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Technical Assistance for Implementation of Institutional Reforms in the Road Sector of Uttar Pradesh

REPORT ON SUGGESTIONS TO REVISE UP ROAD CLASSIFICATION AND MAINTENANCE CRITERIA FOR CORE NETWORK AND OTHER CATEGORIES (FINAL)

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Glossary

ADB	Asian Development Bank
ADT	Average Daily Traffic
AE	Assistant Engineer
BOOT	Build Own Operate Transfer
BOT	Build Operate Transfer
BSSL	Below Single Standard Lane
CBO	Community Based Organisation
CBR	California Bearing Ratio
CE	Chief Engineer
CEO	Chief Executive Officer
CRF	Central Road Fund
CRRI	Central Road Research Institute
CSR	Civil Service Reforms
CVD	Commercial Vehicles per day
DAO	Divisional Account Officer
DASP	Diversified Agriculture Support Program
DBC	Dense Bitumen Concrete
DPR	Detailed Project Report
DRDA	District Rural Development Agency
EC	Executive Committee
EE	Executive Engineer
E-in-C	Engineer in Chief
GC	Governing Council
GIS	Geographic Information System
GPS	Global Positioning System
GO	Government Order
GOI	Government of India
GoUP	Government of Uttar Pradesh
GSDP	Gross State Domestic Product
HDM	Highway Design Model
HGV	Heavy Goods Vehicle
HQ	Head Quarter
HR	Human Resource
HRD	Human Resource Development
HRM	Human Resource Management
IBRD	International Bank for Reconstruction and Development
IDS	Institutional Development Strategy
IDSP	Institutional Development And Strengthening Plan
IRC	Indian Road Congress
IT	Information Technology
ISAP	Institutional Strengthening Action Plan
ILO	International Labour Organisation
IRI	International Roughness Index
JE	Junior Engineer
MDR	Major District Roads
MLA	Member of Legislative Assembly
MOST	Ministry of Surface Transport
MoSRTH	Ministry of Shipping, Road Transport & Highways
MoRTH	Ministry of Road Transport and Highways
MoEF	Ministry of Environment and Forest
M&E	Monitoring and Evaluation
MIS	Management Information System
MSS	Mixed Seal Surface
NABARD	National Bank of Agricultural and Rural Development
NITHE	National Institute for Training of Highway Engineers
NH	National Highway
NHAI	National Highways Authority of India
NOIDA	New Okhla Industrial Development Authority
ODR	Other District Road
OD	Origin and Destination
O&M	Operation and Maintenance
PAC	Public Accounts Committee
PCC	Project Coordinating Consultant
PCI	Pavement Condition Index
PCU	Passenger Car – equivalent Unit
PICUP	Pradeshya Industrial & Investment Corporation of UP
PMS	Pavement Management System
PPP	Public Private Partnership
PRI	Panchayat Raj Institution
PSP	Private Sector Participation
PWD	Publics Works Department
RAP	Resettlement Action Plan
RES	Rural Engineering Services
RIDF	Rural Infrastructure Development Fund
RMMS	Road Maintenance Management System
RSPEU	Road Safety Planning and Engineering Unit
RSC	Road Safety Cell
R&R	Resettlement and Rehabilitation
SDBC	Semi Dense Bitumen Carpet
SDL	Standard Double Lane
SE	Superintending Engineer
SH	State Highway
SHA	State Highway Authority
SML	Standard Multi Lane
SPV	Special Purpose Vehicle
SRF	State Road Fund
SRP-II	State Road Project-II
SRB	State Road Safety Board

SRSC	State Road Safety Council
SRSF	State Road Safety Fund
SRSC	State Road Safety Council
SRSF	State Road Safety Fund
SSL	Standard Single Lane
MIS	Management Information System
TA	Technical Assistance
ToR	Terms of Reference
UP	Uttar Pradesh
UPRNN	Uttar Pradesh Rajkiya Nirman Nigam
UPSBC	Uttar Pradesh State Bridge Corporation
UPSIDC	Uttar Pradesh State Industrial Development Corporation
UPSRTC	Uttar Pradesh State Road Transport Corporation
UPSRP	Uttar Pradesh State Road Project
UPSHA	Uttar Pradesh State Highway Authority
UNDP	United Nations Development Programme
VOC	Vehicle Operating Cost
VR	Village Roads
WB	World Bank
WBM	Water Bound Macadam

1. INTRODUCTION

1.1 BACKGROUND

A road classification system should provide the means whereby it is possible to place individual roads into different designated groups. This can be achieved by using the type of service each group is intended to provide for and is therefore considered a fundamental tool for road planning, engineering, operations, maintenance and management. The grouping of roads with similar functions can also be used as an input to transport planning, road design, road maintenance, and traffic/road operations. A road classification system therefore provides a fundamental management tool for staff dealing with transport issues with the determination of functional classification of a facility being, perhaps, one of the first requirements in the design process.

Like all structures, roads deteriorate over the passage of time. Deterioration is primarily due to accumulation of damage caused by vehicles and the environment. In general, all roads require some form of maintenance before they come to the end of their service life. Maintaining the road surface is the single most expensive task of a roads department. With most roads in India being considered to be of poor quality, and with road maintenance remaining significantly under-funded, it is estimated that about only one-third of maintenance needs are met. The outcome of this is the further deterioration of roads which in turn results in high transport costs to the user.

Any decision to build a new road or upgrade an existing one implies an obligation to maintain the road in order to provide the level-of-service it was designed for. It is therefore necessary to both recognise and address the problem and, ensure full commitment to the introduction of road maintenance friendly policies and practices, which may require significant changes in long established administrative procedures, practices and budgetary 'norms'.

1.2 DETAILS OF THE UTTAR PRADESH ROAD NETWORK

The total road length in U.P. has increased significantly from a figure of 15,113 kms in 1947 to 270,000 kms in 2000. The total road network within the State comprises National Highways (NH), State Highways (SH), Major District Roads (MDR), Other District Roads (ODR), Village Roads (VR) and other departmental roads. Road classification is based on a variety of criteria such as road-width and surface type. From time to time, some roads are reclassified to the next higher category based on traffic density, tourist use and/or industrial importance. Non - urban roads in the State are classified into five categories based on their functional and administrative criteria in the following manner i.e. NH, SH, MDR, ODR and VR.

The total length of highways managed by PWD is given in Table 1.1.

Table 1.1 : Uttar Pradesh road network managed by PWD (km)

Road Category	31-3-2002	31-3-2003	31-3-2004	31-3-2005	31-3-2006
National Highway *	4,860	4,931	4,931	5,570+	3,825*
State Highway	9,098	9,138	9,138	8,546	8,551
Major District Road	7,291	7,251	7,339	7,274	7,345
Other District Road	25,702	25,702	26,015	28,400	29,179
Village Road	67,978	71,041	71,041	77,363	76,462
Total	114,929	118,063	118,464	127,166	125,362

Source: Performance Budget 2006-2007 and secondary data received from Planning Division, PWD

+In the year 2005, after 'entrustment' the road length for National Highways was 5,583 km. After road sections were handed over to National Highways measurements were taken at site and chainages were recalculated. This resulted in a reduction in length from 5,583 kms to 5,570 kms.

* Length maintained by UP PWD with funds provided by NHAI. The remaining 1,745 kms is maintained exclusively by NHAI.

In addition to the above lengths, the PWD also has 4448 km of brick-on-edge and 1549 km of unpaved earthen village roads under its jurisdiction. This brings the total length of the village roads to 82459 km and the total length of the network to 131359 km plus another 1745 km of national highways maintained by NHAI, for a grand total of 133104 km.

The distribution of paved roads by the number of lanes is as follows:

	Single Lane km	Double Lane km	Total km
National Highway	710	3115	3825
State Highway	4162	4389	8551
Major District Road	6713	632	7345
Other District Road	27863	1316	29179
Village Road	76294	168	76462
Total	**115742**	**9620**	**125362**

The lengths of roads under other jurisdictions by their surface type is as given in the table below :

	Black Top km	Unsurfaced		Total km	Total Length km
		Motorable km	Non-Motorable km		
Mandi Parishad	8763	0	0	0	8763
Cane Cooperative	5719	0	0	0	5719
Rural Engineering Service	1138	45336	67202	112538	113676
Zila Parishad	7575	7945	0	7945	15520
Total	**23195**	**53281**	**67202**	**120483**	**143678**

Finally it is to be noted that the report is presented in to two distinct parts. The first section deals with Road Classification(s) and the subsequent section with Maintenance.

2. ROAD CLASSIFICATION

2.1 INTRODUCTION

Road classification can assist with the co-ordination and planning of land use and transportation. Some roads should carry higher volumes of traffic at higher speeds, while others carry lower volumes at lower speeds. This allows neighbourhoods to flourish between main traffic corridors. The absence of a hierarchy of roads would result in less efficient routes for traffic with associated increases in the time and cost of transporting people and goods. It can assist with the establishment of standards and guidelines for pavement reconstruction and maintenance.

A road classification system not only provides a fundamental management tool for transportation staff, but road users as well as communities derive benefits from its existence and consistent application. According to the Transportation Association of Canada (TAC) *Manual of Geometric Design Standards for Canadian Roads - 198*6, road classification is "the orderly grouping of roads into systems according to the type and degree of service they provide to the public."

Individual roads are not independent entities within the network: most travel involves movement through a network of roads. It therefore becomes necessary to encourage this travel to move within the network in a logical and efficient manner. Functional classification helps this process by defining the part that any particular road should play in serving the flow of trips through the network. Functional classification can be used as a basis for allocating jurisdictional responsibility for roads. The primary, long distance, high traffic routes have strategic importance for the wider economy and by their nature are more expensive to construct and maintain. Central Governments acknowledge this by taking responsibility for the high order roads while lower order roads remain the responsibility of local councils.

2.2 FUNCTIONAL CLASSIFICATION PRACTICES OF OTHER COUNTRIES

For a more detailed review of classification practices in other countries the reader is directed to **Annexure 1** in which a review is given of the methods used by the USA, Australia, Canada and the United Kingdom. The main approach of each country is summarised below.

United States of America		
National and State Highways	Provides the highest level of service at the greatest speed for the longest uninterrupted distance, with some degree of access control.	• Connecting major ports, industrial complexes, important growth nodes, pilgrimage and tourist centres • Providing linkages with adjoining countries • Connecting capitals of the states being carved out now or likely in future

Major and Other District Roads	Provides a less highly developed level of service at a lower speed for shorter distances.	• Providing linkages with minor ports, industrial towns, pilgrimage and tourist centres • Connecting the remaining towns with population 5000 and above (population census of 2001 may be the criterion) • Connecting the capital state with district head quarters
Rural Roads	Consists of all roads not defined; primarily provides access to land with little or no through movement.	• Major District Roads (MDR) for the higher order traffic • Other District Roads (ODR) for the lower order traffic
Australia – New South Wales State Government		
State Roads	Functional classifications used in determining class of roads: Travel patterns; Connectivity; Through commercial traffic; Relative traffic usage; Frontage access; Side road connections; Route capacity; Travel Speed; Pedestrian/cyclist provision; Parking; Cross section type; Bus Routes; Vehicle priority; Network spacing.	• Links major commercial, residential and industrial areas and distribution centres and ports • Links major state towns with other major cities • Links these major state towns with each other where there is significant interaction. • Links major regions throughout the State with each other
Regional Roads		• Links smaller towns with the State Road network • Connects smaller towns with each other • Performs a sub arterial function in major urban centres • Provides access from the State Road network to major recreation and tourist areas of State significance • Provides a town or suburban centre relief route for significant flows of through traffic, especially freight vehicles • Provides access for significant flows of freight vehicles to major inter modal interchanges and urban distribution areas
Local Roads		• To provide for local circulation and access to property • To provide connection to the State and Regional Roads and • To support the living environment in which they are located

Canada - Saskatchewan		
Road Class 1	• The road classification system consists of two basic elements - a list of definitions of roadway types and a list of corresponding characteristics of each roadway type.	• Roads serve as major inter-provincial and international travel routes as well as connecting centres with 3,000 or greater population. These roads total 5,637 kilometres representing 3% of the system.
Road Class 2		• Roads serve communities with 1,000 or greater population and link hospitals to regional or base hospitals. These roads total 4,322 kilometres representing 2% of the system.
Road Class 3		• Roads serve communities of 500 or greater population and link special care homes or health centres to hospitals. These roads total 5, 930 kilometres representing 3% of the system.
Road Class 4		• Roads serve as primary inter-municipal links and provide access to communities of greater than 100 population and large industrial sites. These roads total 19,320 kilometres representing 10% of the system.
Road Class 5		• Roads serve as secondary inter-municipal links and provide access to communities with less than 100 population and medium industrial sites. These roads total 21,388 kilometres representing 11% of the system.
Road Class 6		• Roads serve individual residences, school bus routes and small industrial sites. These roads total 64,565 kilometres representing 34% of the system.
Road Class 7		• Roads provide access to the land. These roads total 69,225 kilometres representing 37% of the system.

