REVIEW REPORT ON
DEVELOPMENT OF ROAD NETWORK MASTER PLAN
(FINAL)

Report No. 29

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LEA International Ltd., Canada
in joint venture with
LEA Associates South Asia Pvt. Ltd., India
in association with
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<table>
<thead>
<tr>
<th>Glossary</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADB Asian Development Bank</td>
<td>MLA Member of Legislative Assembly</td>
</tr>
<tr>
<td>ADT Average Daily Traffic</td>
<td>MIS Management Information System</td>
</tr>
<tr>
<td>AE Assistant Engineer</td>
<td>MLNR Multiple Linear Regression</td>
</tr>
<tr>
<td>BOOT Build Own Operate Transfer</td>
<td>NCU National Commission on Urbanisation</td>
</tr>
<tr>
<td>BOT Build Operate Transfer</td>
<td>MOST Ministry of Surface Transport</td>
</tr>
<tr>
<td>CBO Community Based Organisation</td>
<td>MoSRTH Ministry of Shipping, Road Transport &amp; Highways</td>
</tr>
<tr>
<td>CBR California Bearing Ratio</td>
<td>MoRT Ministry of Road Transport and Highways</td>
</tr>
<tr>
<td>CE Chief Engineer</td>
<td>MoEF Ministry of Environment and Forest</td>
</tr>
<tr>
<td>CEO Chief Executive Officer</td>
<td>M&amp;E Monitoring and Evaluation</td>
</tr>
<tr>
<td>CFI Cumulative Functional Index</td>
<td>MIS Management Information System</td>
</tr>
<tr>
<td>CRF Central Road Fund</td>
<td>MSS Mixed Seal Surface</td>
</tr>
<tr>
<td>CRRRI Central Road Research Institute</td>
<td>NABARD National Bank of Agricultural and Rural Development</td>
</tr>
<tr>
<td>CS Central Scores</td>
<td>NITHE National Institute for Training of Highway Engineers</td>
</tr>
<tr>
<td>CSR Civil Service Reforms</td>
<td>NH National Highway</td>
</tr>
<tr>
<td>DAO Divisional Account Officer</td>
<td>NHI National Highways Authority of India</td>
</tr>
<tr>
<td>DASP Diversified Agriculture Support Program</td>
<td>NOIDA New Okhla Industrial Development Authority</td>
</tr>
<tr>
<td>DBC Dense Bitumen Concrete</td>
<td>ODR Other District Road</td>
</tr>
<tr>
<td>DPR Detailed Project Report</td>
<td>OD Origin and Destination</td>
</tr>
<tr>
<td>DRDA District Rural Development Authority</td>
<td>O&amp;M Operation and Maintenance</td>
</tr>
<tr>
<td>EC Executive Committee</td>
<td>PAC Public Accounts Committee</td>
</tr>
<tr>
<td>EE Executive Engineer</td>
<td>PCC Project Coordinating Consultant</td>
</tr>
<tr>
<td>E-in-C Engineer in Chief</td>
<td>PCI Pavement Condition Index</td>
</tr>
<tr>
<td>GC Governing Council</td>
<td>PCU Passenger Car Unit</td>
</tr>
<tr>
<td>GIS Geographic Information System</td>
<td>PMGSY Pradhan Mantri Gram Sadak Yojana</td>
</tr>
<tr>
<td>GPS Global Positioning System</td>
<td>PMS Pavement Management System</td>
</tr>
<tr>
<td>GO Government Order</td>
<td>PPP Public Private Partnership</td>
</tr>
<tr>
<td>GOI Government of India</td>
<td>PRI Panchayati Raj Institution</td>
</tr>
<tr>
<td>GoUP Government of Uttar Pradesh</td>
<td>PSP Private Sector Participation</td>
</tr>
<tr>
<td>GSDP Gross State Domestic Product</td>
<td>PWD Public Works Department</td>
</tr>
<tr>
<td>HDM Highway Design Model</td>
<td>PS Preliminary Screened</td>
</tr>
<tr>
<td>HGV Heavy Goods Vehicle</td>
<td>RAP Resettlement Action Plan</td>
</tr>
<tr>
<td>HQ Head Quarter</td>
<td>RES Rural Engineering Services</td>
</tr>
<tr>
<td>HR Human Resource</td>
<td>RIDF Rural Infrastructure Development Fund</td>
</tr>
<tr>
<td>HRD Human Resource Development</td>
<td>RMMS Road Maintenance Management System</td>
</tr>
<tr>
<td>HRM Human Resource Management</td>
<td>RSPEU Road Safety Planning and Engineering Unit</td>
</tr>
<tr>
<td>IBRD International Bank for Reconstruction and Development</td>
<td>RSC Road Safety Cell</td>
</tr>
<tr>
<td>IDS Institutional Development Strategy</td>
<td>R&amp;R Resettlement and Rehabilitation</td>
</tr>
<tr>
<td>IDDSP Institutional Development And Strengthening Plan</td>
<td>SDBC Semi Dense Bitumen Carpet</td>
</tr>
<tr>
<td>IRC Indian Road Congress</td>
<td>SE Superintending Engineer</td>
</tr>
<tr>
<td>IT Information Technology</td>
<td>SH State Highway</td>
</tr>
<tr>
<td>ISAP Institutional Strengthening Action Plan</td>
<td>SHA State Highway Authority</td>
</tr>
<tr>
<td>IS Intermediate Screened</td>
<td>SPI Settlement Potential Index</td>
</tr>
<tr>
<td>JE Junior Engineer</td>
<td>SGPI Settlement Growth Potential Index</td>
</tr>
<tr>
<td>MDR Major District Roads</td>
<td>SPV Special Purpose Vehicle</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>SRF</td>
<td>State Road Fund</td>
</tr>
<tr>
<td>SRP-II</td>
<td>State Road Project-II</td>
</tr>
<tr>
<td>TA</td>
<td>Technical Assistance</td>
</tr>
<tr>
<td>ToR</td>
<td>Terms of Reference</td>
</tr>
<tr>
<td>TVP</td>
<td>Traffic Volume Prediction Models</td>
</tr>
<tr>
<td>THQ</td>
<td>Tehsil Headquarter</td>
</tr>
<tr>
<td>UP</td>
<td>Uttar Pradesh</td>
</tr>
<tr>
<td>UPSBC</td>
<td>Uttar Pradesh State Bridge Corporation</td>
</tr>
<tr>
<td>UPSRP</td>
<td>Uttar Pradesh State Road Project</td>
</tr>
<tr>
<td>UPSHA</td>
<td>Uttar Pradesh State Highway Authority</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
</tr>
<tr>
<td>VOC</td>
<td>Vehicle Operating Cost</td>
</tr>
<tr>
<td>VR</td>
<td>Village Roads</td>
</tr>
<tr>
<td>WB</td>
<td>World Bank</td>
</tr>
<tr>
<td>WBM</td>
<td>Water Bound Macadam</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

Preparation of a Review Report on Development of Network Master Plan is one of the deliverables of this TA. Given the mandate and responsibility PWD is vested with, efforts towards having a scientific approach in Preparation of Perspective Long Term Plan, and Short and Medium Investment Plan and Strategy becomes very important. For various reasons other than traditional and/or conventional plans and/or documents viz. the Road Development Plan, Five Year Plan, etc no such network master plan document exists with PWD. When this TA was conceived, it was anticipated that Network Master Plan would be made available to the TA consultants for review and suggesting, may be, enhancements thereon. Unfortunately no such document exists with PWD now. Hence, the effort of this report is to suggest a systems approach with explicit economic decision oriented approach. We feel this can and may form/act as a guiding document for preparation of such master plan and/or projects’ identification in future.

2. ROAD DEVELOPMENT PLANNING EFFORTS IN INDIA

The efforts in preparation of Road Development Plans in India dates back to 1927. These efforts are continued in the form of 20 year Road Development Plans thereafter. Indian Road Congress (IRC) is the body which formulates this Plan with Government of India directive.¹

The Road Development Plan which currently forms as guiding document is the Perspective Road Development Plan for India: Vision – 2020. This becomes guiding document at national and state levels in India. The Plan addresses number of wide ranging aspects, including certain fundamental planning and engineering principles, in setting targets for road development by hierarchy.

3. RURAL ROAD PLANNING EFFORTS IN INDIA

In terms of planning efforts, planning for rural roads is very well addressed in many studies and/or practices in India. Several states in India do have such prepared plans. These plans may be old. It is gratifying to note that India has embarked on major rural roads network development program few years back. It is known as Pradhan Mantri Gram Sadak Yojana (PMGSY).² The PMGSY of India is funded by Central Government. The states are advised to develop plans and pose to centre for funding.

