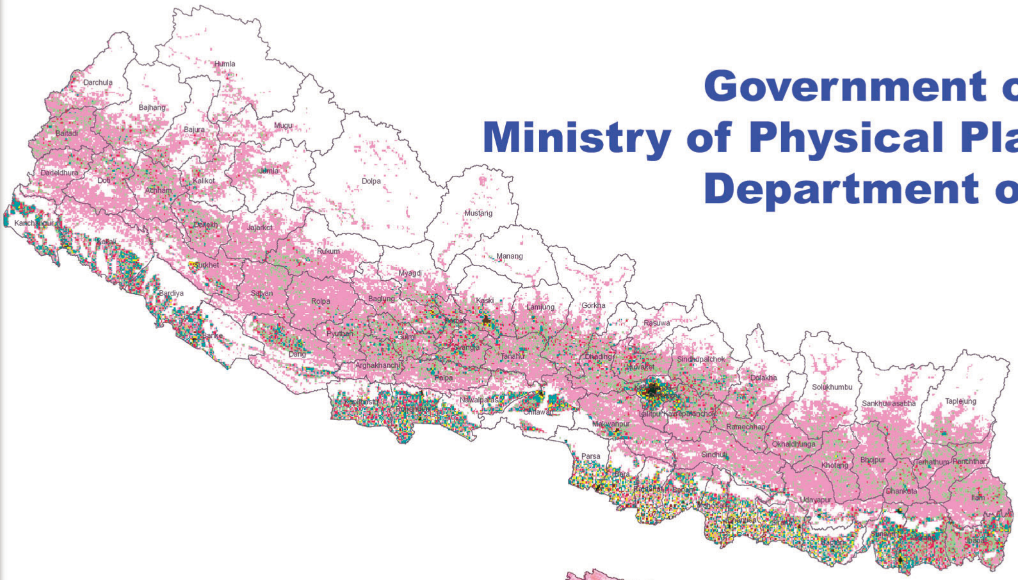
Government of Nepal
Ministry of Physical Planning and Works
Department of Roads



Sector Wide Road Programme & Priority Investment Plan

Final Report

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in association with
SILT Consultants (P) Ltd.
TAEC Consult (P) Ltd.
Consolidated Management Services Nepal (P) Ltd.

April, 2007

Chapter 1

I. INTRODUCTION

A. Purpose of Report

This is the Final Report of the Sector Wide Road Programme (SWRP) & Priority Investment Plan (PIP) Study conducted for the Department of Roads (DoR). The Study was conducted in two Parts: Part I was the overall planning study and Part II involved the detailed feasibility study of around 800km of high priority road improvement. The Study commenced in September 2005 with an initial completion date in December 2006. The Inception Report for Part I of the Study was submitted in December 2005, followed by the Part I Interim Report in early June 2006: the submission of this latter report was substantially delayed due to the difficulties and disruptions associated with the democracy movement during the early part of 2006 culminating with the restoration of Parliament in May. A series of bi-monthly Progress Reports were also submitted in February, April, June, August and October[1] 2006..

The Part I Draft Final Report was submitted in two instalments in January and February 2007 and formed the basis for discussion and consultation initially with the DoR and subsequently with key stakeholders in the roads sector, including Government Ministries, the National Planning Council, other Government Departments, and development agencies. Following these consultations and in response to comments received, the report has new been amended and finalised. A list of comments received and the Consultants' responses are presented in Annex 1. It is intended that this document now represents Government policy for the development of the Roads Sector over the coming 10-year period and it is hoped that it will have broad acceptance within all Government agencies and the foreign-aid community.

Part I of the Study involved a series of 'planning activities' relating to the production of a 10-Year Priority Investment Plan (PIP) comprising maintenance, upgrading and some new construction of an expanded Strategic Road Network of almost 10,000km. In conjunction with the development of this network, the Study also examined the current levels of accessibility throughout the country and has prepared a sector-wide strategy aimed specifically at improving remote area access.

Part II of the Study, which commenced in April/May 2006, involved the Detailed Technical and Economic Feasibility Study of over 800km of high priority sections of the Strategic Network selected for either upgrading or new construction. Due to overall project time constraints is was necessary to identify these roads and commence fieldwork prior to the finalisation of the prioritisation process. The selection process and subsequent design work is documented in a separate series of Reports on Part II of the Study. [As with Part I, work on the detailed

[1] The June and October Progress Reports were included in the Part I & II Interim Reports.

feasibility studies – and especially the fieldwork – was significantly delayed during the earlier part of the year, resulting in delayed submission of some documents.]

This Report contains a record of the work completed during the Study, and a summary of the main findings and conclusions of the Consultants, including work on the development and expansion of the SRN, traffic studies, the preparation of the PIP, and the application of HDM-4 for the development of maintenance and upgrading programmes. Significant use has been made throughout the Study of GIS techniques, including the development of a detailed accessibility model, which has been used to assess the impact of individual roads or networks on the overall levels of accessibility in the remote, non-road-served areas of Nepal.

B. Report Structure

Following this Introduction, the Report contains a further nine Chapters:

Chapter 2: Study Overview: briefly outlines the overall project objectives and content, plus a summary of the overall Study findings:

- Part I: Planning Studies, including the Sector Wide Road Programme and preparation of the 10-Year Priority Investment Plan (PIP); and
- Part II: Detailed Technical & Economic Feasibility Studies for upgrading and new construction of over 800km of priority road.

Chapter 3: Existing Strategic Road Network: contains details of the existing network, including historical development and current status and conditions. Also contains a review of current improvement and expansion proposals resulting in the definition of an ‘existing’ network of almost 8,000km. Existing traffic volumes across the network are presented, based on an assembly of available count data taken over recent years: the basis for traffic forecasting is briefly described. A review of the existing bridges and the SRN is also included.

Chapter 4: Maintenance & Upgrading of SRN: describes the application and use of the HDM-4 model to determine the 10-year optimised maintenance and upgrading programme for the SRN. Specific aspects covered include revisions and updates to the available database, calibration of the model to conditions in Nepal (including updating the VOC model), training in the use of the program, and its establishment within the DoR. The results indicate a total programme (excluding committed schemes) of around Rs16 billion over the 10 year period.

Chapter 5: Development & Expansion of SRN: describes the process adopted to identify potential additions and extensions to the SRN, including initially an assessment of the extent of the existing network and priority ranking system to screen and select schemes for further consideration and evaluation. In total about 3,600km of road have been selected from a long-list of around 9,000 additional kilometres.

Chapter 6: Prioritisation of Upgrading & New Construction: provides details of the analysis and evaluation of the proposed extensions to the SRN, including new hill roads into remote areas, additional links in the mid-hills and, specifically, prospects for new routes accessing Kathmandu from the west or south (Terai), plus the upgrading of gravel or earth roads to sealed standards, and capacity enhancements within Kathmandu Valley.

Chapter 7: Rural Accessibility Standards: describes the approach adopted to assess and measure rural accessibility, based on a detailed understanding of the spatial distribution of population, road network alignments and the travel time on foot from the road. A fully integrated GIS-based analysis system has been developed allowing populations within given walk-times from a road network to be calculated, as well as the total time taken to reach the nearest road-head from any location. The accessibility of the existing and proposed extended SRN – in terms of 4-hours walk in the hills and 2-hours in the Terai – has been calculated, indicating that around 85 percent of the total population will be within the desired targets.

Chapter 8: Rural Access Improvement Strategy: extends the above analysis to take account of the additional impact of the local rural road networks in extending the 'reach' or accessibility provided by the SRN. Overall, it is estimated that over 90 percent of the population will be accessible by 2016 (80 percent in the hills and almost 100 percent in the Terai).

Chapter 9: Environmental & Social Aspects: contains a brief overview of the work undertaken in regard to the social and environmental aspects, including the production of an Environmental & Social Management Framework (ESMF) and recommendations for training and the strengthening of the Geo-Environmental and Social Unit (GESU) in DoR.

Chapter 10: Priority Investment Plan and Sector Wide Road Programme: presents a summary of the key findings from the Study, including specifically a draft outline of a future budget estimate for the coming 10-years, presenting an indication of the likely spending levels and sources of funding.

Chapter 2

II. STUDY OVERVIEW

A. Study Objectives & Outputs

The Study was conducted for the Department of Roads (DoR) as part of the World Bank funded Road Maintenance and Development Project (RMDP). The Study comprised two parts which were scheduled to be undertaken over a 15 month period between September 2005 and December 2006:

- Part I: Sector Wide Road Programme and Priority Investment Plan; and
- Part II: Detailed Technical & Economic Feasibility Studies

Part I, which was effectively the 'planning phase' of the Study, was commenced in September 2005 and continued though to the production of the Draft Final Report in January 2007 and subsequent revisions to produce this final version in April 2007. This Report now presents the Consultants overall findings and recommendations relating to the development of the Sector Wide Road Programme and Priority Investment Plan (PIP) for the Strategic Road Network (SRN) and incorporates comments and observations from Government.

Part II of the Study, which was conducted in parallel from April 2006 onward, involved the detailed technical and economic feasibility study of over 800km of selected high-priority road for either upgrading or new construction. It is proposed that these roads will form the basis for the next IDA-funded Loan in the roads sector. A separate series of Reports – including Detailed Feasibility Studies for 16 individual road projects – have been produced and submitted.

B. Sector Wide Road Programme

The Sector Wide Road Programme (SWRP) has examined the overall road system and has produced recommendations regarding the extent and nature of the required strategic and local networks necessary to achieve the desired levels of accessibility throughout the country. The Study has produced a balanced strategy covering the development and maintenance of an expanded strategic road network, plus the additional local road requirements to achieve the desired levels of accessibility.

The analysis of the overall road network requirements has been undertaken using a GIS-based approach that links the development and expansion of the road networks to the current and projected population distribution throughout the country. This approach was applied initially to the development of the Strategic

Network and subsequently to the identification of areas where additional local roads are required to provide access to all populated areas[2].

Specifically the Study has developed a detailed population density distribution across the country based on the census populations of each of the almost 4,000 VDCs, which have then been re-distributed geographically based on the house and village/urban clusters from the topographic mapping, to create an accurate indication of population location on a 1 sq km grid. This allows populations to be summed within any spatial boundary and – for this project – within catchment areas and buffer zones around road links or networks. A detailed assessment of the areas of influence of roads was undertaken using a terrain-dependent walk-time model, which reflected differing walk speeds related to gradient and was thus able to determine minimum times and optimum routes.

Detailed quantified calculations have therefore been possible of the numbers of people benefiting from improved access – in terms of numbers within the 2 hour and 4 hour access bands from the roads – as well as an indication of the overall reductions in access time (measured in person-hours) to an all-weather road.

The Study did not however attempt to develop detailed local road networks, as this is the responsibility of the relevant District Development Committee (DDC) and is better undertaken locally, where need and priority can be better assessed. The Study has however recommended a substantial expansion of the strategic network – including the incorporation many local/districty roads – in order to provide immproved and more reliable access in rural areas leading to greater social and economic connectivity. These networks which will be complemented by additional local roads which will be developed and funded through the DDCs.

C. Priority Investment Plan

The PIP presents a detailed strategy for the development of the SRN over the next 10 years, including recommendations for the expansion of the network from approximately 5,000 km of currently designated National Highway and Feeder Road to around 9,700 km by 2016. The Study has examined both the capital and recurrent financial implications of the proposed plan and has developed an optimum maintenance strategy for the existing (& expanded) network.

The maintenance strategy has been developed based on an analysis of the existing and committed SRN using the HDM-4 model, to examine and evaluate alternative scenarios and to define an optimal approach. A number of DoR staff have been trained in the use and application of HDM-4, including calibration of the model to operating conditions in Nepal: the program is now set up and operational in the Department. The need to revise and update the data on a regular basis is emphasised, together with annual reviews of the on-going programme.

The Study has examined a full range of possible improvements and additions to the SRN, including new alignments in the hills, the upgrading or improvement of existing heavily trafficked roads, increased network density and upgrading of roads in the Terai (including links to India), additional strategic roads within the Kathmandu Valley, and particularly access routes to Kathmandu – including a broad assessment of the case for a Fast Track link between Kathmandu and the Terai and Indian Border.

[2] Additional local roads will be required in more densely populated mid-hills and Terai areas in order to provide higher levels of accessibility than implied by the basic standards

In total, around 170 potential additional links in the SRN were identified, with a length approaching 9,000 km. These were subjected to a pre-screening exercise, which identified an initial 4,500km of road for possible inclusion in the future SRN. These roads were subsequently further evaluated and assessed prior to inclusion in the PIP. The analyses were primarily based on assessments of improved accessibility throughout the country.

D. Detailed Technical & Economic Feasibility Studies

Part II of the Study includes the Detailed Feasibility Study of over 800km of roads, mostly involving upgrading of existing earth or gravel tracks to sealed all-weather standards. Most of the roads examined are part of a network of hill roads in the Mid and Far Western Regions. These roads were selected from a ‘pool’ of around 1300km of road for potential upgrading or new construction. Additionally some further sections have been reviewed that were previously included under RMDP and which have not yet been completed to a full all-weather standards.

The Feasibility Studies for these roads have shown that most are economically viable, based on assumptions regarding growth in traffic demand following improvement. In addition, the roads will provide substantial overall increases in accessibility, with associated social and economic benefits: the initial selection criteria were based primarily on the level of access improvements provided by the roads.

E. Environmental and Social Aspects

In addition to the above tasks, the Study also included an extensive examination and review of the current environmental and social impact analysis procedures as conducted within the DoR, leading to recommendations for simplification, revision and improvement. A review of the current institutional arrangements within DoR in respect of social and environmental activities was also undertaken and recommendations for necessary strengthening produced. Detailed environmental and social impact studies have been completed for all of the selected upgrading and new construction alignments in Part II.

A separate Draft Environmental and Social management Framework (ESMF) has been produced and circulated for comment among key stakeholders.

F. Main Findings from Study

The overall Study contained five main areas of work, the first four of which are reported on in this document. A separate Final Report is available for Part II (Detailed Feasibility Studies), which summarises the conclusions and recommendations of the 16 individual roads studied. The aspects covered in this Report are:

- Development and expansion of Strategic Road Network;
- Assessment of Accessibility and future road network requirements;
- Development of maintenance & upgrading strategy using HDM-4; and,
- Preparation of 10-year PIP and associated budget estimates.

The separate Part II Final Report presents the results from the 16 individual Feasibility Studies.

1. Expansion and Development of the SRN

The existing designated SRN comprises approx 5,050km of open and operational road, comprising 15 National Highways and 51 Feeder Roads. This network includes around 3,500km of sealed road, 950km of gravel surface, and 600km of earthen road. Much of the earth and gravel network is seasonal in nature and/or not available for regular traffic for significant parts of the year.

These are main national arteries which provide inter-regional connections and links to District Headquarters, international borders, and key economic centres. The SRN is ‘enabler’ of access at a local or district level: without the strategic connections to the main road network (eg East-West Highway and main regional centres), local road networks serve no useful or beneficial purpose.

The DoR has prime responsibility for the construction, development, improvement and maintenance of the SRN.

2. Findings regarding SRN

It is evident that significant expansion of SRN, beyond the ‘official’ length of 5,050km, is already in hand: current commitments alone will extend network to approximately 7,900km by 2010. After this, and within the plan period to 2016, a further expansion of the network is proposed under this Study to around 9,700km. Additional projects are prioritised in terms of network connectivity, improved accessibility (including remote area access), and network strengthening.

Expansion of the SRN comprises a combination of the following three types of road:

- Existing Commitments – roads planned or under construction, for which funding is secured;
- Conversion of existing Local Roads, which may – or may not – require improvement or upgrading, including many that are already being maintained by DoR Divisional Offices; and
- A limited number of new proposals – roads on new alignments mostly into currently un-served areas.

A total of almost 9,000km of potential extensions (170 schemes) were identified, out of which around 1,800 km were selected and prioritised for inclusion in the extended network. The initial screening – based on a multi-criteria approach – was designed to identify schemes based on their ‘strategic’ function: the better performing schemes were then assessed for their economic viability.

Four Categories of road were identified, over and above currently committed schemes and existing roads already maintained by DoR:

- Remote Area Access Links – mostly in the Mid and Far West;
- Mid-Hills Linkages, especially in areas with high population density;
- Strategic improvements and additions, including access to Kathmandu;
- Improvements within Kathmandu Valley to relieve congestion.

All potential components of the 10-year PIP were assessed using HDM on other evaluation techniques to establish their overall feasibility and priority ranking. In general most existing commitments and on-going projects were confirmed and most ranked relatively highly on the overall scoring system. These included the current ADB projects, those proposed and evaluated under Part II of this Study

for potential inclusion in the next WB/IDA Loan, and the improvements and upgrading of Terai roads proposed for Indian Government funding.

The types of improvements and works examined included the upgrading of existing gravel or earth roads to all-weather standards; expansion of the network into remote hill areas; additional links to Kathmandu; and strategic improvements ***within*** Kathmandu Valley.

3. Recommendations regarding the SRN

Key elements of the expanded SRN in the period up to 2016 include:

- the completion of links to ALL District HQs;
- the upgrading of unsealed roads in Terai and main links into the hills;
- the improvement of the network in mid-hills, including inter-District links and the development of a mid-hills corridor, within the more densely populated areas;
- the enhancement of access to Kathmandu, including consideration of the Fast Track and/or Bhimdhunga Link from the Prithvi Highway west of Naubise; and
- capacity enhancement of key Kathmandu Valley roads, including the existing Ring Road and Arniko Highway to Bhaktapur and Dhulikhel.

4. Accessibility

Accessibility has been used throughout the Study as the prime indicator of project 'worth' and overall impact on poverty mitigation and reductions in levels of social exclusion. It has been demonstrated that poor accessibility is strongly correlated with the incidence of poverty and low scores on a range of social and human development indicators.

Measures of accessibility depend primarily on population distribution, the extent and proximity of the all-weather road network, and the walk-time between road and residence. The numbers of people (and percentages) with either 2 hours in the Terai or 4 hours in the hills have been calculated, together the overall walk-time (measured in person-hrs). It can be shown that the 2hr/4hr criterion is not necessarily the best or only measure of accessibility, as it focuses specifically on improving access to the more remote areas, whereas a greater impact can be achieved through smaller improvements to a greater number of people living relatively closer to the road.

Accessibility analysis has been used specifically for three tasks:

- Identification and evaluation of extensions to the SRN;
- Selection of roads for detailed feasibility study; and
- Forecasting of traffic levels on new and upgraded hill roads

The Study has assessed the impact on accessibility from the extensions to the SRN. It is estimated that 65 percent of the total population live within the 2hr/4hr time bands from the SRN at the present time, comprising 50 percent of the hill population and 76 percent of Terai and Valley populations. The expanded network by 2016 raises the 'accessible' population to 70 percent in the hills and 97 percent in the Terai – or 85 percent overall.

This indicates the very significant impact that the Strategic (Main) Road Network has on overall accessibility. It is the initial roads into an area that have the most significant effect as (a) they tend to be located in the more populous areas and

(b) the strategic roads are the first roads built into the non-served areas. The inclusion (in 2016) of an additional 6,000km of local roads (representing a 60 percent increase in overall road length) raises the overall percentage served by only 6 percent to 91 percent[3] , illustrating the diminishing returns from additional local road construction.

5. Application of HDM-4

The objectives of the HDM-4 component of the Study were to develop an economically optimum 10 year investment plan for all roads under DoR and to establish HDM in DoR as a tool for expenditure planning, prioritising major maintenance works and undertaking feasibility studies.

The HDM-4 analysis of SRN was conducted on the 'committed' 2010 network of 7,900km of road, including 5,400km of currently operational road, plus 2,500km of new or additional links. The network assumed the completion of 3,000km of 'committed' upgrading and improvement before 2010. The analysis therefore excluded consideration of any other upgrading in the period to 2010 as sufficient works were already in the pipe-line.

The balanced and optimised analysis produced a total 10-year programme of around Rs16 billion including rehabilitation, periodic maintenance and upgrading, involving total interventions of 4,500km – divided into approximately equal lengths between reseals, AC overlays, rehabilitation and upgrading of gravel roads. An average regular annual maintenance expenditure of around Rs 1 billion should be added to this.

6. Review of maintenance strategies

The HDM model was also used to assess the impact and effectiveness of a change in current Nepali maintenance practices of only using AC Overlays on high traffic roads, with reseals applied to roads with less than 3,000 vpd. The analysis concluded that, far a similar overall level of expenditure, a greater use of overlays produced improved results and, most noticeably, a significantly better (smoother and stronger) pavement at the end of the plan period. One reason for this is that a continuing use of the cheaper re-seals does nothing to improve the overall pavement strength or roughness, and leads eventually to a more expensive full rehabilitation.

The Consultants recommend that HDM results should be treated as advisory and indicative of the scale and types of intervention required. It was also noted that the process requires continuous monitoring and regular updating of the input data. Whilst the model produces an assessment of priorities over 10 year period, it requires to be reviewed and re-run on an annual basis.

7. Preparation of PIP

The preparation of the Priority Investment Plan for the ten years to 2016 includes three main items:

- Firstly, the definition of likely ***maintenance*** requirements;
- Secondly, identifying necessary ***upgrading*** of existing and potential SRN elements (including some currently local roads); and
- Thirdly, the ***Construction*** of new (strategic) links – rural access and network strengthening

[3] Comprising increases from 70% to 80% in the hills and from 97% to 99% in the Terai

The PIP presents a draft budget proposal for DoR for the next ten years, involving the preparation of budget estimates and an assessment of potential funding sources. The estimates indicate an overall budget of around Rs120 billion over 10 years (at current prices), comprising: Maintenance Rs 31 billion; Upgrading Rs36 billion; New Construction Rs27 billion; and access to Kathmandu Rs18_billion. The annual budget is estimated to be in the range from Rs8.5 billion today to Rs13 billion by 2016.

Key elements of the 10-year Plan include:

- a significant expansion of the Strategic Road Network including the incorporation of substantial lengths of the local road network and the extension of the network to serve all Districts;
- the upgrading of the more important earth and gravel strategic roads in both the hills and Terai to provide improved all-weather accessibility;
- consideration of a new strategic access link between Kathmandu and the Terai; and
- strategic improvements within Kathmandu Valley, including upgrading the Ring Road and route to Kathmandu and Dhulikhel.

Chapter 3

III. STRATEGIC ROAD NETWORK

A. Background

1. Function of Strategic Network

The function of the Strategic Road Network (SRN) is to provide linkage and connectivity throughout the country. The network is critical for all economic and social activity: it enables economic growth and development to take place, encourages prosperity and an equitable distribution of wealth, and ensures social wellbeing within the community together with regional and cultural integration.

Development of the SRN aims to enhance national levels of social and economic integration, redress regional inequalities and imbalances, and reduce levels of exclusion in the remote and more disadvantaged areas.

The SRN is a fundamental contributor to the improvement of accessibility in the remote areas of Nepal: it provides connections to the rest of the country and allows the development of local networks within individual Districts. The SRN 'facilitates' the provision of access to remote communities, rather than necessarily provide access directly.

Nepal's transport sector is heavily dominated by road based transport, which accounts for almost all domestic passenger and freight movements. Air services contribute to passenger movements to key commercial and tourist destinations, and to the transport of both passengers and goods into remote hill areas. Internationally, most freight movements are across the land border with India, with internal distribution by road: limited high-value goods are carried by air.

The future and function of the SRN is thus critical to the development of the country. Roads are a pre-requisite of most economic activity and provide links between towns and regional centres throughout the country, and increasingly into the more remote hill areas. In the past, economic development has been concentrated in readily accessible areas of the Terai and around the main urban areas: the development of the road networks in these areas has enabled and encouraged this growth. The expansion of the network into the hills can now provide similar benefits and opportunities to these presently remote communities.

Overall responsibility for the development and maintenance of the SRN lies with the Department of Roads (DoR), within the Ministry of Physical Planning and Works (MoPPW). It is the function of this Study to review the status of the SRN and to recommend a prioritised programme for the maintenance, improvement and expansion of the network over the coming ten years.

2. Historical Development of Network

The road network in Nepal has been developed entirely over the past 50 years since the opening of the first road link to Kathmandu from India – the Tribhuvan

Raj Path – in 1956. Prior to this there were a number tracks and trails in the Terai linking to nearby towns in India and a limited network of roads within Kathmandu Valley on which a few vehicles operated that been carried in over the hills.

Initially development of the strategic road network was slow and, by 1970, only a single north-south link (330 km) had been constructed – linking Kathmandu to the Chinese border at Kodari and to the Indian border at Raxaul. Since 1970, there has been considerable expansion of the strategic network with the assistance of many international development agencies.

Both India and China were instrumental in the construction of key elements of the national network: India with significant sections of the main East-West Highway and with the initial north-south routes from the Indian border to both Kathmandu and Pokhara, and China with the construction of the road to the Chinese border and the main mid-hills link between Kathmandu and Pokhara. Subsequently other bi-lateral and multi-national agencies have been active in the roads sector, with significant sections of strategic network being funded by the World Bank, ADB, the US, former USSR, the British, the Japanese and the Swiss.

During the 1980s and 90s the emphasis of the aid community focussed on the rehabilitation of the strategic network and the development of a sustainable maintenance programme: more latterly the attention of the funding agencies has turned to the further development of road networks to serve the remote hill areas.

In addition to extensions of the strategic network, a considerable expansion of the local rural road network has occurred over the past 10 years, with construction undertaken through a large number of local initiatives and agencies - often involving significant levels of local participation. The construction of rural roads has been seen - at all levels - as an important mechanism to accelerate the social and economic development of remote, non-road-served areas.

This growth is best illustrated by the overall road statistics maintained by DoR since 1970, see Table III.1 and Figure 3.1. These lengths include estimates of the total operational road network, including both Urban and District Roads as well as the Strategic Network. These figures demonstrate a more than five-fold increase in the total road length over the past 30 years, from around 3,000km in 1975 to over 17,000km today – an annual increase of around 6 percent.

Table III.1: Growth in the Overall Road Network, 1970-2004 (km)

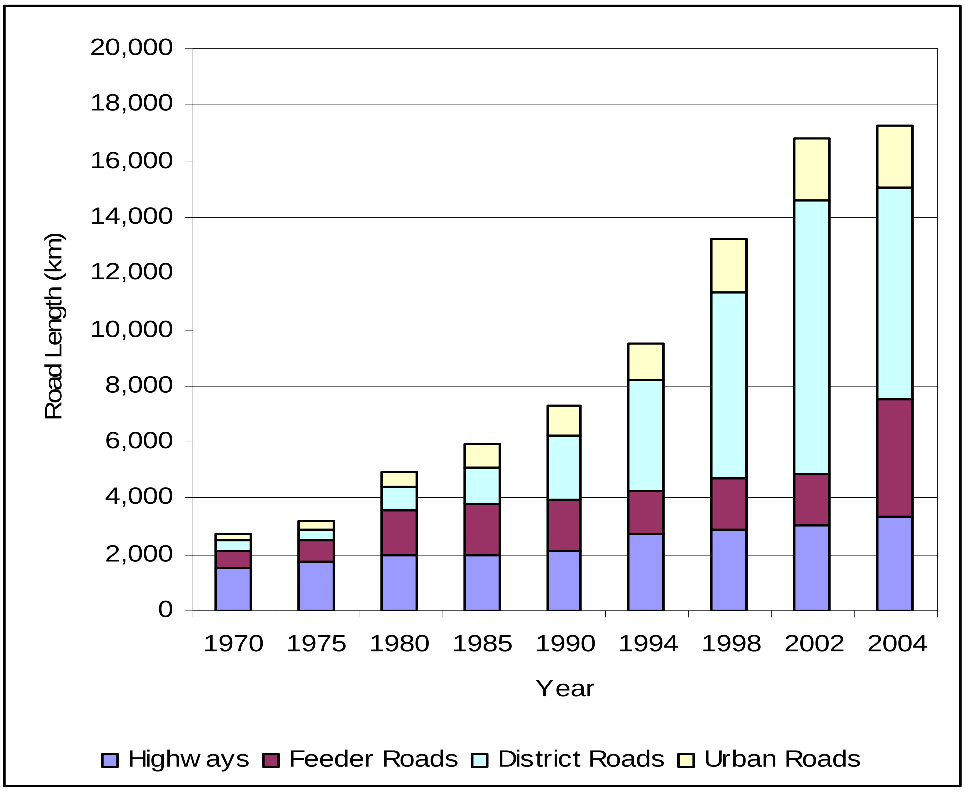
	Highways	Feeder Roads	Urban Roads	District Roads	Total
1970	1,487	679	243	322	2,730
1975	1,728	789	282	374	3,173
1980	1,967	1,603	546	824	4,940
1985	1,960	1,875	866	1,224	5,925
1990	2,111	1,822	1,098	2,299	7,330
1994	2,734	1,520	1,339	3,941	9,534
1998	2,905	1,835	1,868	6,615	13,223
2002	3,029	1,832	2,198	9,775	16,834
2004*	3,339	4,196	2,260	7,486	17,281

Note: *2004 data include the re-designation of some District Roads as part of SRN (NH&FR)
Source: DoR Road Statistics, 1998, 2002 & 2004

It should be noted that the 2004 statistics show a significant increase in the length of the SRN as a result of the reclassification of some District Roads as

Feeder Roads. These changes are not however reflected in the statistics for the "existing SRN" presented in Section 3.2 below.

Figure 3.1: Growth in the Overall Road Network, 1970-2004



Source: DoR Road Statistics, 1998, 2002 & 2004

Ignoring the effect of the re-classification in 2004, the length of the SRN has grown steadily from around 2,000km in 1970 to a little over 5,000km today – the equivalent of 2.5 percent per annum. The 'other' road network, primarily the District Roads, has grown significantly faster – at around 10 percent pa – to reach around 12,000km by 2002 and maybe in excess of 15,000km today.

B. Existing SRN and Need for Change

1. Designated Strategic Network

The existing SRN was designated in 1994 comprising 15 National Highways and 51 Feeder Roads, with a total length today of 5,030km. The current lengths of each category of road are summarised in Table III.2, with a full listing of individual roads given in Annex 3, Table A3.1a.

Table III.2: Length of Designated Strategic Road Network, 2006 (km)

	Bitumen	Gravel	Earth	Total
National Highways	2,451	396	261	3,108
Feeder Roads	1,056	563	303	1,922
Total	3,507	959	564	5,030

Source: DoR Database developed for HDM, with adjustments as noted in the Annex

It is noted that these lengths exclude some sections of the designated SRN that are currently under-construction[4] and which are not open to traffic: additionally many of the 'earth' roads, and some of the gravel roads, are seasonal and are impassable to light traffic for much of the year.

2. The Existing SRN

There are however significant additional lengths of road that operate as part of the strategic network but which are not included in the above totals. The current "defacto" SRN comprises the open and motorable sections of the 'designated' network (ie excluding those sections planned or under construction), plus a number of additional roads that are currently maintained by DoR and some that have been built or upgraded as if they were part of the SRN. These latter roads total around 400km see Annex 3, Tables A3.1b and A3.1c and include the Kathmandu Ring Road a number of important roads in Kathmandu valley, the 'Katari' Road, Bardibas-Jaleshwar, and a number of currently open sections of road to District Headquarters that are not officially designated as Feeder Roads – eg sections of the roads to Khandbari, Bhojpur, Okhuldhunga, Mangalsen (Achham) and Martadi (Bajura).

These additional roads are included in the "existing defacto" SRN of 5,428km, illustrated in Figure 3.2, which represents the best estimate of the currently open main road network in the country. This network forms the basis for the development for the 'extended SRN' and for assessing current and future levels of accessibility: 70 percent of the network is sealed, including all the more heavily trafficked roads, and a further 18 percent has a gravel surface. (see Table III.3)

Table III.3: Existing 'defacto' Strategic Network (open)

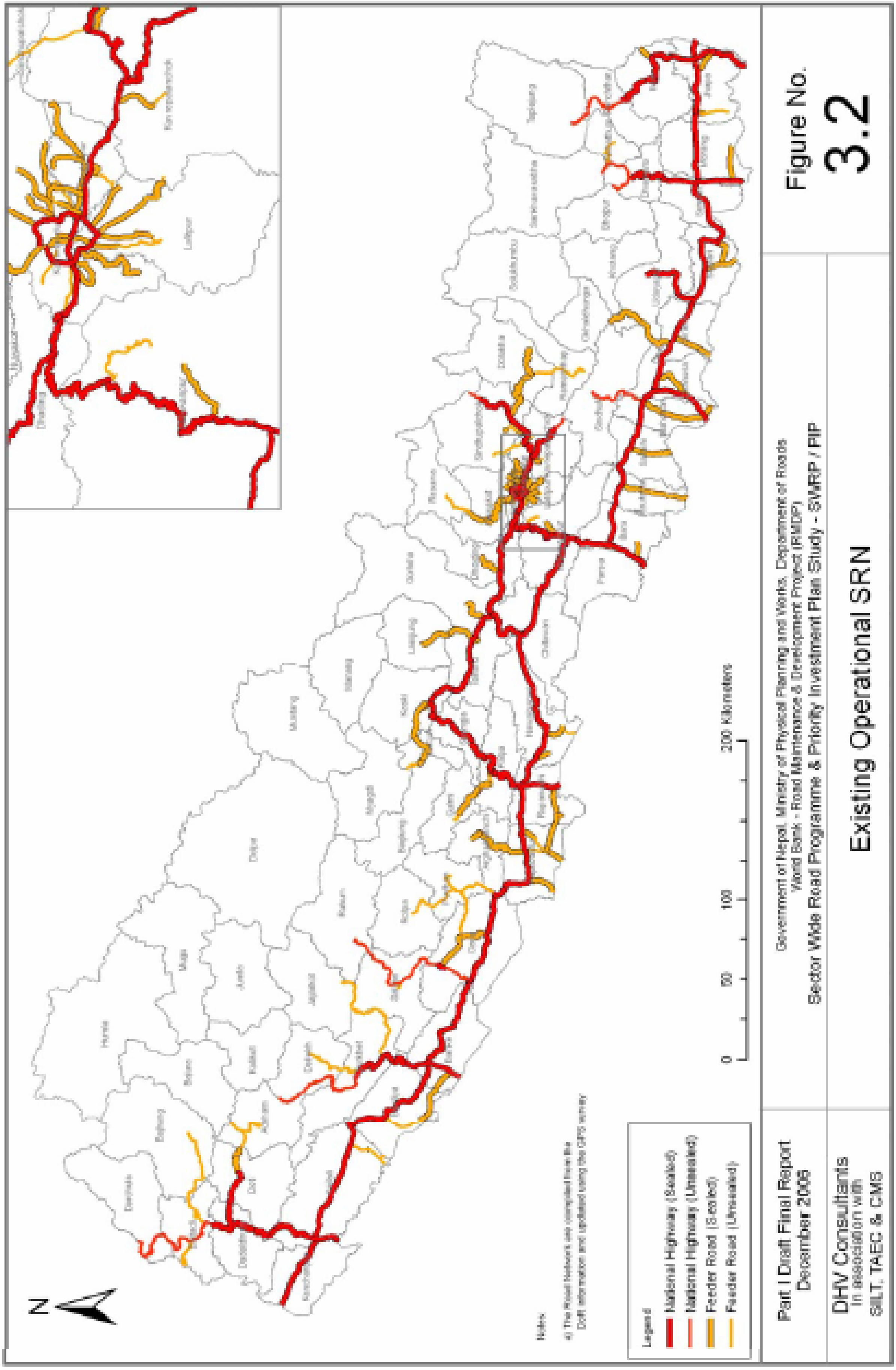
Surface Type:	Length (km)	Percentage
Sealed	3,805	70%
Gravel	985	18%
Earth	638	12%
Total	5,428	100%

Note: Includes additional 'non-designated' sections of road

3. Network for HDM Analysis

The HDM analysis is conducted on a network of 7,917km of road, representing the network expected to be in operation and maintained by DoR by 2010. The network includes the existing designated SRN of 5,030km, plus an extra 440km (which will be completed by 2010) making a total of 5,470km, as shown in Table III.4. In addition, a further 2,447km are included which will form part of the future SRN by 2010, and which comprise both 'new' links currently under construction as well as existing District or Urban Roads of a strategic nature and presently maintained by DoR.

[4] Excluding specifically the final sections of Surkhet-Jumla, Chhinchu-Jajarkot & Khodpe-Chainpur which are currently under construction as earth roads under GoN funding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Notes
Legend
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National Highway (Unsealed)
Feeder Road (Sealed)
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200 Kilometers
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Existing Operational SRN
Figure No.
3.2
Part I Draft Final Report
December 2006
DHV Consultants
in association with
SILT, TAEC & CMS

Table III.4: Existing Strategic Road Network for HDM Analysis (km)

	Existing (designated) SRN	Links to be added to SRN	Total Network for HDM Analysis
National Highways	3,432	1,113	4,545
Feeder Roads	2,038	1,334	3,372
Total	5,470	2,447	7,917

Note: Totals differ from Table 3.2 due to inclusion of incomplete sections of designated roads
Source: HDM Database

This network (Figure 3.3) is representative of the SRN that *will exist* by 2010 following the completion of those committed projects that are currently in the pipeline and for which finance is secured. This network is however marginally different from that used to develop the 'extended SRN' (see Chapter 5) and the accessibility analysis (Chapter 6) due to the inclusion, in the HDM network, of some additional roads presently maintained by DoR.

The full HDM network thus includes the existing operational network of roads maintained by DoR under the Annual Road Maintenance Plan (ARMP), plus those known committed additions and improvements (both upgrading and new construction) that will be completed by 2010. These committed improvements total over 3,000km (see Table III.5) and are not evaluated in the HDM analysis as they are assumed to be implemented as planned: these schemes include improvements to the existing (designated) SRN as well as links to be added to the SRN. A full listing of the proposed improvements and additions is presented in Annex 3, Table A3.2, A3.3 and A3.4.

Table III.5: Committed Improvements to the HDM Road Network (km)

	Existing (designated) SRN	Links to be added to SRN	Total Network for HDM Analysis
Committed Improvements or construction prior to 2010	1,731	1,298	3,029
Balance of network without programmed improvement	3,739	1,149	4,888
Total	5,470	2,447	7,917

Source: HDM Database & DoR

The 'Committed Projects' can be grouped based on their funding source, as shown in Table III.6 below and presented in full in the Annex. The ADB schemes relate to three projects and include recurrent maintenance on the EWH, upgrading of unsealed roads (in both the hills and Terai), construction of 'missing links', and new access routes to border crossings and ICDs.

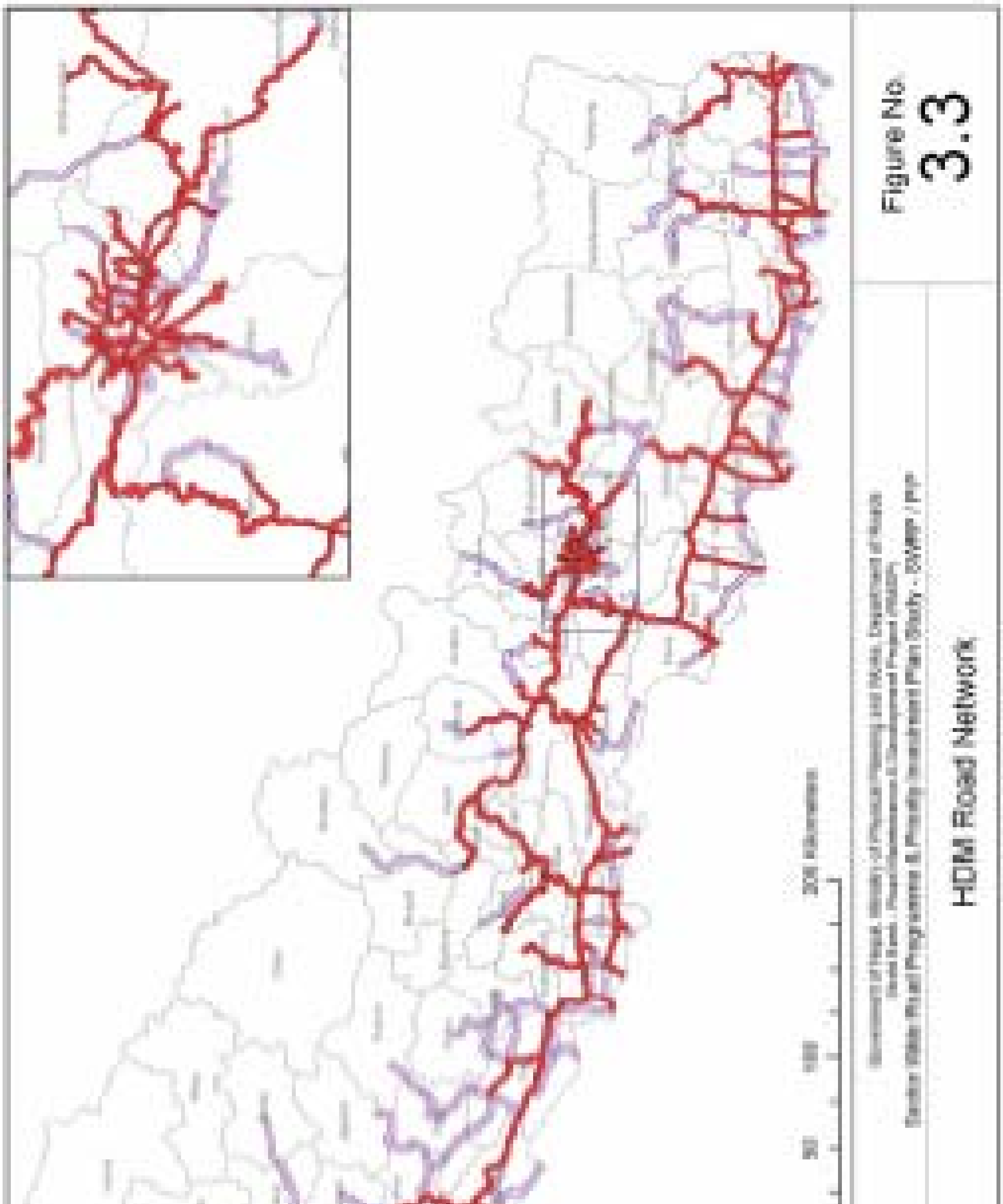


Figure No
3.3
HDM Road Network
Legend
Sealed Road
Unsealed Road
DHV Consultants

Table III.6: Details of Committed Projects in HDM Network – by Agency

Funding Agency	Project	Length	
ADB	RNDP STFP TCP	758 40 143	Road Network Development Project (in progress) Sub-Regional Transport Facilitation Project Transport Connectivity Project (Core Projects)
Govt of China		26	Dhunche-Rasuwaghadi
DFID / UK	RAP	92	Rural Access Project (Feeder Road Component)
Govt of India		1,262	Priority Road Infrastructure in the Terai
Govt of Japan	JICA	32	Dhulikhel-Sindhuli-Bardibas
WB/IDA	RSDP	676	Road Sector Development Project (RMDP2), being prepared under Part II of this Study:
Total		3,029	

Note: The WB total excludes new roads and the additional schemes – see Annex

It is noted that the World Bank (RSDP) being prepared under Part II of this Study includes additional road sections that are not part of the 'committed' HDM Network for 2010. In addition to these externally-funded 'committed' schemes, there are six on-going GoN funded new road construction projects involving access to the District Headquarters of Solukhumbu, Manang, Mustang, Jajarkot/Dolpa, Jumla and Bahjang. The Nepal Army is undertaking some of these works and some sections may be included in the Mid-Term Programme of the ADB Transport Connectivity Project.

C. Network Condition and Inventory

Detailed condition data are available for the existing SRN based on a series of bi-annual surveys of the network carried out for DoR by consultants. The most recent survey was in 2004-5. The surveys are comprehensive and have covered most of the accessible sections of the strategic network: the latest data relate to a total of 4,128km of the network (2,737km of Highways and 1,391km of Feeder Roads.

The DoR surveys have recorded both the Surface Distress Index (SDI) and roughness using the International Roughness Index (IRI). In previous years the DoR have reported on the condition of the network based on the results of the SDI: this is composite index which includes cracking, potholes, ravelling, edge-break and other pavement defects. It is a useful indicator of the pavement condition primarily for the 'manager' of the road network, who is concerned with asset preservation, but it does not necessarily reflect the condition of the road as perceived by the road user. A section of badly cracked road can remain relatively 'smooth', despite having a high SDI.

The condition of existing network – as determined by the SDI – is shown in Table III.7. This indicates that over 85 percent of the surveyed network is in 'good' or 'fair' condition: it should however be noted that this network (4,128km) excludes many of the lower trafficked and unsealed roads that are in poor condition. Based on these criteria, the overall condition of the network can be shown to have improved markedly over the past decade, as a result of improved maintenance procedures and the continuing donor-funded rehabilitation programmes. [In 1995, less that 1,200 km was recorded as being in good or fair condition.]

Table III.7: Condition of Existing Network based on SDI measurements

	National Highway		Feeder Roads		Total	
	km	%	Km	%	km	%
Good (SDI < 1.7)	805.1	29.4%	170.3	12.2%	975.5	23.6%
Fair (SDI 1.7 - 3.0)	1751.8	64.0%	833.2	59.9%	2585.0	62.6%
Poor (SDI > 3.0)	180.4	6.6%	387.5	27.9%	567.9	13.8%
Total	2737.3	100.0%	1391.1	100.0%	4128.4	100.0%

Source: DoR Database (2004), as reported in SWRP Inception Report (Dec 2005)

Maintenance interventions based on SDI alone will not result in the adoption of an economically optimal programme as it takes no account of the future performance of the pavement nor of the costs incurred by the road user over the life-cycle of the treatment adopted. The Consultants recommend that future maintenance interventions are better identified and evaluated using HDM-4 which is based on a life-cycle analysis of the pavement performance, coupled with an assessment of the overall road user costs incurred. This allows the 'total transport costs' – of the road agency and road user combined – to be identified and minimised over any given plan period.

HDM-4 uses the roughness (measured in IRI) as the key indicator of pavement condition and determinant of road user costs: the pavement deterioration models and intervention criteria within HDM are also based on IRI. In HDM pavement condition is also predicted in terms of cracking, potholes and other indicators, not just IRI, and any of these can be used to trigger intervention The roughness index is a measure of surface irregularities, expressed in metres per kilometre (m/km) and as recorded by a Bump Integrator (BI) calibrated to the International Roughness Index.

The current condition of the sealed sections of the HDM Network (4,235km) is summarised in Table III.8 and is illustrated on Figure 3.4. This shows that over 60 percent of the sealed network (2,600km) is in good or fair condition, with less than 10 percent in bad condition. Roughness (IRI) is not considered to be a meaningful indicator for unsealed (gravel or earth) roads as the condition of such roads can very widely over time and – in the case of gravel roads – can be readily restored to lower levels through grading and/or spot re-gravelling. Further discussion and analysis of the current and future network condition is given in Chapter 4.

Table III.8: Roughness of Existing Network (sealed roads only)

IRI (m/km)	Condition	Length (km)	Percentage
< 4	Good	721	17%
4.1 – 6.0	Fair	1,866	44%
6.1 – 8.0	Poor	1,265	30%
> 8	Bad	384	9%
All Sealed Roads		4,235	100%

Source: HDM Database (2004)

It should be noted that the definitions of good, fair, poor and bad are to a large extent arbitrary and can be adjusted to suit individual country conditions. The

ranges of IRI selected – with break points at 4, 6 and 8 – are considered suitable and appropriate for Nepal.

It has been necessary to re-calibrate and re-calculate the 2004 roughness data as previously reported by DoR (see Chapter 4) as the data were clearly erratic and were grouped in a narrow band of observations: most data were clustered between 4 and 6, with few roads in either the good or poor/bad categories. The adjusted data are presented in Table III.8.

D. Criteria for Inclusion in Extended SRN

It is evident that there is a need to re-classify and re-define the extent of the existing and future (extended) SRN. The previous classification and designation was established in 1994: since then the network has been expanded significantly and the relative importance of some roads has changed. The last ten years has seen the construction and upgrading of many feeder roads into the hills and a massive increase in the length of the local (District) road networks.

This increase in the overall length of rural roads requires a clear demarcation of function and responsibility: the DoR-sponsored strategic network should provide access into each District (and between Districts), whilst the local access ***within*** each District should be the responsibility of the local bodies. It is clear that the DoR network of Feeder Roads (and Highways) into the hills should be built and maintained to higher (all-weather) standards, befitting the strategic nature of the connections provided. The Strategic Road Network (SRN) is the prime ***enabler*** of access into the hills, allowing and encouraging the development of local road networks and the consequent stimulation of the local economy.

Chapters 5 and 6 describe the proposals for the expansion of the SRN and the prioritisation of the necessary improvement works. The first requirement is to establish the strategic nature and function of each link, which are not necessarily dependent on either the traffic volume or the economic viability. A set of criteria for inclusion in the SRN was established in 1994 and this remains valid today. The second phase of the planning process determines the appropriate standards and justification for construction or improvement – within a constrained budgetary environment.

As indicated in the following Chapters, the expansion of the SRN includes three elements: (a) committed additions to the SRN, including foreign aid funded projects; (b) the re-designation of existing local or District roads as part of the SRN; and (c) roads on new alignments.

E. Traffic Analysis

1. Traffic Data and Surveys

The DoR have been collecting traffic data on a systematic basis on the main road network since 1988, although the records are incomplete and inconsistent. More reliable data have been maintained since the mid-1990s when MRCU established a series of automatic traffic count sites (using 'traffic loggers') coupled with regular manual traffic counts at sites throughout the country. Data from the loggers however are only available for the period up to 2001, since when the automatic counts have been discontinued.

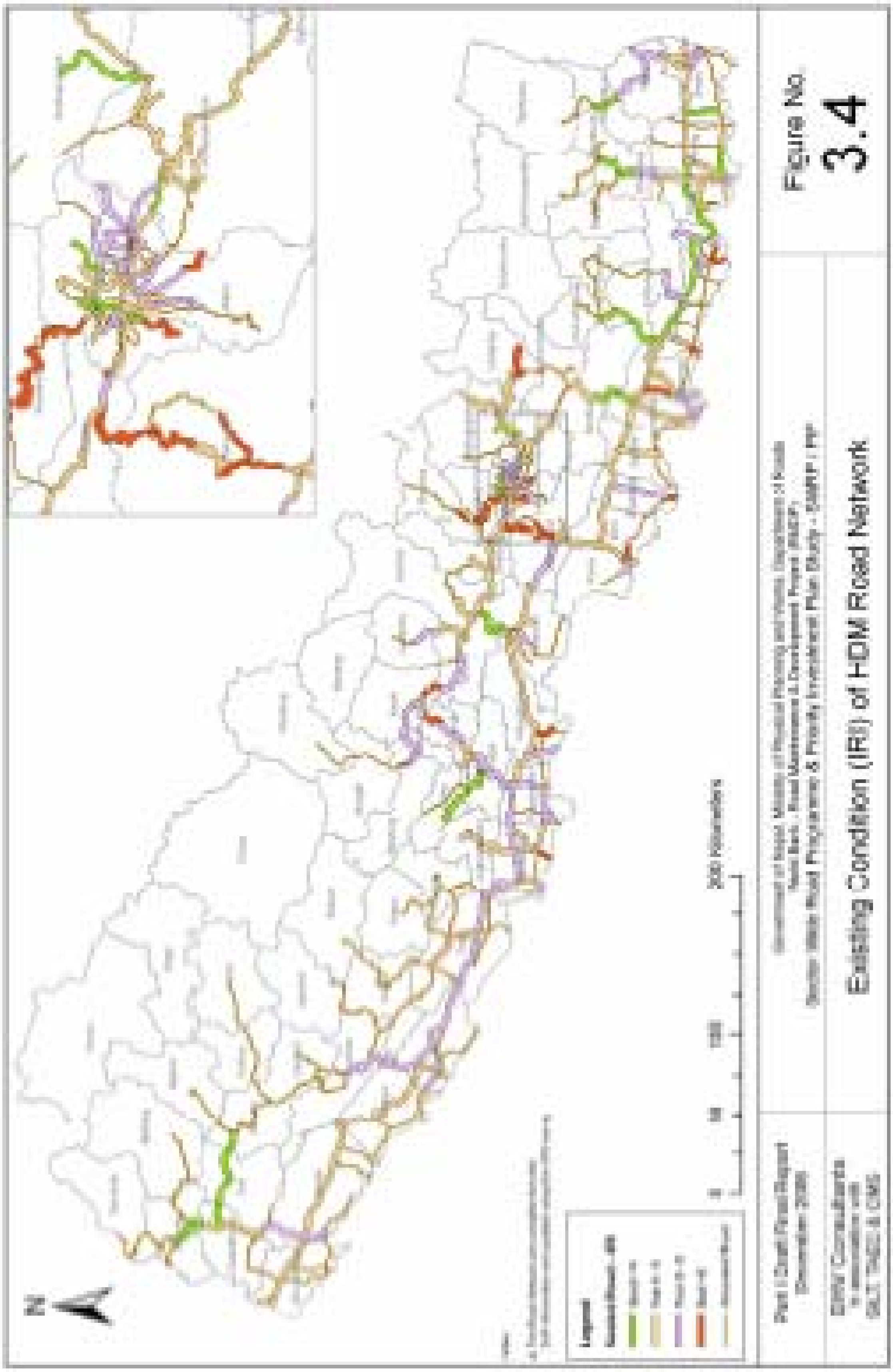


Figure No.
3.4
Existing Condition (IRI) of HDM Road Network

Manual traffic counts have been undertaken on a bi-annual since the late-1990s at 115 sites at key locations on the strategic network. The latest data available are from the counts taken in 2004/05. It should be noted though that traffic flows and movements have been severely disrupted in the years since 2000 as a result of the increasing insurgency and deteriorating security situation. Over this period there have been frequent bandhs (strikes) and closures which have distorted traffic patterns and suppressed demand: additionally frequent security checks on all main roads will have deterred travel and movement in many areas controlled by the Maoists has been restricted. A considerable increase in domestic air travel between the key commercial hubs has also been experienced in the past few years, much of which has been attributed to the difficulties of road travel.

The Consultants undertook a series of three-day (72 hour) manual classified counts at eight key locations on the SRN in April/May 2006 to validate the most recent DoR counts and to provide a check on traffic volumes and vehicle mix. In general the counts confirmed that traffic volumes are depressed below the level that might otherwise be expected. The counts also confirmed that there has been a very substantial increase in the numbers and proportion of motor-cycles in the overall flow – including longer-distance movements.

The Consultants have used the 2004/05 counts as the basis for establishing current traffic volumes on the existing road network. Reference has also been made to the historic data in order to estimate the current growth rates and changes in traffic composition. Specifically data from the loggers over the period 1995-2001 has been used to establish growth rates during a period of more stable activity.

A selection of count data from the more reliable and consistent count sites are presented in. No data are available for 2002-03 or 2005, and the counts in 2004 were seriously influenced by the security situation. The 2006 data shown are from the Consultants counts taken in May: again these data were affected by the disturbances.

Growth in traffic volumes at the four Central Region sites are illustrated in Figure 3.5 (a) and (b). Long-term annual growth rates in the Central Region can be seen to be between 5 and 8 percent, with the key sites at Nagdhunga (or Thankot) (at the entry to the Valley) and Pathlaiya (north of Birgunj) showing the most consistent pattern of growth. The counts at sites outside the Central Region show extreme variability, especially since 2000.

