ESTIMATES OF URBAN INFRASTRUCTURE FINANCING REQUIREMENTS IN INDIA 2006-2031

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TABLE OF CONTENTS

ANNEXURES

ACKNOWLEDGEMENTS

[To be added]

LIST OF TABLES

LIST OF FIGURES AND CHARTS

LIST OF ABBREVIATIONS

2006 - 2031 UIFEE	The Urban Infrastructure Per Capita Investment Cost estimation and projection exercise for urban finance requirements for the period 2006-2031.
24/7	Water supply Continuous drinking water supply
GOI	Government of India
HPEC	High Powered Expert Committee
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
MOUD	Ministry for Urban Development
NIUA	National Institute for Urban Affairs
PCIC	Per Capita Investment Costs
SSLBs	Standard Service Level Benchmarks

Executive Summary

The paper describes the estimation exercise, i.e. the Urban Infrastructure Per Capita Investment Cost estimation and projection of urban finance requirements for the period 2006-2031 referred to as the 2006-2031 Urban Infrastructure Finance Estimation Exercise (2006-2031 UIFEE). The 2006 – 2031 UIFEE is special as it the first one in more than a decade of its nature, covering all urban infrastructure sectors. These new estimates covering the period 2006-2031 will add on to the Rakesh Mohan Committee estimates that projected investment requirements till 2006.

This estimation exercise is unique as compared to the earlier estimation exercises for a host of reasons including the level of granularity of the projections and its reliance on real project data, which has been appraised by a variety of expert institutions. The demand driven nature of the projects also ensure that the projects are essential to the requirements of the citizens. The outputs on financing requirements are very closely driven by the service standards and the 2006-2031 UIFEE, has benefited from the recent effort of the Government of India of creating Standard Service Level Benchmarks for many of the urban services estimated.

The grand aggregate for all services estimated for India for the period of 2006-2031 has emerged to be 71620 billion rupees at 2009 prices and for the period of 2009-2031 the requirement would be 71250 billion rupees at 2009 prices, given the JNNURM investments that have already been chandelled into the sector so far. Given that the Government of India total revenue receipts in 2008-09[1] is Rs. 5621.73 billion represents less than 8 percent of the capital expenditure requirements for the period 2009-2031 ie. 71250 billion rupees. This revelation, though not a surprise in itself raises fundamental policy questions on how the Government needs to address urban infrastructure provision. It is hoped that this analysis will get the serious attention of policy makers and that it will raise and help address the key policy and institutional questions that need to be addressed urgently in the urban infrastructure and service delivery sectors today.

1 Revised estimates for 2008-09, Union budget 2009-10

1 Background and Context

India's urbanization is at a low level, ie. only between 28 to 30 percent of its population lives in urban areas. The urban population growth rate, is higher than that of the rural population growth rate, but the urban growth rate itself, has seen a decline from the peak witnessed during the of 1971-81. This is inspite of the rapid growth of the services and industrial sectors, which are essentially located in urban areas as well as there being a doubling in the number of large villages. It is within this context that the debates on India's urbanization and its relationship to economic development are located. However inspite of the low level of urbanization in India, in real terms the numbers of people living in and migrating to urban areas is huge and steadily increasing in very significant numbers.

Table 1: Decadal Population Growth in India

Census Year	Number of UAs/ Towns	Total Population (in millions)	Rural Population (in millions)	Urban Population (in millions)	Urban Population as percentage of total Population
1901	1,830	238	213	26	10.8
1911	1,815	252	226	26	10.3
1921	1,944	251	223	28	11.2
1931	2,066	279	246	34	12.0
1941	2,253	319	275	44	13.9
1951	2,822	361	299	62	17.3
1961	2,334	439	360	79	18.0
1971	2,567	548	439	109	19.9
1981	3,347	683	524	160	23.3
1991	3,769	846	629	218	25.7
2001	4,378	1,027	742	285	27.8

Note:

1. Urban Agglomerations, which constitute a number of towns and their outgrowths, have been treated as one unit.
2. The total population and urban population of India for the year 2001 includes estimated population of those areas of Gujarat and Himachal Pradesh where census could not be conducted due to natural calamities.
3. The total population and urban population of India for the year 1991 includes interpolated population of Jammu & Kashmir where census could not be conducted.
4. The total population and urban population of India for the year 1981 includes interpolated population of Assam where census could not be conducted

Source: Census of India.2001

Given the legacy of, rural policy orientation of the Indian government and policy makers, and that urban development is a state subject as per the constitution, there has been limited focus and effort in supporting urbanization or improving living conditions in urban areas over the last many decades. Today, therefore, we are in a situation where urban development in India needs immediate attention, not only due to the infrastructure crisis facing our cities due to decades of underinvestment and increasing demand but also as urban areas have emerged to be the engines of India's economic growth and have a central role to play in many important national issues ranging from internal security, poverty alleviation to economic development. .