The principles based on which such plans are prepared are given at Annexure-1.

¹. The IRC formulates document with GOI, MoSRTH guidelines. IRC is the guiding body in India which acts as AASHTO, FHWA, etc.
². PMGSY in English is known as Prime Minister Rural Road Development Plan. This was launched/initiated in 1998-99. It is major rural infrastructure development effort ever initiated in India in recent times. This program is also partly funded by the World Bank and ADB.
4. STATE ROADS PLANNING AND DEVELOPMENT EFFORTS IN INDIA

The state roads are generally planned as per the State Road Development Plan[^3], if prepared and available. If not, the Road Policy[^4] and five year plans form the base. The State Roads like National Highways have got significant attention. Better tools and practices in planning, making investment decisions, engineering designs, maintenance practices, construction management, etc are being particularly followed in states where they are developed with external aid. Towards this, World Bank suggested a process which is followed for inception to the completion of the projects (Annexure-2).

5. A MAJOR GAP - STATE ROADS NETWORK MASTER PLANNING

There exists a major gap, largely in terms of scientific tools followed in evolving the Long Range Perspective Road Network Master Plans at the state level in India. The state of UP is no exception to this. The ensuing sections address this aspect from settlement planning, traffic planning and economic decision perspective.

6. APPROACHES – A REVIEW

6.1 THE CONTEXT

The demand for roads and road transport is growing and is vital. The phenomenon needs to be considered seriously in cases of meeting the demand for roads and road transport. Therefore, a Comprehensive Development Plan for developing all categories of roads is essential.

In this regard, it is worthwhile to mention that whether it is a National Highway (NHs) crossing many states and connecting major (metropolitan) cities or a Village Road (VRs) connecting a small hamlet to its nearby market town, they all have been and will continue to play an important role in achieving the envisaged balanced development of the state. However, for enabling upward socio-economic mobility of society, the efficient and economic planning of network of all categories is essential. Such a planning must include vast category of roads (which were neglected till recent times) falling between the above cited two extremes (NHs and VRs). They include middle order roads such as State Highways (SHs), Major District Roads. (MDRs), and some Other District Roads (ODRs) which connect many medium level towns and small settlements (Fig. 1 and 2).

[^3]: The State Road Development Plans are prepared following generally the guidelines as per the national road development plan.
[^4]: Some states in India have prepared such policy documents. The state of UP is one state which took lead in this effort and adopted it in 1998.
Importance of such roads is two fold. Firstly, these roads act as collector of traffic from thousands of village roads densely spread all over the state, thus, forming a heavy and strong base of pyramid of hierarchy of roads. Secondly, these roads also act as feeder roads to the all important trunk-route system comprising National Highways and some other State Highways (SHs).

Thus, the need to develop the Network Master Plan for road system has been strongly felt. The gap between desired needs and satisfied demand has been vast. These roads not only connect number of large and smaller cities and middle order towns but also several other important centers contributing to the state's economy. These centers include several industrial centers, agricultural market towns, tourist attractions and such towns having important social infrastructure facilities (health education and other amenities).
6.2 THE CONCEPTUALISATION

The study on identification and planning of Road Network should aims at meeting the following pre-requisites:

- Identification of links which would carry heavy traffic volume of certain level (say 5000 PCU/day) and more and identification of a network of such routes.
- The link should connect one-district head quarters to other headquarters and must pass through (at least 50 percent of) the talukas in a district.
- The link in a grid should take into account all potential development corridors and/or such routes, which attract diverted traffic.
- Existing and proposed industrial area should not be away from such links by more than 5 kms.

Thus the main aim of a grid of roads is to fulfill the movement needs of population and goods of that place. Therefore, the pattern of grid must match with the movement pattern of the region. Moreover, the movement pattern will depend upon the spatial distribution of various settlements and location pattern of various functions and amenities in the region. Movement from one settlement to other takes place to fulfill the socio-economic needs of the settlement. Intensity of movement depends upon the degree of dependency of the settlement on the other for its socio-economic needs.

Road network mainly consists of a set of settlements and a set of roads. The process of road network planning mainly comprises of identifying various settlements and then connecting them with roads in an optimal manner. This is a complicated series of steps due to pyramid of settlement types involved. This is so because of various geographic, demographic, political and climatic characteristics. Settlements of different functional order or rank require different treatment as far as accessibility needs are concerned. Thus, it calls for a scientific and methodical approach in planning and programming road network.

In conceptualizing an approach of this nature, two distinct types of analysis are essential to be carried out: one, Settlement Level Analysis; and second, Link Level Traffic Analysis. The first type of analysis helps to assess the relative growth performance and potential of settlements in the state. This process also eliminates many relatively unimportant nodes (settlements) and links. The second set of analysis involves assessment of volume of traffic that those potential links carry and enable in prioritization. In order to carefully sieve out such links, a rational and scientific approach needs to be adopted.

6.3 REVIEW OF THE APPROACHES AND TECHNIQUES

6.3.1. Introduction

This section briefly reviews available approaches and techniques for the road network planning, highlighting the advantages and disadvantages of each as well data needs and outputs of the process. The section is divided into two broad sections. While the first section reviews some of
the approaches and techniques related to transport network analysis the second section discusses the settlement analysis. The last section presents the conclusion.

6.3.2. Transport Network Analysis

6.3.2.1. Conventional Transport Planning Process

It comprises subdividing the study area into smaller zones and sub-zones and studying the inter-zonal trip frequencies through OD matrix to prioritise various linkages. This may not be of much use in the given context as it involves enormous amount of data collection in the form of trip frequencies between all pairs of settlement nodes.

6.3.2.2. Modified Conventional Transport Planning Process

This approach is based on estimating OD trip matrices from volume count and a limited number of OD surveys. Traffic counts are particularly attractive as a database because of their availability in the present case. One variation of this approach assumes that trip making behaviors can be explained by a gravity model whose parameters can be calibrated from traffic counts. Another variation relies on entropy and information theory considerations to estimate the most likely trip matrix consistent with the observed flows. A particular feature of this variation is that they can include prior, perhaps outdated information about the matrix.

6.3.2.3. Systems Approach

In this approach, flow of traffic in a road network is considered analogous to the flow of current in an electric circuit. Entire road transportation system is divided into four parts viz. i) Main settlements ii) Main roads iii) Secondary settlements and iv) Secondary roads providing connection to the nearest main settlement. The final network is generated by the concept of "minimal spanning tree" of graph theory. This approach has been developed to suit the planning needs of village roads only as it assumes that only one connection is sufficient for a secondary settlement. Further, this approach assumes that main system of roads is fully developed in its final forms. On the other hand, various other indices available under "Graph Theory" may be used to compare various alternative networks such as Shamble Index, Associated number, First Betti Number / Cyclometric number, degree of circuitry, degree of connectivity, redundancy index, etc.

6.3.2.4. Clustering Algorithm

Network planning involves rank ordering various settlements, so that priorities for linking the settlements can be worked out. The given approach uses a statistical tool called 'non-hierarchical clustering algorithm' for multi criteria aggregation of settlements, using census information. Later on the settlements are interconnected based on an approach similar to 'system approach' which has been described in the previous section. This approach, thus, although being more scientific in rank ordering, suffers from similar drawbacks.
6.3.2.5. Demographic / Socio Economic Approach

This approach, relies heavily on the concept of force of interaction among various settlements in the study area. Computation of force of interaction is done for each pair of settlements. Links which connect settlement pairs with higher force of interaction are given priority over others.

The force of interaction here is calculated using parameters such as population, amount/number of social amenities and facilities available and distance between the pair of settlements. This approach needs complete demographic and socio economic data for the complete set of settlements involved. This approach is computationally easier to tackle as it involves minimal statistical analysis.

In view of the above, two settlements will not have settlement interaction if their centrally scores (CS) are equal. This is misleading because they may still interact for functions which are mutually absent in them.

6.3.3. Settlement Analysis

Each settlement has its own characteristics based on size and economic function. They carry with them a set of commodity function and population. The settlements are distributed as services, manufacturing and management centers. In the process of selecting an appropriate technique to identify the growth potential of settlements, a careful review of various techniques generally adopted to in this regard is undertaken. Some of the generally used techniques are described as under.

6.3.3.1. Near Neighbor Analysis

This was developed by Clark and Evans in 1954. The nearest neighbor analysis helps in distinguishing three kinds of basic distribution points - uniform, random and clustered. This replaces the conventional visual judgment of the settlement pattern by more scientific judgment of their characteristics with the help of nearest neighbor index.