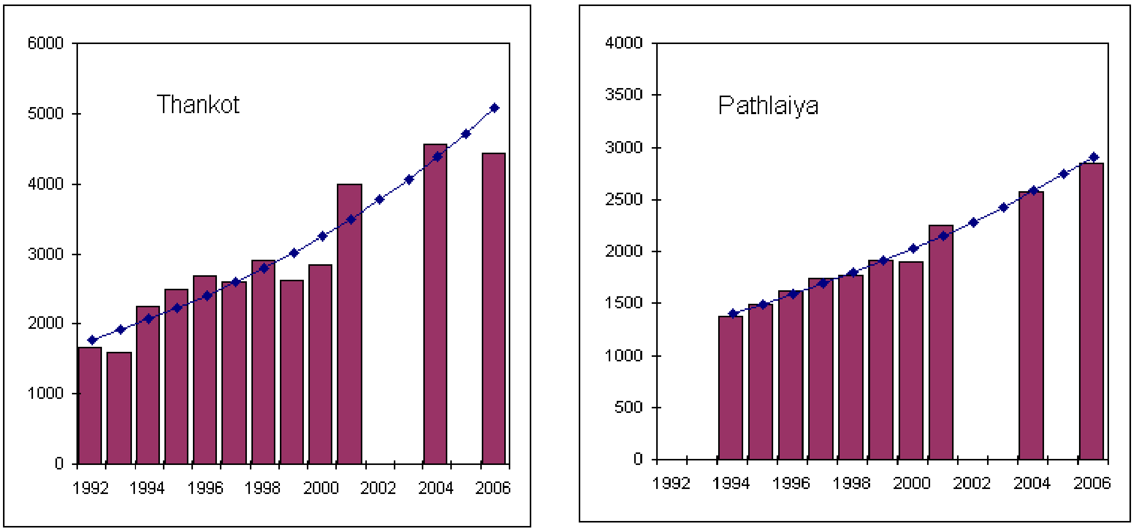


Figure 3.5 (a): Traffic Growth at Central Region Sites (Thankot & Pathlaiya)

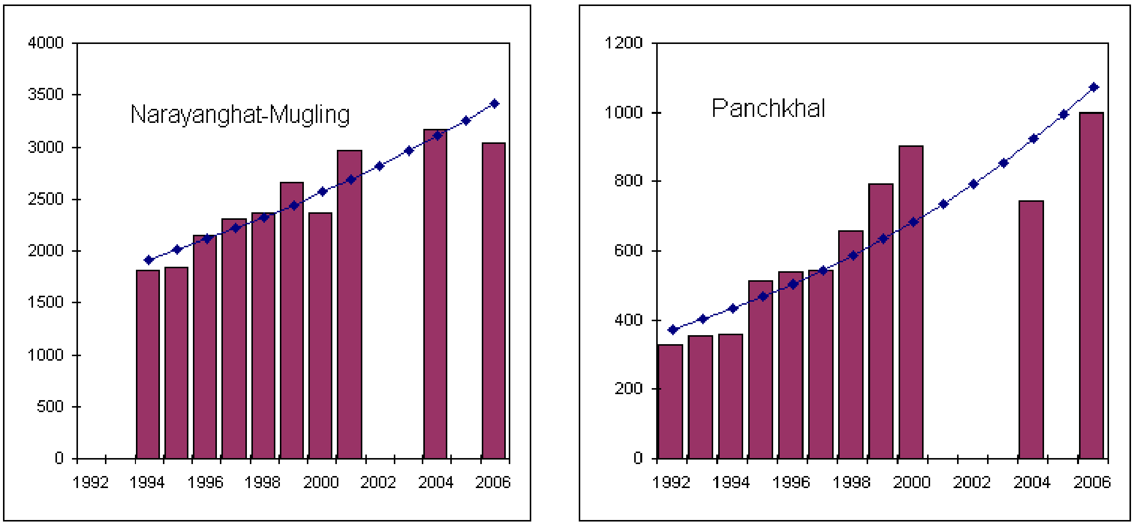


Figure 3.5 (b): Traffic Growth at Central Region Sites (Mugling & Panchkhal)

Table III.9: Historic Traffic Count Data at selected sites (AADT, 1992-2006)

	Central Region				Eastern Region		Western Region		Mid & Far Western Region	
Year	Thankot H0214	Panchkal H0310/1	Bharatpur H0502/3	Pathl'ya N H0129	Charali H0102	Itahari (N) H0804	Bard'ghat H0140/44	Walling H1010/12	Babai H0158/9	Ataria (N) H1403
1992	1665	329								
1993	1596	353								
1994	2237	360	1817	1379						
1995	2482	513	1838	1492	879		936	154	163	95
1996	2684	537	2146	1620	966	1330	1111	151	188	102
1997	2606	543	2303	1731	997	1432	1125	166	216	137
1998	2913	656	2372	1761	1371	1492	1524	263	227	157
1999	2608	794	2650	1916	1134	1521	2214	545	429	191
2000	2842	901	2368	1895	1075	1630	2157	332	513	360
2001	3985	-	2969	2245	995	1605	2545	273	822	329
2002	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	-	-
2004	4558	744	3169	2575	1743	1910	2382	751	655	458
2005	-	-	-	-	-	-	-	-	-	-
2006	4440	1000	3042	2852			2752			199
Growth Rate	7.8%	7.8%	4.9%	6.2%						

Source: DoR counts 1992-2004; Consultants Surveys 2006
Note: All figures exclude Motorcycles (although these were included in the 2004 & 2006 counts)

2. Existing Traffic Volumes

The Consultants have based their estimates of current traffic volumes on the DoR counts for 2004. These are the most comprehensive and consistent available data, despite the uncertainty surrounding the period in which the surveys were undertaken. Fully classified counts are available for 115 sites throughout the SRN including at least one count on each designated Highway and Feeder Road. The 2004 survey was the first time that motor-cycles were included and thus the total

motorised vehicle (MV) count must be treated with care, especially when making comparisons with earlier counts.

Data for the 115 sites, divided by the five major road types, are presented in Table III.10. A total of 41 sites are located on the Core National Highways, including the East-West Highway, links to Kathmandu, major Terai towns and border crossings: these counts averaged a little over 3,000 vpd, with trucks and buses each comprising 22 percent of the total, cars and 'other' 11 percent each, and motorcycles 33 percent. On the 'other' National Highways and Feeder Roads in the hills, traffic volumes are typically around 500 vpd, with trucks and buses comprising 35 percent, cars and 'others' around 30 percent, and motor-cycles 35 percent. Traffic counts on Feeder Roads in the Terai averaged around 1,000 vpd, with almost 50 percent motor-cycles: in Kathmandu Valley flows are substantially higher (with some roads over 10,000 vpd) with cars and motor-cycles dominating.

Table III.10: Summary Data from DoR 2004 Traffic Counts
(Average of observed classified counts)

	No of Sites	Truck	Bus	Car	Other	M/C	Total
Core National Highways	41	717 22%	718 22%	350 11%	360 11%	1051 33%	3194 100%
Other National Highways	21	92 18%	87 17%	79 16%	68 13%	175 35%	501 100%
Feeder Roads (Hills)	27	65 14%	93 21%	57 13%	74 16%	162 36%	452 100%
Feeder Roads (Terai)	18	141 13%	132 12%	83 8%	214 20%	488 46%	1058 100%
Feeder Roads (KTM)	8	808 7%	1445 12%	3879 33%	1268 11%	4522 38%	11922 100%
	115						

It is noted that many of the count sites are located close to settlements or urban areas and thus may over-estimate traffic volumes due to the inclusion of localised movements. This is particularly true for some Feeder Roads where the count has been taken near the start of the road and may not be represent flows along the whole length.

The Consultants have assigned 2006 traffic volumes (and associated vehicle compositions) to all 508 links in the HDM network of sealed and unsealed roads (7,917km). These volumes are based on the 2004 counts, inflated for 6 percent annual growth and adjusted to remove any bias from the count location. Further adjustments were made for sites where the 2004 counts were clearly unreliable or not consistent with previous data.

The resultant traffic flows are illustrated in Figure 3.6, on which the band-width indicates the daily traffic volume, including motor-cycles. It can be immediately seen that the major traffic flows are concentrated in the Central Region and, specifically, on the routes between Kathmandu and the Indian border. Traffic volumes are also generally higher in the east of the country than in the west: flows on the East-West Highway are between 2,000 and 3,000 vpd in the east, between 3,000 and 4,000 vpd in the centre, and less than 2,000 in the west. With few exceptions, traffic volumes on hill roads are less than 500 vpd.

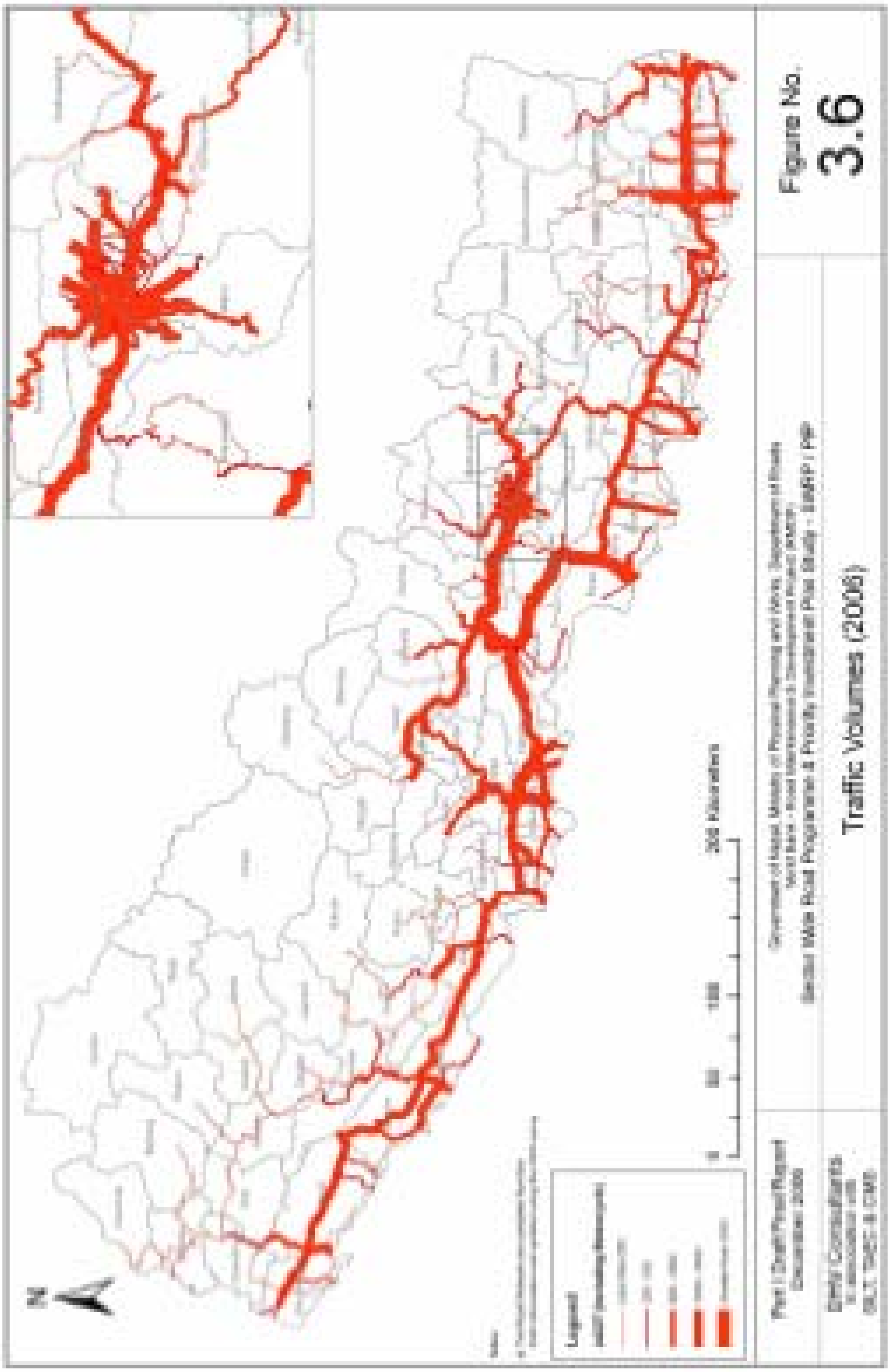


Figure No.
3.6
Traffic Volumes (2006)

The lengths of road within each traffic flow band are given in Table III.11 for both sealed and unsealed roads separately. Over 80 percent of the network carries less than 1,000 vpd: only 1,530 km of mostly sealed roads have more, and only 130 km (wholly within Kathmandu Valley) has over 5,000 vpd. For unsealed roads, almost all (98 percent) carry less than 500 vpd and over half have less than 100 vpd.

Table III.11: Distribution of Road Length (km) by Traffic Volume (2006)

	Sealed		Unsealed		Total	
AADT	Length	Percent	Length	Percent	Length	Percent
< 100	141	3.3%	1,999	54.3%	2,140	27.0%
100 - 200	417	9.9%	919	25.0%	1,336	16.9%
200 - 500	1,262	29.8%	687	18.7%	1,949	24.6%
500 - 1,000	926	21.9%	36	1.0%	962	12.2%
1,000 - 2,000	655	15.5%	40	1.1%	695	8.8%
2,000 - 5,000	706	16.7%		0.0%	706	8.9%
> 5,000	129	3.0%		0.0%	129	1.6%
Total	4,235	100.0%	3,681	100.0%	7,917	100.0%

Source: HDM Database; 2006 Traffic Volumes

For the roads subject to detailed Feasibility Study in Part II, a more extensive traffic investigation has been adopted, including surveys of existing movements and considerations of trip generation potential in the areas served. Current traffic levels on many of the roads studied are severely constrained due to the present condition of the road.

3. Traffic Forecasts

Long-term growth rates on key links in the network are generally in the range 6- 8 percent per annum, with a doubling in traffic volumes in 10 years. Individual links may experience higher growth – especially in urban areas and with the inclusion of motor-cycles. Over most of the network, considerations of traffic growth rates have little impact as network capacity is not a primary concern and only limited sections of road are likely to approach capacity in the plan period.

Within the HDM model, traffic forecasts are based on a series of growth rates for individual vehicle types applied to the current traffic mix on each road section. Overall an annual growth rate of 7 percent has been adopted for all vehicle types, except trucks (5 percent) and NMT (3 percent). These rates were determined based on examination of recent traffic data. The results of the HDM analysis are not particularly sensitive to the growth rates assumed, as most of the network has adequate capacity and upgrading thresholds are best determined on an individual scheme basis.

F. Bridges on SRN

1. Bridge Inventory

An inventory of the existing bridges on the SRN was undertaken on 2004 as part of the RMDP. In total the inventory recorded 1,056 bridges (defined as structures over 6m in length) on the designated SRN. The full list of bridges is presented in Annex 3, Table A3.5, with the key facts summarised in Table 3.12. The current inventory represents an increase of 134 over the 1996 total which included 919 bridges. Most of the increase is due to either new construction or the inclusion of structures omitted from the earlier survey.

Of the total number of bridges, approximately 45 percent (480 bridges) are single-span structures[5], with an average length of less than 25m; a further 20 percent (215 bridges) are 2-span, with an average length of 30m; 25 percent (274 bridges) have 3, 4 or 5 spans with an average length of 60m; and the remaining 88 bridges are multi-span structures with an average length of over 200m.

Table 3.12: Bridges on the Strategic Road Network

	Number of Bridges	Average Bridge Length (m)	Percentage of Total
Single Span	479	24.7	45%
2-spans	215	30.7	20%
3, 4 & 5-spans	274	57.3	26%
6+ spans	88	213.5	8%
Total	1,056	50.2	100%

Source: Draft Bridge Inventory, SILT, August 2005

Almost half of total bridges in the country (515) are on the East-West Highway (Table 3.13), representing a bridge every 2km with an average length of over 60m – or 31m of bridge length per km of road. This reflects the fact that the alignment follows the foothills and crosses a myriad of rivers and water-courses, many of a seasonal nature. Other highways and hill roads typically have one bridge every 8km, with an average length of around 40m (or 5m of bridge per km of road). Feeder Roads in the Terai have approximately twice this number of bridges (one every 4km), again reflecting the increased density of rivers and water courses in the Terai. Hill roads tend to either follow river valleys or are located on ridges, or higher ground, crossing fewer major water-courses and requiring fewer major drainage structures.

Table 3.13: Incidence of Bridges on the Strategic Road Network

	No of Bridges	Length of Road (km)	Bridges per 10km	Length of bridge/km	Av Bridge Length (m)
East-West Highway	515	1,028	5.01	31.39	62.64
Other Highways	293	2,081	1.41	5.56	39.48
Hill Feeder Roads	152	1,477	1.03	3.97	38.57
Terai Feeder Roads	96	444	2.16	7.43	34.34
Total	1,056	5,030	2.10	10.53	50.18

Source: Draft Bridge Inventory, SILT, August 2005

Most of the exiting bridges have been built in conjunction with the development of the road network and, as a result, many are 35-40 years old and increasingly in need of maintenance and repair. Over 80 percent are reinforced concrete, with the remainder a mix of steel trusses (including Bailey Bridges), steel plate girder, pre-stressed concrete and stone or concrete arches in approximate equal numbers of each. There are a limited number (8) of timber bridges.

The longest structures are on the East-West Highway in the Eastern Region: the Koshi Barrage (1.15km with 56 spans) and the Mahuli Bridge (1.13km with 226 spans). Other significant structures are the Karnali Cable-Stayed Bridge (500m, with a 325m main span) and three suspension bridges, each of 125m span, across the Narayani at Mugling, the Marshyandi (Gorka) and the Bheri (Surkhet).

[5] This category includes a limited number of major bridges (including arch, truss or suspension bridges) and long causeways: three quarters of the bridges are less than the average of 25m

2. Bridge Condition and Maintenance

The Bridge Inventory Study also undertook a condition survey of a sample of 96 bridges – from within the total of 1056 – which were identified as being in need of repair or rehabilitation. The selected bridges included 34 bridges on the East-West Highway, 38 on other Highways and 24 on Feeder Roads. The damage and defects notes ranged from ‘complete collapse’, ‘scour & siltation’, ‘corrosion of bearings’, ‘ageing’ to ‘poor condition’: 15 cases of damage due to ‘rebels attack’ were noted.

A total of 10 elements of each bridge were inspected and ranked, including: the approach roads, bridge deck surface, parapets, expansion joints, superstructure, bearings, abutments, piers, protection works, and river training works. The condition of each element was ranked on a scale of 0-4, with the extent of damage and degree of urgency also scored on a scale of 0-4. Details of the recommended remedial works are included in the draft Study Reports: the results of the condition survey are presented so as to enable DoR prioritisation of the remedial works.

A specific recommendation is made regarding the widening of the bridges on the Pathlaiya-Dhalkebar section of the East-West Highway. There are approximately 60 bridges on this section most of which have a carriageway width of only 5.5m: this is below the minimum for Asian Highway Standards and is insufficient for two commercial vehicles to pass in comfort. Furthermore 10 of these bridges are in excess of 100m in length, which adds to difficulties for opposing vehicles to pass. A detailed study of how best to resolve the issue is recommended.

3. Recommendation

This Study endorses the recommendation of the 2005 Bridge Inventory Study to support the continued operation of the Bridge Management System which was originally established in DoR in 1996. Procedures for the regular inspection and maintenance of bridges were defined, although full implementation of the cycle of inspection, planning and maintenance has not yet been established. Effective management of bridges requires the regular inspection, collection and recording of accurate bridge data, together with design and construction records.

There is an on-going need for the training of engineers in the process and procedures of bridge inspection, as well as in updating the record system.

In addition to bridges on the Strategic Network, the DoR also constructs, and is responsible for, a number of key bridges on the local road network, which provide valuable access and linkage into rural areas. This practice should be continued, as DoR have the appropriate skills and expertise, although separate funding procedures should be adopted (see Chapter 10).

It is recommended that a specific programme of bridge rehabilitation and repair be instigated in response to the Bridge Inventory and Condition Survey in 2005, which identified at least 100 bridges in need of remedial works.

Chapter 4

IV. MAINTENANCE AND UPGRADING OF THE DOR NETWORK

A. Introduction

1. Objectives

This Chapter focuses on the analysis of the on-going maintenance and upgrading requirements of the existing – and likely future – Strategic Road Network using the World Bank's Highway Development and Management Model (HDM-4). The aim is to identify the extent of the optimum expenditure on maintenance over the 10-year planning period as an essential first component of future planning and budgeting. Specifically, in regard to HDM, the Study has two objectives:

- To produce an economically optimum 10 year expenditure plan for all roads under the DoR using HDM-4 as the primary tool for evaluation.
- To institutionalise the use of HDM-4 in DoR as a tool for expenditure planning, prioritising roadworks and feasibility studies.

2. Network Definition

The road network forming the subject of the expenditure plan aimed to include all roads for which DoR will be responsible over the period from 2007 to 2016. This comprises:

- Existing links in the currently designated SRN.
- Links under construction or with committed funding which will form part of the expanded SRN.
- Other roads which are not part of the designated SRN but for which DoR has 'de facto' responsibility.

This network, comprising 506 sections with a total length of 7,917km, was described in the previous chapter and was illustrated in Figure 3.3. In practice the network represents the situation that will most likely exist in 2010, following the completion of schemes currently under construction or in an advanced state of planning, and the formalisation of many local roads as part of the SRN.

3. General Approach

The expenditure plans were assembled from two sources:

- Major works (resurfacing, rehabilitation, improvement) which could be evaluated and optimised using HDM-4 on the basis of total transport cost analyses.
- Other works (routine, recurrent and emergency maintenance) which are essential to preserve the integrity of the network but which cannot be prioritised using economic models. These costs were based on existing DoR norms.

Data sources for the analyses came primarily from existing data from the DoR Highway Management Information System (HMIS) and previous consultants' studies.

B. Road Network Data

1. Road Inventory

DoR has an established system for dividing roads into links on the basis of administrative boundaries, major river crossings and major towns. Where a link is only partially sealed, it was divided into two or more analysis sections. Thus the first link on Feeder Road F10 is designated as Link F1001. The first 9.5km of the link is sealed and this section was designated as Section F1001A and the remaining unsealed 8.5km as Section F1001B.

For HDM analysis a number of geometric parameters are needed, of particular importance being horizontal and vertical geometry and pavement width. This data is required for both sealed and unsealed roads. Road width was obtained from the HMIS database while other geometric characteristics were derived from various sources including a GPS survey in 2004 covering 2,000km of the network.

For sealed sections, the type and thickness of surfacing, overall pavement strength (SNP) and pavement age are the main determinants of pavement performance. This data was based on construction records and DCP tests carried out during a previous PIP study in 1997.

Figure IV.1 shows the percentage of network length by pavement width. Single lane roads predominate with major highways being two lane. There are relatively few sections with intermediate lane width.

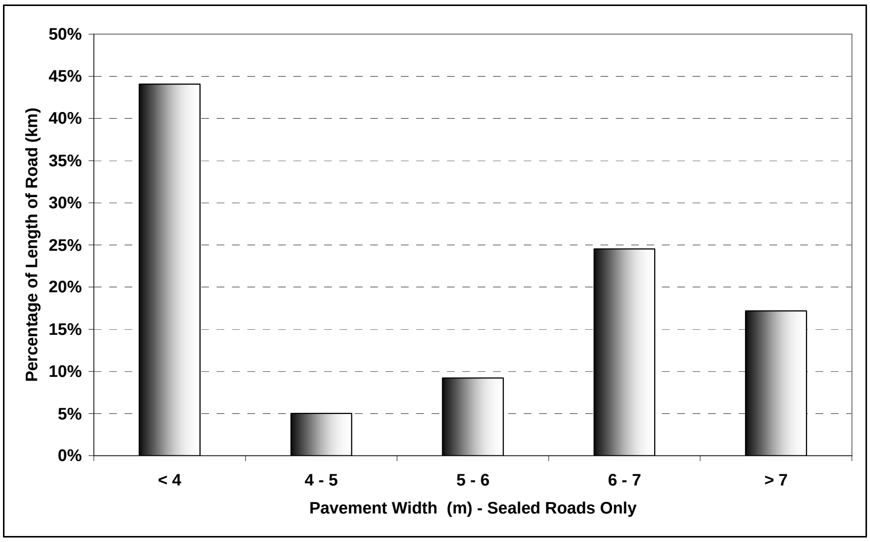


Figure IV.1: Distribution of Pavement Width for Sealed Roads

Figure IV.2 shows the distribution by horizontal alignment expressed in degrees per km of curvature (the measure used in HDM-4). Not surprisingly there is a very high proportion with extreme values of curvature.

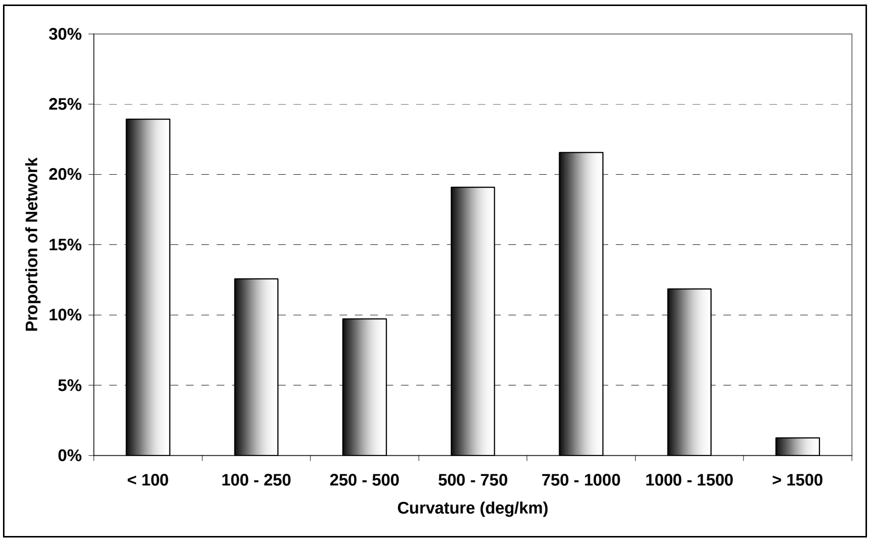


Figure IV.2: Horizontal Alignment

2. Road Condition

The existing SRN has been subject to regular traffic and condition surveys for a number of years. The last set of surveys was carried out in late 2004/early 2005. The data has been screened for reliability and some adjustments made. This applied in particular to the roughness data and a recalibration was carried out as described in the Part II Interim Report (October 2006).

For sealed sections not included in 2004/5 condition survey, estimates of roughness and cracking were based on the pavement age and surfacing type – Surface Treatment (ST) or Asphaltic Concrete (AC).

Little surface maintenance is done on gravel and earth roads and they typically have a high roughness. A standard value of 20m/km IRI was assumed for all unsealed roads.

Figure IV.3 shows the current service level of the sealed network in four classes. This uses roughness as the measure of service to road users and the proportion of the network in poor and bad condition is much higher than previous DoR ratings that used Surface Distress Index (SDI) as a measure of condition. SDI is dominated by cracking and ravelling, defects that are important to road engineers but may not be apparent to road users; a road may be heavily cracked but have a good ride quality. Conversely there are many sections that have received a recent reseal with consequent low levels of SDI but have a high roughness.

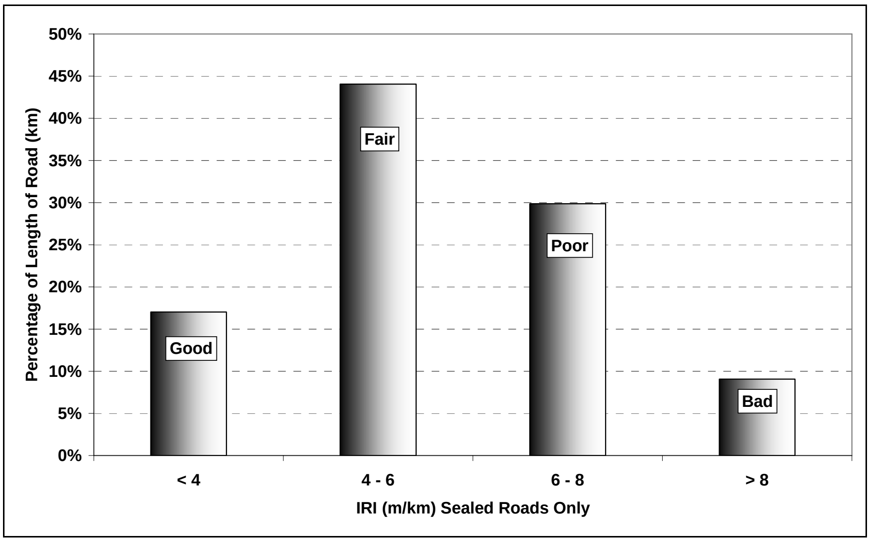


Figure IV.3: Current Service Level of the Sealed Network

3. Traffic

Where available, classified traffic count data from 2004/5 was adjusted to create 2006 volumes. For links without count stations, volumes were interpolated from adjacent counts or estimates made using the extensive knowledge of the DoR and Consultants' staff.

The main contribution to axle loading is the two-axle truck. Axle load surveys have shown a considerable variation in the average loading of these trucks depending on the location of the road; axle loads are higher on the strategic corridor between India and Kathmandu and on certain roads in the Terai. On feeder roads in the hills axle loads are generally lower. To cater for this variation, 3 types of truck (light, medium and heavy) were used in HDM-4 and the volume of trucks allocated to the appropriate type following the guidelines in Table IV.1.

Table IV.1: Allocation of Truck Types by weight

Road Type	Terrain	Truck	VDF
Core Network	All	Medium	4.0
Other highways	Terai	Medium	4.0
Other highways	Hills	Light	2.5
EWH to border	Terai	Heavy	7.0
eder roads	Terai	Medium	4.0
Feeder roads	Hills	Light	2.5

Figure IV.4 shows the distribution of road length by traffic level. Unsealed roads have, generally, quite low volumes although there are a few unsealed sections, mainly in the Terai, with over 500 veh/d. The roads with more than 5,000 veh/d are mostly in the Kathmandu Valley while the core network is mostly in the range of 1 – 5,000 veh/d.

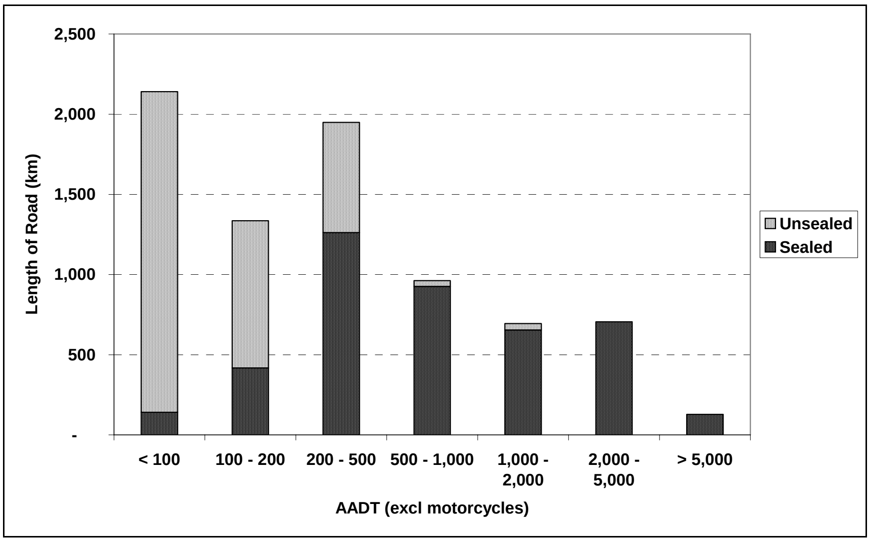


Figure IV.4: Traffic Distribution

4. Ongoing and Committed Projects

As described in Chapter 3, the HDM network includes a number of links for which construction or improvement is ongoing or funding is already assured. The total length of committed works is 3,029km. In many cases it was decided to exclude committed sections from further analysis using HDM. The reasons for excluding sections were:

- overlay is ongoing – there should be no need for further major maintenance in the 10 year plan period;
- improvement to sealed standard is ongoing and no further improvement is needed; or
- reconstruction of existing sealed road – not further major maintenance should be needed in the 10 year plan period.

Other committed sections were included because:

- resealing will be complete by end 2006 and further reseal my be needed before 2016; or
- construction is to earth or gravel standard and the section may be a candidate for improvement to sealed standard after completion of the current project in 2010.

In total, 110 sections with a total length of 2,450km were excluded from the analysis leaving 396 sections with a total length of 5,467km to be evaluated in the constrained budget analysis. This, conveniently, reduced the number of analysis sections below 400, a constraint contained in the HDM program: a later section describes how this enables a constrained budget analysis to be performed with HDM-4.

C. Maintenance and Improvement Standards

1. Resurfacing and Rehabilitation

Periodic maintenance (resurfacing) options followed current DoR practice. Most sealed roads have a DBST surfacing and periodic resealing is done with a single surface dressing. Only for the relatively few roads with higher traffic volumes are asphaltic overlays used.

At a certain level of deterioration it is impractical to reseal as this has little effect on roughness. In these cases DoR normally scarifies and reshapes the existing pavement, adds a new layer of granular base and new surfacing. For higher traffic volumes, asphalt surfacing is used. Table IV.2 shows the intervention levels applied in HDM-4 for the resurfacing and rehabilitation options. These thresholds were an attempt to replicate current DoR policy and they are not necessarily the economic optima. As a sensitivity test, another set of intervention levels was applied with overlay used on the lower traffic ranges when roughness was deemed to be unacceptably high: this is reported in Section 4.6.3 below.

Table IV.2: Intervention Levels for Resurfacing and Rehabilitation

	AADT Range (incl motorcycles)		
IRI Range	**< 1,000**	**1,000 – 3,000**	**> 3,000**
< 8	Seal	Seal	Overlay
8 – 10	Seal	Rehab	Rehab
> 10	Rehab	Rehab	Rehab

2. Road Improvement

For unsealed roads, the only major work considered was improvement to sealed standard. In pavement terms, this normally comprises a new base layer with DBST surfacing, though recent projects have trialled the use of Otta seals. Such improvements are normally accompanied by improved drainage and construction of retaining and breast walls to alleviate slope instability.

3. Unit Costs

Table IV.3 shows the unit costs of roadworks adopted for the HDM analyses. These are simplified rates, averaged across Disticts and between the hill and terai derived from unit rate analyses and compared with recent contract prices. A detailed rate analysis is presented in Annex 4.1A.

Table IV.3: Unit Costs of Roadworks

		Unit Cost (Rs)	
Item	**Unit**	**Economic**	**Financial**
SBST	m^2	97	105
40mm overlay	m^2	506	550
100mm base + DBST	m^2	874	950
200mm base + A/C	m^2	1,288	1,400
Improvement (Terai)	km	3,680,000	4,000,000
Improvement (Hills)	km	5,520,000	6,000,000
Patching	m^2	368	400
Edge Repair	m^2	368	400
Spot regravelling	m^3	74	80

Annex 4.1B, defines the maintenance and improvement standards in terms of the input parameters required by HDM-4.

D. Application of HDM-4

1. Model Calibration

The Consultants' Terms of Reference required a Level 2 calibration of HDM-4. This covers the models for road user effects (RUE) and road deterioration and works effects (RDWE). Annex 4.2A describes the calibration of the RUE models and Annex 4.2B the calibration of RDWE models. In the latter case, calibration focussed on the most important determinants of agency and road user costs which are:

- cracking initiation and progression
- roughness progression
- roughness after resurfacing and rehabilitation

2. Data Import

The road network comprised 506 analysis sections. To enter this data manually into HDM-4 would take a considerable time and would probably lead to multiple errors in data entry. Thus the HDM-4 data import facility was used. The following steps were followed:

- Road characteristics and traffic volumes were compiled in two separate spreadsheets.
- Road characteristics data was imported into an Access database in the correct HDM export/import format (Sections table).
- The traffic data was programmatically converted into the linear form required for the Traffic table in the Access database.
- The Access database was imported into HDM-4 which automatically checks for errors during the import process.

3. Programme Analysis

HDM-4 offers three types of analysis – project, programme and strategy level. For this study the programme level analysis was appropriate. To allow for constrained budget optimisation over a 10 year period, a matrix of alternatives needs to be defined for each section. For sealed roads, the initial treatment may be resurfacing or rehabilitation in each of 10 years giving 20 potential section alternatives to be analysed. For unsealed sections the only alternative considered was improvement to sealed standard. Given the large ongoing and committed programme described above, it was considered unrealistic to consider new upgrading projects in the first four years of the planning period. Thus, improvements were only assigned for the years 2011 – 2016 giving 7 alternatives (with the base case) for unsealed road sections.

In addition a base alternative (do-minimum) must be defined for each section. For sealed roads this included pothole and edge break patching and rehabilitation if roughness exceeds 12m/km in year 11 or later. For unsealed roads spot re-gravelling was applied annually.

The analysis period used was 20 years and after the initial treatment a long term periodic maintenance standard was applied. This comprised resurfacing triggered by either cracking or roughness thresholds.

Table IV.4 shows how a series of section alternatives is defined.

Table IV.4: Example of Section Alternatives

Section Alternative	Year	Work Item	Intervention
RES1	2007	Resurfacing	IRI < 8
	2008	Resurfacing	Cracking > 10%
RES2	2008	Resurfacing	IRI < 8
	2009	Resurfacing	Cracking > 10%
RES3	2009	Resurfacing	IRI < 8
	2010	Resurfacing	Cracking > 10%
RES4	2010	Resurfacing	IRI < 8
	2011	Resurfacing	Cracking > 10%
etc to			
RES10	2016	Resurfacing	IRI < 8

Section Alternative	**Year**	**Work Item**	**Intervention**
	2017	Resurfacing	Cracking > 10%

Many of the section alternatives will be inappropriate for some sections; for example the roughness may already exceed the limit for resurfacing. Manual assignment of alternatives is a slow process and HDM-4 has the facility to copy all the section alternatives from one section to others. This greatly speeds up the process of setting up the analysis and, consequently, standard sets of alternatives were applied to all sealed or unsealed sections. This is a trade-off between set-up time (shorter) and run time (longer because many inappropriate alternatives are analysed). However, run time is not a major problem as the computer can be left to run while the user performs other tasks.

Annex 4.3 defines in more detail the assignment of section alternatives in HDM-4

Table IV.5 shows other parameters used in the analysis.

Table IV.5: Analysis Parameters

Parameter	Value
Condition year	2006
Traffic year	2006
Start year	2007
Analysis period	20 years
Discount rate	12%
Include accident costs?	No

4. Optimisation

HDM-4 provides three methods for producing optimised works programmes under constrained budgets. All three have the same objective function – to maximise Net Present Value for the whole network subject to financial constraint on the total budget for agency costs. The methods are:

- Total enumeration; this produces a wholly correct mathematical solution but it is limited to a small number of sections.
- EBM32 which is an expanded version of the Expenditure Budgeting Module which was add-on application to HDM-III. This uses the Ahmed method of effective gradients and is generally considered to give a nearly optimum solution. There are certain limits to this method including the number of analysis sections (400) and the number of alternatives per section (17). Although the documentation claims that up to 12 budget periods can be used it was found in practice that the limit was 6.
- Incremental benefit/cost ranking; this method has no limit on the number of sections or alternatives tested. This method was initially applied in this study because of the number of sections (over 500) but the results were disappointing and there is clearly some defect in either the programming or specification for this method.

To overcome the limitations of the software, the scope of the programme analysis was reduced to less than 400 sections. This was done by excluding ongoing and committed sections from the analysis, as described earlier. The number of alternatives tested for sealed roads was also reduced from an initial 21 to 11. This was done by combining resurfacing and rehabilitation into the same maintenance standard and applying the mutually exclusive intervention levels given in Table IV.2.

E. Other Maintenance Expenditures

HDM-4 is suitable only to evaluate periodic maintenance and major improvement works. Although it has a limited capability to estimate needs for routine maintenance works (patching, edge break), it cannot analyse many of the roadworks expenditures incurred in Nepal such as landslips.

DoR has a comprehensive definition and budget headings for different types of expenditure:

- **Routine Maintenance**: Maintenance required at all times on every road because of traffic movement as well as environment degradation. It covers grass cutting, drain cleaning, removing debris and draining water from the carriage way, bridge and culvert maintenance, and road furniture maintenance etc.
- **Recurrent Maintenance:** Maintenance required at varying intervals during the year with a frequency that depends mostly on volume of traffic. It is repairing pot holes and ruts, dragging and grading on unpaved roads where, as on paved roads, it covers repairing pot holes, patching, repairing edges and shoulders, sealing cracks and small repairs of structures.
- **Specific Maintenance:** This type of maintenance is done as required by the road condition. The pothole maintenance in large scale, gravelling the shoulder, construction of retaining walls, drain repair, replacing the traffic signs and cross drains etc.
- **Traffic Safety:** Every Road Division is allocated some funds to improve Traffic Safety measures and to repair the existing traffic signs, delineator posts, road markings and other traffic safety related works.
- **Bio Engineering:** These works are carried out by all divisions to stabilize road side slopes where low-cost bioengineering techniques suitable.
- **Emergency Maintenance:** Required for immediate opening of road closures during disasters like flood, land slides and earthquake. It covers removal of debris and other obstacles, placement of warning signs and diversion works.
- **Damage Rehabilitation Works:** For available budget a prioritized list of damage rehabilitation works is made. Then these works are carried out through contractors.
- **Equipment Maintenance and Mobilization:** There are numerous known locations along the strategic road network, which are highly vulnerable to road closure during monsoon and other natural calamities. In order to minimize the risk of long duration road closure, DOR every year prepares an emergency action plan and deploys necessary heavy equipment, manpower and construction materials in all potential and pre-identified locations.
- **Other Works (Miscellaneous):** These recurrent costs include weighing bridges, security arrangements of major bridges and divisional and regional offices, road neighbour empowerment and monitoring and evaluation works.

The need for many of these works varies considerably between road sections and from year to year. To obtain an order of magnitude cost for planning purposes, network average costs per km have been applied as shown in Table IV.6.

Table IV.6: Annual Maintenance Expenditures

Expenditure Category	**Rs/km/year**
Routine Maintenance	30,000
Recurrent Maintenance	35,000
Specific Maintenance	25,000
Traffic Safety	1,200
Bio Engineering	1,000
Emergency Maintenance Works	1,200
Damage Rehabilitation Works	8,000
Equipment Maintenance and Mobilization	3,500
Other Works (Miscellaneous)	2,000
Total	**106,900**

For the network of nearly 8,000km used for the HDM analysis, the total annual cost of the above works is around Rs 850 million per year.

F. 10 Year Expenditure Plans

1. Unconstrained Network Needs

The unconstrained optimum solution is to select the alternative for each section that has the highest NPV. When a road network has a large backlog of roadworks needs the result is a very unbalanced result in terms of annual budgets – very high in the initial year, tailing off in later years. In this analysis, the unconstrained need had two peaks – 2007 for resurfacing and rehabilitation and again in 2011 when upgrading of unsealed roads was first tested. This is shown in Figure IV.5.

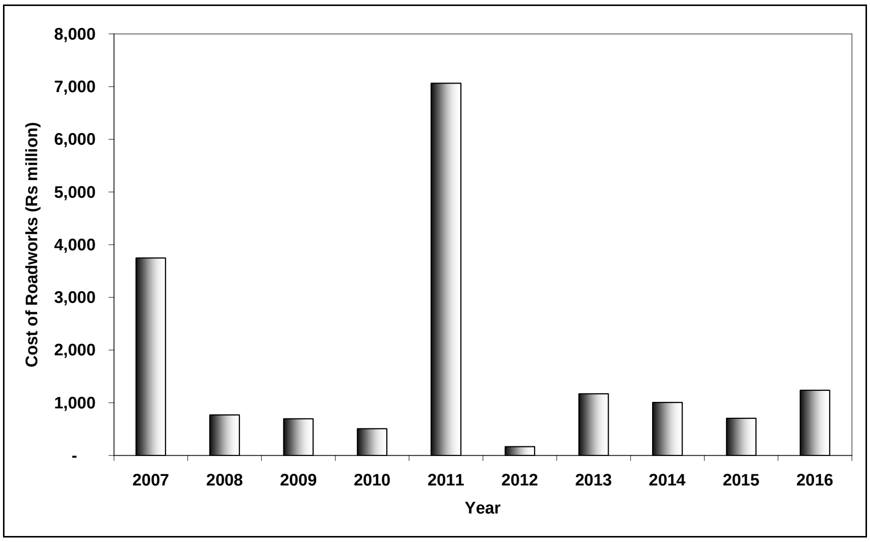


Figure IV.5: Unconstrained Budget Distribution

To provide a more realistic scenario for the unconstrained needs, a light budget constraint was applied, providing the same overall total for the 10 years but with a more equal distribution. As mentioned earlier, the software would only accept 6 budget periods and to accommodate this limitation budgets were applied for two year periods over the 10 year plan with unstrained budget allowed from year 11 onwards to cater for subsequent maintenance works. Table IV.7 shows the budget limitations applied and forecast expenditures in, what is called

in this report, the balanced unconstrained scenario. It can be seen from the Table that expenditure is effectively 'capped' at the imposed limit in Years 1 & 2, and again in Years 6 to 8, but that the full allocation is unused in Years 3 & 4 and 9 & 10. This is an indication that the overall budget provision is adequate.

Table IV.7: Balanced Unconstrained Budget (Rs million)

Period	**Budget Limitation**	**Forecast Expenditure**
2007 – 2008	3,000	2,999
2009 – 2010	3,000	2,276
2011 – 2012	4,000	3,998
2013 – 2014	4,000	3,999
2015 – 2016	4,000	3,009
2017 onwards	unconstrained	
Total	18,000	16,282

The balanced unconstrained scenario is little different to the totally unconstrained case in terms of the types of works applied over the 10 years – only the timing changes with works deferred from 2007 and 2011 to later years. The two are compared in Figure IV.6 and Figure IV.7.

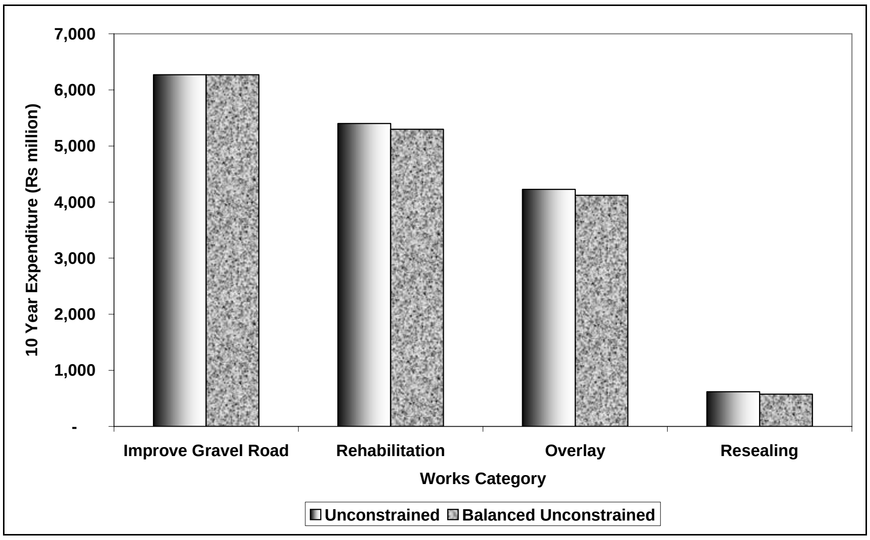


Figure IV.6: Road works by Cost – Unconstrained Budgets

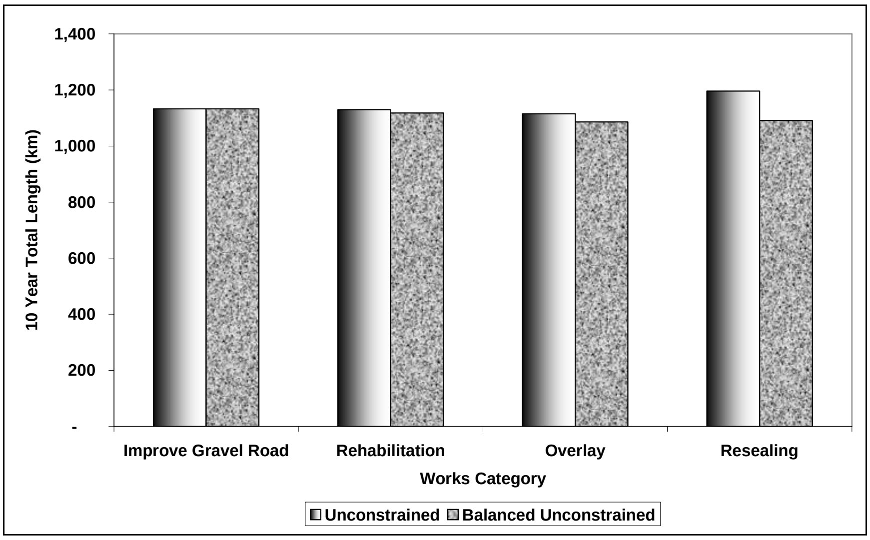


Figure IV.7: Roadworks by Length – Unconstrained Budgets

Although, in terms of length, there is quite even distribution between the four categories of works, in terms of cost the programme is dominated by improvement and rehabilitation works.

The works programme given by this scenario is shown in detail in Annex 4.4[6], and is illustrated in Figure IV.8 showing the extent of the proposed reseal, overlay, rehabilitation, and upgrading proposals. It can be seen that most of the network – apart from sections with committed improvements – receives some treatment in the 10-year period. It is also evident that the overlay is applied only to those elements of the 'core network' with higher traffic volumes: ie routes to Kathmandu and the East-West Highway in the Eastern, Central and Western Regions.

The location of works proposed in the first two 2-year periods, and the remaining six years, are illustrated in Figure IV.9, with the resultant overall network condition after 10 years shown in Figure IV.10. It should however be emphasised that the precise timing and scope of works should be re-examined on an annual basis and the priorities and work programme established accordingly. The HDM programme is indicative only of the scale and content of the likely works.

2. Effects of Budget Constraints

Recognizing that the unconstrained budget may not be affordable, constrained budget results were produced at 75% and 50% of the balanced unconstrained scenario, as required in the ToR.

Figure IV.11 and Figure IV.12 show the effect on different categories of roadworks as the budget is reduced. At 75% of the unconstrained budget, improvement works are hardly affected while rehabilitation is much reduced. At 50% of the unconstrained budget, all categories are significantly reduced with the exception of overlays.

