40m from the economical and technical view points. The distance between two tunnels will be 30m centre-to-centre. The location of north portal is same as the original plan. It is proposed to lower the elevation of the south portal because of technical reasons. As a result, the grade of the 2nd tunnel will be 2.4%, 0.2% steeper than the 1st tunnel. Since the 2nd tunnel will be used for the southbound traffic in down grade, this grade will not affect traffic flow and safety.

12. The same tunnel opening and cross section as the 1st tunnel is adopted.

Tunnel Facility Works

13. For the tunnel facilities such as ventilation, lighting, power supply and emergency facilities, the same systems employed in the 1st tunnel will be adopted from economical and easy maintenance view points.

14. Since the planned tunnel portal will be located just behind the existing control room, it is necessary to relocate the existing control room and substation prior to starting tunnel excavation.

15. Two tunnels will be connected by two cross passages, which will be used for evacuation of tunnel users in case of accidents in the tunnels.

Environmental Study

16. The results of the IEE showed no major environment impacts were observed. Moreover, there do not appear to be any resettlement issues as the necessary ROW is already acquired by NHA. Based on the EIA law in Pakistan, this project would require a full scale EIA.

Construction Plan and O&M Plan

17. As the tunnel construction works is on the critical path in the construction schedule, the plan of tunnel excavation from both portals is recommended. New Austrian Tunneling Method (NATM) will be applied for tunnel excavation and support. For the widening of the access road, construction method of hard rock excavation keeping traffic on the existing access road was examined. Excavation in association with controlled blasting and a hydraulic breaker is recommended.

18. Three years of construction schedule is considered to be most realistic and reasonable. Due to the technical complexity of the project, construction works are recommended to be conducted by a qualified international contractor.

19. NHA has contracted the operation and maintenance of the 1st Kohat Tunnel and Access Roads to a private company as Maintenance Contractor & Operator (MC&O) since its opening in May 2003 under overall supervision of NHA. As the current operation and maintenance system has worked well, the present system of operation and maintenance will be applied expanding the scope of works of MC&O to cover both tunnels

Cost Estimates

20. On the basis of the preliminary design and established unit prices, the project cost was estimated at approximately 6,332 million Pakistan rupees using ICB conditions at mid 2006 prices. At the same time, future operation and maintenance cost was estimated based on the operation record of the existing tunnel.

Project Evaluation

21. The economic evaluation was made by the conventional discounted cash flow methodology, and EIRR of the Project is confirmed as 16.6%. The major economic benefits quantified were the vehicle operation cost saving and travel time saving. The

results of sensitivity analysis also show the robustness of the strong feasibility of the Project.

22. Financial evaluation was carried out by calculating the revenue based on the current toll rates of the existing tunnel. The result shows FIRR of 4.7%. The investment cost cannot be covered by the future toll revenue. However, annual operation and maintenance costs will be sufficiently covered by the toll revenue.

23. These result indicated that the Project is feasible and sustainable.

Project Implementation Plan

24. The need to upgrade the Indus Highway to 4-lane highway is further heightened under the National Trade Corridor program. Stage-wise construction scheme of the Project (postpone the construction of the section in the south of the Kohat Link Road IC) was examined to attain higher EIRR, but the increment is so small as to be negligible (0.7% only).

25. Therefore, it is recommended to construct the 2nd Kohat Tunnel and Access Roads between Kohat Toi and Dara Adam Khel at once.

26. Implementation schedule is prepared on the basis that the Project will be implemented with foreign financial assistance. The estimated opening of the 2nd Kohat Tunnel will be at the earliest at the beginning of 2013.

Recommendation

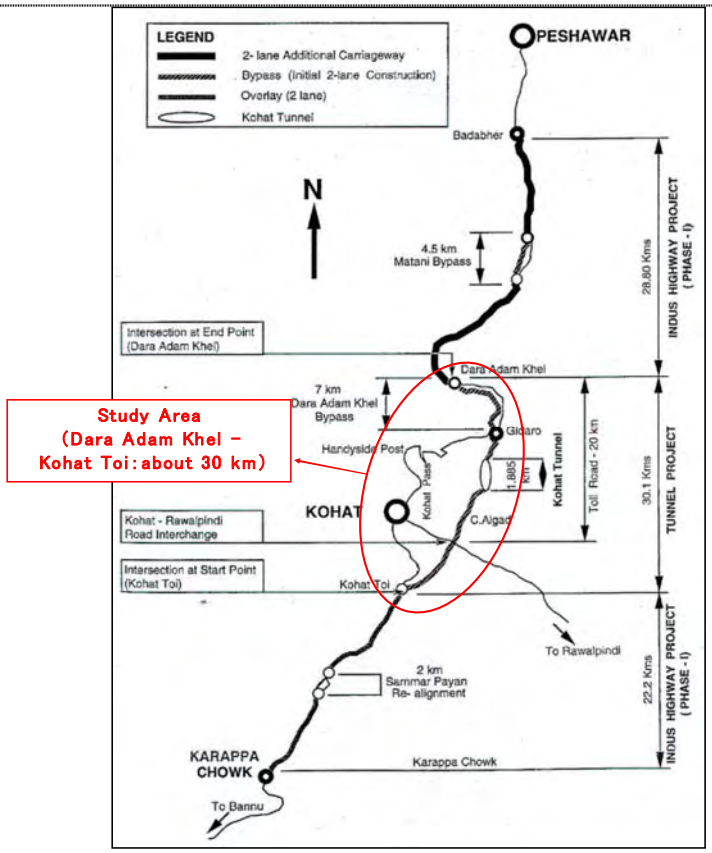
(1) Construction of the 2nd Kohat Tunnel is viable from the macro-economic perspective. It will contribute to the development of the regional economy as well as national economy and have great significance in terms of developing a part of the National Trade Corridor. Moreover, at the earliest possible opening of the 2nd Kohat Tunnel in 2013, the tunnel traffic should have reached the capacity of the 1st Kohat Tunnel. Therefore, the Project should be an urgent project to be implemented at the earliest opportunity.

(2) Prior to undertaking the next step of implementation, NHA should prepare the EIA and receive Environmental Clearance from the EPA of NWFP. NHA/MOC should send this project to the screening process in the Government and expedite the application for financial assistance to appropriate donor agency/country, as soon as this feasibility study is completed. Since the 1st Kohat Tunnel and Access Roads Project was financed by JBIC, JBIC will be one of the most possible sources.

(3) Fortunately, no major accident has ever been experienced in the 1st Kohat Tunnel since its opening, however, the Pakistan Government is requested to continue to take the following actions to keep and ensure smooth and safe highway operation.

- to reinforce control systems to eliminate truck overloading
- to establish education systems for drivers to keep safe driving with good driving manners.

Project Outline

1. Name of the Project	The 2nd Kohat Tunnel and Access Roads Project	
2. Project Area	 30.271 km section of N-55 from Kohat Toi to Dara Adam Khel	
3. Objective	This project is a part upgrading plan of Indus Highway (N-55) in line with the traffic increase and the strategic importance of N-55 including National Trade Corridor, reductin of traffic burden on N-5 and regionally balanced development for western part of the country.	
4. Scope of the Project	To provide two additional lanes on the east side of land in parallel to the existing road to create a dual carriageway road including the tunnel section.	
5. Expected Construction Period	36 months from January 2010 to December 2012 (The 2nd Kohat Tunnel is expected to be opened in January 2013 at the earliest.)	
6. Estimated Project Cost	6,332 million Pakistan rupees at mid 2006 prices	
7. Environment Aspect	No major environment impacts were observed, and also there are no issue of resettlement since NHA already acquired the Right-of-Way (ROW) for the Project. However, because of the Project scale, EIA is required.	
8. Applied Design Standard	Roadway and Structures	AASHTO and NHA (New seismic standard after the October 8 earthquake was applied for bridge design.)
	Tunnel	Japanese Standard for Tunnel and Tunnel Facility Design
	Materials	Standard Construction Specifications, NHA

PAKISTAN TRANSPORT PLAN STUDY IN THE ISLAMIC REPUBLIC OF PAKISTAN

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Chapter 1. INTRODUCTION

1.1 Background of the Study

1.1.1 General

The Islamic Republic of Pakistan is located to the north-east of the Arabian Sea and extends towards the Himalayas on the border with China. The country has a land area of 796,000 km^2 and consists of four provinces, two territories, and a part of Kashmir. The distance between Islamabad (the capital of Pakistan) and Karachi where there are two important international ports, is about 1,200 km in a straight line. The transport system in Pakistan plays an important role in the unification of theses regions in terms of political and economic activities.

The Government of Pakistan has requested the Government of Japan to provide technical assistance in carrying out a comprehensive transport development study titled "the Pakistan Transport Plan Study in the Islamic Republic of Pakistan" (PTPS). The Government of Japan agreed to conduct the study and has entrusted its execution to the Japan International Cooperation Agency (JICA).

The PTPS consists of two phases. The first phase was carried out from June 2005 to March 2006, in which the major task was to formulate a short-term plan (2005/2006 - 2009/2010) and a master plan (2005/2006 - 2024/2025) for the development of the national transport system. The activities and results in the first phase of PTPS are summarized below:

1. The Study Team analyzed the present conditions of the transport sector including road, railway, port and airport, focusing on infrastructure, transportation (passenger and freight), legal framework, organization, administration, financial situation, and environmental consideration. Problems and issues were identified.
2. Nation-wide traffic surveys were carried out in July and August 2005. The surveys consist of roadside O/D interview survey and traffic count survey at 100 sites throughout the country and other supplemental surveys. The present vehicle O/D tables were produced from the traffic surveys.
3. A socio-economic framework for the target years of 2010 and 2025 was prepared. The future traffic demand for road, rail, port and airport was estimated based on the framework. Traffic volumes on roads and railways were calculated from the future O/D tables for passenger and freight transport. Using the result of the forecast, a demand and supply analysis was carried out for all transport modes.
4. Transport policies and development strategies were established, and development plans and short-term investment plans were formulated for the road, rail, port and airport sectors.
5. The Study Team held two seminars on traffic surveys, demand analysis and other technical matters for the National Transport Research Center (NTRC), and organized a seminar to inform the results of PTPS to stakeholders.
6. The Study Team conducted a survey for the restoration of the transport infrastructure in the northern area, in particular the Jhelum Valley Road which had been damaged by earthquake on October 8, 2005.

Among the priority projects defined in the Master Plan, the 2nd Kohat Tunnel and Access Road Construction Project (hereinafter referred to as "the Project") was selected for technical transfer on feasibility study in the second phase of the Study.

The 2nd phase of PTPS commenced at the end of April 2006, and the feasibility study as well as technical transfer on the Project continued until September 2006 at the site. This draft

final report presents all the study results and findings obtained in the Feasibility Study on the 2nd Kohat Tunnel and Access Roads Project (hereinafter referred to as "the Study").

1.1.2 Objectives of the Study

The major objectives of the Study are:

- To conduct Feasibility Study for the 2nd Kohat Tunnel and Access Road; and
- To pursue technology transfer to Pakistani counterparts in the course of the Feasibility Study.

In essence, the Study aims at determining the optimum scope of the 2nd Kohat Tunnel and Access Roads construction through various studies and comparison among conceivable alternatives.

1.1.3 Study Area

The study area is shown in Figure 1.1.1 below.

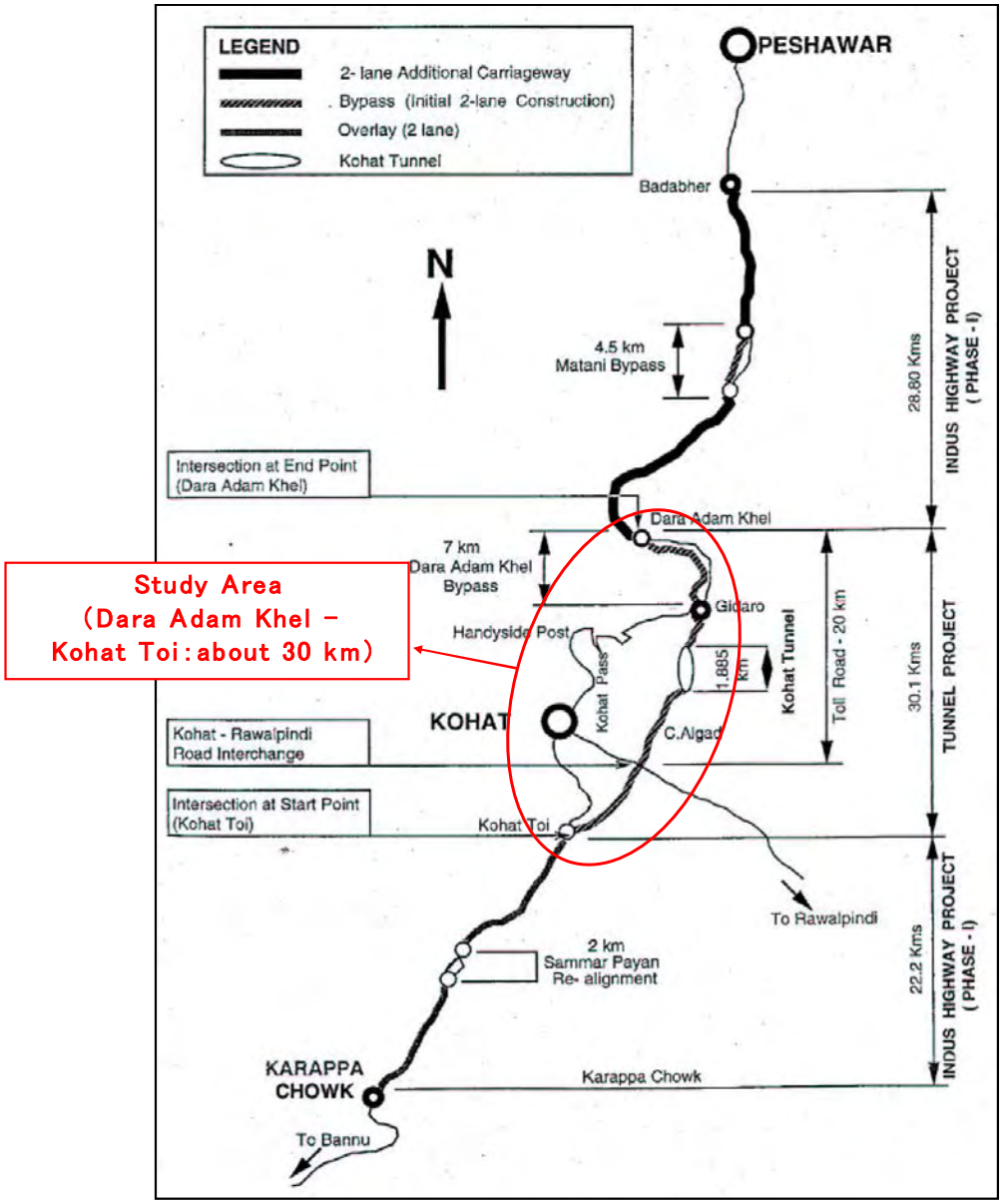


Figure 1.1.1 Study Area

1.2 Work Schedule

1.2.1 Overall Work Flow and Schedule of the Study

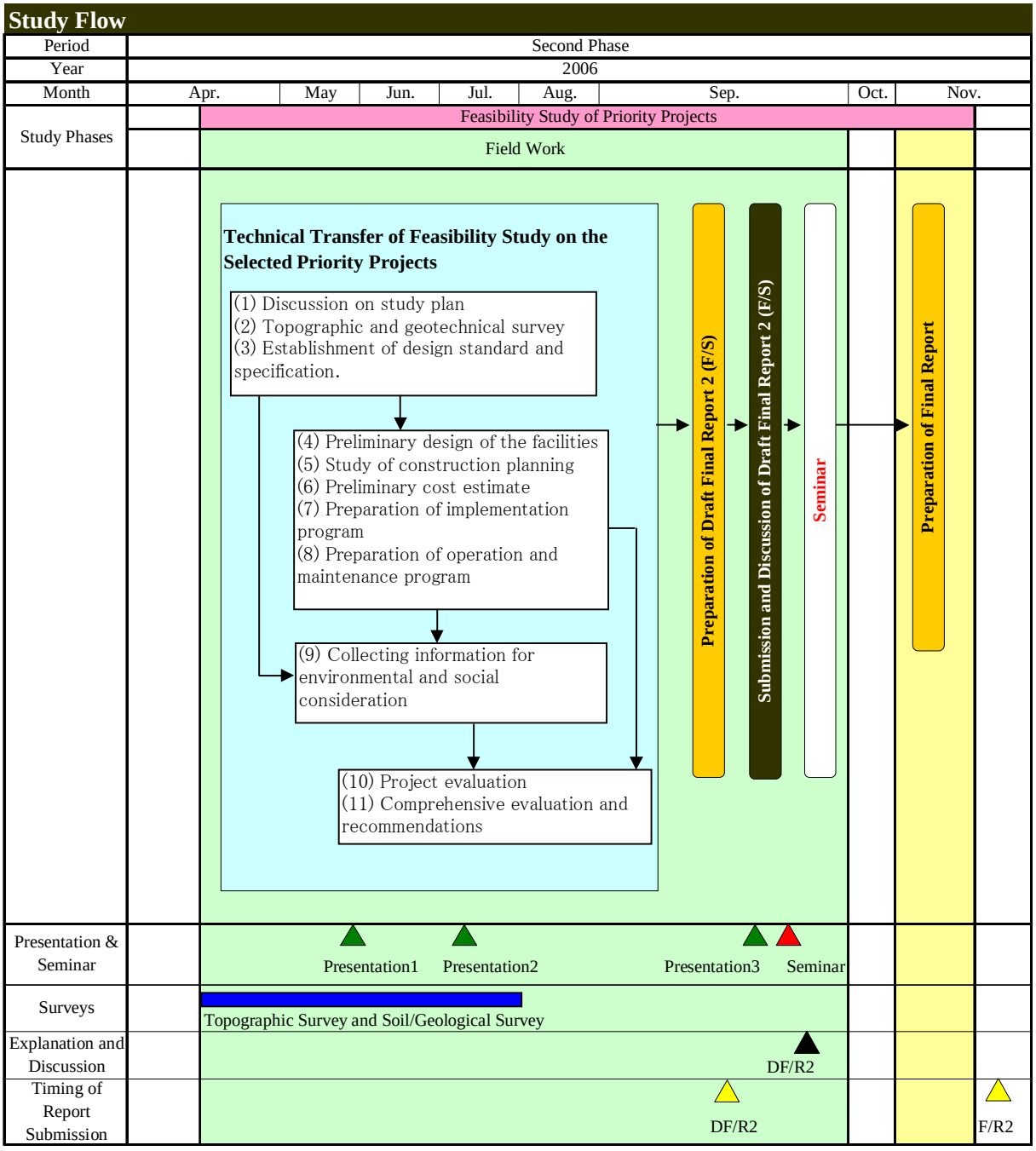


Figure 1.2.1 Overall Work Flow of the Study

1.2.2 Presentations

The Study Team held three presentations on the Study to NHA and NTRC and other stakeholders as part of technical transfer, as summarized in the following table:

	1st Presentation	2nd Presentation	3rd Presentation
Date	29 May, 2006	6 July, 2006	14 September, 2006
Venue	NHA Auditorium	NHA Auditorium	NHA Auditorium
Subjects	- Work Plan and Methodology of the Feasibility Study - Introduction of Japanese Technology in Tunnel Construction - Brief Comments on Roads vs. Railway Tunnel	- Progress of the FS Study / Traffic Forecast / Highway Capacity - Highway and Pavement Design - Tunnel Geology - Tunnel Design - Tunnel Facility	- Outline of the FS Study - Environmental Study - Cost Estimate - Economic/Financial Evaluation - Project Implementation Program and Recommendation

1.3 Organization of the Study

1.3.1 Organization of the Study

The Study was carried out by the Study Team under supervision of JICA and with cooperation of local counterparts from the Ministry of Communication (MOC). The organization chart of the Study is presented in Figure 1.3.1.