United Kingdom		
M Roads	Roads are categorized in terms of their actual or intended uses within the network as a whole. These categories define their design, adoption and management standards, regardless of which local authority is responsible for any particular road. A classified road is a highway, categorised by the Secretary of State and, where appropriate, the local highway authority, according to its importance to the movement of traffic.	• Motorways which link the major cities - generally 3 lanes with hard shoulder. Certain restrictions apply, such as no learner drivers.
A Roads		• Major routes, they can vary in design from motorway-standard to narrow local roads, and have 1, 2, 3 or 4 digit numbers prefixed with 'A'.
B Roads		• Local routes and have 3 or 4 digit numbers prefixed with 'B'.
C Roads		• Rarely signposted or shown on maps and they are reference numbers used by the government bodies that maintain roads.
Unclassified Roads		• Roads which have no designated numbers are “Unclassified Roads”. Local roads or side roads in residential areas are generally unclassified roads. They can form part of the area network (distributor roads) or serve local access needs only.

3. RECOMMENDATIONS TO REVISE UP ROAD CLASSIFICATION SYSTEM

3.1 SIGNIFICANCE OF ROAD CLASSIFICATION

Based on the review of functional classification criteria developed by various overseas agencies and the study of the current conditions in the UP PWD, the following recommendations have been developed for the revision of the functional classification criteria for the various roads within the State.

Functional classification is the process by which streets and highways are grouped into classes according to the character of the service they are intended to provide. Cities, towns, businesses, farms, homes, schools, recreation areas and other places generate or attract trips with these trips involving the movement of vehicles over a network of roads. With this as a base it becomes necessary to determine how travel movement can be channelled within a limited road network in both a logical and efficient manner. Functional classification defines the nature of this channelling process and defines the role that any particular road or street should play in providing the means, whereby, the generated trips can flow over the road network. The heavy traffic movements are directly served by the major channels, and the lesser trips are channelled into other somewhat indirect paths. National highways and state highways provide a direct service for cities and larger towns which generate and attract a large proportion of trips. The major district roads and other district roads serve small towns directly and connect them to the highway network. These major district roads and other district roads also collect traffic from village roads, the bottom level of the classification system, serving individual farms and other rural land uses. The channelling of traffic provides access to property and various levels of travel mobility. Access is a fixed and necessary requirement at both ends of any trip with the level of travel mobility referring to ride comfort, freedom from speed changes, and trip travel time.

3.2 NEED FOR REVISION OF FUNCTIONAL CLASSIFICATION

Functional road classification systems are potentially very useful in all aspects of traffic planning, traffic operations and road asset management. Considerable effort should be invested to keep them current, relevant and consistently applied within and across jurisdictions. With increasing emphasis being placed nationally on cost-effective and equitable management of transport infrastructure, road classification systems should be better designed and implemented than is currently the case.

The functional road classification systems will take on increasing importance in an agency's asset management, traffic and safety engineering and transportation planning, and it should collectively be considering the state of classification over the State. One of the issues is the relationship between urban and rural road classification systems with another being the relativity between cities and regions. If the use of scarce resources (for example, budgets road maintenance and construction funding) is to be rationalised, a consistent set of rules for the road classification system will help ensure that resources are allocated where they are most needed. Funding levels are likely to be tied increasingly to road classifications and common benchmarks,

so that the definitions of each class will be necessary to ensure equity both within regions and between them.

The development of new systems could be enhanced by researching current functional road classification systems. In this way, recent national and international experiences could be evaluated for application locally. The review of literature indicates road classification systems in any jurisdiction is typically, not reviewed very often, so expertise tends to get lost from one "generation" to the next. The review of practices across various agencies shows that the functional classification criteria is based on area type, traffic circulation, access and the land use associated with the roads. Since the collection or gathering of traffic circulation data for the entire State of Uttar Pradesh is not feasible, ***it is recommended that the functional classification for existing conditions be based on land access, area type (urban or rural) and land use adjacent to the roads***. Further research has shown that in some agencies the adopted classification has been based upon road function. Road function can be categorised between mobility versus accessibility as well as factors such as: social, economic, tourism and health related factors. For example, it depends on whether the road is: carrying industrial related traffic; is the an inter-regional or provincial route; whether the road provides access to a hospital, farm site or field; whether the road links one town to another town or, to services provided at a larger urban centre. All roads within the State are generally classified collectively rather than split between provincial and municipal systems.

3.3 THE PRINCIPLES FOR CLASSIFICATION

The following are the general principles that set the basic framework for classification:

- The road network should be safe, reliable and accessible.
- The road network should be sustainable.
- The road network should be consistent in service levels for similar functioning roads and provide for ease of connection to other modes of transport.
- The road network should support economic growth.
- Roads of primarily local interest are best managed at the local level.
- The provincial transport system is best managed through on-going consultation with the stakeholders.
- There should be a shared provincial and local interest in the entire transport system.
- The level of service on a particular class of road should be independent of jurisdiction.
- The grouping of roads by functional classification should not form the basis for jurisdictional assignment. (i.e. No involuntary transfer of roads.)

In order to revise the road classification, updated status and population for all cities, towns and villages is essential, with the population updates being based on latest Census data. Other information includes:

- Location of recreation parks, tourist and historical sites.
- The status and location of hospitals and health centres
- Review the consistency by which the Class NH, SH, MDR, ODR and VR criteria is applied throughout the state of UP.
- Review a map of the entire State and identify any network connectivity of core roads with other classified roads and links to: all urban centres, tourist attractions and, sites of historical importance.

3.4 SUGGESTIONS FOR RECLASSIFICATION

This section compares the functional classification systems as a part of the recommendations to revise such. In general, the roads are classified as national and state highways, major district roads, other district roads and village roads with the classification system having a number of common criteria. In addition, each city has some requirements that are not used by others. With the region's wide and overlapping traffic volume ranges by each class of road, almost all roads in any one class could be expected to fit within an appropriate range.

The review indicates that in most developed countries the classification is based on the traffic volume ranges that have been established for each class under the city or the official plan of the State. In addition, the thresholds which distinguish one class from another are considered to be currently too low, based on regional experience. This results in: many roads being classified too high in the hierarchy and, the generation of unrealistic expectations from geometric road standards. The road classification system is probably not very different in quality from those in the majority of developed countries.

There has been widespread use of a road classification hierarchy for many years in many jurisdictions. However, many variations of the basic hierarchy have been developed and/or proposed from time to time in order to provide more options to take account of local circumstances and preferences within the State or region. The traditional hierarchy may work well in newer urban areas but, in some areas containing remote and rural communities with a legacy roadway system, restricted paved road provision and, direct frontage and access even on major roads, this may not be the case. In addition, substantial development may have occurred and, in some remote areas, structures may encroach on the road.

A road classification system must also have due regard for the absence or presence of truck routes, designated foot paths, parking and loading restrictions, fog (areas of low visibility) route restrictions, etc. The general public should be able to determine the essential characteristics of a road on which they live and/or on which they intend to live, through a transparent and simple process. The classification of roads by function is also important for assessing the applicability of design features during any re-construction or other planning process. For example, vertical traffic calming features (i.e. speed humps) may be appropriate for local and residential roads but are not appropriate for higher class roads. Full or partial control of abutting land uses is also required when development warrants such action and when alternative access can be provided. The challenge is to provide a solution that reflects the existing conditions while not deviating materially from national guidelines and standards.

As the State of Uttar Pradesh continues to face growth related development in urban fringe areas and, redevelopment in existing areas, a sound road classification system is essential. A road classification system is required to guide the design and construction of new roadways as well as provide guidance on appropriate changes for existing road facilities. While there are a number of existing national documents that provide information on current road classifications, including the former Regional Road classifications and official plans, there currently does not exist a single source on existing road classifications as conditions tend to be different from region to region. The options and/or thoughts on a road classification given in this report are intended to form the base and, initiate discussion.

3.5 SUMMARY

The objective of a road classification system is to group streets according to the character of the service they are intended to provide. Thus, the classification of streets assists in establishing, amongst other factors, the geometric design features for each group which is consistent with the long term operational needs of that particular group. Bearing this in mind, it may be considered necessary to adopt a revised functional road classification system for the State for which a number of potential approaches exist.

One option would be to simply adopt national guidelines, which generally describes the characteristics of roads in urban and rural settings using categories ranging from highways to local roads. Given the complexities of the region, and the need to recognise the special characteristics of roads that do not fall neatly into one category, such a standardised approach may not be considered sufficient. Many jurisdictions have used such guidelines as the basis for their own road classification systems but have adjusted or modified these to meet their own needs. ***This approach is, therefore, recommended for Uttar Pradesh, subject to a number of considerations that may need to be further discussed with the PWD, if it is considered that change is required.*** No major change from isolation, except reclassifying the roads based on their function from one category to another.

4. ROAD MAINTENANCE

4.1 BACKGROUND

Without adequate and timely maintenance all roads deteriorate beyond acceptable limits, leading to higher vehicle operating costs, increased number of accidents, and reduced reliability of transport services. Delays in maintenance, in the medium to long run, can also result in extensive rehabilitation and even reconstruction being required which will, inevitably, cost many times more[1] than any maintenance intervention if it had been carried out at the appropriate time. The need to protect the existing network of roads and ensure it is in good condition is paramount, and should therefore take precedence over any new investment.

Maintaining the road surface of the network can therefore be the largest expenditure of a road agency. With roads deteriorating due to both traffic and weather, frequent road inspections are therefore essential to identify existing condition as well as any potential future problems. The majority of Indian roads have flexible pavements and have been the carrier of an alarming increase in traffic in terms of both volume and axle loads. Recent studies of axle loads on National Highways indicated that actual axle loads are very much higher than the legally permitted load. This in itself has resulted in accelerated deterioration of flexible pavements and, in addition, increases in vehicle operating costs.

Road maintenance should ensure the safe passage of vehicles at an appropriate speed and at as low a road user costs as possible. The determination of the required maintenance intervention requires an assessment of road condition; diagnosis of the problem and the selection of the most appropriate treatment. It is recognised that the need for corrective maintenance can be deferred if preventive maintenance is employed at the appropriate time.

In fact if maintenance interventions are applied at the appropriate time the overall condition of the road network should gradually improve. However, where the road structure is inadequate for the volume and axle loading of the current traffic, the road may continue to accumulate 'roughness' despite routine and periodic maintenance. In such cases it will be necessary to restore the road to its original 'smoothness' through rehabilitation, to increase the depth, or strength, of the pavement structure. A network is made up of roads that individually are at all stages of the maintenance cycle. Where maintenance interventions are carried out timely the overall 'roughness' of the network should gradually reduce until such times as an acceptable roughness standard has been attained.

Like all structures, roads also deteriorate over time. Deterioration is primarily due to the accumulation of damage caused by vehicles, although environmental effects, such as thermal cracking and oxidation, often contribute.

[1] One World Bank report suggested that the cost of re-construction was some four times greater than the costs required to maintain the road at the same standard.

In order to keep a country's road network operating indefinitely, therefore, the following activities, as appropriate for individual road conditions, will have to be carried out regularly, periodically and as per site conditions.

- Routine maintenance
- Periodic maintenance
- Emergency maintenance
- Improvement
- Rehabilitation

Pavements are designed for an expected 'service' or 'design' life. Maintenance is considered as a part of the life cycle cost of the road with 'service' at 10, 20 and 30 year milestones. Virtually all roads require some form of maintenance before they come to the end of their service/useful life. Maintenance treatments for asphalt concrete generally includes crack sealing, surface rejuvenation, fog sealing, micro-milling and thin surface applications. Thin surface applications preserve, protect and improve the functional condition of the road whilst reducing the need for routine maintenance, which in turn leads to an extended service life without increasing structural capacity.

Whilst the standard of road maintenance is poor in the state of UP this is typical of all States in India. Roads are deteriorating for want of maintenance and being lost due almost entirely to inadequate maintenance arising from inadequate maintenance budgets.

Roads are among the most important public assets in India with road improvements bringing about immediate and sometimes dramatic benefits to road users through improved access to hospitals, schools, and markets; improved comfort, speed, safety and, reduced vehicle operating costs. For these benefits to be sustained, road improvements must be followed up by a well-planned programme of maintenance. Without regular maintenance, roads can rapidly fall into disrepair, thus negating the realisation of the longer term benefits of road improvements on development, such as increased agricultural production.

Postponing road maintenance results in both high direct and indirect costs. If road defects are repaired promptly, the cost is usually modest. If defects are neglected, an entire road section may fail completely, thus requiring full reconstruction, which can be many times more than the cost of maintenance.

