BASIC DESIGN STUDY REPORT
ON THE PROJECT
FOR
THE IMPROVEMENT
OF
NATIONAL HIGHWAY N-25
IN
ISLAMIC REPUBLIC OF PAKISTAN

JULY 2005

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to a request from the Government of the Islamic Republic of Pakistan, the Government of Japan decided to conduct a basic design study on the Project for the Improvement of National Highway N-25 in the Islamic Republic of Pakistan and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Pakistan a study team from January 8th to February 26th, 2005.

The team held discussions with the officials concerned of the Government of Pakistan, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Pakistan in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the State of Eritrea for their close cooperation extended to the teams.

July , 2005

Seiji Kojima
Vice-President
Japan International Cooperation Agency

July, 2005

Letter of Transmittal

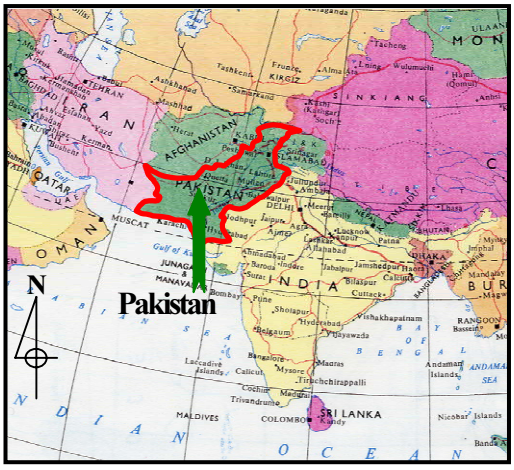
We are pleased to submit to you the basic design study report on the Project for the Improvement of National Highway N-25 in the Islamic Republic of Pakistan.

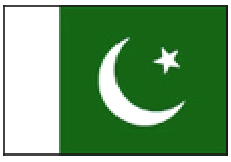
This study was conducted by the joint venture between Construction Project Consultants, Inc., and Nippon Koei Co., Ltd., under a contract to JICA, during the period from December, 2004 to July, 2005. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Pakistan and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Shozo Inoue
Project Manager
Basic design study team on the Project for
the Improvement of National Highway
N-25 in the Islamic Republic of Pakistan
The joint venture between
Construction Project Consultants, Inc.
and Nippon Koei Co.,Ltd.





LOCATION MAP

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Abbreviation

GDP	:	Gross Domestic Product
NHA	:	National Highway Authority
PRSP	:	Poverty Reduction Strategy Paper
IMF	:	I nternational Monetary Fund
JICA	:	Japan International Cooperation Agency
ADB	:	Asian Development Bank
AC	:	Asphalt Concrete
HDM-4	:	Highway Development and Management System-4
BOT	:	Build Operate Transfer
AADT	:	Annual Average daily Traffic
F/S	:	Feasibility Study
PC-1	:	Project Concept -1
RC	:	Reinforced Concrete
UNDP	:	United Nation Development Programme
EIA	:	Environmental Impact Assessment
IEE	:	Initial Environmental Evaluation
ROW	:	Right of Way
WB	:	World Bank
AASHTO	:	American Association of State Highway and Transportation Officials
CBR	:	California Bearing Ratio
DBST	:	Double Bituman Surface Dressing
E/N	:	Exchange of Note
CAD	:	Computer Aid Design
AP	:	Authorization to Pay

Summary

Pakistan has a population of 150 million and has a coastline of 800 km on the Arabian Sea. The country borders Iran and Afghanistan to the west and north, and India and China to the east and north. The land area is 796 thousand km^2, which is approximately twice as large as that of Japan. There are mountains of over 7000 m in the north of the country and the Indus River originates in these mountains flowing into the Arabian Sea through the center of the country. In the west of the country lies Balochistan plateau where the target road for this project (National Highway 25) runs through, and there is fertile Indus plain in the east, exhibiting a contrasting natural environment.

The transportation sector in Pakistan is composed of the four modes of road, railway, aviation, and navigation. It is one of the important industrial sectors that accounts for 10% of GDP and creating about 2 millions of employment. While road and railway traffic are the major means of transportation, the ratio of road transportation is increasing, with its present ratio of 95% in passenger transport and nearly 90% in freight transport. The number of registration of vehicles is also on the rise at a rate of 8 % per annum and the total registration is over 5 million at present. The total length of roads in the country is approximately 250,000 km of which 60 %, corresponding to 160,000 km, is paved. The National Highway Authority (NHA) manages 19 national highway routes. The total length of these routes is 9,252 km. Although its figure accounts for only 3.5 % of the national total, these roads are responsible for 80 % of the total passenger and freight traffic.

The Poverty Reduction Strategy Papers (PRSP), which were released in December 2003 and corresponding to the Five-Year Plan in the past, puts improvement of infrastructure as one of the important elements to accelerate the economic growth that is an indispensable factor to poverty reduction. In the papers, especially the road sector is described as requiring appropriate means of rehabilitation and maintenance in consideration of the future demand. In response to this situation, NHA of Pakistan, an agency under the Ministry of Communication, placed the optimum use of existing road system by rehabilitation and maintenance as one of the priority measures to cope with the problem of deteriorated existing roads (50 % of the National Highway is in poor condition). In the five-year mid-term investment plan for 2005/2006 – 2009/2010 prepared in line with the measures above, the measure is mainly of rehabilitation of existing roads. The

rehabilitation of the section between Kararo-Wadh, the target road section for this project is also included as one of the newly planned improvement work.

The target section of the road for this project, Kararo-Wadh section is a portion of the National Highway 25. The highway 25 is growing in its importance as the sole trunk road passing from north to south in the province of Baluchistan and also as an international road connecting the surrounding inland countries such as Afghanistan directly to the port in Karachi in shortest distance. However, this section of the road contains narrow lanes, sections with many blind curves, and steep slopes. The situation results in frequent accidents such as crushes and falling off the road due to over-speeding at curves and trying to pass other vehicles. NHA is carrying out its own repair work to cope with the problems but it is essentially nothing more than regular maintenance work. Full-fledged rehabilitation is difficult for NHA both economically and technically, which is the bottleneck in the rehabilitation effort. The situation is anticipated to create hindrance to the Kararo-Wad section of the road and it can eventually cause negative effects on the function of National Highway 25. The rehabilitation of this section is, thus, considered necessary and urgent. Under these circumstances, in 2003, the government of Pakistan requested Japan's grant aid assistance on the improvement of traffic safety in the road section (96 km) including widening of the road to 7.3 m, amelioration of sharp curves and steep slopes, and improvement of drainage structures.

The government of Japan, in response to this request, decided to conduct a basic design study. JICA undertook the study and dispatched a study team for the basic design study starting from 8th January to 26th February 2005 and the team conducted a field investigation of the 96 km – section requested for improvement. The study team, through discussions with Pakistani side, reached a consensus with NHA that the rehabilitation work should limit to sections and work items requiring urgent measures by Japan's grant aid and exclude portions of work that could be handled by the Pakistani side. After returning to Japan, the study team determined the scope of work for the grant aid assistance as shown below on the basis of the results of the field investigation.

Imprivement items for the plan	Contents of plan
1) Road improvement section	44.8km
1-1) Roadway	
－Design speed	60km/h（mountains and hills）
Alignment conditions	Minimum radius of curve (135m), Maximum slope (7%)
－Pavement width	7.3m（3.65 m x 2 lanes）
－Pavement structure	Asphalt concrete　12 cm (surface 5cm, base 7cm) Base course: 20cm Sub base course 27cm
1-2) Road shoulder	
－Road shoulder width	Standard 2.0 m（Min1.0m）
－Pavement structure	Surface（double bituminous surface treatment DBST） Base course (Sub base course material) 59 cm
2) Section for minor improvement	51.2 km Reshaping road shoulders Road marking lines (center and side lines)
3)Rehabilitation of transversal drainage structures	Reconstruction of 113 culverts Expansion of 12 culverts
4) Auxiliary facilities	Drainage and retention　: Retention pit, Intake pipe Slope protection　: Masonry wall, flat gabion Road sign　: 103 Guardrail　: 5,500 m Guard post　: 300 Edge marker　: 191 Road marking　: Center and side line 96km Kilo-post　: 97

The items shown in the table above along with other information were integrated in a report on the basic design study. The study team with the mission of presenting and explaining this report was dispatched starting 2nd June to 11th June 2005 and made an agreement with the Pakistani side on the general content of the report.

The study found the period required to implement the project under the scheme of Japan's grant aid assistance to be 8.5 months for detailed designing (including tender) and 42 months for construction work. The project cost was estimated to be 4,156 million yen (Japanese side: 4,113 million yen,　Pakistani side : 43 million yen).

There is no construction work allocated to the Pakistani side in this project. However, since the two parties agreed on the arrangement that the project only focuses on the sections and items that require urgent rehabilitation by Japan's grant aid assistance scheme and that the items and portions of work that can be implemented by the Pakistani side itself have been excluded, the Pakistani side is expected to realize their rehabilitation plans to promote the

function of the Kararo-Wadh section of the highway as a whole.

The target portion of the road for this project is a section of National Highway 25 that is the only trunk road that runs through the province of Balochistan in north-south direction. Implementation of this project is considered to benefit about 7 million of the whole residents in the province of Balochistan. The following are the expected benefits determined through the study.

Direct benefits

－The number of traffic accidents will decrease (average number of accident:120 case/ year for 5 years) due to improved road alignment (max. slope reduced from 10 % to 7 %, min. curve radius reduced from 50 m to 135 m) and improved traffic safety.

－Possible reduction in travel time due to the smooth traffic on improved road with the average speed of 60km/hr, compared with actual speed restriction of 30km/hr on about 30 places of sharp curves and steep slopes

Indirect benefits

－The National Highway 25 that includes the target section for this project is the National Highway directly connecting Afghanistan and the central Asia to the Karachi port in Pakistan. Thus, the implementation of the project, by eliminating the traffic bottleneck in the international highway, can also help promote the revitalization of Afghanistan that is rapidly underway.

－Rehabilitation of the road is expected to bring up the number of buses, ambulances and school buses plying certain routes. This will facilitate transportation to major towns in the area. As a result, the local people will obtain excellent facilities.

－The area along National Highway 25 within the province of Baluchistan constitutes large-scale farmland for cash crops such as fruits and vegetables. Especially around Quetta area, promiculture is widely practiced and the products are exported from the Karachi port. As in this example, the elimination of the traffic bottleneck in highway 25 will contribute to more rapid and secure transportation of harvested farm products to Karachi for both consumption and exportation and eventually contribute to facilities of the local residents.

As described above, this project aims at securing safe traffic by improving the sections with safety problems along Kararo-Wadh section of the highway. The project directly contributes to the amelioration of a major highway in the country, which the Pakistani government requires. In addition, the joint and coordinated realization of the project by Japan's grant aid assistance and the work by Pakistani side is expected to strongly contribute to establishing better relationship between the two countries, which also confirms validity of the project implementation.

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Chapter 1 Background of the Project

Chapter 1 Background of the Project

The transportation sector in Pakistan is composed of the four modes of road, railway, aviation, and navigation. It is one of the important industrial sectors that accounts for 10% of GDP and creating about 2 millions of employment. While road and railway traffic are the major means of transportation, the ratio of road transportation is increasing, with its present ratio of 95% in passenger transport and nearly 90% in freight transport. The number of registration of vehicles is also on the rise at a rate of 8 % per annum and the total registration is over 5 million at present. The total length of roads in the country is approximately 250,000 km of which 60 %, corresponding to 160,000 km, is paved. The National Highway Authority (NHA) manages 19 national highway routes. The total length of these routes is 9,252 km. Although its figure accounts for only 3.5 % of the national total, these roads are responsible for 80 % of the total passenger and freight traffic.

The province of Balochistan, having almost the same area as Japan (350 thousand km^2), has a population of only 7 million. With its 75 % of population living in farm villages, it is a part of the country that is lagging behind both socially and economically. The target section of the road for the project is a section of National Highway 25, the only trunk road that runs through the province of Balochistan in north-south direction, that is increasing in its importance in recent years. The road is also becoming important as an international highway directly connecting the surrounding inland countries such as Afghanistan to the port of Karachi in shortest distance.

The target section of the road for the project, Kararo-Wadh section, recorded a traffic of about 4,300 vehicles per day and large vehicles accounts for as much as 40%. However, this section of the road contains narrow lanes, sections with many blind curves, and steep slopes. The situation results in frequent accidents such as crushes and falling off the road due to over-speeding at curves and trying to pass slowing large vehicles at steep slope sections. An average of 10 cases/month of accidents including minor ones occur within the section. Thus the securing of traffic safety in this section has become an urgent problem to tackle. NHA is carrying out its own repair work to cope with the problems trying to secure the road alignment with a 60 to 100 km/h-design speed. However, full-fledged improvement for this road section is difficult for NHA both economically and technically, which is the bottleneck in the improvement effort. The situation is anticipated to create hindrance to the Kararo-Wadh section of the road and it can eventually cause negative effects on the function of National Highway 25. The improvement of this section is, thus, considered necessary and urgent. Under these circumstances, in 2003, the government of Pakistan requested Japan's grant aid

assistance on the improvement of traffic safety in the road section (96 km) including widening of the road to 7.3 m, amelioration of sharp curves and steep slopes, and improvement of drainage structures.

Chapter 2 Contents of the Project

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2.1 Basic Concept of the Project

The Poverty Reduction Strategy Papers (PRSP), which is the basic principle for national development for Pakistan (released in December 2003), defines improvement of infrastructure as one of the important elements to accelerate the economic growth that is an indispensable factor to poverty reduction. In the papers, especially the road sector is described as requiring appropriate means of improvement and maintenance in consideration of the future demand. In response to these documents, NHA of Pakistan selected the optimum use of existing road system by improvement and maintenance as one of the priority measures to cope with the problem of deteriorated existing roads (50 % of the national highway is in poor condition). In the five-year mid-term investment plan for 2005/2006 – 2009/2010 prepared in line with the measures above, the measure is mainly of improvement of existing roads. The improvement of the section between Kararo-Wadh, the target road section for this project is also included as one of the newly planned improvement work.

While the importance of National Highway 25 is increasing both as an international highway and as a main road in the province, the target section of the highway for the project poses a major problem of traffic safety, having sections with narrow lanes, blind curves, and steep slopes,

Under these circumstances, the improvement of the target section of National Highway 25, Kararo-Wadh section, was decided to be implemented as a project for the purpose of securing safe traffic within the section and avoiding the worst case scenario of traffic interruption due to failure of highly deteriorated road structures or to traffic accidents.

In order to achieve the above goals, the optimum improvement plan was determined through the following examinations: firstly the basic improvement alternatives for the Kararo-Wadh section were examined, secondly classification of the section into subsections based on the present extent of damage of the road and on geographical conditions for each subsection was made, thirdly alternative plans were devised in terms of effect of investment and they were analyzed and compared.

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

2.2.1.1 Basic Policy

The section of the road to be improved which was the subject of the request for collaboration under the current plan is the 96 kilometer section between Kararo and Wadh. The improvement plan included the securing of a roadway width of 7.3 meters, the improvement of steep gradients, sharp curves and drainage structural facilities. However, the improvements relating to the structural facilities only covered work of a trifling nature. The field survey conducted this time to verify the soundness of the structural facilities revealed that there were many such facilities requiring improvement. Consequently, it has been ascertained that the roughly estimated figure based on the implementation plan prepared by the government of Pakistan would be insufficient to cover the road improvement of the section concerned and improvement of the structural facilities. Therefore, consultations were held with the implementing organization (NHA) of the government and, as a result, it was mutually agreed that the work would be divided into sections to be carried out by the Japanese government and sections to be carried out by the government of Pakistan according the necessity and urgency of the condition.

At present, NHA is conducting the improvement work on the flat portion at the Wadh side included in the current plan. This involves widening of the road to 7.3 m, overlaying, formation of road shoulders extending 2m on both sides. The survey team has suggested that the extent and nature of the work that can be carried out by the Pakistani government should be determined with consideration to the results of the aforementioned improvement work and that the scope and nature of the work to be covered under the grant acid scheme of Japan should be limited accordingly. It has been mutually agreed that the final decision regarding the scope and nature of the work will be made at the time of discussion of the draft final report of basic design.

In light of the foregoing considerations, the basic policy with respect to determining the content and scale of the current plan will be as follows:

- Sections of the road where accidents frequently occur or which are conducive to accidents will be the subject of improvements.
- In determining which sections under the plan are to be included in the Japanese government's scope of work and which are to be included in that of the Pakistani government's, sections regarding which it is deemed that the Pakistani

side is capable of carrying out regular maintenance (sections currently being improved and sections deemed to possess similar geographical features and work involvement) will be excluded from the sections to be covered by the current plan.