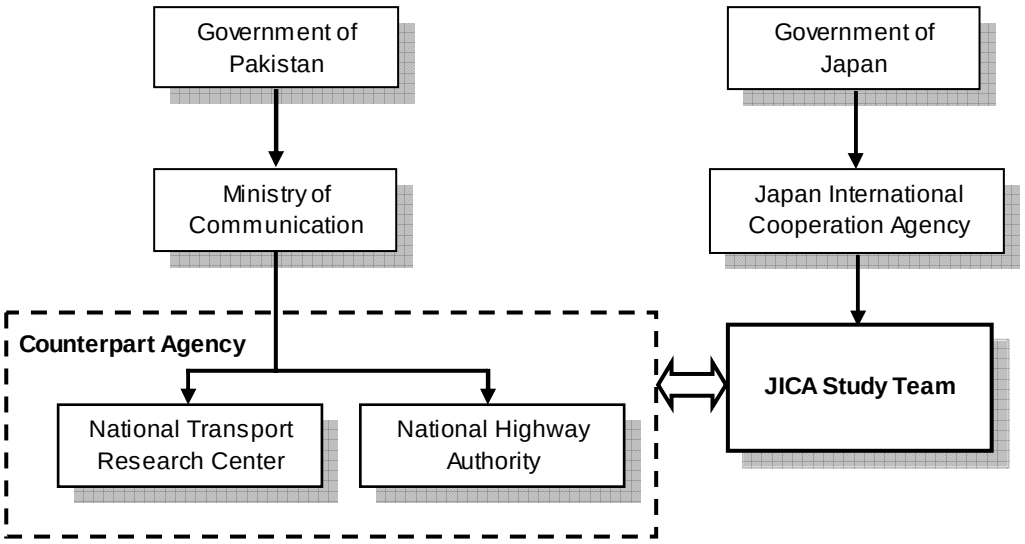


Figure 1.3.1 Organization Chart of the Study

1.3.2 Counterpart

The Government of Pakistan nominated the National Highway Authority (NHA) and the National Transport Research Centre (NTRC) as the Pakistani counterpart for the Study.

The Study Team collaborated closely with the personnel of NHA and NTRC and conducted many works and investigations with the assistance of relating agencies and entities of Pakistan.

The counterpart members from NHA are listed below:

Name	Designation
Mr. Raja Nowsherwan	Member, Planning
Mr. S.A.Latif	General Manager, Planning Contact Person (NHA Head Office)
Mr. Muhammed Naseem Khattak	Chief Operation Officer Contact Person (NHA Kohat Tunnel O&M Office)
Mr. Asim Amin	General Manager, Design Highway design
Mr .Jehanzeb Niazi	Assistant Director, Planning Highway planning
Mr. Sjjad Medhi	Director, Materials Geologist / Slope disaster prevention planning
Mr.Jhangir Larik	Assistant Director, Design Tunnel engineer / Construction planning (including bridges)
Mr. Shabir	Cost Estimate Specialist Tunnel facility engineer / Cost estimate specialist

The counterpart members from NTRC are listed below:

Name	Designation
Mr. Muhammad Kazim Idris	Chief of NTRC
Mr. Bashir Ahmed	Deputy Chief of NTRC PTPS F/S Coordinator
Mr. Muhammad Naeem	Deputy Chief of NTRC PTPS F/S Deputy Coordinator
Mr. Khizer Javed	Research Officer Traffic demand analysis / Traffic demand forecast
Mr. Masoud Bakht	Assistant Chief Economic / Financial analysis
Mr. Shahbaz Latif Mirza	Research Officer Social / Natural environment specialist

1.3.3 Study Team

The Study Team members are listed below:

Name	Designation
Mr. Minoru Shibuya	Team Leader / Comprehensive transport planning
Mr. Koichi Tanuma	Deputy Team Leader /Road planning/Road facility planning
Mr. Shogo Uchida	Traffic demand analysis / Traffic demand forecast
Mr. Atsutoshi Sakata	Geologist/Slope disaster prevention planning
Mr. Shigeru Konda	Highway engineer / Highway planning
Mr. Makoto Kubota	Tunnel engineer / Construction planning
Mr. Kuniaki Nishijima	Tunnel facility engineer / Cost estimate specialist
Mr. Masahito Homma	Economic / Financial analysis
Mr. David Gordon Lees	Social environment specialist
Mr. Hironori Kuroki	Natural environment specialist
Ms. Michiko Matsumoto	Administrator / Topographic and geological survey

Chapter 2. PRESENT TRANSPORTATION SYSTEM

2.1 General

Pakistan has a population of approximately 160 million and is the sixth most populated country in the world. Real GDP was Rs.6,548 billion (by 2004/2005 estimate), and per capita income was estimated at $736 in 2004/2005. Pakistan borders on India to the east, Afghanistan to the north-west, China to the north, Iran to the south-west, and Arabian Sea to the south. Roughly, there are three types of geographical areas in Pakistan. Its northern part is a mountainous area where three of the world's great mountain ranges (the Hindukush, the Karakorams and the Himalayas) meet. Punjab and Sindh, located in the eastern part of Pakistan along the Indus River and its tributaries, are very fertile and populated areas. Balochistan covers a large part of Pakistan in the west, where dry and hilly desert stretches and population density is very small.

Road transport is the dominant mode of inland transport, carrying 91% of passengers and 96% of cargoes in the whole country. The total length of roads is approximately 258,000 km. The Pakistan Railways (PR) has 11,515 km of tracks and 7,791 km of route network with 633 stations. Of the total route-kilometres, 1,043 km have double track and the 285 km long section between Lahore and Kanewal is electrified.

During the 1990s, the road transport volumes grew at 5% per year for passengers and 12% per year for freight, in terms of passenger-km and tonne-km, respectively. The growth rate of freight transport was high in the early 1990s.

Around 95% of imports and exports are handled through the Karachi Port and Port Qasim. Another deep-sea port is now under construction in Gwadar. The Karachi Port handles about 30 million tonnes of cargo, while the Port Qasim handles about 11 million tonnes. Approximately 60% of the imported cargo is transported inland from the two ports by road and rail to the upcountry. The Indus, Chenab, Jhelum, Ravi, and Sutlej Rivers flow through the territory of Pakistan, but inland water transport is very limited.

There are 44 airports including five international airports located in Islamabad, Karachi, Lahore, Peshawar, and Gwadar. PIA (Pakistan International Airlines) is the national flag carrier, while Aero Asia, Shaheen Air International, Royal Airlines, and Airbule are private airlines in Pakistan. Air transport in terms of passenger-km is a tenth of rail transport, and a hundredth road transport.

The Indus, Chenab, Jhelum, Ravi, and Sutlej rivers flow through the territory of Pakistan, but inland water transport is very limited.

2.2 Existing Road Networks

The entire road network in Pakistan has a total length of approximately 258,000 km: 8,900km of national highways (national highways, motorways and strategic roads), 92,600 km of provincial roads and 156,500 km of other roads (district, municipal and cantonment roads). Approximately 60% of the network is paved. The total road length has increased by 50,355 km in the last 10 years since 1994/1995. However the increase since 1999/2000 has been only 9,660 km. The recent trend is that the length of "high type roads" is increasing while that of "low type roads" remains unchanged. This implies that the strategy for road development has been shifted from the road network expansion to the capacity increase of the existing networks.

The road density in Pakistan is 0.32 km/km^2 and the Medium Term Development Framework (MTDF) 2005-2010 proposes to enhance this to 0.42 km/km^2 through the construction of 80,000 km of new roads. The road density in Punjab and Sindh is relatively high at 0.51 and 0.57 km/km^2, while it is extremely low in Balochistan at 0.12 km/km^2 as shown in Table

2.2.1. On the other hand, the road length per population is the highest in Balochistan and it is the lowest in Punjab.

Table 2.2.1 Road Length and Density by Province

	Pakistan	Punjab	Sindh	NWFP	Balochistan
Total Road Length (km)	258,214	106,140	79,834	30,049	42,191
Percentage of Paved Road	63%	78%	69%	46%	13%
Area (km^2)	796,095	206,250	140,914	101,741	347,190
Road Density (km/km^2)	0.32	0.51	0.57	0.30	0.12
Population (million)	148.72	85.33	32.99	23.26	7.14
Road Length per Mil. People (km)	1,736	1,244	2,420	1,292	5,909
Number of Registered Vehicles	4,974,000	2,920,984	1,457,323	430,429	165,264
Road Length per 1,000 Vehicles	52	36	55	70	255

Source: PTPS Final Report, JICA Study Team

2.3 National Highway Networks

There are fourteen national highways (8,600 km), five motorways (767 km), and two strategic roads (207 km) as listed in Table 2.3.1 and shown in Figure 2.3.1. N-5 is the longest and the most important national highway. In view of its high importance, N-5 has been improved to a dual carriageway road. The improvement works are almost completed except for the sections between Karachi and Hyderabad, Peshawar and Torkham, and other small sections. Other national highways are 2-lane roads except for the Badabher-Peshawar section of N-55.

Table 2.3.1 National Highways, Motorways and Strategic Roads

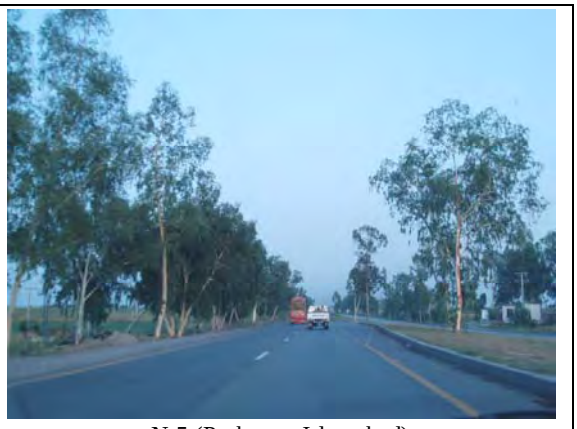
No.	Route	Length (km)
National Highways (8,113 km)		
N-5	Karachi - Hyderabad - Multan - Lahore - RWP - Peshawar – Torkham	1,819
N-10	(Makran Coastal Highway) Liari - Ormara - Pasni - Gwadar – Gabd	653
N-15	Mansehra - Naran - Jalkhad - Chilas Road	240
N-25	Karachi - Nela - Khuzdar - Kalat - Quetta – Chaman	813
N-35*1	(KKH) Hassanabdal - Abbottabad - Thakot - Gilgit – Khunjrab	806
N-40	Lakpss (near Quetta) - Dalbandin – Taftan	610
N-45*2	Nowshera - Dir – Chitral	309
N-50	D.I. Khan - Zhob - Kuchlad (near Quetta)	531
N-55	**(Indus Highway) Kotri - D.G. Khan - D.I. Khan - Kohat – Peshawar**	**1,264**
N-65	Sukkur - Sibi - Saryab (Quetta)	385
N-70	Multan – D.G. Khan - Loralai - Qila Saifullah	447
N-75	Islamabad - Satra Mile - Lower Topa – Kohala	90
N-80*3	Turnol - Fatehjang – Kohat	146
N-85	Hoshab – Panjgur – Nag – Basima – Surab	487
Motorways (711 km)		
M-1	Islamabad - Peshawar Motorway	155(58)
M-2	Lahore - Islamabad including 32 km links & Lahore Bypass	367
M-3	Pindi Bhattian - Faisalabad Motorway	53
M-9	Karachi - Hyderabad Motorway	136
Strategic Roads (207 km)		
S-1	Gilgit - Skardu Road	167
S-2	Kohala - Muzafarabad Road	40
Total		**9,518**

Source: PTPS Final Report, JICA Study Team

Source: PTPS Final Report, JICA Study Team

Figure 2.3.1 National Highways and Motorways Network

M-1 (Lahore – Islamabad)



N-5 (Peshawar-Islamabad)

The road section between Rawalpind and Lahore along N-5 has the heaviest traffic in Pakistan as far as inter-city transport is concerned. According to the PTPS Traffic Survey, the traffic volume between Lahore and Gujranwala was the highest at 22,760 vehicles a day, followed by the Gujranwala to Gujrat section at 19,900 vehicles. As a whole, the traffic volume on N-5 range from 7,000 to 20,000 vehicles, while other national highways have a smaller traffic volume ranging from 1,000 to 4,000 vehicles, except for some sections. The traffic volume on N-55 ranges from 1,300 vehicles at the Jacobabad-Hyderabad section to 7,450 vehicles near Peshawar.

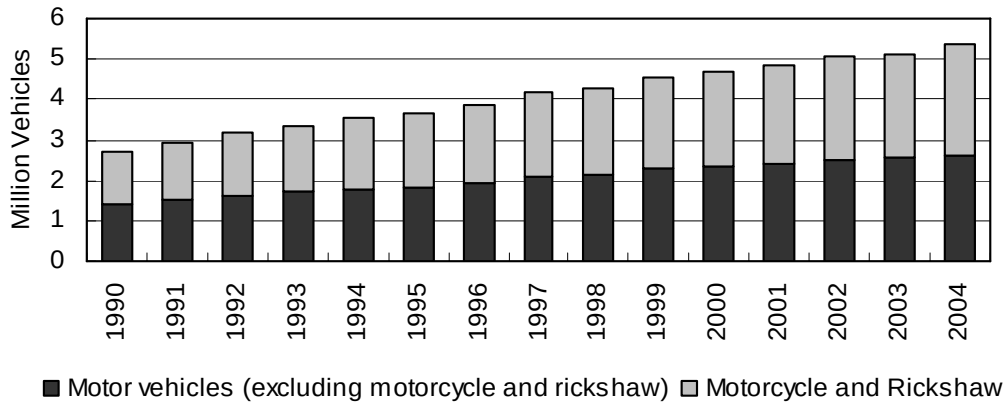
There are many topographic obstacles on national highways. For example, the Kohat Tunnel has only two lanes and the actual vehicle speed is only 15 - 30 km/hour. N-70 has a very dangerous mountainous section between D.G. Khan and Fort Munro. The Khushalgarh Bridge over the Indus River on N-80 is old and narrow. The Lowari Rail Tunnel Project is underway to overcome topographical obstacles on N-45. The Malakand Tunnel (N-45) and the Lakpass Tunnel (N-25) are also planned to improve road transport. Many new bridges over the Indus River and other big rivers are proposed.

2.4 Traffic Demand Forecast for National Highway Networks

2.4.1 Motor Vehicles

The number of registered motor vehicles has been gradually increasing (recently at an annual rate of 4.3%), and was projected to reach 5.4 million in 2004/2005 as shown in Figure 2.4.1. Half of the registered motor vehicles are motorcycles and rickshaws, and their proportion has been increasing slowly.

The share of cars increased from 21% in 1995/1996 to 37%, while the percentage of trucks decreased from 48% to 37%. Trucks still obstruct stable flow of cars on many national highways due to the slow speed of trucks on 2-way/2-lane roads. Most trucks run at a speed of only 40 - 50 km/hr even in a free flow environment.

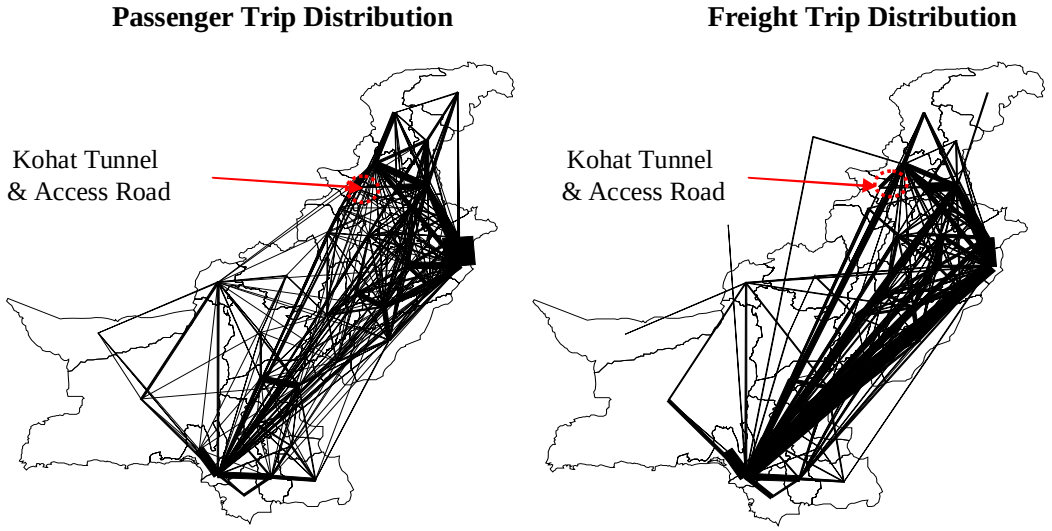


Source: Economic Survey 2004-2005

Figure 2.4.1 Number of Registered Vehicles

2.4.2 Traffic Demand Forecast

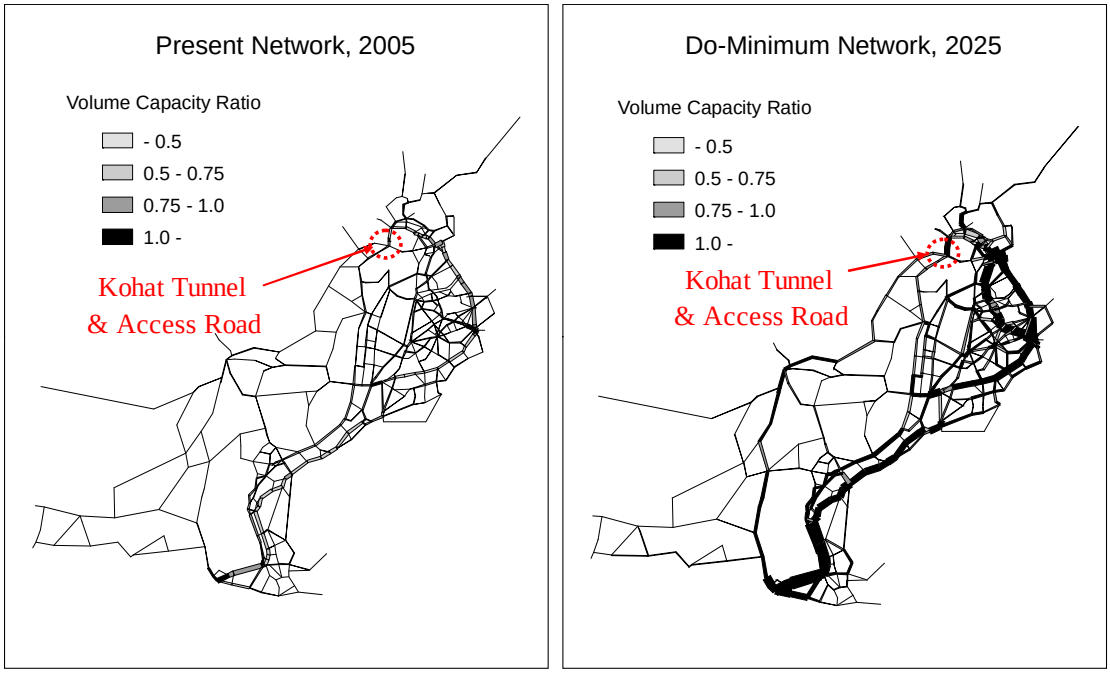
Figure 2.4.2 illustrates the trip distribution (Future OD Matrices) projected by the JICA Study Team in PTPS.