4.2 DEFINITION OF MAINTENANCE

The European Federation of National Maintenance Societies defines maintenance as;

> *"all actions which have as an objective to retain an item in, or restore it to, a state in which it can perform the required function".*

The 'actions' include a combination of all technical and corresponding administrative, managerial, and supervisory actions.

The Indian Roads Congress [IRC] defines road maintenance as;

> *"routine work performed to up keep pavement, shoulder, and other facilities provided for road users, as nearly as possible in their constructed condition under normal conditions of traffic and forces of nature."*

Maintenance includes those works or activities that preserve the riding qualities, safety characteristics, functional serviceability and structural integrity of the facilities that comprise the road.

The goal of maintenance is therefore to preserve the asset, not to upgrade it. Unlike major road works, maintenance must be undertaken regularly. Road maintenance comprises "activities to keep the pavement, shoulders, slopes, drainage facilities and all other structures, and property within the right of way, as near as possible to their 'as constructed' or 'renewed' condition" (PIARC 1994). This includes minor repairs and improvements to eliminate the cause of defects and to avoid excessive repetition of maintenance efforts.

4.3 MAINTENANCE MANAGEMENT

Maintenance practices and planning systems differ from country to country due to variations in local policies, pavement technology, maintenance organisation, climate, geology and other factors. The development of maintenance management procedures, however, requires that condition surveys be undertaken and analysed and, that based on that analysis maintenance interventions are identified and optimised based on any budgetary constraints.

The planning of maintenance in India is generally based on:

- The MOST document on roads contained within the 8th five-year plan
- IRC Code of Practice for the Maintenance of the Bituminous Surface on Highways (IRC : 82 - 1982)
- The MOST Manual for the Maintenance of Roads (1983)
- Tentative Guidelines for Strengthening of Flexible Pavements Using Benkelman Beam Deflection Techniques (IRC : 81 - 1997)

4.4 THE IMPORTANCE OF MAINTENANCE

The key issue for sustaining investments in the road sector is the maintenance of the road assets created. To construct a road and then fail to maintain it leads to a wasted investment. Roads are, or should be, constructed based on need and rigorous economic appraisal. If the road is not maintained then the investment will be lost together with the benefit arising from the construction of that road. Maintenance will ensure that the benefit is maintained and the original investment in the road preserved. To construct a road and then leave it to deteriorate is tantamount to throwing money away. It would have been far better not to have built the road in the first place and to have used the available money to maintain some of the existing roads.

Delayed maintenance has indirect costs as neglected roads steadily become more difficult to use, resulting in increased vehicle operating costs and a reluctance by transport operators to use the roads. This imposes a heavy burden on the economy as passenger and freight services are curtailed, with a consequent loss of economic and social development opportunities.

Countries need a 'core' road network that may well carry some 80 percent of the national traffic plus key roads in urban areas and roads providing sufficient access to rural areas. Some part of the overall road budget must therefore be spent on construction and some part must also be allocated to maintaining the core network. In many countries however, new construction, rehabilitation, or reconstruction of roads have tended to be favoured over that of maintenance. This has consequently led to a steady increase in the backlog of road repairs and a consequential loss in developmental impacts.

The selection of the appropriate maintenance intervention is beneficial in that it will:

- prolong the life of road infrastructure,
- reduce the rate of pavement deterioration,
- reduce vehicle operating costs,
- reduce environmental damage through reduced fuel consumption,
- reduce the rate of accidents, thereby making it safer for road users,
- provide all weather roads for traffic,
- reduce the requirement for large capital outlays for reconstruction / rehabilitation

Given the above advantages/benefits of road maintenance, it is therefore clear that maintenance plays an important role in overall transport economics as well as in the preservation of the environment

4.5 MAINTENANCE SERVICE

Maintenance 'service' defines the minimum conditions for individual assets and also reflects the road user's expectations about day to day serviceability and generally comprises the operational maintenance and repair parameters of road and bridge infrastructure as follows:

a. to a condition that is safe for the road user,

b. that is of an unpredictable and/or non-quantifiable / non-measurable nature, as implied by the response time, frequency and other specified conditions,

c. of such a predictable and/or cyclical nature that the quantity of work can be determined by the frequency specified and,

d. is of a minor nature in terms of its affects on the life cycle of a road or bridge.

4.6 OBJECTIVES

The basic objectives of road maintenance interventions are; protection of the asset, maintenance of network capacity, increased road safety and reduced vehicle operating costs and environmental protection.

The aim of any maintenance strategy is to minimise life cycle costs for all road components consistent with achieving a specified standard of performance. Maintenance operations involve; the assessment of road condition, diagnosis of associated problems and, selection of the appropriate maintenance treatment to rectify the defect / deficiency. The various factors which should form part of a maintenance management system can therefore be identified as:

1. minimum and acceptable maintenance performance standards,
2. other factors that influence maintenance needs, for example; sub-grade soil, drainage, climate, traffic, environmental conditions, etc.,
3. inspections, investigations, field surveys and testing, for the evaluation of road maintenance requirements,
4. rate of pavement deterioration under prevailing conditions and,
5. maintenance costs, availability of materials, manpower and equipment.

5. CATEGORIES OF MAINTENANCE

Maintenance operations can be categorised into 'Routine', 'Periodic' and 'Emergency' activities. Road users normally judge the quality of a road, and the effectiveness of maintenance, on the basis of the 'ride quality' and appearance. The comfort with which users can travel, and the subsequent speed that can be safely achieved, are clearly important criteria for maintenance. A number of maintenance activities, for example; reshaping and grading of unpaved surfaces, patching and pothole repair, repair of traffic signs, road furniture and marking improvement/repair, the control of vegetation, etc., all contribute to the enhancement of comfort, safety and speed of travel.

However, for road asset preservation there are other important activities, such as clearing and repairing drainage structures, erosion control etc., which can also reduce the incidence of special repair requirements. The balancing of these routine maintenance activities along with a regular programme of periodic maintenance, plus prompt response to emergencies, form the basis of an effective maintenance programme.

Some of the main activities under each maintenance category are given below.

5.1 ROUTINE MAINTENANCE

Routine maintenance comprises small-scale work which is conducted regularly and aims "to ensure the daily passability and safety of existing roads in the short-run and to prevent premature deterioration of the roads" (PIARC 1994). Routine maintenance therefore relates to the 'day to day' tasks and activities that are necessary to preserve and keep the road as close to constructed condition as possible.

Frequency of activities varies, however, but is generally once or more a week or month. Typical activities include roadside verge clearing and grass cutting, cleaning of silted ditches and culverts, patching and pothole repair. For gravel roads it may include grading.

Routine Maintenance works are planned and performed on a routine basis to maintain and preserve the condition of the highway system or, to respond to specific conditions and events for restoring the highway system to an adequate level of service.

Routine maintenance therefore means the group of recurrent activities required to; preserve the asset, ensure public safety, maintain the riding quality of the pavement and repair the minor defects on the road and within the right of way, in the required condition. Routine maintenance services, therefore, include all those activities which relate to the ordinary maintenance of a road to a condition that preserves the asset and makes it safe for road users.

Routine maintenance ensures that the roads remain in a safe and usable condition. The quick identification of faults may prevent a minor fault developing into a more serious safety issue or, if left untreated, could result in further increased deterioration thus requiring a more costly repair.

In general, routine maintenance, therefore, covers those activities required to be carried out once or more per year and are typically small scale or simple, but probably widely dispersed, and generally require unskilled labour under the supervision of a skilled person.

To a large degree the need for these activities can be estimated and planned beforehand and can often be carried out on a regular basis. Such activities can include;

- minor carriageway repairs (including pothole repair, local manual patching, spray patching (chits sealing) crack filling, restoration of skid resistance surface and repair of localised failed areas of pavement);
- maintenance of verges, grass cutting;
- reshaping, grading, dragging of unpaved surfaces;
- gully emptying;
- treatment of weeds;
- pruning/lopping of overhanging tree branches, cutting of trees and general tree maintenance;
- repainting and maintenance of road markings;
- repair and cleaning of road signs and kilometre stones;
- maintenance of highway drainage and cleaning/excavating of ditches and drains;
- cleaning of culverts (cross water drains), inlets and outlets;
- replacement and repair of 'cats eyes' and road studs;
- repair/replacement and maintenance of road kerbstones, channels and ditches;
- repair/replacement of crash barriers;
- repair to medians, footpaths, street lights;
- minor repair to culverts, fly overs, sub ways, retaining walls;
- bridge maintenance: attendance to bearings, joints, wearing coat, railings, clearance of weeds and minor repairs to sub and super structure;
- maintenance of arboriculture in right of way;
- repair of erosion damage and erosion control measures;
- emergency work, such as the removal of fallen trees, litter, debris, dead animals or other objects and, the keeping of the road clear of debris;
- reporting of major damage to the road.

5.2 PERIODIC MAINTENANCE

Periodic maintenance covers those activities undertaken on a road section at regular and relatively long intervals, the aim of which is; "to preserve the structural integrity of the road". Such activities are generally undertaken at intervals of several years and are designed to preserve the structural integrity of the road or, to enable the road to carry increased axle

loadings. This category normally excludes those works that change the geometry of a road by way of widening or realignment.

Works can be grouped into the works types of; preventive, resurfacing, overlay and pavement reconstruction. Examples of such are; resealing and overlay works carried out in response to measured deterioration in road conditions. Periodic works are expected to be undertaken at regular, but relatively long, intervals. As such, they can be budgeted for on a regular basis and can be included in the recurrent budget. However, many countries consider these activities as discrete projects and fund them from the capital budget. Such works are identified and included in multi-year plans.

These maintenance interventions tend to be large scale, requiring specialised equipment and skilled personnel. They cost far more than routine maintenance works and require specific identification and implementation planning and often require design. These interventions include;

- Regravelling
- Resealing
- Resurfacing or overlay
- Major structural repairs

5.3 EMERGENCY MAINTENANCE

Emergency maintenance is, as the name implies, for repairs that have not been foreseen but require immediate attention. Such activities are required from time to time whenever sudden / special and unforeseen damage occurs, such as flood damage, major landslides or damage to structures, etc. Emergency activities cannot be estimated based on the annual maintenance needs assessment and no advanced planning of repairs can be made. However, it is necessary to reserve a certain proportion of the overall maintenance budget for emergency repairs. Activities can include but may not be limited to:

- Repair and rehabilitation of failed / collapsed drainage structures
- Repair and restoration following landslides and slips
- Repair and restoration after wash-outs

5.4 CAPITAL INTENSIVE WORKS

All those works or activities which extends the service life of an existing road structure and/or improves the load carrying capacity or, works of special repairs, can be considered as capital intensive works.

5.4.1. Rehabilitation Works

Rehabilitation of a road pavement can be defined as;

"Measures to improve, strengthen or salvage existing deficient pavements to continue service with only routine maintenance. Deficient pavements exhibit distress in excess of what can be handled through routine maintenance."

In other words, although maintenance can slow the rate of pavement deterioration, it cannot stop it. Therefore eventually the effects of deterioration need to be reversed by adding or replacing material to the existing pavement structure and is classified as rehabilitation. Rehabilitation options depend upon local conditions and pavement distress types but typically include structural enhancement that extends the service life of an existing road and/or improves its load carrying capability. Rehabilitation techniques include restoration treatments and structural overlays and involves strengthening and carrying out of treatments to the underlying structure of the road rather than just to the visible appearance of the surface.

Rehabilitation operations to restore the original standard of a road are typically undertaken when maintenance has been neglected for many years, or when the structural and/or riding quality of the pavement drops below the acceptable level.

Roads are being 'lost' (or at least the pavements are being lost) because they deteriorate into muddy, dusty, or potholed dirt and gravel roads. Slivers of asphalt remaining among the potholes may be the only indication that the road was once sealed, i.e., water- and wear-proofed with asphaltic concrete or cement concrete. Pavements do wear out. A bitumen pavement is designed to withstand a predetermined accumulate fatigue and progressively loses its smoothness over time. Rehabilitation will restore this to its initial condition.

Rehabilitation is thus classified as capital expenditure, even though rehabilitation is a part of road maintenance. Accounting conventions treat this as capital expenditure because it is costly and results in a longer life for the asset. Rehabilitation projects, therefore, join the long list of candidate projects all vying for inclusion in the capital budget or investment programme. Nevertheless, rehabilitation should have priority over other investment.

Since rehabilitation is considered as capital expenditure, it may or may not be considered as an activity related to maintenance. If the sections to be rebuilt constitute more than 25 percent of a roads length, then the work is rehabilitation and not maintenance.

Rehabilitation includes all such permanent measures which are necessary for the restoration and repair of collapsed culverts, bridges and retaining walls, washouts, the cutting of a road and, the minimisation of landslides, within the vicinity of a particular road section.