6 Note the final three columns show details of the alternative 'all roads' analysis, described in Section 4.7 below.

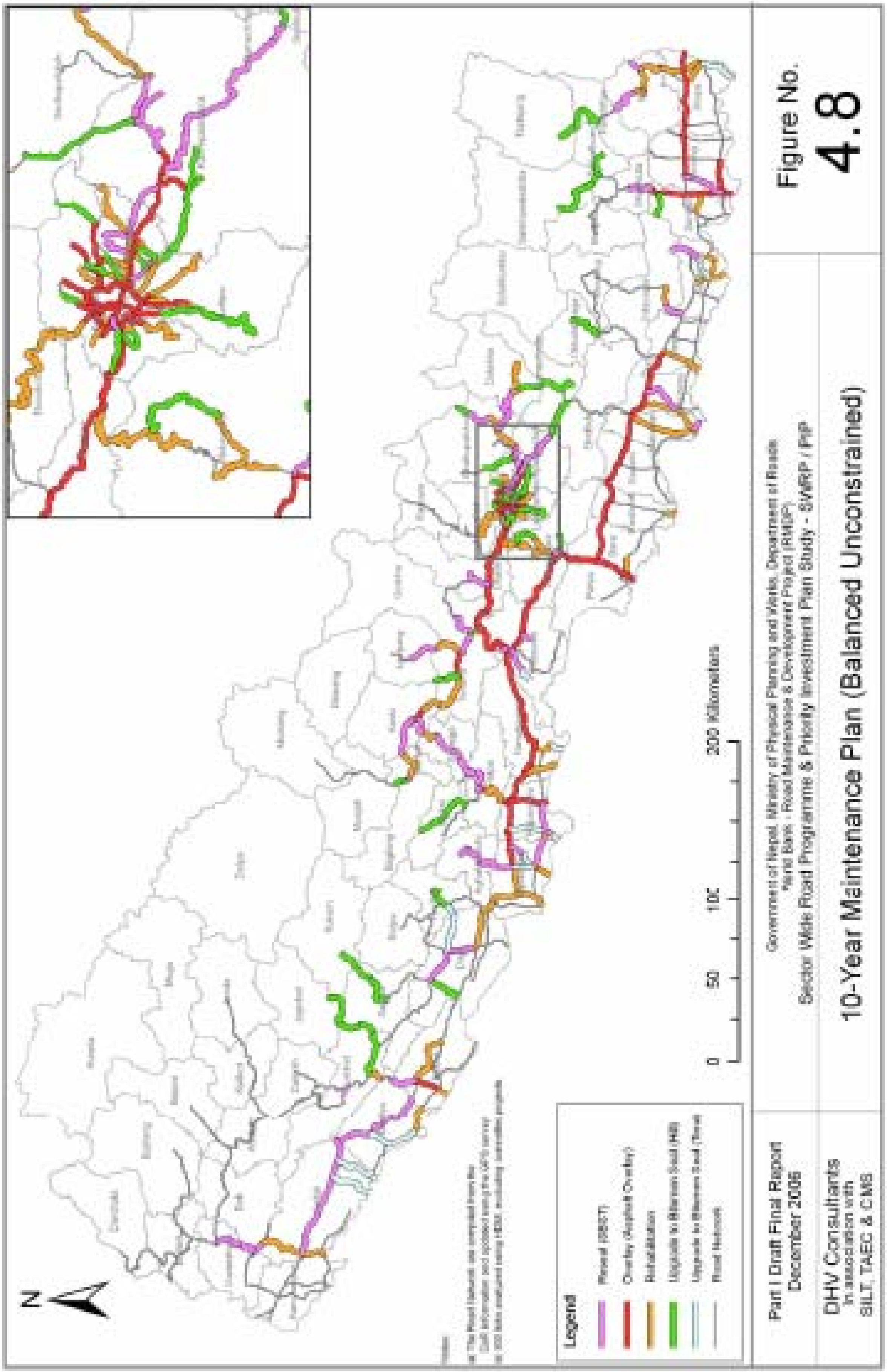
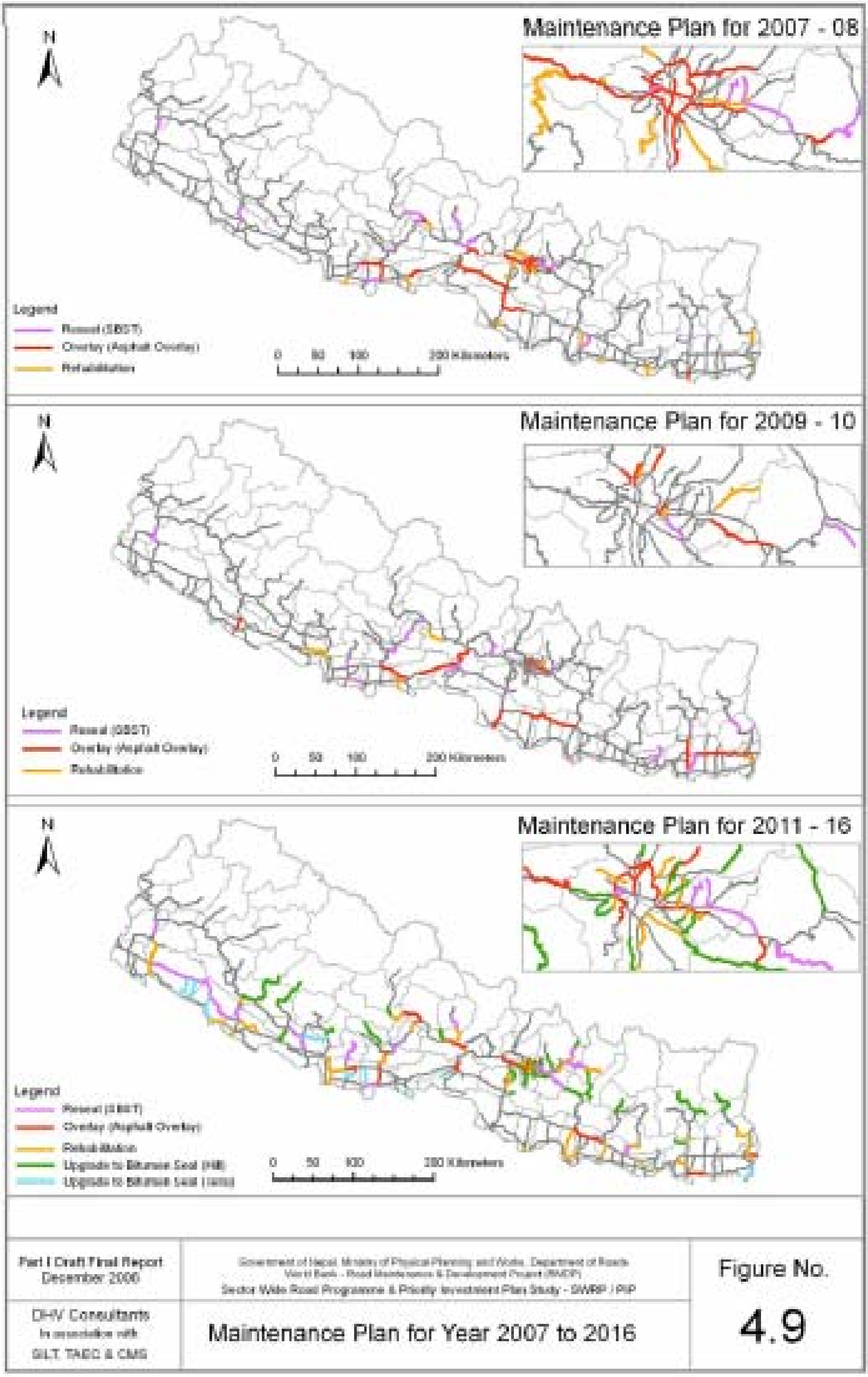


Figure No.
4.8
10-Year Maintenance Plan (Balanced Unconstrained)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Part I Draft Final Report
December 2006
DHV Consultants
in association with
SILT, TAEC & CMS
Legend
0
50
100
200 Kilometers


Maintenance Plan for 2007 - 08
N
Legend
Overlay (Asphalt Overlay)
Rehabilitation
0 50 100 200 Kilometers
Maintenance Plan for 2009 - 10
N
Legend
Overlay (Asphalt Overlay)
Rehabilitation
0 50 100 200 Kilometers
Maintenance Plan for 2011 - 16
N
Legend
Overlay (Asphalt Overlay)
Rehabilitation
Upgrade to Bitumen Seal (Hill)
0 50 100 200 Kilometers
Part I Draft Final Report
December 2006
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
DHV Consultants
in association with
SILT, TAEC & CMS
Maintenance Plan for Year 2007 to 2016
Figure No.
4.9

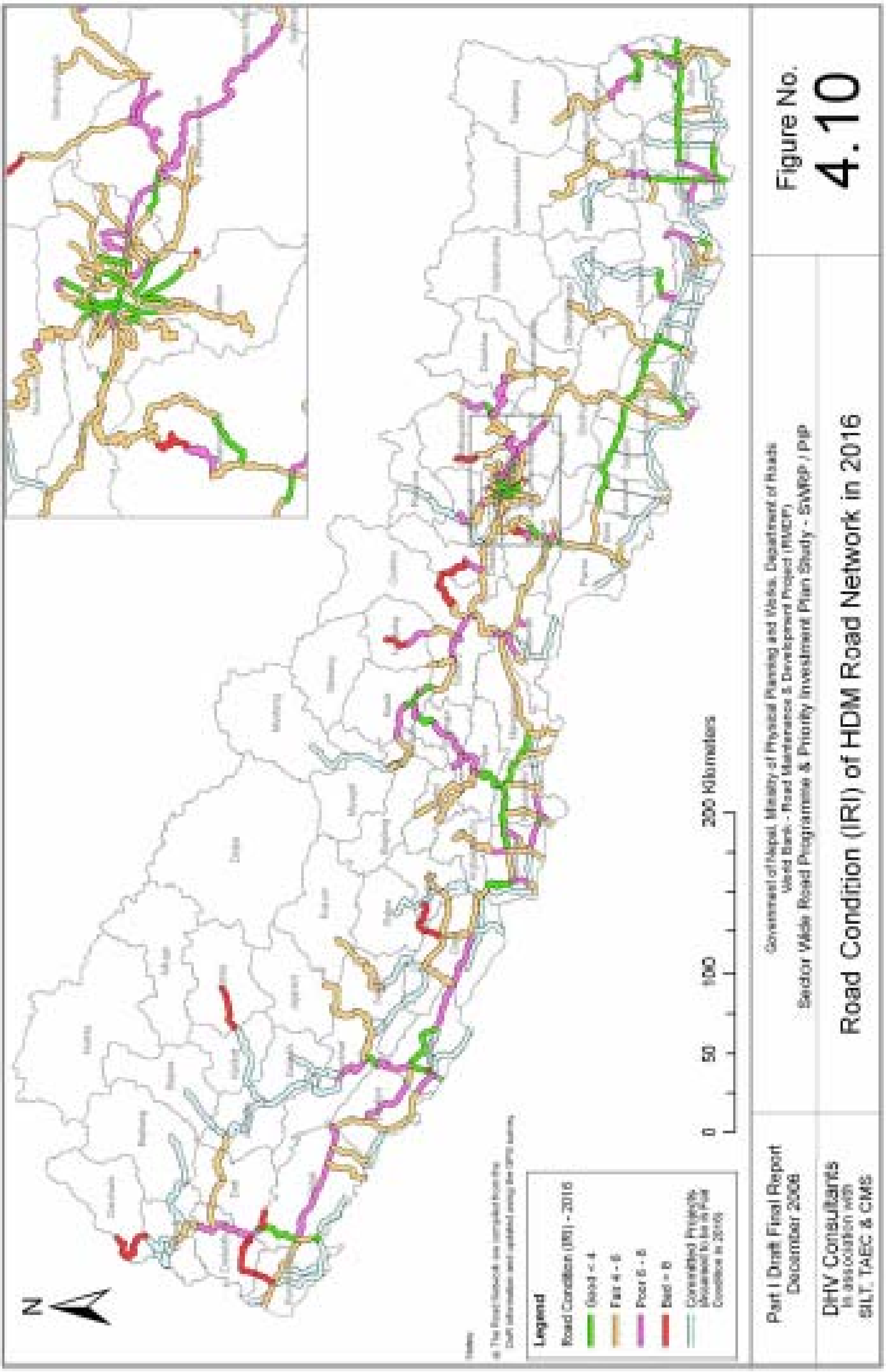


Figure No.
4.10
Road Condition (IRI) of HDM Road Network in 2016
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Part I Draft Final Report
December 2006
DHV Consultants
in association with
SILT, TAEC & CMS
200 Kilometers
0
50
100
Legend
Road Condition (IRI) - 2016
Good < 4
Fair 4 - 6
Poor 6 - 8
Bad > 8
Committed Projects
N

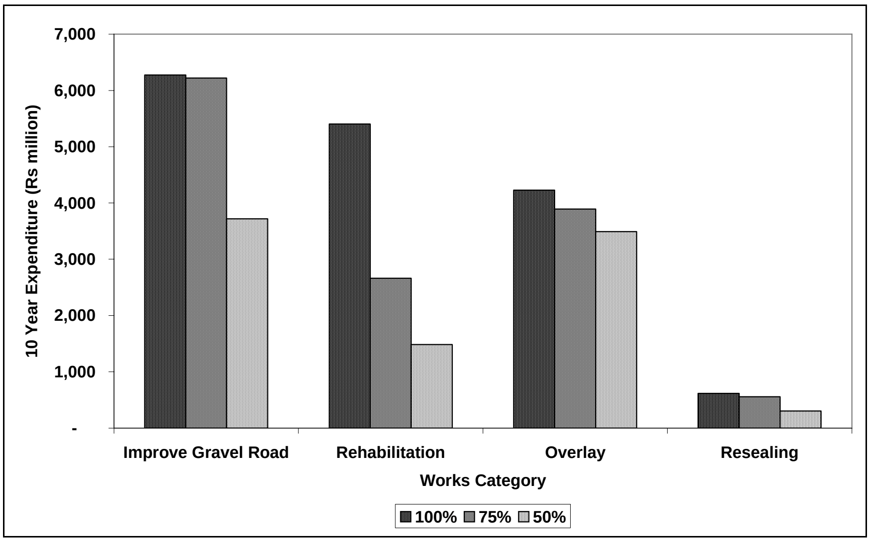


Figure IV.11: Effect of Budget Constraint on Roadworks by Cost

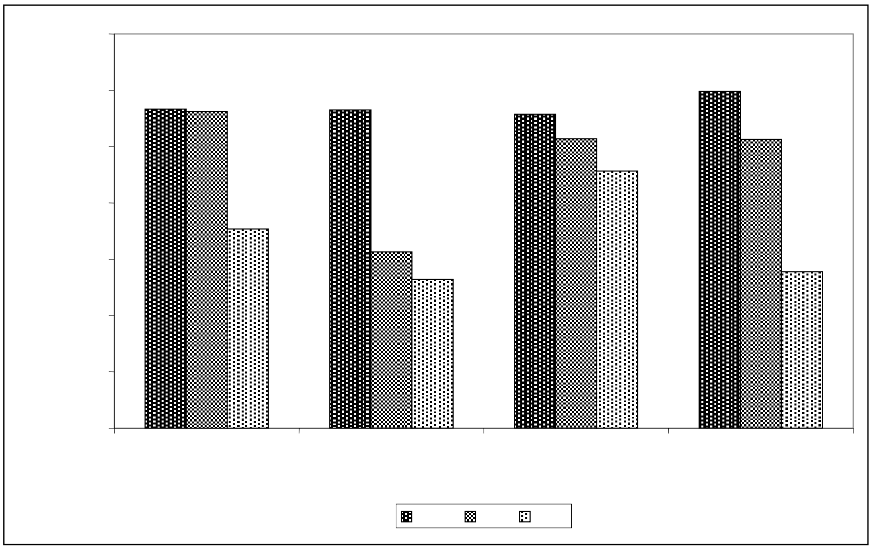


Figure IV.12: Effect of Budget Constraint on Roadworks by Length

Figure IV.13 compares the condition of the sealed network at the end of the 10 year planning period. The reduced budget apparently increases the length in good condition; this is because more treatments are delayed towards the end of the period.

It is evident that the proportion of the network in "poor" and "bad" condition increases from 30 percent to over 50 percent and that in "good and fair" condition drops from 70 percent to 50 percent. This has a significant effect not only on the overall condition of the network (which is considerably worse at the end of the plan period) but also on the ongoing vehicle operating costs. The overall outcome is substantially worse on all on all counts and any reductions in the maintenance allocations are NOT recommended.

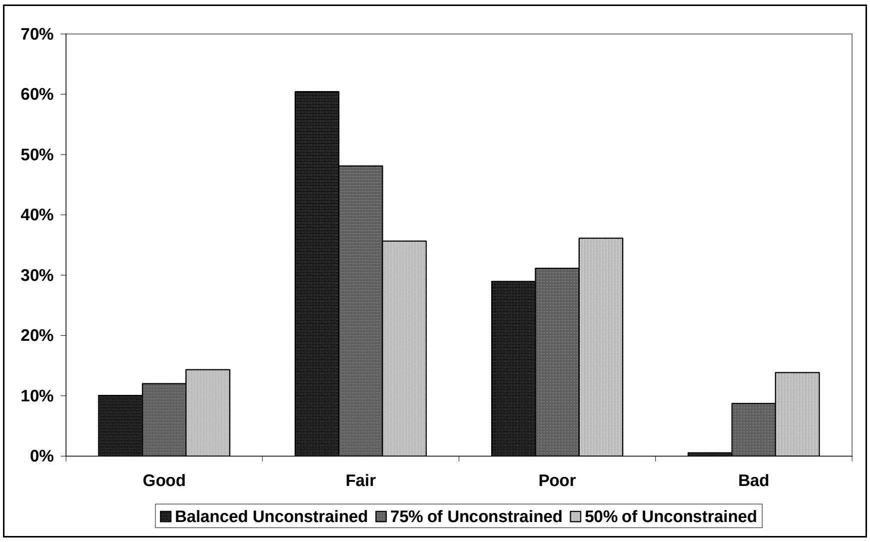


Figure IV.13: Sealed Network Condition after 10 Years

3. Overlays

As shown earlier, a significant portion of the network is in fair or poor condition (IRI > 6m/km). The current practice of using surface dressing for periodic maintenance will not reduce roughness, only stabilise roads and prevent a rapid increase in roughness. To reduce roughness either rehabilitation or overlay is needed. Figure IV.7 showed a large part of the programme as rehabilitation, a relatively expensive treatment compared with overlay (about double the cost). To test the effect of an increased overlay programme the analysis was repeated with a modified set of interventions that allowed overlay to be applied to any road irrespective of traffic volume, the only constraint being to apply seals at low roughness levels. The modified intervention criteria are shown in Table IV.8.

Table IV.8: Modified Overlay Intervention Levels

IRI Range	AADT Range (incl motorcycles)		
	< 1,000	1,000 – 3,000	> 3,000
< 5	Seal	Seal	Overlay
5 – 6	Seal	Overlay	Overlay
6 – 8	Overlay	Overlay	Overlay
8 – 10	Overlay	Rehab	Rehab
> 10	Rehab	Rehab	Rehab

Figure IV.14 and Figure IV.15 show that, with the lower interventions for overlays, rehabilitation is much reduced and sealing almost eliminated with a consequent large increase in the amount of overlay. The overall unconstrained 10 year programme cost with a greater use of overlays is marginally higher at Rs17.1 billion, up 5 percent compared with the previous estimate of Rs16.3 billion, with a small increase in length (up 64km to 4,490km). The average cost of works is increased from Rs 3.67 million/km to 3.80 million/km.

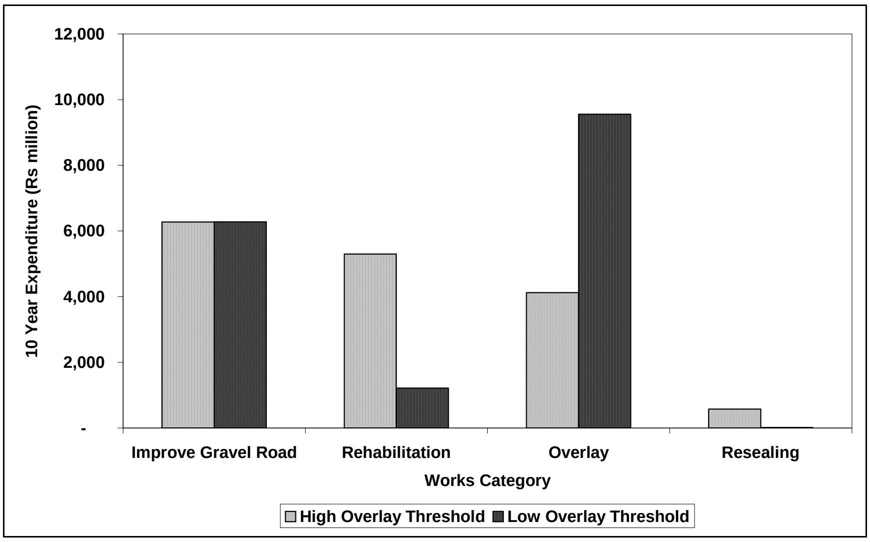


Figure IV.14: Roadworks Expenditure with Different Overlay Policies

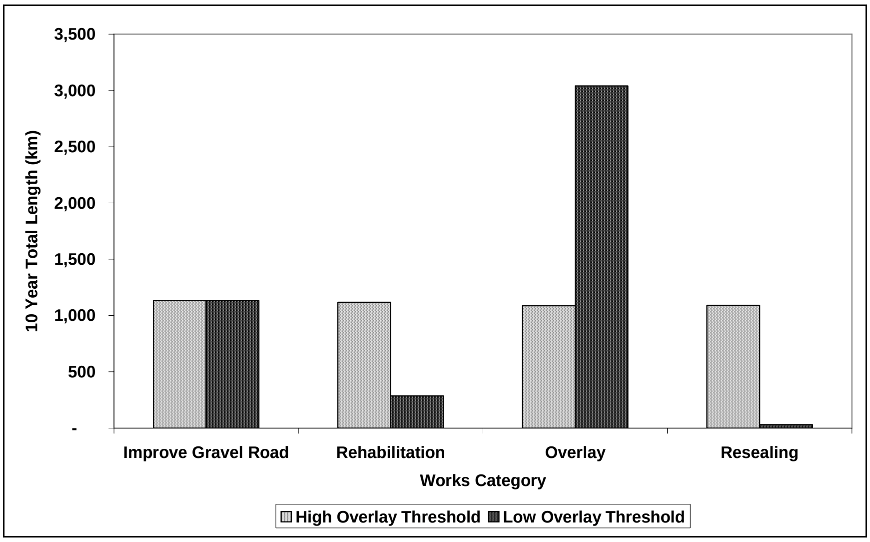


Figure IV.15: Roadworks Length with Different Overlay Policies

Figure IV.16, Figure IV.17 and Figure IV.18 compare network condition after 10 years with the two overlay policies. It is seen that the low threshold overlay policy yields a significantly better result in terms of network service level.

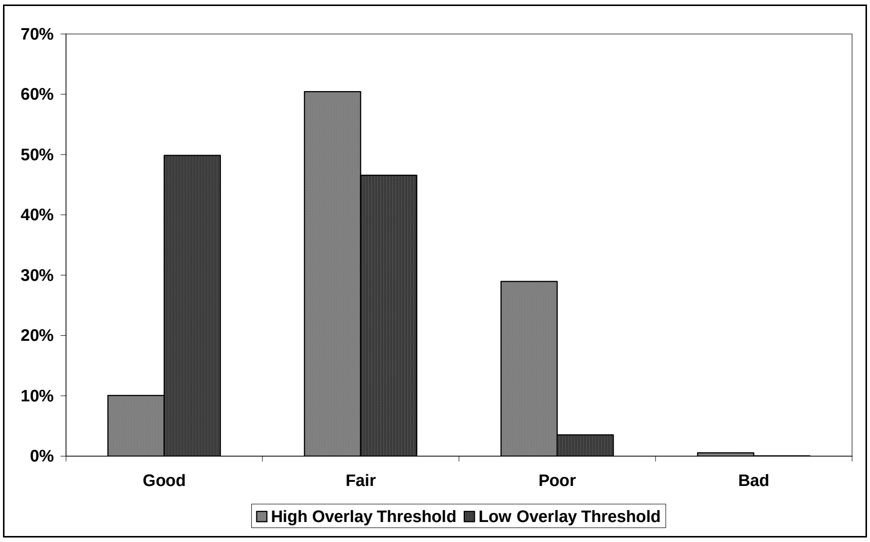


Figure IV.16: Network Condition after 10 Years with Different Overlay Policies

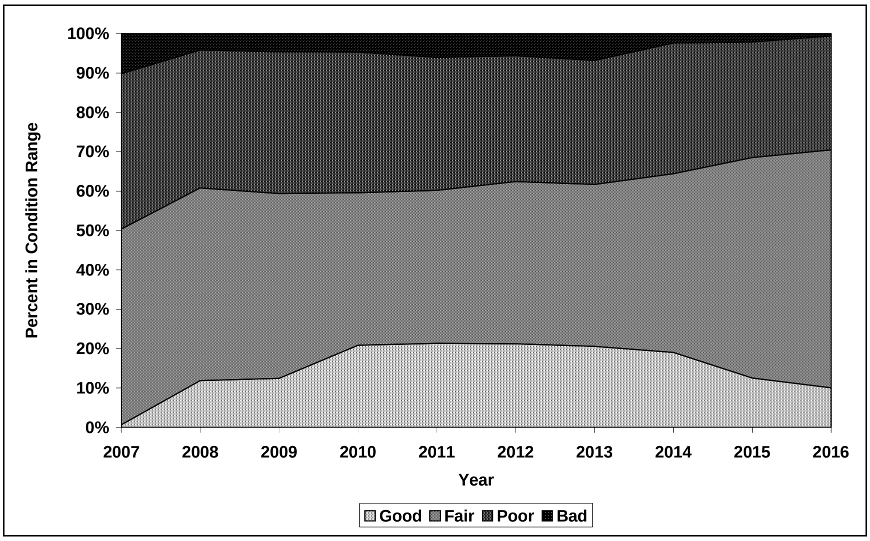


Figure IV.17: Network Condition by Year – High Overlay Intervention

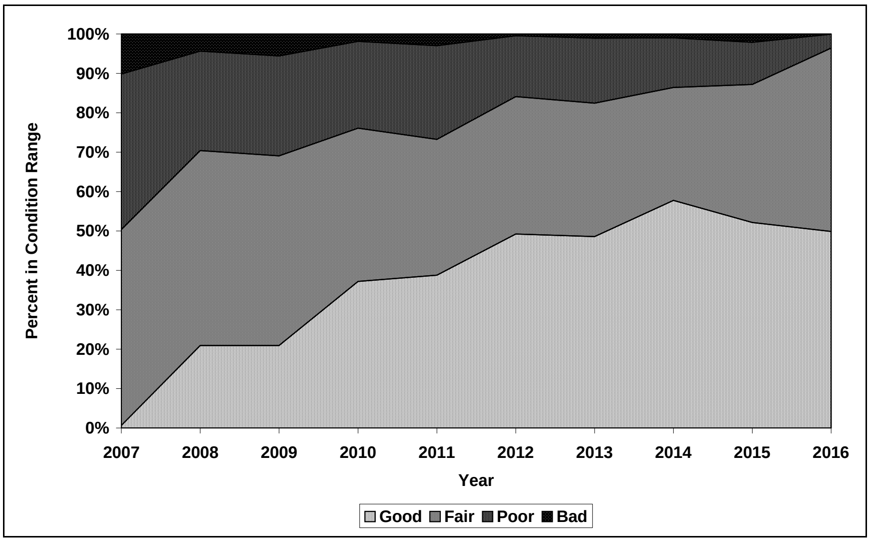


Figure IV.18: Network Condition by Year – Low Overlay Intervention

4. Road User Costs

The objective of any roadworks programme is to stabilise or reduce the costs of vehicle operation and passenger time. It is thus instructive to examine both the gross and incremental costs to road users.

The network analysed in HDM-4 had a length of around 5,500km out of a total network of around 8,000km, the difference being ongoing and committed projects excluded from the analysis. The total estimated road user costs in 2007 for the analysis network was Rs 54 billion for vehicle operating costs and Rs15 billion for passenger time costs, a total of Rs 69 billion. If the VOC component is adjusted pro rata to the total network length the value in 2007 is nearly Rs 80 billion which represents about 13% of Nepal's GDP[7]. If urban and rural roads were taken into account, VOC would amount to somewhere between 15% and 20% of GDP. This demonstrates the importance of the road network to the country's economy.

Table IV.9 compares the discounted (12%) costs over 10 years of the roadworks programme for the balanced unconstrained scenario with the road user cost savings relative to the base alternative which only had routine maintenance in the first 10 years. As the budget is reduced the b/c ratio increases; as resources are constrained they are concentrated on the higher value projects.

There are, of course, user savings after year 10 but the base alternative included rehabilitation in year 11 or later and this would distort the figures. Nevertheless, the b/c ratios show that an adequate return is given for what can be considered a low volume road network.

Table IV.9: 10 Year Discounted Agency Costs & RUC Savings (Rs m)

Budget	Agency Costs	Road User Cost Savings	b/c ratio
Balanced Unconstrained	9,440	21,200	2.2
75% of Unconstrained	7,336	19,597	2.7
50% of Unconstrained	4,891	16,199	3.3

7 Latest available figure for GDP is 2005.

G. Unconstrained Analysis of All Roads

The foregoing analysis has described a constrained budget optimisation of the network, excluding sections that are subject to ongoing or committed projects. In order to assist in prioritisation of the expansion of the SRN (described in a later chapter) an HDM-4 analysis was carried out using the full network, including an evaluation of those sections subject to committed projects: the objective being to confirm (or otherwise) the feasibility and priority of these works. Due to the larger number of sections, a constrained budget optimisation was not possible for this network but the unconstrained results give an indication of the relative priority of different types of work and of improvement needs on different sections.

The total unconstrained budget for the 10 year period was around Rs24 billion compared with around Rs16 billion when the committed projects were excluded. [The additional Rs8 billion represents the cost of the committed projects that were excluded form the earlier analysis.] The distribution of this sum by works category is shown in Figure IV.19 and Figure IV.20.

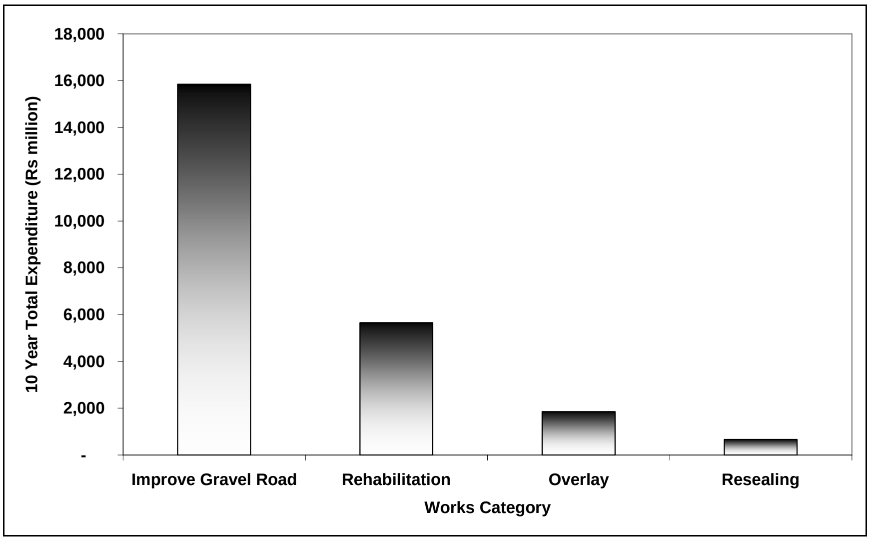


Figure IV.19: All Roads Analysis – Cost Distribution

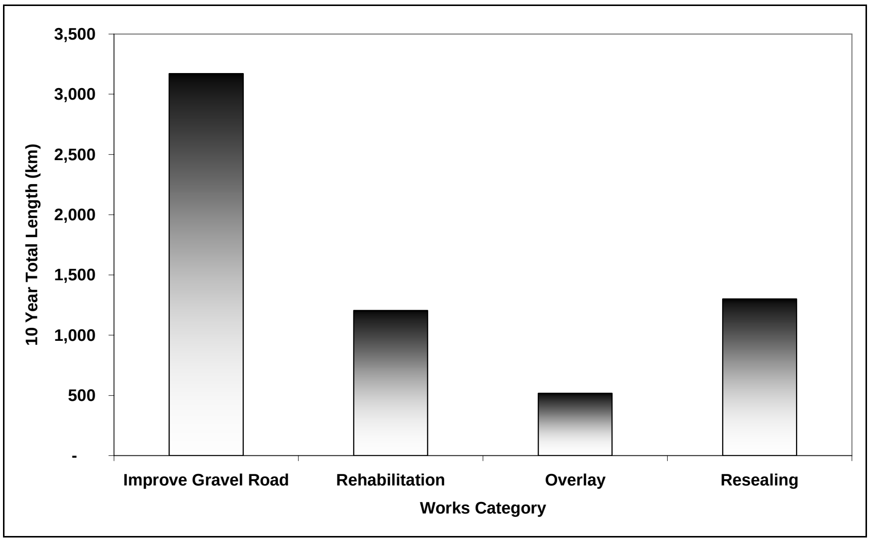


Figure IV.20: All Roads Analysis – Length Distribution

A full listing of the results by section is given in the final three columns of Annex 4.4 and the location of the works is illustrated in Figure IV.21. It can be seen that

virtually all the network is selected for maintenance or upgrading and – specifically – the analysis confirms that almost all of the 'committed' projects for upgrading in the hills (green) and Terai (blue) are confirmed as being feasible. The exceptions to this are some of the low-volume roads in the hills which are not shown as being justified, for example, the roads to the HQs of seven Districts: Darchula, Bajura, Achham, Jumla, Mustang, Manang and Khotang..

The exclusion of the roads to the seven District HQs is an indication that the upgrading of these roads at the present time cannot be justified on the basis of the present traffic volumes. However, as has been shown elsewhere (Part II Draft Final Report and individual road Feasibility Studies) upgrading can frequently be supported on grounds of generated traffic, improved reliability, accessibility, and enhanced economic and social conditions.

More importantly, the HDM-4 model supports – on traffic and operational grounds alone – a substantial programme of sealing of roads in the Terai and the more heavily trafficked road into the hills. As discussed above, the model also indicates a substantial programme of (relatively expensive) rehabilitation on significant lengths of the core network: the Consultants are of the view that a more efficient maintenance strategy could be developed with a more extensive use of AC overlays to prolong the life of these roads (and provide an enhanced riding surface).

H. Road Management Systems in DoR

1. Background

Since 1993, the Department of Roads has carried out systematic network-wide surveys of traffic and road condition. The scope of these surveys has been:

- Roughness: measurement using a TRL vehicle-mounted bump integrator calibrated to International Roughness Index using a TRL Merlin. Data is recorded at 1km intervals;
- surface distress: visual assessment of cracking, raveling rutting etc. This data was recorded on a sample basis of 100m within each km;
- Traffic volume: classified volume counts of 2 – 3 days duration at around 114 locations.

Initially these surveys were carried out annually by DoR but in later years the work was outsourced to consultants. In recent years the surveys were made biannually, the last being carried out in late 2004 and early 2005. In addition to the above, the there is a substantial body of knowledge within DoR about the year of construction/reconstruction and resurfacing of pavements.

The SDI and traffic data has been used to prioritise periodic maintenance works. The roughness data has not been used directly by DoR but has been of value to consultants in carrying out feasibility studies.

DoR has decided to adopt HDM-4 as the primary analysis tool for planning and programming of roadworks and in 2006 purchased the new version 2.0 of the program. In order to provide and update the data inputs required for HDM it is necessary to revise and expand the existing data collection activities as outlined below, including the acquisition of automated roughness data collection equipment. The expansion of these activities should be monitored and defined as part of an ongoing TA support (see section 4.8.5).

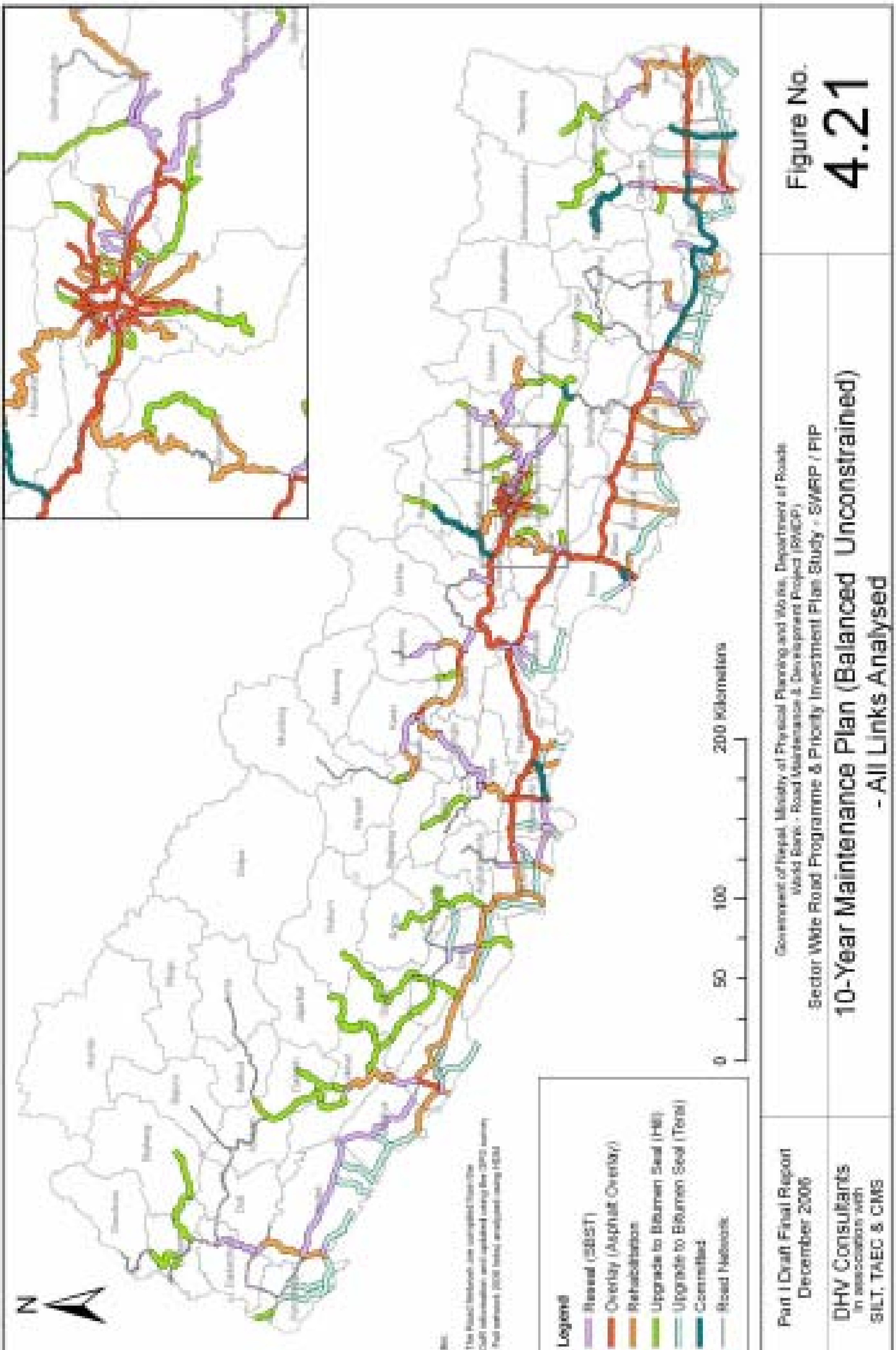


Figure No.
4.21
10-Year Maintenance Plan (Balanced Unconstrained)
- All Links Analysed
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Part I Draft Final Report
December 2006
DHV Consultants
SILT, TAEC & CMS
Legend
Reseal (SBST)
Overlay (Asphalt Overlay)
Rehabilitation
Upgrade to Bitumen Seal (Hill)
Upgrade to Bitumen Seal (Terai)
Committed
Road Network
0
50
100
200 Kilometers

Data Collection

Surface Condition
With the adoption of HDM-4 as the analysis tool in place of the SDI prioritisation method the format of road condition data collection and database should be changed to be directly compatible with HDM requirements. SDI data are recorded on a sample basis (the final 100m of each kilometre). The Consultants have recommended that in future surface condition (cracking, ravelling, edge break etc.) should be recorded on a continuous basis at 50m or 100m intervals given the localised nature of many pavement defects, especially on hill roads.

Roughness

The Consultants have also recommended that an automated data capture system should be used for roughness surveys. The most widely used low cost system is ROMDAS with a cost of around $8,000. Such a system would enable roughness to be recorded on the same interval as the surface condition survey. Recommendations have also been made to tighten up the roughness calibration procedure.

Traffic

The current traffic census system gives inadequate coverage of the existing SRN; with the expansion of the network under DoR a much greater number of count stations should be established. The cost of the survey need not be increased; count duration can be reduced and counts made on a 2 or 3 year cycle. If automated roughness data equipment is procured it can also be used for moving observer counts which form a useful supplement to fixed location counts in providing information on traffic distribution along links. The current vehicle classification system should be expanded to take account of the greater variety of vehicles being used in Nepal; 3-axle and articulated trucks, jeeps and microbuses are not presently identified in the surveys.

Pavement Strength

Data on pavement strength is at the moment fragmentary and outdated. While the project completion reports will help improve the database where roads are rehabilitated and improved, there should be a systematic effort to acquire pavement structural data for roads requiring only normal maintenance. This could be done using either DCP or Benkelman beam testing with a target of, say, 500km per year.

Project Completion Reports

A further recommendation has been made to DoR regarding project completion reports. Currently these focus on financial matters and neglect the technical achievement of projects. It is proposed that supervision consultants are required in their ToR to include the following data following substantial of a contract:

- classified traffic count following the opening or improvement of the road;
- record of pavement structure and subgrade CBR as built including DCP tests;
- key geometric data including pavement and shoulder widths and summary data on alignment (rise/fall, curvature).

This information should be supplied directly to the HMIS Unit in electronic format compatible with the road database structure.

Outsourcing

It is recommended that DoR continue to outsource collection of road condition and traffic data but that data audit procedures be put in place to ensure adequate data quality.

2. Data Processing and Storage

The HMIS unit within the DoR had, at one time, an electronic road database using dRoad software. The DoR no longer use the dRoad software and data are currently stored on spreadsheets.

Under a current contract, IT consultants have been engaged to develop an extensive MIS database for DoR. This includes a road database covering inventory, condition, traffic etc. With the decision to use HDM-4 as the analysis tool, some of the data collection and storage formats are inappropriate and the Consultants have provided advice on future data collection formats and the related structure of the road database.

The new database should have some analysis capability, in particular the identification of homogeneous road sections and transformation of data from different tables to a structure compatible with HDM-4 network import.

3. Planning and Programming

The Consultants have provided extensive training in the use of HDM-4 to a group of 6-7 DoR engineers, two of whom were assigned as full time counterparts. The training involved preparation of data inputs as well as operation of HDM-4.

HDM-4 is a complex model and a user only becomes familiar with the software after extensive use in a normal working environment i.e. using HDM-4 to produce works programmes or feasibility studies rather than training exercises. While the DoR staff have a basic knowledge of the theory and practice of HDM-4, it might take 1 – 2 years of use before they become proficient. For this to happen it is essential that there is continuity and the HDM group remain in their present posts for the next few years.

The 10 year expenditure plans described above should be considered as a first cut and the exercise should be repeated annually with an expanded database and refinement of the analysis sections. As well as guiding medium term funding needs the analyses will also identify priority works in the following 1 – 3 years.

4. Institutional Support

There will be a need for continuing support to HMIS and the HDM group over the next few years covering the following areas:

- data collection procedures and data audits;
- operation of the road database and development of its analytical capability;
- improved calibration of the HDM models as higher quality data becomes available;
- use of HDM-4 for strategic expenditure planning, preparation of annual works programmes and feasibility studies.

This support need not be continuous and could be limited to 1 – 2 months per year of consulting services.

It is also recommended that, each year, 1 or 2 DoR staff attend the annual HDM-4 training course run by CRRI in Delhi, normally in October. This is a 2 week course covering all aspects of HDM-4 including road user effects, road deterioration and works effects, model calibration and analysis.

I. Performance Based Maintenance Contracts

The following section provides a brief overview of the models that are available for administering and implementing road maintenance, based on those that are commonly in use throughout the world. The section also contains a review of the current Performance Based Contracts as operating in Nepal.

1. Models for Implementing Road Maintenance

There are essentially three models that can be applied to undertake basic road maintenance activities: direct labour; regular input-based contracts (based on time and materials or a lump sum); and output or performance based contracts. These are described briefly below.

(a) Direct Labour

Traditionally, road maintenance was carried out directly by the road agency who employed all the staff and owned the equipment used for maintenance. In many countries this method was used because there was no local contracting capability and it was therefore necessary for the government to establish its own capability to construct and maintain infrastructure (public works department).

When well run, direct labour organizations were effective, providing flexibility and quick response to maintenance needs, especially special or emergency works. One of the problems was the way in which governments provided funding, usually under several heads:

- establishment costs – salaries. pensions, housing and other employee benefits
- capital cost of equipment
- running cost of equipment
- purchase of materials

Often there was an imbalance between the different budget heads and in some cases, while establishment costs were met there was no funding for running equipment or purchasing materials leading to staff sitting idle in depots and no road maintenance being performed. Little attempt was made to monitor road condition in a systematic way or to compare road condition with maintenance expenditures.

(b) Input Based Contracts

In the last 20-30 years governments have been encouraged to contract out road maintenance. In the first instance this was done by means of input based contracts, often a schedule of rates with the contractor being paid for completed work. Such contracts would cover either periodic maintenance/rehabilitation or routine and recurrent maintenance, sometimes both. In most cases, contracts were awarded annually reflecting the government accounting practices for annual budgets.

This type of contract had the merit of encouraging efficiency by shifting the onus to the contractor who had a financial incentive to carry out the works at the least cost. This can, however, lead to poor workmanship and a tendency on the part of the contractor to concentrate his efforts on work items he considers to be the most profitable.

The use of contractors does not leave the road agency free of responsibility; the contractors completed work must be checked for quality and measured for payment. This aspect can be carried out by consultants but is often done directly by the agency.

Some problems have arisen from the switch to contract maintenance:

- The agency is left with a pool of staff, many unskilled labourers, which it is politically difficult to eliminate.
- The agency has a pool of equipment with associated workshop facilities.

Too often, the staff and equipment have lingered on (at consequent cost to the government) while road maintenance is executed by contract. The government is, in effect, paying twice for the same service. Ideally the redundant staff should be retired (with appropriate compensation) and the equipment and workshops sold to the private sector but this often does not happen. One alternative, as in New Zealand is to first corporatise and then privatize the entire direct labour operation.

(c) Output (Performance) Based Contracts

A more recent innovation has been output based (performance based) contracts where the contractor is paid a fixed sum to maintain all or part of the road infrastructure to a specified level. As for input based contracts, this can cover both periodic/rehabilitation and routine operations. Three types of PBMC might be mentioned:

1. The contract comprises initial rehabilitation of a road in poor condition followed by routine maintenance for a period of 3 – 5 years. In effect this is simply an extension of the defects liability period.
2. The contract only covers routine maintenance works such as patching, drain cleaning and vegetation control. Such a contract might be for a year or less if funded out of a recurrent budget.
3. The contract is for an extended period(10 years, say) and the contractor is free to decide on his own options and timing of periodic maintenance works required to maintain the road so a specified service level (for example roughness, cracking rut depth).

The choice of the form of contract is often dependent on the funding source. If funded from a recurrent road maintenance budget, option 2 might be the only possibility. In the case of external funding, the agencies normally have a time limit on the duration of a loan and are unwilling to fund recurrent expenditure. In this case, option 1 above might be the most appropriate with the external funding being applied to the initial major works and the government counterpart funding being applied to the subsequent routine works.

To adopt option 3 with a contract period of 10 years requires guaranteed funding for the contract period. For a country like Nepal this can be problematic until such time as the Road Fund provides sufficient income for both periodic and routine maintenance works. For the time being it appears that options 1 and 2 must be applied if PSMC is used in Nepal.

The lengthman system which is used on many roads can be considered to be a form of option 2; the man is paid a fixed monthly sum (his salary) to carry out a certain level of maintenance (clean drains, short vegetation).

2. PBMC in Nepal

The Consultants have reviewed two PBMC contracts that are current in Nepal, each on heavily trafficked 75km sections of the East-West Highway to the east of Pathlaiya.

The form of contract is the first type outlined above. The initial works comprise an overlay and routine maintenance backlog. The PBMC starts after this work is complete and runs for a period of about 4 years.

(a) Specifications

The PBMC component of the contracts includes performance and operational indicators. The performance indicators are surface distress index (SDI), roughness (IRI) and axle load control. The operational indicators comprise specific items relating to pavement, right-of-way, structures, drainage and road signs and marking.

(b) Performance Indicators

The use of SDI seems unnecessary. If the contractor is in full compliance with all the operational indicators (patching, crack sealing etc) then SDI will remain close to zero.

The indicator for roughness requires that it should not increase by more than 10% each year. Again, if the contractor is in compliance with the operational indicators then one would not expect the roughness to increase by more than 10% per year. The only circumstances in which this might happen is if there is severe weakness in the pavement structure leading to extensive deformation. This is something over which the contractor has no control. The initial overlay is to a design given by the client; the contractor does not have the option to provide any needed strengthening that he considers necessary to meet the performance specification in terms of roughness progression.

The axle load control indicator requires that no vehicle shall have an axle load exceeding 10.2 tonnes. If the contractor were to be in full compliance with this indicator he would need to operate permanent weigh stations at each end of the road section and at any intermediate access points used by heavy vehicles. Even given this, the contractor has not legal authority to prevent vehicles using a public road. Monitoring of this indicator would require the client to operate additional (mobile) weigh stations. This indicator seems to be impractical and probably in contravention of legal requirements.

In summary, it is considered that the performance indicators as defined are either unnecessary or unworkable.

(c) Operational Indicators

The operational indicators are comprehensive, though maybe idealistic given general levels of road maintenance in Nepal. There are concerns about monitoring these indicators which is discussed below.

(d) Performance Monitoring

The specification is based on a model document from the World Bank. This puts most of the onus for performance monitoring on the contractor in the form of a “self control unit”. The self control unit is responsible for day-to-day monitoring and reporting with only random checks by the client (or his consultant).

This approach to monitoring requires a high degree of trust in the honesty of the contractor, something that is not normal in South Asia. Without full parallel monitoring by the client it is impossible to determine how honest the self control unit is in reporting, say, unrepaired defects which lead to financial penalties for the contractor. In this regard, several of the items are subject to penalties at a daily rate and in one case the penalty is per hour. To assess these requires a high frequency of road inspections (daily or even hourly!) while joint formal inspections are only monthly. It is felt that some of the requirements are impractical in terms of the necessary monitoring.

(e) Conclusion

It is considered that the PBMC specification could be considerably simplified and reduced in scope to make them more practical in terms of fairness to the contractor and realistic in terms of the monitoring required to assess compliance.

Chapter 5

V. POTENTIAL DEVELOPMENT & EXPANSION OF SRN

A. Identification & Selection of Potential Additions

1. Definition of Extended SRN

The Consultants are required to assess the future needs of the Strategic Road Network (SRN) over the next 10 years and to make recommendations regarding its expansion. It is suggested, in the Terms of Reference, that the future (2016) SRN will likely include around 7,500km of road, an increase over the existing length of around 5,000km. This was considered a realistic expansion of the network over a 10-year period - given the present network size and the capacity and capability of the DoR to manage and maintain the network.

This does not necessarily involve the construction of 2,500km of "new" road, as many of the highest priority roads for inclusion in an expanded network are either already under construction or are existing roads that are not currently designated as part of the SRN. The additional roads thus comprise: some existing roads currently maintained by DoR; some new (strategic) roads presently under construction or planned; some existing local or District Roads that serve a strategic function and could be absorbed into the SRN; and some totally 'new' roads requiring construction on a new alignment.

The Consultants have however taken an open and unconstrained approach to the expansion and extent of the future network. Starting from the existing ‘designated and operational’ network, all potentially strategic additions – from all sources – have been examined. As defined earlier (in Chapter 3) the SRN comprises the main national and inter-regional arteries, connections to the borders, and links to all Districts Headquarters and other centres of economic activity.

The SRN contributes to national integration and enables the required levels of accessibility to be achieved throughout the country. This Study has examined all links of a potentially strategic nature – ie any link which has more than a local function. These are the roads for which the DoR has prime responsibility.

2. Current SRN

A preliminary step in the development of the future SRN was the identification of the extent of the existing network, as described in Chapter 3. The existing network comprises 5,030km of ‘designated and operational’ SRN – 3,108km of National Highways and 1,922km of Feeder Roads – plus an additional 398km of ‘other’ roads considered to be part of the SRN (including some roads within Kathmandu) and which are maintained by DoR. This defines the currently operational SRN with a length of 5,428km, as illustrated in Figure 5.1, which is shown against a background of the current population density distribution.

It is noted that in addition to this total, there are some further sections of the designated SRN which are non-operational (either under construction or planned)

plus other committed roads that will form part of the future SRN. These are considered below.

3. Identification of Long-List

The objective of this Study is to define a future SRN to be developed over the next 10 years – the periods of the 11th & 12th Five-Year Plans. The first step in this process of identifying potential new links was to establish the *"strategicness"* of any proposed link – ie to determine whether it satisfies the criteria to become part of the SRN. Basically a strategic road should serve traffic of national, regional or inter-district nature: therefore if a road serves only *local* movements then it is NOT strategic. This process of identifying the 'strategic nature' of any road link is fundamentally different from establishing whether or not any construction or improvement works are appropriate or required.

The following types of road are considered to meet the requirements that enable them to be classified as strategic:

- Links to District Headquarters;
- Links to *major* Border Crossings;
- Links between *existing* strategic roads;
- Inter-District links, especially between DHQs;
- Links or access to rural airfields; or
- Links to major industrial, commercial or tourist sites.

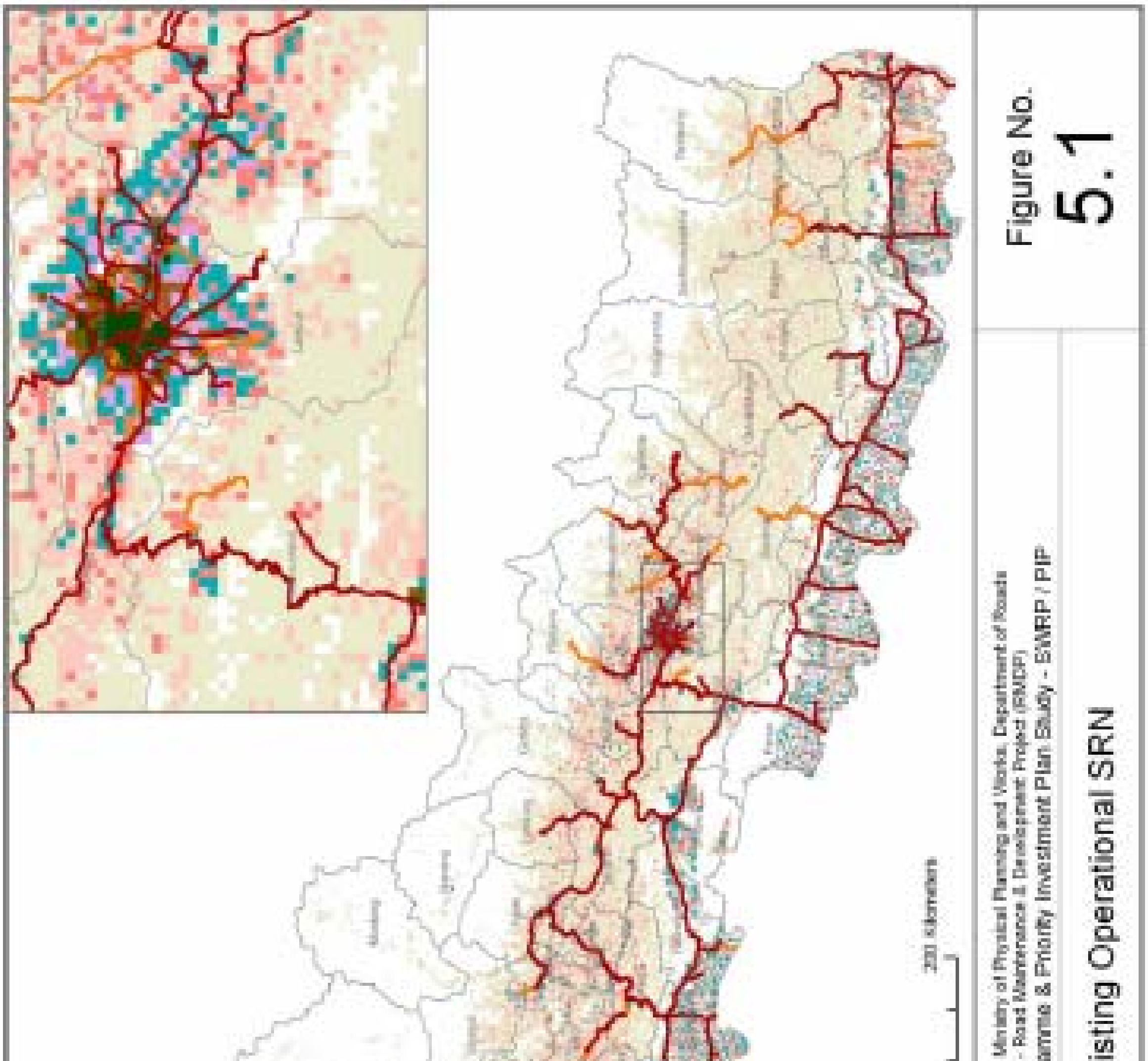
Links that do not meet at least one of these criteria were – in general – excluded: in most cases, they should be considered and classified as District Roads, with no strategic function, although in many cases they may access sizeable pockets of population and/or agriculturally productive areas.

The approach was to use multiple sources to identify potential additions to the SRN, including all relevant previous studies and the recently produced DoR 20-year Master Plan. The other sources consulted to identify potential network additions included:

- the previous Priority Investment Plan Study (1997);
- the ADB Connectivity Study (2005), which contained a screening exercise for potential new roads;
- the IDA North-South Transport Corridor Study (2004);
- the recent ADB Transit Routes Study;
- the ADB Sub-Regional Trade Facilitation Project;
- the initial planning phases of the RMDP and RNDP (FRIP); plus
- local road proposals included in the individual District Transport Master Plans (DTMPs), the DoLIDAR local road inventory, and 20-year Plan for rural roads.

In addition to these roads identified in previous studies – and for which indicative alignments were available – the Consultants have developed a number of other potential new links which could (conceivably) form part of a longer-term strategic network.

This review resulted in the identification 170 potential schemes with a total length of 8,780km, over and above the existing 5,430km, producing a potential SRN of over 14,000km. These 170 schemes comprise the "long-list" of potential additions which were subsequently evaluated and prioritised.


Legend
Sealed Road
Unsealed Road
2006 Projected Population
Distribution Per Sq km
Less than 250
250 - 500
500 - 750
750 - 1,500
1,500 - 3,000
3,000 - 5,000
5,000 - 10,000
Greater than 10,000
N
0
50
100
200 Kilometers
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Existing Operational SRN
Figure No.
5.1
Part I Draft Final Report
December 2006
DHV Consultants
In association with
SILT, TAEC & CMS

B. Classification and Categorisation of Roads

All the road sections forming the additional 8,780km considered for incorporation in the SRN were included in the long-list, as one of 170 “schemes”. Each scheme consists of either an individual link, or of a series of contiguous links, that provides a connection between logical terminal points, such as towns, other links or border crossings. The 170 schemes were classified into three groups, as follows:

- ***Committed additions to the existing SRN*** – Feeder Road alignments either planned or under construction (eg Hile-Bhojpur, Basantapur-Khandbari), or committed potential strategic links (eg Galchi-Devighat, Manthali-Khurkot). There are 18 schemes in this group, with a total length approaching 800km or 9 percent of the length of roads in the long-list.
- ***Established local or district roads*** that may be re-classified as part of SRN and for which detailed alignments are available: eg the Postal Road and other links in Terai, established inter-district District Roads, or local (potentially strategic) roads under construction through ADB, RAP, RAIDP, etc. These comprise 89 schemes with a length of approximately 3,170km or 36 percent of the length of the long-list.
- ***Potential additional NEW links*** for which no detailed alignment is available: these roads are shown as indicative linkages between two points (eg new links to Chinese Border, Kathmandu-Terai Fast-Track, approaches to Kathmandu from west, ‘missing’ sections of mid-hills east-west highway, links to remaining non-connected District HQs, other inter-district links, etc). These comprise 63 schemes with an approximate length of 4,820km or 55 percent the total length of the long-list.

These links are shown on Figure 5.2 which illustrates the total extent of the potential extensions to the SRN considered in the Study. A full listing of all roads considered is included in Annex 5.1 Table A5.1a which includes also the result of the ranking: it should be noted that the lengths quoted are initial estimates, and may have been revised in later stages of the Study. Table 5.1 summarises the lengths of each group of road. Most of the schemes (117) are existing roads or committed projects, although the 63 new alignments are generally longer and represent over half of the potential additional network length. The schemes have been grouped into five categories – Terai Roads, links to unconnected District HQs, links to the Chinese Border, inter-District links, and links to and within the Kathmandu Valley. These are described in greater detail in the following sections.