Source: PTPS Final Report, JICA Study Team

Figure 2.4.2 Desired Line of Road Transport Project (2025/2026)

Figure 2.4.3 depicts the results of traffic assignment on the present network for 2005 and "Do-Minimum" network for 2025.



Source: PTPS Final Report, JICA Study Team

Figure2.4.3 Results of Traffic Assignment for 2005 and 2025

Figure 2.4.4 shows the traffic assignments according to the 2025 demand in two cases: one with constrained capacity and the other with unconstrained capacity. The former case indicates a considerable diversion from congested highways to others. If the road capacity is unlimited, road users choose the shortest paths. Thus a considerable number of vehicles running between Karachi and Peshawar will choose N-55 instead of N-5 in the unconstrained capacity case.

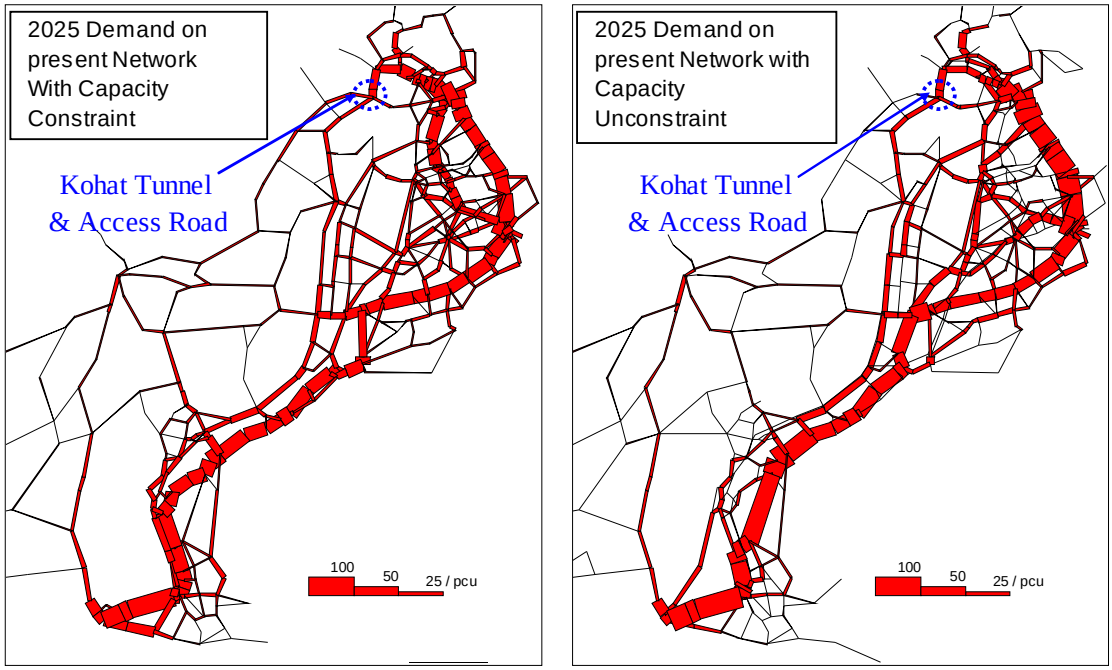


Figure 2.4.4 Assigned Traffic according to 2025 Demand on Current Network

The master plan for road network was proposed based on the result of the demand-supply analysis. Various factors such as regional development and natural resource exploitation were considered in formulating the plan. Required projects for the planned network were identified. N-5 will be the most important corridor as most of the traffic concentrates on this route. N-55 is expected to reduce excessive traffic burden on N-5 as an alternative north-south trunk route.

2.5 Road Administration and National Highway Authority (NHA)

Administration of roads of difference categories by the respective government agencies responsible for the construction and maintenance of roads is as summarized in Table 2.5.1. The Ministry of Communication (MOC) is responsible for the national road sub-sector. The National Highway Authority (NHA) is responsible for administration of national highways, motorways and strategic roads.

Table 2.5.1 Administrative Classification of Roads

Classification	Administration	Length	Function
National Highways Motorways Strategic Roads	• National Highway Authority (NHA), Ministry of Communications	9,000km	Constituting the main transport corridors and providing inter-provincial linkages and connections to neighbouring countries
Provincial Roads	• Communication and Works Department (C&WD), • Works and Services Department (WSD), and • Frontier Highway Authority (FHA)	101,000km	Providing access to the economic and population centres in the four provinces
District Roads	• District Government	94,000km	Providing access to villages and remote areas
Municipal and Cantonment Roads	• Municipal Government and Army	54,000km	Providing access to villages and remote areas

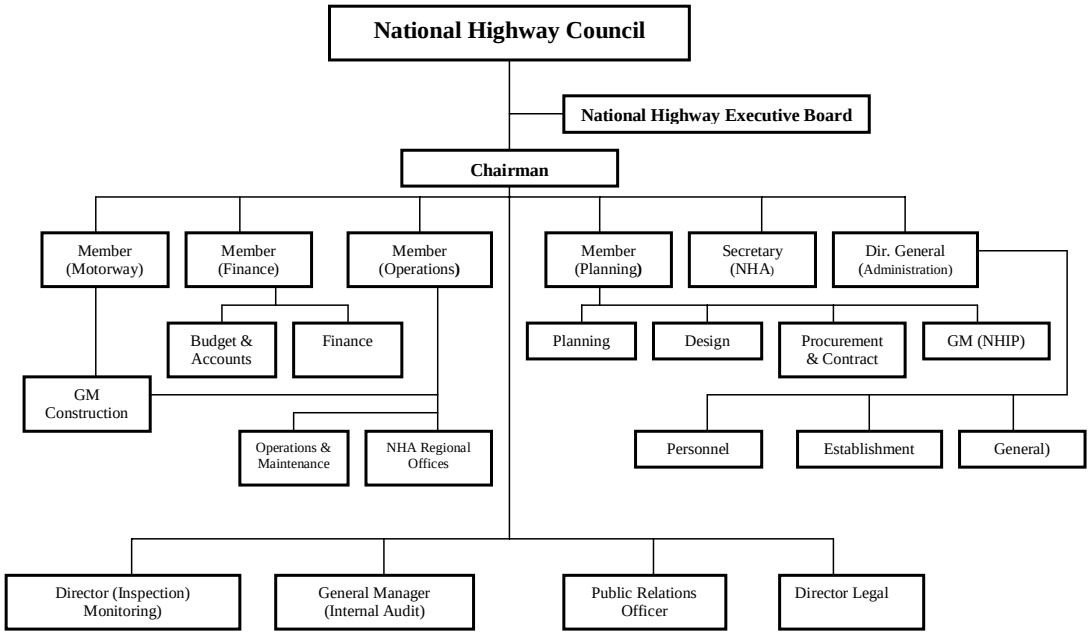
Source: PTPS Final Report, JICA Study Team

Tolls are collected at toll plazas on both the National Highways and the Motorways. Toll plazas were introduced by NHA in 1999. Toll revenue is an important source for maintenance works.

NHA was established by the National Highway Act of 1991 as a semi-autonomous organization under MOC with responsibilities to plan, promote, organize and implement programmes for construction, development, operation, repair and maintenance of national highways, motorways and strategic roads.

NHA's organizational set up comprises six core-wings: Motorway, Construction Planning, Operation, Finance and Administration. The organization chart of NHA is shown in Figure 2.5.1.

The 2001 Amendment removed the Boards power to approve projects costing more than Rs.50 million. For projects costing over Rs.50 million the NHA Executive Board is required to make recommendations to the Central Development Working Party (CDWP) and the Executive Committee of the National Economic Council (ECNEC) for approval.



Source: NHA

Figure 2.5.1 NHA Organization Chart

2.6 Other Transport Systems

2.6.1 Railway

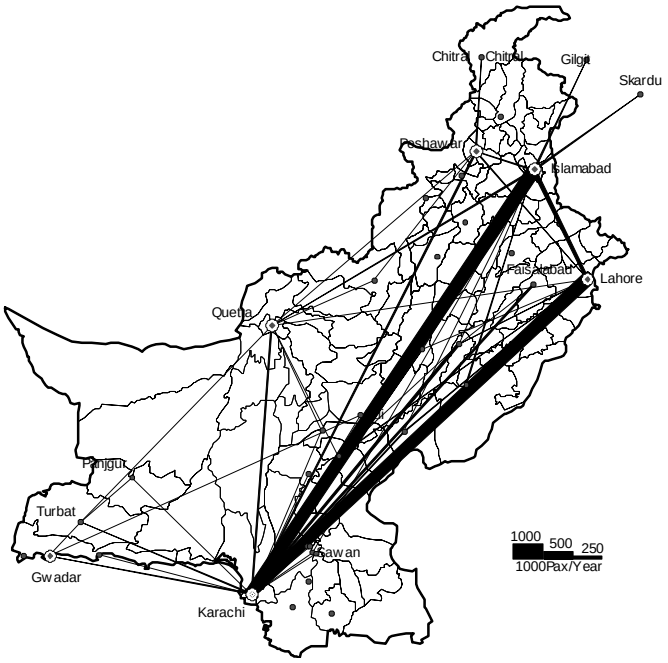
The Pakistan railway network is composed of 7,791 route-kilometres: 7,346 km of broad gauge tracks and 445 km of metre gauge tracks. There are 625 stations in the network, 1,043 km of double-track sections (in total) and 285 km of electrified sections. Figure 2.6.1 illustrates the Pakistan railway network. The major stream of railway traffic is the main corridor of Peshawar- Rawalpindi- Lahore- Karachi section. The Pakistan railway network carried 78.2 million passengers and 6.4 million tonnes of cargos in 2004/2005. Passenger km by rail was 24.2 billion with the average travel distance of 310 km, while the freight traffic in tonne-km was 5.5 billion with the average transport distance of 863 km in 2004/2005.

Source: JICA Study Team

Figure 2.6.1 Pakistan Railway Network

2.6.2 Air Transport

The air routes of Pakistan mainly connect five major cities: Karachi, Lahore, Islamabad, Peshawar, and Quetta. The busiest lines are Karachi–Lahore and Karachi–Islamabad. Domestic flights carried 3.28 million passengers and 56,300 tonnes of cargo in 2005/2006. Passenger traffic on domestic flights reached a peak volume of 4.5 million in 1995/2006, and then decreased rapidly to 2.5 million in 2001/02. Since 2001/2002, the passenger traffic has been increasing at an annual rate of 7.7%.



Source: JICA Study Team

Figure 2.6.2 Air Traffic Volume

2.6.3 Port

There are three deep seaports in Pakistan. Karachi Port is the largest port of Pakistan, handling 28.6 million tonnes (22.1 million imports and 6.5 million exports) in 2004/2005. Port Qasim is the second deep seaport of Pakistan, located to the east of Karachi Port. Port Qasim handled 21.3 million tonnes of cargo in 2004/2005. Gwadar Port is strategically important, located at the mouth of the Persian Gulf near the Iranian border. The port is under development.

Chapter 3. ROAD DEVELOPMENT PLAN

3.1 On-going and Committed Road Projects

The following Table 3.1.1 shows a list of on-going and new projects having been committed by authorized agencies.

Table 3.1.1 List of Ongoing and Committed Projects

No.	Project Name	No.	Project Name
	Ongoing Projects	250	Bridge over River Chenab at Shershah
10	Makran Coastal Road (Balochistan)	260	Interchange at Khangah Dogran on M-2
20	Islamabad – Peshawar Motorway (M-1)	270	Interchange at Sial More on M-2
30	Pindi- Bhattan Motorway (M-3)	280	Lala Musa – Gulyana Thotha Rai Bahadur Road
40	Karachi Northern Bypass	290	Nowshera – Chakdara, Dir-Chitral N-45
50	Lyari Expressway	470	N-5 Rehabilitation Project
60	Islamabad-Muzaffarabad Road	540	Kalat –Quetta – Chaman Section (N-25)
72	**Indus Highway Project (Phase-III), (N-55)**	551	Peshawar-Torkhan Dual Carriageway
80	Mansehra – Naran – Jalkhad Road	552	Malana Junction-Sarai Gambia Dualization
100	Rahim Yarkharn Bahalwalpur (N-5)	**553**	**Badabher – Dara Adam Khel (N-55), ADB**
110	Okara Bypass	554	Sarai Gambia-Bannu-Miran Shah-Ghulam Road
120	Karian – Rawalpindi (N-5)	**650**	**Kohat Tunnel and Access Road (N-55), JBIC**
130	Chablat Nowshera (N-5)	670	Karao-Wad Section, JICA
140	Lowari Tunnel & Access Road		***Committed Projects***
150	Bridge on River Jhelum at Azad Pattan AJK	480	Rehabilitation of 518km of N-5, WB
160	Improvement of N-65 Dera Allah Yar Nutal Section	530	Gujranwala-Hafizabad-Pindi Battian, WB
170	Improvement of N-65 Nutal-Sibi-Dhadar Section	561	Hub – Uthal Section N25, ADB
180	Improvement of KKH (N-35), NWFP	562	Multan – Muzaffargarh, ADB
190	D.I.Khan Mugharl Kot Section (N-50)	563	Khanozai-Mughalkot N50, ADB
200	Improvement of N-70 Qila Saifullar Loralai Bewata	564	Hassanabdal-Abbotabad-Mansera, ADB
210	Ratodero-Shahdakot-Khuzdar Section (M-8)	565	Sukkur-Jaccobabad, ADB
220	Gwadar – Khuzdar Road (M-8)	566	Tarnol-Fatejangh-Jand, ADB
230	Khori-Quba Seed Khan Section	567	Qila Saifullah – Loralai –Wiagum Rud, ADB
240	Realignment of N65 near Jaccobabad	570	Malakand Tunnel/Bypass, ADB

Source: PTPS Final Report, JICA Study Team

With regard to the National Highway N-55 (Indus Highway), the Government of Japan assisted in the implementation of the Indus Highway Project (Phases I and II) and the 1st Kohat Tunnel and Access Roads construction. ADB assisted in the construction of a dual carriageway for the Badabher - Dara Adam Khel road.

3.2 National Road Development Plan

3.2.1 New Road Projects in MTDF

There are 54 road projects in the Medium Term Development Framework (MTDF), consisting of 5 motorway projects, 12 bridge projects, 4 bypass projects, 2 tunnel projects, and others (see Table 3.2.1). The total project cost is estimated at about Rs. 330 billion.

As to the National Highway N-55, improvement of the Dadu - Ratodero (150 km) and improvement and widening of the Ratodero - Sehwan section (200 km) are listed.

Table 3.2.1 List of New Projects in MTDF

No.	Name1)	Type2)	Cost
310	Improvement of Quetta Western Bypass	I	225.5
340	Five Bridges on Gilgit Skardu Road, S-1	N	214.7
350	Noshki- Dalbadin Section (165 Km) (N 40) Balochistan	I	1,986.0
360	Jhalkhad- Chillas Road (63 Km) N-15	I	1,827.3
370	KKH-Skardu Road S-1 (167 Km)	I	4,000.0
380	Ghaggar Phatak Bridge to Kotri N-5	N	2,850.0
390	Jand-Kohat National Highway N-80 (46 Km)	I	1,000.0
400	Link Road from M-1 GT Road to Hazara Road Bypassing Hassanabdal	N	500.0
335	Bridge over River Indus at Larkana	N	2,500.0
410	Dhakpattan Bridge (P.M directive)	N	520.0
415	**Dadu Ratodero (150 Km) Fence+Ser. Rd N-55**	I	3,750.0
330	Bridge over River Indus at Chund (Riwaz)	N	700.0
420	Other Projects (Interchanges on M-2,Urban Areas Development etc)	N	3,000.0
450	Widening & Improvement of Hosahb-Nag-Bsima Surab (459 Km)	I, W	12,100.0
460	Karachi-Hub-Dureji-Kakar Motorway (M-7) 270 Km	N	18,000.0
491	Bridge between Kotri Bridge and Sajjawal Bridge	N	2,500.0
492	Bridge between Kotri Bridge and Dadu Moro	N	2,500.0
493	Bridge between Kandhkot and Ghotki	N	2,500.0
494	Ravi cum Road bridge over Indus linking Chachran with Mithanokot	N	2,500.0
495	Bridge over Indus linking Taunsa and Leiah	N	2,500.0
496	Bridge over Indus at Kalur Kot	N	2,500.0
497	Bridge over Indus linking Mianwali with Isa Khel	N	2,500.0
500	ITS & Corridor Management along the Corridor		6,000.0
830	Ratodero-Rajanpur Motorway Section (M-6), 270 Km	N	21,600.0
520	N-5 (Gujranwala-Kharian-Sara e Alamghir, 98 Km) service road along with fence	I	4,200.0
600	Lakpass-Noshki Section (120 Km), N-40	I, W	3,600.0
640	Improvemant of N-65 Quetta- Dhadhar Section (127 Km)	I, W	6,350.0
580	National Highway N-45 (Chakdara-Dir, Kalkatak- Chitral) 120 Km	I, W	6,000.0
590	Murree- Kohala-Muzaffarabad-Chakothi (S-2)Road N-75, 120 Km	I, W	6,000.0
610	Hydrabad-Khokhrapar (222 Km)	I, W	8,880.0
620	Chakdara- Kalam Road (130 Km)	I, W	6,500.0
630	Khwaza Khela- Besham Road (66Km)	I, W	3,300.0
690	**Ratodero-Sehwan (200 Km) N-55**	I, W	6,000.0
660	N-70 (D.G Khan-Sakhi Sarwar-Bewata, 165km) incl. Ghazi Ghat Bridge.	I, W	6,200.0
680	Bridge over River Indus at Khushalgrah (N-80)	N	3,500.0
700	Rehab/Improv/Widening of KKH (Mansehra-Khunjarab, 712km)	I, W	18,500.0
810	Faisalabad-Multan Motorway M-4	N	22,080.0
820	Periodic Overlay on M2 & Realignment of Slat Range	I	11,840.0
510	Khanewal-Lodharan-Uch Sharif-Mithankot-Rajanpur Motorway M-5	N	42,000.0
840	Karachi-Hyderabad Motorway M-9 (136km)	W	7,000.0
850	Peshawar Northern Bypass (26km)	N	3,078.1
860	Rawalpindi Bypass (28km) & Tarnol Interchange N-5	N	3,489.1
870	Lakpass Tunnel (N-25)	N	570.5
890	Shahdara Flyover N-5	N	4,500.0

1) Names are not necessarily the same as indicated in MTDF.