5.4.2. Improvement Works

These are works that have been identified as a part of the development planning. It includes improvement to the original standard of an existing road, the construction of culverts for an earth road or, the paving of an unpaved road. As such, these works are funded from the capital budget. Examples of such construction works are: the construction of bypasses; the paving of

unpaved roads in villages; the widening of roads; provision of footpaths; installing of guard rails; improvement of the road geometry; construction, reconstruction and improvement of bridges. Improvement work also includes 'Pavement Reconstruction' such as replacement of an existing pavement structure by a new pavement structure having higher traffic load carrying capacity. Reconstruction usually involves complete removal and replacement of the existing pavement structure and may include new and/or recycled materials. Reconstruction of pavement is necessitated when rehabilitation is no longer sufficient.

Spot improvements: Rehabilitation or improvement of short deteriorated sections of road which are otherwise in an acceptable condition. This can be effective on roads with low traffic volumes where short sections are restricting vehicle flow.

Reconstruction: This is a major improvement of the original standard or the construction of an existing road. Almost equivalent to new construction this is often a result of no maintenance being undertaken over a period of several years. New construction is a completely new road.

5.5 PRIORITIES

Routine maintenance is normally given priority over periodic maintenance given that it keeps overall road management costs low and preserves the benefits attributable to roads. Routine maintenance, or preventative activities, should start immediately after the completion of construction or renewal of a section of road and not when the first defects appear. Typically, road users and policy makers base their judgment of the quality of a road, and the effectiveness of maintenance, on the quality of the road surface i.e. whether there are potholes and how smooth the surface is. While these aspects are important, routine maintenance activities, which keep the drainage system open for example, are equally critical and deserve even higher priority for the prevention of structural damage to roads.

Seasonal priorities are usually established for routine maintenance activities in order to cater for the changing requirements and to also ensure that resources are utilised economically. In this respect it is also essential to regularly assess the condition of roads and to plan activities to effectively respond to particular requirements. In India, apart from the widely varying terrain and traffic conditions, routine and emergency maintenance activities should take account of the typical seasonal pattern of heavy rainfall in the monsoons and the prolonged dry spell thereafter.

6. CURRENT UP ROAD MAINTENANCE POLICY

The current up road maintenance policy is based on a regular time cycle for different categories as follows:

State Highways	–	every 4 years
M.D.R	–	every 4 years
O.D.R.	–	every 5 years
Village Roads	–	every 6 years

The criteria adopted for maintenance and renewal therefore requires;

- City roads be renewed after five years;
- The same specification should be followed for surface dressing;
- Badly damaged sections to be 'taken up' under budget heading 'special repairs';

For 'special repairs' the following criteria are to be adopted:

- Priority to be given to those roads with heavy traffic density and axle loading;
- Those sections exhibiting 'boggy' conditions;
- Monsoon damage;
- Repair and reconstruction of old culverts and small bridges.
- Maintenance and repair of major bridges.
- Improvement of city roads

Priority for continued works under S.R.F. schemes.

6.1 OWNERSHIP AND MAINTENANCE ISSUES

6.1.1. UP State Roads

The Public Works Department (PWD) is responsible for the construction and maintenance of National Highways, State Highways, Major District Roads, Other District Roads and part of the Village roads network within the State. The road network that PWD is therefore responsible for is shown in Section 1.2, Table 1.1 which indicates the number of lanes by classification of the road network.

Table 6.1 shows the UP road network by number of lanes as at 2006.

Table 6.1 : Uttar Pradesh road network by number of lanes as at 2006

S.No.	Classification of Road	Double Lane (km)	Single Lane (km)	1.5m lane (km)	Total (km)
1	National highways	3115	315	394	3824
2	State highways	4375	2736	1440	8551
3	Major District roads	632	5195	1517	7344
4	Other District roads	1313	25851	2015	29179
5	Village roads	168	74072	2222	76462
	Total				**125360**

** Also consists of 4420 km of brick pavement and 1549 km of earthwork*

It is also important to note that in addition to PWD, there are several other departments which are also engaged in the construction of rural roads within the State under various schemes launched either by the State Government or the Central Government of India. These include Rural Engineering Services Department, District Rural Development Agencies (DRDA), Mandi Parishad, District Boards, Agriculture Department, etc.

6.1.2. Types of Maintenance Needs

There are four types of works carried out by PWD which are classified as maintenance:

1. routine,
2. periodic,
3. emergency repairs, and
4. special repairs.

Routine maintenance is carried out by Departmental labour using labour intensive methods, with periodic maintenance generally carried out by contractors. Emergency repairs are also carried out by Departmental labour, with special repairs undertaken by a combination of either Departmental labour and/or contractors.

6.2 MAINTENANCE FUNDING

The main issue concerning maintenance is funding. Funds for routine maintenance activities are generally allocated on a lump sum basis. The request for funds submitted by the PWD to the State Government is simply a repeat of the previous year's request plus a percentage increase to cover inflation and any hoped for increase in funding.

The request for funding includes not only the four items listed in Section 6.1 above, but also establishment costs. This latter item covers salaries, office running costs as well as office maintenance, and running costs and maintenance of vehicles.

The PWD generally receives around 30% of its budget request. It has, therefore, been estimated that some 35% of road lengths eligible for maintenance are not being maintained in accordance with the time based policy. Persistent shortage of funds has led the PWD to reduce maintenance activities. Shortage of funds coupled with increasing traffic volumes and axle loads have all resulted in further degradation of the road conditions. The current practice in PWD appears to be to carry out the minimum routine work and spend large sums of money on patching and repair as a preliminary task prior to renewal, which includes a new surface layer and almost all other minor works that have accumulated over the previous years.

7. PROPOSED INTERVENTION CRITERIA FOR MAINTENANCE PLANNING

The current PWD maintenance intervention policy is time based and not related to the condition of the road or other economic implications. Effective and efficient maintenance intervention policies are needs based (condition responsive) and rely upon up to date and accurate condition data analysed using specific computer pavement management programs. This condition data must include roads and bridges and be obtained on a regular basis as detailed in Report No. 34. In addition, it will be necessary to carry out classified traffic counts.

Computerised pavement management systems, such as those based on the Highway Design and Maintenance Standards Model qualitative and quantitative model [developed by the World Bank], have been in use in many countries for a number of years. These systems are complex and require great care during the input of data in order to avoid errors. Pavement management systems based on HDM-4 are very much in an early stage in India.

For Indian conditions, it is considered advisable to adopt condition responsive maintenance intervention criteria. To formulate condition responsive maintenance criteria some basic minimum desired level of service requires to be set based on the widely adopted performance indicators such as roughness, cracking, skid resistance, potholes, etc.

7.1 PLANNING OF MAINTENANCE OPERATIONS:

The basic requirement for planning maintenance operations is the evaluation of the existing pavement condition in terms of its physical condition, structural capacity, roughness, and skid resistance.

Based on the condition evaluation, the causes for the various defects observed should be examined in detail and a decision taken as to whether to initiate a particular maintenance activity, defer its, or to go in for more detailed investigations to determine the maintenance or other needs more precisely. Where potholes occur they should be dealt with as soon as possible, since they not only affect the riding quality of the road but also increase in size over time, especially during the rainy season. For other defects like cracking, ravelling etc the optimal strategy should be determined having regard to the various factors involved including available finance. A decision should be taken whether to go for temporary measures like seal / renewal coat or to strengthen / reconstruct the pavement. If the latter case appears necessary further investigations about structural deficiencies must be undertaken.

Planning of the various maintenance operations should be correlated and looked upon as a total system rather than each activity considered in isolation. This will be one of the primary tasks of the Policy and Planning Unit to be established in the PWD. This work will require a review of the possible maintenance interventions that can be applied to any given section of road. The final maintenance plan will depend upon the overall needs of the road network and likely funding for maintenance activities. Such plan is best prepared using a computerised road maintenance management system.

7.2 MAINTENANCE REQUIREMENTS

Maintenance requirements depend upon:

1. Structural condition of the original pavement which can be measured in terms of rebound deflection using Benkelman beam, falling weight deflectometer, etc
2. Surface roughness measured using bump integrator, etc
3. Surface characteristics of the original pavement, such as distress, cracking, potholes, rutting, ravelling etc.
4. Drainage and other local conditions
5. Traffic intensity, its distribution over the carriageway plus load in terms of cumulative standard axles subjected on the pavement during the life to date, climate and other environmental factors
6. Road maintenance policy and practices which, for example, set out the minimum standard of roughness for a given road classification

In practice there are basically two types of maintenance input, namely:

- Time bound (scheduled) maintenance activities and,
- Pavement condition responsive maintenance

7.3 INTERVENTION CRITERIA

7.3.1. Concept of Performance Indicators in Maintenance Decision

The measures used for the determination of maintenance levels, which have been adopted in most countries, are based on the measurement of some of the service level parameters which are then used to determine a "Pavement Serviceability Index". These are:

- Roughness
- Rutting
- Potholes
- Skid Resistance
- Cracking
- Defective surface area of bridge deck

It has been proposed by the committee on norms for the maintenance of roads within India, to divide up the maintenance programme and link it to three levels of serviceability identified as levels L1, L2 and L3. The level L1 is the optimum level that provides the highest level of comfort, convenience, and safety. Level L2 is the level at which the road deteriorates after 2-3 years of service and level L3 represents the minimum level necessary to protect the investment and

provide reasonable levels of safety. The suggested levels of service based on the measurement of roughness, cracking, rutting etc. are indicated below for National and State Highways

Suggested Serviceability Levels for National and State Highways[2] are given in Table 7.1.

Table 7.1 : Suggested Serviceability Levels for National and State Highways

Serviceability Indicators	Level L1 (Good)	Level L2 (Average)	Level L3 (Acceptable)
Roughness (max. permissible) (mm/km)	2000	3000	4000
Potholes / km (max. number)	Nil	2 - 3	4 - 8
Cracking and patch repairs (%) (max. permissible)	5	10	10 - 15
Rutting (20 mm) max. permissible (%)	1.0	1.5	2.5
Skid Resistance (Skid number minimum desirable)	50 SN	40 SN	35 SN

The suggested intervention criteria is dependent on road classification. It is clear that non core roads [rural or village roads] cannot be expected to be maintained to the same level of service as that for National/State highways simply because operational and functional requirements do not justify such a high level of maintenance.

At present most of the roads in the State of UP fall under level L3 of serviceability, mainly due to the fact that the funding being provided for maintenance is insufficient. As the serviceability concept is new to the State and, with the continuing lack of sufficient funds, it is, therefore, considered appropriate that this new system be restricted to National Highways and high density State Highways only. A database with respect to serviceability indicators will need to be developed for the maintenance of the various corridors under these two categories of roads.

The suggested serviceability indicators and corresponding levels of service required to be maintained for MDR's, ODR's and VR's are given in Tables 7.2 and 7.3[3].

[2] Ministry of Road Transport and Highways: Report of the Committee of Norms for Maintenance of Roads India, 2001

[3] Sample Bidding Document: Procurement of Works and Services under Output and Performance based Road Contracts: World Bank, October 2006

Table 7.2 : Suggested Serviceability Levels for Secondary and Tertiary Roads

Serviceability Indicators	Acceptable Levels		
	L3 ODR, MDR, VR	**L4 ODR, VR**	**L5 VR**
Roughness (max permissible)	3000	4000	5000
Potholes / km (max numbers)	2 - 3	4 - 8	9 - 12
Cracking and patch repairs (max. permissible)	10%	10 - 15%	Up to 25%
Rutting (20 mm max permissible)	5 - 10 mm	10 - 20 mm	Up to 20 mm
Skid Resistance (Skid number minimum desirable)	40 SN	35 SN	30 SN

Source : Ministry of Road Transport and Highways: Guidelines for Maintenance Management of Primary, Secondary, and Urban Roads, 2004

It is assumed that by maintaining ODR, MDR and VR infrastructure as per the proposed standards this will achieve significant savings in fuel and vehicle operating costs.

Table 7.3 : Minimum Service Levels for Paved Roads and Traffic Volumes

	Excellent	Very Good	Good	Fair
Typical Traffic Volumes (Vehicles/day)	5000 plus	1000 – 5000	250 - 1000	Less than 250
Potholes (Max Dia of any single pothole)	No potholes allowed	15^0 mm	30^0 mm	40^0 mm
Potholes (Max number in any 1000m with diameter greater than 10 cm	None allowed	4	8	12
Patching (Response time)	7 days	14 days	28 days	28 days
Cracking (Response time)	28 days	28 days	28 days	28 days
Cleanliness of the pavement surface and shoulders for safety related matters (Response time)	3 hr	6 hrs	8 hrs	10 hrs
Cleanliness of pavement surface and shoulders response time for all other matters (Response time)	3 days	5 days	7 days	14 days
Rutting	20 mm	30 mm	40 mm	40 mm
Rutting (Response time)	28 days	28 days	56 days	56 days
Raveling (Response time)	28 days	28 days	56 days	56 days
Loose Pavement Edges (Response time)	28 days	28 days	56 days	56 days
Height of Shoulders vs. Height of pavement	50 mm	50 mm	50 mm	75 mm
Height of Shoulders vs. Height of pavement (Response time)	14 days	28 days	56 days	56 days
Paved Shoulders (Response time)	28 days	28 days	56 days	56 days

Source: Sample Bidding Documents (Specialisations for Performance - Based Road Contracts), World Bank, Oct 2006

7.3.2. Levels of Maintenance Intervention

The criteria adopted for the selection of various maintenance work by the National Highways Authority of India [NHAI], for BOT works, is given in Table 7.4[4] This Table is made up figures taken from the two sources specified in the foot notes.