In a first time effort in this direction the National government launched the JNNURM in 2006. The program directs significant amount of central financial assistance to urban areas. The program has become the flagship urban program for the country and is possibly the largest centrally administered urban development program in the world today.

While this is a new program and is just in its third year of operation a High Powered Expert Committee (HPEC), has been set up to estimate the urban infrastructure financing requirements and suggest ways and means of improving the outcomes of the program. The core focus of this paper is to develop a methodology and robust estimate of urban infrastructure finance requirements till year 2031. These estimates will therefore help define the wide envelope of finance requirements, which could then help policy makers plan and strategies various ways approaches to meet the financing requirements. It is also hoped that the methodology and projections developed will play a pivotal role in informing as well as generating policy debates around key questions including urban sector wide issues such as effecting decentralization, financing arrangements including public private partnerships, etc; as well as sector specific issues such as standard service levels, delivery mechanisms, use of new technologies and loal economic development etc.

This paper, like a couple of others has been commissioned by HPEC as a supporting technical paper to the committees work. The paper will be published in a companion volume to the main committees report and will inform the committees work. The core focus of the study has been on developing a robust methodology and attempting to comet to most realistic projections given the uncertainties that are always prevalent in such a projection exercise.

While the exercise estimating the quantum of funds required for urban infrastructure requirements, has itself been challenging and rewarding, the authors hope that there will be a number of different debates which will be informed by the exercise presented in this paper. The growth of urban population in India presents a huge challenge to governments not only at the urban local level, but across all three tiers of the federal system.

The output of this HPEC sponsored study will result in critical decisions that will impact not only urban local finances, but also potentially the overall architecture of fiscal federalism.

- The requirement of such an exercise is also essential for a number of reasons now made even more significant since the Government of India is directing central plan funds for urban projects under JNNURM. Without an informed understanding of what the over all requirements could be the Government is not in a good position to design its intervention, engagement or exit strategy. Risks such as over spending and getting caught in a difficult fiscal scenario; creating a dependency syndrome and discouraging or provide negative incentives for lower tiers of government to try and achieve improved fiscal status; or even create a perception that the JNNURM as a funding source is essentially a bottomless pit without any hard budget constraints could easily be encountered.

- Decisions on the appropriate level of urban services that can reasonably be provided and whether or not the country can afford to deliver a high level of urban services if the cost of providing such services is very high. This is especially true due to the disparities in service provision between urban and rural areas;

- Decisions on whether and what new fiscal handles could become available to urban local governments with a view to improve their financial position;

- Decisions on restructuring the fiscal transfers not just between state and local governments, but also potentially across union-state-local levels; and

- Choices on the use of public-private-partnerships for the creation of such infrastructure assets, and their service delivery; this could change the role of urban local governments to a regulatory / supervisory one from a delivery focused one.

2 Departure From Earlier Estimation Exercises

There have been very few occasions in the past where an exercise of a similar nature have been done across urban infrastructure sectors. Two of the most notable and most quoted are the Zakaria committee report of 1963, still used as a basis for estimating urban expenditure and the India Infrastructure Report, 1996 (also known as the Rakesh Mohan committee report). Another similar exercise was undertaken by Shakar Achrya and Rakesh Mohan in 1989. While the Zakaria committee norms are essentially expenditure norms thereby focusing on operations and maintenance, the first attempt of estimating overall costs focusing on capital requirements across India for urban India was undertaken in the 1989 study and later in the Rakesh Mohan Committee Report in 1996. Other than this various Planning Commission background papers during the development of new Plans have tried to project sector specific requirements for plan periods as have RITES for urban transport in Class I cities; and the MoUD for 63 JNNURM cities across urban Infrastructure sectors.