- The specifications will be equivalent to the Pakistani standard specifications and needed to assure the safety traffic flow.
- Structural facilities requiring urgent attention will be the subject of improvements.
- The installation of traffic safety facilities to reduce traffic accidents will be included in the plan.

2.2.1.2 Policy for Natural Conditions

(1) Geographical features

The roads concerned are located at elevations ranging from 400 to 1,200 meters above sea level and course through 45 percent mountainous regions (sections containing numerous sharp curves and steep grades), 29 percent hilly country (sections with continuous undulations), and 26 percent flat terrain. The entire length of the road concerned is covered with a sandy or conglomerate layer and there is a section where the bedrock is exposed. Further, the existence of steep gradients and sharp curves has been confirmed in sections prior and subsequent to some of the structural facilities. These constitute serious bottlenecks to traffic passing through such sections. Therefore, priority will be given to studying improvements in their vertical and holizontal alignments, etc. in the current plan and the resolution of these traffic bottlenecks in the sections concerned will be considered basic policy.

(2) Weather conditions

The yearly variation in temperature is large, ranging from a minimum of 0 degrees Celsius to a maximum of about 45 degrees. The daily temperature difference is also large, being about 20 to 25 degrees. The average annual rainfall varies from around 150 mm to 350 mm. However, the rainfall pattern is not consistent through the year. From past records, only the period from September through October can be called the dry season and there is no rainy season during which rain falls continuously for long periods. Also, there are cases in which localized concentrated rainfall occurs irregularly. According to the records of recent years, there was 163 mm of precipitation in 24 hours

on July 20, 1995 and concentrated rainfall of 212 mm within 48 hours on the 20th and 21st (380-year probability rainfall). As a matter of policy, the work execution plan will be prepared by taking such weather conditions as irregular rainfall pattern, large temperature variations and the like into account.

Furthermore, while it is reported that the flooding caused by localized downpours have caused the destruction of existing structures in sections neighboring the sections in the current plan, floods in recent years in sections covered by the current plan have necessitated the rebuilding of four bridges out of a total of 419 existing drainage facilities. However, as the water flow areas of the minor rivers served by the other water drainage structural facilities are small, the floodwater level does not rise greatly even during increased rainfall.

Hence, it can be said that the risk of destruction of these facilities due to flooding is small and therefore the policy regarding improvement of such facilities will entail considering the improvement of embankments to prevent erosion, measures to facilitate the smooth flow of rainwater in the vicinity of the structural facilities, and so on.

2.2.1.3 Policy for Social Conditions

(1) Regional characteristics and public security issues

As it cannot be said that public security is generally stable in the state of Balochistan the following security measures will be necessary as a minimum:

- Securing of means of communication
  As it is difficult in this region to utilize even fixed telephones, it will be necessary to use satellite telephones as a means of communication.
- Maximum employment of local people
  The current plan involves a project offering one of the few opportunities for employment in the still developing state of Balochistan. It is therefore necessary to consider the promotion of maximum employment of local people.
- Adequate explanation of the project to local populace
  In order to implement the project smoothly, it will be necessary to fully explain the scopes and the effects of the project through NHA and so on to the local inhabitants concerned so as to obtain their understanding concerning the project, before commencing the project.

(2) Environmental considerations

Virtually all of the sections covered by the current plan pass through mountainous and hilly terrain. While there is some agricultural land in the flat section near Wadh for the cultivation of wheat and cotton, most of the land along the route consists of wasteland exposed to arid weather conditions. Hence there are no zones in the sections covered by the current plan which would have a large impact on the environment and neither are there any natural or cultural assets involved. Therefore the IEE (initial environmental survey) of the government's environmental ordinance will be carried out in connection with the improvement plan for the sections concerned.

The IEE environment assessment procedures concerning the sections under the current plan (Improvement plan for National Road 25: between Kararo and Wadh) have been completed without any problems.

2.2.1.4 Policy for Construction Conditions

(1) Labor situation

It will be possible to recruit most of the workers for the project from regions lying along the route but it will be necessary to recruit civil engineers, operators and other skilled personnel from Karachi and other large cities because of the shortage of such personnel. Furthermore, it will be necessary to consider the dispatch of skilled plant-related personnel and experts from Japan and other third countries for the operation and maintenance of construction equipment and facilities that are likely to be brought in from countries outside Pakistan.

Additionally, as most of the necessary construction materials must be procured from locations outside the state of Balochistan, such as Karachi city, personnel experienced in procurement management and familiar with the geography of the districts involved under the current plan, necessary documentary procedures, and so on, will be required. Concerning the engagement of local workers, there is the labor standards law, revised in 2002, which stipulates the working hours for each craft category, working conditions, surcharge conditions, and so on, but apart from minimum wages, there are no detailed pertinent regulations. Working hours, etc., are fixed independently based on the labor contract of the enterprise concerned.
As for working hours, "eight hours per day, 48 hours per week" is the general rule but six hours work per day is recognized for religious reasons during the Islamic fasting period (Ramadan: about 30 days). While the working week generally comprises six

days, i.e., Monday through Saturday, most private firms are switching over to a five-day working week.

(2) Procurement prospects concerning construction materials

With regard to construction materials, practically all materials such as aggregate for concrete, macadam for roads, bitumen material, cement, lumber, plywood, rectangular timber, and the like can be obtained locally. Other materials such as ancillary items for bridges, etc., will have to consist of imported goods. Most types of electrical tools and household electrical goods are available on the local market. Although such items as guardrails and delineators are being made locally, the market is being supplied by only a few manufacturers. Such precision items as testing and measuring equipment and chemical reagents will be imported.

It is considered that aggregate source material for paving purposes, which is an important material for the work, can be obtained in relatively large quantities at two locations along the route. It is also possible to obtain aggregate and good quality soil which satisfy the standards for the lower roadbed, backfilling and so on, along the entire route. Sand for preparing concrete can be gathered at Wadh village, near the route terminal.

(3) Procurement prospects concerning construction machinery

As there are no specialist firms engaged in the leasing of construction machinery, the borrowing of such machinery from local construction firms is basically being considered. Local construction firms have been purchasing second-hand construction machinery and equipment from Japan and other other countries since the latter half of the 1990s. While some quantity of new machinery and equipment had been imported prior to that, the import tax was relatively high compared to that for similar second-hand items and also the exchange rate of the local currency had plummeted. As the risk of plunging residual values became evident, virtually no new construction machinery or equipment is being imported at present. Furthermore, there are no existing asphalt plants, quarry plants or concrete batcher plants in areas along the route.

Consequently, the policy with regard to the procurement of construction machinery and equipment will be, broadly speaking, to conduct comparative studies of the economics of the following two methods: a) leasing of locally available construction machinery and equipment, b) procurement from neighboring countries.

2.2.1.5 Policy of Procurement of Local Contractor

A system is in effect whereby local civil engineering firms are registered with NHA. These firms are classified into six categories, with 12 firms being registered in the topmost class. On making enquiries at some of the latter firms, it has been found that each firm possesses numerous construction machinery and equipment and more than 90 percent of such equipment is currently in operation.
Hence these firms are actively engaged in their respective activities and their maximum possible utilization will be recommended to the Japanese contractors taking part in the current plan.

2.2.1.6 Policy of Management and Maintenence Capabilities of the Execution Agency

The supervisory government agency for the current plan is the Ministry of Communications, with the NHA being the execution organization. While the total number of NHA personnel at the time of its inception in 1991 was about 2,300, as a result of large-scale reductions, due to organizational restructuring, in lower ranking personnel other than those of technical executive class, there are now about 1,300 personnel. Of these, about 300 are engineering class personnel.

Further, organizational and functional reforms were carried out at NHA under the auspices of the World Bank, leading to the introduction of systems to control the overloading of vehicles, road toll collection systems, BOT road construction methods and the like. Thus NHA's organization has been put on a sound footing and it is considered that NHA has attained a level of competence whereby it is technically capable of independently carrying out the operation, maintenance and management of national roads. Therefore it is considered that NHA is adequately capable of executing the current program.

The section covered by the current plan is at present under the control of the Khuzdar maintenance control office. This office is responsible for the maintenance of the 451 km stretch of National Road 25 between Uthal and Kalat. The total maintenance management budget for fiscal year 2003/2004 was 342 million rupees, of which 45 percent, namely 153 million rupees, was allocated to the section covered by the current plan, indicating the degree of importance placed on its maintenance and management. It is thus considered that there are no large problems in NHA's technical approach to maintenance management or associated budgetary measures.

2.2.1.7 Policy for Scale of Facilities under the Project and Determining Their Content

(1) Road facilities plan

1) Design standards

The widths if the roads concerned will be studied with consideration to the Pakistani design standards, Asian Highway (AH) standards, international standards, standards of the roads adjacent to National Road 25 and so on.

2) Design speeds of the sections concerned

As the sections concerned run through a variety of terrain which include flat, hilly and mountainous country, facilities of the scale and type optimal to each terrain will be studied. The figures stipulated as the design speed for each type of terrain as set forth in PC-l of the Pakistani government, viz., flat terrain: 100 km/hr, hilly terrain: 80 km/hr, mountainous terrain: 60 km/hr, will be observed.

3) Policy concerning type and extent of improvements

3-1） Standard cross section

Concerning the width of the roadway, the Pakistani government standards and the other related sections of National Road 25 will be verified and studied with consideration to harmony over the total length of National Road 25 and construction cost. As regards the road standard cross section, the relation with the Pakistani government standards, the adjacent World Bank and Asian Development Bank sections, etc., will be considered. The roadway will be two-lane, with a width of 7.3 m. Regarding road shoulder width, while 2 to 3 meter standards do exist, road shoulder width will be 2 m (min. 1 m) with regard to hilly and mountainous terrain.

Furthermore, regarding the gradients of cutback and banking surfaces, slope gradients considered suitable for the cutback, banking, soft rock, hard rock concerned will be adopted based on the current geological conditions, state of the sloped surfaces, etc., as verified by the field survey.

3-2) Road alignment (Determination of centerline of road under the plan)

Although 24 out of 232 curves in the existing road have smaller radii than required for design speed, there are no sections with an extremely small radius such as a hairpin curve. Some curved sections have unnatural curvature, deviating from an alignment that would allow vehicles to drive easily. These are some of the safety issues. In the designing of road alignment in this plan, topographical conditions and conditions of the

existing facilities are examined together with the situation described above in order to maintain the construction cost at a reasonable level.

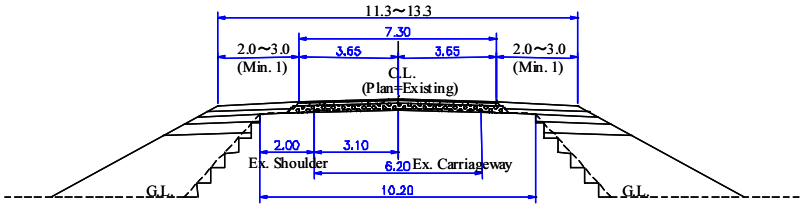
In the designing of the road alignment, the following options were examined and compared as shown in Table 2.1. Options 1 and 2 aim to utilize the existing road as much as possible and option 3 aims to secure detours during the construction of the road. These options were examined and compared from the viewpoints of utilization of the existing road and facilities, reduction of construction cost, securing detours, and minimizing the impact on the social environment. The cost was especially examined carefully because there are many existing structures at the 200 m interval and their improvement cost may significantly affect the total project cost.
As a result of the examination, the first option (Option 1) was found to be most advantageous as the geometric design and adopted as the design policy. The option aligns the planned centerline close to the centerline of the existing road

Table 2.1 Options for Geometric Structure of the Road

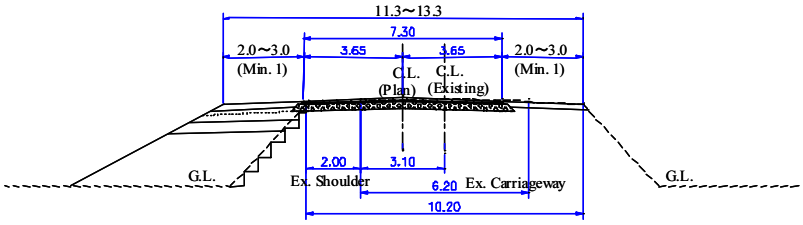
Option for plan	Utilization of existing road	Construction cost	Detour	Influence on social environment	Judgment
1.Existing centerline = New centerline	◎	◎	△	○	◎
2.Expansion of one Side of existing road	○	○	○	○	○
3.New construction beside the existing road	×	×	◎	×	×

Note) ◎: Excellent, ○: Good, △: Fair, ×: Poor

Option 1



Option 2



Option 3

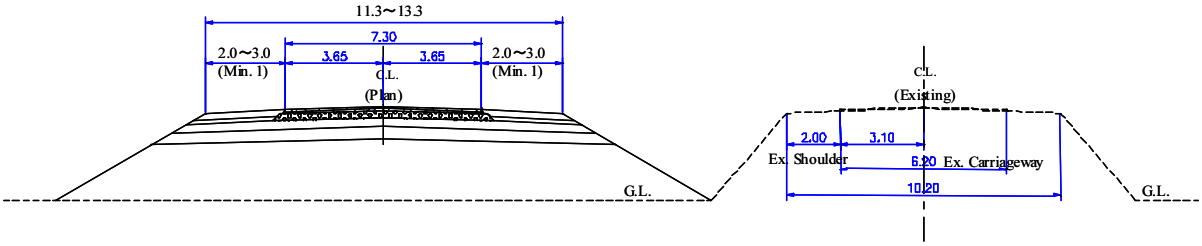


Figure 2.1 Standard Cross-section of Road Plan

3-3) Pavement

The pavement design policy is to maximize the use of the existing road while maintaining the functions required of National Highway 25. In order to realize this policy, the study team will propose an optimum pavement structure plan for the target section of the road, based on the examination of assumed soundness and bearing capacity of the existing road, the traffic survey results that will be conducted in this study. The options for the pavement structure as shown in Table 2.2 are proposed for comparison. As a result of examining and comparing the use of the existing road, reduction of construction cost, extent of maintaining flatness, and construction speed, "Option A" that employs AC surface course and aggregate base course was found to be the most advantageous and therefore adopted as the pavement structure plan.

Table 2.2 Options for Pavement Structure

Option for plan	Utilization of existing road	Construction cost	Flatness	Construction speed	Judgment
a. AC layer + aggregate roadbed	○	○	◎	○	◎
b. AC layer + ATB layer	○	×	◎	×	×
c. AC layer overlay	◎	○	×	○	○

Note) ◎: Excellent, ○: Good, ×: Poor

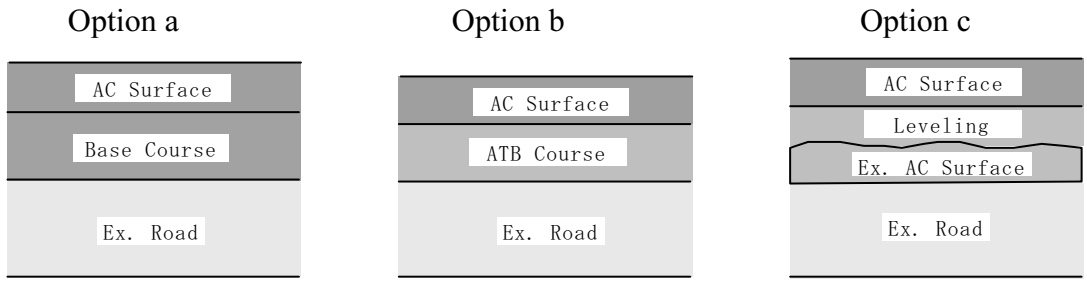


Figure 2.2 Standard Cross-section of Pavement Plan

3-4) Slope protection

Erosion scars are evident at some places in the road shoulders and slopes of the existing road. The erosion is significant in sections where sandy soil has been used for filling the road shoulder and where the slope of the road shoulder is not appropriate (tilting towards the road). Erosion is also significant in the road cut sections where there is no ditch for drainage. In addition, erosion marks can be seen in the road shoulders and slopes on both sides of some culverts and bridges located at the bottom of the vertical curve of the road. To cope with these problems, the use of drainage facilities at places where rainwater converges and the use of materials with higher erosion-resistance for the upper layer of pavement are examined.

3-5) Slope protection (Stone and mortar, gabion, stone pitching)

The existing slope protection is categorized into two groups in terms of their protection target: one for the road and one for drainage facilities. The former group is also divided into the ones constructed at the bottom of the slope of soil fill to minimize construction cost, and the ones installed at the bottom of cut slope to protect the road against falling rocks and soil debris. Most of them are constructed by piling stones or gabions. Other than these structures, there are some stone-pile walls designed to prevent the falling of vehicles.

Those installed for drainage facilities are mostly designed to protect the bridge base, the back of culverts, the slope extending from the culverts. There are also some protected slopes that are presumably designed to restrict stream flows. The structure of these protected slopes for flow restriction is commonly that with mortar lining over piled stone or gabion, especially at the intake and outlet of the bridges and culverts over which water directly flows.