[4] Ministry of Shipping and Transport (Roads Wing): Manual for Maintenance of Roads, December 1983 and Approved Tender Documents Amarawati By-pass, NHAI, 2007

Table 7.4 : Criteria adopted for the selection of various maintenance work by the National Highways Authority of India [NHAI], for BOT works

Sl No.	Defects	Criteria / Extent (% of Sub-section Length)	Treatment / Action	Type of Maintenance
1	**Shoulder and Slopes**			
1.1	Vegetation growth on shoulders and side slopes	Any kind	Vegetation growth be removed	Routine
1.2	Trees	a. All kind	Trim branches of trees less than 4.5 m over road, remove dead/diseased	Routine
		b. Fallen trees on carriageway	Remove immediately	Routine (Urgent)
1.3	Deformation or scour	a. Up to 50	Fill and Compact	Routine
		b. More than 50	Reconstruction	Emergency
1.4	Disturbed stone pitching	a. Up to 30		
		b. More than 30		
2	**Side drains**			
2.1	Earthen (unlined) drains silted / too shallow	Any extent	Clean and repair	Routine
2.2	Standing water on shoulders/drains	Any	Realign to correct gradient, make shallow lateral drains	Routine
2.3	Silting in lined side drains	Any extent	Clean out	Routine
2.4	Damages or scouring of lined drains	Any extent	Repair and reconstruct to adequate size and shape	Routine

Sl No.	Defects	Criteria / Extent (% of Sub-section Length)	Treatment / Action	Type of Maintenance
3	**CD Works**			
3.1	Silted or blocked openings	Any extent	De-silting/cleaning	Routine
3.2	Erosion/Scour in upstream/down stream	Any extent	Repair/fill the boulders	Periodic
3.3	Pot holes erosion in paved surface floor	Any extent	Repair with concreting	Periodic
3.4	Damaged crash barriers	Any	Reconstruct	Emergency
3.5	Vegetation growth at inlet / outlet and near parapets	Any	Remove and Clear	Routine
3.6	Damaged masonry in parapets/substructure/ superstructure	Any extent	Repair to match with existing and report to the Engineer	Emergency
3.7	Painting exposed surfaces of bridge railings, kerb stones, parapets	Any	Repaint/White wash	Periodic
3.8	Cracks in structure	Any	Repair and report to the Engineer	Emergency
3.9	Leached, honey combed, soaked concrete surface and exposed reinforcement.	a. Up to 20	Repair with epoxy mortar or injected concreting	Emergency
		b. More than 20	Reconstruct	Emergency
3.10	Checking of expansion joints	Any	Check and repair	Periodic
3.11	Maintenance of bearings	Any (in case replacement of bearings is required, then specific report to be given to the Engineer)	Check and Carry ordinary maintenance	Periodic

Sl No.	Defects	Criteria / Extent (% of Sub-section Length)	Treatment / Action	Type of Maintenance
4.	**Road Furniture**			
4.1	Dirty road signs/delineators	Any	Wash and clean	Routine
4.2	Damaged/corroded road signs and delineators	Any	Repair, repaint or replace	Routine
4.3	Missing road signs	Any	Replace	Routine
4.4	Damaged/missing median kerbs, boundary pillars, 200m stone, ordinary km stone and 5th km stones	Any	Replace	Periodic
4.5	Painting and printing letters on road signs, km stones, 40m stone, 5th km stones	Any	Repaint and print to match with existing	Periodic
4.6	Safety barriers, fencing	Any	Repair and repaint	Periodic
4.7	Pavement markings	a. Up to 30		Routine
		b. More than 30		Periodic
5	**Road side safety / Miscellaneous**			
5.1	Dead animals	Any	Remove and burry	Routine (Urgent)
5.2	Broken down / accidental vehicle	Any	Inform traffic police and remove	Urgent
5.3	Road blockade	Any	Inform traffic police, removed blockage if reqd. construction temporary diversion.	Routine (Urgent)

Sl No.	Defects	Criteria / Extent (% of Sub-section Length)	Treatment / Action	Type of Maintenance
6	**Carriageway and Crust**			
6.1	Stripping	a. <25	Local sealing	Routine
		b. >25	IInd coat surface dressing	Periodic
6.2	Rutting	a. Depth of ruts <50 mm		
		i. Crack <10	Seal the crack with slurry	Routine
		ii. Crack >10	Surface dressing and Fill ruts with bituminous mix	Periodic
		b. Depth of ruts >50mm		
		i. Crack <10	Seal the cracks with slurry and fill ruts with bituminous mix	Routine
		ii. Crack >10	Surface coat surface dressing over cracked area to be followed by overlay	Periodic/Special Attention
6.3	Pot Holes	a. <20	Patch repair to pot holes	Routine
		b. >20	Patch repair to pot holes and check dressing of crust for strengthening if required	Routine/Special Attention
6.4	Bleeding	a. <25	Spread and roll over 6 mm size heated aggregates	Routine
		b. >25	Apply surface dressing	Periodic
6.5	Cracks	a. <25	Local sealing of cracks	Routine
		b. >25	Local sealing followed by renewal	Periodic
6.6	Hungry Surface	Any	Apply, slurry seal or fog seal	Periodic
6.7	Corrugations		Cutting of high spots and filling of low spots with existing surfacing material and seal the surface	Periodic
6.8	Shoving		Remove the material upto firm base and relay stable mix	Periodic
6.9	Shallow depressions		Repair the depression with pre-mixed materials	Periodic

Sl No.	Defects	Criteria / Extent (% of sub-section length)	Treatment / Action	Type of Maintenance
6.10	Settlements and Upheaval	a. <20	Remove the weak/defective fillupto base and redo	Periodic
		b. >20	i. Remove the wark/defective fill upto base and redo ii. Strengthen the crust by providing additional layers	Periodic
6.11	Edge breaking and edge steps	a. <25	Cut affected area and patch repair to road edge; also repair to unpaved shoulders	Routine
		b. >25	Reconstruct shoulders and repair to edge of carriageway	Routine
7	**Breaches and Blockades of Roadway**			
7.1	Major breaches in the roadway	Any type of breach which endangers safety of traffic and causes obstruction to flow of traffic		Emergency
7.2	Minor cuts, ruts or blockades	Cuts and blockades which do not completely obstruct the traffic but endanger safety of traffic	Remove the blockage and repair the cut	Emergency

7.3.3 Intervention Level for Overlay

The periodic maintenance of a pavement is generally designed to preserve the structural integrity of the road, or, to enable the road to carry increased axle loads. The extent of overlay to be provided depends on traffic volume and growth, axle loads, and deflection measurements. The overlay thickness to meet any structural inadequacy can be determined using Benkelman Beam deflection values and the cumulative number of standard axles to be carried over the design life as per details given in IRC: 81-1997.

At the Focus Group meeting on July 20, 2007, it was unanimously agreed that whenever the road is re-classified or upgraded, its pavement structure should also be strengthened to enable it to carry the anticipated traffic loading over its design life.

This will require carrying out a pavement condition survey, a detailed investigation of the existing pavement structure and its characteristics deflection as determined from a Benkelman beam survey, estimating the msa over the design life (say 20 years) and the target characteristic deflection after overlay. The amount of strengthening or the overlay thickness may be determined from Fig. 9 of IRC : 81 - 1997.

The target deflection after overlay may be estimated from the following table :

Design traffic loading	Target characteristics deflection
0.1 msa	3.00 mm
0.5 msa	2.00 mm
1.0 msa	1.70 mm
2.0 msa	1.40 mm
5.0 msa	1.15 mm
10.0 msa	1.00 mm
20.0 msa	0.80 mm
100.0 msa	0.55 mm

The same procedure should be used whenever an overlay is placed, to ensure that the renewed pavement would have adequate structural capacity.

It cannot be overemphasised that the maintenance strategies are based on the assumption that the pavement is properly designed and has adequate strength to carry the anticipated traffic. It is not possible to maintain a poorly designed and inadequate pavement. Any money spent on attempting to maintain a poor road is a sheer waste of money, and is better spent on first improving and strengthening the pavement.

8. RENEWAL OF PAVEMENTS

Renewals consists of the provisions of a surface layer on the pavements at an interval of time so as to preserve the required characteristics of the pavement and offset the wear and tear caused by traffic, weathering etc. In effect, renewal represents preventive maintenance, which is needed to prevent deterioration of the pavement characteristics and to ensure the initial qualities are retained throughout the design life of the pavement.

The roughness index (IRI) of a road pavement is directly related to the comfort level of the road users and the vehicular operating costs. It the roughness index exceeds the desired intervention level it causes discomfort to the road users and increases the VOC. To reduce both the discomfort level and VOC it is necessary to maintain the roughness index level at, or below, the desired intervention level.

Reduction in roughness is achieved by providing a renewal coat on the existing flexible pavements so long as these pavements are structurally sound. On pavements which are not structurally sound, any renewal treatment will not provide a durable solution for containing the roughness index within the desired level.

8.1 PLANNING AND PROGRAMMING OF RENEWAL

The general practice in India is to finalise the renewal programme on an annual basis. Within the PWD this will be one of the prime tasks of the Policy and Planning Unit with the support from the GIS/RMMS Unit. In India the renewal treatment is generally termed “periodical renewal”. Periodic renewal implies that the renewal treatment is not carried out on an annual basis, unlike routine maintenance which should be carried out annually. The most effective way to plan a renewal programme is to base that programme on up-to-date condition and other surveys.

8.2 TYPES OF RENEWAL

The types of bituminous surfaces prevalent in India are:

a. Surface dressing (one or two coats),

b. Thin premix carpet,

c. Mix seal surfacing,

d. Hot mix semi dense carpets or

e. Bituminous concrete surfacing.

These surfaces have different life spans depending upon traffic and environmental conditions. The specifications adopted for the renewal layer on a particular road would depend upon the type of original surface and its condition at the time of renewal. The specification and the thickness of the renewal course should be such that as far as possible the road surface is restored close to the original condition.

The specifications generally adopted for renewal in India are:

1. Single/double coat of surface dressing
2. 20 mm thick premix chipping carpets
3. Mix seal surfacing
4. 25/40 mm thick semi dense bituminous concrete
5. 30/40 m thick bituminous concrete.

According to IRC : 82-1982 the specifications for renewal surfacing shall be as per the guidelines given in Table 8.1.

Table 8.1 : Specifications for Renewal Surfacing

Type of Original Surfaces	Proposed Renewal Treatment
Hot mix dense carpet (bituminous concrete) surface	Hot mix paver laid mix seal surfacing
Premix chipping carpet	Single coat surface dressing or 20 mm thick premix carpet depending upon the of the worn out surface.

The aforesaid guidelines do not take into considerations vital factors such as traffic and environment which influences the deterioration of roads. In real terms the guidelines given by the IRC seldom provides an effective solution to the problem.

The specification for renewal should be decided after taking into consideration the following factors:

a. Traffic (volume and type)
b. Climatic conditions
c. Existing condition of the pavement

8.3 RECTIFICATION OF PROFILE AT THE TIME OF RENEWAL

The cross profile and super elevation provided initially on a road tend to get flattened out by the traffic during the life of the road. Similarly there may be areas where the longitudinal profile of the road needs to be renewed of adjusted. This work must be carried out before the renewal of surface and the surface profiles corrected by means of a suitable levelling course. The type of material for use as profile corrective course shall be as under:

Where it is to be laid as part of the overlay/wearing course, the profile corrective course material shall be of the same specification as that of overlay or wearing course. If provided as a separate layer it shall be of the specification and details as decided by the road agency.

8.4 CRITERIA FOR RENEWAL LAYER

In order to recommend judicious criteria for renewal layer a review has been made of the prevalent recommendations of Government of India and IRC.

IRC : 82-1982 gives broad guidelines for the type and renewal intervals for determining the annual maintenance budget. The renewal intervals indicated in Table 8.2 are provided as general guidelines for the purpose of budgeting and determining the extent of renewal programmes. It does not indicate either the expected life of the particular type of treatment or the imperative need for renewal after the period indicated.