The nearest neighbor index measures the deviation of any spatial pattern of the distribution of points from randomness. It is the ratio of the actual mean distance between the nearest neighbor points in a given area \(D_o\) to the mean expected distance or random distribution of the same number of points in the same areas, i.e., \(D_r\),

\[
R = \frac{D_o}{D_r}
\]

If \(R\) falls between 0 to 1, then the settlement is approaching cluster and if is from 1 to 2.15, then it is approaching uniform. The demerits of this techniques is that the delineation of the study area is arbitrary and hence the technique can not be used for a long period of time.
6.3.3.2. Rank-size Rule

This technique helps in identifying spatio-economic organization of settlements from very simple to complex forms from the population distribution of the region. According to this rule the population of the town is related in the following Pareto’s distribution.

\[ P_r = KR^{-b} \]

where,

- \( P_r \) is the population of the town whose rank is \( R \).
- \( K \) and \( b \) are constants. This regularity was observed by Zipf and later on by Berry who assumed that this regularity prevails in many parts of the world.

Thus if on double log paper the population \( (P_r) \) of towns of an area are plotted on Y axis and their ranks are plotted on the X axis, a scatter diagram will be created which will closely form straight line having negative slope. The diagram will give uniform line if large number of cities are included. The limitation of this technique is that it lacks empirical finding.

6.3.3.3. Flow Analysis

The flow analysis is based on an empirical study of flow which may refer to different forms of spatial flow such as intra-regional flows. It builds up functional regions on the basis of the direction and intensity of flows between the dominant centre and surrounding satellites. Each flow will show decreasing intensity as it becomes more distant from the main centre and increasing intensity as it approaches another centre. The boundary of the sphere of influence of the dominant centre will be where the flow intensity is at a minimum.

The flow may be of several types. They are often economic (such as goods or passenger, and road or rail) or Purpose (such as shopping or commuting). They may be social (such as flow of students or hospital patients); political, especially the flow of government expenditure; or information such as telegrams, newspapers and telephone calls.

6.3.3.4. Gravitational Analysis

This analysis is concerned with the theoretical forces of attraction between centres rather than the actual flows. The simple gravity model assumes that the interaction between two centres is directly proportional to the mass of the centres and inversely proportional to the distance between the centres. The variable used to measure mass and distance depends on the problem and data availability. Mass may be regarded as population, employment, income, expenditure, and retail turnover, and the distance in physical terms, time, price etc. The intervening opportunities notation of model is as under:

\[ T_{ij} = K x \frac{P_i P_j}{(d_{ij})^a} \]

Where \( T_{ij} \) is the gravitational force between towns \( i \) and \( j \), \( P_i \) and \( P_j \) are the masses of the two centres, \( d_{ij} \) is the distance between them, and \( k_i, a \) are constants.
6.3.3.5. Scalogram Technique

Named after Guttman, this technique is used to identify device that ranks settlements in an area by their functional complexity based on the number and type of functions that are located within them. In this method, firstly the settlements are arranged in descending order of population size and total number and type of facilities in each settlements are noted. Secondly, the facilities are arranged in descending order in terms of total number and types of facilities located in all settlements. Thirdly, the institutional hierarchy of settlements is demarcated. This technique, although gives a comparative picture of the type and level of different functions in the selected settlements it does not provide the nature of interaction and the growth of facilities over a period of time.

6.3.3.6. Sociogram Technique

This technique shows graphically the pattern of interaction or inter-dependence by the movement of people between settlements for selected facilities. In this technique, firstly, the dependency of people for different facilities are marked on different maps. Secondly, superimposed layers are prepared to identify spatial gaps and suggest the possibility of locating new service centres.

6.3.3.7. Bisection Technique

This method is designed to identify on map the high level, middle level or lower level service centres geometrically dividing space on the basis of some knowledge of the ranking of service centres. It is based on the assumption that lower level service centres are expected to develop in the middle of higher level service centres. Thus, if one or two of the most important centres of the specific areas and in the neighbouring area are known, it is possible to logically expect lower level service centres around the bisection line.

6.3.3.8. Cumulative Function Index Technique

This technique is regarded as one of the most rationale method to identify the functional and growth performance of the settlements in a given region. The technique is described as under:

**Step 1**: As a first step, the actual values of each indicator against each settlement has to be tabulated.

**Step 2**: The comparative assessment of Performance Index can be arrived at by using the following formula.

\[ PI = \left( \frac{N - \text{Min}}{\text{Max} - \text{Min}} \right) \times 100 \]

Where, 
- \( N \) = Observed value of each indicator against each settlement
- \( \text{Min} \) = Minimum value of the selected indicator
- \( \text{Max} \) = Maximum value of the selected indicator
- \( PI \) = Performance Index
Technical Assistance for Implementation of Institutional Reforms in Road Sector of Uttar Pradesh

Hence, for example, for settlement A:

\[ A = \frac{6.4 - 4.4}{6.86 - 4.4} \times 100 = 81.3 \]

Repeat the exercise for all the settlements and for all the indicators.

**Step 3:** Construct a table and list all the Performance Index values for all the settlements.

**Step 4:** Add all the values for settlement A and arrive at a Cumulative Functional Index (CFI) value. Repeat the exercise for all the settlements. Rank them accordingly to know the comparative level of growth performance.

### 6.3.3.9. Weightage Index Method

The steps in adopting this method are as follows:

**Step 1:** All the selected indicators have to be assigned a score\(^5\) as under:

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a) Present Economic Base</strong></td>
<td>100</td>
</tr>
<tr>
<td>i) Presence of Industrial Estate</td>
<td>25</td>
</tr>
<tr>
<td>ii) Presence of Industrial Area</td>
<td>25</td>
</tr>
<tr>
<td>iii) Presence of APMC Marker</td>
<td>25</td>
</tr>
<tr>
<td>iv) Presence of Weekly Market</td>
<td>25</td>
</tr>
<tr>
<td><strong>b) Accessibility</strong></td>
<td>200</td>
</tr>
<tr>
<td>i) Connected by NH</td>
<td>25</td>
</tr>
<tr>
<td>ii) Connected by both NH and SH</td>
<td>25</td>
</tr>
<tr>
<td>iii) Connected by SH</td>
<td>25</td>
</tr>
<tr>
<td>iv) Connected by MDR/ODR</td>
<td>25</td>
</tr>
<tr>
<td>v) Connected by both MDR and ODR</td>
<td>25</td>
</tr>
<tr>
<td>vi) Connected with only District H.Qs</td>
<td>25</td>
</tr>
<tr>
<td>vii) Connected with only Taluka Headquarters</td>
<td>25</td>
</tr>
<tr>
<td>viii) Connected with both District and Taluka Headquarters</td>
<td>25</td>
</tr>
<tr>
<td><strong>c) Committed/ On-going Projects</strong></td>
<td>100</td>
</tr>
<tr>
<td>i) Industrial Projects (Both Private and Public Sector)</td>
<td>25</td>
</tr>
<tr>
<td>ii) Commercial (e.g. Mandles, Wholesale markets)</td>
<td>25</td>
</tr>
<tr>
<td>iii) Institutional (e.g. Colleges University)</td>
<td>25</td>
</tr>
<tr>
<td>iv) Recreational (e.g. Amusements Parks, Theme Parks)</td>
<td>25</td>
</tr>
<tr>
<td><strong>d) Tourism/ Potentials</strong></td>
<td>100</td>
</tr>
<tr>
<td>i) Religious, Scenic Beauty, Adventurous, Wild Life, etc.</td>
<td>100</td>
</tr>
</tbody>
</table>

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\(^5\) This is just an illustrative scoring table. The actual scores would be specific to the regional and settlement characteristics under study.
### Step 2: A Table has to be constructed wherein the relevant scores of each indicator for all the settlements have to be listed. The total of each row would give the Development Rating of an individual settlement. The formula for arriving at the Final Development Potential Index is

\[
\text{DPI} = \left(\frac{N}{n}\right)
\]

Where,

- \(N\) = The Total value of each settlement (or) Development Rating
- \(\text{DPI}\) = Development Potential Index
- \(n\) = Number of parameters (groups) used.

#### 6.3.4. Conclusion

The TA consultants, after a careful review chose the last two techniques as the most relevant ones towards preparation of master plan for road network. These two techniques in addition to mapping analysis are used extensively in order to sieve out the potential nodes (settlements) and the potential links that connect them. The TA consultants conceive this to be a rigorous and sequential multi-stage analysis before sieving out such important links in the whole State. The sieving out gives full framework of thoughts on economic domain and decision making framework.