In this plan, the necessity of these existing protection facilities is evaluated and the sites for new construction and expansion are determined followed by the examination of their dimensions and structures.

3-6) Traffic safety facilities

There are only a few facilities for traffic safety installed for some sections on the target section of road improvement: concrete edge markers, metal edge poles (painted red and while), and concrete walls designed to prevent falling. Insufficient protection facilities are installed at places where they are necessary; for instance, at sloping curved sections, on both ends of bridge culverts, and at sections with elevated soil filling. These are considered major traffic safety problems. In the planning of traffic safety facilities, basic improvements of the road such as the vertical and horizontal alignments are first examined. Then, the sites of installation are determined followed by the examination and comparison of structures for the facilities, considering the conditions of the sites and long-term viability of maintenance. The following measures are mainly considered for traffic safety and as auxiliary facilities.

- Signs (traffic signs, road marking)
- Facilities for fall prevention (guardrails, guard posts, edge markers)
- Marking centerline and sidelines
- Kilo marker posts

(2) Drainage facilities plan

The magnitude and details of drainage structures are determined based on the results of a soundness survey of the existing structures conducted in this study.

1) Soundness survey

The soundness survey is conducted by visual inspection of structures to evaluate their structural soundness. The structures were evaluated based on the items shown in “Table 2.3, Evaluation Standard for Bridge Damage” (Guidelines for bridge inspection by the Bureau of Construction, Tokyo) and “Table 2.4, Evaluation Standard for Bridge Load

Bearing Capacity" (Guidelines for bridge inspection by the Bureau of Construction, Tokyo). The culverts are evaluated based on the items shown in "Table 2.5 Evaluation Standard for Culvert Damage" and "Table 2.6, Evaluation Standard for Culvert Functionality".

Table 2.3 Evaluation Standard for Bridge Damage

Evaluation item	Sub-item	Weight (bi)	Evaluation rank (ai)				
			A	B	C	D	E
Superstructure	Main beam	30	1	2	3	4	5
	Cross beam	3	1	2	3	4	5
	Floor slab	10	1	2	3	4	5
Sub-structure	Pier	3	1	2	3	4	5
	Bridge base	3	1	2	3	4	5
	Abutment	5	1	2	3	4	5
Bridge surface	Bridge parapet	1	1	2	3	4	5
	Pavement	1	1	2	3	4	5
Others	Slope protection	2	1	2	3	4	5

Table 2.4 Evaluation Standard for Bridge Load Bearing Capacity

Evaluation item	Sub-item	Weight (bi)	Score
Active load	New	2	1
	New<~<= 40 years old		1.5
	40 years old <		1.6
Large vehicle traffic	4000 =>	1	1
	4000< ~ <= 8000		2
	8000 < ~ <= 12000		3
	12000 <		4
Service life	20 year =>	1	1
	20 year < ~ <= 40 year		2
	40 year < ~ <= 60 year		3
	60 year <		4

Table 2.5 Evaluation Standard for Culvert Damage

Evaluation item	Weight (bi)	Evaluation rank (ai)				
		A	B	C	D	E
Main structure	10	1	2	3	4	5
Intake	5	1	2	3	4	5
Outlet	5	1	2	3	4	5

Table 2.6 Evaluation Standard for Culvert Functionality

Evaluation item	Sub-item	Weight (bi)	Score
High water level	Clearance=> 0.5 m	10	1
	0.5 m <~<= 0 m		3
	0 <		5
Open area ratio	90% <=	3	1
	60% <= ~ < 90%		3
	60% > =		5
Discharge capacity	Sufficient	7	1
	Insufficient		5
Service life	20 year =>	2	1
	20 year < ~ <= 40 year		2
	40 year < ~ <= 60 year		3
	60 year <		4

The soundness of the main members of structures is visually evaluated on a scale of A to E. The evaluation result is combined with those of the bearing capacity inspection and load capacity inspection to give the overall soundness evaluation of the existing structures. The following are the evaluation criteria for each of the five ranks. The results of the evaluation are attached in the appendix 5.

A : Structurally sound without noticeable damage

B : With minor damage that is not structurally critical and can be maintained by regular repair work

C : With some damage that could develop into structurally critical ones depending on future conditions. Does not require urgent repair but normal regular repair work will be necessary.

D : With extensive damage that is structurally critical. Requires the earliest possible repair.

E : With extremely extensive and intensive damage that is structurally critical. Can collapse at any time and injure people. Requires urgent repair.

2) Basic strategy for structure rehabilitation

The rehabilitation concept will be determined for each rank of soundness survey results (A, B, C, D, E) of the structures in consideration of the effective width of the existing road. The following are descriptions of the rehabilitation concepts determined for the soundness survey results.

A : There is no noticeable damage and requires no rehabilitation or replacement. If expansion is necessary, however, the same structure should be added for expansion.

B : There is some damage but it is not structurally critical at present. In the case of serious damage in bridge rails, they should be repaired. If expansion is necessary, however, the same structure should be added for expansion.

C : There is a fair amount of damage but these are not structurally critical at present. The damage can develop into critical ones depending on the future condition of the road (e.g., increase in traffic). If the damage is extensive in some parts, the portions concerned should be repaired or replaced. If expansion is necessary, however, the same structure should be added for expansion.

D: There is extensive structurally critical damage. The earliest possible repair is required. Thus the item concerned is to be replaced in this plan.

E : There is extremely extensive and intensive damage that is structurally critical. It can cause collapse at any time and possibly injure people. Thus, the item concernedfss requires urgent replacement.

Figure 2.3 presents a flow chart on the basic concept of structure rehabilitation.

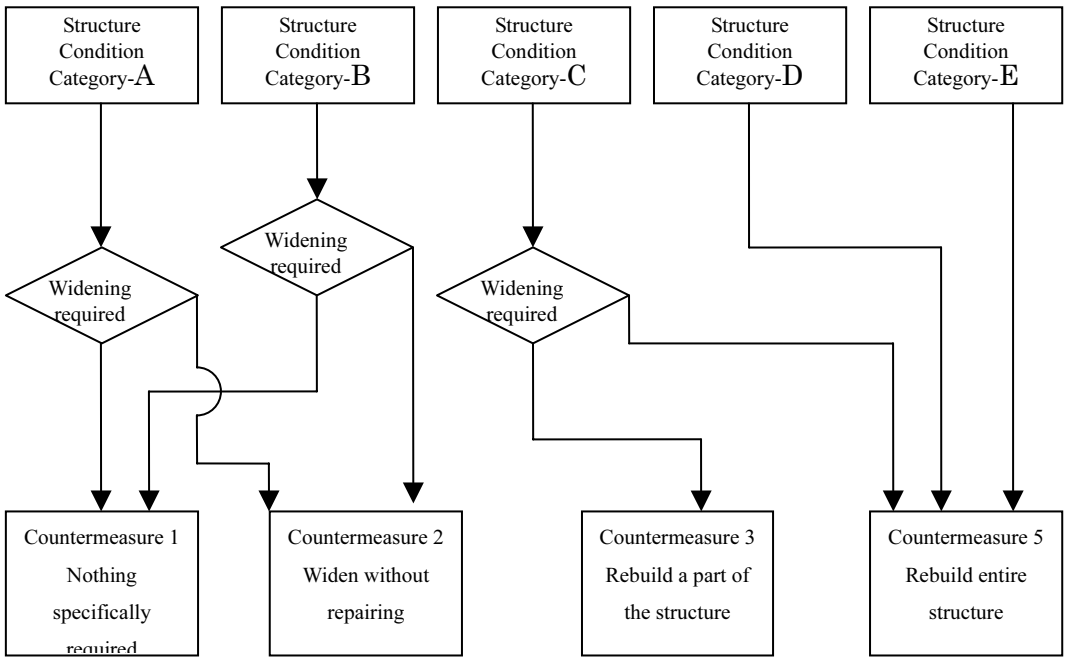


Figure 2.3 Flow chart of basic concept on building structure repair

2.2.1.8 Policy for Construction Methods and Periods

(1) Policy concerning construction period

The policy for determining the construction period takes into account the following points:

- The work shall be started as early as conveniently possible and the schedule will be

formulated on the basis of the nature of the project (road and structures) within the framework of the grant assistance system.

(2) Policy concerning construction methods

The policy for determining the construction methods takes into account the following points:

- In consideration of the fact that the section to be constructed under this plan is included in a trunk road, influence on the current traffic shall be minimized as much as possible. The site conditions require that the construction work be conducted along one side of the road and hence the methods shall be determined taking into account the safe thoroughfare of the current traffic.
- In determining the timing of construction of river crossing structures, particular attention shall be paid to the fact that rapid flooding of rivers may occur because of the characteristics of rainfalls in the area.

2.2.2 Basic Plan

2.2.2.1 Selection of Scope of Basic Design Study under Japanese Grant Aid

(1) Outline

In the 5 years medium term plan for investment by NHA, the improvement plan of Kararo~Wadh (96km) section on National Route 25 has been formulated as a one of the group of project of improvement for existing roads. PC-I has not been originally prepared under the conception of the Japanese Grant Aid, but also for the procurement of local contractors.

As a result of basic design study, the estimated cost of PC-I can not cover the full scale improvement for 96km including the structure rehabilitation.

Therefore, the discussion between the Study Team and NHA was take place and the two parties agreed that the scopes of the project under Japanese Grant Aid will be identified on the basis of determination of Pakistan portion which can be improved by themselves.

(2) Conditions to be considered for the selection of scope

The conditions to be considered for the selection of the project scope are described as follows:

1） Main points to be considered

Main points to be considered for the selection of scope are shown as follow.

Table 2.7 Summary of Elements to be considered

Expected Effect		Current condition of project road	Elements to be considered
1	Decrease of traffic accident	Frequent traffic accident	Improvement of dangerous curve and steep slope
2	Enhance the function as trunk road & international road	Demand of smooth transportation to domestic and international	Widening of road width to 7.3m for international road standard
3	Benefits to the habitant along the road	Difficulty to access the basic social services (e.g. education)	Improvement of road condition

2） Dividing of the road section to be selected

The project road has been divided for the selection of target section in accordance with the topographic features and other considerable condition of road (refer to Fig. 2.4).

(3) Evaluation of alternatives for the selection

Table2.8 shows the result of the evaluation of alternatives for the selection.

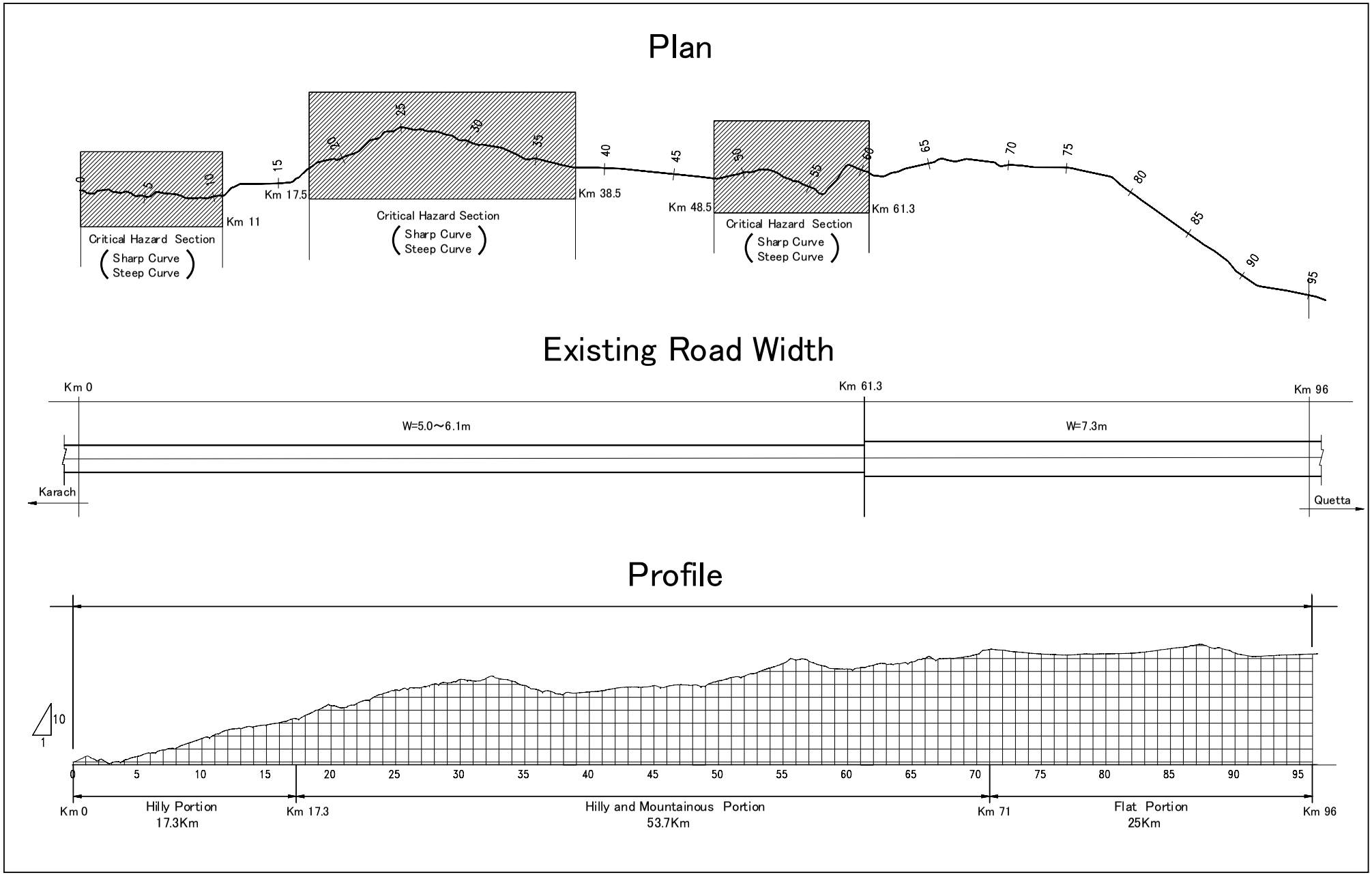


Figure 2.4 Existing Condition and Feature of the Project Road

Table 2.8 Evaluation of alternatives for the selection

Length of selected section		Mile stone	Reason of selection	Design concept	Content of improvement				App. cost (billion PR)
					Road	Drainage structure	Bridge	Ancillary	
1	96km	0km ～ 96km	Original section as same as original PC-I	---------- Full spec. ---------- 1)Pavement width ; 7.3m 2)shoulder ; 3m (min. 1m) 3Min.Radius ; as per design speed 4)Max.gradient ; 7% 5)Structure: Referring to the result of condition survey	Carriageway -Ac surface : 12cm -Base course : 20cm -Subbase course : 27cm Shoulder -Surface : DBST -Base course : 20cm	-Replace of RC pipe (34) -Widening of RC pipe (8) -Replace Box Culvert (251) -Widening of Box Culvert (25) - Widening of Slab C (69) Total:387 Culverts	-Reconstruction to PC garter (5) -Reconstruction to RC garter (6) -Widening of RC garter (2) -Widening of slab bridge (8) Total: 21 Bridges	-Side drain -Retaining wall -Traffic sign -Guard rail -Center line marking -Km post	6.25
2	53.7km	17.3km ～ 71km	Exclusion of flat terrain section, because of on –going improvement. In the rest of section 71km, 17.3km from the start point is excluded at the point of view of topographic condition, difficulty of the works and cost effectiveness	---------- Full spec. ---------- 1)Pavement width ; 7.3m 2)shoulder ; 3m (min. 1m) 3Min. Radius ; as per design speed 4)Max.gradient ; 7% 5)Structure: Referring to the result of condition survey	Carriageway -Ac surface : 12cm -Base course : 20cm -Subbase course : 27cm Shoulder -Surface : DBST -Base course : 20cm	-Replace of RC pipe (16) -Widening of RC pipe (6) -Replace Box Culvert (135) -Widening of Box Culvert (20) - Widening of Slab C (43) Total:220 Culverts	-Reconstruction to PC garter (3) -Reconstruction to RC garter (3) -Widening of RC garter (2) -Widening of slab bridge (5) Total: 13 Bridges	-Side drain -Retaining wall -Traffic sign -Guard rail -Center line marking -Km post	3.5
3	53.7km	17.3km ～ 71km	Same as the above. But, rehabilitation of structures are limited to which are affected by realignment of roads.	----------Limited Spec. ---------- 1)Pavement width ; 7.3m 2)shoulder ; 3m (min. 1m) 3Min. Radius ; as per design speed 4)Max.gradient ; 7% 5) Rehabilitation of structures limited to which are affected by realignment of roads.	Carriageway -Ac surface : 12cm -Base course : 20cm -Subbas course : 27cm Shoulder -Surface : DBST -Subbase course : 20cm	-Replace of RC pipe (1) -Widening of RC pipe (2) -Replace Box Culvert (26) - Widening of Slab C (8) Total:37 Culverts	-Reconstruction to RC garter (1)	-Side drain -Retaining wall -Traffic sign -Guard rail -Center line marking -Km post	2.25
4	96km	0km ～ 96km	Exclusion from road improvement where the pavement width is assured to7.3m. Moreover, exclusion where the Pakistan side can improve the portion expecting the works can be executed related to physical condition. The structures evaluated as D are rehabilitated.	---------- Limited Spec.---------- To 44.8km Section, 0～11km(11km)、 17.5 ～38.5km(21km), 48.5～61.3km(12.8km) 1)Pavement width ; 7.3m 2)shoulder ; 2m (min. 1m) 3Min. Radius ; as per design speed 4)Max.gradient ; 7% 5) Rehabilitation of structures limited to which are affected by realignment of roads and D evaluated structure	To 44.8km Section Carriageway -Ac surface : 12cm -Base course : 20cm -Subbase course : 27cm Shoulder -Surface : DBST -Subbase course : 20cm To 51.2km Section -Shoulder grading -Centerline marking	-Replace of RC pipe (16) -Widening of RC pipe (1) -Replace Box Culvert (97) -Widening of Box Culvert (2) - Widening of Slab C (9) Total:125 Culverts	None	-Side drain -Retaining wall -Traffic sign -Guard rail -Center line marking -Km post	2.0

(4) Determination of selected project scope

According to the evaluation of alternatives, alternative-4 is only feasible for the project. The outline of selected project scope of alternative-4 is shown as follow (refer to Fig.2.5) and the improvement items are summarized in the following table 2.9.