Table 8.2 : Guidelines for Renewal Intervals

Class of Road	Lane width	Traffic (Commercial Vehicles per day)	Type of renewal and periodicity of renewal treatment for		
			Low rainfall up to 150 cm per year	Medium rainfall 150 to 300 cm per year	High rainfall above 300 cm per year
National Highways and State Highways	Single	Less than 450	SD/4	SD/4	SD/4
		450 to1500	SD/4	SD/3	SD/3
		More than 1500	PC/6 Or MS/8	PC/5 Or MS/7	PC/4 Or MS/6
	Double	Less than 450	SD/5	SD/4	SD/4
		45 to 500	SD/4	SD/3	SD/3
		More than 1500	PC/6 Or MS/8	PC/7 Or MS/7	PC/4 Or MS/6
Major District Roads, other District Roads and Village Roads	Irrespective of lane width	Less than 150	SD/6	SD/6	SD/6
		150-450	SD/6	SD/5	SD/5
		More than 450	SD/5	SD/4	SD/3

Notes:

1. SD refers for single coat surface dressing
2. PC refers for 20 mm thick premix chipping carpet
3. MSS refers for mix seal surfacing
4. The denominator refers to the renewal interval in years.
5. For areas subject to snow fall and hilly areas with steep side slopes and heavy rainfall the renewal intervals may be more frequent.

Source: Code of Practice for Maintenance of Bituminous Surfaces of Highways, Indian Roads Congress, 1982 (IRC : 82-1982)

The Committee constituted by the Ministry of Road Transport and Highways on norms for maintenance of roads in India recommended in its report "Life Cycle for Indian National Highways and State Highways" the figures given in Table 8.3[5].

[5] Ministry of Road Transport and Highways: Report of the Committee on Norms for Maintenance of Roads India, 2001

Table 8.3 : Life Cycle Recommendations

Type of treatment/category of road	Traffic intensity in CVD	MR-1	SD-1/ SD-2	PC+ SC	20 mm MSS	25 mm SDBC	25 mm BC	40/50 mm BC for heavy traffic
NH/SHs (Normal)	>4500	-	-	-	-	-	5/4- a	5/4 - a
	1500-4500	-	-	-	-	5/4- a	5/4 - a	-
	450-1500	-	-	-	5/4- a	5/4 - a	-	-
	<450	-	-	5/4- a	5/4 - a	-	-	-
NH/SH (Urban)	>4500	-	-	-	-	-	4/3- a	4/3 -a
	1500-4500	-	-	-	-	4/3- a	4/3 -a	-
	450-1500	-	-	4/3 -a	4/3- a	4/3 -a	-	-
	<450	-	-	4/3- a	4/3 -a	-	-	-
NH/SH Hills	>1500	-	-	-	-	4/3- a +	4/3 –a	4/3 a +
	450-1500	-	-	-	4/3 +	4/3- a +	4/3 –a	-
	<450	-	-	5/4 a	5/4 a +			-
MDR/ODR/VR (Normal)	>1500	-	-	-	-	5/4 a	5/4 a +	-
	450-1500	-	-	-	5/4 a	5/4 a	-	-
	150-450	-	-	-	5/4 a	5/4 a	-	-
	<150	5/4 a	5/4 a	5/4 a	-	-	-	-
MDR/ODR/VR (Urban)	>1500	-	-	-		4/3 a	4/3 a	
	450-1500	-	-	-	4/3 a	4/3 a	-	-
	150-450	-	3	4/3 a	4/3 a			
	<150	3	4/3 a	5/4 a	5/4 a			
MDR/ODR/VR (hills)	>1500	-	-	-	-	4/3 a +	4/3 a+	
	450-1500	-	-	-	-	5/4 a +	5/4 a +	
	150-450	-	3	5/4 a	5/4 a +	-	-	-
	<150	4/3 a	4/3 a	5/4 a	5/4 a +	-	-	-

a - indicates reduced life of treatment due to high rainfall i.e >3000mm

+ - indicates reduced life due to high altitude i.e > 2000 metres

SD-1 is only to be used under conditions of severe resource restrictions

Note: IRC : 82-1982 clearly mentioned that the renewal interval was purely for budgeting purposes and determining the extent of a renewal programme, whereas the Norms Committee specifically mentioned life cycle.

Time constrained renewal, such as that currently adopted by the PWD, is not a viable proposition for maintenance of roads. Needs based, or responsive, maintenance based on pavement condition provides the only viable economic option for pavement renewal.

8.5 RENEWAL OPTIONS

The renewal treatment options recommended by the IRC and Committee of Norms are summarised in Table 8.4.

Table 8.4 : Renewal Treatment Options

Type of treatment	Recommending agency
Metal Road (MR-1)	Committee of Norms
Surface dressing single coat or double coat (SD-1 and SD-2)	Committee of Norms and IRC 82
Premix chipping carpet with seal coat	Committee of Norms and IRC 82
20mm mix seal surfacing	Committee of Norms and IRC 82
25 mm thick semi dense bituminous concrete	Committee of Norms
25 mm thick bituminous concrete	Committee of Norms
40 mm thick bituminous concrete	Committee of Norms

MR-1

The Committee of Norms recommended renewal treatment using a layer of stone aggregate (MR-1) for low traffic volume (<150 CVD) Major District Roads, Other District Roads and Village Roads. Performance of metal roads is not satisfactory under present day fast moving vehicular traffic. Aggregate particles get dislodged because of suction effects of wheels. The surface is not dust proof. Moreover, providing a metal surface on existing asphalt treated pavements is not advisable.

Compacted gravel roads behave much better compared to metal roads and are also cheaper to construct and maintain. Therefore treatment MR-1 is not considered to be a viable option and hence not recommended.

SD-1 and SD-2

IRC 82-1982 recommended surface dressing as a renewal treatment option on all kinds of roads with a traffic volume of up to 1500 CVD. However, the Committee of Norms recommended this option on low traffic volume roads (<450 CVD) such as MDR/ODR/VR and Urban Roads only.

Surface dressing is a simple and inexpensive road surface treatment, which is highly effective if adequate care is taken in the planning and execution of the work. The process is used for both surfacing medium and lightly trafficked roads. Surface dressing can also be used on heavily trafficked roads as a 'holding operation' to postpone for a short time investment in a more costly renewal treatment.

During the period 2000 to 2004, in the State of Gujarat, surface dressing treatment was applied on several State Highways with a traffic volume of 4000 CVD. All the roads treated with surface dressing are behaving exceedingly well.

Surface dressing may whip off in hilly terrain particularly on curves and steep slopes. Similarly surface dressing on urban road sections is not considered suitable because of the stone chips which tend to fly off during, and immediately after, application.

Pavements which have been surface dressed tend to have a slightly higher IRI (International Roughness Index) value (< 4000 mm/km) but cost wise this renewal option is cheaper than other alternatives and simple to apply.

Surface dressing treatment as renewal option is therefore recommended on all roads with a traffic volume of less than 1500 CVD per lane (for double lane road 3000 CVD).

Premix Carpet and Seal Coat:

This renewal treatment consists of a premixed bituminous mix over the pavement and subsequently seal coated with sand or 6 mm stone chippings.

The premix carpet provides an open graded layer which does not prevent water penetration. This can result in early deterioration of the pavement. The seal coat wears out quite early on heavy trafficked roads. Compared to surface dressing the premix carpet is more expensive and less durable.

If the surface dressing is not feasible on account of equipment constraints the option of a premix carpet surfacing may be considered as a renewal treatment on State Highways, MDR, ODR, and VR with traffic volumes of less than 1500 CVD.

20 mm Mix Seal Surfacing

Mix seal surfacing has been recommended as a renewal option for National Highways and State Highways with traffic volumes of more than 1500 CVD.

The hot asphalt mix produced by pre-mixing stone aggregate of specified grading and bitumen in accordance with the MORTH specification is highly porous. Because of the high porosity water easily penetrates the pavement, thus causing early deterioration. Mixed seal surfacing is a favoured option for renewal because of the ease of mixing in a hot mix plant and laying by mechanical paver, but it should be borne in mind that the mix seal surface treated pavement is less durable compared to surface dressing.

Mixed seal surfacing may be used on hill and urban roads where surface dressing is not found suitable.

25 mm SDBC:

25 mm thick SDBC has been recommended as a renewal option for NH, SH, MDR, ODR and VR with traffic volumes of up to 4500 CVD. Besides improving the riding quality (reduced IRI) the SDBC layer imparts structural strength to the pavement. But this treatment is expensive, and not a most desirable option.

25 mm Bituminous Concrete

25 mm bituminous concrete has been recommended as a renewal option for NH, SH, MDR, ODR and VR with traffic volumes above 4500 CVD, and for hill roads with traffic volumes of more than 1500 CVD. As well as improving the riding quality (reduced IRI) the BC layer imparts structural strength to the pavement but this treatment is expensive.

The use of a BC renewal coat is recommended for all categories of roads catering for traffic exceeding 2250 CVD per lane per day and 750 CVD per lane per day for hill roads

40 mm Bituminous Concrete

40 mm thick bituminous concrete has been recommended as a renewal option for NH and SH, which have a heavy traffic volume of more than 4500 CVD. Besides improving the riding quality (IRI reduced), the BC layer imparts structural strength to the pavement, but this treatment is expensive.

The use of BC renewal coat is recommended on all categories of roads catering for traffic exceeding 2250 CVD per lane per day.

Recommended options for renewal:

Table 8.5 shows the recommendations of renewal options for each class / type of road.

Table 8.5 : Recommended Renewal Options

Type of treatment/category of road	Traffic intensity in CVD	SD-1/ SD-2	PC+ SC	20 mm MSS	25 mm SDBC	30 mm BC	40/50 mm BC for heavy traffic
NH/SHs (Normal)	>4500	-	-	-	-	√	√
	1500-4500	-	-	-	-	√	-
	450-1500	√	√	-	√	-	-
	<450	√	√	√	-	-	-
NH/SH (Urban)	>4500	-	-	-	-	√	√
	1500-4500	-	-	-	-	√	-
	450-1500	-	√	√	√	-	-
	<450	√	√	√	-	-	-
NH/SH Hills	>1500	-	-	-	√	√	√
	450-1500	-	√	-	√	-	-
	<450	-	√	√	√	-	-
MDR/ODR/VR (Normal)	>1500	-	-	-	√	√	-
	450-1500	√	√	-	√	-	-
	150-450	√	√	-	-	-	-
	<150	√	√	-	-	-	-
MDR/ODR/VR (Urban)	>1500	-	-	-	√	√	-
	450-1500	-	√	√	√	-	-
	150-450	√	√	√	-	-	-
	<150	√	√	√	-	-	-
MDR/ODR/VR (hills)	>1500	-	-	-	√	√	-
	450-1500	-	-	-	√	√	-
	150-450	-	√	√	-	-	-
	<150	-	√	√	-	-	-

Note: √ Indicates recommended renewal treatment

9. PRESENTATION TO PROJECT STEERING COMMITTEE

Report No. 24: Report on suggestions to revise UP Road Classification and Maintenance Criteria for Core Network and Other Categories

PWD Focus Group - G	
Shri Rajesh Chandra	Managing Director, UP State Bridge Corporation, Lucknow
Shri Prabhat Kumar Mittal	SE, 18th Circle(NH), Allahabad
Shri Vishwa Deepak	T.E. TAC Irrigation
Shri Ram Vinay Kumar Rakesh	EE, CD-3, Baharaich
Shri Arvind Jain	PD, Lakhimpur
Shri Ajay Gangwar	UPRRDA, Lucknow
Shri N. K. Bishayee	IDS, Cell
Shri Rajesh Kumar	IDS, Cell
LEA International Ltd. and LEA Associates South Asia Pvt. Ltd.	
Shri Anand Prakash	Deputy Team Leader
Shri S.K. Pancholy	Contract & Procurement Specialist

Report No. 24: Report on suggestions to revise UP Road Classification and Maintenance Criteria for Core Network and Other Categories

TCE Report's concerns:

Insufficient funds for maintenance

Lack of planned maintenance

Emphasis on potholes & patching

Lack of objective condition-based maintenance

Report No. 24: Report on suggestions to revise UP Road Classification and Maintenance Criteria for Core Network and Other Categories

Recommendations Endorsed by GoUP

Apply techno-economic and financial criteria

Review policies, standards and effectiveness of programme

Dedicate sufficient and timely funds for maintenance

Review and revise maintenance norms for various classes of roads

Report No. 24: Report on suggestions to revise UP Road Classification and Maintenance Criteria for Core Network and Other Categories

UP PWD Road Network

National Highway	3825 km
State Highway	8551 km
Major District Road	7345 km
Other District Road	29179 km
Village Road	76462 km
Total	**125362 km**

Other Agencies

	Black Top	**Unsurfaced**
Mandi Parishad	8763	0
Cane Cooperative	5719	0
Rural Engineering Service	1138	112538
Zila Parishad	7575	7945
Total	**23195**	**120483**

Report No. 24: Report on suggestions to revise UP Road Classification and Maintenance Criteria for Core Network and Other Categories

Classification of Road

Road Classification is meant to assist to:

1. Coordinate and plan transportation
2. Manage transportation system
3. Coordinate and plan land use
4. Allocate jurisdictional responsibility
5. Make funding decisions
6. Formulate maintenance strategies

Report No. 24: Report on suggestions to revise UP Road Classification and Maintenance Criteria for Core Network and Other Categories

The present classification of:

National highway

State highway

Major district road

Other district road

is acceptable as long as the road is properly designated based on traffic and function

Report No. 24: Report on suggestions to revise UP Road Classification and Maintenance Criteria for Core Network and Other Categories

Objectives of Maintenance

1. Preserve the asset
2. Maintain the network capacity
3. Maintain rideability and integrity of road
4. Keep safe driving conditions
5. Reduce vehicle operating costs
6. Reduce travel time
7. Protect the environment

Report No. 24: Report on suggestions to revise UP Road Classification and Maintenance Criteria for Core Network and Other Categories

Types of Maintenance

1. Routine - to ensure:

   (i) daily passability and safety of road

   (ii) prevent premature deterioration

   Carried out year round regularly

   Criteria and treatments given in Table 7.4

2. Periodic - to preserve the structural integrity of the road

   At pre-determined time and selected action.