### 7. THE SYSTEMS APPROACH TO PERSPECTIVE NETWORK PLANNING AND ECONOMIC DECISIONS

#### 7.1 THE DOMAIN

The road network at the state level comprises various classifications. The traffic utilization and the intensity levels on the road corridors reflect the importance and the priority to be accorded thereon in making economic investment decisions. The traffic volumes vary within and across the various road classifications.

The investments in the road sector are seen to be of very high magnitude. With limited budget and resources, the road projects to be implemented need to be streamlined, and prioritized. Towards according priority for planning the investment decisions, it is important to have a comprehensive view of the network, and systematically evolve thereon a high density network for investments.
The identification of high density corridors is a problem of distinct character. Peculiarity lies in the fact that the set of roads in the state carry a wide range of traffic volume. Owing to a virtual lack of planning initiatives in the development of such road network, standard procedures are not available. Developing a suitable approach and methodology therefore is of prime importance.

7.2 THE MODEL SCOPE OF WORK

The TOR suggested is for identification of high (or heavy) density road corridors in the state which would carry heavy traffic volume in the order of 5000 PCU/day and more, and identification of a grid of such routes of size 30km x 30km. The different conditions as laid out in the model TOR can be the following:

(i) that the high density road corridors identified shall result in a grid of 30km x 30km and in no cases be larger than 40 km x 40 km.
(ii) that all district headquarters need to be connected,
(iii) that the identified routes require to pass through 50 per cent of the tehsils in any given district,
(iv) that the identified road corridors shall not be more than 5 Km away from the existing and proposed industrial centers,
(v) that the identified routes shall include all routes with high potential for development of traffic or those routes which would attract diverted traffic, and
(vi) that the identified routes shall facilitate development of ports through privatisation initiatives.

7.3 ABSTRACTION AND APPROACH

The TOR basically involves formulating a network of high density roads by prioritising road links which are part of a larger network of state highways (SHs), major district roads (MDRs) and some other district roads (ODRs).

Main aim of a network is to fulfil the movement needs of populations and goods. The pattern of network must be conducive to the traffic movement pattern in the region/state. The movement pattern will depend upon spatial distribution of various settlements and locational pattern of various functions and amenities in the region. Movement from one settlement to another and the intensity of such movement depends on the requisition and degree of dependence between these settlements for their socio-economic needs.

Road network mainly consists of a set of settlements and a set of roads. The process of roads network planning mainly consists of identifying various settlements and connecting them in an optimal way.
A synthesis of various techniques available\(^6\) is found suitable. The approach adopted should combine most of the advantages of the several techniques available. The conceptualisation of approach leads to formulation and fixation of two distinct phases which will form part of the exercise. This two-pronged strategy involves analysis of both settlements as well as network. The following sections explain this approach in further detail.

### 7.4 METHODOLOGY SUGGESTED

Methodology proposed for development of network master plan involved sequential screening of overall universal road network in the state. Such screening should be done at two levels - settlements-wise and link-wise. Settlement-wise screening included screening based on settlement performance and settlement growth potential. The links should be eliminated further based on traffic utilisation levels and subsequently based on traffic demand levels. The steps for undertaking the exercise are described in further detail in the succeeding sections.

#### 7.4.1. Stage-I: Mapping Analysis

(a) **Preparation of Universal Base Map:** This includes identification and location of the transportation network (as per the state's Perspective Road Development Plan) on the state map showing NHs, SHs, MDRs and ODRs. This also include demarcation of the higher order roads already being developed under various schemes such as, UPSRP, etc.

(b) **Identification of Settlement Pattern:** This sub-stage helps in assessing the spatial distribution of population, amenities and facilities and consequent traffic volume. This sub-stage may include the following:

(i) Identification of settlements based on the following three criteria:

- all urban centers are selected,
- all rural settlements with administrative status of tehsil headquarter (THQ) are selected, and
- all other rural settlements with a population of more than 10,000 persons, are also identified.

The identified settlements should be plotted on the universal base map.

(ii) Administrative status of all settlements should be identified.

(iii) Major transportation network (including NHs, SHs, MDRs) showing existing facilitation of movement.

\(^6\) Available standard techniques (such as Conventional Transport Planning Process, Modified Conventional Transport Planning Process, Systems Approach, Clustering Algorithm, Demographic/socio-economic Approach etc.) have been found to be only partially adequate to deal with the study requirements. Various advantages and disadvantages of all these techniques have already discussed.
(c) **Establishment of the Level of Analysis:** In the process of settlement level analysis, cognition of the existence of development hierarchies for settlements within a region as well as the same from region to region are necessary. Settlement analysis may be carried out at state, district or regional level. Establishment of a suitable level of analysis is the outcome of the following:

(i) assessment of spatial distribution of population,
(ii) assessment of spatial variation in urbanisation, and
(iii) assessment of spatial variation in the growth of urbanisation.

This established level of analysis should be used in all further analysis of settlements.

7.4.2. **Stage-II: Settlement Performance Analysis and Network Establishment**

Traffic volume is a direct consequence of interaction and dependence among settlements in the pursuit of socio-economic needs. A settlement is supposed to fulfil socio-economic needs and missing activity functions through its dependence on proximate settlements. This includes both forward and backward linkages. Therefore, the functionally useful network over a region will be the one which facilitates primary requirement of settlement interaction. The intensity of traffic and development of the same would also depend on and coincide with the direction of growth. Levels of existing and latent transportation demand can be assessed as a consequence of growth of settlements and growing urbanisation. Thus, at this stage, relative growth performance of settlements should be analysed, and suitable networks established. This would include the following sub-stages:

(a) **Settlement Performance Analysis:** This involves assessment of the relative growth performance of all the settlements identified in Stage- I. The following indicators can be used to analyse growth performance of settlements:

(i) growth rate of population by settlements as a measure of traffic demand,
(ii) growth rate of main workers by settlements as a measure of intensity of activities in the settlements, and
(iii) growth rate of secondary and tertiary sector workers which denotes functional character of settlements and which in turn will govern the level of traffic generation.

The growth performance analysis using all the above indicators needs to be carried out using Cumulative Function Index (CFI) method. The composite index developed, called the **Settlement Potential Index (SPI)**, should be graded and such graded indices need to be used in the succeeding stage of network establishment. All settlements and the respective SPI should be plotted on the universal base map on GIS format.

(b) **Preliminary screened network (PS Network) Establishment:** This will involve identification of routes/road corridors as per priority by SPI as established. The several issues involved in the network establishment are:
• all settlements as identified earlier needed to be connected by the identified network,
• the network should give priority to the connecting links as per SPI gradation of settlements,
• the network should give priority to the links as per hierarchical classification of road segments, and
• the network should include the primary road network already developed/existing.

A suitable algorithm needs to be developed and the requisite network established on GIS format. This network of potential high traffic volume, called the PS Network should be used in the succeeding stages of analysis and screening of network thereon.

![Figure 3: Networking Algorithm](image)

7.4.3. Stage-III: Settlement Growth Potential Analysis

This stage involves the assessment of growth potential of the settlements, as identified earlier. This has been proposed to generate a composite index which would be used to sieve out a few and identify the high traffic volume generating settlements.

This index, called Settlement Growth Potential Index (SGPI) should be a composite of the following:

(i) population size of settlements as a measure of traffic volume generated by the settlements at present,
(ii) as a measure of the traffic generation potential latent in the settlements as per the existing state of economic activities, the following indicators should be considered for analysis:

- growth of population by settlements,
- growth of main workers by settlements, and
- growth of secondary and tertiary sector workers by settlements.

(iii) as government programmes (including industrial and infrastructure development) tend largely to concentrate in and around settlements of higher administrative status requiring a lot of service facilitation; and as development of settlements depends on identified/pattern of priority investment decisions and development, the following indicators can be used:

- administrative status of settlements such as DHQs and THQs, and
- priority status identified as per National Commission on Urbanisation (NCU), such as NPCs, SPCs and GEMs.

(iv) as a measure of proposed development potential and consequent high traffic volume generating ability, the following parameters can be considered as indicators:

- identified and existing settlements with tourism potential, and
- proposed and existing industrial development potential of settlements.

As evident the indicators described above are different from each other in quality and in numerical significance. Analysing all these would require suitable statistical technique for bringing about comparability among the indicators. All indicators, subsequently, should be scaled and graded, and uniform numerical values arrived at, for each of the indicators vis-à-vis settlements. A composite index can be developed assigning suitable weightages to each of these indicators. The SGPI, as arrived should be assigned to settlements on the PS Network.