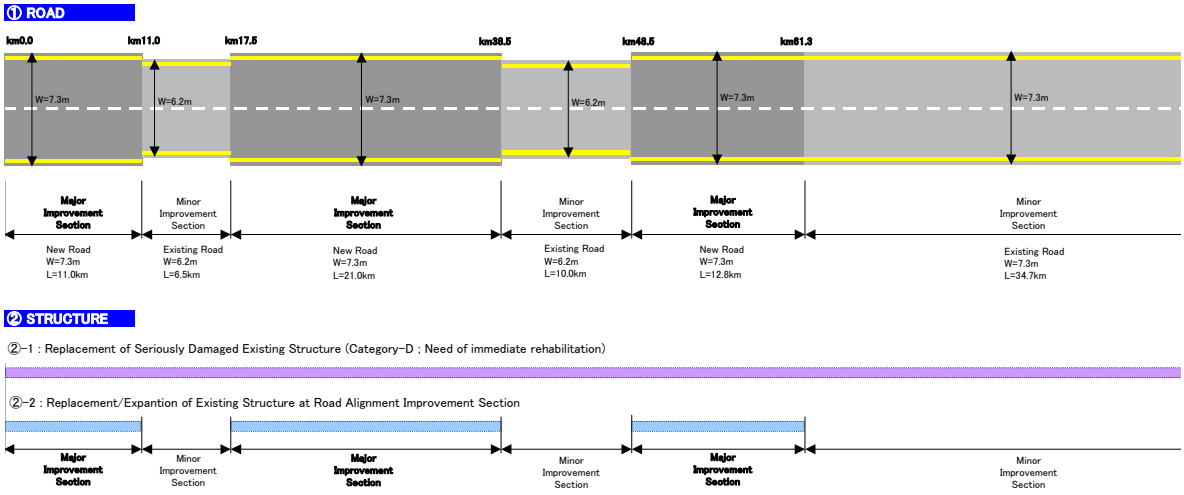


Figure 2.5 Outline of selected project scope

Table 2.9 Items to be rehabilitated in the project

Item	Component	Remarks
Requested section	96km	0km~96km
Project objective section	96km	0km~96km
1.Road		
1) Major improvement section	* Road Length : 44.8km * Carriageway - Width : 7.3m (3.65m x 2 lanes) - Pavement : Surface As Concrete 12cm Base Course 20cm Sub-Base Course 27cm * Shoulder - Width : 2.0m each side (min. 1m) - Pavement : DBST Sub-Base Course :20cm	0km~11km (11km), 17.5m~38.5km (21km), 48.5km~61.3km (12.8km)

2) Minor improvement section	* Road Length : 51.2km * Shoulder grading * Center line marking	11km~17.5km (6.5km), 38.5km~48.5km (10km) 61.3km~96km (34..7km)
2. Drainage structure		
1) Cross drain	(In objective section:0km～96km) * Reconstruction : 113 culverts * Extension of width : 12 culverts	 *D categorized culverts: 88 *C categorized culverts: 25 *A categorized culverts: 6 *B: categorized culverts: 6
2) Longitudinal drain	* Earth ditch : 41,970 m * Masonry ditch : 5,080 m * Concrete ditch : 906m	
3. Bridge		
	* Reconstruction : No bridges to be reconstructed * Extension of width :No bridges to be extended	
4. Ancillary		
	Drainage : Catch basin、Inlet pipe Retaining Wall : Stone Masonary, Gabion etc. Traffic sign : 103 Nos. Guard rail : 5,500m Center line marking : 0-96km Kmpost : 97 Nos.	

Note : Category of actual culvert condition:

A: Good condition

B: No need of rehabilitation

C: Need of rehabilitation in future

D: Need of immediate rehabilitation

In concluding the above, the basic concept for the rehabilitation of structures (especially evaluated as category C) is given as follow.

The structures evaluated as category C have some damage, but not in the critical condition for road user in present. Therefore, these category C structures are excluded from the project at the point of view of emergency degree except the structures affected by road realignment section by the project. They should be maintained in manner by the Pakistan Government with the consideration of traffic increment in future.

Rearding to handling of building structures of soundness evaluation C, the basic philosophy of the survey team in arriving at the foregoing conclusions is as follows:

The structures along the sections whose soundness evaluation value is equal or inferior to D and the sections whose alignment after the completion of the plan does not trace

existing roads are to be repaired under this plan. Structures of soundness evaluation C that are not in urgent need of repair despite some degree of damage will not be repaired. However, in consideration of the possibility of becoming dangerous due to future changes in conditions (increase in amount of traffic, etc.), maintenance (repair, etc.) by the government of Pakistan to prevent actual damage from getting worse is required.

2.2.2.2 Facility Plan for Sections Concerned

(1) Alignment improvement plan

1) Design of sections and design conditions

1-1) Design of sections

Regarding the section of 96km concerned, the sections are designated as "road amelioration" sections and "road improvement" sections, and their repair work has been studied, taking into account the analysis of geographic features and conditions of the existing roads as well as the total construction cost, as follows:

Table 2.10 Improvement work of each design section

Section	Length	Current width	Application	Work
km 0.0 - 11.0	11.0km	5.0 - 6.2m	Major improvement	All major work concerning road improvement
km 11.0 - 17.5	6.5km	6.2m	Minor improvement	Forming of road shoulders, dividing line on road surface, rehabilitation of D class structures, etc.
km 17.5 - 38.5	21.0km	6.2m	Major improvement	All major work concerning road improvement
km 38.5 - 48.5	10.0km	6.2m	Minor improvement	Forming of road shoulder, dividing line on road surface, rehabilitation of D class structures, etc.
km 48.5 - 61.3	12.8km	6.2m	Major improvement	All major work concerning road improvement
km 61.3 - 96.0	34.7km	7.3m	Minor improvement	Forming of road shoulders, dividing line on road surface, rehabilitation of D class structures, etc.

Remarks: Total length of major improvement sections = 44.8km. Total length of minor improvement sections = 51.2km.

1-2) Design conditions

The study was conducted based on the design speeds of 100km/h for flat portions, 80km/h for the hilly portions and 60km/h for mountainous areas, in consideration of the AASHTO values determined by PC-I subject to the standards of Pakistan according to various geographic features of the sections covered by the current plan. After determination of the design sections indicated in the above table, the design speed for the road amelioration sections was fixed at 60km/h, because such sections are mostly located in mountainous areas

The design speed for the road improvement sections were studied by taking km 0 – 71.0 as that for hilly areas and km 71.0-96.0 as that for mountainous areas.

Design standards

Standards of Pakistan and the U.S. (AASHTO) were adopted as design standards. Japanese road standards (Road Construction Ordinance) were also referred to.

Design speeds

Design speeds were fixed respectively for the sections indicated in the table below. For the junctions of sections having different design speeds, attention was paid in order to avoid rapid change of alignment.

Table 2.11 Design speed for each design section

Section	Design speed	Remarks
km 0.0 - 11.0, 17.5 - 38.5, 48.5 - 61.3, 61.3 - 71.0	60km/h	Mountainous and hilly area
km 11.0 - 17.5, 38.5 - 48.5	80km/h	slight hilly area
km 71.0 - 96.0	100km/h	flat area

Horizontal alignment and longitudinal profile

The sections of design speed of 60km under the current plan actually have many curves whose radius does not satisfy the minimum radius. Curves in some sections meet the requirements of minimum radius, but they are often not in harmony with the plan, because, for example, two or more curvatures are hypothesized for a single curve. In this plan, these conditions were taken into account and studied.

Concerning the longitudinal alignment, there are many sections with a design speed of 60km/h that have slopes with inclines exceeding the maximum incline. Such sections are

mostly located in mountainous areas or in sections before and after some structures. In this plan, these sections were taken into account and studied, in consideration of the geographical features of each section, in order to avoid having any slopes with inclines exceeding the maximum incline mentioned below.
The minimum radius and the maximum incline for each design speed are as follows:

Table 2.12 Minimum radius and maximum incline for each design speed

Section	Design speed	minimum radius	maximum incline
km 0.0 - 11.0, 17.5 - 38.5, 48.5 - 61.3, 61.3 - 71.0	60km/h	135m	7%
km 11.0 - 17.5, 38.5 - 48.5	80km/h	250m	6%
km 71.0 - 96.0	100km/h	435m	5%

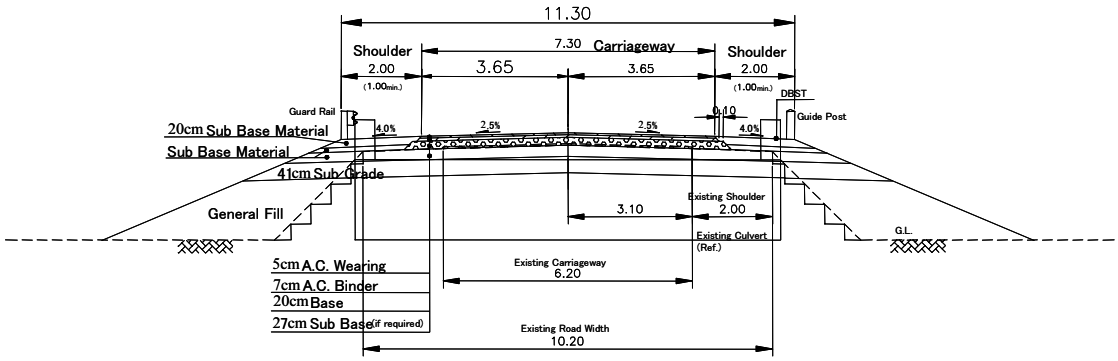
Superelevation

The maximum superelevation value is to be 6% with consideration to the safety of large cars passing through curves. Curves whose radius exceeds R3000 shall not be superelevated.

Width of roads

For the road amelioration sections, the number of lanes shall be two and the roadway width shall be 7.3m, in consideration of the design standards, the results of traffic analysis, the width of adjacent sections, etc.
The width of road shoulders shall be basically 2m, because the road amelioration sections are mostly located in hilly or mountainous areas. However, in some areas such as hard rock excavation areas where it is difficult to ensure a 2m width, a width of 1m shall be ensured at the least. For the road improvement areas, the width of road shoulders shall be kept as it is and only the road shoulders that need to be repaired, such as those from which waste water flows onto roadways, shall be reformed by grader.

Typical Cross Section（Fill Section



Typical Cross Section（Cut Section）

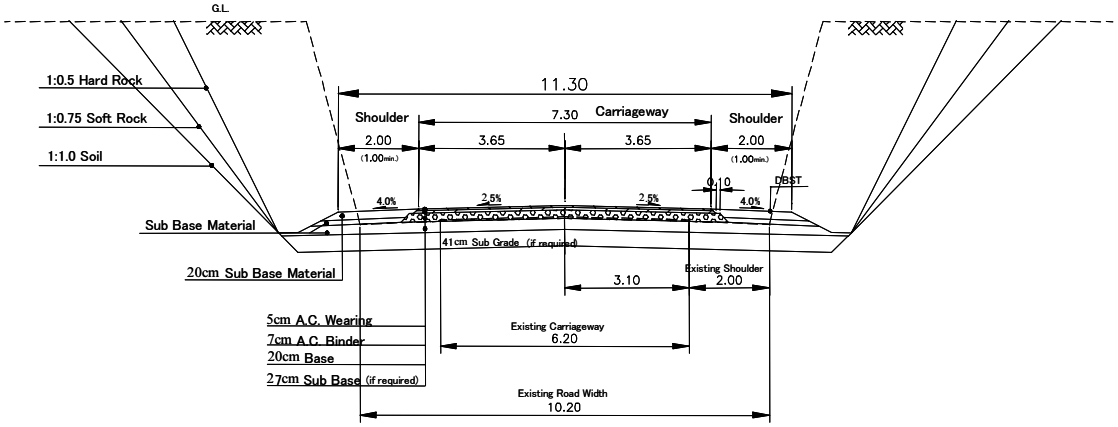


Figure 2.6　Basic sectional view of road

Slope protection method

In consideration of the soil conditions at the site, the incline of embankment slope made of soil with pebbles shall be 1:0.5, and that of embankment slope made of other soils shall be 1:2. The incline of excavation slope made of hard rock shall be 1:0.5, that of excavation slope made of soft rock shall be 1:0.75 and that of excavation slope made of normal rock shall be 1:1. As countermeasures against the erosion of embankments by rainwater, surface soil containing seeds and leaf mold stripped at the time of clearing and eradicating work shall be put back on the surface of the embankment slope and concrete steps shall be prepared around sagging parts where rainwater tends to converge. As foot protection of steep embankment slopes and as a countermeasure against falling stone from the excavation slopes, retaining walls are to be installed.

Outline of Design Conditions

The study team and the counterpart personnel of NHA discussed the design conditions, after the joint field survey by the study team and the counterpart engineers, during the study in Pakistan in January and February 2005. The study team analyzed and examined the results and the design details proposed by PC-I, and finalized the design conditions of the road rehabilitation plan for the target section as presented in the following table. The following shows the outline of section-wise design conditions that include design speed, road width, shoulder width, and slope dimensions.

Table 2.13 Outline of Design Condition

Description		Units	Terrain Condition		
			Flat	Rolling	Mountainous /Hilly
Design Speed		Km/hr	100	80	60
No. of Lanes		No.	2	2	2
Roadway Width		m	13.3	11.3	9.3
Carriageway Width		m	7.3	7.3	7.3
Shoulder Width		m	3	2	1 Min
Cross Fall on Carriageway		%	2	2	2
Cross Fall on Shoulder		%	4	4	4
Minimum Radius of Horizontal Curve		m	435	250	135
Maximum Gradient		%	5	6	7
Maximum Superelevation		%	6	6	6
Minimum Sight Distance		m	160	110	75
Fill Slope	Granular soil	Angle	1:1.5	1:1.5	1:1.5
	Other soil	Angle	1:2	1:2	1:2
Cut Slope	Hard Rock	Angle	1:0.5	1:0.5	1:0.5
	Decomposed Rock	Angle	1:0.75	1:0.75	1:0.75
	Other than Rock	Angle	1:1	1:1	1:1

2) Land for road construction

The study team confirmed, in the discussion with NHA in January 2005, that 30 m-wide strip of land on both sides of the centerline of the existing road had been secured for this rehabilitation project.

3) Section-wise traffic and standard axle load by vehicle type

The traffic survey conducted at the end of January 2005 revealed that the annual average daily traffic (AADT) is 4313 vehicles. The figure is composed of the following: small vehicle: 38.4%, bus: 8.0%, large vehicle including tractors: 31.4%. This figure is also close to 4428 confirmed by the PC-I survey conducted in August 2003. For axle load for each vehicle type, typical values (converted to 8.2 ton axle load, ESA) for the vehicle types were adopted based on the figures in the PC-I and also on the results of some surveys conducted in Pakistan in the past. The following is the traffic and standard axle load per vehicle type.