2. Emergency - for unforeseen collapse, washout, landslide

3. Rehabilitation - Improve / strengthen the existing pavement, so that it needs only routine maintenance

   Generally capital work

Report No. 24: Report on suggestions to revise UP Road Classification and Maintenance Criteria for Core Network and Other Categories

UP PWD Pavement Renewal Policy

State Highway	every 4 years
Major District Road	every 4 years
Other District Road	every 5 years
Village Road	every 6 years

Shortcoming:

(1) Not based on condition

(2) Does not take into account the requirements of the pavement

Policy can be used for budgeting only

Report No. 24: Report on suggestions to revise UP Road Classification and Maintenance Criteria for Core Network and Other Categories

In the Report guidelines are included for:

(1) Maintenance activity required to rectify problems

(2) Type of renewal surface based on traffic volume and climatic conditions

(3) Type of renewal surface type and its expected life

These guidelines can be used for budgeting and monitoring purposes

Report No. 24: Report on suggestions to revise UP Road Classification and Maintenance Criteria for Core Network and Other Categories

It was the unanimous consensus of the Focus Group that:

(i) Whenever a road is re-classified or upgraded, its pavement structure should also be strengthened

(ii) Whenever an overlay is placed, a detailed pavement condition, thickness and Benkelman beam deflection survey should be carried out to determine the thickness of overlay required to carry the anticipated traffic

ANNEXURE 1: EXAMPLES OF ROAD CLASSIFICATION PRACTICES OF OTHER COUNTRIES

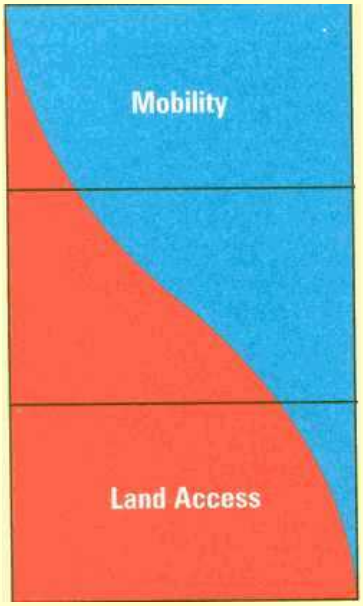
1. UNITED STATES FEDERAL HIGHWAY ADMINISTRATION

One of the first steps in the design process is determining the functional classification of a facility. Functional Classification is the process by which streets and highways are grouped into classes, or systems, according to the character of traffic service that they are intended to provide. The non-urban roads in the state can be classified into five categories i.e. National Highways(NH), State Highways(SH), Major District Roads(MDR), Other District Roads(ODR) and Village Roads(VR), based on the functional and administrative criteria in the following manner which has already been done.

Functional System	**Services Provided**
National Highways & State Highways	Provides the highest level of service at the greatest speed for the longest uninterrupted distance, with some degree of access control.
Major District Roads & Other District Roads	Provides a less highly developed level of service at a lower speed for shorter distances.
Rural Roads	Consists of all roads not defined; primarily provides access to land with little or no through movement.

Typically, travellers will use a combination of these roads for their trips. Each type of road has a specific purpose or function. Some provide land access to serve each end of the trip. Others provide travel mobility at varying levels, which is needed en route. There is a basic relationship between functionally classified highway systems in serving traffic mobility and land access, as illustrated in figure below:

Figure 1: Relationship of functionally classified highway systems in serving traffic mobility and land access.



National Highways & State Highways

- higher mobility
- low degree of access

Major District Roads & Other District Roads

1. balance between mobility and access

Rural Roads

- lower mobility
- high degree of access

Source: Safety Effectiveness of Highway Design Features, Volume I, Access Control, FHWA, 1992

National Highways

National highways constitute the primary system of road transportation of the country. These roads play a vital role in national transportation endeavour in as much as they carry 40 per cent of the total traffic, although their length is only about 2 percent of the road network. For NH network 2-lane road is a minimum requirement on considerations of both mobility and safety.

For the expansion of NH network the following factors are need to be kept in view:

- Connecting major ports, industrial complexes, important growth nodes, pilgrimage and tourist centers
- Providing linkages with adjoining countries
- Connecting capitals of the states being carved out now or likely in future

State Highways

State Highways constitute the secondary system of road transportation in the country. The State Highways provide linkages with National highways, district head quarters of the state and important towns, tourist centers and minor ports. These roads also carry medium to heavy traffic.

The state government may review the network keeping in view the following factors:

- Providing linkages with minor ports, industrial towns, pilgrimage and tourist centers
- Connecting the remaining towns with population 5000 and above (population census of 2001 may be the criterion)
- Connecting the capital state with district head quarters

Major District Roads and Other District Roads

Major district roads and other district roads run within the districts connecting areas of production with markets, connecting the rural areas to district head quarters and to State Highways and National Highways. The state government may review the requirement keeping in view linkages with Tehsil head quarters, other growth centers, major mandis (agriculture and fruit markets) local tourist centers etc.

Major District Roads (MDR) for the higher order traffic.

Other District Roads (ODR) for the lower order traffic.

Rural Roads

Rural roads serve as one of the key infrastructure to break the sense of isolation and for integrated rural development which has become a matter of growing urgency for considerations of social justice, national integration and economic uplift. Rural roads provide accessibility to schools, health centers, productive resources and physical mobility of raw material, farm produce and other products, promote specialization, increase size of market and create conditions for strengthening economic linkages and to more employment opportunities. Rural roads are roads connecting villages or groups of villages with each other and to the nearest district roads, national or state Highway or railway or navigational routes.

But according to Guidelines for Maintenance Management of Primary, Secondary and Urban Roads the entire road network is categorized as:

i) Primary Roads – Expressways and national Highways (NHs)

ii) Secondary Roads – State Highways (SHs) and Major District Roads (MDRs)

iii) Tertiary Roads – Other District Roads (ODRs) and Village Roads (VRs)

iv) Urban Roads – Roads in Urban limits / Territory

Of late, a new category of roads under “Major State Highways” also has come into existence in some of the states, wit specifying the geometric features of State Highway equivalent to that of National Highways. Though, the intended purpose of any category of these roads is to provide satisfactory level-of-service to road users, the stated level-of-service may not be the same in all cases. The construction specifications, traffic, pavement strength, ancillary structures, adjoining facilities, etc may differ in their characteristics among the various categories of roads. Accordingly, the structural and functional requirements and hence the maintenance needs also differ within these categories.

2. AUSTRALIA - NEW SOUTH WALES STATE GOVERNMENT

The process of classifying roads is a mechanism used by the State Government to assist in the effective allocation of State Government road funds, and the allocation of road management responsibility between State and local government jurisdictions. A review of road classification provides an opportunity to make adjustments at the network margins to ensure an up to date network that meets the social and economic needs of the community and industry, within the available levels of funding.

Functional Road Classification

The identification of State and Regional roads is based on road function. Functional classification is the process by which roads are grouped into classes or systems according to their function or character of the service they are intended to provide. Individual roads do not serve travel independently in any major way. Rather most travel involves movement through a network of roads. It becomes necessary to encourage this travel to move within the network in a logical and efficient manner. The following are the functional Characteristics of roads:

- Travel patterns
- Connectivity
- Through commercial traffic
- Relative traffic usage
- Frontage access
- Side road connections
- Route capacity
- Travel Speed
- Pedestrian/cyclist provision
- Parking
- Cross section type
- Bus Routes
- Vehicle priority
- Network spacing

Functional classification helps this process by defining part that any particular road should play in serving the flow of trips through the network. Functional classification can be used as a basis for allocating jurisdictional responsibility for roads. The primary, long distance, high traffic routes have strategic importance for the wider economy and by their nature are more expensive to construct and maintain. Central governments acknowledge this by taking responsibility for the high order roads while lower order roads remain under responsibility of local councils. The development of a strongly differentiated hierarchy of roads on a functional basis is essential to maximize the effectiveness and efficiency in the spending of road funds by the differing jurisdictions, support appropriate traffic management regimes and efficient traffic flow and promote road safety. A generic hierarchy comprises freeways, primary arterial roads, secondary

arterial roads, collector roads and local access roads. The broad classification of roads has been State, Regional and local roads.

State Roads – Classification Criteria

State Road network is formed by the primary network of principal traffic carrying and linking routes for the movement of people and goods within the urban centers of major cities throughout the State. National Highways will be considered part of the State Road network.

A road may be a State Road if its primary function meets atleast one of the following criteria:

- Links major commercial, residential and industrial areas and distribution centers and ports
- Links major state towns with other major cities
- Links these major state towns with each other where there is significant interaction.
- Links major regions throughout the State with each other

Regional Roads – Classification Criteria

Regional roads comprise the secondary network which together with State Roads provide for travel between smaller towns and districts and perform a sub arterial function within major urban centers.

- Links smaller towns with the State Road network
- Connects smaller towns with each other
- Performs a sub arterial function in major urban centers
- Provides access from the State Road network to major recreation and tourist areas of State significance
- Provides a town or suburban center relief route for significant flows of through traffic, especially freight vehicles
- Provides access for significant flows of freight vehicles to major intermodal interchanges and urban distribution areas

Local Roads

Local Roads are those other roads whose primary purpose is:

- To provide for local circulation and access to property
- To provide connection to the State and Regional Roads and
- To support the living environment in which they are located

3. CANADA

A Perspective

A street network performs most efficiently and safely from both a traffic operations and a road safety perspective if roads are designated and operated to serve their intended purposes. These purposes include the efficiency of travel for all modes and the safety and convenience of all road users. Local roads serve primarily to provide access to properties and serve a relatively minor role in the wider City context for carrying motorized traffic. Consequently, traffic volumes and speeds on these roads should be low. Conversely, expressways carry high volumes of motor vehicle traffic at relatively high speeds. Collector streets serve to collect and distribute traffic between local streets and higher order roads. Arterial roads (with the expressway system) provide the major corridors for traffic (including surface transit) movement.

Arterial roads are also important for pedestrians and cyclists. As motor vehicle speeds and volumes are higher on these roads than on local and collector roads, special facilities such as bicycle lanes will often be necessary to ensure the safety of cyclists. Sidewalks, while important on all streets except expressways, are particularly necessary on collector and arterial roads.

A classification system designates streets into different groups according to the type of service each group is intended to provide and is a fundamental tool for road management. Grouping roads with similar functions can improve transportation planning, road infrastructure design, road maintenance, and traffic and road operations. A road classification system also helps manage urban development.

A road classification system groups streets in a hierarchical manner with different groups performing different functions. The hierarchy provides for a gradation in service with high traffic service levels and no access to abutting properties for the highest order roads (expressways) and conversely low traffic service levels but full property access for local roads. Between these two extremes, arterial roads provide relatively high traffic service levels with some property access, while on collector roads, traffic service and property access are equally important. Collectors, as their name implies, serve to collect traffic from local streets and provide access to arterial roads, which then may connect to expressways. Collectors also can be thought of as distributors of traffic from the main roads to the minor roads. As would be expected, traffic volumes are typically higher on higher level roads than on lower level roads

Core Road Classification System in Canada

A road classification system consists of two basic elements - a list of define roadway types and a list of corresponding characteristics of each roadway type. Building on the work already completed by the various agencies, three different roadway types are proposed for rural roads and six types are proposed for urban road as follows:

Rural Roads

- Rural Local
- Rural Collector
- Rural Arterial

Urban Roads

- Residential Local
- Industrial/Commercial Local
- Residential Collector
- Industrial/Commercial Collector
- Minor Arterial
- Major Arterial

TAC Classification

The Transportation Association of Canada (TAC) Design Classification includes a number of characteristics used to classify rural and urban roadways as listed below:

- service function
- land service
- traffic volume
- flow characteristics
- design speed
- average running speed
- vehicle type
- normal connections/desirable connections
- transit service*
- accommodation of cyclists*
- accommodation of pedestrians*
- parking*
- minimum intersection spacing*
- right-of-way width*

(* In the TAC Geometric Design Guide for Canadian Roads, these characteristics are identified for urban roads only.)