Table 5.1: Classification of Potential Additional Links in SRN

	No of Schemes	Length (km)	Percentage
Committed Extensions	18	791	9%
Existing Local/District Roads	89	3,170	36%
Potential New Links/Alignments	63	4,818	55%
Total	170	8,779	

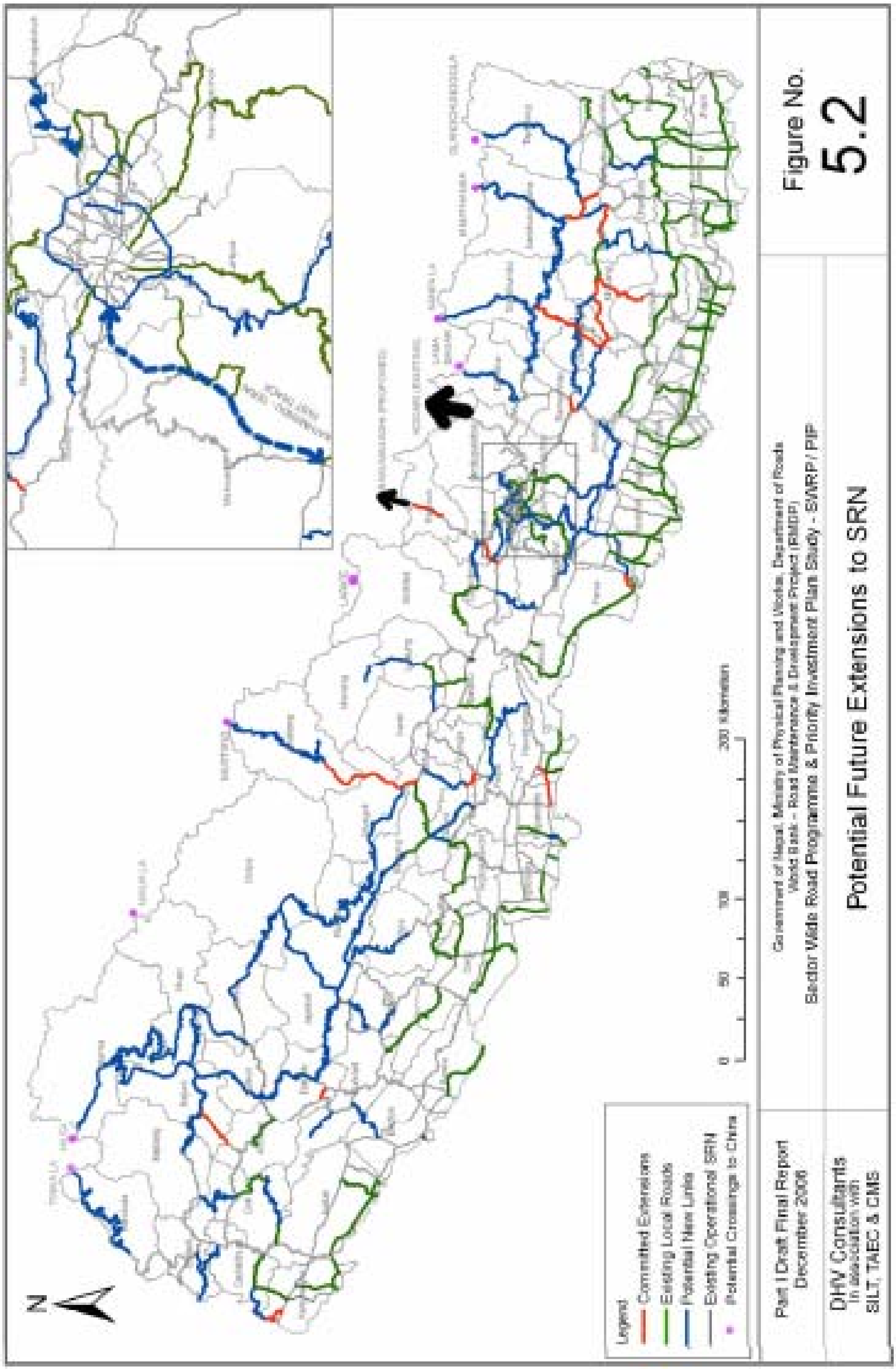


Figure No.
5.2
Potential Future Extensions to SRN
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Part I Draft Final Report
December 2006
DHV Consultants
In association with
SILT, TAEC & CMS
Legend
Committed Extensions
Existing Local Roads
Potential New Links
Existing Operational SRN
Potential Crossings to China
0
50
100
200 Kilometers
N

1. Terai Roads

The Terai roads considered are those south of the existing East-West Highway, including those linking to Indian border crossings, sections of the east-west Postal Road[8], and other connections to towns and villages. Most of the roads are established earth or gravel tracks which follow existing alignments and are used by local traffic, including cycles, rickshaws and bullock carts. No entirely new alignments considered, although significant improvements, including construction of bridges may be required. Many of the alignments considered form part of the proposed Indian Government Assistance Programme for "prioritised road and bridge infrastructure improvements in the Terai".

The two proposed new approach roads to the International Customs Depots at Birgunj and Bhairahawa (via Parasi), as included in the ADB-funded Sub-Regional Trade Facilitation Project, are considered as candidates for inclusion into the SRN.

2. Links to Unconnected District HQs

It has been a long-standing objective of successive Governments to provide all-weather road access to all District HQs throughout the country. At the time of the previous PIP (1996) there were 17 non-road-connected HQs: since that time work has continued and limited access is now available to five of these[9]. Construction is on-going to extend access to nine of the 12 remaining non-connected districts[10], leaving three districts (Dolpa, Mugu and Humla) without any currently committed access proposals. Details of the current status of access to these 17 District Headquarters are given in Table 5.2.

It would appear from this analysis that satisfactory progress is being made to connect most District HQs, with the possible exception of Diktel (Khotang) in the east. The remaining HQs for which committed schemes are not in place (eg Dolpa/Dunai and Mugu/Gamgadhi) have substantially smaller populations and thus have a lower priority: these aspects are covered further in later sections of this report.

The links to all the remaining non-connected HQs should be included in the long-term strategic network, together with any existing links to District HQs that are not classified as part of the current SRN.

[8] A historic track within Nepal linking towns close to the Indian Border: much of the previous alignment still exists although upgrading would require the construction of a number of bridges.

[9] Limited access is available to Okhaldhunga since 2000 (although a bridge is required across the Sunkoshi), Rukum/Musikot since 1998, Darchula since 2006, and Kalikot & Jumla via the Karnali Highway in early 2007: access to the latter four District HQs is limited to tractors and the roads may not be open for regular public traffic.

[10] The remaining 12 Districts with unconnected HQs are: Sankhuwasabha, Solokhumbu, Bhojpur & Khotang in the East; Manang & Mustang in the West; Jajarkot, Dolpa, Mugu & Humla in the Mid West; and Bajhang & Bajura in the Far West

Table 5.2: Current Status of Connections to District Headquarters (2007)

	District/Headquarter	Status
Eastern Development Region		
1	Sankhuwasabwa/Khandbari	Construction in progress: included in ADB/RNDP & DFID/RAP
2	Solokhumbu/Salleri (from Okhaldhunga)	Initial construction under Upper Sagarmatha Agricultural Project: local rural access initiatives to be pursued or possible ADB funding
3	Bhojpur	Feeder Road under construction through DFID/RAP
4	Okhaldhunga (open 2000)	Initial construction by Army: feasibility study completed under SWRP: selected for 'fast-track' implementation under RSDP
5	Khotang/Diktel	Local road access from Hilepani started under DFID/RAP: alternative access under GoN funding from Gaighat
Western Development Region		
6	Manang/Chame	Local access under construction with GoN funding north from Besisahar
7	Mustang/Jomosom	Access being developed by Army from Beni with GoN funding; alternative access available from Tibet to Upper Mustang
Mid-Western Development Region		
8	Dolpa/Dunai	Local access track from Jarjarkot being developed by District & local road agencies: low priority for upgrading
9	Jumla/Jumla *	Access via Karnali Highway under construction by Army: initial track open early 2007: possible upgrading under RSDP
10	Kalikot/Manma *	Access via Karnali Highway under construction by Army: initial track open early 2007: possible upgrading under RSDP
11	Mugu/Gamgadhi	Local road construction proposed through DRILP & Districts: feasibility study from Karnali Highway conducted by SWRP
12	Humla/Simikot	Access available from Tibet via Hilsa border crossing: local rural access initiatives being pursued
13	Jajarkot/Jarjarkot *	Initial track under construction by Army with GoN funding: possible upgrading through RSDP
14	Rukum/Musikot * (open 1998)	Access track open since 1998: feasibility study for upgrading under SWRP
Far-Western Development Region		
15	Bajura/Martadi *	Access from Sanfe commenced under RMDP: feasibility study under SWRP: completion possible under RSDP
16	Bajhang/Chainpur	Track under construction by GoN funding: feasibility study under SWRP: selected for 'fast-track' implementation under RSDP
17	Darchula/Darchula * (open 2006)	Track constructed through GoN funding: feasibility study under SWRP: part selected for 'fast-track' implementation under RSDP

Source: Updated from 1997 PIP and WB North-South Corridors Study (2004)
Notes: * District connections previously proposed under WB/RMDP
SWRP = Sector Wide Road Programme (this study)
RSDP = Proposed WB/IDA Road Sector Development Project

3. Roads to Chinese Border

Eleven potential cross-border links have been identified including the nine locations examined in the earlier North-South Corridor Study as discussed during

the 2003 DoR mission to PRC/Tibet: The sites included four sites in the east[11], the existing crossing at Kodari, the proposed crossing at Rasuwagadi, plus Lo Mantang (Mustang), Hilsa (Simikot) and Tinka La. Other potential crossings at Nanpa La (Solukhumbu), Larke (Gorkha) and Namja La (Mugu) were not considered feasible. The locations of all these potential border crossings are indicated in Figure 5.2.

Only Kodari and Rasuwagadi are considered as possible through vehicle transit routes within the 10-year plan period. The four eastern connections are not acceptable to the Chinese (within the Qomolunga National Park) and require lengthy (and difficult connections on the Nepali side). Lo Mantang (Mustang) and Hilsa-Simikot could be considered as possible access routes from China to otherwise non-road connected northern areas: it is possible that the Mustang link could (eventually) be connected into Nepal through the Jomsom-Beni link. A crossing at Tinka La should be reviewed as a potential tourist and pilgrimage route but be studied in conjunction with existing and potential routes within India.

4. Inter-District Links

Expansion of the SRN potentially includes a grid of east-west and north-south roads, involving the inclusion (and re-classification) of key local (district) roads and the construction of links on new alignments. In the Eastern, Central and Western Regions, a number of such inter-district roads exist or are under construction through various donor-funded initiatives. In the Mid and Far West, there are fewer such existing roads and a more ambitious network of new alignments would be required.

The requirements for the links to be included are that they should connect between adjacent districts (or more specifically district HQs), should provide improved access to significant local populations – especially those outside the 2hr/4hr walk criteria – and should improve local connectivity (ie allow inter-District travel between hill areas avoiding unnecessary circuitous travel via the Terai). Roads wholly within any one district have not in general been considered for inclusion in the SRN, unless they provide access to a significantly important destination.

Links thus identified can become also elements in the future mid-hills east-west highway or ‘corridor’, which – in reality – will be a combination of a series of local links, and not a through route designed for long-distance travel. Sections of an embryonic Mid-Hills East-West Corridor (MH-EWC) already exist in the form of the Prithvi Highway between Kathmandu and Pokhara, with extensions west to Baglung, and east to Dhulikhel and Nepalthok-Kurkot. Other potential sections of the route exist in the Eastern, Mid-Western and Far-Western Regions.

Other potential east-west connections are plausible in the lower hills and/or Inner Terai, through relatively densely populated areas to the north of the existing EWH. It is also possible – although unlikely in the foreseeable future – that other east-west routes could be developed further north linking between the more northerly District HQs, although traffic demand would be low and the terrain challenging.

5. Links to and within the Kathmandu Valley

Numerous previous studies (including the 1997 PIP) have identified the problems associated with the restricted number of access routes between Kathmandu and

[11] Olangchunggola (Taplejung), Kimathanka (Sankhuwasabha), Nangpala (Solukhumbu) Lamabagar (Dolakha)

the Terai, the remainder of the country, and the major border crossings with India. At present there is only one effective link between Kathmandu and the "outside world"[12], via the Thankot-Naubise section of the Tribhuvan Rajpath. This road is poorly aligned – being both steep and tortuous – and has limited capacity. Current traffic volumes are approaching 4,500 vehicles per day, comprising around 50 percent trucks and 30 percent buses. Virtually all goods and commodities consumed in Kathmandu – and almost all bus passengers – enter via this road.

There are four groups of alternative or additional access routes to Kathmandu Valley:

- Completion of the Japanese Road from Dhulikhel to Sindhuli and on to Bardibas on the EWH;
- Construction of the 'Fast Track' from Kathmandu to Hetauda and/or EWH, via either a tunnel option or along the Bagmati Corridor;
- Construction of an alternative approach from the west linking the Prithvi Highway west of Naubise with the Kathmandu Ring Road; or
- The upgrading and improvement of existing (or partially built) local roads to provide a link of trunk road standards.

This Study has considered a number of options, which are to a degree mutually exclusive, and some preliminary observations on the relative merits of each are presented in a later Chapter. The scale of investment considered is however significantly greater than that envisaged for other components of the proposed expansion of the SRN and thus it is recommended that further detailed studies be undertaken of the more promising options.

Within the Kathmandu Valley, the DoR is presently responsible for maintaining a network of 10 radial roads (sections of two National Highways and eight Feeder Roads), plus a number of other urban roads of a strategic nature – including the Kathmandu Ring Road. These are included in the existing operation network of 5,430km.

The Study has however considered the inclusion of a number of additional orbital and radial roads in the future SRN (including the proposed Outer Ring Road), although it is not possible to evaluate these on a comparable basis with roads elsewhere in the country. Development of the road network to serve the increasingly urbanised Kathmandu Valley should be the subject of a detailed land-use and urban planning exercise.

C. Screening Criteria and Methodology

The process of defining the potential future SRN links was based primarily on a screening process to select candidates from the long-list. This screening was undertaken using a compound ranking, or multi-criteria analysis (MCA), process. In this each link – or scheme comprising of a series of connected links – was allocated scores for indicators reflecting its relative importance in the road network. The total of scores for all indicators was used to indicate the ranking. Details of the indicators used and the scoring system are given in Annex 5.1, with a summary given below.

A single screening process was applied to all 170 schemes, totalling almost 9,000km, despite the differing characteristics and size of the schemes which can,

[12] The only alternative external connection is via the Arniko Highway to the Chinese border at Kodari: light 4-WD vehicles can also travel on local earth roads via Trisuli to Galchi or via Pharping and Kulikani to Bhimphedi, but neither route is suitable for large vehicles

in other circumstances, create difficulties in making direct comparisons. However in this case, the main concern is regarding the 'strategic' function of each scheme and no direct comparison of economic viability is attempted at this stage.

The basic criteria for inclusion as part of the strategic network – as either a National Highway or Feeder Road – have already been established in the Nepal Road Classification System. These criteria form the basis of the screening system, although it was necessary to add further indicators and a scoring system related to such factors as traffic level, population density and economic activity, in order to establish relative priorities.

The indicators used were as follows:

- Strategic connectivity – network effects, MH-EWC, etc;
- Population density served;
- Improvements to accessibility – impact on reducing in-accessible population;
- Connections to District HQ – either initial or secondary link;
- Border crossings – including potential as a transit route;
- Potential tourist or pilgrimage function;
- Serving area of economic activity, mineral extraction, rural airfield, etc
- Estimated traffic volume;
- Terrain difficulty and altitude – length of grades, max altitude;
- Poverty Index – the human poverty index for the districts traversed.

The final indicator, relating to the relative poverty of the area through which the road passed, was added to the original indicators at the request of the DoR. After the initial ranking it was decided to use an equal weighting for all the indicators, as this appeared to produce the most reliable results, without any undue bias.

D. Results of the Screening and Prioritisation

From the list of 170 schemes, the highest ranked 100 schemes – with a total length of around 5,000km – were retained as 'candidate roads' for subsequent assessment for inclusion in the extended SRN. These roads form the basis for the proposed extended SRN as illustrated in Figure 5.3: the results of the full ranking of the 170 schemes are included in Annex 5.1 Table A5.1b, which presents the total unadjusted 'scores' of each scheme.

The first step was to identify the 'committed' schemes – most of which were ranked 'high' on the priority listing. Additional roads were then drawn from the priority ranking, including BOTH existing District Roads and potential new alignments. The final ranking was not based solely on the ranking obtained from the MCA scores, as adjustments were made to produce a more logical priority list in which, for example, competing or duplicating schemes were removed, and some lower ranked schemes were elevated where these provided connections to high priority schemes.

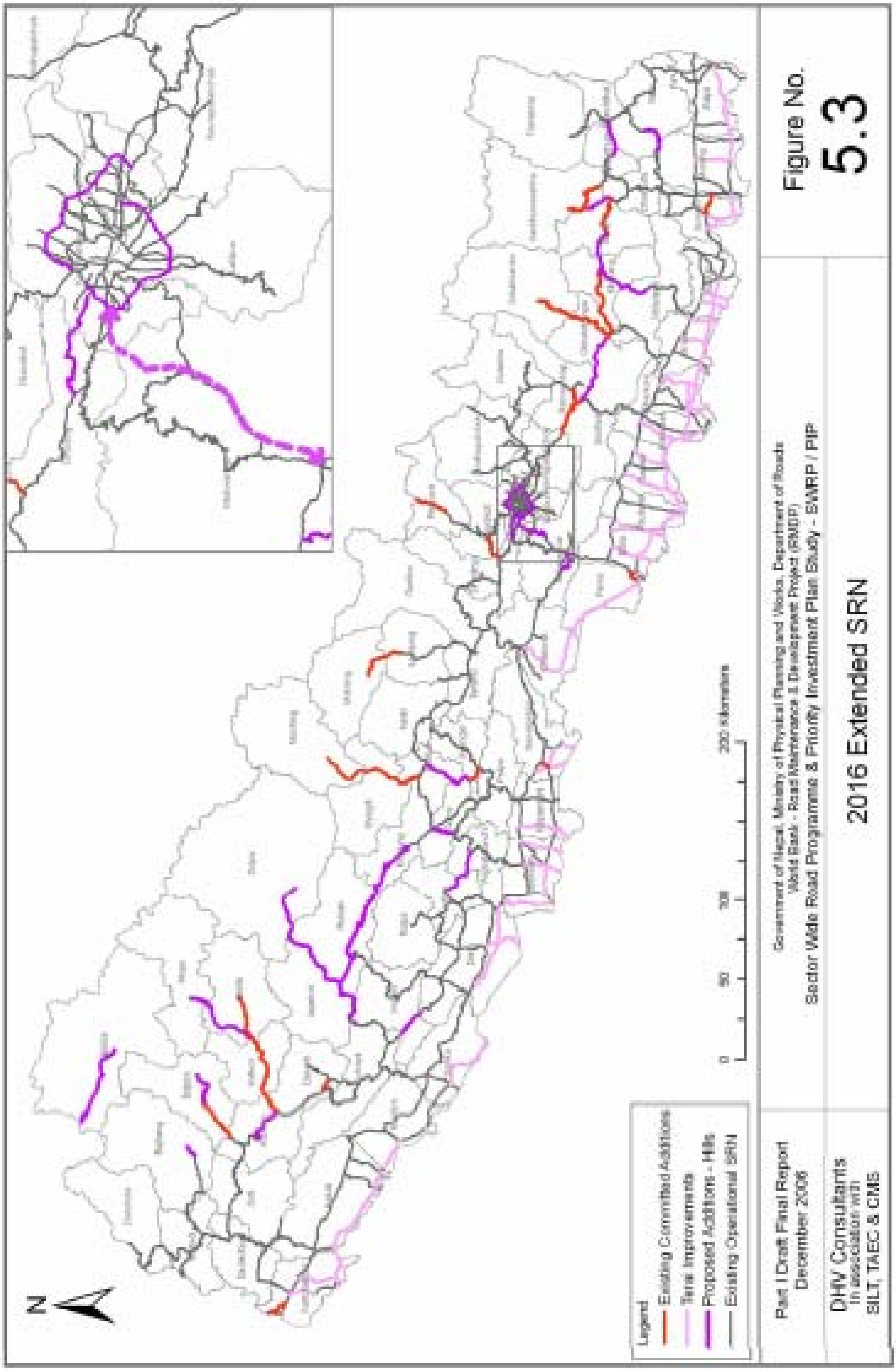


Figure No.
5.3
2016 Extended SRN
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Part I Draft Final Report
December 2006
DHV Consultants
In association with
SILT, TAEC & CMS
Legend
Existing Committed Additions
Terai Improvements
Proposed Additions - Hills
Existing Operational SRN
0
50
100
200 Kilometers
N

The resultant lists (Tables 5.3 to 5.6) also include some sections of the currently designated SRN which are not operational and which do not appear in the MCA analysis.

The priority list of around 100 schemes was drawn up in three groups: committed roads and other high priority schemes divided into Terai Roads and Hill Roads (Tables 5.3, 5.4 and 5.5). The MCA approach was used initially to identify around 3,000km of additional road to be included in the extended SRN in 2016, including 800km of committed schemes, a further 800km of roads in the Terai, and 1,400km of hill roads. This total is significantly in excess of the requirement (in the ToR) to identify an additional 2,200km of road.

In addition to these roads, further schemes have been identified for inclusion in the extended SRN: these additional roads include those currently maintained by the DoR, existing roads accessing major tourist or pilgrimage sites, and schemes proposed for upgrading under foreign-aid projects.

1. Committed Schemes

There are 20 'committed' schemes, with a total length of 797km[13], including existing roads, roads under construction or upgrading, and those for which funding is in the 'pipeline'. The roads are listed in Table 5.3 below in priority order as determined by the MCA ranking. Specifically the list includes the proposed ADB core projects from the Connectivity Study, the access roads to the two ICDs, and links to ten District Headquarters. These schemes are shown in RED on Figure 5.3.

Table V.3: The 20 Priority Additions to the SRN (Committed & Existing)

	Status	Scheme	km
1	ADB (STFP)	ICD (Pokhariya) - Parwanipur	10
2	ADB (USARP)	Okhaldhunga - Salleri	29
3	ADB (TCP)	Dhunche - Rasuwagadhi	26
4	ADB (STFP)	Bhumahi - Parasi - Siddharthanagar (ICD)	29
5	ADB (TCP)	Galchhi - Devighat	20
6	ADB (TCP)	Khurkot - Manthali	11
7	ADB (RNDP)	Basantapur-Tumlingtar-Khandbari (north of Mude)**	81
8	Exists	Maldhunga - Beni	13
9	u/c (India)	Shabha (Mahendranagar) - Brahmhadev	13
10	u/c RMDP	Sanfebagar – Martadi (remaining section) **	43
11	Exists (WB)	Sunkoshi - Okhaldhunga	41
12	u/c (RAP)	Leguwaghat - Bhojpur	66
13	u/c (RAP)	Hilepani - Diktel	67
14	u/c (Army)	Beni - Jomsom	80
15	Exists (GTZ)	Upper Dhungeshwor - Lower Dhungeshwor**	8
16	Exists (hydro)	Malunga - Kaligandaki	20
17	Exists DR	Inaruwa - Duhabi	11
18	u/c in part	Besisahar - Chame	65
19	Karnali Highway*	Tunibagar (Rakam) - Kalikot - Jumla	132
20	Dhulikhel-Sindhuli*	Nepalthok-Khurkot	32
		Total	797

* Not included in prioritisation process as already included in Designated SRN
** Remaining Sections

[13] Lengths (and some schemes) differ from Table A5.1A as some roads are partially constructed and open to traffic.

These links have been identified in the screening and ranking process as high priority schemes and include a number of current and proposed aid-funded projects. Specifically, the 20 high priority schemes include:

- *Access to ten currently non-road-connected District Headquarters (totalling 604km):* Khandbari, Bhojpur, Diktel, Okhaldhunga, Salleri, Chame, Jomosom, Manma, Jumla and Martadi;
- *Three Missing Links (51km):* Nepalthok-Khurkot, Khurkot-Manthali and Lower-Upper Dungeshwor (access to Dailekh);
- *Access to four Border Crossings (98km):* improved access to Birgunj & Bhairawa ICDs (ADB/STFP); Dhunche-Rasuwagadhi (Chinese Border) and Galchhi-Devighat; and Mahendranagar-Brahmadev; and
- *Three Existing Roads (44km):* Maldhunga-Beni, Malunga-Kali Gandaki and Inaruwa-Duhabi

2. Other High Priority Schemes (Terai)

Twenty-five sections of road, with a length of 815km, have been identified and prioritised within the Terai, comprising both elements of the east-west Postal Road and north-south links between the East-West Highway and the Indian Border. These roads are listed in priority order (based on the MCA) in Table 5.4 below: all are included in the programme of infrastructure improvements proposed for funding by the Government of India (GoI).

It has been determined that all the Terai roads proposed for upgrading or reconstruction under the GoI programme would, in future, become part of the extended SRN. In total, an additional 1,500 km of Terai roads are added to the existing SRN on this basis, including over 500km of the Postal Road. It is noted that, overall, the GoI improvement programme includes 1,450 km of road, some of which are part of the already designated SRN. Two sections of road in the eastern Terai, which are currently being upgraded under the ADB-funded RNDP, are also included in the extended SRN.

These additional links in the 2016 SRN are shown in Figure 5.3 in PINK. It can be seen that all potential sections of the Postal Road are now proposed for inclusion in the extended SRN, together with an additional 13 north-south connections between the East-West Highway, main centres and the Indian border.

Table V.4: The 25 Priority Additions to the SRN in the Terai

	Type	Scheme	km
1	Local Rd	Taulihawa - Bahadurgunj	22
2	Local Rd	Janakpur - Samsi	20
3	Postal Rd	Jaleswor - Malangawa	40
4	Postal Rd	Malangawa - Gaur	51
5	Postal Rd	Gaur - Kalaiya	66
6	Postal Rd	Rajbiraj - Siraha	69
7	Postal Rd	Siraha -Janakpur	38
8	Local Rd	Rampur - Lumbini	20
9	Local Rd	Pipra - Chakarchauda	27
10	Postal Rd	Gulariya - Murtiya	3
11	Local Rd	Manmat - Matiarwa	28
12	Local Rd	Sati - Khakraula	5
13	Local Rd	Parasi - Maheshpur	12
14	Postal Rd	Bhadrapur - Gaurigunj	47

	Type	Scheme	km
15	Postal Rd	Gaurigunj - Rangeli	25
16	Postal Rd	Birgunj - Jagatpur - Bharatpur	98
17	New	Lumbini Circumambulatory	12
18	Local Rd	Lumbini - Kakarhawa	8
19	Postal Rd	Nepalgunj (Birendrachowk) - Baghauda	49
20	Local Rd	Lamahi - Koilabas	34
21	Local Rd	Phuljor - Tribhuvannagar	24
22	Local Rd	Naya Road - Madhuwan	42
23	Local Rd	Tamagadhi - Simraungadh	40
24	Local Rd	Lahan - Thadi	18
25	Postal Rd	Dhangadhi - Bariyarpatti	17
		Total	815

3. Other High Priority Schemes (Hills)

A further 25 potential additions to the SRN in the hills, with a total length of around 1400km (see Table 5.5), have been identified based on the MCA analysis and in discussion with the DoR. These include a mix of new construction and upgrading (and re-classification) of District Roads. The ‘new’ links include access links to the three remaining non-connected District HQs – Gamgadhi, Simikot and Dunai - and options for improved access to Kathmandu Valley from the south and west. The two alternative options for each of the approaches to the Kathmandu Valley are shown shaded in Table 5.5. The suggested alignments for the additional hill roads are coloured PURPLE on Figure 5.3.

PLEASE NOTE: This ranking is based on strategic importance only and NOT on economic viability or prioritisation. Additionally some of the schemes as shown are mutually exclusive and require a comparative evaluation of the options. These aspects are considers in the next chapter.

This list indicates a high priority for the provision of an additional access route to Kathmandu Valley – to be selected from among the alternatives for access from the West or South (taking account also of the timing and lead-time for construction) – plus the construction of the Kathmandu Outer Ring Road, links to the three un-connected District HQs, and a number inter-District links in the mid-hills of eastern and western Nepal, which taken together could create a mid-hills east-west corridor. This mid-hills corridor (MHC) should not be conceived as a major through highway – that role is served by the existing East-West Highway – but rather a series of local links to improve local accessibility and connectivity.

Table V.5: The Next 25 High Priority Additions (Hills)

	Type	Scheme	km
1	New	Hetauda Bypass	15
2	New	Chourjahari - Musikot	53
3	New	Outer Ring Road (ORR) & Mulpani-Thimi	70
4	New - DHQ	Simikot - Hilsa	88
5	New - DHQ	Access to Gamagadhi	100
6	New	Dharke - Bhimdhunga - Sitapaila (RR)	33
OR	New	RR Gongabu – Kolphu (60km)	
7	Local Rd	Tulsipur – Bhotechour (MHC)	86
8	Local Rd	Baglung – Burtibang (MHC)	105
9	Local Rd	Mangalsen - Belkhet (Rakam) (MHC)	40
10	New	Kaligandaki - Kusma	67

	Type	Scheme	km
11	New	Kathmandu-Terai Fast Track	65
OR	New	Bagmati Corridor (90km)	
12	New	Brahmhadev - Jogbudha	30
13	Local Rd	Jhumka - Chatara - Barahachhetra	26
14	New - DHQ	Jajarkot - Dunai	144
15	Local Rd	Bhojpur - Diktel (MHC)	55
16	New	Hilepani -Sunkoshi – Khurkot (MHC)	43
17	Local Rd	Fattepur - Kanchanpur	27
18	Local Rd	Phidim - Terhathum (Myaglung) (MHC)	75
19	New	Leguwaghat - Sabha	32
20	Local Rd	Chatara - Dharan	13
21	New	Burtibang - Musikot	145
22	Local Rd	Tamghas – Sandhikharka (MHC)	30
23	Local Rd	Sandhikharka – Pyuthan (MHC)	49
24	Local Rd	Tandi, Ratnanagar - Saurah	7
25	Local Rd	Dumre - Bandipur	8
		Total	1406

The roads may be grouped into three broad categories: strategic network improvements (Kathmandu Valley approaches, Hetauda By-pass, Kathmandu Outer Ring Road); remote area access (the three District HQs); and mid-hills linkages, including the potential mid-hills corridor.

Improved access to the Kathmandu Valley is clearly a major priority in the coming decade. The sole existing route between Thankot and Naubise (and the section within Kathmandu Valley) is operating close to effective capacity, with frequent delays and congestion experienced: furthermore the reliance of the capital on this single approach road has severe strategic and logistical implications, as has been frequently demonstrated in recent years.

All of the suggested additional access routes to Kathmandu Valley – from both the west and south – are ranked highly in the MCA, suggesting that an evaluation of a new access route should have a high priority. There are many complex and inter-related issues to be addressed and it is suggested that initially only one (of the four broad options considered) should be pursued. The issues associated with the alternatives are presented in greater detail in the following Chapter.

Examination of the population density distributions (see following sections) reveals that significantly more people will be served though an increase in road network density in the mid-hills rather than by extensions of the network into the sparsely populated northern areas. Consequently, improvements to accessibility may be more readily achieved by the development of roads in the mid-hills to provide enhanced mobility and better connectivity to a greater number of people.

The MHC could start in the east at the Pashupatinagar border crossing with Darjeeling [14] and traverse the whole of the country via Phidim, Terhathum, Bhojpur, Diktel, Kurkot, Dhulikhel, Kathmandu, Pokhara, Baglung, Gulmi, Sandikharka, Pyuthan, Dang, Surkhet, Sanfe, Silghadi, Dadeldhura and Baitadi to the Indian Border at Jhulalghat in the Far West. The total length would be around 1,700km and the route would connect (or pass close to) 24 District Headquarters. Around 960km of the route already exists as links in the SRN, a further 430km follows local road alignments (either existing or under construction) and the

[14] or alternatively via a new border link to the north of Phidim

remaining 290km would be new construction. [An alternative more northerly alignment is available between Baglung and Surkhet via Musikot and Jarjarkot but this would serve significantly fewer people.]

In addition to these roads that were identified and evaluated through the MCA, a number of additional hill roads have been proposed for inclusion in the extended SRN (see Table 5.6). These additions, totalling almost 600km, include a number of roads that are presently maintained by DoR, some important inter-District local roads which are open year-round and have regular bus services, and access roads to major tourist or pilgrimage sites.

Table V.6: Additional Hill Roads proposed for inclusion in SRN

	Type	Road Section	Length (km)
1	Local Rd	Kanti Rajpath (Hetauda - Tikabhairav)	93
2	New	Leguwaghat - Sabha	32
3	Exists	Ridi - Wamitaksar	51
4	Local Rd	Tamghas - Wamitaksar	19
5	Local Rd	Gwarko - Namobuddha - Kavre Bh	42
6	Local Rd	Pharping - Kulekhani	27
7	Local Rd	Dhadingbesi - Gorkha	67
8	Local Rd	Jogbudha - Budar	34
9	Exists	Dumre - Bandipur	8
10	Local Rd	Bhedetar (KRM) - Budhabare	50
11	Local Rd	Budhabare - Ranke	66
12	Exists	Panchkhal - Palanchowk	11
13	NEA	Bhimphedi - Kulekhani	12
14	Exists	Sahajpur - Barchhain (BP Nagar)	38
15	Local Rd	Daiji - Jogbudha	35
		Total	585

E. Conclusions regarding Expansion of the SRN

The Study has completed a thorough and comprehensive review of all potential additional links to be considered for inclusion in as extended SRN over the next ten years. The analysis commenced with a review of all previous studies and recommendations, and identified almost 9,000km of potential new strategic road, including a mix of new alignments and upgrading of existing local roads. The start point was the existing ‘designated SRN’ comprising around 5,050km of open and operational road, plus around 400km of ‘other’ roads considered to be part of the existing SRN (including a network of roads within Kathmandu Valley).

The extent of the network is however in a degree of flux at the present time, as there are a number of on-going construction and improvement programmes (mostly foreign aid funded), in various stages of completion, which influence the exact length of the network to be considered. Additionally, there have been many changes and extensions to the network over the past 12 years since the last comprehensive classification was undertaken.

The expansion of the SRN will comprise three main components: committed schemes and existing strategic roads; the conversion of local roads to SRN; and the construction of new alignments. The first group comprises non-SRN roads that the DoR currently maintains, as well as committed projects including specifically new links to District Headquarters.

The second group (local roads) includes a substantial length of existing earth or gravel roads (in excess of 1,200km) in the Terai which are the subject of an

Indian Government Improvement Programme: it is assumed that, on completion, all these roads will be transferred to DoR responsibility. It is also suggested that a number of key inter-District local roads in the hills be re-classified as part of the SRN and transferred to the DoR.

The third group includes new roads to enhance accessibility in remote areas and within the more densely populated mid-hills, as well as some key new strategic links to strengthen the network and improve access to Kathmandu. These latter schemes are potentially the most economically attractive prospects, whereas the new roads in the hills will improve accessibility, encourage development, provide social benefits, and reduce regional disparities.

The Study recommends the expansion of the SRN to around 9,900km over the period to 2016. The following Chapter examines and evaluates a number of the individual schemes, to assist in developing a prioritised list of improvements and in determining budget requirements.

The final recommendations for the expansion of the SRN are presented in Chapter 10, together with a detailed listing of prioritised projects. Subsequent Chapters (7 and 8) examine the impact on accessibility of the extensions and/or improvements to the strategic and local road networks. This analysis provides general support for a significant expansion of the SRN (mainly though the redesignation of key local/district roads) as the most effective means of enhancing accessibility and providing a basis for economic growth and development. Details of the future, expanded SRN comprising almost 10,000km are given in section 7.4.2.

Chapter 6

VI. PRIORITISATION OF UPGRADING & NEW CONSTRUCTION

A. Introduction

The previous chapter described the screening process used to identify additional links to be included in the extended SRN based on their 'strategic' function. A review has been undertaken of the proposed SRN to determine which sections are likely to be economically viable for upgrading or new construction during the next ten years. This prioritisation, leading to the development of the PIP, is described in this chapter. Roads considered a priority for inclusion in the SRN are not necessarily priorities for construction or upgrading, but there is some correlation between being strategic and there being significant benefits from good road condition. Strategic roads are often those that have, or potentially have, higher traffic than other roads in the network, which gives greater potential for significant benefits.

Some roads can be directly included in the SRN with no works required, other than an ongoing maintenance liability, whilst others require construction or upgrading on the basis of condition and/or traffic volume. In this chapter a review has been made of the priority for construction or improvement to proposed additions to the SRN based on the economic returns on the investment required for such works. The potential projects are diverse in nature. The types of projects that could be involved on the roads proposed for inclusion in the SRN, and the sources of the major benefits to be derived, are:

- Capacity expansion (widening of roads) - road user benefits from higher vehicle speeds.
- New network roads - road user benefits from reduced travel distance and higher speeds.
- New hill roads - road user benefits from replacement of trail movements and air transport by truck and bus traffic, plus development benefits.
- Upgrading earth and gravel roads - road user benefits from reduced surface roughness and higher vehicle speeds.
- Rehabilitating paved roads - road user benefits from reduced surface roughness and higher vehicle speeds.

It is not necessary to consider all roads for such works. Many of the proposed additions to the SRN, especially the highest priority sections, are committed roads that have already been assessed and do not require further analysis, except where the current proposals would leave the road in an unsealed state. In these cases the viability of upgrading to sealed standard has been examined where possible. Some of the proposed SRN roads are currently under construction. Again, where these works are to unsealed standard, they have been evaluated for upgrading to sealed standard. Some roads have already been studied in detail elsewhere and found to be viable: these have not generally been

reassessed in this Study. The results of those that were studied for the feasibility studies in Part II of this Study are reported in this Chapter.

Some roads cannot realistically be studied within this Study, as they require specific, detailed information and careful analysis if the results are to have any validity. Therefore only those where an evaluation would be useful and possible at an acceptable level of accuracy have been studied.

Two types of analysis have been carried out:

- Population based analyses of new construction or upgrading of roads providing access in hill areas.
- Traffic based analysis of new roads replacing or augmenting existing roads.

Population based analysis determines the number of people that would be served by a road, in that it provides their main access to external centres and the rest of the road network, and from this estimates the amount of traffic that would use the road. The method is based on assumed rates of freight and passenger traffic generation per head of population, and the benefits of diversion from trail movement to road transport. It can only be carried out accurately if the road under study is the main access to a defined area. However it can also be used for interconnecting roads, such as sections of the Mid-Hills East West Link if the road sections serve significant numbers of people. Several of the links proposed for the SRN have been analysed in this way as part of the feasibility studies carried out in Part II of this Study.

The traffic based analysis determines the road used savings provided by shorter and/or better aligned routes compared with existing route; that is, diverted traffic benefits. This is a more conventional analysis based on vehicle operating and time cost savings from a shorter route, and has been applied to some roads in the core network. It is not generally applicable to roads such as the Mid-Hills East West Link because the level of traffic that would divert from existing routes is unknown.

Other types of analysis are not practical within the scope of this study. Specifically capacity expansion schemes have not been studied (although the widening of the Narayanghat - Mugling Road was studied in the Feasibility Studies reported in Part II). Traffic levels in Nepal are for the most part low and so there are few cases where upgrading in the form of capacity expansion is required; the exceptions are in – and on the approaches to – the Kathmandu Valley. In this type of project the benefits are typically very small per vehicle-km, but can justify investment because of the high volume of traffic. Specific information about traffic flow and speed-flow relationships over short distances is required to estimate the benefits.

B. Evaluation of SRN Improvements and Expansion

The proposals for the expansion of SRN, as described in Chapter 5, were based on an assessment of ‘strategic’ nature of potential links. Three types of expansion of the SRN were identified:

- Existing Commitments
- Conversion of existing Local Roads
- New proposals

The analysis identified, by 2010, a network of around 7,900km of existing roads and committed schemes that comprise the expanded ‘committed’ network which

is taken as the base for further work. This committed network has been evaluated using HDM to determine priorities for upgrading and major maintenance interventions as described in Chapter 4.

The previous chapter established the scale and extent of the future SRN: this Chapter now assesses and evaluates the needs and priorities for development work on the network – in terms of both new construction and upgrading. Initially, the following section examines the upgrading requirements of the existing network.

Subsequent sections review the various options for extensions to the network, strengthening of the network, and the potential for further upgrading or capacity enhancement.

1. HDM Analysis of Upgrading

The HDM model and database have been used to identify priorities for upgrading of existing (and proposed) gravel and earth roads that form part of the committed network. For the purposes of this analysis ALL potential schemes (except those actually under construction) have been evaluated, in order to confirm priorities among the current proposals. Due to constraints of the HDM-4 model, it is not possible to optimise the programme but merely to identify those schemes that are assessed as feasible in the period to 2016.

The resultant schemes are listed in Annex 6.1 and are illustrated in Figure VI.1, which indicates separately those ‘committed’ projects which are assumed to be implemented by 2010 and those additional projects recommended for sealing post-2011. The analysis confirms that most of the ‘committed’ projects (shown in PINK) – including the proposed Terai road improvements – are priorities before 2016, with the exception of the final sections of the roads to Darchula and Jumla: the forecast traffic levels on these two roads are insufficient to justify upgrading to sealed standards on the basis of road-user savings alone[15].

The remaining schemes – shown in green – are those links in the 2010 network that are identified by HDM-4 for upgrading in the period beyond 2011. This category includes a number of radial roads within the Kathmandu Valley and the sealing of remaining sections of hill road which are not included in any current programme.

In total, almost 2,600km of earth and gravel road are proposed for upgrading over the 10-year plan period, see Table VI.1, at a total estimated cost of Rs 13.5 billion. About 60 percent of the length is in the hills with the remainder (1,000km) in the Terai.

Table VI.1: Roads proposed for Upgrading to sealed Standards

	Number of Links	Length (km)	Cost (Rs billion)	Average Cost/km
Hills	71	1,598	9,569	5.99
Terai	50	980	3,908	3.99
Total	121	2,578	13,476	5.23

[15] It is probable however that both would be justified if the full benefits from generated traffic were included: both sections were included in the previous phase of RMDP and the amount of outstanding works required to complete to sealed standards has been assessed in Part II of the Study.

2. Evaluation of extensions beyond 2010

The previous Chapter recommended the further expansion of the SRN beyond 2010 by approximately 1,800km to a total length of around 9,700km by 2016, as illustrated in Figure 5.3. This expansion includes the reclassification of some exiting roads as part of the SRN and the construction of new links, both extensions into non-road-served hill areas and new links accessing Kathmandu Valley.

Key elements of the expanded SRN include:

- Completion of links to ALL District HQs;
- Upgrading of unsealed roads in Terai and main links into the hills (as described above);
- Improvement of the road network in the mid-hills, including inter-District links and the potential mid-hills corridor;
- Enhancement of access to Kathmandu – including the proposed "Fast Track" to the Terai and/or Bhimdhunga Link to Prithvi Highway; and
- Capacity enhancement of key Kathmandu Valley roads – including the existing Ring Road, Bhaktapur-Dhulikhel, etc

Wherever practical, schemes involving new construction have been evaluated, based on the potential identifiable benefits. In the case of hill roads in previously unserved areas, the evaluation is based on the populations served and the benefits from generated traffic and transfers from air and foot travel to trucks and buses: in situations where there is existing or potentially divertable traffic, the benefits are based on road user savings. However in some cases, it is not possible to identify specific quantifiable benefits and no attempt to evaluate these projects has been made.

In total 23 proposed sections of new construction have been evaluated: nine of these are classified as 'remote area access', a further nine as 'mid-hills links', and the remaining five as 'strategic network improvements'. The proposed schemes are illustrated in Figure VI.2. Specifically, it should be noted that the schemes evaluated include TWO options for the Kathmandu-Terai link and TWO options for improved access from the west (Prithivi Highway). In each case these are <u>alternatives</u> which need to be evaluated against each other and – in practice – <u>both</u> pairs of options should be considered together as part of a study of improved access to Kathmandu and they are, to an extent, inter-dependent.

It is also noted that not all the potential new roads have been evaluated, as in some cases (e.g. Kathmandu Outer Ring Road) it is not possible to quantify the potential benefits without exhaustive study.

The results of the evaluations are presented in Table VI.2 for the 23 schemes, with a total length of a little over 1,400km and a combined estimated cost of Rs 47 billion. It can be seen that – with five exceptions – all the evaluated schemes produce a positive return, in many cases in excess of 20 percent. The schemes which fail to produce adequate returns are mostly the more remote extensions to the network in the hills – Hilsa-Simikot, Nagma-Gamagdhi, Jajarkot-Dunai and Chaujari-Musikot. The Gongabu-Kolphu-Galchhi alignment for the improvement of the western approach to Kathmandu is also shown to be non-feasible.

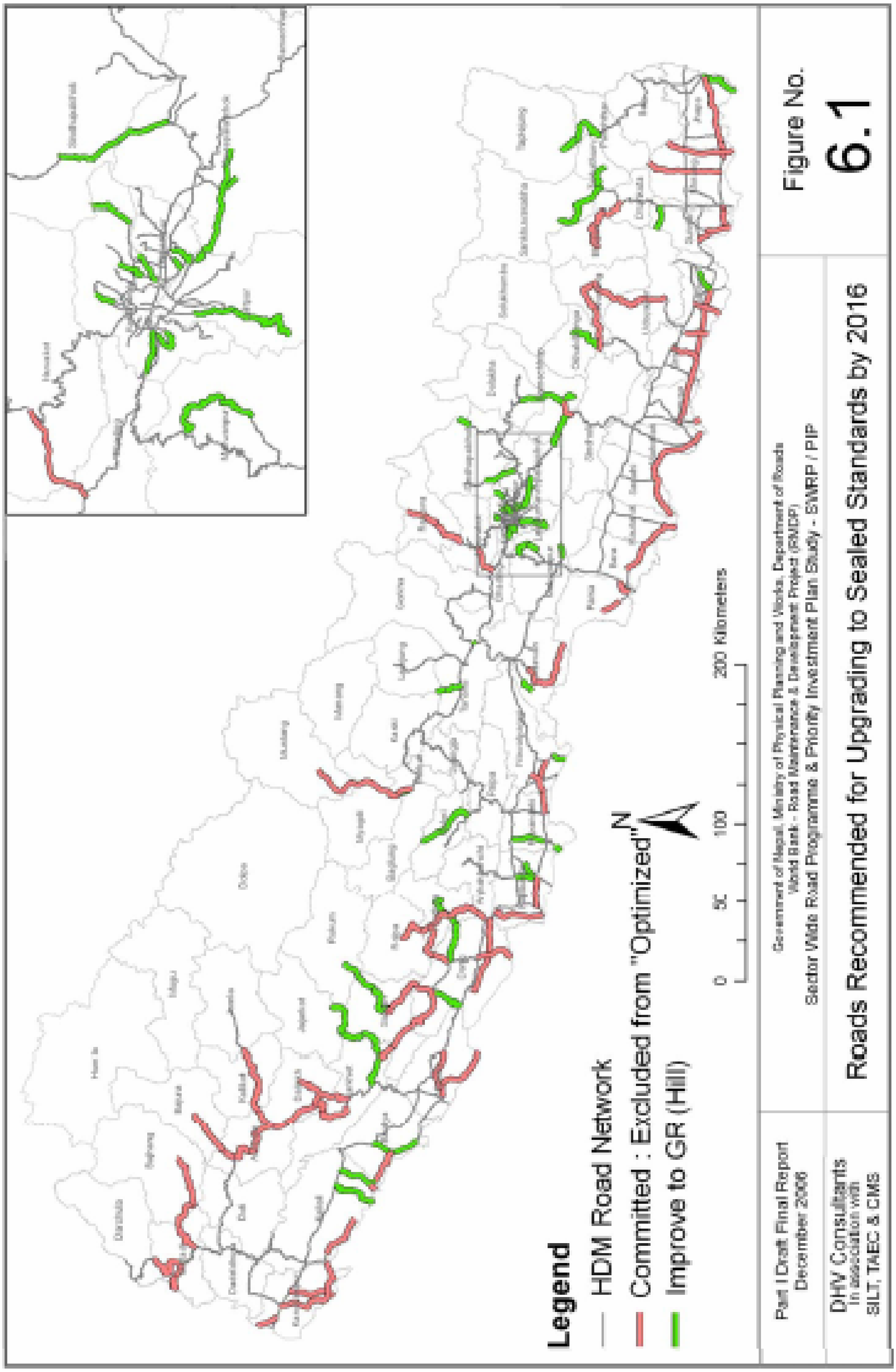
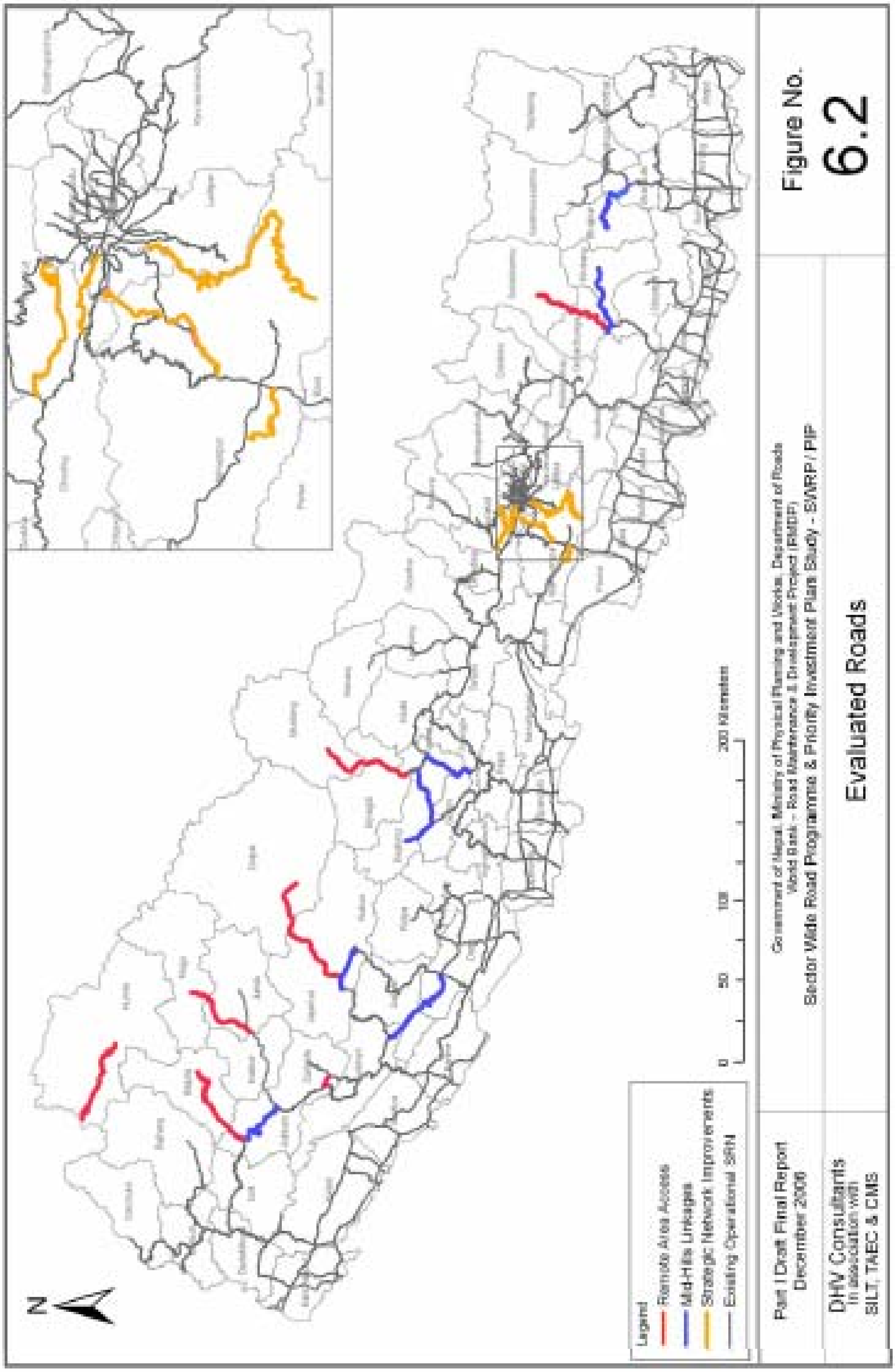

Legend
HDM Road Network
Committed : Excluded from "Optimized"
Improve to GR (Hill)
N
0 50 100 200 Kilometers
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Figure No.
6.1
Roads Recommended for Upgrading to Sealed Standards by 2016
Part I Draft Final Report
December 2006
DHV Consultants
In association with
SILT, TAEC & CMS

Table VI.2: Evaluation of Links proposed for New Construction

	Length (km)	Cost ** (Rs mill)	IRR (%)
Remote Area Access			
Sunkoshi – Okhaldhunga*	40	261	22.5
Okhaldhunga – Salleri	29	333	14.4
Beni – Jomsom	80	480	14.5
Upper – Lower Dhungeshwor*	8	85	13.9
Nagma – Gamagadhi*	88	1,475	7.6
Simikot – Hilsa	88	1,012	4.7
Jajarkot – Dunai	144	1,656	8.5
Sanfebagar – Martadi	57	600	34.2
Martadi – Kolti*	51	673	23.1
Mid-Hills Linkages			
Diktel – Hilepani	67	402	21.6
Hile – Leguwaghat	26	156	21.1
Leguwaghat – Bhojpur	66	396	20.9
Kaligandaki – Kusma	67	771	17.7
Chourjahari – Musikot	53	610	2.6
Tulsipur – Bhotechour*	78	873	20.0
Baglung – Burtibang	105	630	35.2
Mangalsen – Sanfebagar*	38	289	15.1
Mangalsen – Belkhet*	49	576	17.8
Strategic Network Improvements			
Kathmandu – Terai Fast Track	70	18,000	16.2
Bagmati Corridor	94	9,720	18.4
Hetauda Bypass	15	375	25.0
Dharke – Bhimdhunga – Sitapaila	33	2,600	15.0
Gongabu – Kolphu – Galchhi	60	5,000	3.8
Total	**1,406**	**46,973**	

* Schemes evaluated in detail in Part II Feasibility Studies
** Incl VAT

Seven of the schemes examined (marked with an asterisk) are subject to detailed Feasibility Study under Part II of the project: greater detail of the evaluation procedures and results are available in the Part II Final Report and individual reports on each road. The rates of return for each of the Strategic Network Improvements are based on traffic projections assuming that only that scheme is implemented. As noted above, some, such as the Kathmandu-Terai Fast Track and Bagmati Corridor, are clearly mutually exclusive and only one would be implemented. In other cases two schemes could be implemented but the impact on traffic would lower rates of return.


Legend
Remote Area Access
Mid-Hills Linkages
Strategic Network Improvements
Existing Operational SRN
0
50
100
200 Kilometers
Part I Draft Final Report
December 2006
DHV Consultants
in association with
SILT, TAEC & CMS
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Evaluated Roads
Figure No.
6.2

All of the remote area and mid-hills projects were assessed using the 'population served' approach, traffic forecasts are made based on estimates of increases in volumes of freight consumed and frequency of trips made per head, with and without the road improvement. A summary of the basic assumptions is presented in Table VI.3, which indicates the changes for populations in the immediate zone of influence of the road (assumed at 4 hour walk) and the broader catchment area. These estimates have been correlated against observed traffic flows on roads into hill areas before and after improvement: the most notable change is the increase in the number of bus passenger movements from the population in the immediate area of influence.

Table VI.3: Estimates of Freight Consumed and Trips made with and without improvement

	BEFORE	AFTER Improvement	
	Restricted Access	Wider area	Within 4 hour walk
Freight Consumption (kg / head / year)	40kg	60kg	80kg
Passenger Trip Generation (trips/year)	0.4	0.6	1.5

The approach is discussed in more detail in Annex 6.2. In general, acceptable rates of return are obtained for roads of moderate length serving areas with significant population densities – ie within the mid-hills. It is only the longer roads into the sparsely populated northern mountain areas that fail to produce acceptable returns.

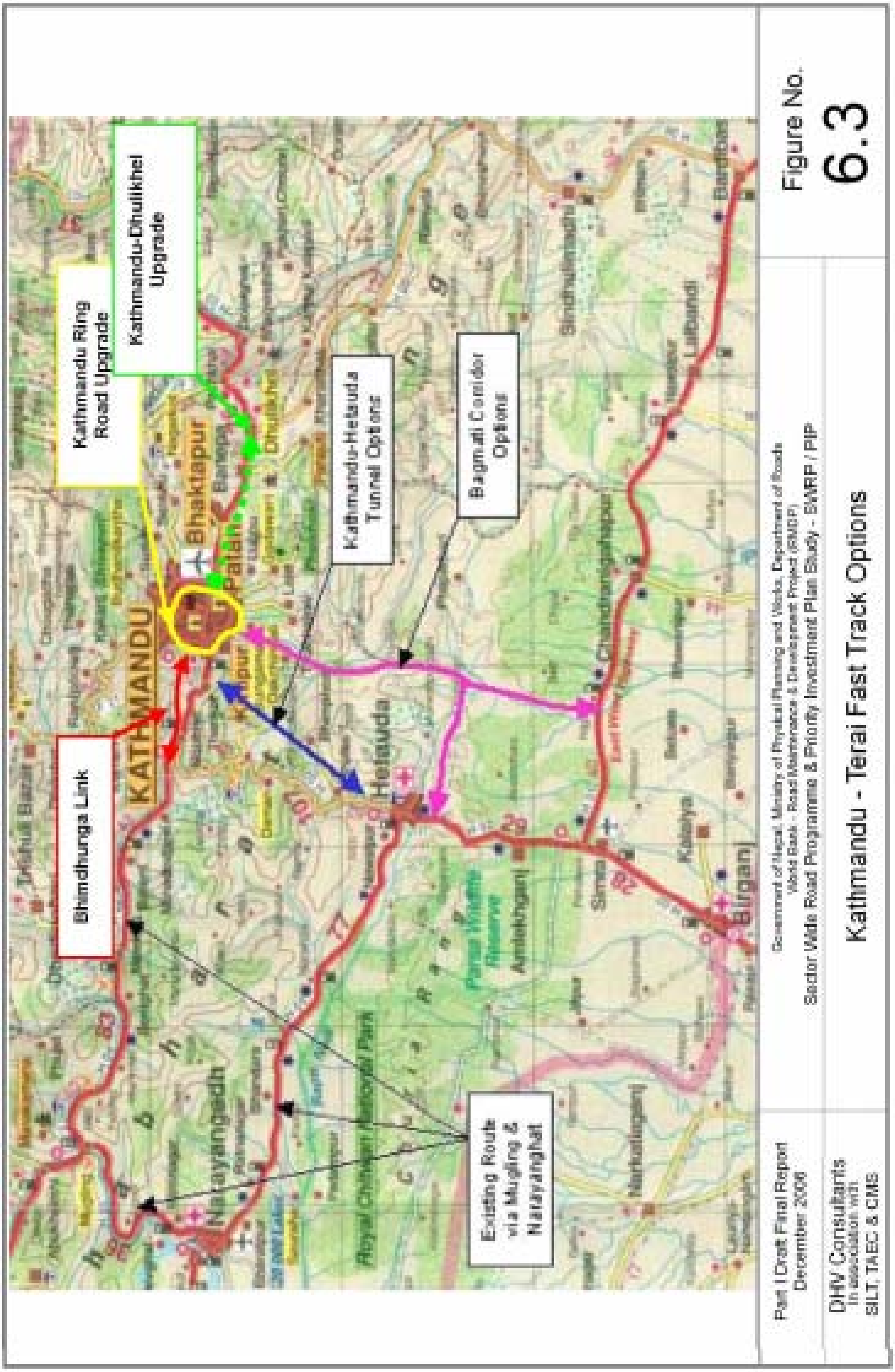
The Strategic Network Improvements were analysed using a conventional road appraisal approach, with potential benefits based on road user savings (vehicle operating cost and passenger time savings) from shorter and higher speed routes. Road user costs were determined for the main vehicle types for range of road conditions and terrain types using the HDM-4 based Roads Economic Decision (RED) Model. Estimates of costs per km were produced for different road conditions. Although roughness varies over time it is generally acceptable to use a single estimate that reflects average roughness over time for each road type, consistent with an assumption of the application of typical maintenance operations. An IRI of 4 was used as the standard measure of roughness. Road gradient and curvature are also inputs to VOC calculations. Standard averages applicable in different terrain types were used.