7.4.4. Stage-IV: Intermediate Screening of Network

a) Establishment of cut-off point: With the SGPI available through preceding stages of analysis, it will be possible to establish a cut-off point in order to sieve out certain number of settlements and consequently a few of the links. The cut-off point should be established after an assessment of the SGPI vis-a-vis the following criteria:

- SGPI vis-a-vis population of settlements,
- SGPI vis-a-vis growth rate of population,
- SGPI vis-a-vis growth rate of main and non-farm workers, and
- SGPI vis-a-vis potential industrial and tourism development centers.
b) **Screening of Network:** A cut-off-point has to be applied to the settlements on the PS Network and settlement having SGPI value lower than the cut-off point need to be sieved out.

Following the procedure and algorithm developed in the establishment of PS Network (as applied on the Universal Base Map), the links are sieved out at this stage, on the PS Network.

The resultant network thus derived should be rationalised following the principles of:

- Minimum distance,
- Hierarchical classification of roads, and
- All other principles as laid down in the TOR.

This screened network, called the Intermediate Screened Network (IS Network) should be used for subsequent link level traffic analysis.

### 7.4.5. Stage-V: Traffic Intensity and Utilisation Level Analysis

So far, the total approach towards getting a high density network has been `settlement' focussed. Although based on a set of strong reasonings and premises, it leaves a lot unsaid about the criteria which directly contributes to the `density', whether `high' or not. The criteria was the `Traffic Volume Level'. Whether a link is a high-density-link or not depends solely on the intensity of traffic plying on it. And this directly contributed to the problem of finding out utilisation levels of the links concerned.

Utilisation levels of road links should be analysed by assessing the traffic volume in relation with the capacity of the link. The capacity of any road section here is defined as the number of vehicles that can be cleared subject to a given minimum average speed for mechanised vehicles, say, 60 kmph. The capacity would vary with the `mix' of the various types of vehicles that passes over the road sections. Given a road section with certain specifications regarding surface quality and width of roadway, the section will have different mean speeds of mechanised vehicles for different vehicle-mixes. The state PWD has formulated a hierarchy of roads based upon the parameters discussed above according to which, each link or section in the state's road network conforms to a set of width/surface characteristics and mix type.

Thus, the traffic utilisation levels should be assessed based on traffic volume band levels by link hierarchy. One alternative of doing this could be to go in a traditional manner and find out volume-capacity ratio for each and every link. The output of such analysis would be a single ratio associated with each link. This in turn makes the whole analysis link-specific, robbing the comprehensiveness and integrity of the total approach.

Instead, it is proposed to code the entire network in computer based Geographical Information System. This means that along with different ratios and specification for each link, alongwith its geographical location and inter-relationship with other geographic features in the entire network. This network is further graded according to the hierarchy of the links which ultimately enables us to access each and every particular link simultaneously on the network-map and a database inherently adjoined.
Further, this information system (the GIS) would be in addition to the parallel GIS created for settlement analysis and involves distinct digitization and vectorisation of every link on the network. Although this involve a gigantic effort, in no way, it means that the two GISs would be unrelated. Instead, the two layers of information would be geographically superimposed so that decisions regarding high-density corridors can be made from the synthesis of the two. This will maintain the comprehensiveness and integrity of the total analysis and avoid any pitfalls of ad-hoc or piecemeal approaches towards such problems.

This whole analysis is primarily aimed at appreciating the intensity and utilisation levels of road links of Intermediate Screened (IS) network identified at the previous stage of the methodology. The following are sub-stages involved in this traffic analysis:

(a) **Compilation of Traffic Census Data**

The historical traffic volume census data provided by the state PWD, first, needs to be compiled. This becomes all the more necessary, as the data is needed to be transferred and coded with GIS system for different points in time and space (time-series and spatial distribution of data)

(b) **Base Year Traffic:**

The data compiled from different sources will be for different years and time periods. Although, this cannot be termed as anamoly in anyway, it demands a comparative appreciation and formulation of a single base year data, so that a level field could be provided for further analysis.

(c) **Traffic Volume Prediction Models:**

The complete set of traffic volume data compiled in the above two steps may still leave certain gaps for some of the links. These are mostly those parts of stretches of corridor for which existing number of count points did not suffice. This is so because of some intermediate settlements which fall along its length and become capable of changing the nature of flow on it. Thus, Traffic Volume Prediction Models (TVP models) should be developed to over-come the data gaps.

Uttar Pradesh being a large state, it would be infeasible to develop a single model which can predict traffic volumes all over the state. This being so, the whole state should be divided into smaller units based on traffic volume - homogeneity characteristics. For each one of these units, an area level model needs to be developed for near accurate link volume establishment.

It was discussed earlier that , the relative attractiveness of settlements (in traffic terms) can be hypothesised to be a function of different parameters such as population (absolute), growth of population, growth of main workers, growth potential (industrial and tourism) etc. After testing each one of these parameters, in one of the studies undertaken, it was found that SGPI (Settlement Growth Potential Index) is most ideal to relate for traffic estimation. This is so because SGP Index combines existing as well as latent growth potential in one single parameter. Multiple linear regression (MLNR) technique is used to develop such relationships which are then validated with actual counts as well as statistical checks such as T-test and F-test. The volume so assessed are combined with previously compiled data and transferred to the IS network.
(d) Network Screening:

This step involved joining the total traffic volume database with the base-network map. It is followed by plotting the same data on the map which enabled identification and screening of road links carrying traffic volume below 5000 PCU. This was done taking care that if an alternate route/link is available on either side (within 15km) of link than it is to be removed. If this was not so, the link will be retained inspite of its low volume. This is required to achieve the ultimate objective of forming 30km x 30km grid and identifying ‘Potential High Density Network’.

7.4.6. Stage-VI : Traffic Growth and Demand Analysis

In the last section, it was mentioned that the traffic volume data base may be available not just for one single point in time. Instead it may be on a time series basis. These trends should be used to generate volumes for the coming five to ten years. Further, the state’s development scenario has been studied at macro level to appreciate potential traffic generation along with assessing the potential traffic diversion from Origin-Destination data available from earlier studies. This data can be analysed by plotting desire lines between every pair of settlements and thus, identifying major corridors of movement.

Validation of the trends observed in time-series data should be undertaken to build confidence and reliability in the future predictions. This appreciation and analysis shall lead to fixation of assessed traffic level in the coming five to ten years. A further screening needs to be done to eliminate relatively low volume road links and get a grid of High Density Network only.

7.5 THE CHECK

The resultant corridors identified and the grids formulated need to be subjected to a thorough check in order to assess its being conducive to fulfil all criteria as per TOR.

8. PRESENTATION TO PROJECT STEERING COMMITTEE
Report No. 29: Review Report on Development of Road Network Master Plan

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The various Road Plans reviewed to make the suggestions for the preparation of **Network Master Plan** were:

**Perspective Road Development Plan for India: Vision – 2020** (dated 2001)

**Pradhan Mantri Gram Sadak Yojana – PMGSY**

**State Road Development Plan**
CURRENT SITUATION

A major gap exists in evolving the Long Range Perspective Road Network Master Plans at the State level in India. The State of Uttar Pradesh is no exception to this.

CURRENT CONTEXT

The demand for roads and road transport is growing. This demand requires a Comprehensive Development Road Network Master Plan for developing all categories of roads within the State of UP. This will ensure that all development is in accordance with a pre-determined Master Plan and does not follow the present ‘ad hoc’ process.
Report No. 29: Review Report on Development of Road Network Master Plan

MIDDLE ORDER ROADS – A CASE OF OMISSION
REQUIREMENTS

- Identification of links which carry heavy traffic volume of certain level (say 5,000 PCU/day) and more and identification of a network of such routes.

- The link should connect one-district head quarters to other headquarters and must pass through (at least 50 percent of) the talukas in a district.

- The link in a grid should take into account all potential development corridors and/or such routes, which attract diverted traffic.

- Existing and proposed industrial area should not be more than 5 kms away from such links.
DEVELOPING A NETWORK MASTER PLAN

Two distinct types of analysis are essential:

1. **Settlement Level Analysis** - helps to assess the relative growth performance and potential of settlements in the State. This process also eliminates many relatively unimportant nodes (settlements) and links.

2. **Link Level Traffic Analysis** - involves assessment of volume of traffic that those potential links carry and enable in prioritization. In order to carefully sieve out such links, a rational and scientific approach needs to be adopted.
TRANSPORT NETWORK ANALYSIS

1. Conventional Transport Planning Process
   Entails subdividing the study area into smaller zones and sub-zones and studying the inter-zonal trip frequencies through Origin Destination matrix to prioritise various linkages. This involves an enormous amount of data collection in the form of trip frequencies between all pairs of settlement nodes.