Table 2.14 Section-wise traffic and standard axle load per vehicle type

Vehicle Type		Traffic		Axle load
		Number	Ratio	(ESA/Vehicle)
1	Motorcycle	954	22.1%	-
2	Passenger car, Taxi	903	20.9%	-
3	Wagon, Pickup truck	754	17.5%	-
4	Bus	346	8.0%	0.504
5	Tractor	74	1.7%	5.680
6	Truck (2 axle)	567	13.1%	4.670
7	Truck (3 axle)	413	9.6%	8.840
8	Trailer (4 axle)	195	4.5%	10.350
9	Trailer (5 axle)	96	2.2%	10.840
10	Trailer (6 axle)	11	0.3%	10.840
11	Other vehicles	0	0.0%	-
Total		4313	100%	

4) Material and bearing strength of the existing road

CBR tests on the existing road were conducted to grasp the present conditions of pavement and roadbed and in order to optimize its use. The tests revealed that all the samples yielded values over CBR 30 required for typical lower roadbed materials and they were found to be good at least for the lower roadbed. The following is the result of the tests.

Table 2.15 Test Result on Material and bearing strength of the existing road

Item	Pavement					Sub grade
	Surface (cm)	Base course (cm)	Sub base course (cm)	Total (cm)	Asphalt content (%)	Bearing strength (CBR)
Average	4.72	15.57	18.35	38.65	3.90	43.46
Standard deviation	1.04	4.26	5.39	-	0.20	6.86
Max.	6.60	24.00	30.00	60.60	4.25	61.70
Min.	2.90	9.00	8.00	19.90	3.38	35.90

(2) Pavement plan

1) Design method

The existing road is paved with either asphalt (DBST) or low-cost asphalt (Bitmac). At the time of the field survey, one section of the road (km 65 - 93) was being converted from DBST to Bitmac. In this plan, the pavement structure and thickness were determined considering the existing conditions, current situation, bearing capacity, traffic, and axle loads, in order to maximize the use of the existing road. The design is also in line with AASHTO guidelines and the service life of the pavement was set at 10 years. The following are the design conditions and pavement specifications.

2) Design conditions

Design pavement service life : 10 years
Design traffic : 4313 vehicles/day/direction
Design axle load : 29.4 million, cumulative standard axle load (ESAL)
Roadbed bearing capacity : 30 or over for existing road, 10 or over for extension

3) Pavement structure and specifications for roadway

Surface course : 12 cm asphalt concrete (5 cm surface + 7 cm base layer)
Base course : 20 cm, size-adjusted crushed aggregate
Sub base course : 27 cm granular material, (procured at site)

4) Specifications of road shoulders

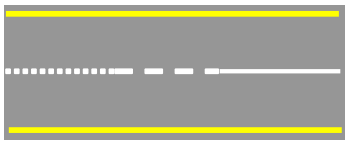
Surface layer : double bituminous surface treatment (DBST)
Roadbed material : 59 cm, granular material (procured at site)

(3) Traffic safety facilities plan

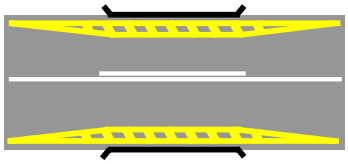
1) Pavement marking

The centerline and sideline designs are prepared for the entire section of the target road. In addition, 20 zebra zones for schools and villages on the road and 40 warning zones for existing bridges were also planned. The following shows designs of the typical road markings.

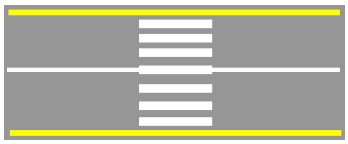
General



Bridge Area



Pedestrian Crossing



2) Traffic signs

Traffic signs are planned for the following locations that require such signs.

Table 2.16 Traffic Sign Design Plan

Item	Quantity	Remarks
Speed limit	15Nos.	In vicinity of public facilities, at tight corners
Curve	22Nos.	At curves with small radius
Slope	31Nos.	At road sections with high longitudinal slope
Stop	11Nos.	Intersection with minor roads in villages, at the entrance
Intersection	11Nos.	Intersection with minor roads in villages, at the entrance
Pedestrian crossing	13Nos.	At schools, villages
Total	103Nos.	

3) Safety barriers

The following facilities are planned to ensure safety of traffic at places where they are required.

Guardrails : For road sections with bridges and both ends of the bridges, for road sections where over 5m of earth filling is expected, problematic sections in road alignment (tight corners)

Guard post : At both ends of guardrails

Edge marker : At both ends of Guard post, at other necessary places

(4) Drainage facilities plan

1) Transversal drainage facilities

1-1) Design conditions of drainage facilities

The design conditions follow both "Standardization of bridge superstructures" of Pakistan (Jan. 2005) that is based on AASHTO and the "specifications for highway bridge designing (I, II, III, IV, V) of Japan Road Association. The adopted figures are listed in table 2.17.

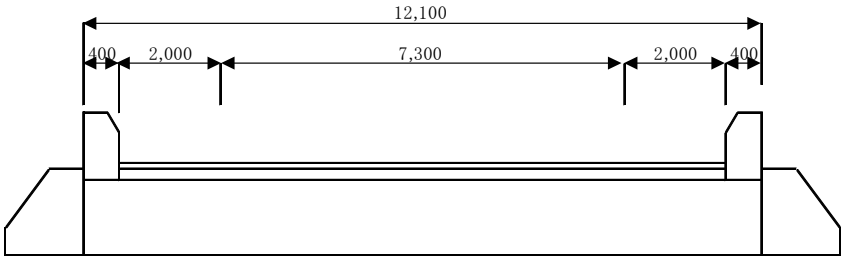
Table 2.17 Design Standard for Transversal Drainage Facilities

Item		Design Standard	Remarks (design basis)
Design load	Active load	Pakistani Standard Class-A	Bridge design Standard
	Temperature load	±25°C	Bridge design Standard
	Centrifugal load	None	Close to line on plan
	Seismic load	k=0.1g	After Seismic Zones of Pakistan
	Dead load	Steal : 77kN/m^3 (7,850kg/m^3) Reinforced concrete : 24.5 kN/m^3 (2,500kg/m^3) Concrete : 23.5 kN/m^3 (2,400kg/m^3) Asphalt concrete : 23.5 kN/m^3 (2,400kg/m^3)	Bridge design Standard for concrete and asphalt concrete
	Asphalt pavement	50mm	Bridge design Standard
Design strength of concrete		Culvert : 25N/mm² Bridge superstructure : 25N/mm² Bridge substructure : 21N/mm²	
Additional facilities		None	

Note) Design strength of concrete : 28th day strength

1-2) Road width plan

The detailed widths of culverts are taken to be the same as those of the road. The roadway width is 7.3 m and the shoulder width is 2.0 m (12.1m for two lanes) based on the standard of Pakistan as shown in the following figure.



1-3) Outline of rehabilitation

The rehabilitation work for drainage facilities (culverts) in this plan is divided into the following two modes in terms of the extent of rehabilitation: A) replacement, B) expansion. The replacement work includes intake and outlet facilities construction and expansion work includes construction of intake and outlet facilities designed in accordance with the road alignment.

The culvert structures to be rehabilitated for the target road section in this plan are those judged D for their structural soundness and those require reconstruction to fit the improved road alignment. The rehabilitation methods for those structures are listed in Table 2.18.

Table 2.18 Mode of Rehabilitation for Target Culverts

Basis for rehabilitation	Judged Soundness	Rehabilitation detail	Number of target
Structures to be reconstructed due to road re-alignment	A	Use of existing facilities	6
	B	Ditto	6
	C	Remove the existing, new construction	22
Structures requiring urgent rehabilitation	D	Ditto	91

1-4) Rehabilitation of culvert by replacement

- Examination of internal width and height

The culverts to be replaced all have sufficient drainage capacity according to the interview survey at site (no record of overflowing). Thus, the designing maintains the existing internal width and height. The mode and magnitude of replacement for the target culverts are listed in Table 2.19.

Table 2.19 Mode and magnitude of replacement for the target culverts

No.	Sta.No.	Existing Culvert					Damaged Level	Mode and magnitude of rehabilitation						
		No. of Cell	Total Length l(m)	Heigth (m)	Culvert Width (m)	Skew		Type	n @ B x H					
									Span		Width		Heigth	
1	00+690	2	1.5	0.75	8.9	90	D	Pipe	2	@	0.75	x		
2	00+995	1	3.8	2.8	10.1	90	C	Box	1	@	4.00	x	3.00	
3	02+466	1	1.8	0.9	11.4	90	C	Pipe	2	@	1.52	x		
4	07+558	2	10.4	2.2	11.4	85	D	Box	2	@	5.50	x	2.50	
5	08+732	1	3	4	13.5	70	D	Box	1	@	3.00	x	4.00	
6	10+000	1	2.75	3.6	13.2	70	D	Box	1	@	3.00	x	4.00	
7	12+200	1	2	1.65	8.45	90	D	Box	1	@	2.00	x	2.00	
8	12+415	1	6.15	4.63	11.5	90	D	Box	1	@	6.50	x	5.00	
9	12+608	2	10.9	4.1	9.6	45	D	Box	2	@	5.50	x	4.50	
10	13+284	1	1.5	2.3	12.3	90	D	Pipe	2	@	1.52	x		
11	14+280	1	1.8	1.1	10.6	80	D	Box	1	@	2.00	x	1.50	
12	18+114	1	2.52	2.75	8.8	45	D	Box	1	@	3.00	x	3.00	
13	18+211	1	3	3.4	8.25	90	C	Box	1	@	3.00	x	3.50	
14	18+780	1	1.78	2.5	12.7	90	D	Box	1	@	2.00	x	2.50	
15	18+955	1	3.3	2.4	13.74	60	D	Box	1	@	3.50	x	2.50	
16	19+797	1	2.43	3.6	8.8	80	D	Box	1	@	2.50	x	4.00	
17	19+997	1	2.65	2.1	10.03	90	D	Box	1	@	3.00	x	2.50	
18	20+362	1	1.87	2.4	8.8	90	D	Box	1	@	2.00	x	2.50	
19	27+477	1	8	5.3	10	62	C	Box	1	@	8.00	x	5.50	
20	27+598	1	2.7	3	9.12	70	C	Box	1	@	3.00	x	3.00	
21	29+495	1	6.9	7	7.65	70	C	Box	1	@	7.00	x	7.00	
22	30+404	1	7.3	5.2	10.2		C	Box	1	@	8.00	x	5.50	
23	31+412	1	4.55	4.6	9.9	90	C	Box	1	@	5.00	x	5.00	
24	31+700	1	3	2.3	19.6	70	C	Box	1	@	3.00	x	2.50	
25	32+690	1	1.26	2.8	11.85	80	D	Pipe	2	@	1.52	x		
26	32+740	2	2x1.0	1	9	90	C	Box	2	@	2.00	x	2.00	
27	32+825	1	3.1	2	9	60	D	Box	1	@	3.50	x	2.00	
28	32+900	1	3.1	3	13.1	60	D	Box	1	@	3.50	x	3.00	
29	37+437	1	4.5	2.5	12	90	D	Box	1	@	4.50	x	2.50	
30	38+032	1	2.4	2.1	14.9	90	C	Box	1	@	2.50	x	2.50	
31	44+832	2	2x0.9	0.9	10	60	D	Pipe	2	@	1.22	x		
32	45+810	1	4.5	3.5	10.9	80	D	Box	1	@	4.50	x	3.50	
33	50+690	1	2.5	1.65	10.65	80	C	Box	1	@	2.50	x	2.00	
34	52+780	5	24.8	2.8	11.85	50	D	Box	5	@	5.00	x	3.00	
35	52+995	1	8	2.0	11.6	37	D	Box	1	@	8.00	x	2.50	
36	54+135	1	2.3	1.5	14.2	80	C	Pipe	2	@	1.52	x		
37	54+665	1	3.1	1.9	13.5	90	D	Box	1	@	3.50	x	2.00	
38	54+931	1	1.9	0.8	12.2	85	D	Box	1	@	2.00	x	1.00	
40	55+710	1	3.67	2.4	12.7	65	C	Box	1	@	4.00	x	2.50	
41	55+845	1	3.2	2	12.5	65	C	Box	1	@	3.50	x	2.00	
42	55+900	1	3.1	1.9	10.9	70	C	Box	1	@	3.50	x	2.00	
42	56+089	1	3.45	2	9.9	65	C	Box	1	@	3.50	x	2.00	
43	56+341	1	3.1	2.45	13.4	65	C	Box	1	@	3.50	x	2.50	
44	56+850	1	3.7	1.4	13.5	80	D	Box	1	@	4.00	x	1.50	
45	57+875	1	2.4	2	11.5	70	D	Box	1	@	2.50	x	2.00	
46	58+835	1	1.9	1.3	9.6	75	D	Pipe	2	@	1.52	x		
47	58+945	1	1.25	1.2	12	80	C	Pipe	2	@	1.22	x		
48	59+246	1	1.8	1	12.4	90	D	Box	1	@	2.00	x	1.00	
49	59+630	1	1.7	1	11.5	70	D	Box	1	@	2.00	x	1.00	
50	61+170	1	5.6	3.6	9.7	55	C	Box	1	@	6.00	x	4.00	
51	61+227	1	3.3	3.1	10	85	C	Box	1	@	3.50	x	3.50	

No.	Sta.No.	Existing Culvert					Damaged Level	Mode and magnitude of rehabilitation						
		No. of Cell	Total Length l(m)	Heigth (m)	Culvert Width (m)	Skew		Type	n @ B x H					
									Span		Width		Heigth	
52	62+095	1	2	1.5	12.8	90	D	Pipe	2	@	1.52	x		
53	64+720	1	3.7	1.45	10.5	45	D	Box	1	@	4.00	x	1.50	
54	65+625	1	2.3	2.3	11.8	80	D	Box	1	@	2.50	x	2.50	
55	70+665	1	1.4	0.5	10	80	D	Box	1	@	1.50	x	0.50	
56	71+186	1	1.8	1.1	11	60	D	Box	1	@	2.00	x	1.50	
57	72+545	1	3.4	1	9.8	75	D	Box	1	@	3.50	x	1.00	
58	72+605	1	0.75	0.75	9.7	90	D	Pipe	2	@	0.76	x		
59	72+815	1	1.3	1	9.2	90	D	Pipe	2	@	1.52	x		
60	73+237	1	4	1.1	12.6	85	D	Box	1	@	4.00	x	1.50	
61	73+748	1	1.1	1.1	9.7	90	D	Box	1	@	1.50	x	1.50	
62	73+825	1	1.1	1.1	9.7	90	D	Box	1	@	1.50	x	1.50	
63	74+290	1	1.5	1.1	9.7	90	D	Box	1	@	1.50	x	1.50	
64	76+915	1	1.8	0.8	10.1	90	D	Box	1	@	2.00	x	1.00	
65	76+955	1	1.8	0.8	11.8	90	D	Box	1	@	2.00	x	1.00	
66	77+025	1	1.7	0.7	10	90	D	Box	1	@	2.00	x	1.00	
67	77+130	1	1.2	0.4	9.3	90	D	Box	1	@	1.50	x	0.50	
68	77+220	1	1.8	1.1	11.5	90	D	Box	1	@	2.00	x	1.50	
69	77+337	1	1.8	0.6	9.4	90	D	Box	1	@	2.00	x	1.00	
70	77+545	1	1.2	0.6	9.7	90	D	Box	1	@	1.50	x	1.00	
71	77+770	1	1.6	0.3	9.7	90	D	Box	1	@	2.00	x	0.50	
72	77+908	1	2.1	0.7	11.6	90	D	Box	1	@	2.50	x	1.00	
73	78+095	1	2.1	0.65	8.4	90	D	Box	1	@	2.50	x	1.00	
74	78+265	1	2.2	0.4	10.7	90	D	Box	1	@	2.50	x	0.50	
75	78 + 310	1	2	1	9.7	90	D	Box	1	@	2.00	x	1.00	
76	78+472	1	2.2	0.6	9.4	90	D	Box	1	@	2.50	x	1.00	
77	78+645	1	2.2	1.2	9.3	90	D	Box	1	@	2.50	x	1.50	
78	78+662	1	1.8	1	8.6	90	D	Box	1	@	2.00	x	1.00	
79	78+745	1	2.4	1	9.4	90	D	Box	1	@	2.50	x	1.00	
80	78+945	1	1.3	0.6	9.7	90	D	Pipe	2	@	0.76	x		
81	78+975	1	1	0.5	9.7	90	D	Pipe	2	@	0.61	x		
82	79+090	1	1.3	1	9.7	80	D	Box	1	@	1.50	x	1.00	
83	79 + 132	1	1.8	0.5	9.9	80	D	Box	1	@	2.00	x	0.50	
84	79+200	1	1.5	0.65	9.2	90	D	Pipe	2	@	0.91	x		
85	79+260	1	1.5	0.4	10	80	D	Box	1	@	1.50	x	0.50	
86	79+740	1	1.3	0.5	9.3	90	D	Box	1	@	1.50	x	0.50	
87	79+788	1	1.8	0.8	9.5	80	D	Box	1	@	2.00	x	1.00	
88	79+855	1	1.9	0.5	9.5	80	D	Box	1	@	2.00	x	0.50	
89	79+900	1	1.9	0.5	9.5	80	D	Box	1	@	2.00	x	0.50	
90	79+995	1	2.4	0.6	9.8	90	D	Box	1	@	2.50	x	1.00	
91	80+040	1	2	1	9.7	90	D	Box	1	@	2.00	x	1.00	
92	80+160	1	1.8	0.8	9.7	90	D	Box	1	@	2.00	x	1.00	
93	80+338	1	1.8	0.4	9.7	90	D	Box	1	@	2.00	x	0.50	
94	80+400	1	1.3	0.8	9.8	90	D	Box	1	@	1.50	x	1.00	
95	80+510	1	1.8	0.6	10	90	D	Box	1	@	2.00	x	1.00	
96	80+670	1	1.2	0.5	9.4	90	D	Box	1	@	1.50	x	0.50	
97	80+840	1	1.8	0.8	10.4	90	D	Box	1	@	2.00	x	1.00	
98	80+967	1	1.2	0.3	9.1	90	D	Box	1	@	1.50	x	0.50	
99	81+490	1	1.8	0.6	10	90	D	Box	1	@	2.00	x	1.00	
100	81+650	1	1.8	1.1	11.85	90	D	Box	1	@	2.00	x	1.50	
101	81+695	1	1.8	0.6	9.4	90	D	Box	1	@	2.00	x	1.00	
102	81+760	1	1.6	0.7	11.85	90	D	Box	1	@	2.00	x	1.00	
103	81+910	1	1.7	0.4	9.5	90	D	Box	1	@	2.00	x	0.50	
104	81+995	1	1.3	0.5	9.7	90	D	Box	1	@	1.50	x	0.50	
105	82+055	1	1.6	0.4	9.6	90	D	Box	1	@	2.00	x	0.50	
106	82+152	1	1	0.2	9.6	90	D	Box	1	@	1.00	x	0.50	
107	82+255	1	1.3	0.2	9.1	90	D	Box	1	@	1.50	x	0.50	
108	82+328	1	1	0.3	9.1	90	D	Box	1	@	1.00	x	0.50	
109	82+360	1	1.8	0.5	9.4	90	D	Box	1	@	2.00	x	0.50	
110	82+420	1	1.8	0.5	8.7	90	D	Box	1	@	2.00	x	0.50	
111	82+504	1	1.1	0.3	9.2	80	D	Box	1	@	1.50	x	0.50	
112	82+610	1	1.8	0.3	9	90	D	Pipe	2	@	0.61	x		
113	83+070	1	0.7	0.3	9.6	80	D	Pipe	2	@	0.46	x		