C. Network Strengthening

Five schemes involving network strengthening within the Central Region have been evaluated. These include two alternatives for a link between Kathmandu and the Terai, two alternatives for an improvement to the western approach to Kathmandu from the Prithvi Highway, and a by-pass for Hetauda.

1. Access to Kathmandu

The provision of an alternative access to Kathmandu from either the south (Terai) or west (Prithvi Highway) is possibly the single most important prospect for the improvement of traffic conditions and the creation of a major economic impact in Nepal over the coming decade. Reference to Figure 3.6, which illustrates the current traffic flow pattern, reveals that the only roads with significant volumes of traffic are in the Central Region and the dominant movement is on the indirect link between Kathmandu and Birgunj, via Mugling and Narayanghat.


Kathmandu Ring Road Upgrade
Kathmandu-Dhulikhel Upgrade
Kathmandu-Hetauda Tunnel Options
Bagmati Corridor Options
Bhimdhunga Link
Existing Route via Mugling & Narayanghat
KATHMANDU
Bhaktapur
Patan
Hetauda
Narayangadh
Birganj
Figure No.
6.3
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Kathmandu - Terai Fast Track Options
Part I Draft Final Report
December 2006
DHV Consultants
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Any improvement or reduction in distance for traffic on this route will clearly have a significant and far-reaching impact. The potential economic benefits to road users are clearly of an entirely different magnitude to those available from improvements to hill roads in the west, where traffic volumes are negligible in comparison. The options for the Fast Track are considered in more detail below.

The two sets of alternatives – from the south or west – are, to an extent, inter-dependent as both potentially serve the same (or similar) traffic. If the Fast Track to the Terai were to be committed (and built) in the near future, then the demand and requirement for an upgrade of the western approach to Kathmandu would be significantly reduced. However, if a decision to construct the Fast Track were to be deferred for at least 10 years, then the pressure and justification to improve the western approach to Kathmandu from the Prithvi Highway would be substantially strengthened. The overall location of the improvements are shown on Figure VI.3.

It is clear that, of the two alternative western approaches examined, the shorter option from Darke via Bhimdhunga is preferred. The second option – linking from the Galchhi-Devighat road through the Kolphu Valley to enter Kathmandu near Balaju – is substantially longer and less well aligned. Either option would produce benefits of a similar scale and thus the shorter – and consequently cheaper – route is preferable.

In this Study, it has not been possible to assess the impact of all the externalities and inter-relationships relating to the timing and sequencing of the provision of improved access to Kathmandu. It is however clear, from the analyses that have been conducted, that the rates of return on the (more expensive) direct links between Kathmandu and the Terai are of a similar level to those from the (more modest) improvements to the western approach. However – if the Fast Track option is likely to be built in the longer term – the benefits from the improvements to the 'western' approach will be reduced.

The level of potential benefits from the Fast Track option is much greater. This would suggest that, if guaranteed funding were available on a timely basis, then the full Fast Track option should be pursued and the western approach improvements deferred. However, if there is uncertainty regarding the ability to complete the Fast Track within a fixed timeframe, then further more detailed consideration should be given to the 'western' improvements.

2. By-Passes

There are substantial benefits available from the construction of a by-pass for Heatuda, due to the significant volumes of through commercial traffic plus the possibility that the by-pass route could be shorter than the more congested route through town.

By-passes of other towns on the East-West Highway were considered but none – with the exception of Narayanghat/Bharatpur, which is already by-passed – offer similar potential benefits. It is suggested that the existing Narayanghat by-pass (FR37) should be considered for upgrading, together with the relocation of the bus stand from the centre of town and the introduction of a ban on through bus and truck traffic.

Other potential by-passes should be considered for the border towns of Birgunj and Biratnagar, to reduce the significant congestion on the existing approaches to the border crossing. The situation in Birgunj could be substantially improved with the operation of the ICD for road based traffic.

D. Kathmandu - Terai Links

1. Previous Studies

The previous PIP Study examined a number of possible alignments for a new link between Kathmandu and the Terai: these were subsequently reviewed by the IDA-funded North-South Corridor Study in 2004. The options studied involved construction on a new alignment, including tunnel sections, linking Kathmandu to Hetauda (via Bhimphedi), as had been previously studied independently in the early 1990s by both Finnida and the Japanese. The previous PIP Study also evaluated the potential function and effect of the JICA-funded Sindhuli Road as an alternative route to the Terai. Other possible options, including the upgrading of the existing Kanti Rajpath, were reviewed and discounted.

The findings of previous PIP have been revised and updated. The basic conclusions remain valid, with the tunnel options reducing the current distance from Kathmandu to Hetauda (220 km via Mugling) to around 65 km. A reduction of this magnitude – on a route carrying large volumes of commercial traffic – will produce significant transport cost savings, together with the possibility of private sector funding with repayment through toll revenues.

The Sindhuli Road, when complete in 2010, will provide a substantial reduction in travel distance between Kathmandu and the Eastern Terai, although it will not benefit traffic bound directly to Hetauda, Birgunj or India via Raxaul. The full potential benefits to Eastern Region traffic will however only be obtained if the road were constructed to full 2-lane bitumen standards[16].

2. The Fast Track

The objective of the development of a Fast Track route is to reduce significantly both the distance and travel time for all traffic travelling between Kathmandu and the Terai. For geographic, topographic and historic reasons the existing routes to Kathmandu are both lengthy and indirect. The first route completed, in 1956, was the Tribhuvan Rajpath, constructed by Indian Army Engineers. It follows a tortuous 'hill' alignment crossing three significant ridges and has limited capacity: the road is single lane, is in poor condition and resultant traffic speeds are low.

Subsequently an alternative route was completed in the 1970s which, in the main, follows river valleys from Kathmandu to the Terai, via Mugling and Narayanghat. It is less direct – being almost 90km longer – but has a considerably superior alignment, allowing greater speeds. Despite the increased length, the route is generally quicker (especially for commercial vehicles) and is used by virtually all traffic between Kathmandu and the Terai.

The possibility of a more direct route has been discussed for many years and has been the subject of a number of investigations. The 'crow-fly' distance from Kathmandu to Hetauda for example is just 40km, compared with 130km via the Rajpath or 220km via Mugling and Narayanghat. The more direct tunnel routes offer the possibility of reducing this distance to around 70km. The location of the options are shown in Figure 6.3.

Access to Kathmandu from the south is of major commercial, economic and strategic significance. Virtually all goods and services enter Nepal from the south via India – except for limited movements by air or across the land border with Tibet to the north. The main border crossing with India is at Birgunj (south of

[16] The current construction provides only a 5.5m roadway, which is unsuited to significant volumes of heavy commercial traffic

Hetauda), where there is a connection with Indian Railways and a recently constructed Inland Customs Clearance Depot (ICD): over 50 percent of all Nepal's external trade is through Birgunj[17].

Traffic volumes on the existing approach route to Kathmandu have been increasing steadily in recent years. Volumes have increased from around 1500 vehicles per day in the early 1990s to approximately 4,000 vpd today, representing a consistent growth of around 10 percent per annum. Any significant reduction in the travel time between Kathmandu and the Terai will obviously lead to further substantial increases, in addition to any continued 'natural' growth.

A recent study (Nepecon, 2003) specifically examined routes that did NOT involve tunnelling. The study examined a series of options including the upgrading of existing routes, the development local road alignments, and a 'new' option following the Bagmati River and terminating at Nijgadh on the East-West Highway, approximately 20km east of Pathlaiya (see Figure 6.3). The Report concluded that the development of a no tunnel 'Fast Track' concept was only possible on the Bagmati alignment, as the alternatives were considered to be not technically feasible due to the lengths of route involved and the difficult terrain.

It is evident that a direct link between Kathmandu and the Terai would offer the possibility of reducing the distance to Hetauda from the current 220 km via Mugling to around 70 km, with the same reduction of 150 km for all trips to the Indian border at Birgunj/Raxaul and to eastern Nepal. The construction costs will be substantial – currently estimated at US$240 million – but, given the significant distance and operating cost savings, the project can be shown to be economically feasible. Additionally, it is probable that the project could also offer potential financial returns to a private investor, with the possibility of tolls related to user cost savings.

The preferred alignment of the 'tunnel' route between Thankot (at the entrance to the Kathmandu Valley) and Bhimphedi (north of Hetauda) is illustrated in Figure VI.4. The route, as originally developed in the 1993 Study, involves two tunnels, each of around 3.5km beneath the major ridges. The central section of the route follows the eastern bank of the Kulekhani Reservoir: the southern section involves upgrading the existing Feeder Road (FR19) between Bhimphedi and Bhainse and thence a section of the Tribhuvan Rajpath (H02) to Hetauda.

It is clear that further study is required of the available options, including both tunnel and no-tunnel alignments. There are a series of issues relating to relative cost, impact and effectiveness that need to be addressed.

E. Further Network Upgrading

The Study has also examined the potential for further development and/or upgrading of the SRN in the period to 2016. These potential improvements are based on consideration of road capacity, deficiencies, missing links or other network 'weaknesses'.

[17] Biratnagar and Bhairawa account for a further 10-15% each, other crossings to India 10%, crossings to Tibet 8%, and the airport 6%: all by value.

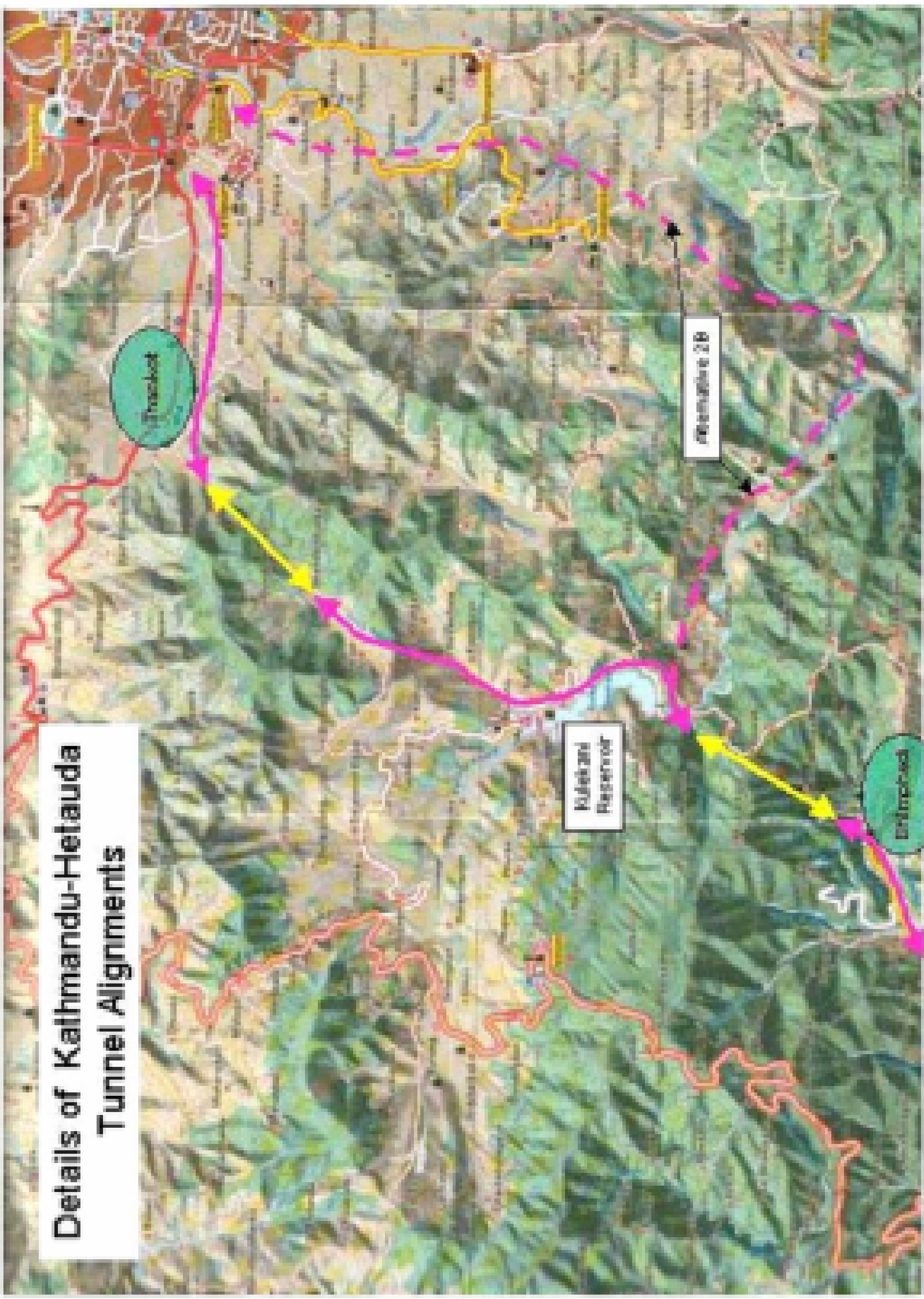

Figure No.
6.4

Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP

Details of Kathmandu - Hetauda Tunnel Alignments

Part I Draft Final Report
December 2006

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Consideration of traffic volumes in Nepal (see Figure 3.6) suggests that there are likely to be few instances where highway capacity is a major concern, requiring investment in widening or duplication. The exceptions to this are roads within Kathmandu Valley (see below) or the approach route to Kathmandu (Naubise to Thankot) which carries substantial volumes of commercial traffic and is both steep and poorly aligned. It is recommended that minor improvements only be considered to the Thankot-Kalanki section of the Tribhuvan Rajpath in the short term, to accommodate existing demand, until a satisfactory long-term solution is developed for improved access to Kathmandu Valley. Longer term improvements need to be examined is the context at the proposed Kathmandu-Terai Fast Track and/or the construction at a new route from the west (Prithivi Highway). A futher possibility, worthy of consideration, would be the construction of a short tunnel (up to 1km) beneath the ridge at Thankot/Nagdhunga to eliminate the steepest section of the approach to the summit from the west.

1. Kathmandu Valley Roads

A full assessment of the transport and highway capacity issues and requirements within the Kathmandu Valley is beyond the scope of this present Study: however, based on the available traffic data and an overall knowledge of the conditions, it is possible to make some preliminary observations and recommendations.

Apart from issues wholly within the urban area, there are two broad aspects that require consideration:

- the capacity of key radial routes, including specifically Koteshwar-Bhaktapur-Benepa-Dhulikhel and Kalanki-Thankot; and
- the capacity and operation of the existing Kathmandu Ring Road.

The capacity problems and related issues of both the radial and orbital roads are compounded by poor traffic management and regulation, inefficient traffic control, a diverse mix of vehicle types, and bad driver behaviour. Many of problems experienced could be alleviated through relatively cheap and cost-effective measures and by improvements to driver discipline.

Notwithstanding this, the capacity of the urbanised sections of both the main radial highways (to Thankot and Bhaktapur) will require improvement in the near future. Relief to the Kalanki-Thankot section will be provided in conjunction with the implementation of either the Fast Track or Bhimdhunga projects, however, a package of short-term improvements should also be considered. These could involve minor widening, construction of sidewalks, the provision of off-street bus parking and, most critically, the enforcement of strict regulations regarding vehicle parking and waiting.

Similarly, the Koteshwar-Bhaktapur corridor could benefit from improved traffic management, regulation and enforcement. However, the traffic volumes are such that a duplication to provide 4-lanes for through traffic, plus service roads for local traffic, would almost certainly be justified. Just such an improvement was recommended in the previous PIP 10-years ago and, it is understood that the Japanese Government has recently committed to support the improvement of this corridor..

It is suggested that the improvement should include some form of grade separated crossing for local traffic, possibly involving the construction of under-passes beneath the main roadway, linking the frontage roads each side.

It is probable also that, within the next 10 years, that the widening should be extended beyond Bhaktapur initially to Banepa and subsequently to Dhulikhel. A

study of the justification and timing for this improvement should be conducted in the context of the overall pattern of urbanisation and growth potential within the Kathmandu Valley and adjoining areas. The corridor to the east, towards Banepa and Dhulikhel, offers the only significant opportunity for growth in the Kathmandu Metropolitan Region.

Congestion and delays on key sections of the Kathmandu Ring Road are causing considerable difficulties and problems for both residents and businesses alike. Significant delays are regularly experienced at Kalanki (where almost all vehicles entering or leaving the Valley must pass), at Balaju and near the bus park, at the junction with Maharajgunj, and in the Chahabil area. Whilst it is recognised that many of the difficulties and problems are a result of poor traffic management and ill-disciplined driver behaviour – including specifically buses and micro-buses waiting for passengers in, and on the exits to, the junction – it is probable also that some form of junction capacity improvements will be required in the coming 10 years.

In addition to the junctions – which are the prime determinant of the capacity of any urban road – further improvements to the overall cross-section of the Ring Road are required to ensure that the road operates efficiently and safely. It is recommended that the road be progressively re-modelled to provide two full lanes in each direction, physically separated with a dividing median, and with frontage service roads on each side to access adjacent development. A comprehensive package of works should be envisaged, including environmental improvements, tree planting, facilities for pedestrians, and controls on truck movements and parking.

Chapter 7

VII. ACCESSIBILITY AND STRATEGY NETWORK EXPANSION

A. Concepts and Measures of Accessibility

Nepal is one of the few countries in the world with a significant proportion of its total population living in areas not served by a motorable road. Previous estimates have indicated that up to 40 percent of the population of the hills are more than 4 hours walk from an all weather motorable road and 13 percent of the Terai population are more than 2 hours walk from a road. These areas of poor accessibility are strongly correlated with the incidence of poverty and low levels of human development.

Measurement of improved levels of rural accessibility are being used throughout this Study as the prime indicator of project effectiveness and overall 'worth'. Accessibility analysis depends on an understanding of both population distribution and the geographical relationship to the associated road networks: both elements may be plotted graphically using GIS techniques to measure and quantify the effects.

The methodology developed is intended to assist with future road network planning by allowing relationships between the existing (or future) population distributions and any given road (or road network) to be established. The system is fully coordinated to allow integration with road design and to enable the effects of terrain to be modelled.

The existing population of Nepal has been plotted geographically onto a 1 sqkm grid – representing a population density distribution – and an estimate of access times to or from the road network has been developed using a digital terrain model, to replicate walk-speeds across different terrain types and make allowance for the barrier effect of rivers. It is thus possible to calculate the populations served by any road network, within the given 2 hour and 4 hour walk times in the Terai and hills respectively and also to compute the associated total (person-hours) walk time to/from any network.

A principle objective of the Study is the identification of a transport network comprising both strategic and rural roads that will bring inhabited areas of Nepal within 4 hours walk in the hills and 2 hours walk in the Terai from an all weather motorable road.

In 2004 under the Rural Access Improvement Project (RAIP) a preliminary accessibility profile and maps of all Village Development Committees (VDCs) of Nepal to all weather roads were prepared. The profile and the maps of the hill and mountain districts as well as Terai districts were prepared based on 4 hours and 2 hours walking time from the VDC centres to all-weather roads. The profile and maps were prepared manually based on hard copy of 1:25000 topographic maps. This was based on an estimated relationship between the aerial (straight-line) distance to walking time. The aerial distance between each VDC centre the nearest all weather road was measured and the walking time calculated. All the

VDCs centres within 4 hours walking time in the hills and 2 hours walking time in the Terai were considered accessible, and those outside the walking time were considered inaccessible.

Based on the above analysis, about 39% of the people in hills and mountains were beyond a 4 hour walk to the nearest all-weather road and about 13% of the Terai people were more than 2 hours from an all weather road. Preliminary analysis during this Study of these existing data, and of the information available from DOLIDAR, revealed that out of 55 districts in hills and mountains 46 can be classified as having a serious access problem, with over 20 percent of the population are outside 4 hours criteria. Of the Terai districts, more than 10 percent of the population are beyond the 2 hour limit in 9 districts out of the total of 20.

The Consultants have refined the method used by DOLIDAR by expanding the population distribution within the individual 3913 VDC down to settlement level as well as developing a terrain-based model to replicate walking speeds in the hills.

B. Population Density Distribution

1. Approach

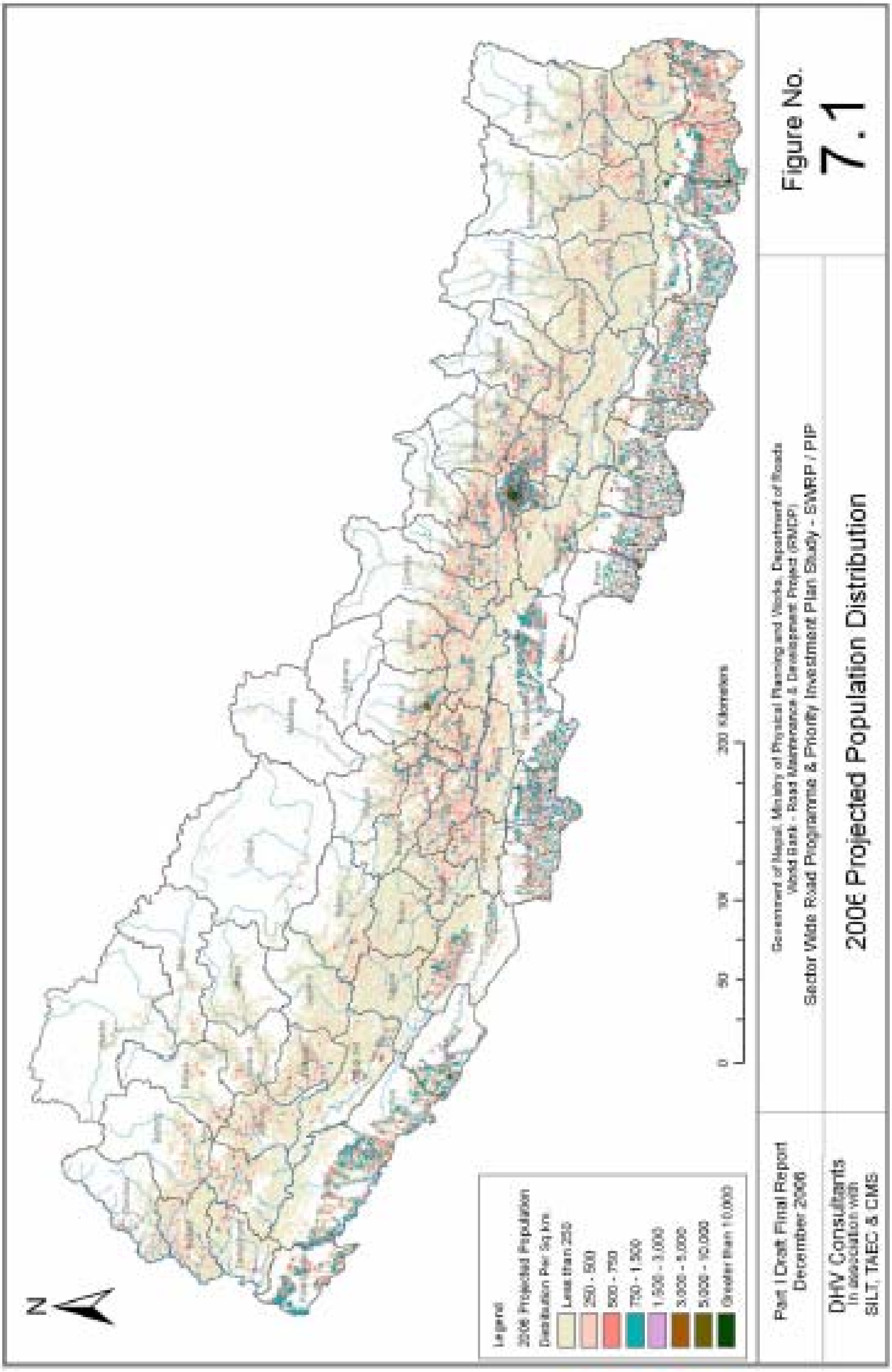
An understanding of the distribution of population throughout the country is a fundamental input to any assessment of accessibility and the associated development of road networks to improve the current access situation. A quantified understanding of population densities and distribution provides valuable input to the identification of new road alignments and the calculation of populations within influence areas.

The population data are based on the 2001 census information at VDC level. These populations have then been "redistributed" geographically based on the distribution of houses throughout the VDC as recorded on the Finnmap surveys from the mid-1990s. Adjustments have been made with reference to the urban clusters, to reflect the effect of higher population densities in the urban core areas.

Estimates of 2006 VDC populations have been based on an extrapolation of the growth rates between the 1991 and 2001 censuses: this provides an indication of any on-going migration trends – including within districts (eg to the DDC centre), between Hill Districts and the Terai, and to the major urban centres (eg Kathmandu, Birgunj or Biratnagar). This is effectively represented by higher growth rates in the Terai and urban areas, and lower rates (including some negative values) in remote, rural VDCs.

The analysis procedure provides both a visual indication of density, see Figure VII.1, and an ability to compute (& assemble) populations within any given area. This is a basic input to the accessibility analysis and to the development and evaluation of the extensions to the SRN.

The higher overall population densities in the Terai are immediately evident, as well as the concentrations of population in and around Kathmandu and other major urban centres: the relatively even population distribution throughout the mid-hills area is also evident, together with the extremely sparse habitation in the northern mountain areas.


Legend
2006 Projected Population
Distribution Per Sq km
Less than 250
250 - 500
500 - 750
750 - 1,500
1,500 - 3,000
3,000 - 5,000
5,000 - 10,000
Greater than 10,000
0
50
100
200 Kilometers
Part I Draft Final Report
December 2006
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Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
2006 Projected Population Distribution
Figure No.
7.1

For the purposes of the analysis, a further refinement of the definitions of "hills" and "Terai" has been adopted, based on the actual terrain rather than the District administrative boundaries. In addition to the main contiguous area of the Terai adjacent to the Indian border, significant other plain areas in the "Inner Terai" and major Valleys (Kathmandu, Pokhara, Dang, Surkhet, etc) have been included, as illustrated in Figure VII.2. As a result, the total 2006 population (25.87 million) is divided as 11.3 million in the hills and mountains and 14.6 million in the Terai and Valleys: the comparable 2006 figures based on the 'Hill & Mountain Districts' and the 'Terai Districts' are 13.1 and 12.8 million respectively.

2. Methodology

The census record provides the population at VDC level. This population figure can be utilized to develop a population distribution assuming the population is evenly distributed in a VDC to provide an average population density by VDC. In reality the population is not evenly distributed and VDCs differ in size by a large margin and thus an equal population distribution within each VDC will give misleading results.

In the present Study a different approach has been used to derive the population density. Following are key aspects of the methodology used:

a) The 1996 & 1994 topographical mapping contains the houses as well as built up areas for the entire area of Nepal. These locations provide an indication of the population distribution within any given boundary. The VDC population distribution is proportional to the map house counts and defined built-up area markings.
b) The 2001 census population and 2006 population projection have then been distributed among the indicated houses and the built up areas. This produces a reasonable distribution of the population within each VDC as growth is concentrated on the existing settlement in proportion to the numbers of map house count and the built-up areas.
c) In case of the built-up areas, to derive the population density, a "simulated" house is assumed at 15 x 15m size and accordingly the numbers of houses are estimated based on the built up area. The population is then distributed within a VDC by summing up the individual house count from map and the simulated houses from the built up area. For each house point a population is derived by dividing the total population by the house count.
d) To derive the population distribution, a 1 km x 1 km grid is used within which all the house point populations are summed. This produces a population density distribution for the whole country on a 1 sqkm grid.

C. Development of Walk-Time contours

The second important aspect in assessing accessibility is the calculation of walk-times in different terrain types. The Consultants have developed a system based on digital terrain modelling (DTM) using a 90m grid of spot-heights which allows walk times and distances to be calculated and calibrated against known travel times.

The concept of the walk-time contours has been developed based on the DTM and walk speeds achievable in different terrain. Additionally a defined network of *major* rivers has been used to represent a barrier to movement – apart from at defined (known) bridge locations. This approach has been calibrated against known travel times (and routes) and can be shown to produce acceptable results.

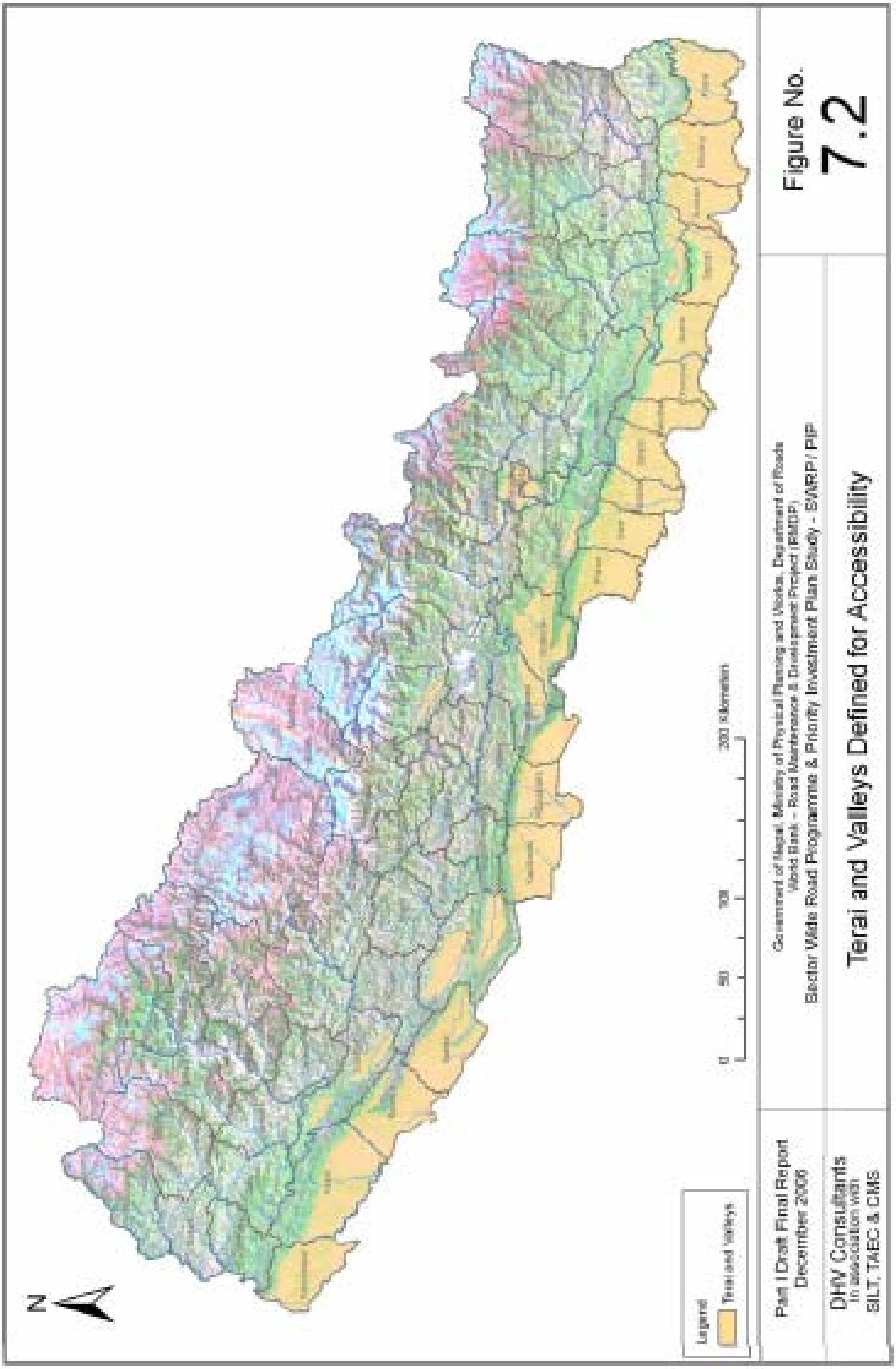


Figure No.
7.2
Terai and Valleys Defined for Accessibility
Sector Wide Road Programme & Priority Investment Plan Study - SWRP/ PIP
Part I Draft Final Report
December 2006
DHV Consultants
SILT, TAEC & CMS
Legend
Terai and Valleys
N

The approach adopted in this Study to assess rural accessibility is thus much more detailed than the earlier DoLIDAR work. The method is based on actual terrain information, rivers and bridges, instead of computing a "crow fly distance" with subsequent adjustments, on a subjective basis, of the terrain and drainage factors. The method adopted uses a rigorous mathematical approach which takes account of the terrain effects (based on a 90m grid of spot-heights) and the barrier effect of rivers. The basics of the method adopted are as follows:

- Assumption of a base travel distance per hour (effective walking speed) for terrain with less than 12% gradient of 4 kph;
- Linear decrease in the travel speed with an equivalent increase in gradient: e.g at 24% gradient, the travel speed will be 2 kph;
- Development of a 90m slope-grid for the entire country and assignment of the travel time for each element of the grid based on its slope;
- Cell based modelling for computing the travel time from origin to destination: this approach gives the least time to reach any destination from the selected origin; and
- Modelling non-crossable major rivers as barriers with bridges as the only access points across such rivers.

In order to model the river and bridge effects, the location of trail bridges on the major rivers were used in the analysis. The bridge locations are taken from the 1996/94 topographical maps as well as from the MOLD Trail Bridge Division maps. There are numerous additional minor rivers for which there is no detailed bridge information: these rivers have therefore been excluded from the present analysis.

The model has been calibrated in selected locations of the Nepal where average travel time were available. The following cases were analysed.

i. *Sundarijal to Tharepati:* the above approach was tested for the origin at Sundarijal up to the destination at Tharepati. The reported travel time from the trekking guide maps is about 15.5 hours in forward direction and 18.5 hours in backward direction. The model estimated travel time in forward and backward direction as 16.7 hours. As model uses same difficulty levels for travelling uphill and downhill hence the travel distances are same for both the directions. The mean error in the model and the reported travel time is about -1.8% with forward error of 7.7% and backward error of -9.7%.

ii. *Khandbari to Num:* The route Khandbari, District HQ of Sankhuwashbha District, to Num is a heavily used route accessing the northern part of the district and the Chinese border. This trail is the only means of getting to Num and areas beyond. The reported travel time from the trekking guide maps is about 9.5 hours in forward direction and 10.5 hours in backward direction. The model estimated travel time of 11.2 hours. The mean error in the model and the reported travel time is about 10.7%.

iii. *Jiri to Lukla :* The route from the Jiri to Luka is a very popular trekking route towards the Everest Region. The reported travel time from the trekking guide is about 45.75 hours (or 7 days) in the forward direction. The model estimated a travel time of 50.2 hours, resulting in a mean error in the model against the reported travel time of about 8.9%

It can be seen from the above comparisons that the model has been validated and provides reasonable estimate of the travel time within a 10% error. There are many factors that determine travel time in the hilly terrain, all of which can not be modelled precisely. The approach used above provides a sound and reasonable basis for estimating distance travelled for a given time in various parts of Nepal.

The model calculates the shortest time path across the terrain, with speed dependent on the gradient. The model thus replicates the likely (minimum time) path and the time contours from any location – allowing travel times and zones of influence (ZoI) to be calculated. The results from the model's route selection process confirm the adoption of a 'path of least resistance': ie the routes selected will – because of the relative travel speeds – tend to follow ridges, contours or valleys, whilst avoiding the steeper land. This generally reflects the alignment of trails established in Nepal.

D. Accessibility of Strategic Road Network

1. Overall Function of SRN

Previous Chapters of this report have discussed and described the development of the Strategic Road Network (SRN) from its present extent of around 5,000km to a projected 9,700km by 2016. It has also been stressed that the SRN 'enables' the improvement of rural accessibility, through the provision of trunk links and access to all Districts, but that <u>local</u> accessibility will only be achieved through the provision of a complementary network of local or rural roads.

Notwithstanding this, the impact of the SRN on overall levels of accessibility is significant. Apart from in the Terai and main urban centres, the existing SRN provides the primary – and in many cases <u>the only</u> - all-weather access facility. This includes substantial areas of the country and especially the more remote regions.

The overall access situation in the country is illustrated in Figure VII.3, based on the currently committed strategic network. This shows all those areas of the country that are more than 10 hours walk from the nearest road, and also time bands up to 60 hours walk – around 8 days. These areas cover a significant portion of the country but – it should be remembered – these areas are sparsely populated: the total population in the areas indicated as being over 10 hours from a road is approximately 1.9 million or 7.5 percent of the total population.

Substantial areas of the hills and mountains rely on access from a network of "hill" roads – ie roads that connect northwards form the main elements of the SRN: the East-West Highway, Prithvi Highway and Siddartha Highway. There are around 22 individual 'catchment areas' served by such hill roads, as illustrated in Figure VII.4, with a combined population of 9.3 million – or around 36 percent of the national total. [The remainder of the population, including the Terai and main urban centres, are served by the core road network.]

The role and function of these hill roads are essential for economic development and activity within the areas served: the roads provide the economic and social life-line for the hills, providing for the import of most goods consumed and the export of any production. The development and upgrading of the networks serving the Mid and Far Western Regions are the subject of the Feasibility Studies conducted under Part II of this Study.

2. Expansion of the SRN

The Study recommends the expansion of the designated SRN from its current (operational) length of 5,030km to almost 10,000km by 2016. This expansion is achieved primarily by the re-designation of the more important (and potentially strategic) existing District or Local Roads as part of the SRN. Of the additional 4,600km of Strategic Road, over 3,300km (70 percent) are existing District or Local Roads: less than 1,300km of new roads are proposed.

Four networks have been defined to assess the impact of the network growth on accessibility, as illustrated in Figure 7.5:

- *The Existing Designated SRN (2006)* – 5,030km – comprising all sections of the designated SRN (15 Highways and 51 Feeder Roads) that are currently operational;
- *The Existing (effective) Operational SRN (2006)* – 7,360km – including additionally all existing and open sections of road that will be incorporated into the future SRN – including substantial lengths of District Roads;
- *The Committed SRN for the Year 2010* – 8,390km – as above, plus additional projects scheduled for completion by 2010 that are currently in hand and for which funding is assured;
- *The Future Extended SRN for the Year 2016* – 9,930km – includes the additionally the extensions to the SRN proposed in Chapter 5.

The first two relate to 2006 and are respectively the ‘official’ and ‘de-facto’ networks as maintained by DoR; the third includes the additional committed schemes, and those in the ‘pipeline’ with funding committed, that will be in place by 2010; and the fourth represents the recommended extended SRN by 2016.

The composition and source of the additional 4,900km of proposed road are presented in Table 7.1, including the completion of 306km of currently designated (but not operational SRN).

Table 7.1: Recommended Additions to the Strategic Network (2006-2016)

Length (km)	Additional Operational Roads (2006)	Committed & Pipeline Additions (2010)	Proposed Additional Links (2016)	Total Additional Road Length	Percent
Designated SRN	0	229	77	306	6%
Local Hill Roads	1,059	70	501	1,631	33%
Terai Roads	513	214	71	798	16%
Postal Roads	614	129	0	743	15%
Urban Roads	147	0	0	147	3%
New Alignments	0	388	890	1,278	26%
Total	2,334	1,030	1,540	4,904	100%

A full network description by District and individual road is presented in Annex 7, Tables A7.1 and A7.2.

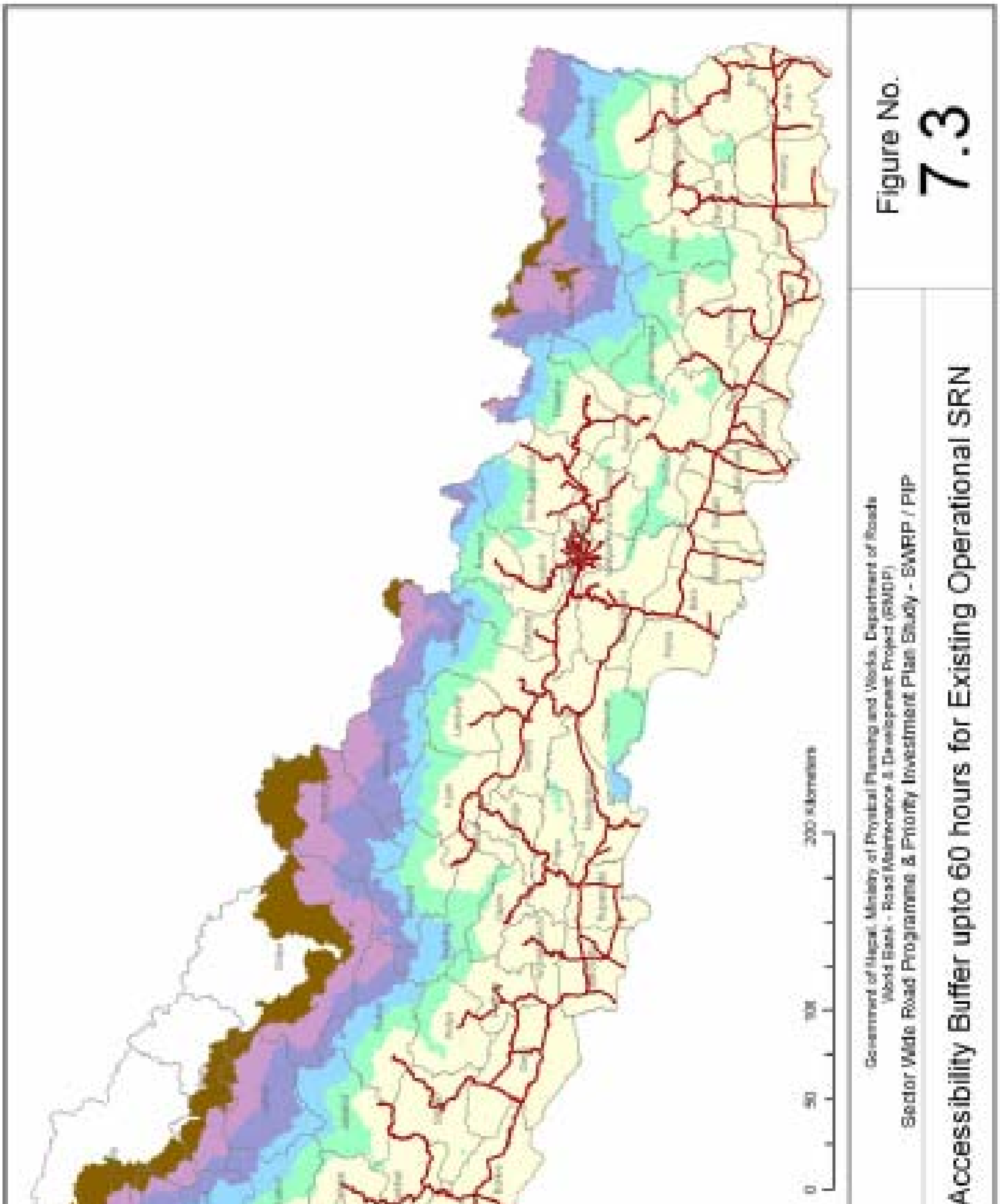


Figure No.
7.3
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Accessibility Buffer upto 60 hours for Existing Operational SRN
Part I Draft Final Report
December 2006
DHV Consultants
In association with
SILT, TAEC & CMS
Legend
Operational SRN
Travel Time
Less than 10 hrs.
10 - 20 hrs.
20 - 30 hrs.
30 - 40 hrs.
40 - 50 hrs.
50 - 60 hrs.
0
50
100
200 Kilometers
N

Accessibility Provided by SRN

The resultant plots of accessibility by time-band are illustrated on Figure VII.5, showing those areas within 1, 2, 3 & 4 hours walk from the SRN. The populations outside these areas are shown in beige, illustrating the density distribution of the non-served (or inaccessible) population. A summary of the overall accessibility provided by each of these four networks is given in Table 7.2, illustrating an overall improvement from 65 percent to 86 percent within the 2 hour and 4 hour criteria.

Table 7.2: Accessible Populations to Existing & Extended SRN

	SRN Length km	Population served		
		Hill	Terai	Total
Existing Designated SRN 2006	5,030	5.68 50%	11.07 76%	16.74 65%
Existing / Operational SRN 2006	7,360	6.52 58%	13.70 94%	20.22 78%
Committed Additional SRN Links 2010	8,390	7.08 63%	14.00 96%	21.08 81%
Extended SRN 2016	**9,930**	**7.94** **70%**	**14.21** **97%**	**22.15** **86%**

Note: Total Population of 25.9 million is divided into Hills 11.3 million & Terai 14.6 million

3. Accessibility for Existing Designated SRN (2006)

The Existing Designated SRN has a total length of 5,028km. The accessibility provided by this network is 50 percent within a 4 hour walk for the hill areas, and 76 percent within a 2 hour walk in the Terai and Valley areas. Nationally, the overall accessibility is 65 percent, which implies that 9.3 million people (36 percent of the total population) are living outside the desired accessibility norms, including half of the total population of the hills.

4. Accessibility for Existing (effective) Operational SRN (2006)

The Existing Operational SRN has a total length of 7,360km and includes the designated SRN plus other operational links under DoR management. The accessibility provided by this network is 58 percent in the hills and 94 percent in the Terai and Valley areas. The overall accessibility is increased to 78 percent, with the bulk of the improvement in the Terai, due to the inclusion of a substantial network of existing all-weather roads, including the Postal Road. The additional roads considered are coloured red in upper map on Figure 7.5. The improvement in the hills is primarily due to the inclusion of the road to Okhuldhunga in the east and to Burtibang in the west.

5. Accessibility for Committed SRN for the Year 2010

By 2010 the Committed SRN will comprise 8,390km, with the addition of 801km of roads to the existing operational SRN, as shown in purple on middle map on Figure 7.5. The accessibility will be improved to 63 percent in the hills and 96 percent in the Terai and Valley areas: the overall accessibility increases to 81 percent. The improvements are mostly in the hills, resulting from the northerly extensions to the network serving non-connected District Headquarters.

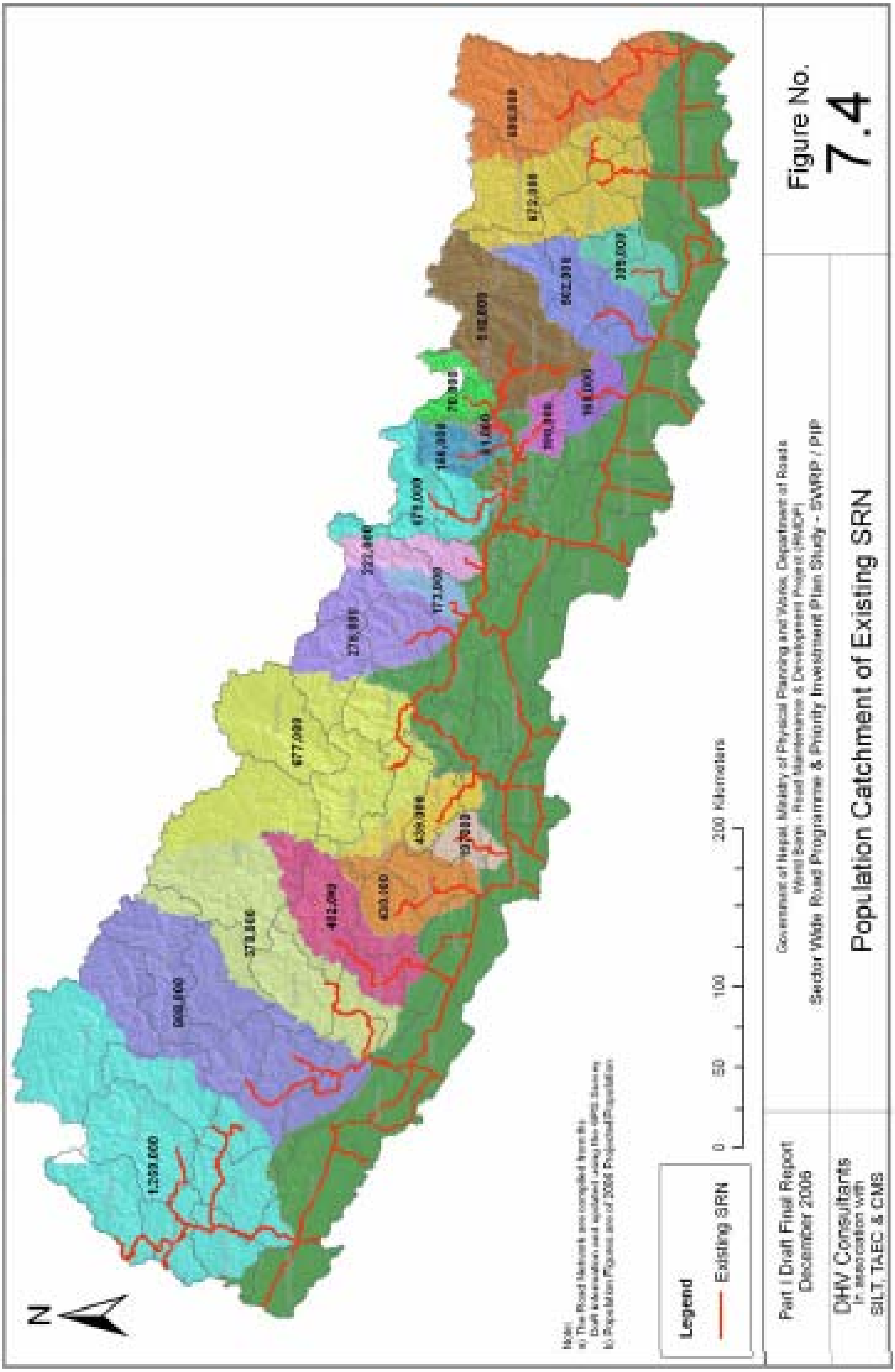
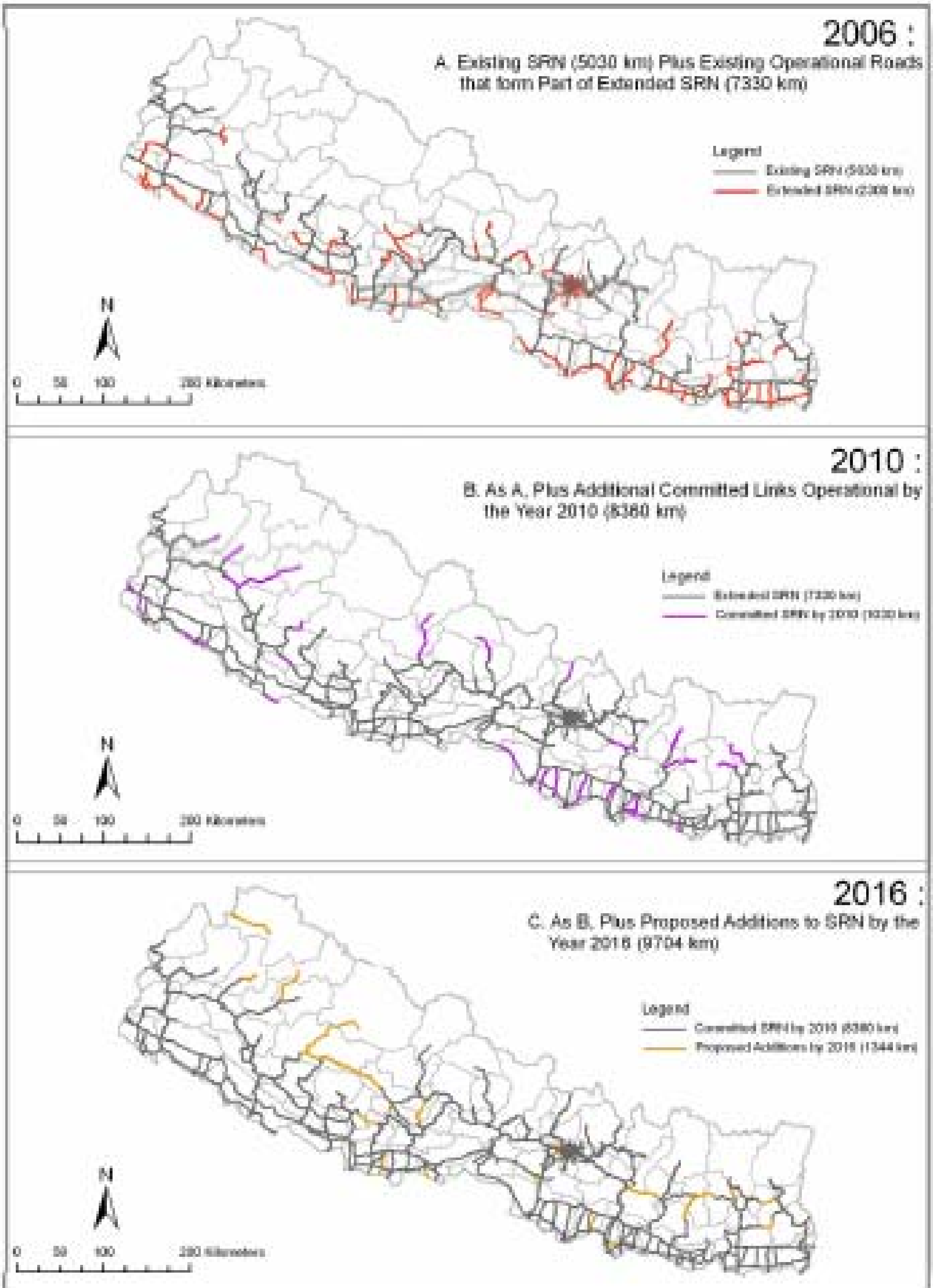
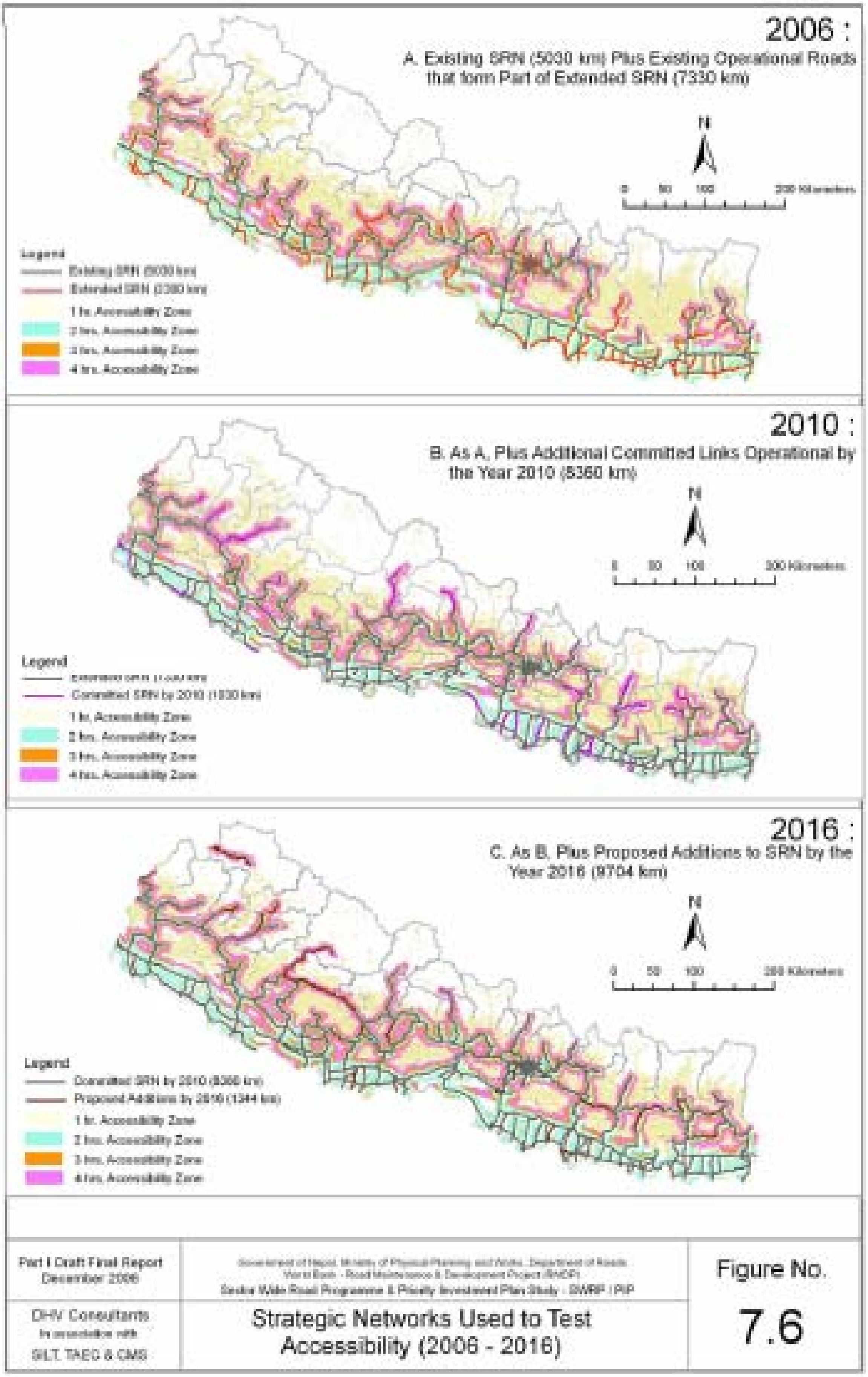


Figure No.
7.4
Population Catchment of Existing SRN
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Part I Draft Final Report
December 2006
DHV Consultants
In association with
SILT, TAEC & CMS
Legend
Existing SRN
0
50
100
200 Kilometers
N



Part I Draft Final Report December 2006	Government of Nepal, Ministry of Physical Planning and Works, Department of Roads World Bank : Road Maintenance & Development Project (RMDP) Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP	Figure No.
DHV Consultants In association with SILT, TAEC & CMS	Strategic Networks Used to Test Accessibility (2006 - 2016)	7.5



Strategic Networks Used to Test Accessibility (2006 - 2016)

6. Accessibility for Future Extended SRN for the Year 2016

The Extended SRN in 2016 will comprise 9,930km with the addition of a further 1,463km of roads, mostly in the mid-hills. The accessibility in the hills provided by this network is increased to 70 percent and to 97 percent in the Terai and Valley areas: the overall accessibility is 86 percent. The overall increase in accessibility results form the additional roads in the mid-hills.