2. Modified Conventional Transport Planning Process
   This approach is based on estimating Origin Destination trip matrices from volume count and a limited number of Origin Destination surveys. Traffic counts are particularly attractive as a database because of their availability in the present case.
3. Systems Approach
In this approach, the flow of traffic in a road network is considered analogous to the flow of current in an electric circuit. The entire road transportation system is divided into four parts viz. i) Main settlements, ii) Main roads, iii) Secondary settlements, and iv) Secondary roads providing connection to the nearest main settlement. This approach has been developed to suit the planning needs of village roads only as it assumes that only one connection is sufficient for a secondary settlement.

4. Clustering Algorithm
Network planning involves rank ordering various settlements, so that priorities for linking the settlements can be worked out. It uses a statistical tool called 'non-hierarchical clustering algorithm' for multi criteria aggregation of settlements, using census information.
Demographic / Socio Economic Approach

This approach, relies heavily on the concept of force of interaction among various settlements in the study area. Computation of force of interaction is done for each pair of settlements. Links which connect settlement pairs with higher force of interaction are given priority over others.

The force of interaction here is calculated using parameters such as population, amount/number of social amenities and facilities available and distance between the pair of settlements. This approach needs complete demographic and socio economic data for the complete set of settlements involved.
SETTLEMENT ANALYSIS

Each settlement has its own characteristics based on size and economic function. They carry with them a set of commodity function and population. The settlements are distributed as services, manufacturing and management centres. In the process of selecting an appropriate technique to identify the growth potential of settlements, a careful review of various techniques generally adopted in this regard is undertaken.

Cumulative Function Index and Weightage Index are recommended as the two most relevant techniques that could be adopted.
The steps for Developing the Road Network Master Plan are:

**Stage I**: Mapping Analysis

**Stage II**: Settlement Performance Analysis and Network Establishment

**Stage III**: Settlement Growth Potential Analysis

**Stage IV**: Intermediate Screening of Network

**Stage V**: Traffic Intensity and Utilisation Level Analysis

**Stage VI**: Traffic Growth and Demand Analysis
ANNEXURE - 1: PRADHAN MANTRI GRAM SADAK YOJANA (PMGSY) GUIDELINES

1. INTRODUCTION

1.1 Rural Road Connectivity is not only a key component of Rural Development in India, it is also recognised as an effective Poverty reduction Programme. Notwithstanding the efforts made, over the years, at the State and Central levels, through different Programmes, about 40% of the Habitations in the country are still connected by all weather roads. It is well known that even where connectivity has been provided, the roads constructed are of such quality that they cannot be categorised as All-weather roads.

1.2 Government have resolved to provide Rural Road Connectivity to all habitations and accordingly decided that 50% of the Cess on High Speed Diesel (HSD) would be earmarked for this Programme. Accordingly, Rs. 2500 crore (being 50% of the Cess on High Speed Diesel (HSD) has been earmarked for the purpose during the year 2000-2001.

1.3 On the 15th August 2000, the Prime Minister announce a Centrally Sponsored Scheme called the Pradhan Mantri Gram Sadak Yojana with the objective of connecting, within next three years, every village that has a population of more than 1000 through good All-weather roads and every village of more than 500 persons similarly connected by the year 2007. The budget for the year 2000-2001 indicates the flow of funds for Rural Roads as Additional Central Assistance. Since this has been taken into consideration while determining the Plan size of States, it is proposed to retain the arrangement as such for this year. From the year 2001-2002 onwards, it is proposed to commence a 100% Centrally Sponsored Scheme, with the same objectives.

2. PROGRAMME OBJECTIVES AND COVERAGE

2.1 The objective of the Government is to provide Road Connectivity, through good All-weather roads, to all Rural Habitations with a population of more than 500 persons by the year 2007 (end of Tenth Plan Period). In the process, all unconnected Habitations having a population of more than 1000 persons would be covered in the next three years. Accordingly for the year 2000-2001, the Programme would cover Habitations having a population of more than 1000 persons. Where a State has no uncovered Habitations of this population size, smaller habitations may also be covered, subject to the minimum population size being 500. In case of hilly/desert tracts, this may not be less than 250.

2.2 The primary focus of the programme will be on construction of new roads. However, upgradation (to prescribed standards) of existing roads will be permitted to be taken up under the programme so as to achieve connectivity through good All-weather roads. In taking up upgradation, the population norms indicated in Para 2.1 above shall be observed. Upgradation would involve conversion, depending on the need of Gravel roads/Water Bound Macadam (WBM) roads to Black-Topped (B.T.). Extension of existing roads to the SC/ST Habitations in the village would also be covered under upgradation. Upgradation would, however, not cover repairs of existing Roads.
2.3 The Programme shall cover only ‘Other District Roads’ (ODRs) and ‘Village Roads’ (VRs).

2.4 The Rural Roads to be taken up will, by and large, be surfaced roads (black topped/cement concrete). However, depending upon the soil conditions, All-weather roads may also be Gravel Roads, but with all necessary cross-drainage structures.

3. IMPLEMENTATION OF THE PROGRAMME

3.1 Each State Government / UT Administration would identify one or two suitable Agencies (having a presence in all the Districts and with established competence in executing time-bound programme), to be designated as Executing Agencies.

3.2 At the District level, the Programme will be planned, coordinated, and implemented through the Executing Agencies. A Programme Implementation Unit (PIU), entirely directed towards the programme, will be set up in all the Districts concerned. All PIUs will be manned by competent technical personnel from amongst the available staff or through deputations and no new posts will be created for the purpose.

3.3 The State Governments will establish suitable linkages in this behalf with the District Rural Development Agencies (DRDAs). Funds would be released to the concerned DRDAs for the year 2000-2001.

District Rural Roads Plan

3.4 The PIU will formulate a Master Plan for each Block indicating the Habitations in that Block and the existing status of road connectivity, including the proposed new construction as well as roads requiring upgradation. Roads under construction under other Schemes such as RIDF, the erstwhile BMS, externally aided projects or State/District Sector Schemes should also be clearly specified. This shall thereupon be integrated into a District Master Plan, to be called the District Rural Roads Plan. The Plans so prepared would be subject to close technical scrutiny so as to arrive at the most economical cost of achieving the targets of the Programme and would also indicate the spacing execution of works. The Master Plan would be approved in the Governing Body of the respective DRDA, taking into account the views and suggestions of the local Members of Parliament and Members of State Assembly.

State Level Standing Committee

3.5 The DRDA will, thereupon, forward the Master Plan to the State-Level Standing Committee, set up by the State Government (ideally headed by the Chief Secretary), to ensure close and effective monitoring of the Programme. Upon approval by the said Standing Committee, the project proposals would be forwarded by the State Government to the Ministry of Rural Development.

3.6 It will be the responsibility of the Standing Committee to oversee that lands are available for taking up the proposed road works. A Certificate to this effect will accompany all the proposals. No provision is to be made for the Land Acquisition under this Programme.
Empowered Committee

3.7 At the Central level, the Project proposals received from the State Governments would be considered by an Empowered Committee (to be Chaired by Secretary, Department of Rural Development) and including the AS&FA, Ministry of Rural Development; Advisor/Additional Adviser (Transport), Planning Commission; Director, Central Road Research Institute, New Delhi; One Expert to be nominated by the Ministry of Rural Development; and Joint Secretary (RC), Department of Rural Development as Members. The Deputy Secretary/Director handling the Programme in the Ministry of Rural Development would be the Convener. The representatives of the State Government, whose projects are being considered by the Empowered Committee, may be invited to attend the Meetings, as and when required. The recommendations of the Empowered Committee would, thereafter, submitted to the Ministry of Rural Development for further orders / approval.

4. EXECUTION OF WORKS

4.1 On clearance of the Project proposals, the relevant projects would be executed by the PIUs and completed within a period of 9 months, from the date of approval; in exceptional cases, this period may be extend up to 12 months. Delayed execution of projects could also hold up further sanctions.

4.2 The well-established procedure for tendering, through competitive bidding, would be followed for all projects. The projects would be tendered in packages of appropriate size (between Rs. 1 crore to Rs. 5 crore).