2) I: Improvement, N: Construction, W: Widening, D: Dualization

Source: MTDF, NHA, JICA Study Team

3.2.2 Projects in PTPS

(1) Proposed Projects in PTPS

The MTDF published in May 2005 sets an ambitious goal for Pakistan to become a developed, industrial, just and prosperous country within 25 years, by attaining a 7 - 8 percent annual economic growth rate. In order to achieve the goal, development of

infrastructure in the transport sector is prerequisite. A demand and supply analysis in PTPS indicated that the present road network will not meet the future transport demand of Pakistan to achieve the target economic growth, even if all ongoing and committed projects are completed.

Economic growth is given the top priority under the current national development plan and transportation has to shoulder an important role to support high economic growth. One of the main policies of the Master Plan in PTPS is to develop a transport system to support the people's economic and social activities so as to reduce regional disparities and realize the optimal modal share between road and railway.

The implications of the analysis on the road planning in PTPS are summarized as follows.

- M-7 and a new road between Hyderabad and Sukkur along the Nara Canal can be used as new shortcut roads of N-5.
- **The road capacity of N-5 and N-55 in Sindh Province should be expanded as early as possible. Construction of new roads or dualization of N-55 can be considered.**
- The road capacity of N-5 and M-2 between Rawalpindi and Lahore should also be expanded. Access control of N-5 and traffic control in urban areas are important because construction of new roads along this corridor may be difficult.
- Construction of new bridges on the Indus, Jhelum, Chenab, Ravi and Sutlej Rivers is necessary. River crossing demand is very high in Punjab Province.
- M-4 will significantly reduce the detour rate between Multan and Faisalabad, and can be given high priority.

The implementation plan of the Master Plan was prepared by each transport sub-sector in the short term (FY2005/2006 - 2009/2010), medium term (FY2010/2011 - 2014/2015) and long term (FY2015/2016 - 2024/2025). The identified projects were evaluated and prioritized primarily based on the Economic Internal Rate of Return (EIRR). Secondly, the projects were examined from the viewpoints of balanced growth among regions, profitability, network integration, international linkage, social equity/poverty and environmental issues. Finally, based on the comprehensive evaluation results, the projects were classified into short, medium and long terms, also considering the possible budget envelope.

A list of proposed projects (motorway, highway, tunnel, bridge and urban bypass projects) in PTPS is shown in Table 3.2.2. Widening of N-55 to a dual carriageway road and construction of the Second Kohat Tunnel are among the projects listed.

(2) Priority Projects in PTPS

The following priority projects in PTPS have been selected for the next MTDF (or in parallel with the current MTDF) in view of their contribution to national economy, alleviation of traffic congestion, and safety improvement:

- Capacity Expansion of Karachi - Lahore Railway Corridor.
- **Second Kohat Tunnel.**
- M-13 (Lahore - Sialkot Motorway) Construction.
- M-16 (Hyderabad -Nawabshah - Khaipur Desert Road) Construction.
- Murree - Muzaffarabad Road Improvement.
- Bridge Construction in Punjab.
- Karachi Southern Bypass.
- Qasim Port Access.
- Lahore Strategic Peripheral Route Development.
- Lahore Multi-modal Terminal Construction.
- Bypass Construction.

It is recommended to carry out feasibility studies and plan the implementation program for these projects as soon as possible.

Table 3.2.2 List of Proposed Projects in PTPS

Code	Name	Type	Cost
	Motorways		
951	M11 (Chakwal – Shorkot, 289km, 4-lane)	N	29,645
952	M12 (Lahore – Faisalabad, 137km, 4-lane)	N	8,673
953	M13 (Lahore – Sialkot, 136km, 6-lane)	N	12,575
954	M14 (Sialkot – Bhatian, 180km, 4-lane)	N	11,395
955	M15 (Quetta – Khuzdar, 327km, 4-lane)	N	32,143
956	M16 (Hyderabad – Ratodero, 287km, 6-lane)	N	29,336
957	M17 (Bargah – Rajanpur, 280km, 4 lanes)	N	20,526
958	M18 (Khairgarh Fort – Shorkot, 276km, 4-lane)	N	20,273
959	M19 (Khuzdar – Bela, 228km, 4-lane)	N	19,087
	Total		**183,653**
	Highways		
985	**N55 Dualization (Kohat – D.I.Khan)**	W	14,230
986	**N55 Dualization (D.I.Khan – D.G.Khan)**	W	9,600
987	**N55 Dualization (Rajanpur – Ratodero)**	W	11,630
959	**N55 (Dadu - Kotri) 4-lane**	W	10,000
974	N65 Dualization	I	23,645
1002	Lahore Peripheral Road	N	24,299
	Total		**93,404**
	Tunnel		
655	**Second Kohat Tunnel (N-55)**	N	6,000
	Sub-total		6,000
	Bridges		
961	Bridge on River Chanab at Garh Maharaja, District Jang	N	1,000
962	Bridge on River Sultaj to link Chistan Burewala Road	N	500
963	Bridge on River Chanab near Head Mohammadwala	N	600
964	Jhelum, Gatalian Mirpur Bridge	N	1,250
330	Bridge on River Chanab at Chund	N	700
966	Bridge on River Ravi near Qutab Shahara	N	500
967	Bridge on River Ravi at Syedwala	N	600
968	6-Lane Bridge (4-lanes for roadway and two lanes for LRT Lahore–Shahdrah)	N	950
969	Victoria Bridge Linking Malikwal - Pind Dadan Khan.	N	1,000
982	Bridge on River Indus (Khanote – Hala old)	N	2,500
983	Bridge on River Indus (Dault pur – Shehwan)	N	2,500
	Total		16,360
	Urban Bypasses in Punjab Province		
1011	Chakwal	N	1,380
1012	Bhakkar	N	850
1013	Khushab	N	1,275
1014	Mianwali	N	850
1015	Jhang	N	1,200
1016	Toba Tek Singh	N	960
1017	Mandi Bahauddin	N	1,290
1018	Sialkot	N	1,800
1019	Multan	N	1,900
1020	D.G.Khan	N	2,125
1021	Layyah	N	750
1022	Muzaffargarh	N	1,176
1023	Rawalpindi	N	8,000
1024	Lahore	N	16,900
1025	Gujranwala	N	3,430
1026	Bahawalpur	N	920
1027	Bahawalnagar	N	341
1028	Rahim Yar Khan	N	219
1029	Khan Pur	N	170
	Total		45,536

Note: I: Improvement, N: Construction, W: Widening, D: Dualization

Source: PTPS Final Report, JICA Study Team

Currently, 10 motorways (M1 - M10) with a total length of 2,667 km are under operation or have been planned already. In addition to these, nine motorways totalling 2,140 km were proposed by PTPS (Figure 3.2.1). As the highway network configuration has been almost completed, the main stream of road investment is "widening and improvement" rather than "new construction" (Figure 3.2.2). In connection with the highway development, 17 new bridges were proposed to be constructed on the Indus River and its tributaries in addition to the existing 48 bridges (Figure 3.2.3). Urban bypasses were also proposed for 37 cities, in addition to the existing 65 bypasses (Figure 3.2.4).

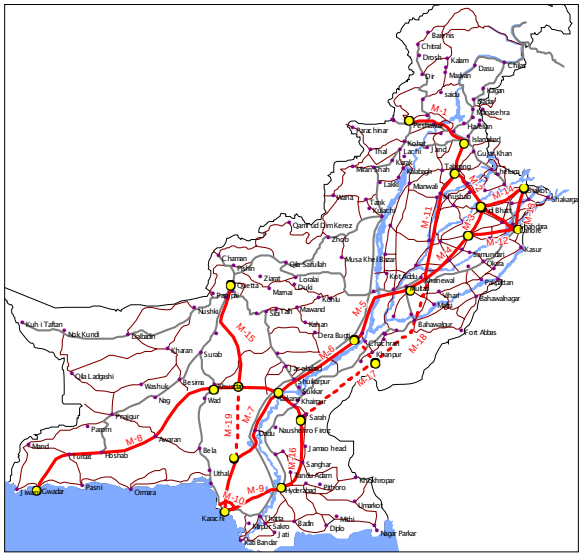


Figure 3.2.1 Proposed Motorway Network

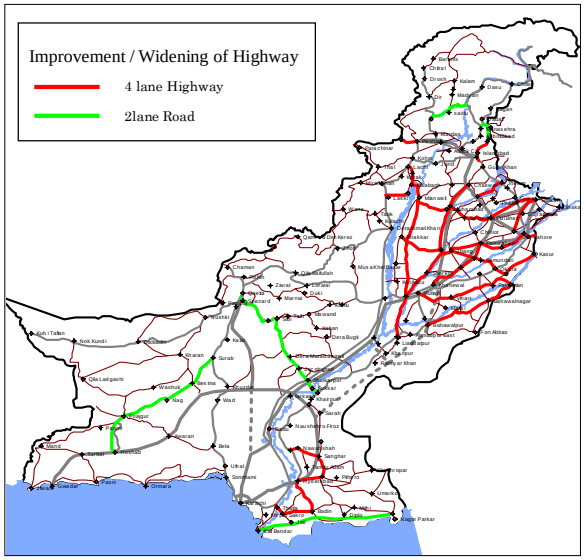
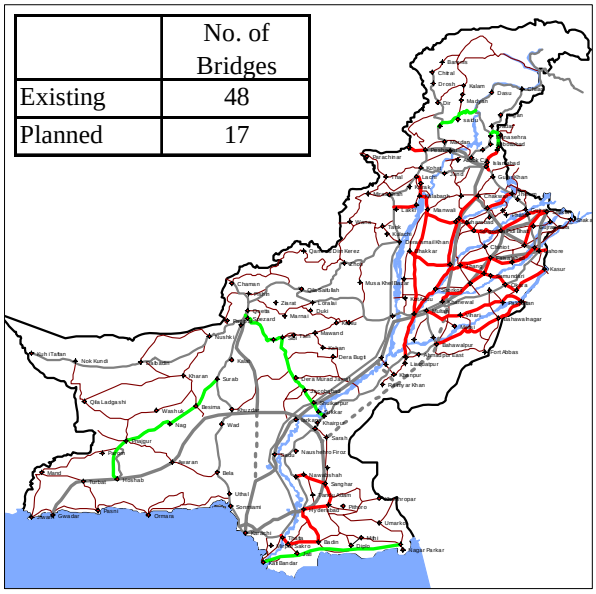
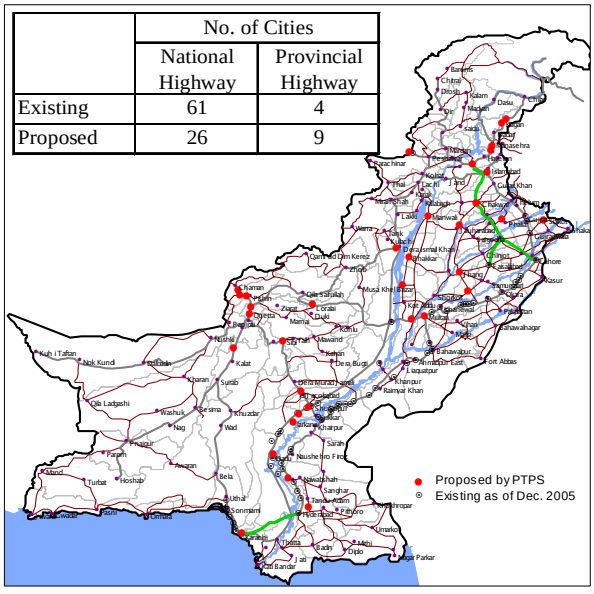


Figure 3.2.2 Highway Improvement and Widening



	No. of Bridges
Existing	48
Planned	17

Figure 3.2.3 Existing and Proposed Bridge



	No. of Cities	
	National Highway	Provincial Highway
Existing	61	4
Proposed	26	9

Figure 3.2.4 Existing and Proposed Bypass

(3) Non-investment Projects

The action plan for legislative, institutional and enforcement improvement recommended for the road sector in the Master Plan is as summarized in Table 3.2.3. These actions are essential for developing a rational plan and effective use of infrastructure.

Table 3.2.3 Recommended non-Investment Projects for Road Sector in PTPS

Sector	Project	Policy					Strategy				
		Support economic & Social Activities	Support regional Balanced growth	Realize optimal modal share	Financially realizable Master Plan	Transparent prioritization	Pursuit safety	Inter-modal facilities	Cross-border Facilities	Institutional capacity enhancement	Environmental consideration
General	Adoption of Quake Resistant Design Standard						■				
Road	Establishment of Highway Research and Training Center		■		■					■	
Road	Implementation and Enforcement of Traffic Safety Improvement Measures						■				
Road	Implementation and Enforcement of Anti-overloading Measures			■			■				
Road	Database Building on Traffic Accidents						■				
Road	Road Development Account and Capitalization of NHA Debt		■		■						
Road	Introduction of Road Tax	■			■						

Source: Extracted from PTPS Final Report, JICA Study Team

3.2.3 National Trade Corridor (NTC) Program

Pakistan's national road transportation system mainly depends on the north-south links. The existing north-south links are N-5 on the east bank and N-55 on the west bank of River Indus. N-5 serves for the life of Pakistan as it connects approximately 80% of the urban population. N-55 acts as an alternative route to N-5 and has a high potential for future expansion.

Pakistan has common borders with four countries and the main overland trade routes with these countries are:

- Taftan in Balochistan (Pakistan-Iran border).
- Chaman in Balochistan (Pakistan-Afghanistan border to the south).
- Torkham in NWFP (Pakistan- Afghanistan border to the north).
- Sust (Gilgit) in N.A. (Pakistan-China border)
- Wagah in Punjab (Pakistan-India border)

The World Bank introduced to the Prime Minister of Pakistan the concept of North-South National Trade Corridor (NTC) in August 2005. This corridor plays a pivotal role in the transit trade to Afghanistan and the landlocked Central Asian countries.

A Task Force was established under the Deputy Chairman, Planning Commission with representatives from the Ministries of Communications/NHA, Railways, Ports & Shipping/KPT, CBR, and the World Bank.

Pakistan is geographically placed at a strategic location in South Asia. It is adequately linked by road with neighbouring countries and this ideal location has offered Pakistan the most attractive transit route to the inland countries. The two Karachi ports are linked to Charman through N-25 and to Torkham via N-5 and N-55. The Gwadar Port will be connected to the Central Asian states by the Khuzdar - Ratodero Motorway (M-5, N-25, N-55 and N-5). M-8 will link Gwadar with N-25 at Khuzdar and Indus Highway (N-55) at Ratodero. The National Highway N-35 (Karakoram Highway) will link N-5 at Hasanabadal to Khunjrab at the border with China.

The construction of infrastructure to the required international standards is a prerequisite to achieve the targets. NHA is finalizing the route plan for NTC from Karachi to Torkahm at the Afghan border (refer to the implementation plan in Table 3.2.4).

Table 3.2.4 Route Plan of National Trade Corridor (NTC)

	Route / Section	Length (km)	Scope of Work	Estimated Cost (Mil. Rs.)	Financed by	Implementation Period
M7	Karachi - Dureji - Dadu	250	2-lane carriageway + 4-lane structures	18,000	GOP	2006-10
N-55	**Dadu - Ratodero**	150	2-Lane additional carriageway	11,250	GOP & GOJ	2007-10
N-55	**Ratodero - Shikarpur**	44	Converted to 4-lane Expressway	3,750	GOP & PPP/ADB	2008-09
N-65	Shikarpur -Sukkur	37	Converted to 4-lane Expressway	2,775	GOP & ADB	2007-09
N-5	Sukkur - Khaniwal	495	Converted to 4-lane Expressway	37,500	GOP & WB	2007-10
M-4	Khaniwal - Faisalabad	184	Construction of 4-lane Expressway	22,000	GOP & PPP-Malaysia	2007-10
M3	Faisalabad - Pindi Bhattian	54	Completed and open to traffic			-
M-2	Pindi Bhattian - Islamabad	243	Completed and open to traffic			
M-1	Islamabad - Peshawar	154	To be completed by 2006 (6-Lane) Two sections (37km+21km) were opened			-2007
	Peshawar Northern Bypass	34	Construction of 4-lane Expressway	3,078	GOP & PPP	2006-09
N-5	Peshawar - Torkhan Expressway	51	Construction of 4-lane Expressway	8,600	GOP & ADB	2006-09
N-5	Guranwala - Dina Expressway	100	Upgrading of ACW a& ECW	6,000	GOP & WB	2008-10
	Pindi Bhattian – Hafizabad - Wazirabad	100	Construction of 4-lane Expressway	6,600	GOP & WB	2007-09
	Four Bridges Over River Indus		Construction of 4 Bridges	12,000	GOP & WB	2008-11

Source: NTRC/NHA

3.2.4 Indus Highway (N-55) Improvement Program

The Indus Highway (N-55) Project, 1,264 km in total length, which constitutes the north-south link on the west bank of Indus River, was initiated in late 1980s. There was only one route (N-5) linking the northern and southern parts of the country. The Indus Highway provides an additional or an alternative route for N-5 reducing the overburdened traffic on it. The most important contribution of the project is the reduction in distance between Karachi and Peshawar by 500 km compared to the N-5 route.