7. Impact of SRN on Accessibility

The above analysis indicates that the overall accessibility provided by the SRN increases from a nominal 65 percent today (based on the officially designated network) to 81 percent with the completion of current commitments in 2010, and to 86 percent with the proposed expansion by 2016. Over the 10 year period an additional 5.5 million people will – potentially – be brought within range of the all-weather SRN: less than 4 million people (almost exclusively in the hills) will be outside the 4 hour walk limit in 2016.

E. Effect of the Local Road Network

In addition to the SRN, there is a sizeable network of local District and Village Roads that contribute significantly to overall levels of accessibility, although many of these roads are of low standard and are – at best – seasonal in nature. An analysis of the improved accessibility potential of these roads is given in the following Chapter, together with an assessment of the additional requirements to achieve higher levels of accessibility throughout the country.

The Consultants have identified a network of approximately 4,460km of existing (operational) local roads (see chapter 8). The impact of this 'existing' Local Road Network (LRN) is less than might be expected as most of these roads are relatively short and are (obviously) located in areas close to and already served by the SRN. In the remote hill areas, it is the embryonic SRN that provides the initial access and major improvements to accessibility: the LRN complements this and enhances access by increasing the proportion of the population within 1-2 hours of the road. Similarly a large proportion of the LRN is in the Terai, where the basic 2 hour access is already provided by the future SRN: this does not negate the need nor the value of the LRN, as it is required to provide the higher levels of access expected (and justified) in the more densely populated areas.

It is however stressed that the detailed planning of the alignments and priorities for construction of such additional local roads can only be attempted at a local (District) level. This Study has identified those geographic areas – or inhabited pockets of land – where the desired standards of access are not achieved and has suggested how much additional road might be required to resolve the short-comings.
Nonetheless – given the topography and population distribution of Nepal – it is unrealistic to expect that road access could be practically or feasibly provided to <u>all</u> settlements. As has been indicated above, some of the more remote areas are currently 8-10 days walk from a road, and even the most ambitious road building programme would not serve all of these areas. Indeed some of the areas are populated <u>because</u> they are remote and primarily serve adventure tourism – eg the Khumbu (Sagamartha National Park) or the Annapurna Circuit – where the resident population supplies lodging and facilities to tourists. [These areas are incidentally some of the richest in rural Nepal and would not necessarily welcome road construction.]

It is therefore unrealistic – and undesirable – to attempt to achieve a 100 percent coverage of 4 hour accessibility in the hills. There will always be some remote

areas unreserved by road as it would be totally uneconomic and environmentally disastrous to construct roads into these areas for the minimal populations involved.

F. Assessment of Total Walk Time

An alternative indicator of the level of accessibility provided by any network can be measured by calculating the total 'access time' to the nearest road from all inhabited areas. This is expressed in terms of thousands of person-hours, which represents the product of the number of people and their time (in hours) from the road. Thus 10 people 1 hour from the road would have the same impact as 1 person 10 hours from the road: this measure makes allowance for the number of people affected by a road or a road improvement.

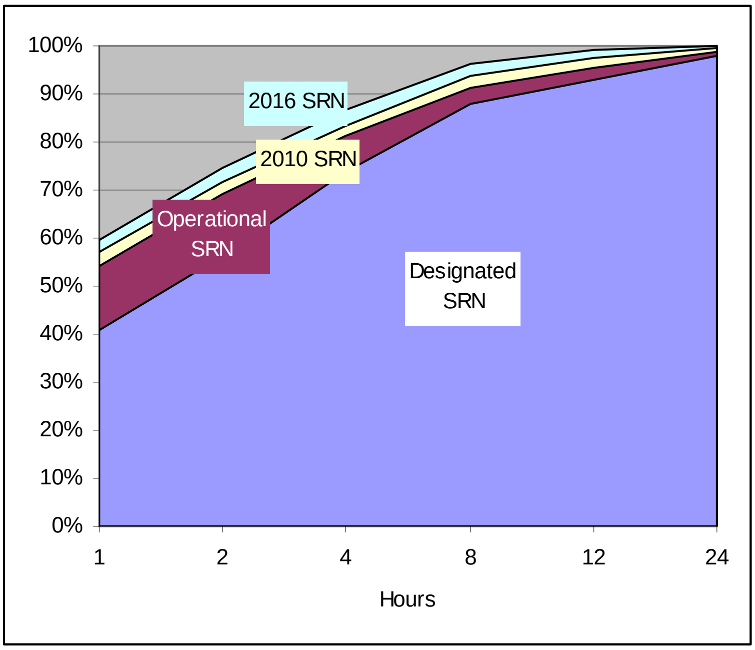
The populations in progressive time-bands from the nearest strategic road are given in Table VII. for the four networks examined. This indicates that the population within 1 hour of the SRN increases from 41 percent in the Designated Network to 59 percent in the 2016 Extended Network and, as a consequence, the proportion over 4 hours reduces from 27 percent to 14 percent.

Table VII.3: Population within Time-Bands of SRN (millions)

Time Band	Strategic Road Network							
Hours	Designated		Operational		2010 Committed		2016 Extended	
1	10.47	41%	13.78	53%	14.55	56%	15.35	59%
2	3.90	15%	3.89	15%	3.77	15%	3.93	15%
4	4.45	17%	3.03	12%	2.94	11%	3.12	12%
8	3.60	14%	2.59	10%	2.69	10%	2.46	10%
12	1.34	5%	1.06	4%	0.98	4%	0.69	3%
24	1.22	5%	0.83	3%	0.50	2%	0.23	1%
over 24hrs	0.83	3%	0.62	2%	0.36	1%	0.01	0%
Total	25.80	100%	25.80	100%	25.80	100%	25.80	100%

These same data are presented graphically in Figure VII. which shows that the impact of the network extensions are particularly evident in the areas closest to the road, reflecting the fact that the population densities are highest in these areas.

Figure VII.7: Cumulative Population by Time Band



The overall total walk times for the same four networks described above are given in Table VII.4. This shows a substantial (47 percent) reduction in the total 'access time' to the network nationally from 113 million person-hours walk to 60 million, with similar reductions in both the hills and Terai. It is also possible to express the impact in terms of average walk time: this shows an overall reduction of 2 hours from 3 hours 20 mins to 1 hours 20 mins, with the greatest impact in the hills (from an average of over 7 hours to less than 4 hours).

Table VII.4: Total Walk Time to access Network & Average Walk Time
[Person-Hours (thousands) and Hours]

		2006	2006	2010	2016
Network Length	km	5030	7360	8390	9930
Hills					
Total Walk Time	p-hours	83,471	69,440	54,047	42,137
Average Walk Time	Hours	6.40	5.16	3.79	2.74
Terai					
Total Walk Time	p-hours	29,599	19,411	18,475	17,453
Average Walk Time	Hours	1.03	0.33	0.27	0.20
Total – All Country					
Total Walk Time	p-hours	113,070	88,881	72,522	59,589
Average Walk Time	Hours	3.37	2.44	1.80	1.30

G. District Level Accessibility by SRN

1. Current (2006) Situation

The currently operational SRN (7,360km) provides access within 4 hours to over 80 percent of the population: the remaining 4.9 million people are distributed through the hills of Nepal. There are 21 Districts with over 100,000 people more than 4 hours from a strategic road. These, ranked in order of population, are listed in the left-hand columns of Table 7.5. It should be noted that there are other districts with higher percentages of un-served populations, including 22 Districts with over half the population beyond 4 hours from a road. These are listed in the right-hand columns of Table 7.5.

Table 7.5: 4-Hour Accessibility by District from 2006 Operational SRN

Districts ranked by Population Unserved				Districts ranked by percentage Unserved			
No	District	Unserved Population	Percent	No	District	Unserved Population	Percent
13	Khotang	238,244	100%	64	Kalikot	120,552	100%
20	Sindhuli	200,413	66%	11	Solukhumbu	111,453	100%
10	Bhojpur	199,788	97%	63	Jumla	76,364	100%
54	Rukum	154,175	75%	65	Mugu	46,387	100%
53	Rolpa	151,742	68%	66	Humla	44,180	100%
9	Sankhuwasabha	144,188	87%	62	Dolpa	30,513	100%
61	Jajarkot	143,488	99%	42	Mustang	14,292	100%
21	Ramechhap	133,808	59%	41	Manang	12,626	100%
47	Palpa	125,462	44%	13	Khotang	238,244	100%
14	Udayapur	121,782	37%	61	Jajarkot	143,488	99%
64	Kalikot	120,552	100%	10	Bhojpur	199,788	97%
69	Achham	117,623	47%	67	Bajura	108,179	93%
74	Baitadi	116,082	47%	9	Sankhuwasabha	144,188	87%
45	Baglung	114,456	40%	54	Rukum	154,175	75%
11	Solukhumbu	111,453	100%	43	Myagdi	89,512	74%
46	Gulmi	110,024	36%	1	Taplejung	95,810	68%
67	Bajura	108,179	93%	53	Rolpa	151,742	68%
12	Okhaldhunga	107,096	65%	20	Sindhuli	200,413	66%
68	Bajhang	103,694	57%	12	Okhaldhunga	107,096	65%
28	Nuwakot	102,678	34%	21	Ramechhap	133,808	59%
52	Pyuthan	102,526	45%	68	Bajhang	103,694	57%
				75	Darchula	66,468	53%

It can be seen that, based on population, there is a significant cluster of 8 Districts in the east – Khotang, Sindhuli, Bhojpur, Sankhuwasabha, Ramechhap, Udayapur, Solukhumbu and Okhaldhunga – all with over 100,000 people more than 4 hours from the operational SRN. The total un-served population in these Districts is in excess of 1.25 million

Similarly there are 12 Districts in the West, Mid-West and Far-West each with over 100,000 people un-served and with a total population of 1.5 million stretching through the mid-hills from Palpa, via Gulmi, Baglung, Pyuthan, Rolpa, Rukum, Jajarkot, Kalikot, Achham, Bajura, and Bajhang to Baitadi in the Far West.

This analysis presents a different complexion to one based on percentages of non-served population. There are nine Districts with 100 percent of the population more than 4 hours from a road, and a further four Districts with only a small proportion of the total served by road, although many of these Districts have low absolute populations. The Table highlights the need for improvements in the

more densely populated mid-hills region, and also identifies the substantial un-served populations in the relatively more affluent eastern areas of the country.

A full listing of the accessibility parameters in 2006 by District is presented in Annex 7, Table A7.3, which provides data on the hill and Terai populations, the percentages of these within the 2-hour and 4-hour limits, the total person walk-time to the nearest road, and the average access time to the road.

The 'severity' of the lack of access is probably best measured by the total person-hours walk from the road network, which allows for the incorporation of both the time from the road and the numbers of people affected. The 25 least accessible districts in 2006 ranked on these criteria are presented in Table 7.6 and are illustrated on Figure 7.8.

Table 7.6: Ranking of 25 Least-Accessible Districts – 2006 Operational SRN

Dist No	District	District Population ('000s)			Percent Accessible (2hr/4hr)	Man-hrs Walk ('000s)	Av Walk Time (hours)
		Hill	Terai	Total			
13	Khotang	239	-	239	0%	2,976	12.4
63	Jumla	78	-	78	-	2,936	37.5
66	Humla	44	-	44	-	2,907	65.8
64	Kalikot	122	-	122	-	2,506	20.5
10	Bhojpur	205	-	205	3%	2,391	11.7
65	Mugu	47	-	47	-	2,379	50.7
9	Sankhuwasabha	169	-	169	13%	2,126	12.6
61	Jajarkot	147	-	147	1%	2,118	14.4
67	Bajura	118	-	118	7%	1,966	16.7
11	Solukhumbu	113	-	113	-	1,838	16.3
20	Sindhuli	271	38	309	33%	1,806	5.8
54	Rukum	207	-	207	25%	1,802	8.7
62	Dolpa	31	-	31	-	1,499	47.9
53	Rolpa	227	-	227	32%	1,222	5.4
36	Gorkha	306	-	306	72%	1,124	3.7
43	Myagdi	124	-	124	26%	1,036	8.4
47	Palpa	288	-	288	56%	1,029	3.6
21	Ramechhap	225	-	225	41%	1,014	4.5
74	Baitadi	255	-	255	53%	1,006	3.9
45	Baglung	288	-	288	60%	945	3.3
69	Achham	250	-	250	53%	935	3.7
30	Dhading	373	-	373	80%	921	2.5
12	Okhaldhunga	165	-	165	35%	919	5.6
68	Bajhang	183	-	183	43%	916	5.0
14	Udayapur	178	153	331	56%	916	2.8

Note: Ranked according to walk-time to nearest SRN

These Districts can be seen to form two major 'blocks' in the east and west, with the 10 worst Districts (four in the east and six in the west) being: Khotang, Bhojpur, Solukhumbu and Sankhuwasabha in the east; and Humla, Jumla, Mugu, Bajura, Kalikot and Jajarkot in the west. It is also noted that Gorkha and Dhading rank in the top 25, due to substantial populations in the northern areas away from the District HQs.

The average walk time to access the SRN ranges from a high of 66 hours in Humla to 2.5 hours in Dhading, the lowest among the worst 25 Districts. In other more accessible Districts, the average walk time reduces to fractions of an hour, with a national average of 2.4 hours. Overall, the average walk time to a road currently exceeds 8 hours (1 day) in a total of 16 Districts.

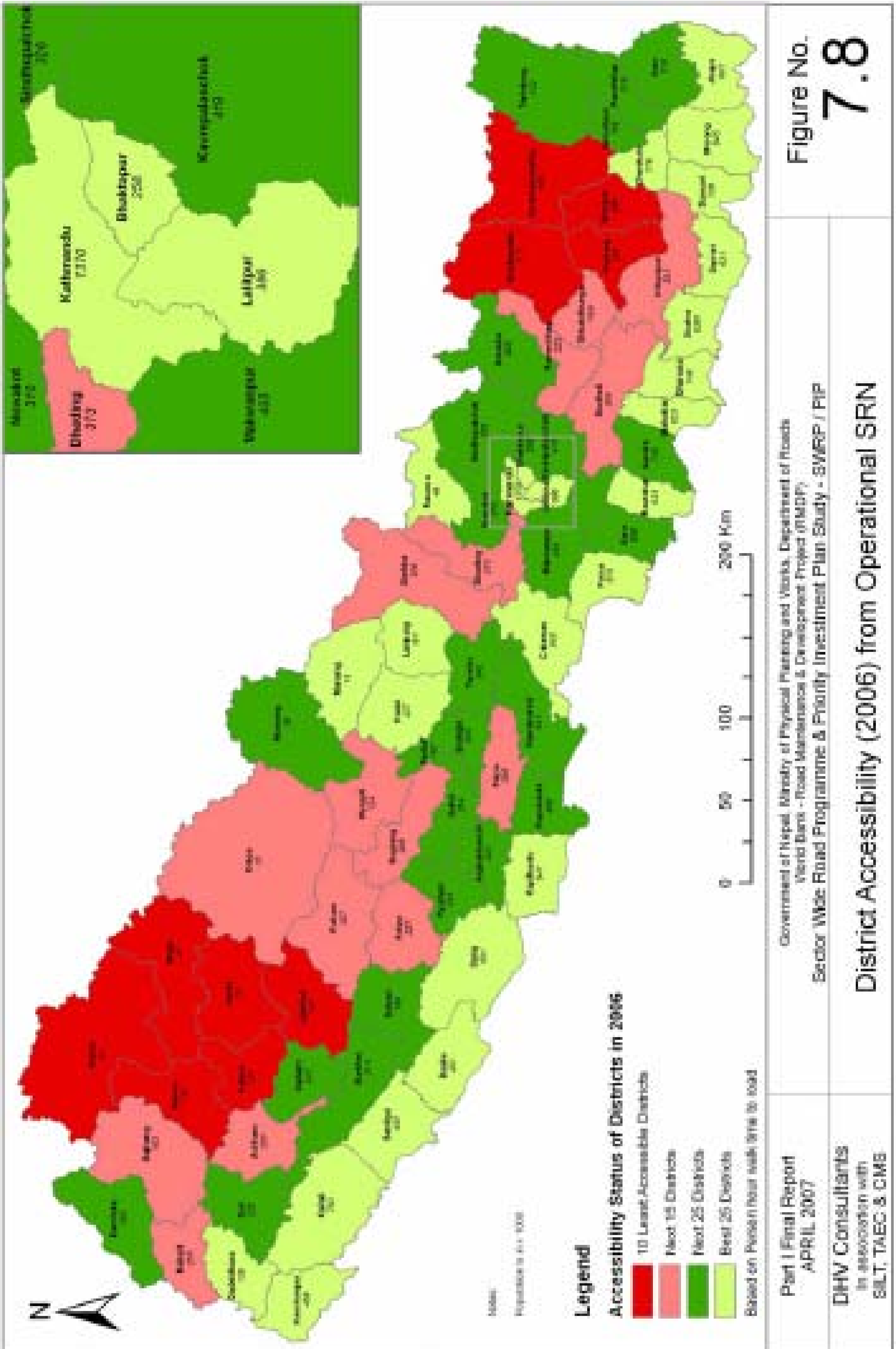


Figure No.
7.8
District Accessibility (2006) from Operational SRN
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Part I Final Report
APRIL 2007
DHV Consultants
In association with
SILT, TAEC & CMS
Legend
Accessibility Status of Districts in 2006
10 Least Accessible Districts
Next 15 Districts
Next 25 Districts
Best 25 Districts
0
50
100
200 Km
Kathmandu
Bhaktapur
Lalitpur
Dhading
Makwanpur
Kavrepalanchok

2. Impact of Extended SRN in 2016

Proposals to extend the SRN to 9,930km by 2016 are described elsewhere, resulting in an overall increase in accessibility (measured on the 2hr and 4hr criteria) from 78 percent to 86 percent, and a reduction in the average walk-time to access the SRN from 2 hours 30 mins to 1 hour 20 mins.

The number of Districts with more than 100,000 population more than 4 hours from a strategic road is reduced from 21 to 6: see Table 7.7. The number of Districts with more than half the population outside the 4-hour limit reduces from 22 to 13, and all Districts have some road access.

Table 7.7: 4-Hour Accessibility by District from 2016 Extended SRN

Districts ranked by Population Unserved				Districts ranked by percentage Unserved			
No	District	Unserved Population	Percent	No	District	Unserved Population	Percent
	Rolpa	144,446	64%		Humla	37,995	86%
	Khotang	123,871	52%		Manang	9,856	73%
	Palpa	122,868	43%		Solukhumbu	80,586	71%
	Sindhuli	110,807	36%		Mugu	32,937	70%
	Baitadi	107,361	42%		Taplejung	92,947	65%
	Bhojpur	105,986	52%		Jajarkot	95,470	65%
					Rolpa	144,446	64%
					Dolpa	16,757	54%
					Myagdi	64,311	52%
					Kalikot	63,039	52%
					Khotang	123,871	52%
					Bhojpur	105,986	52%
					Okhaldhunga	83,774	51%

The Districts with large populations not served by the extended SRN in 2016 are all in the mid-hills – three in the eastern part of the country (Bhojpur, Khotang and Sindhuli) and three in the west (Palpa, Rolpa and Baitadi). These are the areas in which specific priority should be given to the development of additional local road access.

The listing of the overall ‘least well served‘ Districts in 2016, following the expansion of the SRN to 9,330km, is shown in Table 7.8 and is illustrated in Figure 7.9: full details are given in Annex 7, Table A7.4. The ranking is based on the calculated total person-hours walk-time from the road network. Almost all of the ‘Top 25’ ranked least-accessible districts are in the mid-hills, reflecting the higher population densities coupled with an inadequate road provision. Access to the previously highly ranked remote northern Districts in the west of the country will, to a large extent, have been resolved by 2016 through the proposed extensions of the SRN.

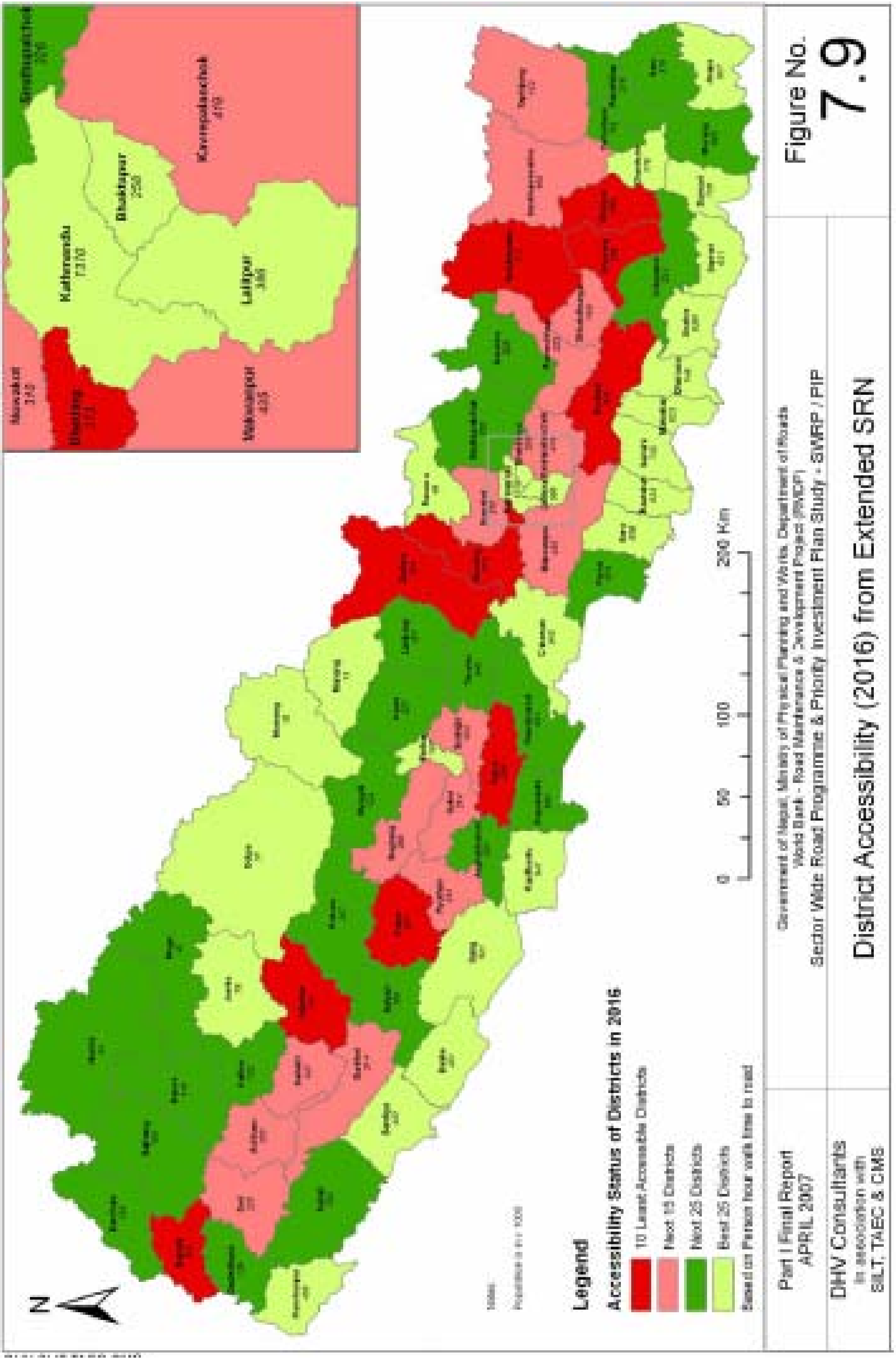


Figure No.
7.9
District Accessibility (2016) from Extended SRN
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Legend
Accessibility Status of Districts in 2016
10 Least Accessible Districts
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Kathmandu
Bhaktapur
Lalitpur
Kavrepalanchok
Makwanpur
Dhading
Nuwakot
Sindhupalchok
0
50
100
200 Km

It is also evident that, by 2016, there will be more access deficiencies predicted in the eastern and central parts of the country than in the west. This may be due – at least in part – to the ongoing initiatives to improve access in the west. It is also notable that many of the Districts close to Kathmandu are among those shown to have poor levels of access.

The maximum average walk-time among these 25 worst Districts is now reduced to less than a day (7 hours), with an average across the country of 1.3 hours.

Table 7.8: Ranking of 25 Least-Accessible Districts – 2016 Extended SRN

Dist No	District	District Population ('000s)			Percent Accessible (2hr/4hr)	Man-hrs Walk ('000s)	Av Walk Time (hours)
		Hill	Terai	Total			
53	Rolpa	227	-	227	36%	1,032	4.5
13	Khotang	239	-	239	48%	989	4.1
47	Palpa	288	-	288	57%	955	3.3
61	Jajarkot	147	-	147	35%	939	6.4
36	Gorkha	306	-	306	75%	926	3.0
74	Baitadi	255	-	255	58%	871	3.4
20	Sindhuli	271	38	309	59%	861	2.8
11	Solukhumbu	113	-	113	29%	826	7.3
10	Bhojpur	205	-	205	48%	819	4.0
30	Dhading	373	-	373	83%	791	2.1
9	Sankhuwasabha	169	-	169	59%	782	4.6
21	Ramechhap	225	-	225	56%	768	3.4
70	Doti	229	-	29	63%	767	3.4
28	Nuwakot	310	-	310	71%	739	2.4
24	Kavrepalanchok	419	-	419	83%	719	1.7
1	Taplejung	142	-	142	35%	716	5.1
60	Dailekh	247	-	247	67%	683	2.8
31	Makwanpur	310	125	435	81%	669	1.5
12	Okhaldhunga	165	-	165	49%	663	4.0
46	Gulmi	314	-	314	77%	660	2.1
69	Achham	250	-	250	70%	635	2.5
59	Surkhet	199	115	314	74%	634	2.0
52	Pyuthan	233	-	233	67%	632	2.7
39	Syangja	334	-	334	79%	629	1.9
45	Baglung	288	-	288	75%	628	2.2

Note: Ranked according to walk-time to nearest SRN

This analysis highlights the need for the construction of a complementary network of local roads to supplement the accessibility provided by the SRN, specifically within the more densely populated mid-hills areas.

H. Project Selection and Prioritisation in MW + FW

The above approach has been used in Part II of the Study to identify and evaluate the proposed network improvements and upgrading in the Mid and Far Western Regions. The overall objective of the proposed road improvement package is the alleviation of poverty and a reduction in the levels of 'exclusion' experienced in the remote hill regions in the west of the country. Access improvements are key elements in the fight against poverty and the creation of a more equal society.

The total population of the hills in the Mid and Far West is 3.46 million and currently 2.44 million (70%) are more than 4 hours from a road: the total walk-time to existing sealed roads is 43.2 million person-hours – or an average of 12.5 hours per person. Upgrading (or constructing) a network of 800km of roads was estimated to reduce the 'inaccessible' population from 2.44 million to 1.81 million, or 52 percent of the total population – bringing an extra 640,000 people within the 4 hour access target.

Similarly, the inclusion of the additional 800km of all-weather road would reduce the walk-time from 43.2 million person-hours to 25.5 million person-hours – an average of 7.4 hours per person, implying an average 5 hour saving per head.

The populations by time-band before and after the proposed improvement of 800kms of road in the Mid and Far West are presented in Table VII.9. It can be seen that there is a substantial increase in the population within the 2, 4 and 8 hour time-bands with consequent reductions in the number of people more than 8 hours from the nearest road.

Table VII.9: Effect of Proposed Road Improvements – MW & FW Hills

Time Band	Existing Percentage of Population	Future Percentage of Population	Change in Population
< 2 hrs	19.9%	30.8%	+376445
2-4 hrs	9.5%	17.0%	+260881
4-8 hrs	15.7%	22.9%	+245483
8-24 hrs	38.8%	23.1%	-543560
>24hrs	16.2%	6.3%	-339249
Total	100%	100%	0

Chapter 8

VIII. RURAL ACCESS IMPROVEMENT STRATEGY

A. The Role of the SRN and LRN

The previous Chapter has examined in some detail the concept of accessibility throughout Nepal. This was based on an understanding of the population density distribution, walking speeds in different terrain, and the extent of the all-weather road network. The analysis was based initially on the accessibility provided by the existing Strategic Road Network (SRN) and then subsequently the 'extended' SRN that is proposed to be operational in 2016. It is proposed that by 2016, the SRN will comprise around 9,930 km of all-weather road, linking all Districts and providing access – within 4 hours in the hills and 2 hours in the Terai – to about 85 percent of the total population. The analysis has indicated that there are a number of significant 'pockets' of population – specifically in the hills – that are outside the desired accessibility standard: approximately 30 percent of the 'hill' population remain un-served by SRN in 2016.

It is evident that the extended SRN cannot – and will not – achieve universal accessibility throughout the country: that would clearly be both impractical and unrealistic. The SRN is intended to provide strategic linkage to and between Districts and it will be complemented by a network of local roads providing local access.

It is equally obvious that it is impractical to provide road access within 4 hours to all habitation in the country: this would imply that a road to an isolated nomad in Dolpa is worthy of consideration ahead of the construction or upgrading of other substantially more economically viable roads elsewhere in the country. It is thus necessary to apply a 'cut-off' at maybe the 90th or 95th percentile of the national population, and accept that the remaining 'extremely remote' population remains un-served.

Furthermore, some non-road-served tourist areas owe their popularity to their remoteness: it would defeat the objective of many of the trekking areas in Nepal if easy road access were available. Tourists pay substantial dollars in order to travel to – and walk in – areas untouched by much of modern civilisation to the economic benefit of the local communities: Nepal has a responsibility to the world to preserve some of the natural areas of beauty and culture where people can travel and experience a simpler life.

B. Local Road Network

1. Data Sources

Data for the Local Road Network (LRN) have been compiled from various sources. The main sources have been the various DTMPs (District Transport Master Plans), which are available in digital format for 52 of the 75 districts, plus the Transport Layer of the 1994-96 Topographical Maps (1:25,000/1:50,000). In addition to these two sources, significant data on the road networks developed and/or planned by various aid agencies – eg GTZ, RCIW, RAIDP, DRILP, RAP &

DRSP – were also compiled and projected into a similar coordinate system as used for the SRN.

It is difficult to estimate exactly the length of the LRN as the reported and map lengths show significant differences. Furthermore the lengths reported in the DoLIDAR inventory are difficult to verify due to large difference in the plotted and tabular lengths.

2. Existing Local Network

Based on the most reliable available data, it is estimated that the LRN currently contains approximately 4,460km of operational roads, comprising 450 individual roads in 62 Districts. There are no operational local roads in 13 Districts[18], although sections of road and parts of the future Strategic Network may be under construction or, in part, operational. A summary of the 2006 Local Road Network is given in Table 8.1, and the network is illustrated in Figure 8.1.

Only 3 percent of the local network is sealed, a little over 40 percent is gravelled, and the remainder is simple earth construction: as a result, much of the network, especially in the hills, is seasonal in nature. Over half of the network (2,390 or 54% of the total) is located in the 20 Terai Districts and, of these roads, three-quarters are all-weather gravel or black-top. In the hills, by comparison, over 80 percent of the are simple earth construction. A detailed listing of the roads in this network is presented in Annex 8, Tables A8.1 and A8.2, by both District and individual road.

Table 8.1: Summary of Local Road Network (2006) by Length (km)

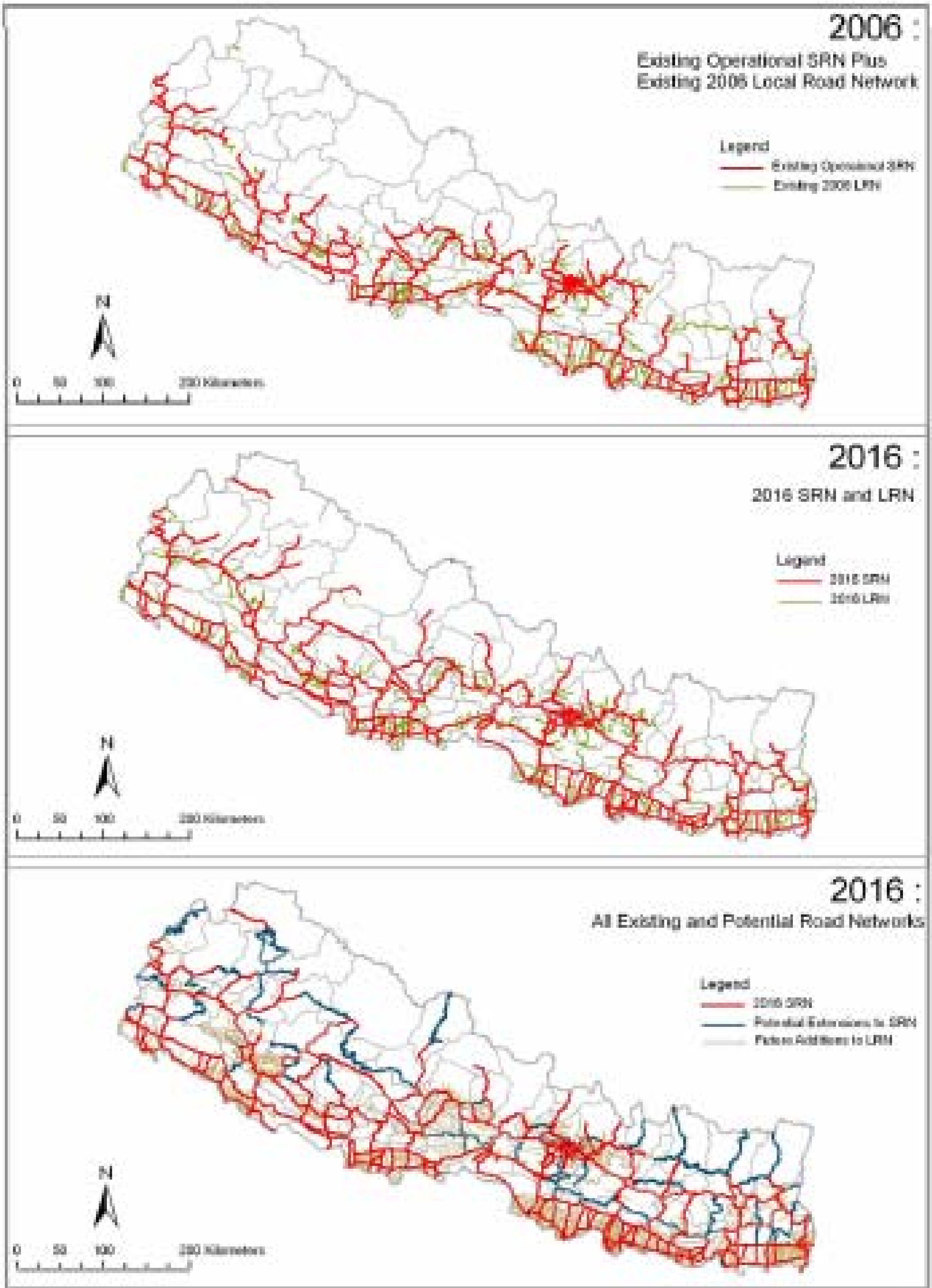
	Black Top	Gravel	Earth	U/Constr	Total	Percent
Terai	87.3 4%	1686.1 71%	552.9 23%	63.5 3%	2389.8 100%	54%
Hills	61.6 3%	196.5 10%	1722.2 83%	86 4%	2066.3 100%	46%
Total	148.9 3%	1882.6 42%	2275.1 51%	149.5 3%	4456.1 100%	100%

3. Future Local Network

It is difficult to predict what will be the extent of the local network in 2016. It is probable that there will be a substantial and continuing programme of local road construction promoted through the local District and Village Development Committees, with assistance from the various donor and development agencies. These roads will provide enhanced levels of access to substantial populations within the Districts and will be built to meet local demands for improved access – especially in regard to local movements to markets, schools and service centres.

The Consultants have adopted two approaches to define the Local Road Network for 2016, as illustrated in the lower two maps on Figure 8.1. The first (5,860km) contains all existing and committed local roads and the second includes an additional 13,500km of planned or proposed roads, taken from the available District Transport Master Plans (DTMPs).

[18] The 13 Districts without local roads are: Sankhusabuwa; Solukhumbu; Manang; Myagdi; Rukum; Jajarkot; Dolpa; Jumla; Kalikot; Mugu; Bajura; Bajhang; & Darchula



Part I Draft Final Report December 2006	Government of Nepal, Ministry of Physical Planning and Works, Department of Roads World Bank - Road Maintenance & Development Project (RMDP) Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP	Figure No.
DHV Consultants In association with SILT, TAEC & CMS	Strategic Networks and Local Road Network Used to Test Accessibility	8.1

Many of these roads will, however, provide only marginal increases in accessibility (as measured with the 2 hour and 4 hour criteria), as they will be constructed in the more densely populated areas that are already defined as being accessible. Further construction of local roads will obviously reduce the access time for individuals and will be of benefit to the local community and, doubtless, additional roads will be constructed that will increase the road density in populated areas: even today in much of the Terai, as would be expected, the road density greatly exceeds that required to meet the 2 hour access standard.

This Study is concerned primarily with establishing the basic network of strategic and local roads that are required to meet the Government's accessibility standards. The Study has thus focussed initially on the SRN – which is an essential pre-requisite for any measure of accessibility – and secondly on those additional local (or District) roads required to access pockets of population not otherwise served.

The basic LRN for 2016 has therefore been defined as the 2006 network, plus all those known additions that are presently under construction or consideration through the main rural access development programmes. This approach undoubtedly under-estimates the extent of the future network which will – in the more populated areas – include many additional local access roads.

Details of the assumed 2016 LRN, by both District and individual road, are presented in Annex 8 (Tables A8.3 & A8.4) comprising 463 roads in 63 Districts with a total length of approximately 5,860km: it should be noted that – by 2016 – some of the 2006 LRN will have been re-classified as part of the SRN and thus the net gain in the local road network is more than the implied increase of around 1,400km.

The alternative version of the 2016 LRN includes an additional 13,530km of planned or proposed local roads, making a future LRN of approaching 19,400km and a total road network (including the extended SRN) of over 29,000km. The additional 13,500km comprise 1,800 individual roads in 50 Districts – many in the Terai, where they do not contribute significantly to improved access. Full listings by both District and individual road (including the DTMP Code) are given in Annex 8, Tables A8.5 and A8.6.

C. Calculation of Accessibility of Strategic and Local Road Networks

1. Accessibility for the Year 2006 with SRN and Existing LRN

An assessment of the impact of the Local Road Network on overall levels of accessibility has been undertaken by adding the known and likely LRN to the existing and proposed SRN lengths in both 2006 and 2016. The initial (2006) test assumes an LRN length of 4,460km as illustrated in Figure VIII.1. This is the basic 'known and verified' network of operational roads: as can be seen these roads are mostly short and close to the existing SRN. Their effect on accessibility is primarily to expand the accessible band-width adjacent to the SRN, rather than to improve access to remote areas.

The effect on the overall population served in 2006 is shown in the top two rows of Table 8..2, which compares the data with the 'SRN only' scenario. Overall accessibility is increased from 78 percent to 85 percent, with an increase from 58 to 68 percent in the hills and from 94 to 98 percent in the Terai. The existing LRN in the Terai is thus seen to provide almost total coverage.

Table 8.2: Additional Populations served by LRN

	Length	Population served		
	km	Hill	Terai	Total
Existing / Operational SRN 2006	*7,360km*	*6.52 58%*	*13.70 94%*	*20.22 78%*
PLUS 2006 LRN	+4,460km= 11,820km	7.67 68%	14.36 98%	22.04 85%
Extended SRN 2016	*9,930km*	*7.94 70%*	*14.21 97%*	*22.15 86%*
PLUS 2016 LRN (Committed)	+5,860km= 15,790km	9.09 81%	14.51 99%	23.61 91%
PLUS All known existing & planned roads	~29,000km	9.92 87%	14.48 100%	24.40 94%

Note: Total Population of 25.9 million is divided into Hills 11.3 million & Terai 14.6 million

2. Accessibility for the Year 2016 with SRN and LRN

In 2016, the initial network tested includes the proposed Extended SRN (9,930km) plus the 5,680km of existing and currently planned local roads, giving a total of 15,790km. This network provides 81 percent accessibility for the hill areas and 99 percent in the Terai and Valleys, producing an overall accessibility of 91 percent – an increase of 5 percent compared to the extended SRN alone.

Two local networks are tested in 2016: the first (above) assesses the impact of the known (existing & planned) LRN on the 2016 Extended SRN and the second examines the impact of all potential local and strategic roads. As can be seen from Table 8..2, the overall accessibility is increased from 86 percent firstly to 91 percent with the committed LRN and then to 94 percent with all potential planned roads. Ultimately 100 percent coverage is achieved in the Terai and 87 percent in the hills.

The “all roads” scenario for 2016 is based on an assembly of all potential road alignments, including the planned roads in all the available DTMPs, the DoR 20-Year Master Plan, the indicative alignments (9,000km) for additional SRN links identified during this Study, and local networks proposed by various development agencies. The total length of this network is approaching 29,000km, comprising 9,930km of SRN; 5,680km of existing and currently planned local roads; and about 13,500km of planned or proposed DTMP roads and DoR Master Plan Roads.

3. Effect on Walk-Times

The comparable data illustrating the total and average walk-times to the 2006 and 2016 networks are given in

Table 8.3, again with the ‘SRN-only’ figures for comparison. The ‘SRN plus all roads’ scenario provides a significant reduction in the ‘Total Walk Time’ and ‘Average Walk Time’ in both the hills and Terai: the impact in the Terai is relatively small as the opportunities for improvements are limited. In the hills there are still around 1.5 million people more than 4 hours walk from a road (13 percent of the hill population, see Table 8.2) – indicating that it is increasingly difficult (and certainly uneconomic) to expand the network still further to encompass the whole country.

Table 8.3: Total Walk Time to access Network & Average Walk Time [Person-Hours (thousands) and Hours]

	Year	2006		2016		
	SRN Length	7,360km		9,930m		
		SRN Only	SRN + 2006 LRN	*SRN Only*	SRN + 2016 LRN	SRN + ALL Roads
Hills						
Total Walk Time	p-hours	*69,440*	56,242	*42,137*	34,430	27,130
Average Walk Time	Hours	*5.16*	4.03	*2.74*	2.05	1.40
Terai						
Total Walk Time	p-hours	*19,411*	16,020	*17,453*	15,218	14,605
Average Walk Time	Hours	*0.33*	0.11	*0.20*	0.05	0.01
Total – All Country						
Total Walk Time	p-hours	*88,881*	72,262	*59,589*	49,648	41,734
Average Walk Time	Hours	*2.44*	1.82	*1.30*	0.92	0.62

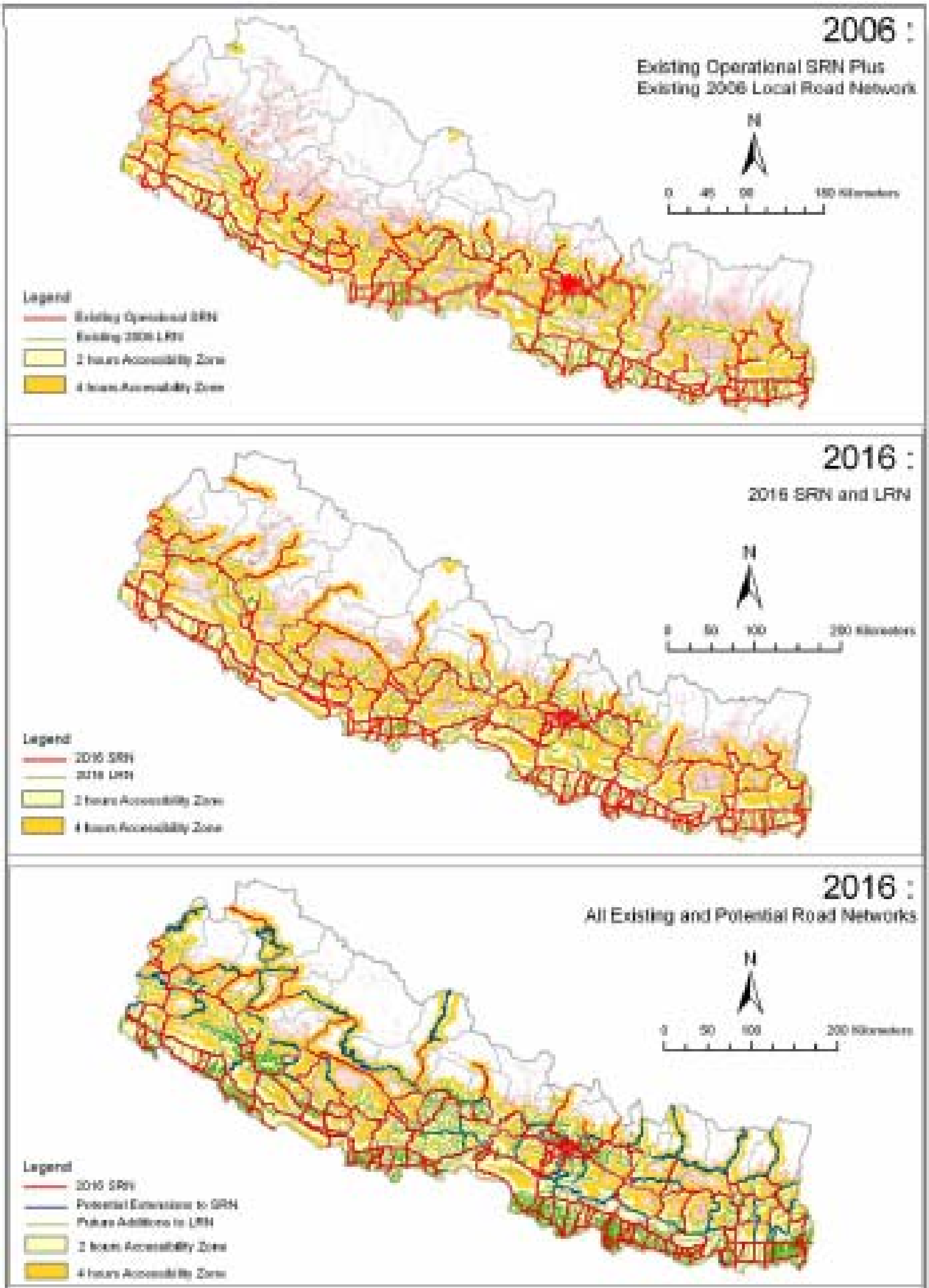
4. Accessibility Coverage

The geographical extent of the areas served by each of the three networks are illustrated in Figure VIII.2, which also indicates the population distribution. It is clear that substantial areas of the country are still not-road-served but it is equally evident that many of these areas are supporting small or negligible populations. It is clearly impractical to pursue the planning or construction of roads into these remote northern areas.

However, in 2016, with the extended SRN and the known and committed LRN, around 2.3 million people in the hills (20 percent) are still beyond a 4 hour walk from their nearest road. This population is primarily in a limited number of relatively densely populated areas in the mid-hills – in both the east and west of the country. A strategy is required to fulfil the accessibility criteria in these pockets by the concerned local authorities or the agencies working in the rural road sector.

The ‘un-served’ populated areas for the two networks tested in 2016 are shown on Figure VIII.3, indicating those areas where additional local road construction will be required to meet the access needs of the population. It is interesting to note that, despite the inclusion of an additional 13,500km of road - almost a doubling of the network – the size and scale of the un-served areas are remarkably similar between the two options tested in 2016.

It is evident therefore that a focussed plan for additional local road construction should be considered in the east (Bhojpur, Khotang & Okhaldhunga) and the west (Palpa, Syangja, Myagdi, Rolpa, Jajarkot and Kalikot). The population densities in other non-served areas are unlikely to warrant new road construction.



Part I Draft Final Report December 2006	Government of Nepal, Ministry of Physical Planning and Works, Department of Roads World Bank - Road Maintenance & Development Project (RMDP) Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP	Figure No.
DHV Consultants In association with SILT, TAEC & CMS	Accessibility to Strategic Networks and Local Road Network	8.2

D. District Level Accessibility

The previous Chapter illustrated the accessibility at a District level provided by the SRN in both 2006 and 2016. This showed that approximately 4.9 million people (19 percent of the total population) lived more than 4 hours from the currently operational SRN and that, by 2016, this number could be reduced to 3.4 million people (or 13 percent overall). The inclusion of the known and committed local networks in 2006 and 2016 can reduce the un-served populations to 3.6 million (14 percent) and 2.2 million (9 percent) respectively.

The inclusion of the LRN in 2006 reduces the number of districts with more than 100,000 people outside the 4-hour limit from 21 to 14, with two main clusters of poorly served Districts in the east (Sindhuli, Sankhuwasabha, Khotang, Bhojpur and Solukhumbu) and the west (Rukum, Jajarkot, Rolpa, Kalikot, Baitadi, Bajura and Bajhang). By 2016, with the inclusion of the known LRN, there are only two Districts (Rolpa & Khotang) with over 100,000 people more than 4 hours from a road.

Figure 7.9 (in the previous Chapter) illustrated the Districts with poor accessibility from the SRN in 2016, highlighting those Districts where local road access was a priority. Figure 8.4 presents similar information with the addition of the ‘known’ LRN: it can be seen from that some of the immediate problems (including areas close to Kathmandu) are resolved, but that further expansion of the LRN is required in the mid-hill Districts in both the east and west of the country.

A detailed listing of the accessibility indices for the SRN plus known LRN in 2006 and 2016 are presented in Annex 8, Tables A8.7 and A8.8. The inclusion of the LRN in the analysis has a significant impact on the average walk-time to access the road network, as shown in Table 8.4, with a 25-30 percent reduction overall, and an even greater impact within the Terai.

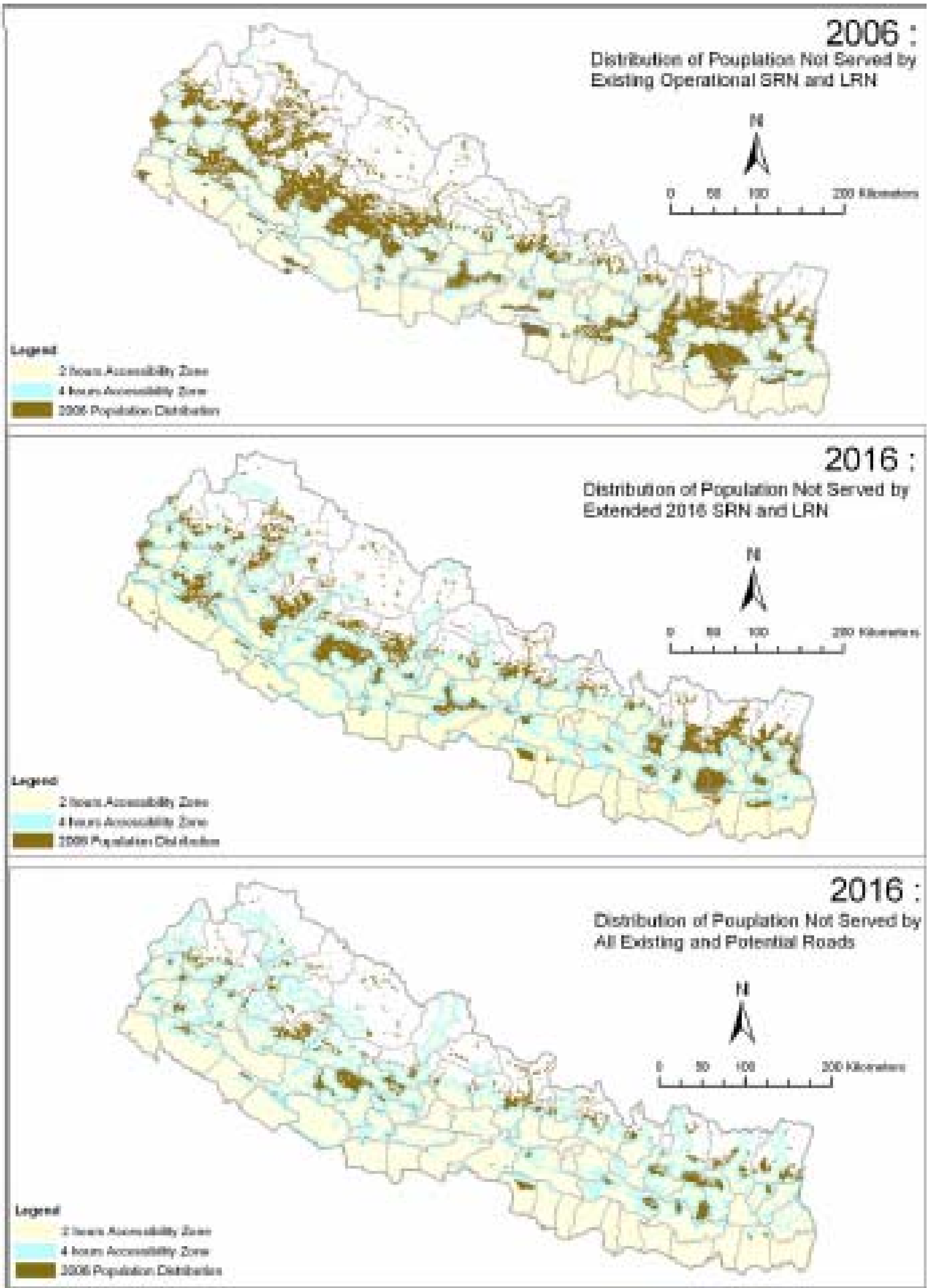
Table 8.4: Average Walk-Time to access the Network (SRN & LRN)

	2006			2016		
	Hills	Terai	Overall	Hills	Terai	Overall
SRN Only*	5hr 12m	20min	2hr 26m	2hr 45m	12min	1hr 18m
SRN plus LRN**	4 hrs	7min	1hr 50m	2hrs	3min	55min

Notes: * SRN = 7,360km in 2006 and 9,930km in 2016
** SRN & LRN = 11,820km in 2006 and 15,790km in 2016

Currently, with the effective operational SRN (7,360km), the average walk-time to access the network is 2½ hours: the inclusion of 4,460km of local roads reduces this to less than 2 hours on average – 4 hours in the hills and 7 minutes in the Terai. By 2016, with the extended SRN (9,930km) the national average access time is reduced to 1 hour 20 minutes and the known LRN will reduce this to less than an hour on average – 2 hours in the hills and 3 minutes in the Terai.