This estimation exercise, i.e. the Urban Infrastructure Per Capita Investment Cost estimation and projection of urban finance requirements for the period 2006-2031 here in after referred to as the 2006-2031 Urban Infrastructure Finance Estimation Exercise (2006-2031 UIFEE) is therefore special as it the first one in more than a decade of its nature, covering all urban infrastructure sectors. These new estimates covering the period 2009-2031 will add on to the Rakesh Mohan Committee estimates that projected investment requirements till 2006. Other than this it is also unique as compared to the earlier estimation exercises for a host of reasons identified below. :

1. *Granularity:* This exercise is being undertaken bottom up giving the estimates a depth of granularity not involved in any other past estimation exercise in India. The model has estimated requirements for each Class Size of city separately (JNNURM categories - A, B, C and Census categories : Class I to VI separately). Towards this end the first input into the estimation model has been population projections. After a few iterations the population model chosen is a modified version of the projections developed by the Population Division of the United Nations Department of Economic and Social Affairs (http://esa.un.org/unup/index.asp). This projection model was modified to assign growth rates to city – class sizes as per census of India definitions.

2. *Real project data:* The next quantum leap in the value added that this model brings up is the fact that it is based on real project data. The Project level data that are inputs into the model are from the first three years of projects approved under JNNURM. This has also ensured that there are a large number of data points that feed into the model. As in the case of Water Supply there are 102 projects that have been analyzed. Earlier estimates did not have the luxury of dealing with large numbers of real project data. The 1989 study relayed on plans and the 1996 estimates relied on a much smaller set of projects.

3. *Higher quality of project data:* While the quality of data can always be improved, there is a high level of due diligence on project costs and plans that has gone into the selection of projects by JNNURM, that has improved the quality of the project data. Other than professional Detailed Project Reports prepared by external consultants, each project has also been appraised at the central level by a technical team before being approved. Several reviews / appraisals conducted on the data.

4. *Demand Driven Projects:* Projects selection is in line with the City Development Plans, which were developed by the municipal corporations as a vision and plan for their cities. This implies that the projects are a response to real demand from the municipalities and their citizens within the outline framework provided by the JNNURM. Being demand driven ensures that the projects are rooted to their context and reflect felt needs. The DPRs are submitted by agencies which have strong technical knowledge and past implementation experience.

5. Policy framework and Standard Service Level Benchmarks (SSLBs): Each urban infrastructure sector has seen changes in the policy environment since earlier estimates. Though there are many areas of uncertainty in the policy framework an important addition is the

development of the SSLBs. These service level benchmarks are output standards related a host of urban infrastructure services which have been adopted by the National Government and are expected to guide state and local governments and service provision agencies. This estimation exercise therefore is closely linked to the desired SSLBs for each sector. Many standards have changed such as in water supply, waste management and urban transport sector level policies therefore drive the assumptions as well as the structure of the model in a basic way as will be evident from the description of each of the model descriptions later in the paper.

6. New technologies : are also being adopted in sector such as in waste management and urban transport and this estimation exercise takes cognizance of these changes.

7. Two new sectors : Mass Transport and Traffic Management Systems, while these two sectors have not been part of core urban sectors, partly because the responsibility has not been ascribed to local city governments in India in the past, they have been included in the UIFEE so as they are now seen as essential services for urban areas.

Ultimately, however any estimation exercise of this nature is only as good as the data inputs and the certainty and quality of project level information. In our view this is the key positive for this estimation as the data has been consistently generated by the cities themselves and therefore truly reflect the demand from cities perspective and are not only supply side or theoretical or normative. This itself makes this exercise unique and much more reliable as it is driven from a strong fundamental demand reflective base.

3 General Principles Of The Method Of Estimation And Limitations

The first step involved in developing this estimation exercise was to shortlist the infrastructure services which were to be projected. After a review of the pervious urban infrastructure estimation papers as well as after discussions at the HPEC the core urban infrastructure services for which investment projections are

a. Water Supply
b. Sewerage
c. Solid Waste Management
d. Urban Roads
e. Storm Water Drains
f. Street Lights
g. Mass Transport
h. Traffic Management Systems

Other possible sectors which were discussed but left out of this estimation exercise included:

a. Education and health facilities – most municipalities don't provide these, but some larger corporations provide them, so for consistence they have been left out. This was also the case in the Rakesh Mohan Committee estimates.

b. Land Acquisition and Development as well as Housing is mainly delivered by housing boards and development authorities which are essentially state agencies and are yet to come under the municipal domain and therefore have not been taken up in this estimation.