4.3 The road works, including the Cross Drainage works, will be executed as per the technical specifications prescribed by the Ministry of Surface Transport/Indian Roads Congress. The Ministry of Rural Development will, in due course, issue further Guidelines in this regard. Special care will be taken in coastal areas etc. to see that the shoulders are duly consolidated. Use of locally available material, including product like Ash, should be encouraged subject to adherence to technical norms. The roads must have proper drainage facilities. The bridges may be designed as to serve, where feasible, as bridge-cum-Bandharas. No lead charge would be payable for transportation of soil (except in case of Black Cotton soil).

4.4 Time / Cost over-runs (and consequent cost escalations) will not be permitted and, in such and eventuality, the State Government concerned would have to bear the additional expenditure. To avoid such a contingency, the Executing Agency will incorporate suitable Penalty Clauses in the Contract.

4.5 The roads constructed under this programme are expected to be of very high standard, requiring no major repair for at least five (5) years after completion of construction. In order to realise this objective, suitable clauses relating to Performance Guarantee shall be included in the Contract Documents.

4.6 Planting of fruit bearing and other suitable trees, on both sides of the roads, would be one of the contract conditions.
4.7 It will be the responsibility of the PIUs to ensure timely payments to the contractors. Each Road works will be photographed at three stages – beginning, middle and at the final stages.

4.8 The Ministry of Rural Development will indicate the design of a logo, road borders and all relevant information and these will be duly installed.

5. **SUPERVISION OF WORKS AND QUALITY CONTROL**

5.1 Quality of works being the essence of this Programme, all works will be effectively supervised. It will be the prime responsibility of the PIU to make certain that the work done (and all the materials utilised in the same) conforms to the prescribed specifications. In addition to checking the quality of materials at site, the steps warranted in this direction should include:

- Obtaining the Test Certificates of manufactured materials from the sources from which these are procured.

- In the case of mineral aggregate, inspection of the quarry, (or even stationing a representative) to ensure that only approved rock is crushed to the required sizes.

- For works involving processing (i.e. stabilisation or compaction involving equipment), requiring the contractor to do the work on a trial stretch so as to ensure that the equipment and procedures used turn out work of the highest quality.

5.2 Periodic inspections of works will be carried out by the competent supervisory Authorities of the Executing Agency. It will be necessary for the Executing Agencies to set up Quality Control Units, independent of the PIU.

5.3 The State- level Standing Committee will oversee that the supervision of works is continuous and effective.

5.4 The Ministry of Rural Development will engage Independent Monitors (Individuals / Agency) for inspection of works under the Programme. It will be the responsibility of the PIU to facilitate the inspection of works by the Monitors, who shall be given free access to all records, administrative, technical and financial.

6. **MONITORING**

6.1 The Ministry of Rural Development would evolve suitable software for an "Online Management & Monitoring System". The State authorities are advised to equip the PIUs with necessary Computer Hardware to enable on-line monitoring. The cost of the Hardware may be included in the Project cost. The cost would also include the cost of digitisation of maps, for which the Ministry of Rural Development would issue separate Guidelines.

6.2 The Ministry of Rural Development will in co-operation with the Nodal Department for the Programme at the State Level organise suitable Training Programmes for the PIU personnel.

6.3 The Ministry of Rural Development will prescribe Periodical Reports and Returns for monitoring the performance and progress of Projects taken up under this Programme.
7. MAINTENANCE OF RURAL ROADS

7.1 The Rural Roads constructed / upgraded under this Programme will be maintained by the concerned Panchayati Raj Institution (District Panchayat / Intermediate Panchayat). The concerned Panchayati Raj Institutions would need to be identified while submitting the project for approval and the State Authorities will be required to furnish an Undertaking that they would remit (to the identified Panchayats Raj Institution), from the State Government funds, the requisite cost of maintenance. The State Government will also offer an Undertaking for the release of maintenance costs, along with their project proposals. The Ministry of Rural Development would oversee the implementation of this undertaking.

7.2 Efforts will be made to involve local people’s participation in the maintenance of Rural Roads. Suitable mechanisms and procedures will be evolved by the State Governments in consultation with the Ministry of Rural Development.

8. FUNDING

8.1 For this year (2000-2001) only, funds under the Programme are being provided by the Centre to the States as Additional Central Assistance (ACA) and will follow the normal pattern of Additional Central Assistance. The Ministry of Rural Development will indicate the manner of release of funds, possibly including an "On-line payment system" for the Programme from the next financial year.

8.2 The Ministry of Rural Development may allocate additional funds to any State taking into consideration, inter alia, the Special Problems/Needs of specific areas.

8.3 For the year 2000-2001, the cost of the approved Projects will be released to the concerned DRDAs, through the State Governments, in two installments. The release will be made by the Ministry of Finance on the recommendations of the Ministry of Rural Development. State Governments will be required to transfer funds to the concerned DRDAs within 15 days of release by Government of India. The funds will be nonlapsable at the DRDA level.

8.4 It will be incumbent on the DRDAs to open a separate and single Bank Account for the funds received under this Programme. These funds will remain entire separate from those of any other Programme/Scheme. The interest earned on this Account will not be diverted to any other Programme, even on temporary basis.

8.5 The funds for the Second Installment will be released after fulfillment of procedures prescribed by the Ministry of Rural Development, which will include satisfactory reports from Independent Monitors engaged by the Ministry of Rural Development. For the year 2000-2001 alone, the Ministry of Rural Development may release the entire approved cost in one installment, subject to the total release being limited to the allocation for the State / UT.

8.6 The Head of the PIU, subject to not being below the rank of an Executive Engineer, will be competent to operate on this Account, subject to the normal rules and regulations of the State Government concerned. The funds earmarked for each Project are to be utilised for the Project only. The Head of the PIU will sent a Monthly Account to the
Project Director, DRDA. The Second Installment for each Project will be claimed by the Project Director, DRDA through the State Government.

8.7 It will be open to the State Government to nominate the Head of the District PIU as the ex-officio Project Director, DRDA for the purposes of this Programme.

9. ACCOUNTS & AUDIT

9.1 The well-established accounting system of the Works Departments would be utilised for this Programme. The Ministry of Rural Development may evolve suitable accounting procedures, including computer-based ones, keeping in view the normal procedures that are in force.

9.2 The Ministry of Rural Development would lay down the Audit requirements for the Programme. In addition to such Audit procedures as may be prescribed, the works under this Programme would be subject to audit by the Office of the Comptroller and Auditor-General of India (C&AG). The Audit of the work done would cover aspects of quality, in addition to financial audit.

9.3 All the road works will be subjected to Social Audit by way of discussion in the Gram Sabha. Relevant information in this regard will be made available to the Gram Sabha. State Governments will issue necessary instructions in this regard.

10. MISCELLANEOUS

10.1 No Agency charges will be admissible for road works taken up under this Programme. The Executing Agencies will not levy charges in any form, such as Centage charges etc.

10.2 The Ministry of Rural Development may allow costs incidental to execution of the road works, such as Telephone and other Office expenses, and cost of travel and may lay down suitable Guidelines in this regard. Such cost would be treated as Project expenses and would be debited to the Project Cost.

10.3 To maintain quality and ensure timely completion of works, the Ministry of Rural Development will lay down a scheme of incentives/disincentives to the States/Districts.

10.4 The Ministry of Rural Development may, from time to time, issue such directions as may be necessary for smooth implementation of the Programme.

10.5 For the year 2000-2001 only, the Project proposals may include the road works initiated under the erstwhile Basic Minimum Services (BMS) Programme which are still incomplete. The Project proposals should clearly specify the value of the work done under the BMS component and the value of the work remaining incomplete. Such works shall be completed within the specified period.
Annexure - 2:
An Example of Participation Agreement

INDIA

STATES' ROAD INFRASTRUCTURE DEVELOPMENT

TECHNICAL ASSISTANCE PROJECT

MODEL PROJECT IDENTIFICATION AND PREPARATION FRAMEWORK

(PIPF)

Objective and Strategy

1. The overall objective of the Bank's assistance is to improve the beneficiary State's road transport infrastructure (physical network, operations and management) in a sustainable manner, by efficiently removing road transport bottlenecks, lowering transport costs and improving the maintenance of road network assets.

2. The overall strategy identified between the Government of India (GOI) and the Bank for effective project-based lending assistance to States in this context, is to strengthen and shift onto a sound business management approach, the provision, management and maintenance of road infrastructure, through:
   - Emphasis on overall network planning, with priority for the needs of high-traffic density routes/corridors;
   - Achievement of effective sustainable funding and management of road maintenance;
   - Introduction of international road construction methods, quality and management standards;
   - Demonstration of the effectiveness of independent technical consultants and contractors in project implementation, and of competition in the delivery of road infrastructure services;
   - Implementation of sound high-return road infrastructure investments;
   - Comprehensive preparations for management of the environmental implications and the social impacts of proposed road investments; and
   - Strengthening and modernization of State institutional arrangements, policies, resources and capacities for the management of the sector.