Overall this level of accessibility is considered to be a plausible standard to aim for in Nepal over the next ten years. Access in the Terai is reduced to a nominal level and the average in the hills (2 hours) is a reasonable target given the severe topographical constraints and prevailing population densities in non-road-served areas.



Part I Draft Final Report December 2006	Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP	Figure No.
DHV Consultants In association with SILT, TAEC & CMS	Distribution of Population Not Served by SRN and Local Road Networks	8.3

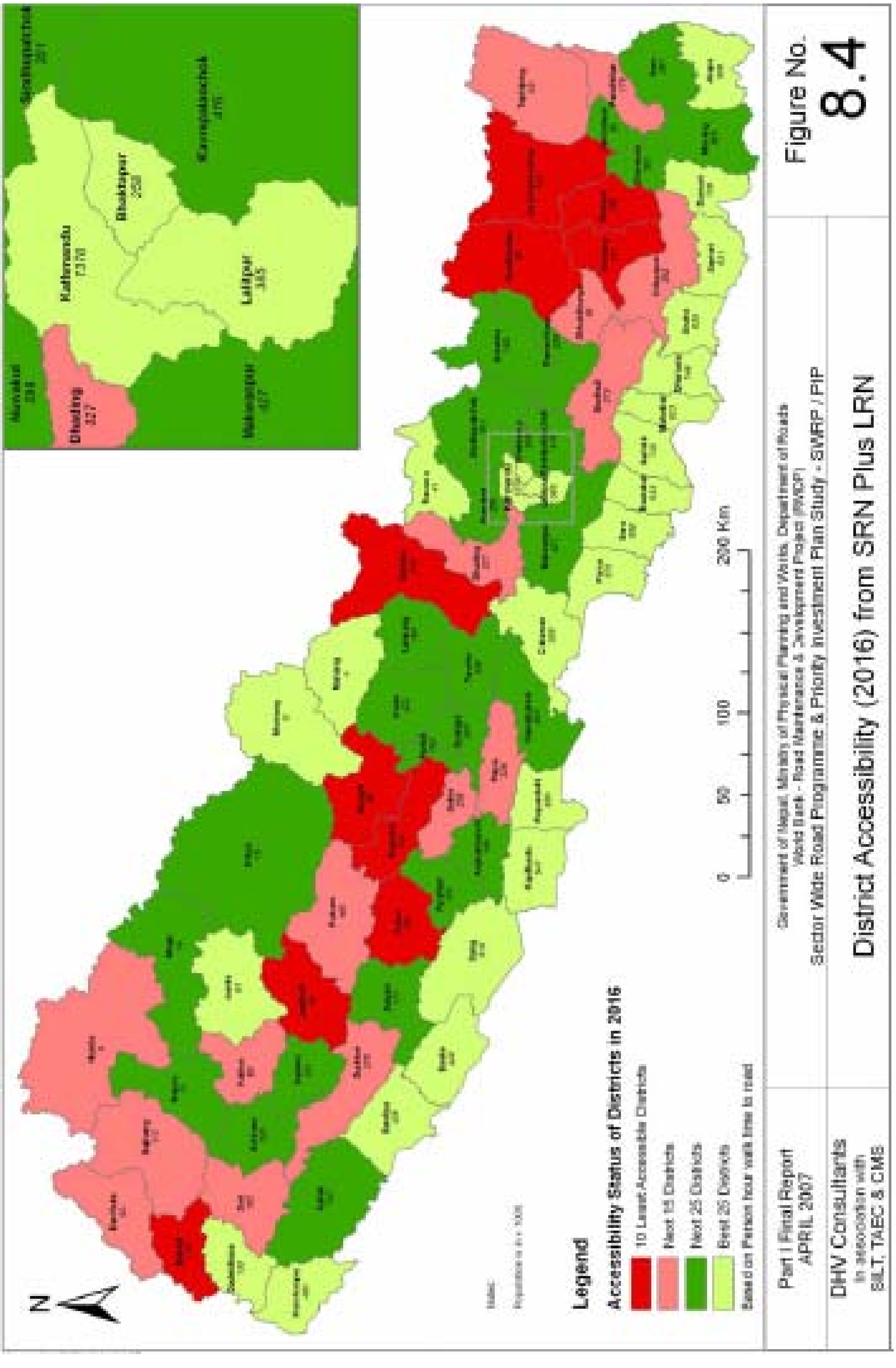


Figure No.
8.4
District Accessibility (2016) from SRN Plus LRN
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Part I Final Report
APRIL 2007
DHV Consultants
in association with
SILT, TAEC & CMS
Legend
Accessibility Status of Districts in 2016
10 Least Accessible Districts
Next 15 Districts
Next 25 Districts
Best 25 Districts
Based on Person hour walk time to road
0
50
100
200 Km
Kathmandu
Bhaktapur
Lalitpur
Dhading
Nuwakot
Makwanpur
Kavrepalanchok
Sindhupalchok

Chapter 9

IX. ENVIRONMENTAL AND SOCIAL WORKS (PART I)

For Part I of the Feasibility Study the Consultants undertook three main activities in the field of environmental and social aspects associated with rural road development projects. The principal work consisted of the elaboration of a framework for social and social management to be used as guidance for all similar projects in the future. Other activities focused on the institutional strengthening of those units of the Department of Roads which are responsible for the incorporation and monitoring of environmental and social safeguards in road development projects. Closely related to this activity and based on a need assessment was the preparation of a Training Plan aiming at capacity building and development of skill among the staff of the respective units of DoR.

A. Environmental and Social Management Framework ESMF

Road construction incurs various environmental and social impacts, including both beneficial as well as adverse ones. Particularly in a country like Nepal, which has young and fragile geology, widespread poverty in the mostly remote rural regions, vulnerable communities, rich natural biodiversity, road construction can bring significant adversities to the local, regional and national environmental setting and socio-cultural fabric of the affected population. With foresight, appropriate research and diligent planning and implementation of mitigation measures and monitoring, many, if not all, of the adverse impacts can be minimized or avoided or dealt with positive and constructive ways.

To cover and address these aspects, the Consultants were required to prepare for DoR a general guidance document that covers environmental and social safeguard aspects in a broad manner, giving particular attention to the practicality for implementing mitigation measures that are in full conformity with the GoN policies and regulations, are technically sound and suitable, take up all requirements for land acquisition and potential resettlement, and identify institutional arrangements as well as capacity building needs. The ESMF document is also meant to combine the requirements of both the national government and international donors operating in Nepal’s transport sector.

The ESMF has been written whilst keeping a number of stakeholders (planners, survey teams, consultants, contractors) and stakeholders (line agencies, donors, CBOs/NGOs, investors) in mind. The document intends to provide technical and managerial inputs and guidance into the design, implementation and supervision of countrywide rural road projects. Based on a broad literature review and lessons learned particularly during the RMDP the ESMF also intends to raise awareness of those responsible for planning, implementing and monitoring road development projects with respect to common and specific environmental and social issues related to such activities, to mitigate potential impacts and promote opportunities to enhance foreseen benefits.

The Environmental and Social Management Framework document contains the following sections:

Chapter 1: Introduction, including background and rationale for providing this ESMF, linkage to the Sector-wide Strategic Road Network Development Programme, methodological approach, sources of information and an analysis of the potential users and stakeholders of this guidance document.

Chapter 2 describes the tools and procedural steps for Environmental & Social Impact Assessment to address the environmental and social issues for all project-related activities, and describes stepwise the corresponding management requirements in the entire project cycle. Emphasis is given to describing the legal framework and methodological steps for carrying out IEEs/EIAs, including environmental auditing. It also provides the basic principles (Environmental Code of Practice, comprehensively detailed as an Annex) for planning, implementing and monitoring mitigation measures while considering road development projects.

Chapter 3 reviews the legal framework - policies, regulations and guidelines of the Government of Nepal, and those of the major donor agencies, that bear relevance to rural road development projects. This section makes reference to some 25 acts and the Government's Tenth Five Year Plan, all pertaining to various aspects of road development projects. The review refers particularly to resettlement policies, including those supporting vulnerable communities. The chapter discusses relevant sectoral policies and guidelines prepared by the DoR, and makes specific reference to environmental and social policies being compared with those of international donors, above all, of the World Bank.

Chapter 4 describes the qualitative and quantitative analysis of potential environmental and social impacts that are commonly encountered in rural road development projects in Nepal. This section broadly discusses both beneficial and adverse (direct and indirect) impacts. Case studies are included to demonstrate country-specific issues and consequences for the biophysical, social and socio-cultural environment.

Chapter 5 delineates the Public Consultation framework that needs to be applied while carrying out EAs for rural road development projects. This chapter also includes the consultative procedures and participatory approach required for different project implementation phases as outlined in the Environmental Management Plan and in the Social Action Plan. Public disclosure of information including employment, gender issues and controlling/ grievance resolution mechanisms are analysed under the aspect of applicability for the present Feasibility Study.

Chapter 6 presents a compendium of environmental and social impacts mitigation measures in rural road development projects, particularly those being part of the current Feasibility Study. This section provides technical aspects how to maximize beneficial impacts and how to avoid or minimize of adverse impacts under the typical setting in the forthcoming road development program. This chapter identifies practical, feasible, credible and cost effective measures to offset or to reduce adverse environmental and social impacts to acceptable level, and ways to enhance positive impacts. It gives guidance for preparation of an Environmental Management Plan. As applicable, also it also addresses secondary, induced and cumulative impacts that may be associated with the forthcoming road construction activities, and the inclusion of a Resettlement Action Plan as required.

Chapter 7 outlines the Resettlement Policy Framework (RPF) applicable for typical rural road development projects, focusing on land and property acquisition, eligibility, compensation and resettlement. It assesses the compatibility of the core principles of GoN policies with those of the main donor agencies, identifies gaps, and gives recommendations for addressing these gaps.

The chapter addresses a series of current issues relating to the extent of RoW to be considered and the associated land acquisition procedures, including the definition of properties, households and individuals.

Chapter 8: The Vulnerable Community Development Framework describes the requirements and options to develop support programmes for vulnerable communities and persons, and how to integrate such planning in the design of rural road projects.

Chapter 9 identifies the institutional arrangement for implementing the ESMF. It identifies the key players in this process being governmental and non-governmental agencies, as well as service providers (consultants and contractors). It assesses the institutional arrangements procedures necessary for implementation of the overall sector wide environmental and social management framework under the coordinating role of the Geo-Environment and Social Unit (GESU) of the Department of Roads.

Chapter 10: highlights various aspects for Institutional Strengthening of DoR. This chapter identifies gaps and needs related to capacity building within the DoR, focusing particularly on the Geo-Environment and Social Unit (GESU) responsible for environmental and social components of road and traffic management planning and supervision.

In separate annexes the ESMF includes (i) the ToR for this document, (ii) the Environmental Code of Practice for 20 different sectors, (iii) a glossary of relevant terms and (iv) a list of references/documents consulted.

B. Institutional Strengthening Recommendations, with Respect to Environmental and Social Safeguards

Following the mandate set out in the ToR, the Consultants had various sessions with different sections within the DoR to identify gaps and recommendations concerning institutional strengthening. Focal aspects were the development of mechanisms that would strengthen the capacity of the Geo-Environmental and Social Unit (GESU) being in charge of environmental and social safeguard aspects pertaining to road building and maintenance activities within the DoR. Together with the Head of GESU and other officials from DoR the Consultants developed an institutional strengthening plan which

(i) focuses on GESU's institutional and organizational capacity situation, relating to both individual and organizational competence and effectiveness in addressing environmental and social problems commonly associated with road development projects;

(ii) proposes a re-organization of the former GEU[19] to widen its capacities for social safeguard aspects associated with road development projects (e.g. resettlement, land acquisition and compensation, promotion of special assistance programmes for vulnerable groups and severely-affected families);

(iii) provides assistance for carrying out environmental assessment (EA) studies, and actively participating in the process of EA document review and amendments;

(iv) provides assistance in assessing and elaborating budget requirements for the environmental and social mitigation measures (incl. resettlement) in

[19] During this Project, the proposed reform has been institutionalised, resulting in the creation of a Social Section within the GEU, hence the name of this Unit changed into 'Geo-Environmental & Social Unit' GESU

accord with the EA studies and, as applicable, the respective Resettlement Action Plans;

(v) enables the Unit to coordinate with other line agencies and to monitor/supervise the environmental and social safeguard and mitigation measures laid out in the Environmental Management Plans described in the EA documents;

(vi) promotes mechanisms for incorporating social and environmental safety requirements in all of Nepal's road development programmes (e.g. works contracts specifications, monitoring indicators, compliance verification and effect monitoring techniques);

(vii) devises a training plan tailored for bridging the identified gaps and promoting skill development in the said areas.

C. Training Plan for GESU

The proposed training arrangement, being a result of the need identification process during this FS, resulted in a document entitled '*Training Plan for Environmental and Social Safeguard Measures Relating to Road Development Projects in Nepal*'.

Feedbacks and lessons learned from previous and ongoing road projects in Nepal indicate the stark need for strengthening the capacity of those engineers and DoR staff who are in charge with procurement of services and supervising contractors, especially with respect to ensuring safeguard provisions provided in the respective Environmental and Social Management Plans outlined in the project documents and, at times, in the respective clauses in the works contracts. The same holds true for strengthening the skill of GESU staff, DoR planners, implementers and supervisors of construction works, particularly with regard to good practices and environmental safeguard considerations.

The objective of the Training Plan is to provide practice-oriented training and production of easily understandable manuals, tailored to Nepal's unique environmental and social settings, and being complimentary to the already existing guidelines, and being supplementary to other relevant skill development programs which recently have been proposed to DoR.

The proposed Environmental and Social Safeguard Training Courses primarily target the Geo-Technical & Environmental Unit (GEU) and selected personnel of the Department of Roads. It is further envisaged to include in the training selected service providers like contractors and domestic consulting firms.

The Training Plan proposes four training modules to be carried out as in-house training courses[20], each involving 8-11 days, with some 20-25 trainees:

<u>Module (1)</u> addresses environmental and social impacts that are likely to occur in connection with road development projects. The module is structured in four major segments:

- Identification of environmental / social impacts: causes and effects
- Framework conditions for conducting Environmental Assessment
- Methodological approach for impact analysis
- Preparation and Review of Environmental Impact Documentation

[20] with field trips/on-hand training, as applicable

Module (2) addresses the need to include, to the maximum extent possible, good construction practices in all stages of planning, executing and monitoring road development projects. The training is tailored in accordance with the Environmental Code of Good Practice (ECoP) established in the ESMF (see above).

- Training in basic principles of EcoP, including site selection, management of construction plants and equipment, spoil management, bio-engineering, erosion control, drainage, habitat protection, work safety, health regulations, social aspects, vulnerable groups, support programs and compensatory measures);
- Skill development and awareness raising among road engineers involved in planning, designing, implementation and supervision of road construction works;
- Local consulting firms and contractors to become familiar with the requirements of ECoP;
- Consultants to adopt development of new ideas in designing and supervision of road projects with reference to ECoP
- Provision of hand-outs and practical manuals.

Module (3) addresses the processes, quality ensuring and supervision of procuring private sector companies to become involved in a range of services to be provided for planning and construction works, under competitive procurement procedures.

- Setting up a robust and transparent contract procurement and contract management (incl. coordination processes with outsourced activities);
- Specific environmental and social safeguard considerations to be incorporated in the specifications and clauses of Work Contracts (incl. practical examples, lessons learned from similar projects in Nepal, pitfalls and specific issues);
- Setting up a database to facilitate pre-selection and/or exclusion of service providers;
- Demonstrate instruments to minimize (costly and time-consuming) claims by all parties involved in contracts;
- Ensuring good and anti-corruption practices during contract performance.

Module (4) is a Training for Trainers programme, being developed in close coordination and consultation with ongoing capacity building activities proposed under the RMDP. Focal points are:

- update of Staff Training Plans based on need assessments
- revision of external training proposals
- design of training for impact assessment models
- effective sharing of information obtained during training activities
- integrating project-related experiences in training programmes
- training of staff in training management and skills
- preparing budgets for training programs.

For the implantation of the Training Plan, external/international trainers will be required, recruited in international bidding, with qualifications and records pertaining to undertake the proposed training modules. The cost estimate for the proposed training courses amounts to approximately USD 60,000.

Chapter 10

X. PRIORITY INVESTMENT PLAN & SECTOR WIDE ROAD PROGRAMME

A. Overall Findings & Conclusions

1. Introduction

This Chapter summarises the key findings of the Sector Wide Road Programme and Priority Investment Plan (PIP) Study, conducted for the Department of Roads (DoR). The Study was carried out, with funding from a World Bank/IDA Loan, over an 18 month period commencing in September 2005. The Consultants' initial findings were presented in their Draft Final Report in January/February 2007 and were the subject of presentations and discussions prior to the finalisation of this Final Report.

The Study is primarily concerned with the maintenance and development of the Strategic Road Network (SRN) which is the main responsibility of the DoR. A key objective of the Study is the preparation of a 10-Year Priority Investment Plan (PIP) for the SRN, including recommendations for expansion and improvement.

Nepal is in a period of great change and is potentially poised to enter a period of substantial and dynamic growth. The problems of the past decade, including the long-running insurgency and frequent changes in government, have resulted in economic stagnation and increased polarisation between relatively wealthy urban dwellers and the rural poor.

The new Government of Nepal (GoN) is embarking on a major programme of reconstruction and rehabilitation of facilities in the conflict-affected rural areas, including the upgrading of poorly maintained, damaged or inadequate roads, the construction of new roads, and the completion of projects deferred due to security concerns.

Additionally, investment is required in and around the economic and commercial centres, including Kathmandu, Pokhara and the main Terai towns, to position the economy to respond to future opportunities for growth and to compensate for past inadequacies in funding.

It is necessary therefore for the Sector Wide Road Programme to address a broad range of concerns and priorities, in both the short and longer-term, and in both the rural and core economic sectors. Accessibility and connectivity are the two key parameters to describe the development of the road sector: these encompass issues relating to the inequitable provision of road access in the remote and generally impoverished rural areas, and the need for improved linkages – both domestically and internationally – between the major commercial centres.

2. Regional Structure

The overall structure of the economic linkages and the associated transport network within Nepal may be conveniently divided into three broad regions – Central, East and West – as illustrated in Figure 10.1. The East and West are to a large extent independent with regional centres, at Biratnagar and Nepalgunj respectively, servicing their hinterlands.

The 'Central' Region contains the heart of the economic activity of the country, including the main border crossings with India and the only two urban centres of any consequence outside the Terai. The region effectively has four main nodes – Kathmandu Valley, Birgunj, Butwal/Bhairahawa and Pokhara – which together comprise an economic quadrangle with strong inter-linkages: Narayanghat-Hetauda form a secondary cluster, and Janakpur services a distinct area towards the east.

Both the Eastern and Western regions have a north-south divide between the hills and the Terai and both are to an extent marginalised from the economic mainstream. Secondary service centres in each are also in the Terai (or inner Terai), with no major settlements in the hills. The East is undoubtedly richer and more developed than the West and has greater potential.

The West has a clear focus on Nepalgunj, with a series of lesser, satellite centres at Dhangadhi, Surkhet and Tulsipur/Ghorahi: these, in turn, have distinct sub-regions associated with them, although all areas in the West also have a direct relationship with Nepalgunj.

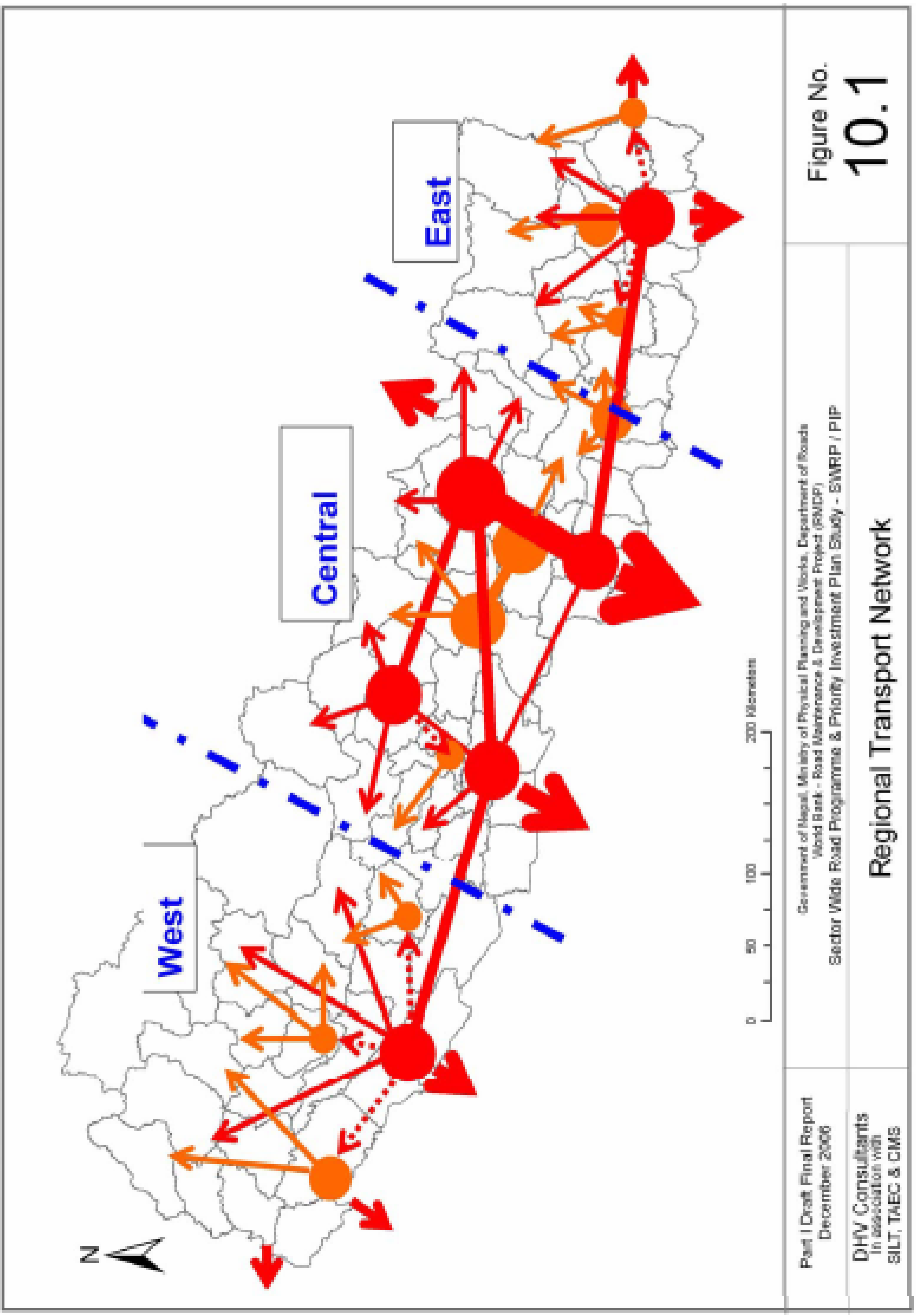
Similarly in the East, Biratnagar (with Itahari) is the main service and distribution centre, with secondary centres at Birtamod/Chandraghadi, Dharan/Dhankuta and Lahan.

The Central Region has a different character. Both Kathmandu and Pokhara have their own spheres of influence, as well as the Central Region inter-dependence. Butwal-Bhairahawa, Hetauda-Narayanghat (plus Birgunj) and Janakpur serve the Terai and low hills, with Tansen as a subsidiary centre for the mid-hills. The linkage of Janakpur with Kathmandu and the Central Region will be strengthened with the completion of the Dhulikhel-Sindhuli-Bardibas Road.

3. Content of PIP for SRN

The preparation of the DoR 10-Year Priority Investment Plan for the Strategic Road Network will comprise three main tasks:

- Firstly, a definition of likely ***maintenance*** requirements;
- Secondly, the ***Upgrading*** of existing and potential SRN elements (incl some local roads); and
- Thirdly, the ***Construction*** of new (strategic) links – for both rural access and network strengthening


West
Central
East
N
0
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200 Kilometers
Part I Draft Final Report
December 2006
DHV Consultants
in association with
SILT, TAEC & CMS
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Regional Transport Network
Figure No.
10.1

The focus and content of the PIP is significantly different from the plan prepared 10 years ago. The main component of the previous PIP plan, after consideration of the maintenance needs, was the extension of the network into the non-road-served hill areas, including the construction of new roads to connect 12 of the 17 unconnected District Headquarters. This plan has mostly been achieved, although some of the HQs are only now being connected. It is fair to conclude that the previous plan was followed – by Government and aid agencies alike – although progress has been slower than planned due to difficulties in execution and implementation (rather than funding deficiencies).

The current plan has four different components, in addition to the on-going maintenance obligations and the completion of the previous plan elements:

- Firstly a significant expansion in the extent of the Strategic Road Network and the incorporation of substantial lengths of existing local and District Roads into the SRN;
- The upgrading of existing earth or gravel roads in both the Terai and hills to all-weather sealed standards, in order to provide an improved level of accessibility and to promote economic activity and growth;
- The consideration of major new access routes to Kathmandu Valley to provide a significant time and distance savings between Kathmandu and the Terai (and India), and to relieve the existing routes; and
- The improvement of key heavily trafficked routes within the Kathmandu Valley, including the Ring Road and route to Bhaktapur and Dhulikhel.

It is however important to note that, during the first four or five years of the plan, most of the expenditure will be on projects that are already committed (or are in the funding 'pipeline'): it is only in the latter years of the plan – post-2011 – that new schemes will be included.

The expansion of the network is accomplished by the construction of some new roads, but more significantly through the 'conversion' of existing local or District Roads and tracks to SRN status. The new roads include extensions into remote non-road served areas, key missing links especially in the hills, and new strategic access routes to Kathmandu. However many of the potential new strategic links merely involve the re-designation of existing operational roads or else follow the alignment of an existing local road or track. In these cases, the inclusion of a road in the SRN may involve only a marginal additional costs – ie the additional on-going maintenance obligation and possible subsequent upgrading to sealed standards.

A significant programme of upgrading earth and gravel roads to sealed standards in both the hills and Terai is proposed. Specifically this involves the improvement of a number of Terai roads (including the Postal Road) to all-weather standards, together with the provision of the necessary bridges and drainage structures. These Terai roads improve access for substantial populations in the areas close to the Indian Border and link the border towns more effectively than the East-West Highway. In the hills, despite the comparatively small traffic volumes, it is recommended that the initial 'trunk' sections of the north-south road networks are also upgraded to sealed standards to accommodate existing and potential traffic flows.

This also marks a change in the previous policy which stressed the extension of the network to serve all areas of the country: the current emphasis is directed towards a *'consolidation'* of the network and the provision of improved standards

and greater reliability on the critical (core) elements of the hill road network. These sections of road are fundamental to the provision of improved access to whole regions, as well as providing direct access to more people in the immediate vicinity.

Reference to the population density distribution map reveals that – away from the major urban centres – there are significant concentrations of population in both the Terai and mid-hills areas (see Figure 10.2). In the latter case there is a ‘band’ of population in and around the key ‘hill towns’, with particular clusters in the area south and south-west of Pokhara, in the Inner Terai Valleys (Dang and Surkhet), in the hills north of Kathmandu and Dhading, and to a lesser extent in the Far West and East.

Most importantly, it is evident that there are minimal populations in the areas to the north of the existing (and proposed/committed) roads: there is thus no case to be made for further northerly extensions to the network and future network development should concentrate on an intensification of the network in populated areas and improvements to the serviceability and reliability of existing roads.

This is a significant change in policy to that of the previous PIP in the mid-1990s, which placed a higher priority on the provision of basic fair-weather extensions to the network rather than upgrading to higher standards: this reflects the changed circumstances now prevailing and the fact that most of the basic initial access roads have been completed or are under construction.

It is recognised that the provision of improved, reliable, all-weather access not only reduces operating costs for existing traffic but, more significantly, leads to a substantial growth in the numbers of passenger trips made and volumes of goods consumed. The opportunity to make quick, comfortable and affordable trips on a reliable basis can be seen to transform travel habits and lead to greater economic activity and social interaction.

B. Strategic Network

1. Extent of Network

The existing ‘designated’ SRN comprises around 5,030km of road – 3,100km of National Highway and 1,920km Feeder Road. In addition, there are a further 400km of open and operational road (maintained by DoR) that will form part of any future SRN. The existing network thus comprises 5,430km of road, of which 70 percent (3,800km) has a bituminous surface and the remainder is either gravel (18 percent) or earth track (12 percent).

It is notable that there are substantial additional lengths of road that are either currently maintained by DoR (as if they were part of the strategic network) or are committed improvements that will form part of the SRN by 2010. As described in Chapters 3 and 4 above, the HDM analysis of the maintenance and upgrading requirements of the SRN has been based on an assumed network of 7,920km of road in 2010, including all schemes presently in the ‘pipeline’, which have been taken as committed. The following discussions on the maintenance budgets are based on this road length.

In regard to the development and expansion of the SRN, the analysis is based on a current (2006) network of 7,360km, which includes ALL roads currently being maintained by DoR; an expansion of 1,030km to 8,390km by 2010; and an additional 1,540km, mostly proposed by this Study, to create a total of 9,930km

by 2016. This network is illustrated in Figure 10.3, showing the phasing of the expansion: a full listing of the links is included in Annex 7, Tables A7.1 and A7.2.

The current 2006 network includes an additional 2,330km of non-designated SRN roads that are currently maintained by the DoR Divisional Offices: included in this total are 116km of urban roads within Kathmandu, substantial lengths of Terai roads (including most of the Postal Road), and a number of existing schemes in the hills built under various aid or development initiatives. The additions by 2010 (1,030km) are mostly 'committed' schemes in the hills and the remaining links in the Terai that are part of the package of Indian-funded improvements.

The remaining additions prior to 2016 (1,540km) comprise mostly the schemes identified and prioritised within this Study, including a series links within the mid-hills corridor, connections to the remaining non-road-served District HQs (Humla, Mugu and Dolpa), new and improved access routes to Kathmandu, and network improvements within Kathmandu Valley.

These latter improvements – including upgrading of the existing Ring Road, dualling of the Kathmandu-Bhaktapur-Dhulikel Road, and the possibility of an Outer Ring Road (ORR) coupled with improvements to radial routes – cannot be realistically assessed within scope or remit of this strategic study, and will require detailed specialised evaluations. In particular the ORR should be evaluated in the context of the overall Urban Development Strategy for Kathmandu Valley, as it will have a fundamental influence on the patterns of growth and urbanisation in the Valley – in much the same way as the existing Ring Road did 25 years ago. The proposed ORR is much more than a 'road project' as it will determine land-use and affect land values over a broad area: it may also lead to the continuing proliferation of unplanned low-density developments that are inefficient and expensive to service, and which will destroy the last vestiges of open space and agricultural production within the Valley.

2. Regular Annual Maintenance

The first "call" on the budget in any year should be for the continuing and on-going maintenance obligations, referred to here as *Regular Annual Maintenance* and including Routine, Recurrent, Specific and Other Maintenance. The costs of each are estimated on a per km basis across the whole network.

- Routine: including grass cutting, drain clearing, debris removal, signs and markings, etc;
- Recurrent: minor repairs carried out on a cyclical basis, including pot-hole repairs, patching, edge-break repair, shoulders, etc;
- Specific: more substantial works as dictated by road condition – eg gravelling shoulders, building or repairing retaining walls, etc; and
- Other: traffic safety, bio-engineering, emergency maintenance, drainage rehabilitation, equipment repair and servicing,

The total annual costs of these regular maintenance liabilities over the 10 Year plan period are summarised in Table 10.1, based on the assumed increases in the length of the SRN, from 7,360km in 2006 to 9,930km in 2016, plus an allowance for non-SRN roads and strategic urban roads that are not otherwise included. The ten-year total is Rs 11.1 billion, increasing from Rs 1.09 billion to Rs 1.27 billion per year over the period.

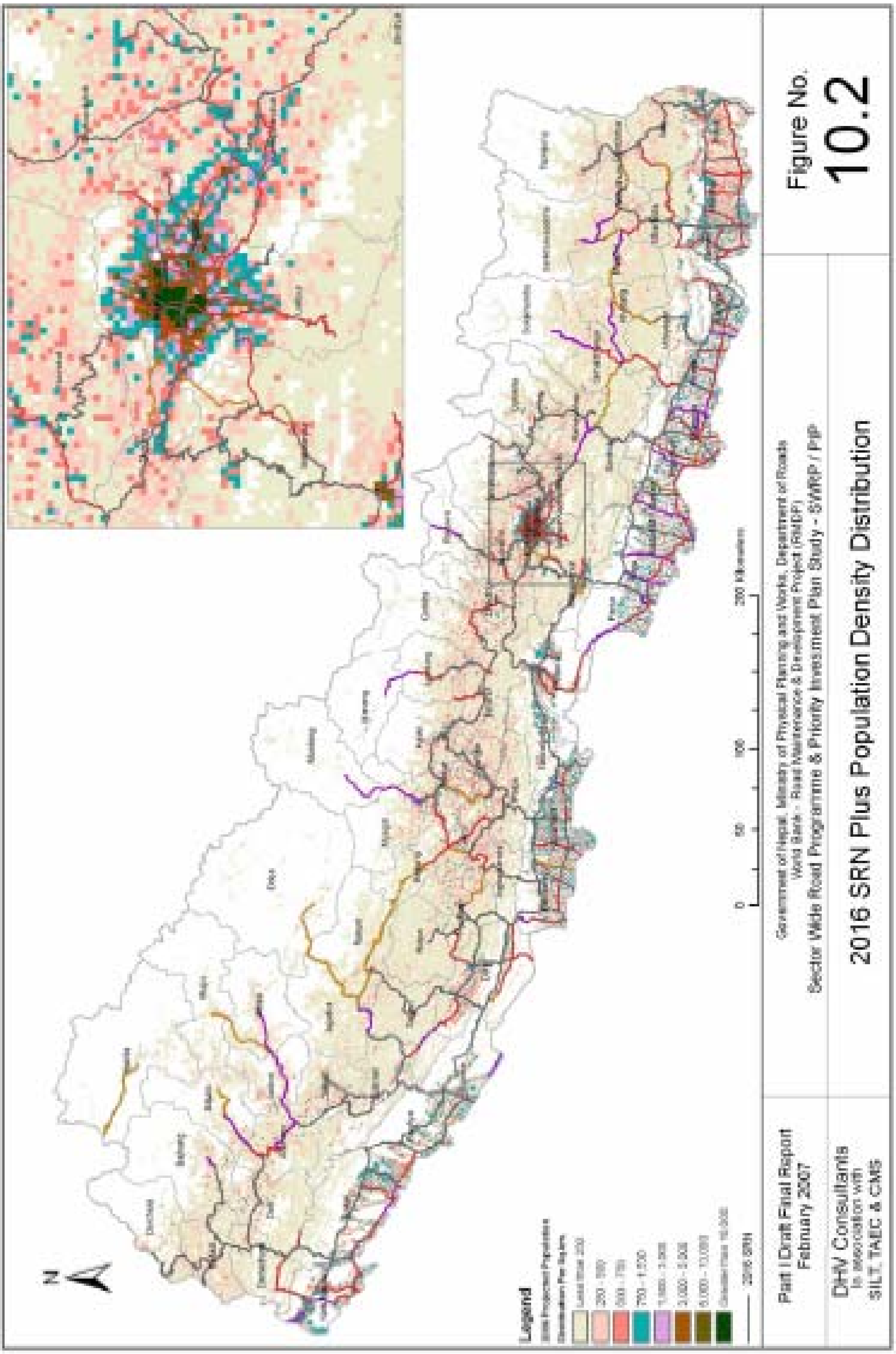
Figure No.
10.2
2016 SRN Plus Population Density Distribution
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Part I Draft Final Report
February 2007
DHV Consultants
In association with
SILT, TAEC & CMS
Legend
0
50
100
200 Kilometers
N

Table 10.1: Regular annual maintenance (Rs million)

Type of Maintenance	Unit	Rate (Rs/km)	Total Cost over 10 years	Percent
Routine	Rs/km/year	30,000	3,104	28%
Recurrent	Rs/km/year	35,000	3,621	33%
Specific	Rs/km/year	25,000	2,586	23%
Other	Rs/km/year	16,900	1,748	16%
Total			11,059	

Funding for the Regular Annual Maintenance should unequivocally be available through the Road Fund, itself funded through a fuel levy, tolls, and vehicle registration and licence fees. It is noted however that adequate funding is not currently available from this source.

3. Periodic Maintenance

Periodic maintenance involves the resealing, overlay or rehabilitation of existing roads on a cyclical or demand responsive basis. The future periodic maintenance requirements for the SRN in Nepal have been assessed using the Highway Development & Management Tool (HDM-4) as described in Chapter 4. This model optimises the maintenance and improvement (upgrading) interventions on the network, by minimising the life-cycle costs incurred by both the road agency and road users.

The model has identified an overall economically optimum 10-year investment programme for the strategic network of 7,900km. The evaluation assumes the completion of approximately 3,000km of committed schemes (new construction or upgrading) by 2010 and further assumes that no additional interventions will be required on many of these (2,450km). In total, HDM-4 recommends interventions on 4,124km of road over the 10 years at a total cost of Rs15.7 billion, including almost 3,000km of periodic maintenance – reseals, overlays and rehabilitation – at a cost of Rs9.5 billion. Around 1,130km of earth and gravel road are proposed for upgrading to sealed standards, after 2010 (see below).

The results are summarised in Table 10.2 for the full 506 links considered in the HDM analysis. It can be seen that 110 links (2,450km) are assumed to have committed improvements by 2010 (and thus no further interventions before 2016) and 79 links (1,343km) have no intervention programmed.

Table 10.2: Summary of Periodic Maintenance and Upgrading (Optimised, Balanced & Constrained) – 2007-2016

	Number of Links	Length (km)	Cost (Rs billion)	Average Cost/km
Upgrade to Seal				
Hills	45	871	5,226	6.00
Terai	17	262	1,047	4.00
Total	62	1,133	6,273	5.54
Rehabilitation	95	1,132	5,357	4.73
Overlay	100	955	3,611	3.78
Reseal	60	904	485	0.54
Committed Schemes	110	2,450		
No Intervention	79	1,343		
Total	506	7,917	15,725	

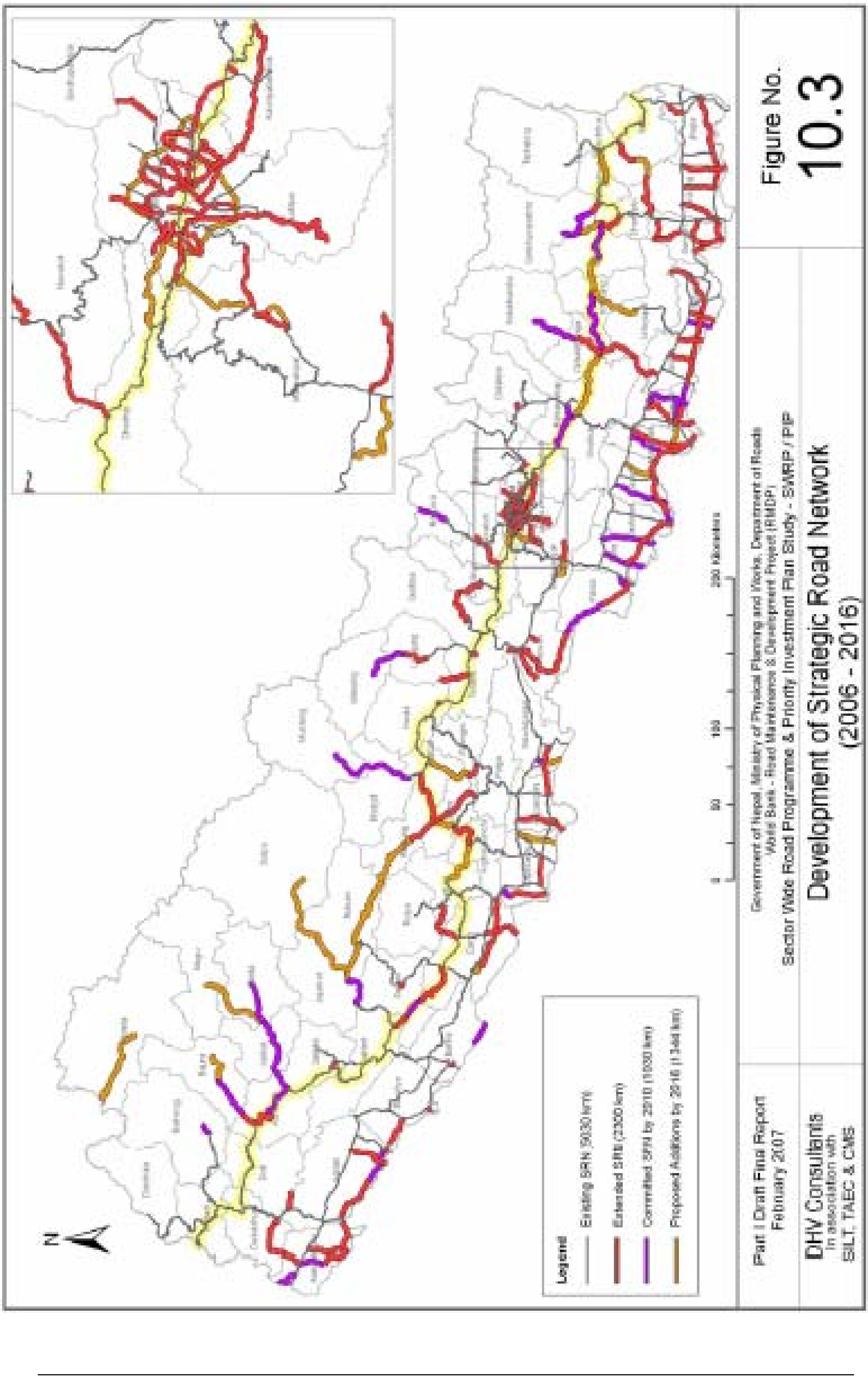
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Figure No.
10.3
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Development of Strategic Road Network
(2006 - 2016)
Part I Draft Final Report
February 2007
DHV Consultants
in association with
SILT, TAEC & CMS

The approach adopted in the model has been designed to replicate current practice in Nepal, involving specifically the application of AC overlays only for roads with higher traffic flows (ie in excess of 3,000 vpd). The implication of this approach is (and has been) the extensive use of relatively low-cost reseals on much of the network. Whilst this approach helps conserve the integrity of the pavement, it only has minimal effect in reducing roughness or in adding strength: as a result, over time, it will become necessary to undertake significantly more expensive rehabilitation works.

The proposed 3,000km programme of periodic maintenance described above contains a substantial proportion of major rehabilitation (1,132km) representing almost 60 percent of the total periodic expenditure. This is as a consequence of the past practice of applying only reseals (DBST or SBST) which do little – in the long term – to enhance the quality or strength of the pavement

The alternative approach is to adopt the initially more expensive AC overlay on any road with traffic in excess of (say) 1,000 vpd. This has the effect, for a marginal increase in overall cost, of providing a smoother surface whilst also adding strength to the pavement, with the result – as demonstrated in Chapter 4 – that vehicle operating costs are reduced and the network at the end of the analysis period is in a substantially better overall condition.

It is therefore recommended that the current practice be reviewed and a greater use of AC overlays be introduced. This has a beneficial impact on the overall efficiency of the management of the road network – although the initial costs of the works are higher: it may therefore be necessary to retain the involvement of foreign aid during the transition period whilst the new practices are being introduced.

[The Consultants are also of the opinion that the costs of AC overlays will reduce if the volume and certainty of continuity of AC work were to improve, encouraging contractors to invest in the plant and equipment.]

4. Upgrading to Sealed Standards

The above analysis has also identified 1,130km of earth and gravel road for upgrading to sealed standards – 870km in the hills and 260km in the Terai. It should be noted that these upgradings are additional to the currently committed programmes – including the Indian funded upgrading in the Terai and the current WB and ADB proposals. Because of the scale and extent of the current road improvement programmes planned over the next four years, the HDM model was constrained to allow upgrading to occur only after 2010.

In addition to the optimised analysis described above, which was constrained to less than 400 links, an unconstrained test was conducted on the full network, to determine the ‘true’ relative priorities of all schemes (excepting those presently under construction), including those previously considered as committed.

This fully unconstrained analysis of the full network identified a total of almost 2,600km of existing (or proposed) gravel and earth roads to be upgraded to sealed standards over the 10-year plan period. The total cost of this upgrading is estimated at around Rs13.5 billion. The analysis confirms the inclusion of substantial lengths of ‘committed’ improvements, plus additional lengths in the hills and in and around the Kathmandu Valley. The location of the projects are shown on Figure 6.1, which separately identifies the ‘committed’ and additional

schemes. Of the total, 1,600km are in the hills and 980km are in the Terai, as summarised in Table 10.3.

Table 10.3: Recommended Upgrading to Sealed Standards

	Number of Links	Length (km)	Cost (Rs billion)	Average Cost/km
Hills	71	1,598	9,569	5.99
Terai	50	980	3,908	3.99
Total	121	2,578	13,476	5.23

Note: Based on 'all-links' analysis and includes committed schemes

A full prioritised listing of the roads recommended for upgrading is included in Annex 10 as Table A10.1: the ranking is based on the NPV/C[21] as a measure of project 'worth'. Any road with a positive NPV – which is equivalent to an IRR in excess of 12 percent – is worth constructing: beyond this, the higher the NPV/C, the better value of the road scheme. A list of those schemes that failed to achieve a positive NPV is also included (Table A10.2).

The above analysis is a purely technical economic evaluation based on current traffic volumes. It includes NO allowance for social factors nor for increased economic activity (and associated increased traffic) induced by the improved levels of access provided.

It is noted that not all of the roads selected for detailed feasibility study, or subsequently recommended for upgrading, are included in the prioritised list, including Gokuleshwar-Darchula, Sanfe-Martadi, Sanfe-Mangalsen-Belkhet, and final sections of the Karnali Highway to Jumla. These results are however purely a reflection of the exceedingly low levels of present traffic and an evaluation procedure that takes no account of generated traffic nor diversion from other modes. As would be expected these non-feasible sections are the most remote sections of road, serving relatively small populations: the 'trunk' sections of the hill roads (and all the Terai roads) are all shown to be feasible.

The specific analyses of the roads in the Detailed Feasibility Studies (Part II of this Study) take into account additionally the potential for significant changes in trip making (and freight consumption) resulting from the road improvement: as a consequence all of the roads selected for upgrading have been shown to be feasible. Details of the IRRs calculated are included, where appropriate, in Table A10.2.

5. Expansion/Extension

The above analysis is concerned with the maintenance and upgrading of the network of 7,900km that will exist in 2010. This is the prime concern of the DoR and should form the "core" of any future budget provision. However the Consultants have also examined the potential for expanding the SRN beyond this, and for the inclusion of additional roads in the network: these additional roads include both 'new' construction and the inclusion (and re-classification) of existing local roads.

In practice, the 'existing' 2006 network as maintained by DoR has been defined to comprise 7,360km of road (see para 10.2.1.above) and the 2010 network additionally includes a further 1,030km of committed roads, producing a total of 8,390km. The difference in the network lengths compared with the HDM analysis results from the inclusion of additional roads in the Terai and within Kathmandu

[21] The ratio of Net Present Value (= Present Value of benefits minus PV costs) to Capital Cost

Valley (116km) that were not included in the HDM analysis due to a lack of available data.

It is recommended that an additional 1,540km of road be considered for inclusion in the SRN by 2016, making a total network of 9,930km. These additions include both the re-designation of existing local roads and new construction. The addition of local (District) roads does not necessarily involve any direct cost, although the overall maintenance liability will be increased and the roads will need to be assessed for upgrading. In addition to current commitments and proposals, it is estimated that a further 700km of roads (500km in the hills and 200km in the Terai) will require upgrading to sealed standards towards the end of the 10-year plan period.

6. New Construction

Only limited amounts of truly new construction are proposed in the forthcoming 10-year period, beyond that which is presently committed. Over the past decade considerable lengths of new road have been built (or planned) both at the District level and as extensions of the SRN to District HQs. The emphasis of the plans now is on the consolidation and upgrading of these roads to provide reliable and sustainable access. This may involve the transfer (and upgrading) of locally built roads and tracks to the SRN, placing the responsibility for on-going maintenance at the central (DoR) level.

The exceptions to this that involve new construction are the links to the remaining three District HQs for which no “commitments” presently exist (Humla, Mugu and Dolpa – see below), ‘missing’ sections of the mid-hills corridor and other mid-hills links, and new access routes to Kathmandu. The provision of road access to all District HQs has been a long-standing priority of successive Five-Year Plans, although it has been recognised, from the previous PIP (1997) onwards, that these linkages are unlikely to be economically justified as the roads serve insufficient populations.

(a) Remote Area Access

Following the completion of present commitments (and schemes in the ‘pipeline’), three District HQs will remain unconnected: Humla, Mugu and Dolpa. The economic benefits of constructing these roads are low – see Chapter 6 – and it is recommended that initial access tracks be developed through local District-based initiatives, with DoR involvement for upgrading considered only at a later date.

It is proposed to provide motorable access to Simikot (Humla District HQ) from China via Hilsa. An 88km track is presently under construction and, when complete, this will enable basic goods and foodstuffs to be provided from the Chinese side, where a motorable road exists. The provision of a road access from within Nepal would involve a lengthy route and very substantial construction costs, and cannot be justified once a link via China has been established. It is recommended that access within Nepal continues to rely on air services from both Surkhet and Jumla.

The feasibility of a 88km access road from Nagma on the Karnali Highway to Gamgadhi (Mugu District HQ) was considered in Part II of this Study. The road was not shown to be economically feasible (IRR = 7.6%), even with the higher levels of trip making and goods consumption, on account of the low population density and extremely small numbers of people served. The area however has considerable tourist potential and if this were to be developed, the demand for

access and support services could help justify the road – even if the main tourist access remained by air.

It is however recommended that the road be initially constructed through local efforts and initiatives, with funding through DRILP[22]: subsequent upgrading should be considered only post-2016. At this stage however it is important to ensure that the alignments (horizontal and vertical) adopted are suitable to allow subsequent upgrading to Feeder Road Standards.

A local road is under construction to connect Dunai (Dolpa District HQ) with Jajarkot using local initiatives and District-level funding: it is probable that this will take many years to complete. Construction of this road was shown (Table 6.2) to have a very low rate of return (IRR = 8.5%) and it is recommended that the present locally-based approach be continued and that upgrading be considered only at a later stage.

(b) Mid-Hills Corridor and links

A series of additional links in the mid-hills totalling around 650km are proposed, which would connect between District HQs and link up existing sections of the potential east-west corridor. A number of these were evaluated in Chapter 6 (Table 6.2) and most would appear to produce a healthy economic rate of return, due primarily to the relatively dense populations in the areas served and the connectivity provided between the centres in the hills. Some other schemes, which were not evaluated as they scored low on the original ranking, have been excluded. A list of the proposed additional links is included in Annex 10, Table A10.3, which shows also the IRRs, where calculated. For roads not specifically assessed an estimate (high / medium / low) of the economic return is shown, based on the population served.

(c) Access to Kathmandu

Improved access to Kathmandu has been identified as the single most effective and significant potential project in the transport sector during the plan period. It offers the opportunity of reducing the travel time between Kathmandu and the Terai by between 4 and 5 hours, with a distance saving of around 150km. Such a reduction would revolutionise the current trading and travel patterns between Kathmandu and the Terai and would provide very substantial benefits for the significant volumes of mostly commercial traffic.

There are two groups of options – from the west linking from the Prithvi Highway to Kathmandu and providing relief to the Naubise-Thankot section; and more extensive schemes linking Kathmandu to the Terai either directly via a series of tunnels or else via a longer route following the Bagmati River corridor. Either alignment would be expensive – estimated at US$40 million for the western approach and US$240 million for the Fast Track (tunnel) option – although each would likely be economically viable due to the substantial time and vehicle operating cost savings available.

As both groups of options are addressing the same central issue, construction of both is mutually exclusive. The shorter cheaper western approach routes resolve the immediate capacity and strategic issues associated with the single steep approach route to Kathmandu, but these do not offer the same scale of benefits that are associated with the direct link to the Terai and the 150km distance saving. Initial construction of the western approach would detract from the viability of the

[22] DRILP = Decentralised Rural Infrastructure and Livelihoods Programme; ADB / SDC

direct Fast Track route – and would itself not be feasible if it were assumed that the Fast Track were built within the next 15-20 years.

The issues involved in the selection of the preferred option to improve access to Kathmandu are complex and inter-related and, without doubt, any one of a number of schemes would be viable. No clear decision can be made without a detailed combined study of all the options, although it may be safely concluded that it would be counter-productive to pursue more than one option.

One of the key issues is the scale of the investment required: it is probable that the “best” option – in the long term – will be the most expensive option, but if adequate finance is not forthcoming then it may be preferable to pursue a sub-optimal solution.

The size and nature of the project would make it an ideal candidate for private sector involvement through some form partnership or BOT-style financing, with the potential of cost recovery through tolls. The following analysis assumes that the Fast Track forms part of the future DoR budget, whereas in practice funding may come from elsewhere.

7. Network Strengthening and Improvement

In addition to the upgrading from gravel to sealed surface and the proposals for extensions for the SRN, a limited number of capacity deficiencies and potential improvements have been identified, mostly within the Kathmandu Valley. For those within the urban area, it has not been possible to conduct a complete evaluation, although international experience would indicate that very substantial benefits will accrue from these schemes – if they can be implemented with no or minimal land acquisition and resettlement

The urban schemes require specialised evaluation, taking account of the specific traffic mix, road and junction capacity, traffic demand and growth, the needs of public transport, and road safety. The other proposed projects will also require detailed individual feasibility studies to take account of their specific features. The schemes recommended for further detailed study are:

- *Kathmandu-Bhaktapur-Dhulikhel:* initially the Koteshwar-Suryabiniyak section to be upgraded to dual 2-lane highway with frontage roads for local traffic and access; improvements to junctions and facilities for public transport; second phase widening to 4-lanes to Banepa and Dhulikhel.
- *Kathmandu Ring Road:* upgrade and improve to dual 2-lane urban standards with frontage roads (as required) to provide for local access, parking, etc; preparation of detailed traffic management plan to regulate and control public transport services, truck movements and parking; evaluation of alternative improvement proposals for key junctions to include traffic management measures, local widening and at-grade channelisation improvements, as well as possible grade-separated solutions.
- *Kathmandu Outer Ring Road and construction/upgrading of additional radial routes:* a plan for a comprehensive road network to serve the outer areas within the Kathmandu Valley should be prepared in conjunction with an overall urban development strategy for the Valley to ensure the coordinated provision of services and a rational and efficient distribution of land-uses. The future strategy and plan for the whole Kathmandu Valley should be developed with the overall national context and policy structure regarding decentralisation and balanced regional growth, and to ensure environmental sustainability and the protection of agricultural land.

An Outer Ring Road should NOT be developed in isolation nor as a means to stimulate land development in the outer areas.

- *Koshi Bridge and replacement of Barrage:* a detailed investigation of the replacement of the existing (barrage) crossing of the Sapta Koshi in Eastern Nepal; two broad alternatives are available: a bridge-barrage-high dam at Chatara where the river leaves the hills, or a lengthy multi-span bridge on the line of the East-West Highway, approximately 5km north of the existing barrage.
- *Hetauda By-Pass:* consideration should be given to the options for a by-pass of Hetauda, including the potential impact of the construction of the Fast Track.

8. North-South Corridors

The previous WB/IDA funded N-S Corridors Study (2004) examined a total of nine potential crossing points to China in the context of developing north-south transit routes between India and China. The Study concluded that, although the volume of trade was currently small, there was significant potential for expansion. The Study specifically recommended the development of a second border crossing at Rasuwagadhi to supplement the existing road crossing at Kodari, which should also be retained and expanded. There are however constraints at Kodari – both in the approach routes and land available at the border – which constrain the future capacity. There are commitments on both the Nepali and Chinese sides to the development of Rasuwagadhi: the Chinese have completed their access road to the border and are currently funding the development of an 18km link within Nepal, to link with the existing road network north of Dhunche. Within Nepal, the ADB Connectivity Project will upgrade the access to Dhunche and complete a missing link to connect to the Prithvi Highway west of Kathmandu.