The Government of Japan extended three loans (Jyen 41,781 million in total) through OECF/JBIC for the improvement and construction of 761 km (approximately 60% of the

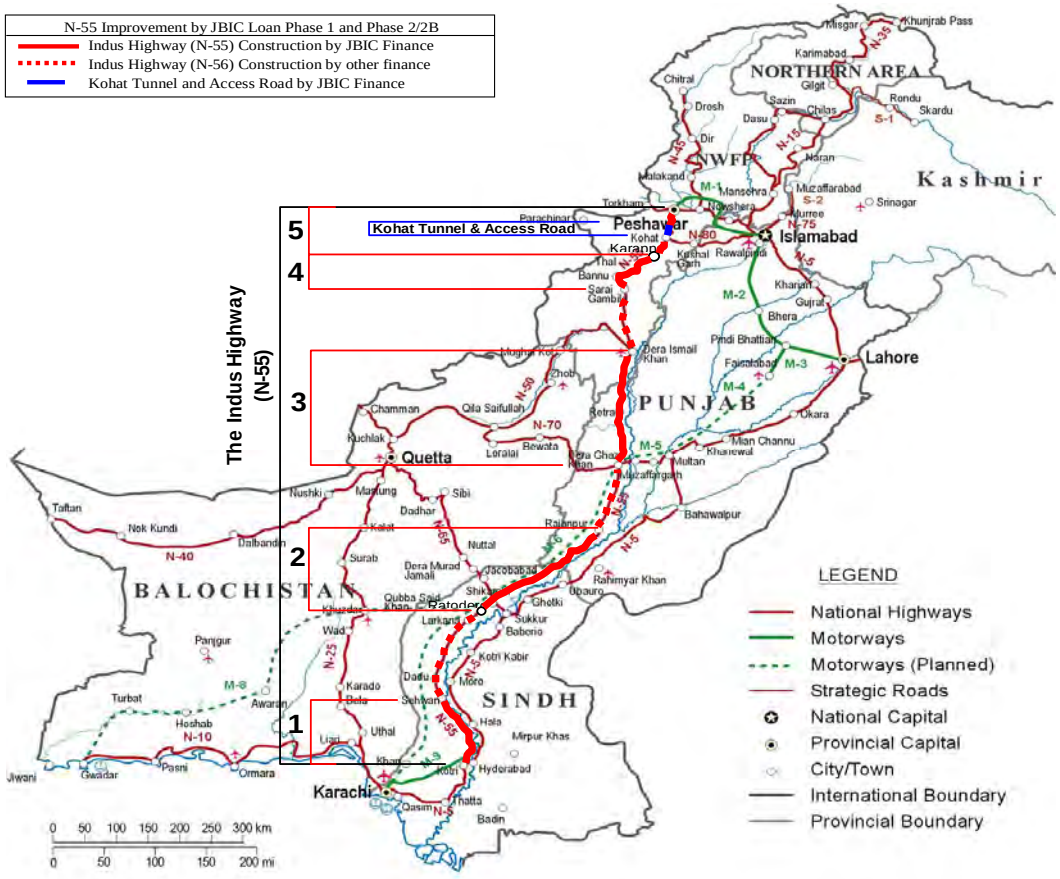
total length) of Indus Highway from 1989 to 2003.

Table 3.2.5 Japanese Loans for Indus Highway Project

Item	Phase 1	Phase 2	Phase 2B
Loan Amount	Jyen 8,299 million	Jyen 33,482 million	
Loan Agreement Signed	March 1989	January 1991	August 1993
Loan Completion	August 2000	May 2000	January 2003

Note: Post-Evaluation Report of JBIC on Indus Highway Project, 2004

The sections listed in the following Figure 3.2.5 and Table 3.2.6 were improved with JBIC assistance to 2-lane standard roads, except for the 29 km long section near Peshawar which has 4 lanes.



Source: JICA Study Team

Figure 3.2.5 Indus Highway Construction with JBIC Loans

Table 3.2.6 Indus Highway Project with JBIC Loans

No.	Section	Length (km)	Scope of Work	Completion Year
1	Janshoro (Kotri) - Sehwan	133	Improvement /Widening	1999
2	Ratodero - Rajampur	270	Improvement /Widening	1999
3	D.G.Khan - D.I.khan	211	Improvement /Widening	2001
4	Sarai Gambila - Karappa	96	Bypass Construction	1998
5	Karappa - Peshawar	51	Improvement /Widening (22km) Additional lanes (29km)	1996
	Total	761		

Source: Post-Evaluation Report of JBIC on Indus Highway Project, 2004

GOJ through JBIC also extended loans totalling Jyen 12,618 million for the construction of the Kohat Tunnel (1885 m) and Access Roads (28.7 km) including consultancy services from 1994 to 2006.

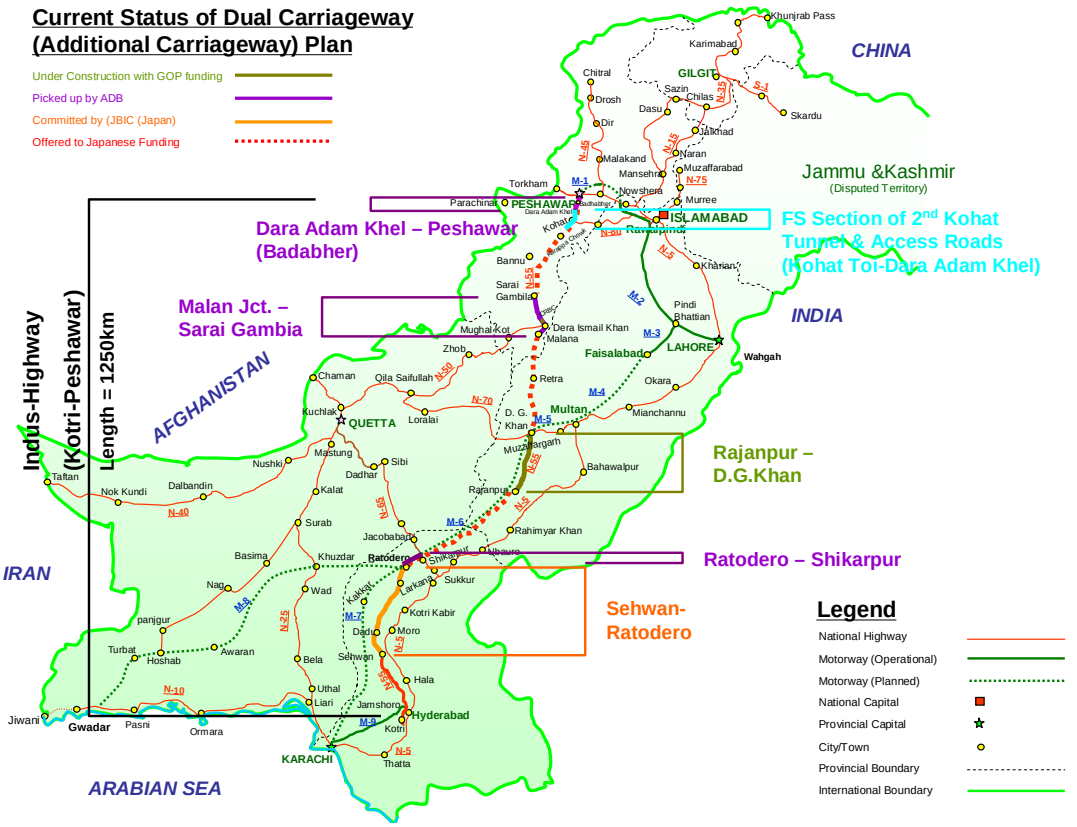
NHA has planned to improve the Indus Highway by widening it to a dual carriageway road in line with the traffic increase and the strategic importance of N-55, including NTC, reduction of traffic burden on N-5 and regionally balanced development for western parts.

The upgrading plan proposed, or to be offered, to JBIC and ADB for their financial assistance is summarized in Table 3.2.7 and Figure 3.2.6. JBIC will commit to financing the construction of additional two lanes for the Sehwan - Ratodero section (200 km).

Table 3.2.7 Present Situation and Proposed Upgrade of Indus Highway

Section			Length (km)	Present Width	Finance	Completion	Proposed Upgrading	
							Scope	Expected Donor
Janshoro (Kotri)	-	Sehwan	134	2-lane	JBIC	1999		
Sehwan	-	Ratodero	199	2-lane			ACW	JBIC
Ratodero	-	Shikarpur	44	2-lane			ACW & ECW	ADB
Shikarpur	-	Rajanpur	226	2-lane	JBIC	1999	ACW	JBIC
Rajanpur	-	D.G. Khan	106	2-lane			ECW	GOP
D.G. Khan	-	Malana Junction	206	2-lane	JBIC	2001	ACW	JBIC
Malana Junction	-	Serai Gambila	117	2-lane			ACW	ADB
Serai Gambila	-	Karappa Chowk	93	2-lane	JBIC	1998	ACW	JBIC
Karappa Chowk	-	Kohat Toi	26	2-lane	JBIC	1996		
Kohat Toi	-	Dara Adam Khel	30	2-lane	JBIC	1996		
Dara Adam Khel	-	Peshawar (Bada Ber)	28	4-lane	JBIC	1996		
Total			1209					

Note: ACW: Addiitonal Carriageway, ECW: Improvement of Existing Carriageway



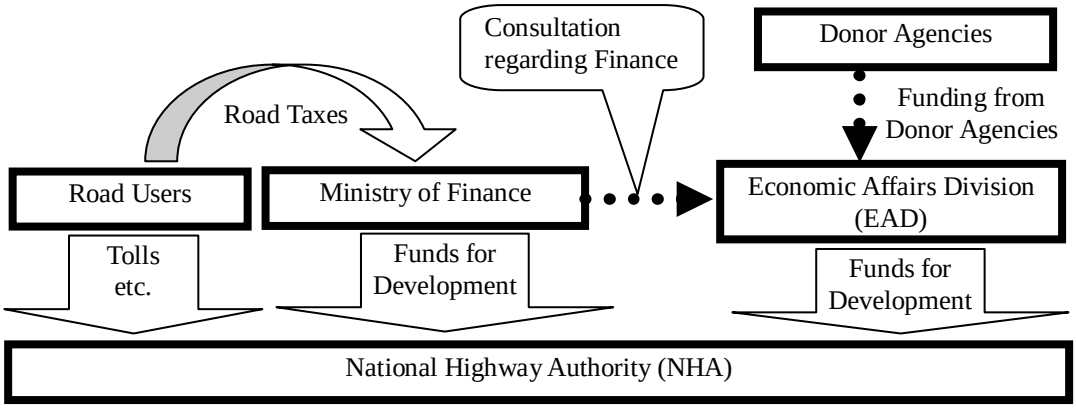
Source: NHA

Figure 3.2.6 Indus Highway Dual Carriageway Plan

3.3 Financial Situation of National Highway Authority

3.3.1 Financial Resources for National Highways

NHA is funded in the following manner:



Sources: Interview with NHA

Figure 3.3.1 Flow of Funds for NHA

NHA collects tolls from road users and borrows money or issues bonds after consultation with MOC. In 1991, the Government decided that the road development should be switched from grants to loans.

The biggest components of the "Road Taxes" (Figure 3.3.1) are the surcharges on petroleum, oil and lubricants (POL) to be borne by road users. The following table shows the funding sources for NHA.

Table 3.3.1 Funding to NHA

(Unit: Million Rs.)

Fiscal Year	Type of Funding					Total
	Loan for Development Fund	Grants for				
		Maintenance	Administration	Others	Sub-Total	
1991/92	5,152	378	6		384	5,537
1992/93	9,498	410	16		426	9,924
1993/94	8,084	430	17		447	8,530
1994/95	7,406	452	16		468	7,874
1995/96	6,100	356	15		371	6,471
1996/97	7,183	521	11		532	7,715
1997/98	9,952	600	20		620	10,572
1998/99	17,325	605	20		625	17,950
1999/00	16,364	660	21		681	17,045
2000/01	10,312	482	22		504	10,816
2001/02	10,900	760	23		783	11,683
2002/03	15,263	800	30	3	833	16,096
2003/04	16,243	825	32	3	860	17,103
2004/05	15,562	N.A.	N.A.	N.A.	N.A.	15,562

Source: PTPS Final Report, and additional information from NHA

3.3.2 Financial Outlook of NHA

(1) Financial Status of NHA

NHA has engaged in commercial activities since 2001 and is now preparing the

commerce-based financial statements. Based on the draft financial statements (un-audited), the JICA Study Team has prepared Table 3.3.2 showing the financial status of NHA.

Table 3.3.2 Financial Status of NHA

(Unit: Rs.Million.)

FY	1998/99	1999/00	2000/01	2001/02	2002/03	Data Source
(1) Revenues						
Grants in Aid from Government	**625**	**681**	**504**	**783**	**833**	Data From NHA
Maintenance Grants	605	660	482	760	800	
Establishment Grants	20	21	22	23	30	
Other Grants	0	0	0	0	3	
Grants from Foreign Donors	3	3	2	2	2	
Toll Income	**184**	**1,022**	**2,186**	**2,220**	**2,570**	Financial Statement (Draft)
Others	121	355	241	369	591	
Total	**933**	**2061**	**2933**	**3374**	**3996**	
(2) Expenditure						
Maintenance & Restoration	621	756	1,051	2,355	1,406	Financial Statement (Draft)
Financial and other Charges	28	1,522	367	240	712	
Others	748	2,874	1,913	1,333	666	
Total	**1,397**	**5152**	**3,331**	**3,928**	**2,784**	
(3) Surplus before Depreciation (1)-(2)	-464	-3,092	-398	-555	1,211	Financial Statement (Draft)
(4) Depreciation Charges	771	1,305	1,342	1,207	972	
Surplus (3)-(4)	-1,235	-4,397	-1,740	-1,761	239	

Source: Prepared by JICA Study Team with NHA Financial Statement (Draft) and Other Documents from NHA

According to Table 3.3.2, NHA continued to run at a loss until the fiscal year 2001/2002. Even though there was a surplus in the fiscal year 2002/2003, this is due to the financial support received from the Government. Accordingly, since NHA does not have enough financial resources for loan repayments and interest payments, NHA owed a total amount of Rs. 103 billion from loans at the end of the fiscal year 2002/2003 as shown in Table 3.3.3 below:

Table 3.3.3 Loans of NHA at the End of FY 2002/2003

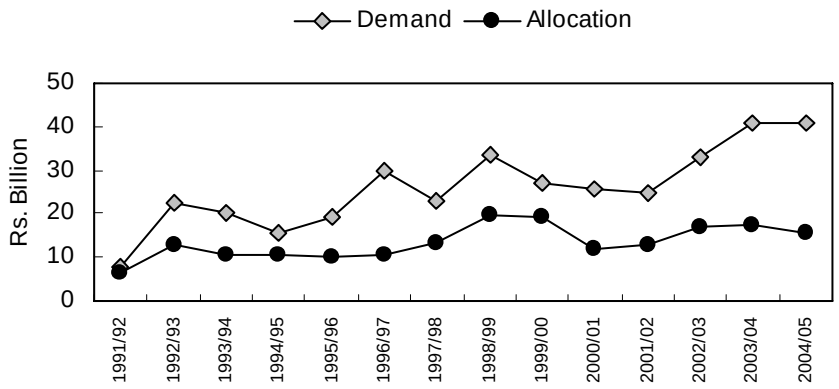
(Unit: Rs million)

Lenders	Details	Amount
Government of Pakistan	Cash Development Loans from the Government	68,082
Foreign Re-lent Loans	IBRD	6,274
	OECF/JBIC	13,688
	International Development Association	78
	Asian Development Bank	232
	Islamic Development Bank	324
Foreign Direct Loans	Turk Exim Bank (for work on the M1)	934
	Dawwoo (for work on the M2)	13,447
Total		103,061

Source: NHA Financial Statement (Draft)

(2) Fund and Expenditure for Development

For the construction and improvement of national highways, NHA has received funds from the Government through the Public Sector Development Program (PSDP). However, the allocations made available to NHA fell short of demand, as illustrated in Figure 3.3.2.



Source: NHA

Figure 3.3.2 Demand and Allocation of PSDP

(3) Road Maintenance Account (RMA)

Toll revenue is the major source of funding for maintenance of the national highway network. In addition, the Federal Government provides to NHA an annual Maintenance Grant which amounted to Rs. 825 million in 2003/2004.

In 2003/2004, the total fund raised for maintenance was Rs. 3,774 million, 78% of which was the revenue generated, and the remainder came from the maintenance grant from the Federal Government, as shown in Table 3.3.4. However, the total fund for maintenance was insufficient to meet the increasing expenditure.

Table 3.3.4 Maintenance Fund and Expenditure

Fund (Unit: Rs.Million)

Source	2001/02	2002/03	2003/04	2004/05	Total
Maintenance Grant	760	800	825	829	3,214
Net Revenue Generated	2,024	2,432	2,949	3,704	11,109
Total Fund	2,784	3,232	3,774	4,533	14,323

Expenditure

Province	2001/02	2002/03	2003/04	2004/05	Total
Punjab	1,660	191	3,932	N.A	5,783
Sindh	548	320	821	N.A	1,689
NWFP	134	119	1,244	N.A	1,497
Balochistan	311	510	1,036	N.A	1,857
Total Expenditure	2,653	1,139	7,033	N.A	10,826

Source: NHA RAMD (Road Asset Management Unit

3.4 Road Safety and Overloading

3.4.1 Road Safety

Table 3.4.1 summarizes the accidents reported by NTRC. The accident data in 2001 shows 4,527 fatal and 6,060 non-fatal accidents resulting in 5,421 deaths and 12,942 injuries,

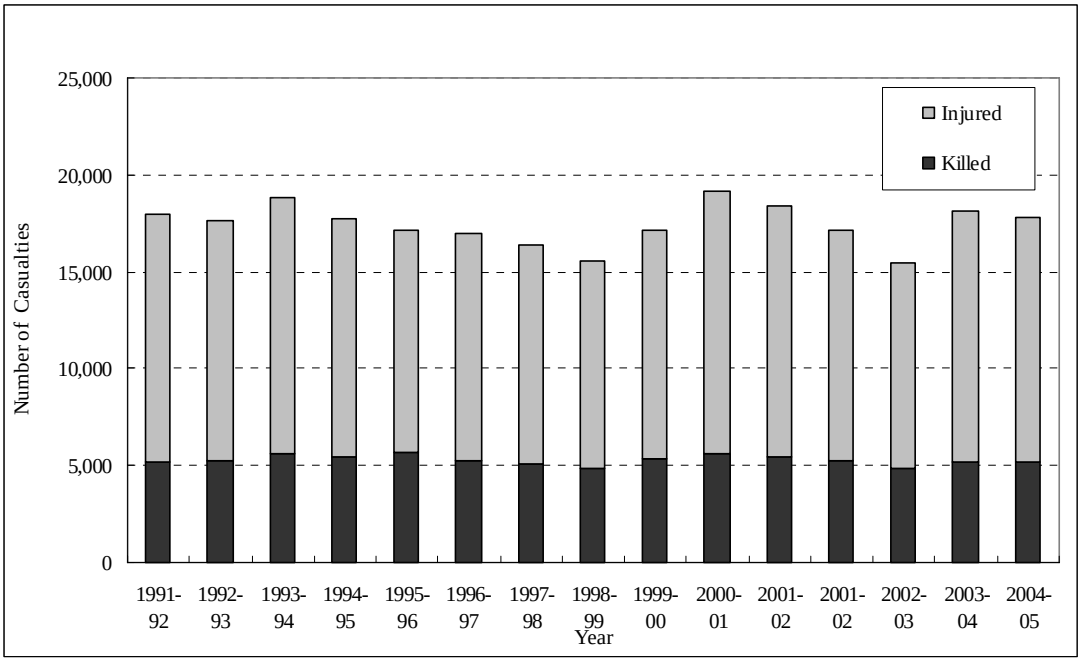
Table 3.4.1 Traffic Accident Statistics

Year	Fatal	Non-Fatal	Others	Total	Killed	Injured	Total
1996	4,383	5,369	2,938	12,690	5,301	11,697	16,998
1997	4,407	5,249	2,737	12,393	5,141	11,229	16,370
1998	3,620	4,317	418	8,355	4,196	9,817	14,013
1999	4,637	5,635	449	10,721	5,371	11,797	17,168
2000	4,629	6,114	409	11,152	5,627	13,479	19,106
2001	4,527	6,060	338	10,925	5,421	12,942	18,363

Source: Accident Statistics (1991-2001), NTRC

A road safety study conducted by NHA in 1998-1999 estimated 7,000 fatalities, 140,000 injuries and 1,400,000 property damage cases based on sample surveys carried out in four provinces, but a recent study by the ADB indicated that the road traffic accidents involved over 10,000 fatalities per year (over 30 per 10,000 vehicles) and 150,000 injuries. These are higher than the figures in Southeast Asia though better than those in India and Bangladesh.