Examination of intake and outlet facilities

In order to secure smooth discharge and to prevent erosion of the riverbeds and side slopes, intake and outlet facilities are planned at the upstream and downstream sides of the culvert respectively. The structure of the facilities is determined from the viewpoints of cost, workability, and durability. The sidewall is covered with stone and mortar, and the riverbed is protected with concrete. In addition, gabion is placed at the end of the intake and outlet to prevent riverbed erosion.

1-5) Rehabilitation of culvert by expansion

Examination of structure

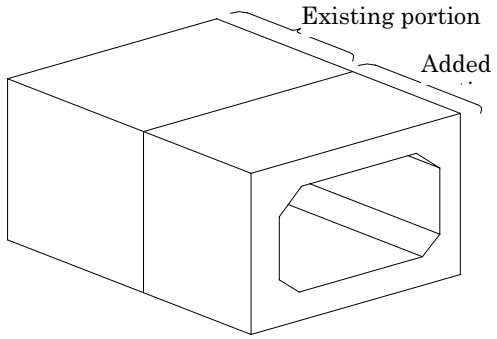
The expansion of a culvert aims to add a new piece of culvert to the existing one so that the combined culvert will satisfy the required width of 12. 3 m (roadway 7.3 m + shoulder 2 x 2 m). The additional portion of the culvert should have the same structure as the existing one.

Structure	Existing structure → Expanded structure
Top slab	Concrete → concrete
Side wall	Concrete → concrete
	Stone and mortar → stone and mortar

The mode and magnitude of rehabilitation for the culverts to be widened are listed in Table 2.20

Table 2.20 Mode and magnitude of rehabilitation for the culverts to be widned

.No.	Sta.No.	Existing Culvert							Damaged Level	Mode and manitude of rehabilitation				
		Type	Type of Slab	Type of Side Wall	No. of Cell	Width (m)	Heigth (m)	Skew		n @ B x H				
										Span		Width		Heigth
1	02+766	Box	Concrete	Mason	1	2.4	3.2	78	B	1	@	2.40	x	3.20
2	03+810	Pipe	Concrete	Concrete	1	2x1.0	1	90	B	2	@	1.22	x	
3	19+242	Box	Concrete	Mason	1	4.5	5.4	80	B	1	@	4.50	x	5.40
4	27+710	Box	Concrete	Mason	1	2.4	2.1	90	B	1	@	2.40	x	2.10
5	29+957	Box	Concrete	Mason	1	2.47	3.7	30	B	1	@	2.47	x	3.70
6	30+747	Box	Concrete	Concrete	1	4.52	3.75	90	A	1	@	4.52	x	3.75
7	53+689	Box	Concrete	Concrete	1	4.6	2.85	90	A	1	@	4.60	x	2.85
8	53+720	Box	Concrete	Mason	1	5.7	2.4	65	A	1	@	5.70	x	2.40
9	53+905	Box	Concrete	Mason	1	2.45	1.9	55	A	1	@	2.45	x	1.90
10	58+700	Box	Concrete	Mason	1	1.85	2.8	80	A	1	@	1.85	x	2.80
11	59+145	Box	Concrete	Mason	1	2.4	2.5	90	A	1	@	2.40	x	2.50
12	61+077	Box	Concrete	Mason	1	3.45	3.5	75	B	1	@	3.45	x	3.50



Proposed Expansion of Culvert

Examination of intake and outlet facilities

If a culvert is added upstream of an existing one, an intake is constructed and if downstream, an outlet is constructed. The structures of the intake and outlet should be the same as those of the existing culvert. The sidewall is covered with stone and mortar, and the riverbed is protected with concrete. In addition, gabion is placed at the end of the intake and outlet to prevent riverbed erosion.

2) Roadside ditch

Roadside ditches are constructed with both stone and mortar, and concrete. In the sections where there is a possibility of erosion (ex. where the ditch is constructed in the soil fill of a road cut slope section), stone and mortar lining is employed for the ditch in principle. In the sections where a ditch slopes, a concrete lined ditch is employed. In consideration of the above, the required length of each type of ditch is summarized as follows.

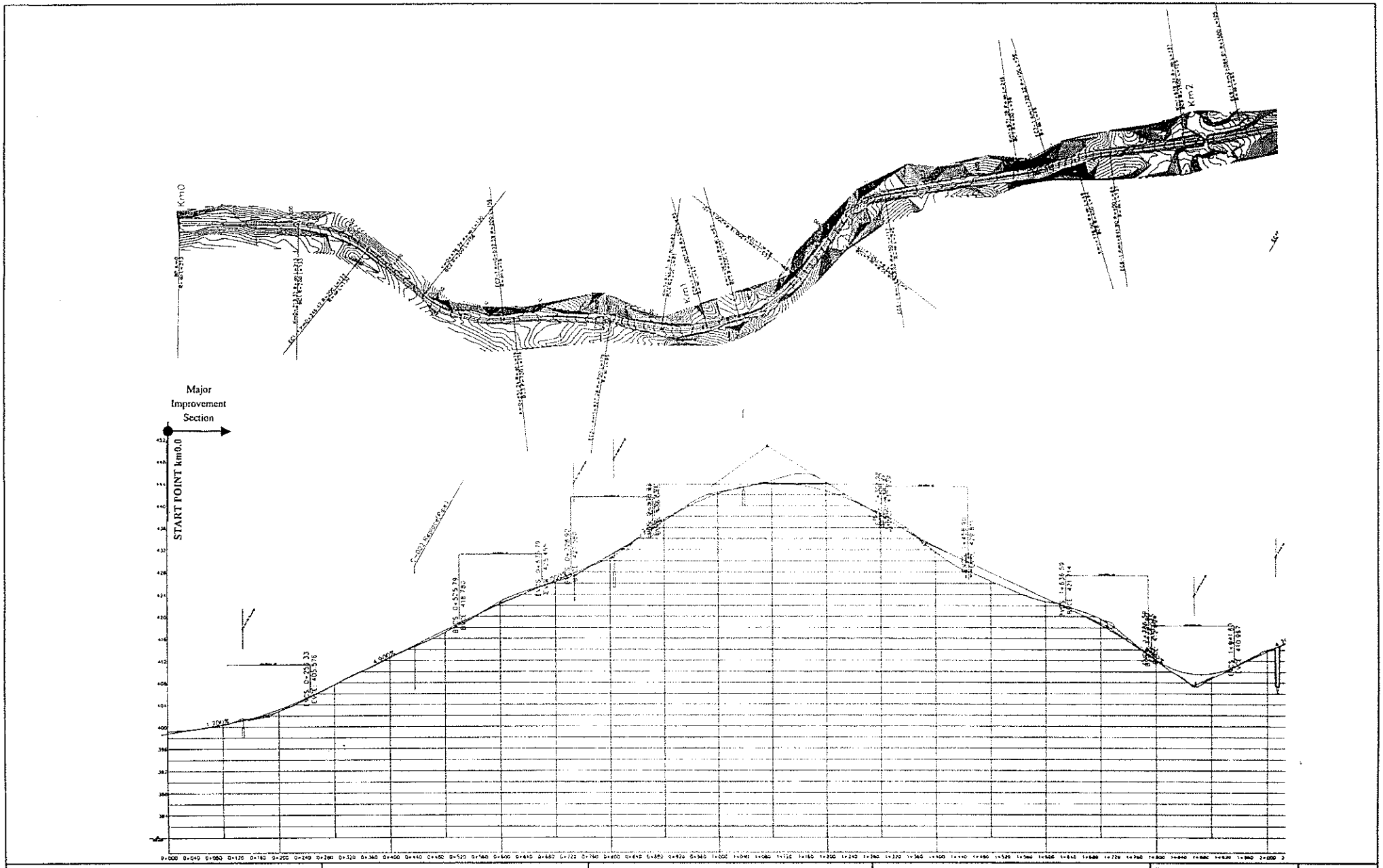
Type of ditch	Total length	Remarks
Soil ditch	42 Km	On road shoulders in road cut section
Stone and mortar ditch	4.9 Km	Where there is a risk of erosion
Concrete ditch	0.9 km	At steep slope, drops

2.2.3 Drawings for Basic Design

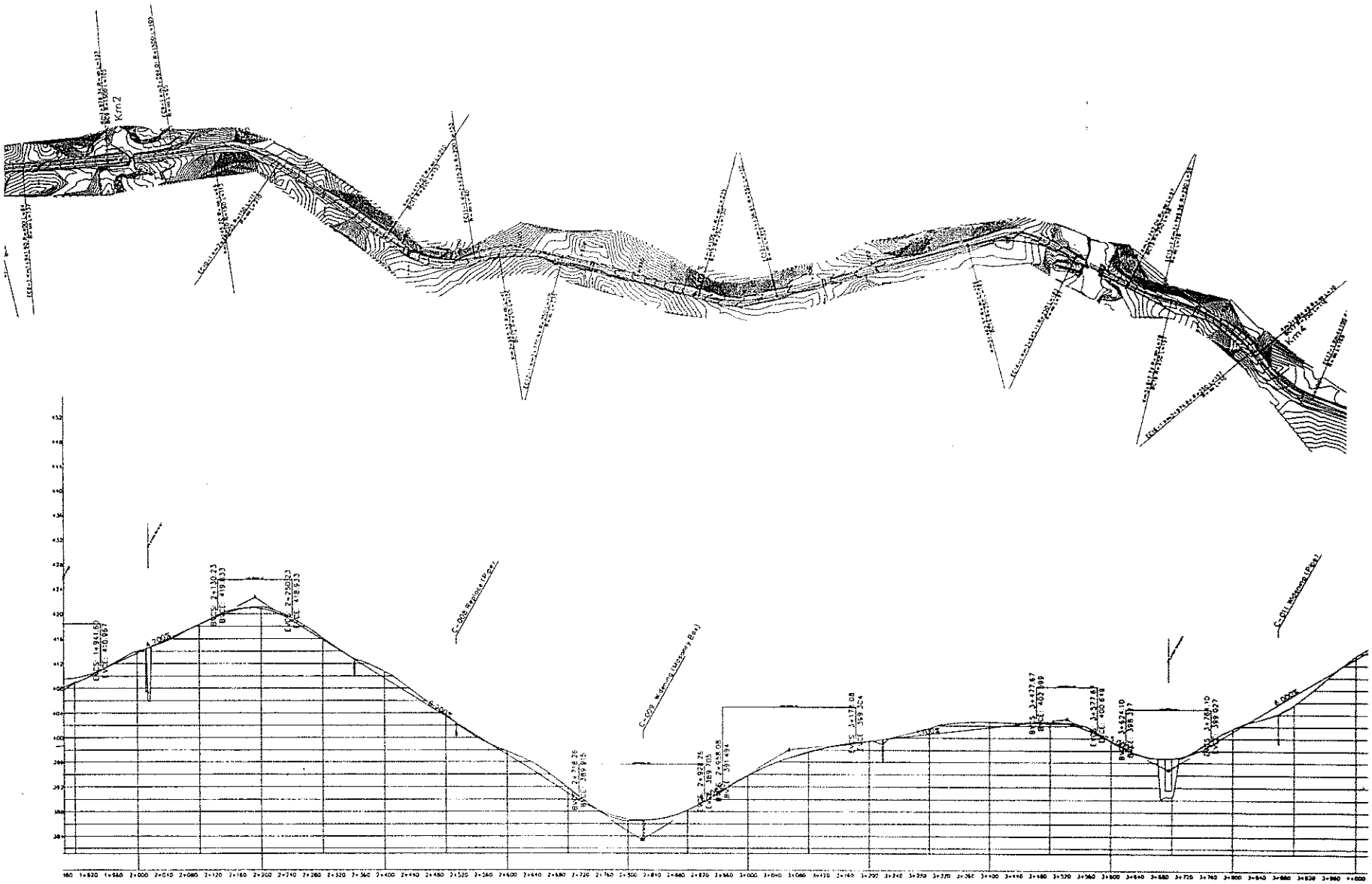
The drawings prepared based on the design conditions discussed above are presented below.