Many of these road classification characteristics can apply without qualification to the road system in Hamilton in order to define the core classification of a road section. However, there are some characteristics that should be possible to vary, depending on the road section in question. These include:

- traffic calming*
- vehicle type
- accommodation of cyclists
- accommodation of pedestrians
- parking
- boulevards between walk and curb*

* not included in TAC definitions

A Core Classification should include traffic service function, land service/access, traffic volume, flow characteristics, design speed, average running speed, desirable connections, transit service, right-of-way width, and minimum intersection spacing. Every road section in Hamilton would be categorized as **arterial, collector, or local** using these core characteristics. Road sections not meeting all of the characteristics in a category would necessarily fall into a lower category, as these characteristics should be considered non-variable. Building on the TAC Guidelines and the Draft Road Classification System for Hamilton a core road classification system was proposed for rural and urban roads respectively.

Other Elements to be Considered with Road Classification

In addition to the core classification elements, there are several other roadway features that could apply to particular road sections including:

- higher order transit system features
- special character roads, heritage roads, and scenic routes
- truck routes
- culs-de-sacs
- sub-categories of roadways types within a Core Road Classification

It is proposed that these features be considered on an “as justified” basis, and not be included in the core road classification system. Similar to the core classification elements that are permitted to vary, these elements would be addressed through special studies.

Each of these special features is discussed below.

Higher Order Transit Features

The long range transit plan for Hamilton has, since 1971, included recommendations to establish a system of higher order transit, most likely Bus Rapid Transit (BRT). BRT could be implemented to varying degrees and could include the following elements:

- transit signal priority
- dedicated transit lanes
- restricted parking and/or loading
- enhanced transit stops and/or stations

- pedestrian connections
- pre-board fare payment
- special land use designations along the corridor
- other urban design features

Truck Routes

There is currently a Truck Route system that has been established by by-law, and it is recommended that the model be continued. However, trucks routes should only be permitted on Arterial Roads and higher, unless there is a special circumstance requiring a variance.

Additional details on the truck route system are provided in the Goods Movement Policy Paper.

Culs-De-Sac

Culs-de-sacs could be considered separately or within the local road category of the core classification system.

Culs-de-sac would not have to be considered as a separate category if a model of core

classification system plus detailed matrix were adopted. There is considerable evidence to support limiting the lengths of new culs-de-sac to 150m, and there may be options for reduced rights-of-way and sidewalks on culs-de-sac.

Sub-Categories Within A Core Road Classification in Canada

A number of studies have recommended special classifications – mobility streets, traditional streets, primary roadways, secondary roadways, and so on. The numbers and variations have become difficult to track and understand. It is therefore recommended that every roadway be categorized according to the core classification system. However, for planning purposes, other roadway descriptions could be used. These descriptions would have no legal standing.

Policy Perspective

The establishment of a clear and understandable road classification system is a basic requirement for any urban area. In the preparation of this policy paper, several different approaches were considered for developing the road classification system for Hamilton. One approach considered was to adopt a standard road classification system based on the Transportation Association of Canada's system. A second approach considered would be to develop a more elaborate system to include the many possible features and characteristics applicable to roads in the City of Hamilton. The latter approach has certain legal implications in that it may undermine the City's ability to enforce a basic road classification system (which is necessary for the efficient operation of the City's roadways) and it may also open up the City to liability issues. In the end, a hybrid approach was adopted whereby a basic roadway classification system is proposed, with provisions for other roadway features and characteristics to be considered when required, in conjunction with planning studies falling under the class

environmental assessment process. Based on this general direction, the following recommended policies and implementation actions are proposed for inclusion in the Transportation Master Plan.

Recommended Policy

Adopt a core road classification system that is sufficiently broad so as to permit the assignment of every road in Hamilton to the core system, but also allows for refinements that recognize nonstandard or special situations through the application of features involving traffic calming, vehicle type, accommodation of cyclists, accommodation of pedestrians and persons using mobility aids, parking, and boulevards, without requiring the revision of roadway classifications.

In conjunction with planning studies, consider variations to the core classification system and additional descriptors where appropriate to account for unique or special roadway characteristics.

Implementation

- On approval of the classification system, the City should assemble a special team to classify all roadways under the jurisdiction of the City of Hamilton. In most cases, this will be a matter of re-affirming existing classifications as identified in neighbourhood plans.
- Prepare and maintain a geographic information system of roadway section by classification.
- Consult existing guidelines and design manuals (e.g. Traffic Calming Guidelines, Hamilton Bicycle Design Guidelines, etc.) in determining the rationale for and implications of varying from default roadway characteristics in the Core Roadway Classification System.
- Consider other roadway elements in conjunction with road classification on an “as needed” basis including: ·higher order transit system features, special character roads, heritage roads, and scenic routes, truck routes, culs-desacs and sub-categories of roadways types.
- Respect special roadway designations when applying design standards and in developing and applying maintenance practices while ensuring safety to all road users.

Impacts of Policy Options

Assessment Factors

Assessment of policy options is based on factors for achieving sustainable growth and development across all of the policy papers developed in this project. They fall under the three major categories of social, economic and environmental impacts.

Summary of Evaluation

The assessment factors have been applied to the policy options associated with road classifications in Hamilton as discussed in previous section. The results of a preliminary qualitative assessment show that the policy option with adoption of a core road classification system that is sufficiently broad so as to permit the assignment of every road in Hamilton to the core system, but also allows for refinements that recognize nonstandard or special situations through the application of features involving traffic calming, vehicle type, accommodation of cyclists, accommodation of pedestrians and persons using mobility aids, parking, and

boulevards, without requiring the revision of roadway classifications got the highest positive rating in all social, economic and environmental impacts.

Saskatchewan Highways and Transportation (Province)

A committee from the Department of Highways and Transportation (DHT), Municipal Affairs, Culture and Housing (MACH), Saskatchewan Association of Rural Municipalities (SARM) and Saskatchewan Urban Municipalities Association (SUMA) had undertaken a study to move towards a more integrated and coordinated approach to managing the highway and rural road network. Currently highways are classified as major or minor arterial, collector or local. Municipal roads are classified as primary grid, grid, main farm access, special, local and land access. Construction standards were generally based upon these classifications. A new classification system was developed which categorizes rural roads collectively, both highway and municipal, by function. Construction standards would be based upon the function, the type and volume of traffic.

The committee categorized roads into seven different classes based on established criteria. Each road class can be described as follows:

- Class 1 roads serve as major inter-provincial and international travel routes as well as connecting centres with 3,000 or greater population. These roads total 5,637 kilometres representing 3% of the system.
- Class 2 roads serve communities with 1,000 or greater population and link hospitals to regional or base hospitals. These roads total 4,322 kilometres representing 2% of the system.
- Class 3 roads serve communities of 500 or greater population and link special care homes or health centres to hospitals. These roads total 5, 930 kilometres representing 3% of the system.
- Class 4 roads serve as primary inter-municipal links and provide access to communities of greater than 100 population and large industrial sites. These roads total 19,320 kilometres representing 10% of the system.
- Class 5 roads serve as secondary inter-municipal links and provide access to communities with less than 100 population and medium industrial sites. These roads total 21,388 kilometres representing 11% of the system.
- Class 6 roads serve individual residences, school bus routes and small industrial sites. These roads total 64,565 kilometres representing 34% of the system.
- Class 7 roads provide access to the land. These roads total 69,225 kilometres representing 37% of the system.

In addition, the committee developed a framework to examine the level of service for each class. Four alternative levels of service for each class were developed. Expenditures for each alternative were determined to understand the magnitude of the costs to maintain a particular level of service.

An interim report was submitted to the participating provincial departments and associations. The committee recommended approval of the classification criteria, the development of cost sharing

options and permission to undertake stakeholder consultations. Approval was given in-principle for the classification criteria and the committee was directed to undertake stakeholder consultations.

A consultation committee consisting of representatives from SARM, SUMA, MACH and DHT consulted with all rural and urban municipalities and other stakeholders who are dependent on the transportation system. Consultation also included meetings with the New North and First Nations. In total, twenty-eight meetings were held across the province. These consultation meetings included a review of classification principals, criteria, level of services and the draft road classification map.

The stakeholders consultation meeting were well received. Participants' provided a high level of co-operation in finalizing an integrated Rural Road Transportation Network. Overall the committee is confident that stakeholders are supportive in adopting this new Rural Road Classification system. Stakeholders expressed the concern that the transportation network is continually changing and that periodic review of the classification will be a requirement. The concept of Level of Service is not well understood. Additional work is required to clarify Level of Services, identifying present conditions of the road system, before establishing a Level of Service for each class to manage this large rural transportation network.

The Rural Road Classification Committee are recommending and seeking approval for the following:

- Adopt and implement the Rural Road Classification System to provide an integrated transportation network to assist road authorities in providing a transportation system that will enhance provincial economic and social growth.
- Establish an independent committee to facilitate changes to individual road segments and periodically review the Rural Road Classification System.
- The Rural Road Classification Steering Committee undertake the task to further develop the Levels of Service elements and undertake a Level of Service gap analysis and develop strategies for the Rural Road Network.

Should the above recommendation be approved then this committee also seeks approval of the following recommendations:

- Revise the Class 1 and Class 2 criteria for linking all cities to one another to better reflect the commercial, economic, and social activities between all cities.
- Approve a revision to the Class 3 criteria as follows: "link all USA border crossings with a three year average annual vehicle crossings >15,000."
- Address the road requirements related to the heavy crude oil industry during the proposed Level of Service process.

4. UNITED KINGDOM

The following explains the road classifications and hierarchies as set out by the Secretary of State and, where appropriate the local highway authority. New road types introduced by innovative traffic management schemes such as Home Zones (HZs) and 20mph zones are also explained.

The following explains set up of how roads hierarchies are planned and designed for their intended uses.

Home Zones

Home Zones comprise residential streets designed to give greater priority to people over cars and to encourage greater social activity on the street. Vehicles should only be able to travel a little faster than walking pace (less than 10 mph). This means that the street layouts are completely redesigned to slow traffic, but also to include, amongst other things, children's play areas, planting trees, cycle parking and seats for residents to use.

Home Zones should therefore make residential areas safer for pedestrians and cyclists, and improve the quality of the street environment. Home Zones aim to improve the local quality of life in residential streets - by making them places for people, and not just traffic. They are designed to meet the needs of the local community and detailed consultation with residents is crucial in their design.

20 mph zones

These are traffic management schemes intended to improve safety in residential streets, and they are defined by a 20mph speed limit and traffic calming measures such as road narrowing, pavement build-outs, junction tables and humps.

Local Area Treatments

These can be a wider package of measures, including a 20 mph limit, and may include road closures to prevent a road being used by unsuitable traffic.

Road Classifications and Hierarchies

Roads are categorized in terms of their actual or intended uses within the network as a whole. These categories define their design, adoption and management standards, regardless of which local authority is responsible for any particular road. There is a national structure, which is interpreted locally with regard to local conditions.

The national structure is set out in *Roads and Traffic in Urban Areas* (*RTUA* 1987) published by the IHT. A classified road is a highway, categorized by the Secretary of State and, where appropriate, the local highway authority, according to its importance to the movement of traffic.

Classified Roads may be either I, II or III. All class I and II roads and some Class III roads are given numbers, generally with the prefix A, B or C respectively.

- A-roads are major routes, they can vary in design from motorway-standard to narrow local roads, and have 1, 2, 3 or 4 digit numbers prefixed with 'A'.
- B-roads are local routes and have 3 or 4 digit numbers prefixed with 'B'.
- C-roads are rarely signposted or shown on maps and they are reference numbers used by the government bodies that maintain roads.
- Roads which have no designated numbers are “Unclassified Roads”. Local roads or side roads in residential areas are generally unclassified roads. They can form part of the area network (distributor roads) or serve local access needs only.

In London, the distinction between A, B and other roads has reduced in significance due to the complexity of the road network and the general growth in traffic. Although the hierarchy reflects the area’s historical development, it remains a basis for road and traffic management for the future. Changes to the hierarchy are generally made by the local highway authority (the Boroughs), the Highways Agency and if necessary, the Secretary of State.