Traffic accidents are also recorded by the Federal Bureau of Statistics. Despite a doubling of vehicle numbers, the number of fatal accidents and fatalities remains the same over a 15-year period (Figure 3.4.1). These data indicated that about 5,000 people are killed annually on the roads in Pakistan.



Source: PTPS Final Report, JICA Study Team

Figure 3.4.1 Number of Casualties in Traffic Accidents

3.4.2 Overloading

Overloading by trucks is one of the most typical phenomena in Pakistan. An Axle Load Study of the National Highways conducted by NTRC in 1995 showed that 43% of rear axle

loads exceed the 12-tonne limit (the legal axle-load limit mandated by the Road Safety Act 2000). Figure 3.4.2 shows allowable load limits for national highways as per the National Highway Safety Ordinance-2000.

Allowable Axle Loads

The National Highways Safety Ordinance 2000 stipulates maximum axle loads and tyre pressures:

- Front axle – 5 tones
- Single axle - 12 tones
- Tandem axle – 22 tones
- Tridem axle – 33 tones
- Tyre pressure rear axle 120 psi
- Tyre pressure – front axle 100 psi

These regulations were passed in 2000 but an agreement was reached between NHA and the transport industry to allow some concessions on National Highways but not on motorways. The current situation for the various configurations is shown below.

Truck Type	Allowed on National Highways	Concession Granted by NHA in 2002	Allowed on Motor Ways
2 AX SINGLE (BEDFORD)	17.5	20	17.5
2 AX SINGLE (HINO / NISSAN)	17.5	23	17.5
3 AX TANDEM	27.5	32	27.5
3 AX SINGLE	29.5	32	29.5
4 AX SINGLE TANDEM	39.5	42	39.5
4 AX TANDEM SINGLE	39.5	42	39.5
4 AX SINGLE	41.5	44	41.5
5 AX SINGLE TRIDEM	48.5	51	48.5
5 AX TANDEM TANDEM	49.5	52	49.5
5 AX SINGLE SINGLE TANDEM	51.5	54	51.5
5 AX TANDEM SINGLE SINGLE	51.5	54	51.5
6 AX TANDEM TRIDEM	58.5	61	58.5
6 AX TANDEM SINGLE TANDEM	61.5	64	61.5

National Highway Safety Ordinance 2000 is being amended after the Steering Committee meeting held in Karachi in August 2005 to provide for the greater punishment of originators of overloading.

Figure 3.3.2 Concept of National Highway Ordinance-2000

Chapter 4. GENERAL CONDITION OF THE PROJECT AREA

4.1 Socio-economic Conditions

4.1.1 Overview of Social Indicators in Pakistan

Pakistan is experiencing economic growth but poverty is still widespread throughout the country. It is difficult to state definitively which province is the poorest. For all practical purposes, NWFP and Balochistan are ranked equally the same in terms of poverty level. There are a number of factors which characterize poverty in Pakistan:

- Education: the proportion of literate household heads in poor households is almost a half that in non-poor households.
- Poor households on average have 75% more children than non-poor households. In general these children do not receive any education.
- Over one third of poor households are headed by aged people who are dependent on pensions and similar forms of social support.
- The poor have few physical assets, such as land or livestock
- The poor rely on casual employment, such as day labour in agriculture, construction, trade and transport. Poverty is high among self-employed people, such as street vendors
- Inequality in land ownership makes the poorest sections of rural society more vulnerable to poverty shocks.
- Environmental degradation is a cause of poverty in Pakistan, particularly in health effects.
- Waterborne diseases are widespread because 17% of the urban and 47% of the rural population do not have clean drinking water.
- The poor are more vulnerable to disease as they have limited income to spend on health, and sickness reduces their productivity.

Poverty usually means lack of food, clothing, and shelter (housing) essential for reasonable living standards. There are many “living standards” measures but the most important variables remain income and expenditure. Living standards are not determined by income and consumption alone, but also by other non-economic aspects such as life expectancy, mortality, access to clean drinking water, education, health, sanitation, electricity and security which are measures of well being. NWFP is lacking in social services as it has shortages of water, sanitation, clinics and schools.

There is little documentation on the gender dimensions of poverty but incidence of poverty among women in Pakistan is higher compared with men, and is characterized by low endowment of land and productive assets, unemployment, discrimination in the labour market, and limited access to economic options and political processes. Income or consumption-related vulnerability is likely to be high in female headed households clustered around the poverty line.

The Government recognizes that sustained growth is critical for poverty reduction but growth alone is not enough. A sustained economic growth policy must be accompanied by other poverty alleviation measures such as investment in education, health and other human development activities, integrated small public works programs in both urban and rural areas, and other social safety net measures. Expenditures on roads and highways constitute the major share in community services. This has grown 250% in three years from Rs.6.34 billion in 2001/2002 to Rs.16.6 billion in 2004/2005. This will contribute to mitigating poverty in rural areas.

The Government has adopted the Millennium Development Goals which include halving poverty by the year 2015. The Government has stated that improvement in transport infrastructure through the provision of better road conditions is a major factor in poverty alleviation.

4.1.2 Key Social Indicators in NWFP

NWFP has relied mainly on roads for communications in the past as there is no well developed rail system, except for the rail link through the Khyber Pass to Landi Kotal. NWFP has an extensive rural road network and the poor sector of the population may benefit most from any road improvement project.

NWFP is regarded as one of the poorest provinces. The Kohat tunnel project will pass through the Kohat district and the tribal areas. Information on the tribal areas is limited although the main place impacted by the road scheme is Dara Adam Khel town which is a well developed urban centre.

The Kohat district depends on Kohat town which is an important armed forces centre. A comparison of socio economic indicators for Kohat and NWFP in general is given below.

Table 4.1.1 Socioeconomic Indicators for NWFP and Kohat District

Socio-economic Indicators	North West Frontier Province	Kohat
Population	17,744,000	563,000
Annual population growth rate	2.8%	3.3%
Persons / household	8.0	7.4
Unemployment rate	26.8%	38.4%
Drinking water supply inside house	35.3%	57.63%
Electric lighting	72%	86%
Wood used for cooking	83.7%	77%
Gas used for cooking	9.8%	11%
Illiterate – all population	65%	56%
Illiterate – male population	50%	35%
Illiterate – female population	81%	76%
Number of primary schools - male	10,692	503
Number of primary schools - female	6,188	286
Number of hospitals	123	7

Source: "Socio-economic Indicators at District Level NWFP", Federal Bureau of Statistics, GOP 2002

The population growth rate in Kohat is slightly higher than the province average. Unemployment is higher indicating lower job opportunities. In general supply of electricity, drinking water and cooking fuel in Kohat is higher than the province average. Illiteracy levels are lower than average and the number of schools and hospitals is slightly higher than the average. In general discussions with residents, all were in favour of a new tunnel and Kohat ring road as it will benefit local people. According to discussions with local government officers, the EPA, Wildlife Department and Forestry Department all stated that they had no objection to the scheme.

4.2 Topography and Geology

4.2.1 General Topography

On the east bank of the Indus River in the northwest of Pakistan, the Potohar Plateau with an elevation between 400 m and 700 m above sea level spreads from north to south. The area of the Potohar Plateau has the shape of a distorted trapezoid. Its north edge extends from the junction of the Indus River and the Kabul River in the west to Rawalpindi City in the east along the Highway No.5. The Salt Range with an elevation between 1,000 m and 1,500 m above sea level forms the base of the trapezoid in the south, and the Indus and Jhelum Rivers form its west and east edges respectively. The Potohar Plateau is characterized by many hills, terraces and alluvial plains. The hills consist of Tertiary formations and terraces consist of Quaternary deposits partially covered with Aeolian losses.

On the west bank of the Indus River, branches of the Hindu Kush Mountains ranging in elevation from 2,000 m to 3000 m flow from north to south along the border with Afghanistan. The Project area is located on the Adam Khel Mountain which is one of these branches. It extends from east to west at an elevation between 1,000 m and 1,200 m and forms a watershed between the Peshawar Basin (EL=600 m) in the north and the Kohat Basin (EL=500m) in the south.

The 2nd Kohat Tunnel and Access Road will be constructed in parallel with the 1st Kohat Tunnel and Access Road on their east side. This 30 km long highway connects the above two basins.

4.2.2 Geology

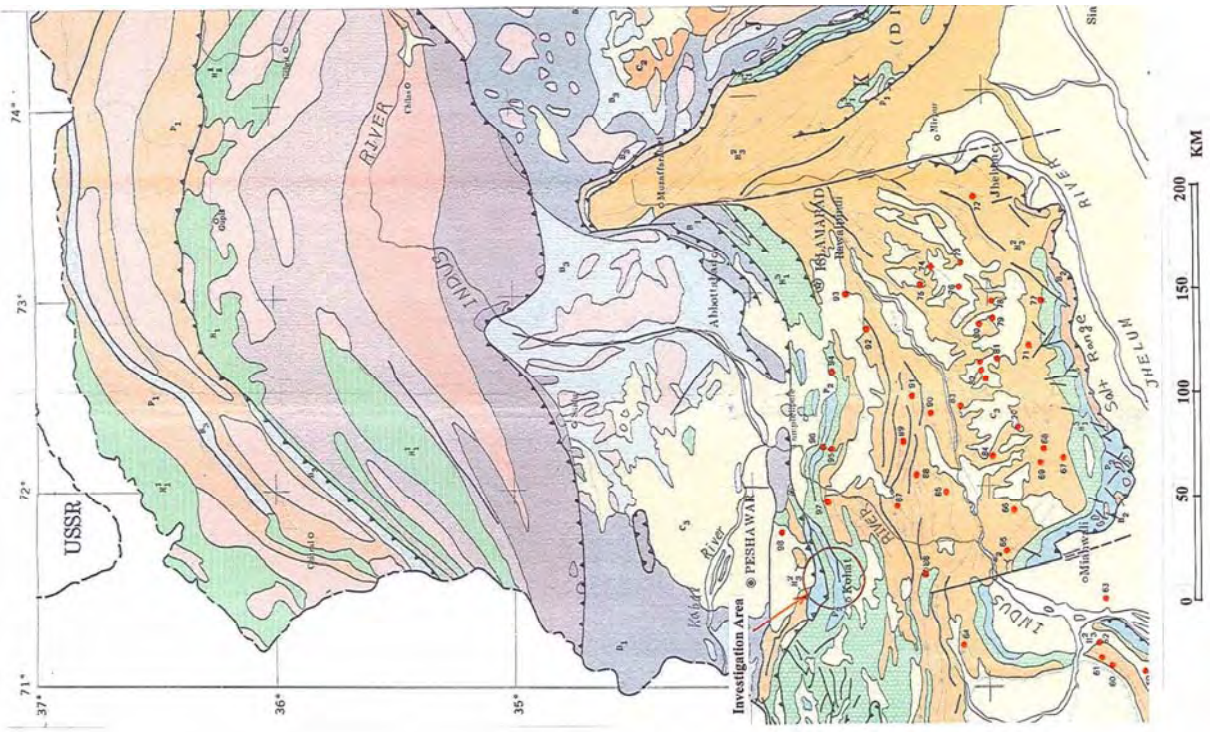
A geological map of North-West Frontier Province and Northern Punjab Province is shown in Figure 4.2.1, and the stratigraphy of the Potohar Plateau is illustrated in Table 4.2.1. As shown in these table and figure, the Adam Khel Mountain consists of Samana-Sak formation of Upper Palaeocene, Lockhart formation of Middle Palaeocene, and Patara formation of Lower Palaeocene. All of these formations are marine sediments and comprise sandstone, shale, limestone and their alternation. They are complexly folded and faulted by the Himalayan Orogenic Movement during the Tertiary age.

The central part of the mountain consists of limestone named Kohat Limestone. The southern access road is located on a flood plain and hills of the Kohat Basin. There exist many small composite fans at the foot of the mountain. The flood plain is covered with gravel partially accompanied by clay. Most rivers are influenced by a seasonal semi-dry climate, therefore there is no running water in the river channel except in the monsoon season from July to August. Hills consist of basement rock but sometimes they are covered with Soan formation of Pleistocene. The northern access road is constructed at the foot of the mountains and in a narrow valley plain. Therefore, this road passes through basement rocks and alluvial gravels. According to the geological map of Pakistan, the Indo-Pakistan plate moved from south to north and collided with the Eurasian plate during the Eocene age. As a result, rapid upheaval of the Himalaya Mountains and Tibet Highland began at the north edge of the Indian Sub-continent, while large scale subsidence occurred at the south edge of the collision. Thick Tertiary formations are deposited in this subsidence area where the Indus River flows from north to south at present. The Project area is located on the south edge of the Himalayan Fold Belt formed by the orogenic movement.

Table 4.2.1 Stratigraphy of Potohar (Potwar) Plateau

Era	Period	Epoch	Geological Formation	Lithology
Cenozoic	Quaternary	Holocene	Alluvial Plain Deposit	River Deposit Unconsolidated gravel, sand, silt, and clay
		Pleistocene	Aeolian Terrace Deposit	Potohar Silt and Losses. Yellowish brown, unconsolidated silt and strongly cemented red silt
			Upper Siwalik Group (Soan Formation)	Fresh Water Clastic Sediment. Conglomerate, sand stone and clay stone
	Tertiary	Pliocene	Middle Siwalik Group (Soan Formation)	Fresh Water Clastic Sediment. Cyclic alternation of clay, sand stone and gravel.
		Miocene	Lower Siwalik Group (Chinji, Nagri Formation)	Fresh Water Clastic Sediment. Red clay and sand stone
		Eocene	Rawalpindi Group (Muree , Kamlial Formation)	Fresh Water Clastic Sediment. Alternation of sandstone and shale.
		Oligocene		
		Palaeocene	UpperPalaeocene (Patala Formation)	Marine Sediment. Shale with limestone and sandstone
			Middle Palaeocene (Lock hart Formation)	Marine Sediment. Medium grained nodular limestone.
			Lower Palaeocene (Hangu Forrmation)	Marine Sediment. Sandstone
Mesozoic	Cretaceous		Upper Cretaceous (Kawagrah Formation)	Marine Sediment. Fine grained limestone with shale.
	Jurassic		Middle Jurassic (Samana Suk Formation)	Marine Sediment. Limestone
Pre-Cambrian (Basement)			Salt Range Formation.	Marine Sediment (Evaporite Sediment) Rock salt, gypsum and marl

Bedrock of Human Prehistory in Pakistan, Syed Muhammad Ashfaque, Pakistan Study Centre, University of Karachi (1994)



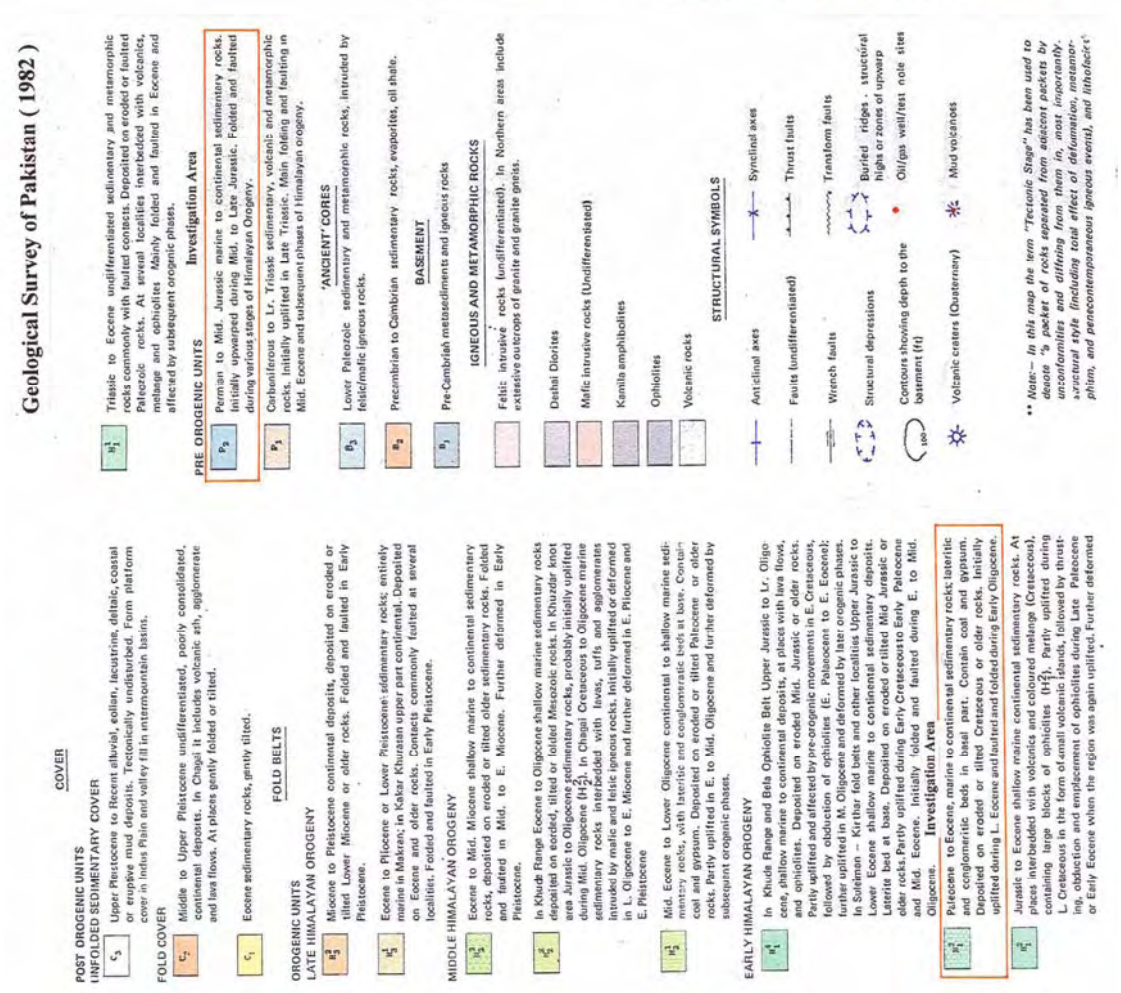


Figure 4.2.1 Geological Map of Pakistan

Chapter 5. EXISTING KOHAT TUNNEL AND ACCESS ROADS

5.1 Background

The National Highways N-5 and N-55 on the north-south axis are the major trunk road transport corridors in Pakistan. N-55 (Indus Highway) runs on the west bank of the Indus River from Kotri to Peshawar through D.G. Khan, D.I. Khan and Kohat over a total length of 1,264 km.