List of Drawings

Drawing No.	Detail of drawing	Number of sheets
1～49	Road plan and longitudinal profile	49
50	Standard transversal profile of road	1
51～58	Designs of transversal drainage facilities	8
59	Auxiliary road structures	1



• The Ministry of Communication of The Islamic Republic of Pakistan • Japan International Cooperation Agency	CONSULTANTS: Construction Project Consultants, Inc. (CPC) AND Nippon Koei Co.,Ltd.	PROJECT NAME: The Improvement of Kararo-Wadh Section of National Highway N-25	DRAWING TITLE: SCALE: AS SHOWN	Date: Prepared by: Checked by:	DRAWING No.: 1



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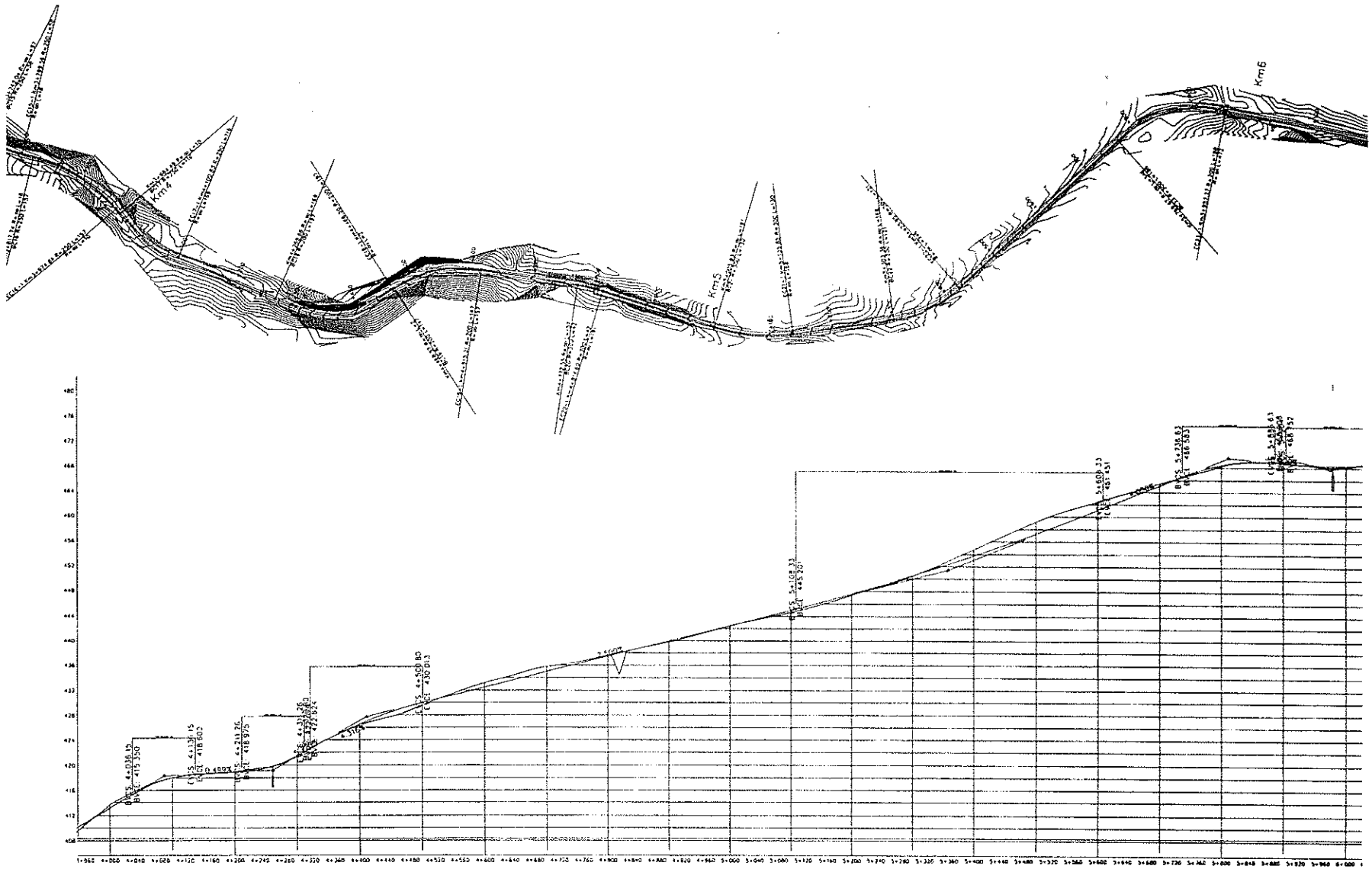

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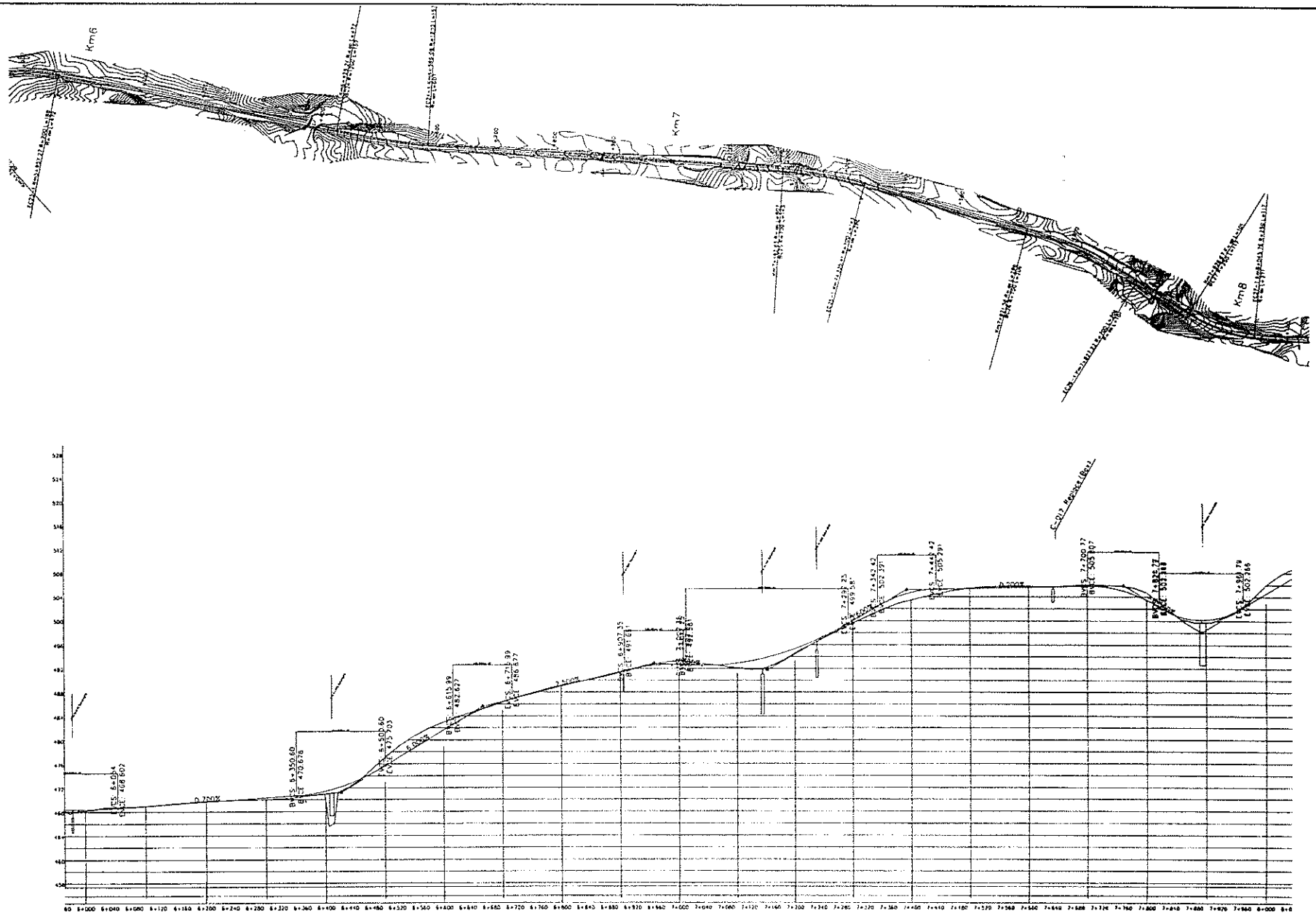

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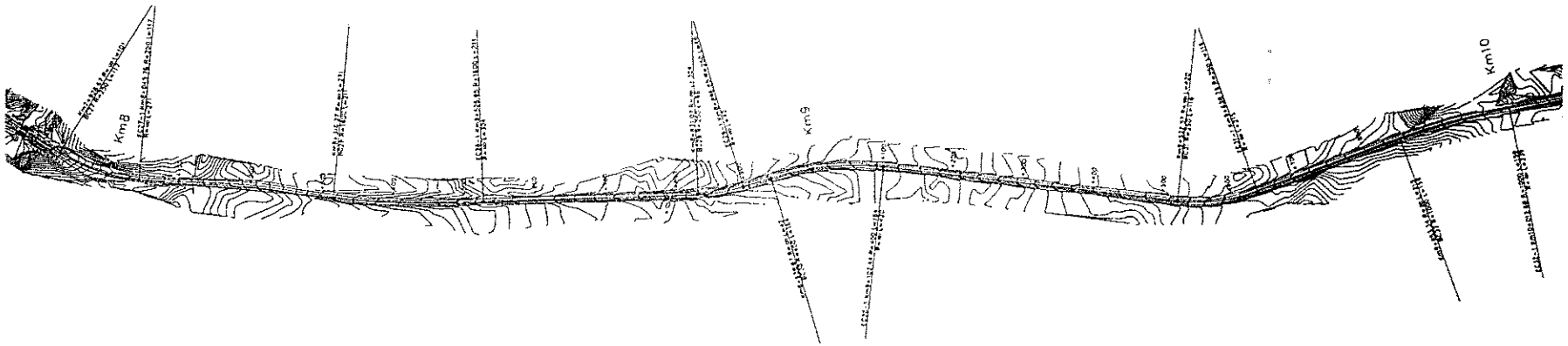

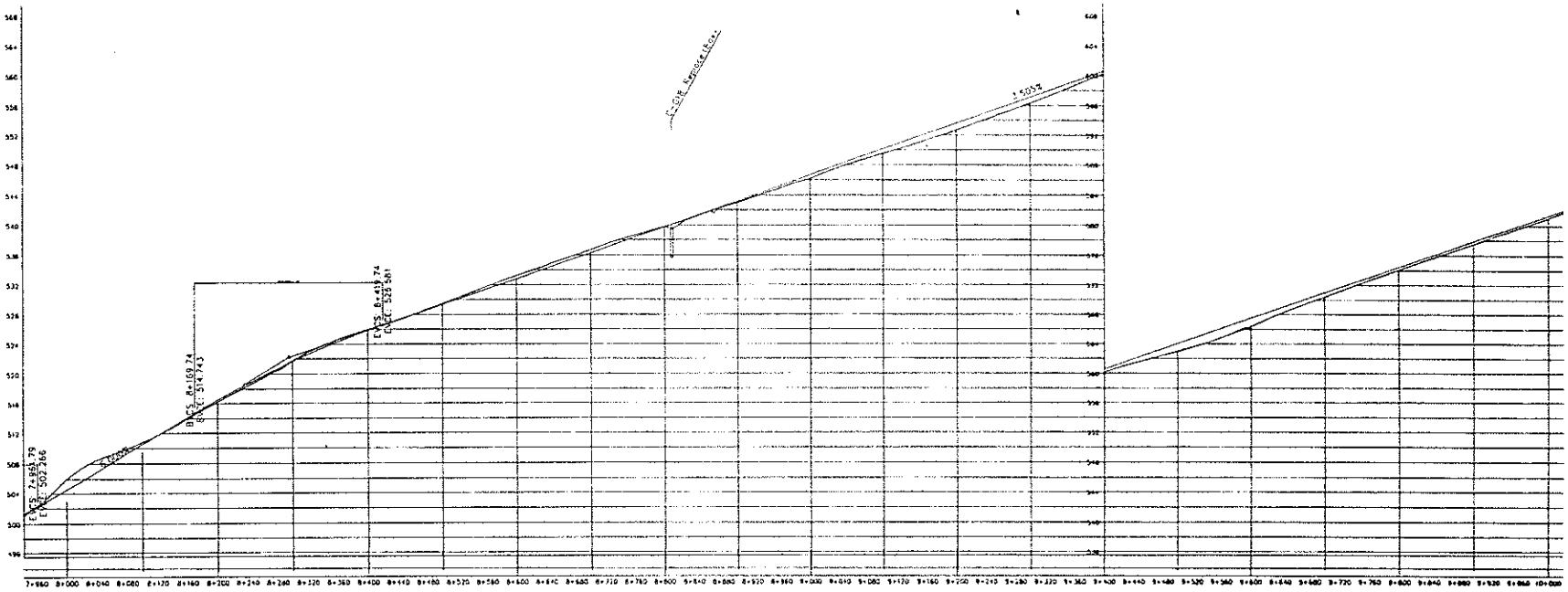

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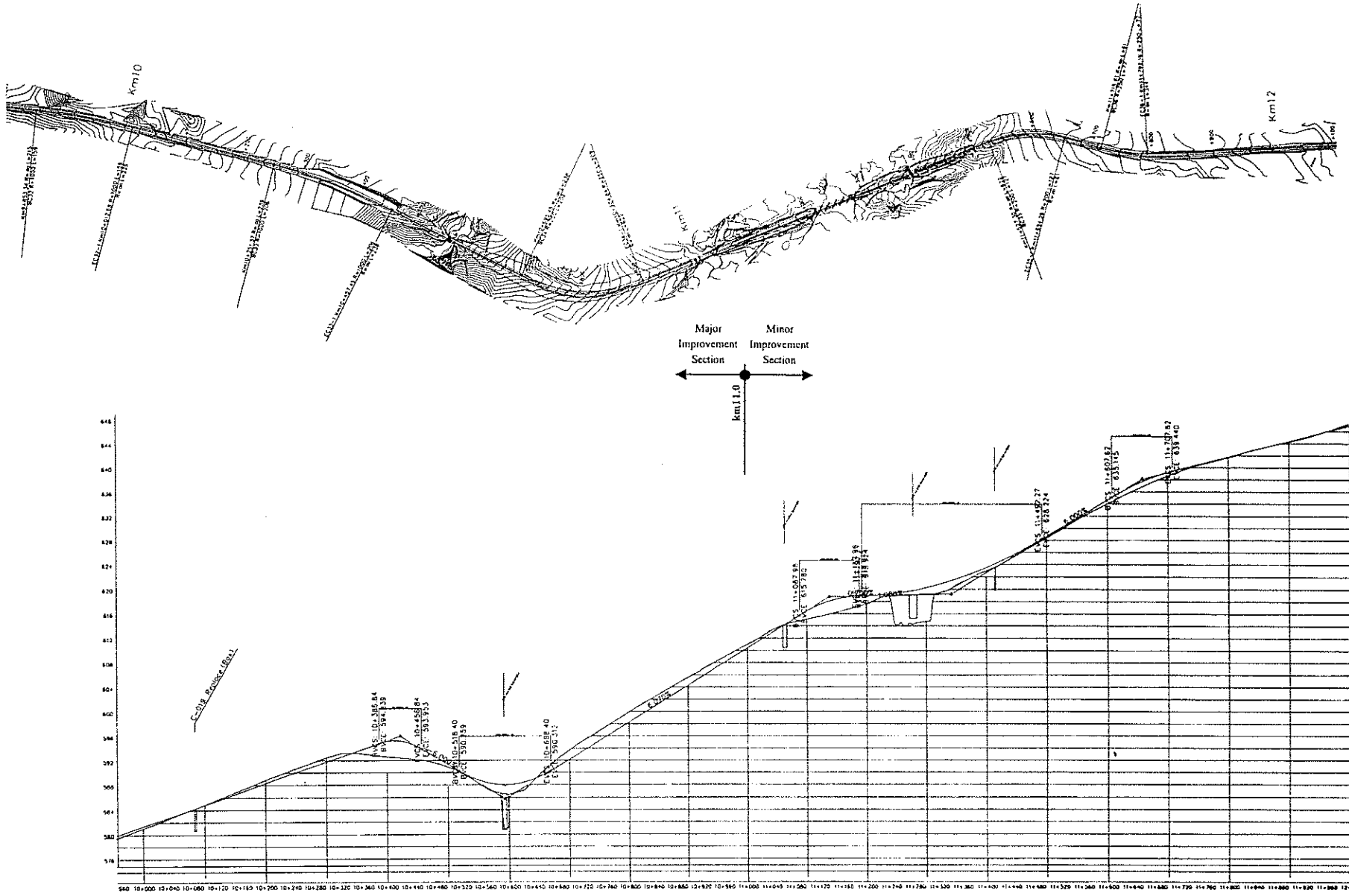

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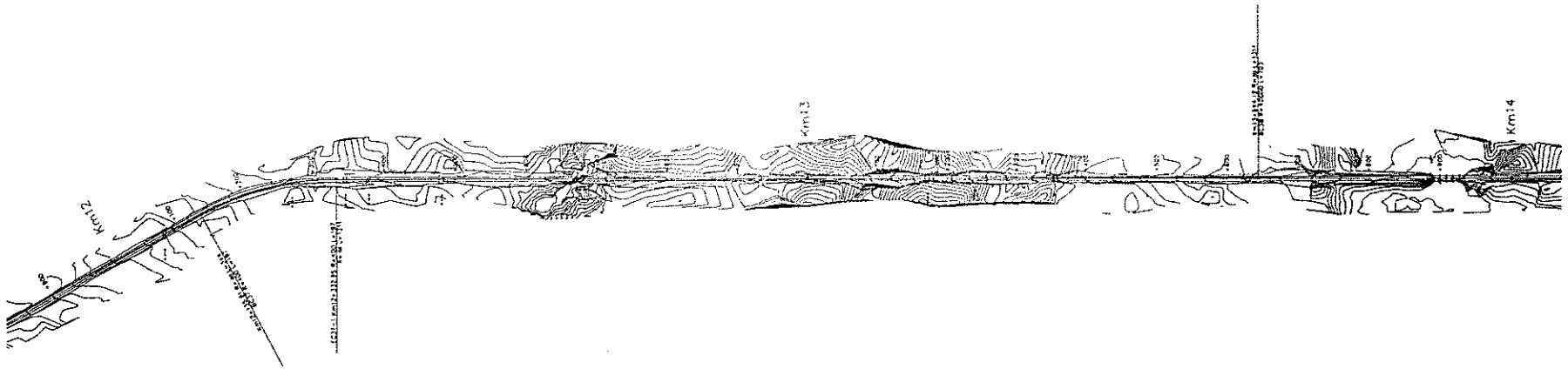