It is expected that the Rasuwagadhi crossing could be operational by 2010. In conjunction with the new and upgraded approaches from Nepal, it is possible also to develop transit facilities and/or an export/import processing zone on the ample available flat land near Devighat (south of Trishuli).

The N-S Corridor Study strongly recommended that investment in north-south potential transit routes be focussed on the development and upgrading of these TWO locations only. To be effective and to attract potential transit traffic, the routes need to be developed to a high standard (eventually capable of taking 40ft container traffic) and investment in more than two routes would be counter-productive: it is better to concentrate the available resources on the provision of two routes, until such time as the level of demand is assessed and the available capacity becomes an issue.

Additionally, the N-S Corridor Study considered the possibility of further cross-border connections in the west and recommended that two potential locations be considered for LOCAL movements: at LoManthang in Upper Mustang and at Hilsa, to provide access to Simikot the District HQ of Humla. These crossing locations are currently being developed for local traffic and road access is available from China to otherwise non-road-connected areas in Nepal. In the longer term, these crossings might from part of a through route, but the distances and standards of road involved make their use for transit traffic improbable.

In addition to transit trade, it is considered that bi-lateral trade from Nepal to both India and China is equally important, as this leads directly to domestic economic benefits. Such bi-lateral trade with China will obviously benefit from investments

in north-south transits routes, which should be designed to provide facilities to handle domestic import and export traffic.

9. Bridges on the Strategic Network

The DoR Bridge Unit is responsible for the construction and maintenance of bridges on the SRN: a separate budget is provided on an annual basis to cover both recurrent and development (capital) expenditure. The Bridge Unit maintain their own inventory of bridges and this forms an adequate basis to establish annual maintenance requirements, together with a refurbishment or replacement programme as required.

The Recent (2005) Bridge Inventory Study and Condition Survey identified around 100 bridges in need of significant rehabilitation and repair. A specific budgetary item should be included to provide for on-going annual rehabilitation. Separate allowance should be made for the construction and maintenance of bridges (as requested) on the local and District road networks.

In general adequate bridges exist on most of the existing designated network of 15 National Highways and 51 Feeder Roads. Earlier sub-standard bridges on some of the more heavily trafficked sections of the core network have been replaced over the past 10-15 years and – with a few notable exceptions where bridges have failed in a dramatic fashion – most of the existing bridges are in adequate condition, although minor periodic maintenance may be required to repair parapets, erect warning signs, etc.

The recent Bridge Inventory and Condition Survey identified approximately 100 bridges (10 percent of the total) as requiring substantive repair or rehabilitation – ie more than routine maintenance. These works should be programmed and prioritised and an on-going inspection regime established. An annual budget allocation of Rs1 billion is proposed to cover this item.

As noted in the Survey, the bridges on the ‘Russian’ section of the East-West Highway between Pathlaiya and Dhalkebar which are of substandard width (5.5m between kerbs) and do not allow commercial vehicles to pass – except at a crawl. Due to the length of some of these bridges, this creates severe difficulties and dangers to traffic, to pedestrians and to slow-moving vehicles. Given the ever increasing traffic volumes – and thus conflicts between opposing vehicles – the situation will deteriorate rapidly and a solution will be required.

For the lower volume hill roads, bridges are generally constructed in conjunction with upgrading and improvement projects in accordance with the overall design requirements to achieve an all-weather connection. It is suggested that a set of guidelines be developed to assist with the selection of the appropriate form of crossing (ford, culvert, causeway, floodway, submersible bridge, RCC bridge, steel truss bridge, etc) in conjunction with the forecast dry-weather and flood conditions and anticipated traffic volumes. It is observed that in some cases bridges on low-volume roads have been over-designed and permanent structures provided where simpler causeways might have been appropriate.

The proposed (Indian-funded) programme of improvements to Terai roads will require the provision of a substantial number of bridges (or causeways) across major rivers and water-courses. This applies particularly to the east-west Postal Road, which runs parallel to the Indian Border and crosses at least as many rivers as the East-West Highway: to be effective, the improvement package

should include the bridges or causeways necessary to provide all-season serviceability.

On average, existing roads in the Terai (EWH and Feeder Roads) have over 4 bridges in each 10km of length (1 bridge every 2.4km), with an average length of 40m, excluding major bridges. It can this be deduced that the 'Indian' programme, involving the upgrading of 1,500km of road, will require over 600 bridges. Assuming that half of these may exist (or that their construction may be deferred), the requirement for new bridges could amount to Rs6.6 billion (approaching US$100 million), which is similar in scale to the estimated road improvement cost.

The proposed development and expansion of the SRN will require a number of additional major bridges across some of the more important rivers in the country. The proposed extensions to the SRN will require at least sixteen major bridges, as indicated, across the following eleven rivers:

- *Arun* – Leguwaghat (Hile-Bhojpur)
- *Tamur* – Phidim-Myaglung
- *DudhKoshi* – Hilepani-Diktel
- *SunKoshi* – Gaighat-Diktel; Katari-Okhaldhunga; Khurkot-Mantali
- *Kaligandaki* – Kusma; Beni; Beni-Jomsom (2)
- *Bheri* – Chhinchu-Jajarkot
- *Sharada* – Botechaur-Tulsipur
- *Rapti* – Nepalgunj-Bagauda
- *Karnali* – Belkhet-Rakam
- *Tila* – Surkhet-Jumla
- *Sinja* – Surkhet-Jumla

Elsewhere bridges should be constructed in conjunction with the upgrading of roads in accordance with the proposed guidelines: it should be noted that bridges are not an essential pre-requisite for an all-weather road – causeways, vented causeways or floodable/fordable bridges are an acceptable solution in many locations, where the periods of closure may be limited to a few hours or even days following heavy rain during the monsoon.

Beyond the present commitments, approximately 890km of new road are proposed which will likely require around 200 additional bridges at a cost of Rs4.5 billion (US$60 million).

It is noted also that the DoR constructs bridges – on request from the Ministries or DDCs – on the local road networks which are not specifically the responsibility of the Department. In many ways, this is a perfectly legitimate function for the DoR to perform, as the Department has the necessary skills and expertise to design and construct (or supervise construction) of these bridges. However, the funding and prioritisation of these bridges should be strictly the responsibility of the relevant DDC (or Ministry), unless the structure is on a road alignment that will eventually form part of the SRN.

C. 10-Year Priority Investment Plan

The above sections have detailed the anticipated maintenance and development work proposed on the SRN over the next 10-year plan period to 2016. This has included regular and periodic maintenance; upgrading and surfacing of unsealed roads; expansion and extension of the network (through both new construction

and the re-designation of existing roads and tracks); and network strengthening and improvement.

1. Proposed Budget (2007-2016)

This section summarises and combines the proposed expenditures on each of these items to produce a consolidated budget estimate for road works for the next 10 years. The results are summarised in Table 10.4, showing the indicative levels of expenditure under the main budget headings for each year from 2007 to 2016: a more detailed breakdown is given in Annex 10, Table A10.4. [Please note that these estimates excludes any establishment or overhead costs.]

The total expenditure over the 10 years is estimated at Rs120 billion (US$1.7 billion), with annual budgets increasing from around Rs8.5 billion today to Rs13 billion in 2016. All costs are presented in current (2006) values.

Table 10.4: Summary of Draft DoR Budget (2007-2016) Rs million

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
SRN Length (km)	**7,360**	7,781	8,202	**8,390**	8,647	8,903	9,160	9,417	9,673	**9,930**	
Length maintained by DoR (km)	8,596	9,099	9,605	9,859	10,192	10,528	10,869	11,215	11,566	11,923	
Regular Annual Maintenance	919	973	1,027	1,054	1,089	1,125	1,162	1,199	1,236	1,275	11,059
Periodic Maintenance	2,331	2,416	2,171	2,228	1,364	1,435	2,171	2,246	1,850	1,929	20,141
Improvement & Works: Upgrade	2,068	3,027	3,243	4,324	5,147	5,193	3,017	3,070	3,867	3,258	36,215
New Construction	2,611	2,938	2,938	2,588	2,964	1,833	2,693	2,693	2,693	2,693	26,644
Kathmandu Access	0	0	1,000	1,000	1,000	3,000	3,000	3,000	3,000	3,000	18,000
Sub-Total (All Improvements)	4,679	5,965	7,180	7,911	9,111	10,027	8,710	8,763	9,560	8,952	80,859
Design & Superv'n, etc	474	582	685	749	850	930	831	842	913	871	7,727
Total by Year	8,403	9,936	11,063	11,942	12,415	13,516	12,874	13,050	13,559	13,027	119,785

The overall maintenance expenditure is estimated at Rs31.2 billion, representing 28 percent of the total[23]. The Regular Annual Maintenance (Rs11.1 billion) is calculated on a per km basis for a network length increasing from 7,360km in 2007 to 9,930km in 2016, plus a continuing allowance for non-SRN roads maintained by DoR. The Periodic Maintenance estimate of Rs20 billion is based on the HDM-4 output, referring to a network of 9,700km, plus an allowance for the additional road length and on-going bridge maintenance.

The largest portion of the total budget (Rs36.2 billion or 32 percent of the total) is allocated to the upgrading of earth and gravel roads to all-weather sealed standards. This figure includes, in the early years, a significant proportion of 'committed' expenditure, including projects funded by ADB, World Bank and the Indian Government (in the Terai).

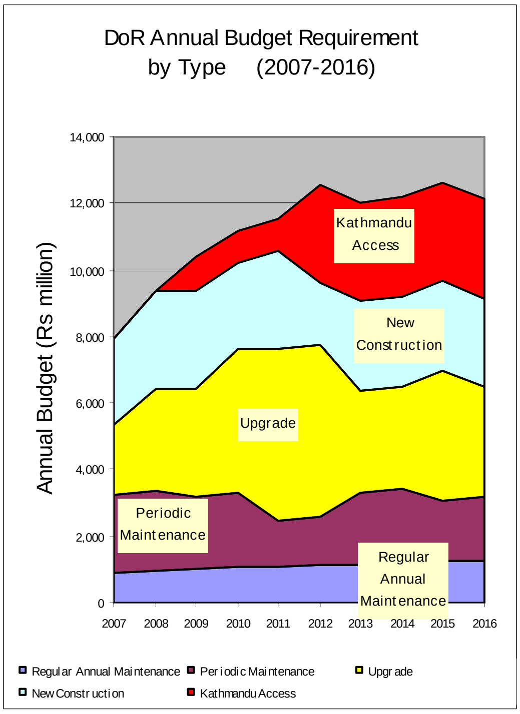
The estimated expenditure on new construction (Rs26.6 billion or 24 percent of the total) includes committed projects of the ADB, World Bank and JICA plus, in

[23] Percentages are of total 'works' costs (Rs112 billion), ie excluding Design, Supervision & TA

the later years, a programme of new links in the mid-hills and into remote areas as proposed in this Study.

The construction of a new access to Kathmandu would potentially dominate the overall expenditure in the latter years, estimated at Rs18 billion (US$240 million), representing 16 percent of the ten year budget.

The overall composition of the budget is illustrated in Figure 10.4 below: the left-hand graph indicates the proportion of the 'works' budget allocated to each sub-heading and the right-hand graph suggests the source of funds. Specifically, the bottom 'slab' of expenditure in right-hand graph shows the funds that should be raised by the Roads Board, which remains relatively constant at around Rs3.2 billion per year, through to 2016. The second slab (in green) illustrates the funds that are already committed (or will shortly be committed) by the various foreign aid agencies: this can be seen to taper off from 2011 onwards, as current commitments expire.



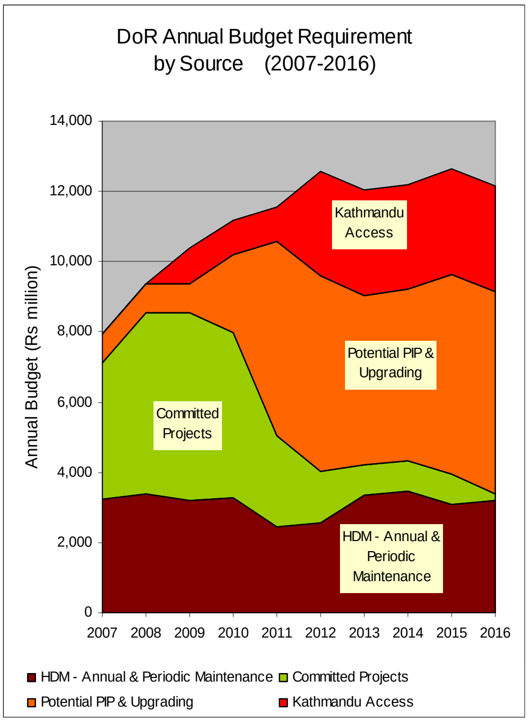
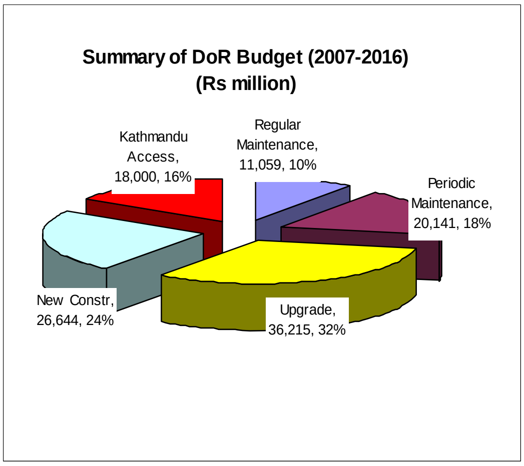


Figure 10.4: DoR Annual Budget Requirements (2007-2016)
(excludes Design, Supervision & TA)

The third slab of expenditure (in orange) represents the projects identified in this PIP and is synonymous with the potential 'funding gap' for additional (new) projects. The final block of expenditure (in red) indicates the potential scale of the funding required for the Kathmandu-Terai Fast Track: it is expected that private sector – or public-private partnership (PPP) – funding would be sought for this project.

The total distribution of funds by type and source are given in Figure 10.5 below, which illustrates the scale of the overall Fast Track project (in red) and the dominance of the expenditure on upgrading (yellow). It can also be seen that the Roads Board should be funding around 30 percent of the overall 'works' budget, although it is recognised that the Road Fund is not yet fully operational. As a result and, in part due to the recommendation to adopt more widespread use of

the initially more expensive AC overlays, it may be necessary for DoR to continue to use aid money to support their maintenance activities.



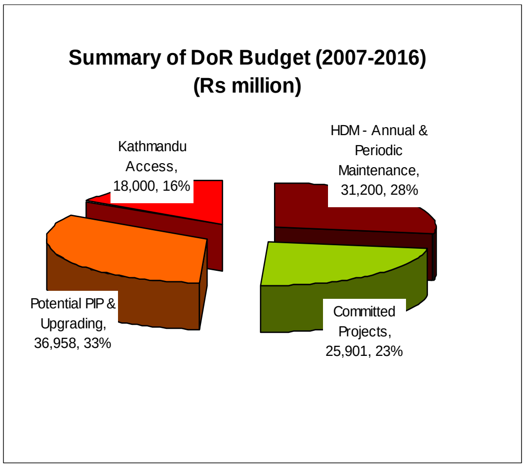


Figure 10.5: Distribution of Overall Budget by Type & Funding Source

2. Composition of the PIP

Within the above categories – and in addition to the maintenance expenditure – there are six main components of the proposed 10-year Plan for the SRN:

- Terai Roads Upgrading – mostly with Indian Government funding
- Access to Rural Areas – but more distant links have low IRRs
- Mid-Hills Links – good returns, unless serving only small population
- Strategic Network Improvements – eg Fast Track, Bhimdhunga
- Kathmandu Valley – high priority – need specialised evaluations
- Bridge Construction, Repair and Rehabilitation

(a) Terai Roads Upgrading

The overall proposals contain a substantial expansion of the SRN in the Terai and specifically the area between the East-West Highway and the Indian Border. The Indian Government funded improvement programme proposes the upgrading of 1,450km of roads to all-weather sealed standards, all of which are assumed to from part of the SRN by 2016. In total 1,500km of road (including 500km of the Postal Road) will be added to the SRN. The HDM (all-roads) analysis of the existing DoR road network recommended the upgrading of 980km of Terai roads at a cost of Rs3.9 billion: the Indian programme proposes 1,450km at a cost of Rs8 billion. This is assumed to be a “committed” element in the future roads plan and has not been considered or prioritized further.

The accessibility analysis has confirmed the benefits of road improvements and upgrading in areas with high population densities. Basically this includes the whole of the central and eastern Terai (from Birgunj eastwards), the areas around Bhairahawa and Lumpini (Rupandehi and Kapilbastu), and to a lesser extent to the west of Nepalgunj. The Postal Road should be completed – including bridges or causeways across major water-courses – over these sections, together with additional and improved north-south linkages.

(b) Access to Rural Areas

The remote area access schemes involve the continuation of the programmes initiated during the 9th and 10th Plans to provide road access to the non-road-

served District Headquarters: much of the expenditure now proposed is for the upgrading of the initial earth or gravel tracks that have been opened over the past 10 to 15 years. It is recognised that there are significant additional benefits to be achieved through the provision of regular and reliable access, which are manifest by more frequent trip-making and increased overall consumption of goods.

Notwithstanding this, the current and forecast traffic volumes on these roads are low in absolute terms and the scale of the vehicle operating cost savings alone would not be enough to justify the construction or upgrading. However there are additional economic and social benefits, brought about by the release of the currently suppressed demand for movement which appears as ‘generated’ traffic following the completion of the improvement works.

The main trunk routes into the hills, which serve very substantial populations (upwards of 600,000 people in many cases), are prime candidates for upgrading as the benefits of improved levels of access are widely distributed. However the improvement of the more distant sections of road – which serve significantly lower numbers of people – cannot be justified so easily. There is thus a limit as to how far (literally) the Government should go in building roads into the remote areas: it is clear that there are diminishing returns from building roads to remote settlements with populations numbered in hundreds not thousands.

(c) Mid Hills Links

The construction of additional roads in the mid-hills – which are relatively densely settled – is however shown to be economically viable and a network of additional links between Districts and specifically District Headquarters are recommended for improvement to sealed standards: most of these proposed links for inclusion in the SRN follow the alignment of existing local-level District Roads.

It is thus possible to create a Mid-Hills East-West Corridor (as highlighted in yellow on Figure 10.3) that serves or passes close to 23 District HQs and connects with the Indian Border and Darjeeling in the east, and Jhulalghat in the west. It is not intended that this route would (in any way) serve as a long-distance east-west highway – that function is taken by the existing East-West Highway in the Terai – but it would serve as a link between adjacent Districts and an alternate route to the main centres in the hills, including Kathmandu and Pokhara.

The Mid-Hills Corridor is estimated to be almost 1,700km in length, of which over 1,000km currently forms part of the existing SRN. Most of the remaining length comprises either existing local roads or new links under construction: the only section not currently planned is the 45km section along the Sun Koshi between Ghurmi and Khurkot in the east.

(d) Strategic Network Improvements

The construction of the Fast Track between Kathmandu and the Terai would undoubtedly be the single largest project ever undertaken in the transport sector in Nepal and potentially the most significant in terms of reducing overall transport costs and influencing the growth and development of the country. The project is remarkable in its scale – involving the construction of 70km of new high standard road with two tunnels of approximately 3.5km each – and its potential impact on the transport network in the country.

For the full benefits of the project to be realised, it is recommended that the design standards and alignment are not compromised. The intent is to create a

high standard route with the shortest practical distance between Kathmandu and the Terai: for the route to be effective in achieving its objectives it must be possible for all traffic to travel at speeds of at least 50kph (preferably 80kph). This will allow Hetauda to be reached within an hour and Birgunj within two hours from Kathmandu.

Due to the scale and importance of the project, it is clearly essential that the best alignment is selected as it will remain a key element in the road network for generations to come. It is therefore important that a full and detailed assessment of the alternatives is undertaken before a final decision is taken and construction committed. The scale and cost of the project also requires that an innovative approach to funding be adopted, including joint public and private partnerships, and the key multi-lateral donors.

(e) Kathmandu Valley

Kathmandu is the dominant urban centre in the country and a major contributor to overall economic activity. The urban area has grown dramatically over the past decade and the transport conditions have deteriorated significantly, as a result of increased population pressure and a very substantial growth in vehicle numbers, including an inexorable increase in the numbers of motorcycles.

The dilemma posed by the unrelenting growth of Kathmandu is in contrast to the oft quoted vision for Valley, which aims to:

- limit future growth by decentralising activities to alternative locations (by promoting secondary towns);
- preserve the last vestiges of agricultural land from urbanisation;
- reduce pollution by the introduction of strict environmental controls; and
- promote the Valley as a centre for education, central level administration and tourism.

Kathmandu is now beginning to experience serious traffic congestion, leading to delays at key locations throughout much of the day. The congestion is caused not only by the increases in vehicle numbers but, more significantly, by poor traffic management and driver discipline. There is a critical need to address these problems and to produce a coordinated package of improvement measures, including some physical measures to address capacity deficiencies.

Within Kathmandu Valley, two specific strategic improvement projects have been identified: the widening and upgrading of the Kathmandu-Bhaktapur-Dhulikhel corridor and a package of improvements to the existing Ring Road.

The corridor east to Bhaktapur and beyond to Banepa and Dhulikhel serves the only available axis for significant development and growth within, or around, the Valley. It can thus be expected that traffic growth in this corridor will be sustained and current travel conditions will deteriorate unless significant improvements are made. It is recommended initially that the first 10km to Bhaktapur be widened and improved to provide a four-lane divided highway, with frontage roads to service adjacent development and local traffic.

Similarly the Ring Road should be widened to provide dual 2-lanes throughout, together with frontage roads and specific facilities for public transport (buses, micro-buses and tempos): particular attention should be paid to the design and management of the junctions, which are the current main problem areas.

(f) Bridge construction, repair and rehabilitation

A separate budget provision for bridge construction and rehabilitation is required, as the regular maintenance procedures do not prioritise or make allowance for expenditure on bridges. The recent inventory and condition survey has identified at least 100 bridges in need of remedial works and a comprehensive programme should be developed in response to these needs.

It is common DoR practice for bridge construction to be pursued independently from road construction or upgrading, except where both are funded by donors. In conjunction with the extensive upgrading works proposed over the next ten years (including the re-designation of substantial lengths of District Road, especially in the Terai), it is expected that there will be a substantial demand for new bridge works. An allowance has been incorporated in the budget estimates, based on the frequency and length of bridges on the existing network.

D. Programme Details – Priority Schemes

A comprehensive list of Priority Road Schemes – including both upgrading and new construction – has been developed based on the analysis, priorities and evaluations presented above. The first step in the process is the identification of all currently committed schemes for which funding is assured, followed by a prioritized list of other projects ranked on the basis of their preliminary economic – and to an extent social – evaluation. The full list is presented in Table 10.5 and the components are described below.

A key element in the overall programme is the construction or upgrading of links to District Headquarters. In total access improvements (either new links or upgrading) are proposed to 24 District HQs:

- the Committed Projects provide improved access to six Districts (3 new connections and 3 upgrades);
- upgrades to sealed standards are proposed for nine Districts;
- new connections to Feeder Road standards are proposed for five Districts; and
- new connections as simple earth tracks are recommended for four Districts.

Table 10.5: Priority Road Schemes for Upgrading and/or New Construction

	Scheme	Length (km)	Traffic (ADT)	Cost Rs (m)	NPV/C	IRR	FS	Comments and/or Committed Funding Source
A. COMMITTED SCHEMES								
	Basantapur-Mude-Chainpur-Khandbari	96		1,920				ADB – RNDP - Construct access to District HQ
	Galchhi-Devighat-Syabrubesi	79		760				ADB – Connectivity - Upgrade access to Border Crossing
	Khurkot-Manthali-Tamakosi	64		660				ADB – Connectivity
	Phidim-Taplejung	87		704				ADB – Connectivity - Upgrade access to District HQ
	Pokhariya-Parawanipur (Birgunj ICD)	10		320				ADB – SRTFP
	Bhumahi-Parasi-Bhairahawa ICD	30		928				ADB – SRTFP
	Baitadi-Satbanjh-Gokuleshwar	74	80	518	0.7	18%	*	WB/IDA – RSDP Ph1
	Khodpe-Jhota-Chainpur	110	120	770	0.2	16%	*	WB/IDA – RSDP Ph2
	Bangesimal-Rakam-Tila River (km135)	135	270	675		large	*	WB/IDA – RSDP Ph3
	Sun Koshi-Okhaldhunga	42	160	270	0.7	22%	*	WB/IDA – RSDP Ph4
	Hile-Leguwaghat-Bhojpur	92		1,320				DFID: RAP Feeder Road
	Nepalthok-Khurkot	32		1,920				Govt of Japan/JICA
	Kathmandu-Bhaktapur	10		1,000				Govt of Japan/JICA
	Syabrubesi-Rasuwagadhi	26		520				Govt of China
	1400km of Terai Roads	1,500		9,000				Govt of India
	Sabha-Bramadev	13		260				Govt of India
	Total	2,400		21,545				
B. UPGRADING SCHEMES - EXISTING DoR ROADS (to Sealed Standards)								
H03	Barabise - Kodari	8	645	48	9.2			Connection to Border: included with Fast Track Study
F13	Bhalubang – Chakchake – Rolpa (Liwang)	108	30-300	650	7.6			Upgrade access to District HQ
H11	Ameliya – Tulsipur	30	130-400	178	7.1			Upgrade section of National Highway
F30	Panchkhal – Melamchi	23	200-400	135	4.8			Upgrade access to Tourist Area
F47	Chhinchu – Devisthal – Jajarkot	107	150-300	642	2.3		*	Complete construction & Upgrade access to District HQ
H18	Maldhunga-Beni	13	200	78	2.1			Upgrade access to District HQ
H11	Tulsipur – Shitalpati – Salyan	54	350-500	322	1.5		*	Upgrade access to District HQ
F14	Chakchake - Pyuthan	25	65	150	1.1			Upgrade access to District HQ
H11	Shitalpati – Musikot	86	120	511	0.9	28%	*	Upgrade access to District HQ
F133	Tulsipur – Purandhara – Botechaur	86	50	516	0.2	14%	*	Upgrade link between District HQs
F48	Lower Dhungeshwar - Dailekh	28	120	218		20%	*	Upgrade access to District HQ
H20	Sanphebagar-Martadi	57	100	302		35%	*	Upgrade access to District HQ
H25	Mangalsen-Belkhet/Rakam	51	50	509		18%	*	Upgrade inter-District & inter-Regional linkage
H25	Safebagar-Mangalsen	38	100	256		15%	*	Upgrade access to District HQ
	Total	714		4,515				NB: Costs as per HDM evaluation
C. NEW CONSTRUCTION (to FR Standards - sealing subject to FS)								
	Karnali Rajmarg (km135 to Jumla)	118		1,180				Completion & upgrading Kalikot-Jumla (118km)
	Martadi-Kolti	51		673		23%	*	Upgrade GTZ track
	Hilepani-Diktel	67		402		22%		Provide access to District HQ (upgrading of RAP track)
	Beni-Jomsom	80		480		15%		Upgrade of track constructed by Army
	Okhaldhunga-Salleri	50		333		14%		Upgrading of Green Road / Army construction
	Total	366		3,068				
D. NEW CONSTRUCTION (as Earth Track mostly through local efforts)								
	Jajarkot-Dunai	144		1,656		9%		Track opening by local efforts - access to Dolpa District HQ
	Simikot-Hilsa	88		1,012		5%		Track opening by local efforts
	Besisahar-Chame	65		780				On-going DoR construction
	Nagma-Gamgadhi	88		1,306		8%	*	Track opening by local efforts (DRILP): FS under SWRP-PIP
	Total	385		4,754				
E. UPGRADING OF LOCAL ROADS TO SRN STANDARDS								
	Baglung-Burtiwang	90		630		35%		Upgrade ADB RIDP Road
	Kaligandaki-Kushma	67		771		18%		Requires Feasibility Study
	Sandhikharka-Tamghas	31		217				Upgrade inter-District link
	Sandhikharka-Pyuthan	49		343				Upgrade inter-District link
	Tamghas-Warmitaksar	19		133				Upgrade inter-District link
	Pharping-Kulekhani-Bhimphedi	24		240				Upgrade inter-District link & alternate access to Kathmandu
	Bhedetar-Ranke	115		805				Upgrade inter-District link
	Okhaldhunga-Khurkot	43		430				Construct inter-District link
	Phidim-Myaglung	75		750				Upgrade inter-District link
	Bhojpur-Diktel	55		550				Construct inter-District link
	Daijee-Jogbuda-Budar	68		476				Upgrade inter-District link
	Total	636		5,345				
F. NEW CONSTRUCTION TO ACCESS KATHMANDU								
	Kathmandu-Terai Fast Track **	65		18,000		16%		Major access improvement between Kathmandu & Terai
	Sitapaila-Bhimdhunga-Dharke **	33		2,600		15%		Alternative acces improvement to Kathmandu from West
G. OTHER STRATEGIC ROAD IMPROVEMENTS								
	Kathmandu Ring Road Upgrade	28		2,800				Provide dual carriageway, frontage roads & junction imp'vts
	Bhaktapur-Banepa-Dhulikhel	20		1,000				Dual carraiageway upgrade
	Narayanghat-Mugling Improvement	36		220		32%	*	Widen to 7.5m formation (Asian Highway Standards)
	Hetauda By-Pass	15		450				
	Koshi Barrage Replacement **	50		1,270				Assumes 50km diversion & 350m cable-stayed bridge

Notes:
* FS undertaken under SWRP-PIP Study
** Requires Deatiled Feasibility Study
All COSTS are indicative
NPV/C & IRRs quoted as available

1. Committed Schemes

There are 16 schemes that are assumed to be committed and for which funding is assured and which are mostly expected to be constructed over the next 3-4 years. These schemes are therefore not included in the subsequent prioritisation process, although they are included in the overall budget estimates.

The 16 committed schemes – Table 10.5, Section A – comprise:

- six schemes included in three on-going ADB projects - Road Network Development Project, Connectivity Project (three Core Schemes), and Sub-Regional Trade Facilitation Project;
- four upgrading schemes selected for 'fast-track' implementation under the forthcoming WB/IDA Road Sector Development Project (RSDP);
- one DFID-funded Feeder Road;
- one new and one improvement scheme funded by JICA;
- one Border Crossing link funded by the Government of China; and
- the upgrading of 1500km of existing roads/tracks in the Terai in three priority packages over 9 years, plus a new connection to the Mahakali Barrage at Bramhadev, funded by the Government of India.

Excluding the Indian programme in the Terai, these schemes comprise around 900km of upgrading and new construction and will represent the bulk of the foreign-funded involvements on the SRN over the next 3-4 years. The Indian programme will significantly improve access within the Terai areas over the next 10 years and will account for a substantial proportion of the proposed expansion of the SRN.

The total cost of the committed works is approximately Rs21.5 billion (US$305 million), with the Terai Roads accounting for Rs9 billion (US$130 milion), over 40 percent of the total.

These committed schemes include the completion of an initial road access to three District HQs – **Khandbari** (Sankhasabhuwa), **Chainpur** (Bajhang) and **Bhojpur** – plus the upgrading of access to three more: **Taplejung**, **Baitadi** and **Okhaldhunga**.

It may be necessary subsequently to consider upgrading the roads to Khandbari and Bhojpur to sealed standards, as well as the link from Baitadi to Jhulaghat (on the Indian Border): the latter should be considered in conjunction with a possible border bridge over the Mahakali River.

2. Upgrading Schemes

The highest priorities among the non-committed schemes are the 14 upgrading schemes – Table 10.5, Section B – totaling over 700km at an estimated cost of Rs4.5 billion (US$65 million). These comprise the upgrading to sealed standards of the most important and strategic sections of the existing (and extended) SRN which are presently unsealed. The priorities may be grouped as follows:

- Barabise-Kodari;
- Bhalubang-Chakchake-**Rolpa** & Chakchake-**Pyuthan**;
- Amelia-Tulsipur-**Salyan** (Sitalpati)-**Musikot**;
- Panchkhal-Melamchi;
- Chhinchu-Devisthal-**Jajarkot** (incl construction of final section);
- Tulsipur-Purandhara-Botechaur;

- Lower Dhungeshwar-**Dailekh**;
- Maldhunga-**Beni**;
- Sanfe-**Martadi**; and
- Sanfe-**Mangalsen**-Belkhet

An additional nine District HQs (highlighted above) will be connected by a sealed road. The selection and ranking of the schemes has been based on the NPV/C as calculated though the HDM-4 analysis or IRR for individual schemes subjected to detailed feasibility study. Feasibility Studies were undertaken for all or parts of eight of the 14 schemes, as shown by an asterisk on Table 10.5.

This programme will have upgraded and sealed the access roads to all of the currently road-served District HQs, with the exception of **Darchula**: upgrading of the final section (from Gokuleshwor) should be examined subsequently.

3. New Construction

The priorities for new construction involve the completion and possible upgrading of 366km of existing (or under-construction) access tracks to a further five District HQs – see Table 10.5, Section C. The cost is estimated at a little over Rs3 billion (US$44 million). Feasibility Studies are required to ascertain the timing of any subsequent upgrading to sealed standards.

- Karnali Highway (from km135-**Kalikot** (Manma)-**Jumla**;
- Hilepani (Sunkoshi)-**Diktel** (Khotang);
- Okhaldhunga-**Salleri** (Solukhumbu);
- Beni-**Jomsom** (Mustang); and
- Martadi-Kolti.

The priority for four of these five schemes has been established during this study (see Chapter 6): the fifth scheme was not evaluated at it entails the completion of the Karnali Highway from km135 (Tila River, Kalikot Border) to Jumla. Initial construction of part of this section is on-going through the Nepal Army and the final section to Jumla was constructed through local contracts under RMDP. Completion of the Karnali Highway is a core element of the overall strategy and it should be accorded a high priority.

A second access is simultaneously being developed by GoN to Diktel (Khotang) from Ghaighat. This project has a lower priority than the alternative from Hilepani, as it serves fewer people and requires an additional bridge over the SunKoshi. It should be retained, as part of the extended SRN, to serve the local population and link the two District HQs.

An additional four schemes (total length 385km) with a lower priority and lower economic returns are also proposed for new construction – see Table 10.5, Section D. These schemes, listed below and connecting to the final four District HQs, should be pursued only as earth tracks at present, built mostly through local efforts and initiatives. The preliminary cost estimate is Rs4.8 billion (US$68 million). These should only be considered for upgrading to full Feeder Roads Standards at a later date.

- Jajarkot – **Dunai** (Dolpa)
- **Simikot** – Hilsa (Humla – connection to China)
- Besisahar – **Chame** (Manang – GoN Construction)
- Nagma – **Gamgadhi** (Mugu)

Budgets for the construction of the three roads within the Karnali Cluster should be channeled through DoLIDAR and associated local funding options (eg DRILP) or local Districts funds. Construction of the Chame road should continue directly through GoN.

4. Upgrading of Local Roads

In addition to the above improvements and extensions to the existing SRN and links to District HQs, the PIP includes recommendations for the improvement or upgrading of eleven local roads (totaling 636km) to Feeder Road Standards, at an indicative cost of Rs5.3 billion (US$76 million). These should be subject to detailed feasibility study to determine priorities and appropriate standards. The links considered mostly form part of the proposed mid-hills east-west corridor and are designed to improve inter-District connectivity and accessibility to densely populated hill regions. The schemes are listed below and described in Table 10.5, Section E.

- Baglung-Burtiwang (upgrade RIDP earth track)
- Kaligandaki-Kushma (construct new link)
- Sandhikharka-Tamghas (upgrade local road)
- Sandhikharka-Pyuthan (upgrade & complete local road)
- Tamghas-Warmitaksar (upgrade local road)
- Pharping-Kulekhani-Bhimphedi (upgrade local road)
- Bhedetar-Ranke (upgrade local road)
- Okhaldhunga-Khurkot (construct new link)
- Phidim-Myaglung (construct new link)
- Bhojpur-Diktel (complete/upgrade RAP track)
- Daijee-Jogbuda-Budar (upgrade local road)

5. New Strategic Links

The Study has identified and confirmed the overall priority for the construction of improved access between Kathmandu Valley and the Terai. There are two broad options to be considered: a “Fast Track” direct link on a new alignment with the potential of providing significant reductions in time and distance; and smaller schemes to remove worst constraints on the existing route and to improve the access to the Valley from the west. The adoption of either option should be subject to detailed and exhaustive Feasibility & Funding Studies that are beyond the scope of the present Study.

The Study however recommends that a full detailed Engineering Feasibility Study be undertaken to establish realistic and updated cost estimates for the “tunnel” options as these will undoubtedly produce the ‘best’ long term solution with the greatest potential benefits to the country. The longer (and geologically vulnerable) routes along the Bagmati Valley are likely to produce lower benefits.

If required, improvements to the western approaches to Kathmandu would be best achieved through construction of a new 30km link from Darke on the Prithvi Highway, via Bhimdhunga, to Sitapaila on the Ring Road. The alternative route via the Kolphu Valley is significantly longer and offers no compensatory benefits.

The Study recommends that the following schemes be pursued to improve overall access to Kathmandu Valley:

- Kathmandu-Terai Fast Track (tunnel to Hetauda)
- Sitapaila-Bhimdhunga-Dharke

6. Other Strategic Road Improvements

Although the Study has not specifically focussed on urban transport issues, it is evident that two major strategic road schemes within the Kathmandu Valley have a high priority on a National level. These are:

- Upgrading of the Kathmandu-Bhaktapur-Banepa-Dhulikhel corridor;
- Improvements and widening of existing Ring Road

It is understood that funding has been committed by the Government of Japan for the widening and improvement of the Kathmandu-Bhaktapur road to four-lanes: it is recommended however that the upgrading be extended in subsequent phases to Dhulikhel to service the likely traffic growth resulting from increased urbanization in the corridor and the completion of the Sindhuli Road.

It is additionally recommended that funding be sought from other donors for a comprehensive upgrading of the Ring Road, with specific attention to traffic management, road safety, public transport requirements, and junction layout: the improvements should be accomplished with minimal land-take.

The present SWRP has investigated the improvement of Narayanghat-Mugling to meet Asian Highway Standards. This can be achieved with minor widening and realignment, in conjunction with the next major maintenance intervention. As part of the improvement of the main route between the Kathmandu and the Indian Border (and as a key location on the EWH), it is recommended that a by-pass to Hetauda be constructed in order to remove heavy through traffic from the town centre.

Consideration should also be given to the construction of an alternative crossing of the Sapta Koshi in Eastern Nepal to replace the existing Koshi Barrage which is Indian owned and operated, is on the Indian border, and has an uncertain structural future. It is the only link to the eastern areas of Nepal. Two alternatives have been examined: one at Chatara close to where the river leaves the hills and the other on a more direct route passing immediately north of the Koshi Tappu Nature Reserve and involving a longer bridge crossing.

7. Priority Ranking

The 14 upgrading schemes (B) have the highest priority after the committed schemes. These should be followed by the new construction (Schemes C) and local road upgrading (Schemes E). Other non-prioritised projects should not be entertained until these programmes are complete or funding is assured. The lower priority remote area access schemes – listed under (D) – should be pursued under local initiatives.

E. Sector Wide Road Programme

The key objective of the overall Study is the preparation of a Sector Wide Investment Plan for the Road Sector to provide all-weather motorable access within four hours walk of remote settlements (ref: ToR, page 1). The Study has addressed this requirement and has completed a comprehensive analysis of accessibility throughout the country which has determined the most cost-effective and efficient means of achieving the desired levels of accessibility – within the bounds of practicality.

Determination of accessibility is dependent on three key factors:

- Firstly the location and distribution of population;
- Secondly the location and extent of the all-weather road network; and
- Thirdly the time taken to walk between home and the nearest road.

The Study has addressed all three aspects and has developed a GIS-based tool that enables the accessibility of any particular road or network of roads to be determined mechanically. Two measures of accessibility have been adopted in the Study: the first – as required in the ToR – measures the percentage of population within the desired access-bands (ie four hours walk in the hills and two hours in the Terai); and the second calculates a total measure of accessibility as the product of the number of people times their (time) distance from the road. The output of the second measure is in terms of thousands of person-hours – with ten people one hour from a road being equivalent to 1 person ten hours from a road.

It is considered that this second measure is a very useful additional indicator of overall accessibility, although the 2-hour and 4-hour criteria are retained as the primary indicator.

The approach adopted has only been possible through the use of GIS techniques which allow the computation of vast numbers of individual calculations. Previous attempts at measuring accessibility have been based primarily on manual methods and use of topographic mapping, with resultant constraints on accuracy and applicability.

The first key task was the preparation of the population density distribution maps for the whole country. These are based on the population data abstracted from the census at VDC or Municipal ward level. The populations within each of the almost 4,000 VDCs have then been re-distributed geographically, within the VDC boundary, based on the location of individual houses or house clusters taken from the 1:25,000 topographic maps (which are in turn based on the 1995 air photography). The distribution was adjusted to take account of the households within the urban clusters based on an assumed house size: the adjustments and assumptions were verified by means of a reality-check on household size.

The second task was the definition (in GIS coordinates and attributes) of the existing and proposed road networks. Data were collected initially for the SRN and the proposed extensions, and subsequently also for the local (District level) networks. These data have been compiled into the series of networks presented in Chapters 7 and 8: considerable effort was applied to the verification of the local road network data, which were obtained from records maintained at DoLIDAR and from the individual District Transport Master Plans (DTMPs). Supplementary data were also obtained from the various donor agencies active in the rural roads sector.

The analysis regarding the impact of the local road network is presented at two levels: initially those roads for which the alignment and condition has been verified and secondly all potential road alignments taken from the comprehensive (but unchecked) inventory of 22,000km of road kept by DoLIDAR. The 'verified' network contains around 4,460km of operational road in 2006, increasing to 5,860km by 2016 on the basis of known commitments from various donor agencies. [The unchecked network, when coupled with the SRN, creates a total network of around 29,000km of potential road alignment.]

The third and final stage was the development of the walk-time model which is based on walking speeds which are dependent on the gradient developed from a

digital terrain model (DTM) based on a 90m grid of spot heights, coupled with the barrier effects of rivers. This walk-time model develops a shortest path algorithm between any two points, thereby allowing the development of time contours, zones of influence, and catchment areas: when coupled with the population density distributions, it is possible to compute populations within any given area and also the time taken to reach the nearest road from any location.

Application of these modelling techniques has allowed the impact of the existing SRN, and the proposed extensions, on overall levels of accessibility to be determined. The results of this analysis are presented in Chapter 7. The existing designated SRN (5,030km) provides access – as measured by the 4 hour and 2 hour criteria – to 65 percent of the total population: 50 percent in the hills and 76 percent in the Terai. The extension by 2016 to 9,930km increases the overall accessibility to 86 percent – 70 percent in the hills and 97 percent in the Terai.

Similarly, the proportion of people within 1 hour of a road increases by 50 percent from 10.5 million people to 15.4 million, and those more than 12 hours from a road reduce from 8 percent today (2.05 million) to around 1 percent (0.24 million). These are clearly very significant impacts, but illustrate also the difficulty (and impracticality) of providing the 4 hour level of access to ALL people.

Analysis conducted at a District level indicates that the most severe problems – measured in terms of person-hours walk-time from a road – are currently experienced in the remote northern Districts in the east and west of the country: this is due primarily to the distances involved to reach the nearest road. However, once the initial access has been provided into these areas, the priorities for additional road construction are no longer in these remote regions, but rather in the more densely populated mid-hills Districts – including a number of Districts relatively close to the Terai or to Kathmandu.

The overall impact of the proposed expansion of the SRN between 2006 and 2016 is a reduction in the average walk-time to reach a road from 2½ hours to 1 hour 20 minutes, with a reduction from over 5 hours to less than 3 hours in the hills and from 20 minutes to 12 minutes in the Terai.

The additional impact of the inclusion of the local road network on the 2 hour and 4 hour accessibility is comparatively minor, as most local roads are built in areas close to (and served by) the SRN and most are relatively short. Local roads do however improve accessibility by reducing the access time to the SRN, but this is primarily in areas that are already served.

The effect of the LRN is however significant in terms of the additional reduction in walk-time to reach a road, as most of the local roads are constructed in areas with a high population density. In 2016, the LRN produces an overall reduction of 30 percent in walk-time (from 78 minutes to 55 minutes), with an even more dramatic reduction in the Terai (from 12 minutes to 3 minutes).

The overall analysis has however identified a limited number of pockets of high density population that are NOT served by either the SRN or the LRN. It is recommended that local road programmes be developed in these areas to define the best and most appropriate form of local road to meet the observed access deficiencies.

The District analysis has identified initially those Districts with *current* poor levels of accessibility, and these are basically in the remote northern areas in the east and west of the country. By 2016, with the extension of the SRN, the picture is

significantly different: the worst Districts are those with higher population densities in the mid-hills and many are in fact close to Kathmandu. This requires a different response and different interventions. Consideration of the currently-known local road network, and proposed extensions, addresses the deficiencies to an extent, but a significant proportion of the "least accessible" Districts remain in the mid-hills region. It is recommended therefore that a programme to improve local road provision in these worst-effected Districts be instigated.

It is clear also from the analysis that there are relatively few people living in the northern mountainous regions of the country that are <u>beyond</u> the area served by the proposed extensions to the SRN. There is thus no prima facie case for more northerly extensions of the network. [It is also noted that much of the population of these northern areas is there to support the tourism industry which, in turn, is based on the beauty and remote, inaccessible nature of the region. Construction of roads into these areas – which are mostly National Parks or Conservation Areas – would indeed be counter-productive and damaging to the fragile ecology of the area.]

F. Part II Detailed Feasibility Studies

Part II of the Study involves the Detailed Feasibility Study of around 1,060km of road for upgrading or new construction. The original ToR and Contract specified a total of 600km, of which approximately 400km would be upgrading and 200km would be new construction. Selection of the roads was carried out in the early phases of the Study and was targeted specifically at improving levels of accessibility in the remote hill areas: roads with on-going projects were excluded, as were those with funding committed from other donors. For practical scheduling reasons, it was necessary to select the roads for study prior to the completion of the ranking and prioritisation for the extension of the SRN.

It became evident early in the selection process that there was limited potential to identify entirely new alignments for road construction: in almost all cases, some form of local road or track existed, constructed either by the local DDC or under some other donor-funded local road initiative. It was also evident that the priority need was for the upgrading of previously constructed earth or gravel tracks to an improved (and more reliable) all-weather standard. Substantial lengths of new road and track had been built – both as part of the SRN and as local roads – but a large proportion were in poor condition and not available for general traffic for much of the year.

The initial screening process eliminated many potential roads in the Central and Eastern Regions as these were mostly included in on-going or proposed projects funded by either ADB or DFID. An initial list of around 640km was finally agreed and approved by DoR on 25th June 2006, although survey work had commenced following the resolution of the conflict and the restoration of democracy in late May. An additional 168km of road for upgrading was requested during September 2006, bringing the total to 815km. The Consultants were further obligated to review and update the designs for four sections of road (236km) which had been included in the previous phase of the RMDP but which had not been completed due to the conflict situation.

The location of the roads studied are illustrated in Figure 10.6: it can be seen that most are in the hills in the Mid and Far Western Regions of Nepal, plus one road in the East and the improvement also of the Narayanghat-Mugling section of the main route between Kathmandu and the Terai.

The Consultants' approach to the roads in the Mid and Far West has been to consider them as a 'network' aimed at improving the overall levels of accessibility and integration, by improving to sealed standards a mix of both north-south and east-west routes. The objective was to improve all-weather accessibility to the disadvantaged and excluded rural hill populations.

Despite the relatively low existing traffic volumes on the roads selected (which is primarily due to the very poor condition and unreliable service offered), the Consultants consider that upgrading to sealed standards will produce net benefits from the increased traffic levels to be expected after improvement. Specifically passenger trip making can be shown to increase significantly with the availability of faster and more frequent bus services that become practical with a sealed all-weather road, and more people will be within easy reach of the services provided.

Similarly, the volume of freight imported into the hills can be expected to increase as individual consumption rises with increased proximity to well stocked and supplied markets. [Improved access tends to have minimal impact on agricultural production in the short term and, in any event, the potential volume of exports is not significant in relation to the volume of goods being imported: typically imports in the hills are around 10 times the volume of exports – and thus any produce exported gets a 'free ride' as back-haul cargo on otherwise empty trucks.]

The results of the analysis of the 15 upgrading roads, the one 'new construction', and four additional 'review and update' roads are presented in Table 10.6. All the upgrading roads are shown as having a positive NPV and IRR in excess of 12 percent. The exception is the one new construction road (Nagma-Gamgadhi) which is not justified at the present time: it is recommended that this road be built as an earth track using a local participatory labour-based approach. All the upgrading roads were evaluated with a 3.5m Otta Seal which, in all cases, produced a superior result than a gravel surface.

The methodology for the 'review and update' roads was firstly to identify the extent of works that was left 'undone' (based on a review of the original contract and the payments made for works completed) and then to re-cost these works based on current rates: this – plus the cost of a new base course and Otta Seal – was then taken as the works required to complete the road to a sealed standard.

The widening of Narayanghat-Mugling to Asian Highway standards – 6.0m, plus 0.75m shoulders – is justified in conjunction with an AC overlay throughout.

The schemes are justified in most cases because of the exceedingly poor condition of the present roads, which suppresses traffic demand: the provision of an improved all-weather road surface has been shown elsewhere to have a significant impact on traffic levels and in the type of vehicle operating.

The total cost of the 20 road schemes (1,060km) is estimated at Rs7.8 billion or a little over US$100 million.

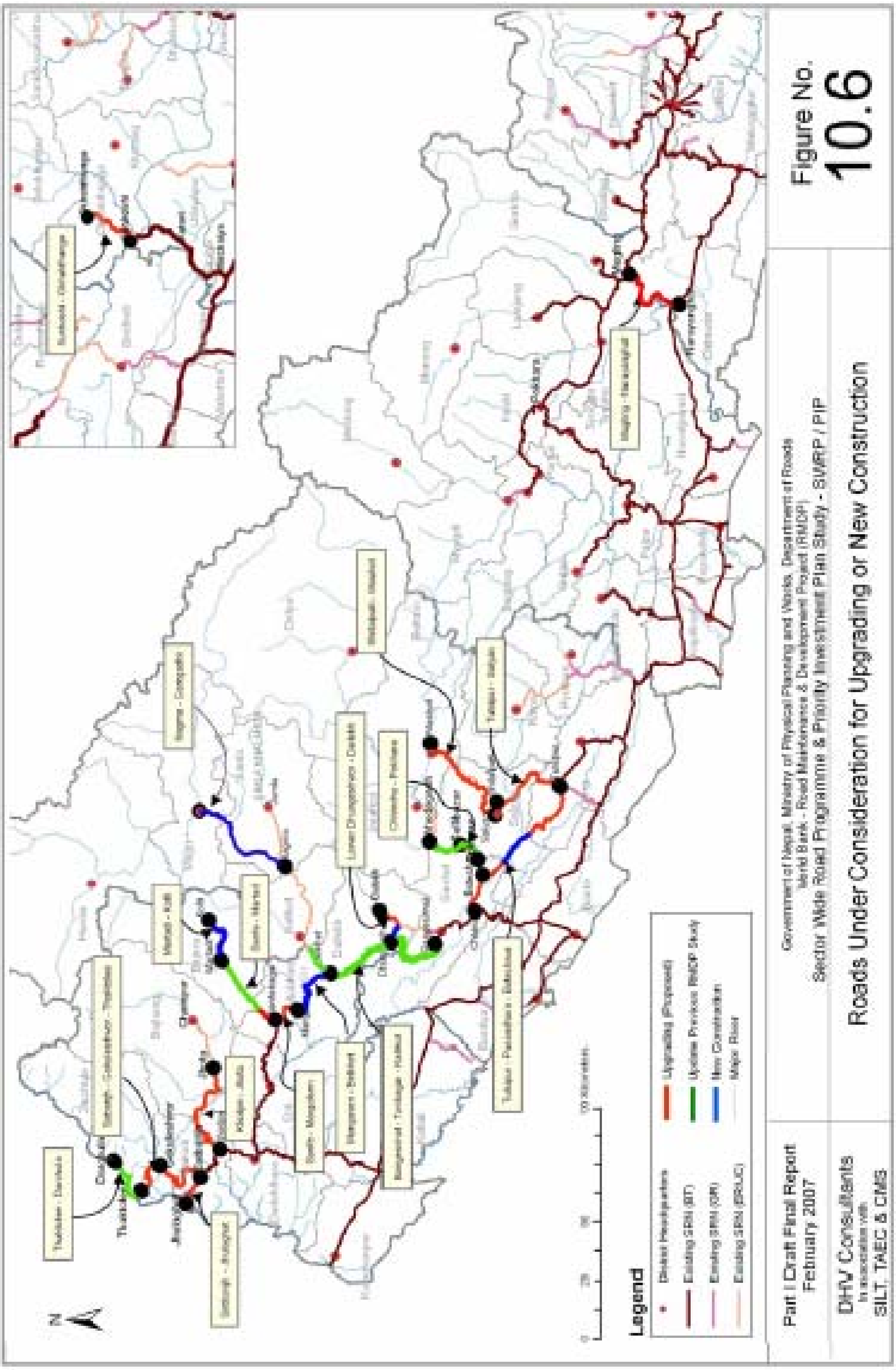

Legend
District Headquarters
Existing SRN (BT)
Existing SRN (GR)
Existing SRN (ER)
Existing SRN (BRUC)
Upgrading (Proposed)
Update Previous RMDP Study
New Construction
Major River
Part I Draft Final Report
February 2007
DHV Consultants
SILT, TAEC & CMS
Government of Nepal, Ministry of Physical Planning and Works, Department of Roads
World Bank - Road Maintenance & Development Project (RMDP)
Sector Wide Road Programme & Priority Investment Plan Study - SWRP / PIP
Roads Under Consideration for Upgrading or New Construction
Figure No.
10.6

Table 10.6: Summary of Findings of Detailed Feasibility Studies

Road Section	Length (km)	Traffic ADT*	Status	Buildings directly affected	Constr Cost (Rs m)	Cost per km (Rs m)	NPV	Rate of Return
Upgrading Roads:								
Satbanj-Jhulalghat	37	76	Open	5	247	6.72	3.8	12.2
Satbanj-Gokuleshwar	54	96	Open	6	413.7	7.66	297.6	21.6
Gokuleshwar-Thaktholi	41	74	Rough	1	296.9	7.73	52.9	14.6
Khodpe - Jhota [- Chainpur]	78	128	Open	5	548.1	7.03	153.9	15.9
Sanfe - Ekadighat [- Martadi]	15	121	Rough	0	135.4	6.64	280.9	34.2
Martadi-Kolti	52	66	Track	84	595.5	11.5	525.5	23.1
Sanfe-Mangalsen	38	93	Rough	0	255.5	5.84	53.7	15.1
Mangalsen-Belkhet	51	51	Track	25	509.4	9.93	212	17.8
Lwr Dungeshwar- Dailekh	28	113	Open	24	217.8	7.84	121.8	20
Chhinchu-Pokhare	25	119	Open	0	109.2	4.24	72.4	20.1
Tulsipur-Purandhara-Botechaur Tulsipur-Cement Works	55 25	111 511	Part open Open	0 0	772.1	8.7 [6.5]	78.7	14.1
Tulsipur-Salyan	63	137	Open	0	339.7	5.53	384.5	24.9
Sitalpati-Musikot	86	180	Rough	10	613.6	7.15	791.6	28
Mugling-Narayanghat	34	3,400	Open		194.4	5.76	744.5	32.2
Sun Koshi-Okhaldhunga	42	164	Not linked	4	231.3	5.77	175.4	22.5
New Construction:								
Nagma-Gamgadhi	88	58	Foot Trail	12	1,305.6	14.63	-343.9	7.6
Roads previously examined under RMDP (Phase 1):								
Thaktoli-Darchula	31	30	Track		182.6	5.37	9.6	12.8
Sanfe-Martadi (from km29)	28	87	Foot Trail		166.6	4.38	460.7	41.9
Surkhet-Kalikot	132	270	Part Open		488.8	3.62	2,378.2	59.6
Pokhare-Chhedegadh	45	149	Part Open		206.2	3.38	842.8	55.3
Total:	**1048**	**km**			**7,829**	**7.47**		

Notes: Cost per km for individual roads excludes major bridges; all costs exclude VAT
* ADT on year of opening