The Government of Pakistan (GOP) through NHA implemented the Indus Highway Construction Project. The Government of Japan extended three loans (Jyen 41,781 million in total) through OECF/JBIC for the construction of 761 km (60%) of the Indus Highway from 1989 to 2003. However, the road section crossing the steep mountainous terrain at Kohat Pass was the bottleneck of the Indus Highway, particularly caused by heavy vehicles that can run only at a speed of 10 - 30 km/hour maximum due to steep gradients and sharp bends (see following photographs).

Kohat Pass (Aug.2006)

Kohat Pass (Aug.2006)

The Kohat Tunnel study was initiated in 1973 and several studies were conducted since then. The latest feasibility study of the Kohat Tunnel and Access Roads (Kohat Toi-Dara Adam Khel Section) was conducted in 1990 as a part of the Indus Highway Project and the detailed design was conducted in 1990/1991. GOJ extended loans totalling Jyen 12,618 million in 3 phases for the construction of the Kohat Tunnel and Access Road including consultancy services (Table 5.1.1).

Table 5.1.1 Japanese Loans for Kohat Tunnel and Access Road Project

Item	Phase 1	Phase 2	Phase 3
Loan Amount	Jyen 5,437 million	Jyen 4,032 million	Jyen 3,149 million
Loan Agreement Signing	November 1994	July 2001	February 2003
Loan Completion	January 2001	Not yet completed	June 2006

Note: Post-Evaluation Report of JBIC on Kohat Tunnel Construction Project, 2005

In September 1996, NHA awarded a contract for consultancy services on Kohat Tunnel and Access Road Project to Pacific Consultants International (PCI), Mouchel Consulting Ltd. in association with Engineering Associate (EA) and NESPAK. The consultant reviewed the design of the Kohat Tunnel and Access Road including the tunnel route in 1998. Subsequently NHA awarded a contract for the construction of the 1st Kohat Tunnel (a bidirectional 2-lane tunnel) and Access Road to Taisei Corporation (Japanese firm) in June 1999. The construction was started in August 1999 and completed in April 2003 with a construction period of 45 months.

5.2 Construction of the 1st Kohat Tunnel and Access Roads

5.2.1 Outline of the 1st Kohat Tunnel Construction Project

The stage construction was applied for the Kohat Tunnel Construction Project. The 1st Kohat Tunnel was opened in 2003, and the 2nd Kohat Tunnel was planed to be opened around 2015 in the original plan when the 1st Kohat was designed. According to the Design Review Report of 1st Kohat Tunnel, service level of the tunnel was estimated to be Level D in 2006 and become Level E after 2015. The construction of 2nd tunnel was planed when the service level became lower. This stage construction reduced the initial investment and increased economic efficiency (EIRR) of the Project.

The total length of the Project is 30.630 km: 28.745 km of access roads and 1,885 m of tunnel. The Project included 5 major interchanges/intersections, 11 bridges and allied facilities (Administration Building, Tunnel Control Room, Emergency Area Building, and Main Toll Plaza). Main features of the 1st Kohat Tunnel and Access Roads Projects are as outlined in Table 5.1.2 (also refer to the photographs in the next page).

Table 5.2.1 Summary of 1st Kohat Tunnel and Access Roads Project

Item	South Section	North Section
Access Roads		
Design Speed	90 km/hour	80 km/hour
Length (28.745 km)	20.985 km	7.760 km
Carriageway Width	7.30 m (2 lanes)	7.30 m (2 lanes)
Shoulder Width	3.00 m (both sides)	3.00 m (both sides)
Pavement	AC Pavement	AC Pavement
Bridges (654 m)	7 Nos. (364 m in total)	4 Nos.(290 m in total)
Underpasses (Vehicular)	8 Nos.	5 Nos.
Intersections/Interchanges		
	Kohat Toi (Start Point) N-80 (Rawalpindi Road) IC *Kohat Link Road IC	Dara Adam Khel (End Point) NWF (Sanda Basta) Road IC
Allied Facilities		
	Administration Building Tunnel Control Room Main Toll Plaza *Toll Plaza for Kohat Link Road	Emergency Area Building
Tunnel		
Length	1,885 m	
Total Width	9.40 m	
Carriageway Width	7.30 m (2-lanes)	
Shoulder Width	0.30 m (both sides)	
Walkway Width	0.75 m (both sides)	
Vertical Clearance	5.10 m	
Gradient	2.2% (ascedeing to northbpund)	
Pavement	Concrete pavement (t=30 cm)	
Emergency Areas	5 Nos.	
Ventilation	Jet Fans (10 Nos.)	
Other Facilities		

Note: * Constructed by NHA's own funding

NHA constructed the Kohat Link road (7.0 km in length) connected to the Kohat Tunnel Access Road at Sta.15+575. About 40% of the traffic uses this link road for access to/from Kohat Town instead of N-80 IC at Sta.9+645.

NHA then constructed a new toll plaza at Sta.17+400 to combine the Main Toll Plaza at Sta.10+600 and the Kohat Link Road Toll Plaza at Sta.15+575. Operation of the new toll plaza was initiated by NHA in July 2006.

Kohat Toi Intersection (Start Point)

Dara Adam Khel Intersection (End Point)

Main Toll Plaza at Sta.10+600

Administration Building

Access Road in Tunnel South Section

Access Road in Tunnel North Section

Kohat Tunnel South Portal

Kohat Tunnel North Portal

5.2.2 Bridge Construction

Eleven bridges listed in Table 5.2.2 were constructed under the Project. Of these, the Bridge No.4 was constructed with a dual carriageway (4-lane bridge) while the others were constructed as 2-lane bridges. Seven bridges cross over rivers and five over roads, railways and tracks. Nine bridges are of PC girder type and two of RC girder type. Cast-in-palace piles (dia.750 mm and 900 mm) foundation was applied for the bridges except Bridge No.8 for which spread foundation was adopted.

Table 5.2.2 List of Bridges under 1st Kohat Tunnel and Access Roads Project

No.	Station (at center)	Type	Length (m)	Span	Pile Length (m)	Remarks (Crossing over)
1*	2+736.245	PC Girder	120	4 - 30 m Span	16	Jerma Minor/Kohat Toi
2*	4+735.415	PC Girder	50	2 - 25 m Span	14	Chagai Algad
3A	9+454.363	PC Girder	20	1 - 20 m Span	20	Railway
3B	9+645.760	PC Girder	30	1-30 m Span	21.5	National Highway N-80
9	14+800.000	RC Girder	12	1-12 m Span	20	Bazi Khel Road
10	16+585.000	RC Girder	12	1-12 m Span	20	A track
4**	19+205.000	PC Girder	120	4-30 m Span	18	Chanzi Algad
Kohat Tunnel						
5*	18+920.415	PC Girder	50	2 - 25 m Span	20	Osti Khel Algad
8	19+082.700	PC Girder	20	1 - 20 m Span	Spread Fd.	NWF Road
6A*	21+260.525	PC Girder	180	6-30 m Span	12	Osti Khel Algad & Panderi Algada
7*	25+388.915	PC Girder	40	2-20 m Span	20	Mullah Khel Algad
Total:			654	m		

Notes: 1. * River bridges, 2. ** Dual carriageway (4-lane bridge)

Bridge No.4 (L=120 m, Pier Height=30 m)

Bridge No.3A (L=20 m)

Bridge No.3B (L=30 m)

Bridge No.8 (L=20 m)

5.2.3 Civil Works Cost

The final civil works cost was Rs.5,114 million. Earthworks accounted for 26.9%, the tunnel and its facilities 33.5%, pavement 11.4%, and structures (bridges and box culvers) 11.5% of the total cost as summarized in Table 5.2.3.

Table 5.2.3 Summary of Civil Works Cost of 1st Kohat Tunnel and Access Roads

Bill No.	Description	South Section		North Section		Tunnel		Total	
		Amt.	Share	Amt.	Share	Amt.	Share	Amt.	Share
Bill No.1	Earthworks	879	17.2%	497	9.7%			1,376	26.9%
Bill No.2	Sub-Base and Base Course	295	5.8%	119	2.3%			414	8.1%
Bill No.3	Surfacing	125	2.4%	43	0.8%			168	3.3%
Bill No.4A	Structures - Box Culverts	146	2.9%	56	1.1%			202	3.9%
Bill No.4B	Structures - Bridges	289	5.7%	101	2.0%			390	7.6%
Bill No.4C	Structures - Pipe Culverts	12	0.2%	5	0.1%			17	0.3%
Bill No.5	Drainage and Erosion Works	41	0.8%	300	5.9%			341	6.7%
Bill No.6	Ancillary Works	126	2.5%	95	1.9%			221	4.3%
Bill No.7A	Tunnel Civil Works					1,139	22.3%	1,139	22.3%
Bill No.7B	Facilities Works					573	11.2%	573	11.2%
Bill No.7C	Building Works					43	0.8%	43	0.8%
Bill No.8	Sub-Soil Investigation	6	0.1%					6	0.1%
Bill No.9	Provisional Sum	56	1.1%					56	1.1%
Bill No.10	Indirect Cost (Engineer's Facilities)							168	3.3%
Total		1,975	38.6%	1,216	23.8%	1,755	34.3%	5,114	100%

Source: Final Statement of Civil Works Contract, Kohat Tunnel and Access Road Project

5.3 Operation and Maintenance of the Existing Kohat Tunnel and Access Roads

5.3.1 Management and Operation Organization

NHA has contracted with the Management Contractor & Operator (MC&O), a private company (M/S.AXS Pakistan (Pvt) Ltd.), for the operation and management of the Kohat Tunnel and Access Roads since their opening in June 2003. The current organization of the tunnel operation and management is as shown in Figure 5.3.1. The organization is headed by the Chief Operating Officer of NHA stationed in the Kohat Administration Office. The head of MC&O is the Operations Manager, who is supported by an Administration Officer and an Assistant Operations Manager.

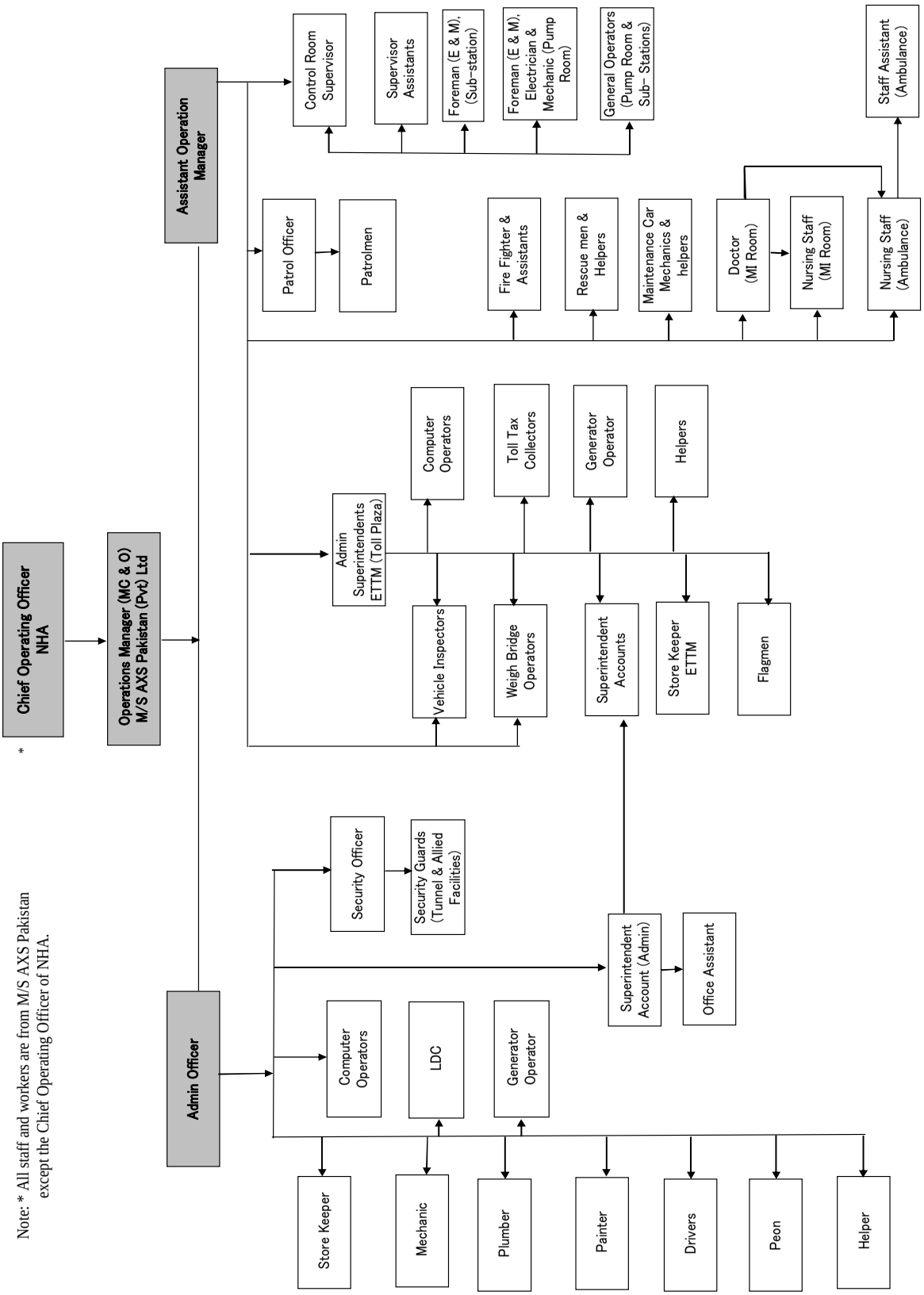


Figure 5.3.1 Organization of Kohat Tunnel Operation and Maintenance Office

5.3.2 Operation and Maintenance Cost

The current contract amount is Rs. 442 million for a 5-year period. This is within the toll revenues. Seventy six percent (76%) is for staff salaries, 8% for vehicles, and 16% for operation and maintenance (electricity consumption charge, replacement of lights, etc.).

Table 5.3.1 Summary of Operation and Maintenance Cost for 1st Kohat Tunnel

Item	Description	Amount	
		(Rs.)	(%)
1	Staff Salaries	335,883,660	76.0
2	Tunnel Vehicles	35,353,000	8.0
3	Operation and Maintenance	70,921,281	16.0
	Total	442,157,941	100.0

Source: NHA Kohat Tunnel Operation & Maintenance Office

A substantial part (approximately 86%) of the operation and maintenance item shown in Table 5.3.1 is for electricity charge. The monthly charge is approximately Rs. 1 million of which 83% is for lighting of tunnel and operation of jet fans as indicated in Table 5.3.2. Electric power is supplied directly by a separate power line. Two generators are kept on standby in the control room for backup in case of blackout.

Table 5.3.2 Electricity Consumption in May 2006

Item	Description	Amount	
		(Rs.)	(%)
1	Tunnel	843,532	82.5
2	Toll Plaza	49,375	4.8
3	Administration Building	74,769	7.3
4	Staff Resident Camp	32,240	3.2
5	North Emergency Building	22,013	2.2
	Total	1,021,929	100.0

Source: NHA Kohat Tunnel Operation & Maintenance Office

5.3.3 Operation and Maintenance Facilities

The following facilities have been provided for operation and maintenance of the tunnel and access roads:

- Administration Building
- Control Room (including CCTV monitoring, control boards, etc.)
- North Emergency Building
- Toll Plazas and weigh bridges
- Seizing barriers and vehicle inspection points
- Ventilation and lighting facilities including standby generators
- Emergency facilities for tunnel (emergency parking areas, press alarm buttons, emergency phones, fire extinguishers, etc.)
- Information and sign boards.

Control Room at South Portal

CCTV Monitoring and Control Board

There are 10 jet fans for ventilation and the operation (activating numbers) is controlled by CO percentage and visibility rate automatically. Eleven Hi-resolution CCTV cameras are installed at about 180m intervals for monitoring the tunnel inside and 5 cameras for the emergency areas for 24 hours/day.

The tunnel operation is classified into normal, partial, and emergency modes. The normal operation means when two-way is secured. The partial operation is one-way traffic at regular time intervals from both sides escorted by a patrol car, which is required in times of tunnel system maintenance, earthquakes and after emergencies. The control system is basically in auto mode for these operations. The emergency mode in the tunnel includes vehicles collision, vehicle breakdown, fire, excess CO, poor visibility, power failure, terrorism, etc. In an emergency case, the tunnel is closed immediately for all vehicles and tunnel facilities are run in the manual mode and planned actions are taken.

5.3.4 Standard Operation Procedures (SOP)

Training of MC&O was carried out by Japanese tunnel operation and maintenance experts prior to the opening of the tunnel to public traffic. The 1st version of the Standard Operating Procedures Manual (SOP) for the tunnel was developed jointly by the personnel involved. Japanese experts then revised it after 3 months of physical operation by incorporating the remedies for troubles encountered and improvements suggested by MC&O. Further revision of SOP has been made recently and is waiting for formal approval by NHA.

Preventive maintenance has been planned on a weekly, monthly and yearly basis. Fire and rescue exercises are carried out periodically.

5.3.5 Staff and Vehicles

MC&O has supplied 377 officers, supervision staff and working staff in total. These staffs are assigned for the Administration Building, Toll Plaza, Control Room, Substation, North Administration Building, Weigh Bridge, MI Room, and Pump Room as detailed in Table 5.3.3. These staffs and workers work in two shifts for 24 hours.

Table 5.3.3 Operation and Maintenance Staff

Item	Description	Number	%
1	Operation Manager and Officers	5	1.3
2	Administration Building	75	19.9
3	Toll Plaza	73	19.4
4	Control Room	54	14.3
5	Substation	21	5.6
6	North Administration Building	60	15.9
7	Weigh Bridge	54	14.3
8	MI Room (Doctor and nursing staff)	10	2.7
9	Pump Room	25	6.6
	Total	377	100.0

Source: NHA Kohat Tunnel Operation & Maintenance Office

There are 21 vehicles (as listed in Table 5.3.4) for the tunnel and access road operation and maintenance. Approximately 30% of vehicles are for administration use. Broken cars, if any, in the tunnel (a few incidents daily) are moved out by towing tractors. Fire vehicles are kept on standby for emergency.