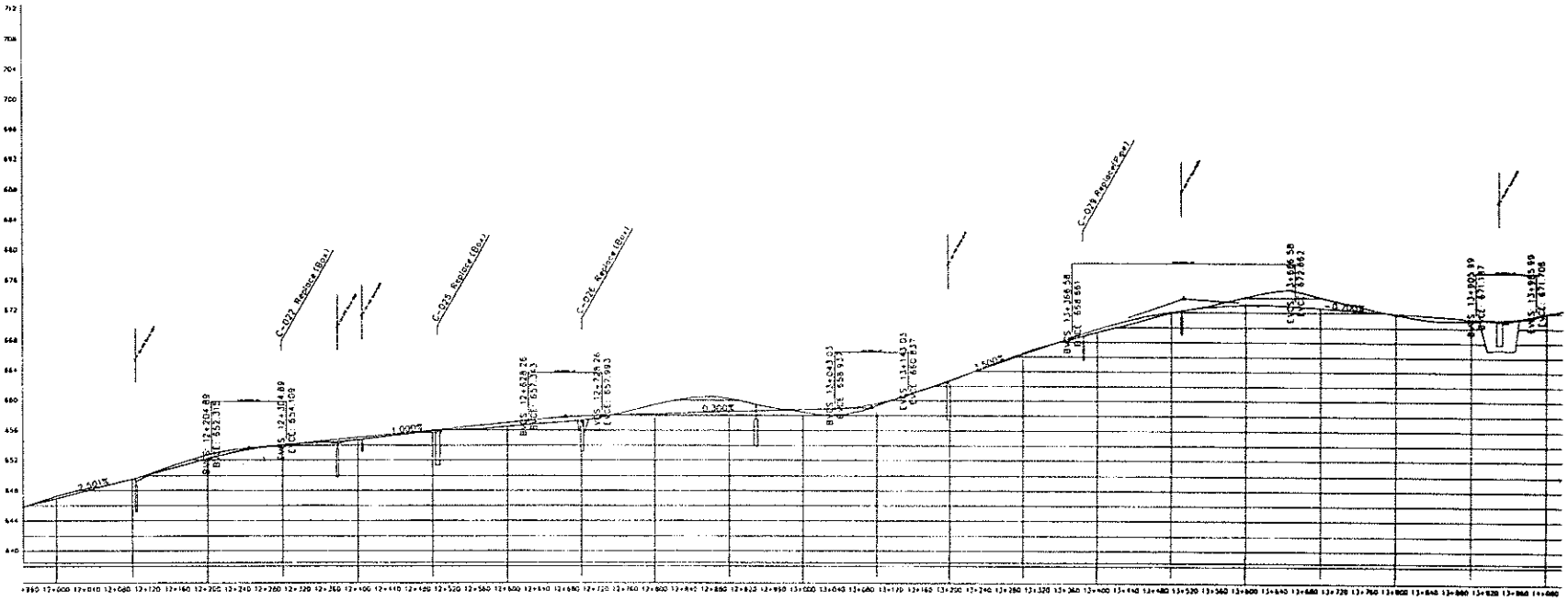

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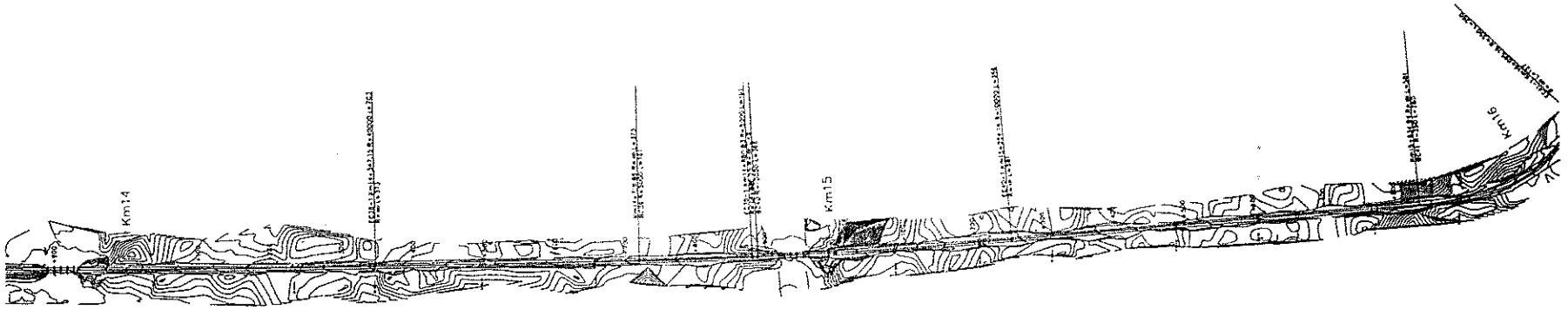

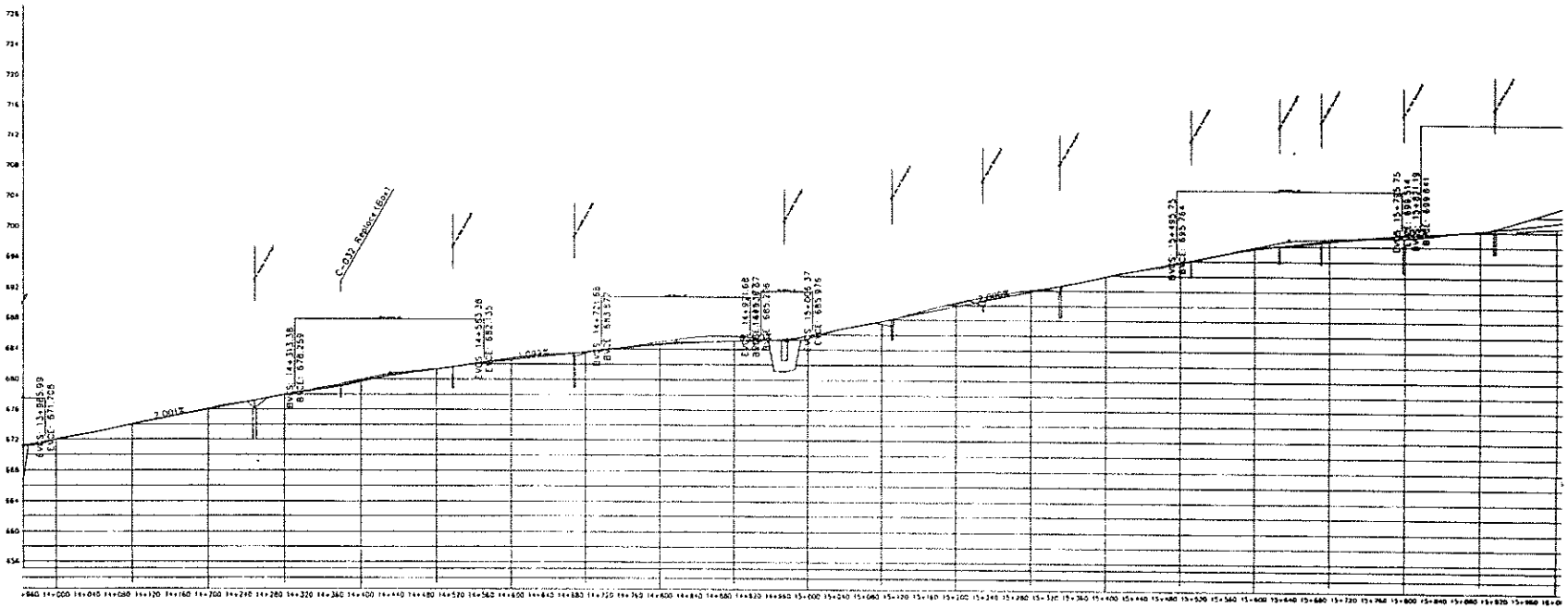

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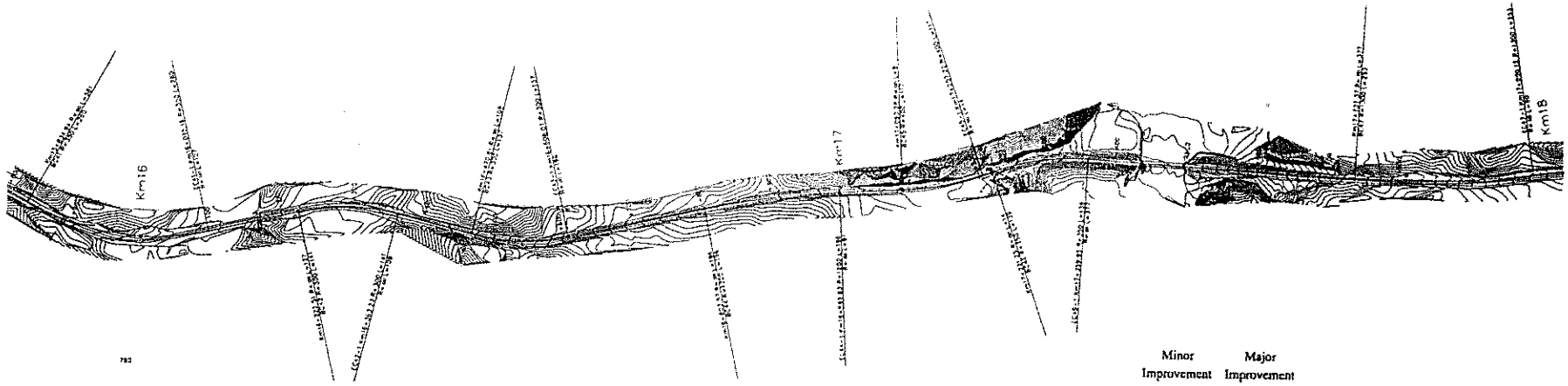

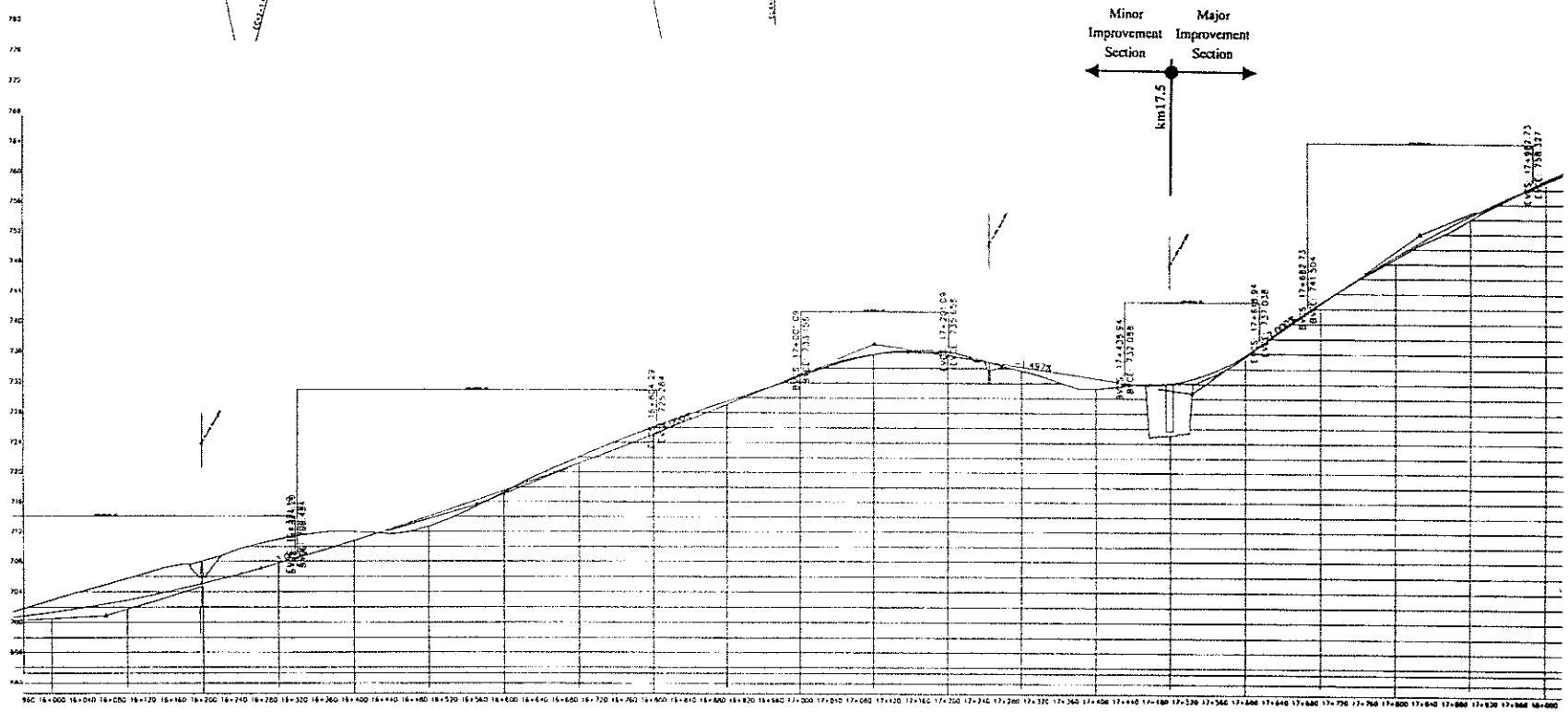

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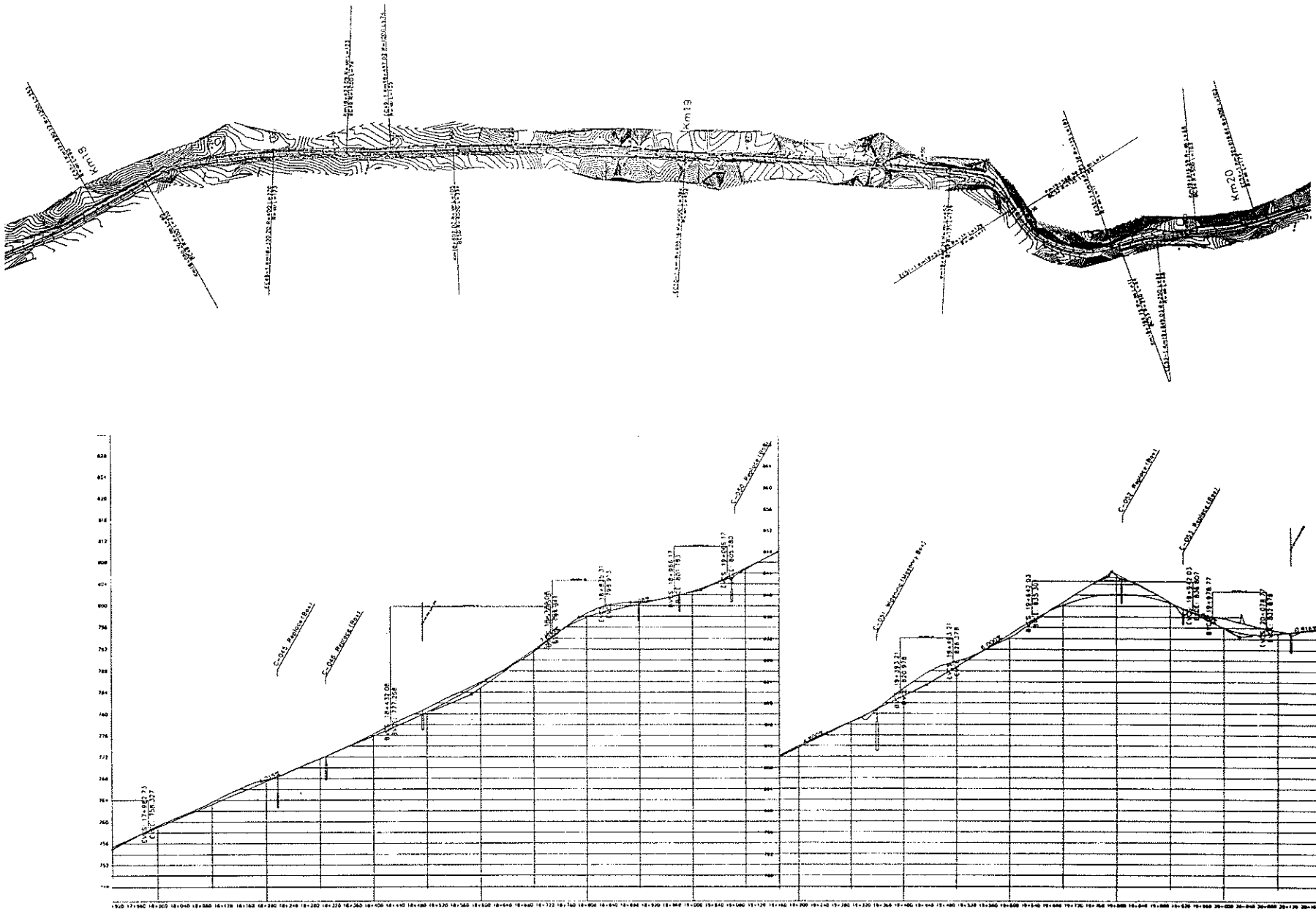

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