Identification, Preparation and Implementation Requirements

3. To be confident of achieving efficient, timely and sound project implementation, the preparation of proposals for any Bank-assisted state-level road infrastructure investment projects in India will normally need to comprise the following key elements:
(a) **Strategic Options Study.** The first substantive action, to be initiated by the individual State, will be a preliminary network-wide Strategic Options Study (SOS), typically using road and traffic network data already available to the State. This SOS is aimed at (i) providing an objective basis for and strengthening the selection rationale for the likely roads investment priorities; (ii) confirming the State's road funding history, and (iii) outlining the State's intended project financing strategy. The SOS should include verified data on relevant State-wide population size, composition and distribution; any protected 'cultural heritage' assets, and sensitive environmental features which should all be taken into account in planning for the proposed project.

(b) **Feasibility Study(-ies).** Full economic and technical feasibility studies on the priority investments identified via the Strategic Options Study. The feasibility studies will also include a state-wide social and environmental screening, inclusive of the preparation and review of full strip maps of the proposed road sections; maps of environmentally sensitive areas such as reserves, forests, national parks, wetlands and/or sensitive habitats; and census-based population distribution maps/data indicating relevant population intensities and locations of indigenous peoples' groups near the project sites.

(c) **Preliminary Engineering and Environmental & Social Impact Assessments.** Preparation of preliminary engineering design standards for the full length of the proposed road investments under the project, to be ready by Bank appraisal stage, as a basis for and coordinated with preparation of an appropriate Environmental Assessment and preparations for any necessary Social Impact (Resettlement & Rehabilitation) action plans (see (d) and (e) immediately below).

(d) **Environment Assessment.** A Sectoral Environmental Assessment (SEA) will be required for all of the civil works components of the project, in parallel with the project feasibility studies; followed by a full Environmental Assessment (EA) wherever sensitive issues have been identified in the SEA, prior to Bank appraisal. The preparation of the SEA and EA must be in full compliance with the World Bank's Operational Directive (OD) 4.01.

(e) **Social Impact / Resettlement & Rehabilitation (R&R).** The preparation of (i) a preliminary screening of likely Project Affected Persons (PAP) and structures along the proposed project road sections; (ii) a full Baseline Socio-Economic-Survey (BSES) for the identified impact areas of all proposed works, and (iii) a satisfactory draft R&R policy-based Resettlement Action Plan (RAP) which has been endorsed by the State Government, will each be required as part of project preparations, as per the Bank's OD 4.30 on Involuntary Resettlement. In addition, if indigenous people ("tribals") are likely to be sited within the impact areas, a full Indigenous Peoples Development Plan (IPDP) will need to be prepared, in accordance with the Bank's OD 4.20 on Indigenous Peoples.
In all projects, the principle of linking completion of resettlement with any order to proceed with civil works shall apply. No physical work shall be undertaken on any stretch of road before resettlement has been undertaken in accordance with a framework of entitlements, which shall be agreed upon before appraisal. This framework shall describe categories of losses, definitions of affected and entitled persons, their entitlements in the form of compensation or other assistance, and the institutional framework for implementing a Resettlement Action Plan (RAP). It shall also contain mechanisms for public participation and local consultation, for monitoring and evaluation, and for coordination among the project authorities and the various local jurisdictions involved in the road infrastructure project. This framework must conform to OD 4.30 and shall apply for all components of the project, also in cases where a phased approach is being used.

Based on this framework, a draft RAP shall be prepared before the project's appraisal. It shall contain an estimate of likely affected persons as described below, as well as a budget and a schedule of implementation, and other details as described in the applicable Terms of Reference (TOR). The draft RAP shall be finalized after detailed designs are completed and exact impacts and numbers of affected persons are known, based on one or a combination of two scenarios:

(i) Where the alignment is known, a full census of all likely PAPs must be included in the RAP. Detailed engineering designs must be available for at least 25% of the project roads, and preliminary design must be completed for the remaining 75% of the project roads, to identify PAPs within the entire corridor of impact. Once designs are finalized, the RAP shall be modified to incorporate any changes in impacts on PAPs, or their numbers.

(ii) Where the full alignment is not known before project appraisal, a phased approach shall be used. Preliminary screening shall be undertaken before determining the alignment, and likely social impacts and losses of assets shall be weighed along with financial, technical, environmental and other screening criteria. Once that has been done, the RAP must be updated to incorporate the new information.

(f) **Final Engineering for Project Appraisal Requirements.** Preparation before the time of Bank project appraisal of a representative sample (in terms of different types and settings) of at least 25% of the total length of proposed project road investments to detailed engineering standard. At this stage, the planned civil works should also be arranged into sufficiently large contract 'packages' to attract international as well as domestic contractors with larger-scale high-quality road construction experience.

(g) **Institutional Strengthening.** As an integral part of the overall project preparations, prior to Bank appraisal, this will require the preparation of essential non-capital components aimed directly at sustainable enhancements to the State's capacity for effective road infrastructure management and financing, via (inter alia):
(i) action for early strengthening of the State's capacity to manage the proposed project and ensure timely implementation through a review of procurement decision-making procedures, provision of appropriate training and upgraded resources, appropriate Technical Assistance (TA), and early establishment of a dedicated agency unit (e.g., Project Management Unit) to manage the proposed project.

(ii) preparation (or updating) of a State transport sector strategy, covering the main physical, operational, financial and policy aspects of the major transport modes over the next 5-10 years (subject to the quality of the available data and indicators), including a particular focus on the outlook for the road transport subsector in this context and the realistic financing strategy(-ies) for both ongoing road maintenance and road infrastructure investment priorities.

(iii) review of the State's future financial and organizational requirements for more effective management of road infrastructure development and maintenance in a transport-oriented context, resulting in the preparation of specific time-bound action plans for regulatory/policy, organizational and financing improvements, inclusive of:

- Indicators for improved road agency and sector performance;
- State-level policy/regulatory measures to improve the efficiency of road transport and of the management of road infrastructure;
- Measures for more effective facilitation of private sector investment and participation in the provision and management of road infrastructure; and
- Specifications for an effective framework for consultation with public and private sector 'stakeholder' representatives on road infrastructure plans and priorities.

(iv) training and staff development action to re-orient and enhance the institutional capabilities of the State agency(-ies) and key private sector participants concerned with the provision and maintenance of road infrastructure in the State; and

(v) comprehensive improvement of relevant budgeting, programming, financial and contract management, project management and monitoring / reporting systems, skills and practices, to ensure sustainability of the proposed project's benefits.

(h) Project Implementation Supervision. The implementation of all civil works under the project, implemented once the project has been approved by the Bank's Board, will require the services of independent Supervision consultants engaged by the Borrower and appointed with full powers as the Engineer as per FIDIC conditions.
Financing and Procurement Aspects of Project Preparation

4. The initial production of an SOS which satisfactorily meets the aims and purposes described at para. 3 (a) above, will be each individual State's responsibility. The costs of any consultancy services engaged by the State for this purpose should normally also be met by the State concerned from its own finances.

5. For the action at stages (b), (c), (d), (e) and (f) above, the State should secure the services of internationally-experience Project Coordination Consultants (PCC) to manage and coordinate the feasibility studies, other techno-economic, environmental and social preparations, preliminary and final engineering of the proposed project, resulting in the preparation of a project package suitable for Bank appraisal, as well as subsequently assisting the State with the project's implementation and supervision stages.

6. The costs of such PCC services for effective project preparation action up to the stage of Bank appraisal will be substantial (typically in the range of US $1.5 -3.5 million, depending on project size/complexity). The likely services for subsequent PCC services, beyond Bank appraisal, e.g. for stage (h) above, cannot be confirmed until the outcome of preparations for Bank appraisal is known.

7. The cost of the separate technical and professional services likely to be required for preparation of assessments, policy measures, action plans, etc., for the Sector Institutional and Financing Reforms/Strengthening component(s) outlined at stage (g) above, can only be separately determined once the specific features of each State's sector circumstances and proposals are fully resolved.

8. Procurement action for all civil works funded with Bank assistance under any resultant investment project will be in strict accordance with World Bank International Competitive Bidding (ICB) and/or National Competitive Bidding (NCB) procedures. The procurement of both civil works and consultants' services will use the India-specific version of the Bank's Standard Bid Documents as promulgated by the Government of India (GOI), and where appropriate, the standard 'pre-qualification' documentation also promulgated by GOI for all externally-assisted projects.