Table 5.3.4 Operation and Maintenance Vehicles

Item	Description	Number	%
1	Administration & Staff Car	6	28.6
2	Patrol Car	3	14.3
3	Ambulance	2	9.5
4	Fire Vehicle	2	9.5
5	Maintenance Vehicle and Sky Lift	2	9.5
6	Coach for Shift Duty	3	14.3
7	Water Tanker	1	4.8
8	Towing Tractor / Recovery Vehicle	2	9.5
	Total	21	100.0

Source: NHA Kohat Tunnel Operation & Maintenance Office

5.3.6 Physical Repair and Maintenance of Road Facilities

Maintenance of road facilities is carried out under contracts using the maintenance budget of NHA. NHA has executed shoulder repairs, bridge scouring repair, slope protection works, guardrail replacement, etc. since the opening of the tunnel and access roads. Shoulders damaged at many locations by passage of vehicles have been reconstructed by NHA with cement concrete pavement or asphalt concrete pavement. The foundations of Piers 3 and 4 of the Bridge No.1 which had been scoured by floods in the last rainy season have been protected with gabions by NHA. NHA has spent Rs.22 million for shoulder repair and Rs.9 million for scouring protection works since the opening of the access road. Cut slope protection works (by grouted riprap) are under way at Sta.18+200 - Sta.18+600.

Shoulder / Guard Rail Damages

Scouring Repair Works by Gabion for Bridge No.1

5.3.7 Evaluation of Tunnel and Road Maintenance

(1) Tunnel and Associated Facilities

Operation and maintenance of the Kohat Tunnel is carried out by a private company under contract with NHA. The operation and maintenance works are under the direct control of the Chief Operating Officer of NHA stationed in the Kohat Administration Office. **The current operation and maintenance system is working well as evaluated in Table 5.3.5.**

The tunnel operation and maintenance is carried out in accordance with the Standard Operating Procedures (SOP) which are periodically reviewed. All required facilities are provided under the Kohat tunnel civil works contract. Sufficient staff and equipment have been assigned and trained. So far no traffic accidents happened in the tunnel. NHA has conducted daily patrol and scheduled exercise for emergency operation and procedure. The toll fees collected are sufficient to cover the operation and maintenance cost.

Table 5.3.5 Evaluation of Kohat Tunnel Operation and Maintenance

Category / Item		Evaluation	Problems / Comments
O&M Method	O&M Contract (Private Company)	Good	Current contract system is working well
Organization		Good	
O&M Manual		Good	Being reviewed periodically
Staff	Staff Number	Sufficient	
	Staff Quality	Good	
	Training	Good	Drill being conducted periodically
Facilities and Operation	Administration Building	Good and sufficient	
	Control Room (South Portal)	Good and sufficient	CCTV, computer-operated CO and visibility control panel, etc. are working well
	Emergency Building (North Portal)	Good and sufficient	
	Toll Plaza	Good	Two toll plazas have recently been combined into one
	Weigh Bridge	Good but operation is insufficient	Operation started recently.
	Ventilation, Jet fans, lighting, communications	Good	
	Power supply	Good	Standby-generators work automatically in case of power cut
Equipment	Number	Sufficient and all in good condition	
	Types	Sufficient	
Vehicle Control	Overloading	Fair	Overloaded vehicles are still allowed to pass after paying fines. This situation should be improved.
	Out-sized materials	Good	Size-control facilities exist at both south and north portals
	Dangerous materials (Fuel, oil, etc.)	Good	Guards check materials on vehicles
	Vehicles with insufficient maintenance	Fair	NHA checks and controls poorly maintained vehicles entering the tunnel
Budget	Source	O&M Budget	Toll fees can cover all O&M Cost
	Allocation	Sufficient	

Note: Evaluation by Study Team

(2) Access Roads

NHA has carried out physical maintenance and repair of road facilities. The major maintenance works include shoulder repair, bridge maintenance (prevention of scouring and approach section depression), cut slope stabilization (by rock nets and grouted riprap) and repair or replacement of other road facilities. The budget for these maintenance works is allocated sufficiently by the NHA head office. Those maintenance and repair works are carried out under contracts and the quality of works is acceptable. However, NHA needs to exert more efforts for controlling heavy vehicles passing or parking on shoulders to minimize damage.

5.4 Current Problems of the Existing Kohat Tunnel and Access Road

5.4.1 Vehicle Running Speed and Level of Service

The control speed of vehicles for the tunnel south section access road is 90km/hour and that for the north section is 80km/hour (same as the design speed). The 1st Kohat Tunnel was constructed as a 2-lane road (single carriageway) with a 2.2% gradient. The design speed of vehicles in the Kohat Tunnel is 60 km/hour. Vehicle running speed has been controlled at 40 km/hour and overtaking is not allowed in the tunnel for safety reason.

However, the actual travel speed is 16.7 km/hour and it takes 7 - 8 minutes (Table 5.4.1) for the north bound (up-grade) traffic to pass the tunnel, as the travel speed in the tunnel depends on heavy vehicles which are overloaded and has low vehicle performance.

Table 5.4.1 Travel Speed in Tunnel

From South Portal to North Portal (Up-grade)

No.	Time			Speed (km/hour)
	In	Out	Time	
1	11:20:00	11:28:00	0:08:00	14.1
2	11:36:00	11:44:00	0:08:00	14.1
3	11:55:00	11:59:15	0:04:15	26.6
4	12:15:00	12:20:27	0:05:27	20.8
5	12:30:00	12:42:37	0:12:37	9.0
6	12:50:00	12:54:00	0:04:00	28.3
7	13:03:00	13:10:00	0:07:00	16.2
8	13:21:00	13:29:49	0:08:49	12.8
9	13:40:00	13:48:16	0:08:16	13.7
10	13:57:00	14:07:13	0:10:13	11.1
Average			0:07:40	16.7

From North Portal to South Portal (Down-grade)

No.	Time			Speed (km/hour)
	In	Out	Time	
1	11:30:00	11:34:00	0:04:00	28.3
2	11:49:00	11:52:55	0:03:55	28.9
3	11:02:00	11:05:56	0:03:56	28.8
4	12:23:00	12:26:55	0:03:55	28.9
5	12:45:00	12:48:34	0:03:34	31.7
6	12:58:00	13:01:00	0:03:00	37.7
7	13:14:00	13:17:35	0:03:35	31.6
8	13:34:00	13:37:48	0:03:48	29.8
9	13:51:00	13:54:49	0:03:49	29.6
10	14:10:00	14:13:21	0:03:21	33.8
Average			0:03:41	30.9

Notes: 1. Tunnel Length is 1.885km, 2. Survey by the JICA Study Team on 20th June 2007

The travel speed for the south bound traffic is 30.9 km that is less than the controlled speed even though it is down-grade traffic because of low vehicle performance and overloading. The current level of service (LOS) in the tunnel section is "D", in accordance with the Highway Capacity Manual (HCM) of Transportation Research Board, National Research Council, USA. Traffic flow in the tunnel is stable not only for the north bound traffic but also for the south bound traffic.

Slow Movement of Traffic at North Portal

Slow Movement of Traffic in Tunnel due to Heavy Trucks

The current ADT figure is approximately 7,400 vehicles but it will increase at high rates (refer to Chapter 7). The current LOS of the Kohat Link Road - Dara Adam Khel section is estimated at "C" but will drop to "D" level in the near future.

5.4.2 Public Complain on Auto Emission

The ventilation capacity (jet-fans) of the tunnel is sufficient and it is well-controlled by a computer-assisted system based on visibility and CO content, both of which are well below

the admissible levels according to regulation. However, the public has complained of auto emission associated with forced slow travel speed in the tunnel. The emission problem was caused by slow movement of heavy vehicles due to overloading, insufficient vehicle maintenance and low quality fuel. However, those problems are not easy to solve even with NHA's continuous efforts to overcome them.

The best solution would be to construct the 2nd tunnel to increase the travel speed and reduce the travel time in the tunnel. It will increase satisfaction of the users while reducing complaints.

5.4.3 Safety in Tunnel

NHA has monitored safety aspects and maintained the tunnel on a 24-hour basis. Sufficient equipment and control systems, including CCTV, communication systems and other facilities and personnel, have been introduced. Vehicles carrying dangerous items like oil and out-sized materials are not allowed to enter the tunnel. These vehicles use the Kohat Pass road (see following photos).

Oil-tankers Passing on Kohat Pass Road

Trucks Carrying Oil and Over-sized Materials passing on Kohat Pass Road

The maintenance and emergency procedures have been standardised and staff are well trained. Fortunately no car collision and fire have occurred in the tunnel since its opening However, there are risks in the case of fire and other unexpected incidents in the tunnel because there are no evacuation tunnels.

5.4.4 Kohat Link Road

The traffic flow between Kohat Town and Peshawar in the original plan was through the N-80 Interchange (Kohat-Rawalpindi Road IC) at Sta.9+645. NHA constructed the Kohat Link Road (L=7.0 km) at Sta.15+575 to provide a short-cut between Peshawar and Kohat and to reduce the passage of heavy vehicles through the Kohat Town centre. This Link Road contributes to minimizing traffic jam in the Kohat Town centre. Approximately 40% of the traffic goes to Kohat Town through the Kohat Link Road and 60% goes further to the south.

**Kohat Link Road On-Ramp,
No proper On-ramp for South**

**Kohat Link Road Off-Ramp,
Narrow Box-culvert for Underpass**

NHA has constructed a new toll plaza that started operation in July 2006 at Sta.17 + 400 combining the existing Main Toll Plaza at Sta.10 + 600 and the Kohat Link Road Toll Plaza at Sta.15 + 575. This arrangement will provide a function of bypass road (ring-road) for Kohat Town traffic as vehicles from/to the northern part of Kohat Town are allowed to pass the southern part of the Kohat Tunnel Access Road without payment. However, the current layout of the interchange facility between the Access Road and the Kohat Link Road is inappropriate to accommodate the bypass traffic.

5.4.5 Damage of Shoulders

Many parts of the shoulders have been damaged by passage of heavy vehicles on them. The west side shoulder has been damaged over a length of 1,000 m and the east side shoulder over a length of 800 m. As the existing shoulder width is 3.0 m, that is not much different from the carriageway width of 3.65 m, some drivers misunderstand that it is a 4-lane road or they simply use shoulders as a convenient overtaking lane. As the pavement structures between the carriageway (AC 26 - 27cm thick) and the shoulders (DBST) are substantially different, the latter have been damaged by the passage of heavy vehicles. NHA has repaired the damaged shoulders either by replacing them with cement concrete or asphalt pavement using the maintenance budget provided by the head office.

Damage of Shoulders

Repair of Damaged Shoulders

If additional two lanes are constructed, this kind of failure will be reduced substantially as overtaking can be done on the carriageway which has sufficient pavement strength. Heavy vehicles will be regulated to use the left lane and light vehicles the right lane.

5.4.6 Rutting and Pavement Failure

Pavement failure occurring earlier than the planned design life of roads is one of the major problems for the road administration. The major damage is rutting, pavement deterioration (cracking) and base failure due to heavy traffic, overloading, insufficient drainage, use of inappropriate materials, and substandard construction.

Minor Rutting (Depth 5-10mm)

Rutting (Depth 15-20mm)

No major pavement failures have been observed on the 1st Kohat Tunnel Access Road since its opening in 2003 except for the above shoulder damage, because thick pavement (21 -

22cm AC base and 5cm AC wearing) was applied. However, minor rutting is seen and it might develop to serious condition in future. Besides, it is necessary to carefully monitor the development of cracks from the viewpoint of medium- to long-term stability of asphalt concrete because the applied bitumen content during the construction was at the lowest value (3.5%) of the Standard Construction Specifications of NHA, taking resistance to rutting into account.

5.4.7 Settlement of Bridge Approaches

Settlement of bridge approaches was observed because no bridge approach slabs were provided for abutments. Though the settlement is 20 - 30 cm, it requires careful monitoring and periodical repair to ensure safety for the structures and pubic traffic.

Settlement of Bridge Approach (Bridge No.3)

Settlement of Bridge Approach (Bridge No.4)

5.4.8 Overloading

Overloading of trucks is one of the major reasons for slow movement of vehicles in the tunnel. As overtaking is not allowed in the tunnel and the share of heavy vehicles is approximately 25%, the driving speed of heavy vehicles controls that of all other vehicles. Overloading also causes earlier pavement failure.

The Kohat Operation and Maintenance Office started overloading control utilizing weigh bridges at the Main Toll Plaza in July 2006 in accordance with the National Highways Safety Ordinance 2000.

A computer-assisted system is used. The gross weight of vehicles is measured when they pass on a weigh bridge installed at approximately 100 m before the toll gate and the recorded data are transmitted to the computer. Extents of overloading and imposed fines are indicated on an electrical board (see following photographs). Fines are collected by the operation and maintenance staff.

Weigh Bridge at Main Toll Plaza

Computer Assisted Overloading Control and Fines Imposing System

5.4.9 The 2nd Tunnel and Access Roads in the Original Plan

The basic plan (the original plan) for the 2nd tunnel and access roads was made in the 1st Kohat Tunnel and Access Roads Project. Intersections and interchanges were constructed with 4 lanes. The Bridge No.4 at Sta.19+200 was also constructed with a dual carriageway (a 4-lane bridge). The right of way (ROW) necessary for future widening was already secured on the east side (right hand side) of the existing road.

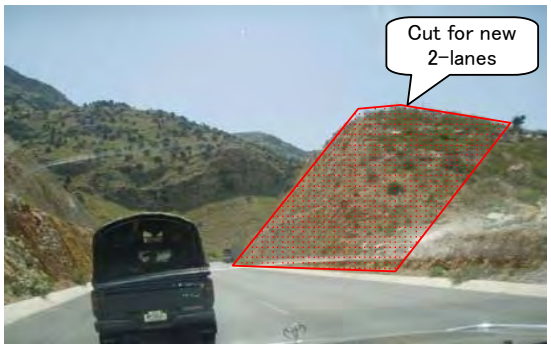
However, there are the following problems in the original plan to be considered for planning the 2nd Kohat Tunnel and Access Roads Project.

- It is necessary to design the new two-lane road utilising the 50 m wide ROW, which has been secured already (see following photos).

Existing ROW Fence for the 2nd Kohat Tunnel Access Road

- The original design did not use transition curves in the road geometry.
- There exist high cuts (H=20 - 30m) which may disturb the existing traffic during construction at several locations (see following photos).

High Cut in South Section
At Sta.18+100 -Sta.18+700



High Cut in North Section
At Sta.23+850 -Sta.23+975

- The traffic capacity at intersections is insufficient in the original design.
- The originally proposed location of the south portal is 70 m to the east of the 1st Kohat Tunnel. However, as there is a steep creek on the right (see following photos), this location may face mud-flow during heavy rains. The location at 30 - 40 m to the east would be more stable but this would require the relocation of the existing tunnel control room.

South Portal

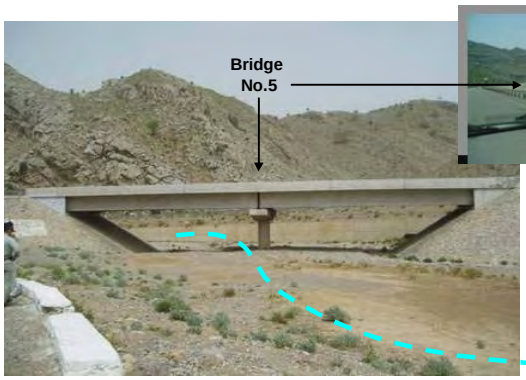
A Steep Creek at South Portal (Right) in the Original Plan

- No approach concrete slabs were provided to prevent settlement of bridge approaches.
- It is better to use the already constructed Bridge No.4 (L=120 m) as a 4-lane bridge for the 2nd Kohat Tunnel Access Road (see following photographs).

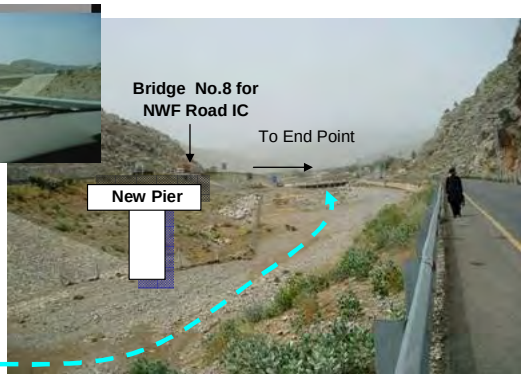
Bridge No.4 already constructed as a 4-lane bridge

Bridge No.4 already constructed as a 4-lane bridge

- The new Bridge No.5R is to be constructed at a river bend at Sta.18+935.



Bridge No.5 at Sta.18+935 Direction (Towards Up-stream)



Bridge No.5 at Sta.18+935 Direction (Towards Down-stream)

- The design of the bridges for the 1st Kohat Tunnel Access Road was conducted in 1990 and the applied seismic force was 0.05g - 0.07g (see Figure 5.4.1) in Zone III. NHA has reviewed the Peak Ground Acceleration (seismic force) and seismic zone after the earthquake at Muzaffarabad on October 8, 2005. The new PGA (0.26g for the Project area) shall be used for the design of bridges under the 2nd Kohat Tunnel and Access Roads Project.

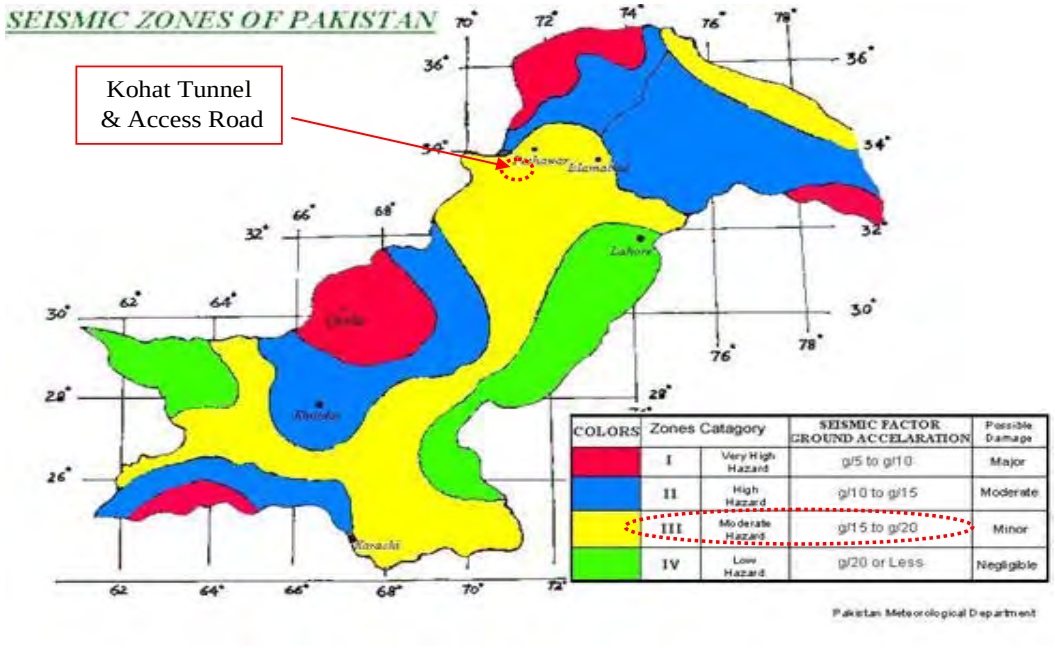


Figure 5.4.1 Old Seismic Force Zoning for Project Area under Review