On deciding on the core urban services the next effort was to review other past and ongoing projection exercise and determine the basic methodology for this study. The authors found what was documented in the Sankar Achrya and Rakesh Mohan paper[2] , referred to by them as Method A to be the most relevant methodology for such an exercise. While the methodology was modified in many ways the basic basis of projecting population and developing Per Capita Investment Costs (PCICs) for each service has been the basis of this estimation exercise too. As mentioned in the section above, the authors have however broken down each sector into a set of most important components and have also calculated PCICs bottom up for each class size of town/cities separately.

There are actually two groups of core services, which are closely related to each other in terms of the estimation methodology. The first set of the sectors are Water, Sewerage and Solid Waste Management. These infrastructure services have been calculated primarily on the basis of per capita costs multiplied by the projected population. The per capita costs been driven from real projects. The other set of services are essentially city roads and sectors closely related to it i.e Mass Transport, Storm Water Drains and Street lighting. City Roads itself has been driven from a theoretical construct on the form of a city and the norms for roads to provide improved mobility with in it. The estimates of Mass Transport, Storm Water Drains and Street lighting emanate from the estimate of road requirements.

The next broad activity was research into, norms, practices and the most important policy debates on each of the sectors. Each of the urban infrastructure sectors chosen were researched and understood in depth, through literature reviews and discussions with sector experts. This included studying the prevalence of norms and service delivery standards. Also an over view of current practices in the sector, its key problems as well as current sector reform issues. These aspects are very important as policies and SSLBs drive the assumptions and structure of each sector specific models.

The next large task was to choose among a variety of population projections the one that was the most realistic and could match the granularity of project data that was available. A modified version of the UN projections, which had ascribed different growth rate to different size class towns was chosen as it was the most robust among the projections available.

After deciding on the population projections, PCICs for each sector, per city class size were estimated. This was first done by splitting each sector into different components based on the SSLB measures as well as the CDP backlog data granularity. PCICs for each of these components were then arrived at using DPR data which lists the key items of costs of each project to arrive at investment costs differently for each

2 An Analysis of Projected Urban Infrastructure Investment Costs in India" Sankar Achrya and Rakesh Mohan, 1989

category within a sector for each class sizes of city. Once the PCIC for each category and sub-sector were established these were multiplied with the relevant population numbers for each city class size.

4 Summary Of Urban Infrastructure Finance Requirements 2006-2031

Capital Expenditure Requirements

This section summarizes and presents the output numbers of the capital investment requirements for urban infrastructure for the period 2006 to 2031 and the period 2009-2031, given the investments already made into the various sectors under the JNNURM program. The Table No 2 below presents the Per capita investment costs (PCIC) for all sectors in each city class size. As is evident the capital costs associated with city road network development and development of public transport are the largest segments. This also reflects the low level of investment that urban transport has received in the past. It is also noticeable that though there are differences between the per capita finance requirements in each sector the overall per capita finance requirements across the city class sizes are not entirely different, essentially because of sector specific scale economies as well as the fact that mass public transit as a function is not allocated in the less than million plus population cities. Although there is no difference in Class II, III and IV cities at this stage, due to the lack of project level data from these city categories, it is hoped that some new data being currently sources will throw up some light on the difference especially in water supply and sewerage. Also similar estimates can be made or recalculated as more data on smaller towns come through future implementation programs.

Table 2: Per Capita Investment Costs by sector and city size

Sector	City Size					
	Class I A	Class I B	Class I C	Class II	Class III	Class IV+
Water Supply	5458	2760	2215	2215	2215	2215
Sewerage	3006	2454	3626	3626	3626	3626
Total Roads	57483	83160	80520	96283	96283	96283
Storm Water Drains	722	1213	940	940	940	940
Street Lights	103	141	167	185	185	185
Mass Transmit Systems	51945	16678	0	0	0	0
Traffic Management Systems	200	800	800	0	0	0
Total	**118591**	**107455**	**89049**	**104031**	**104031**	**104031**

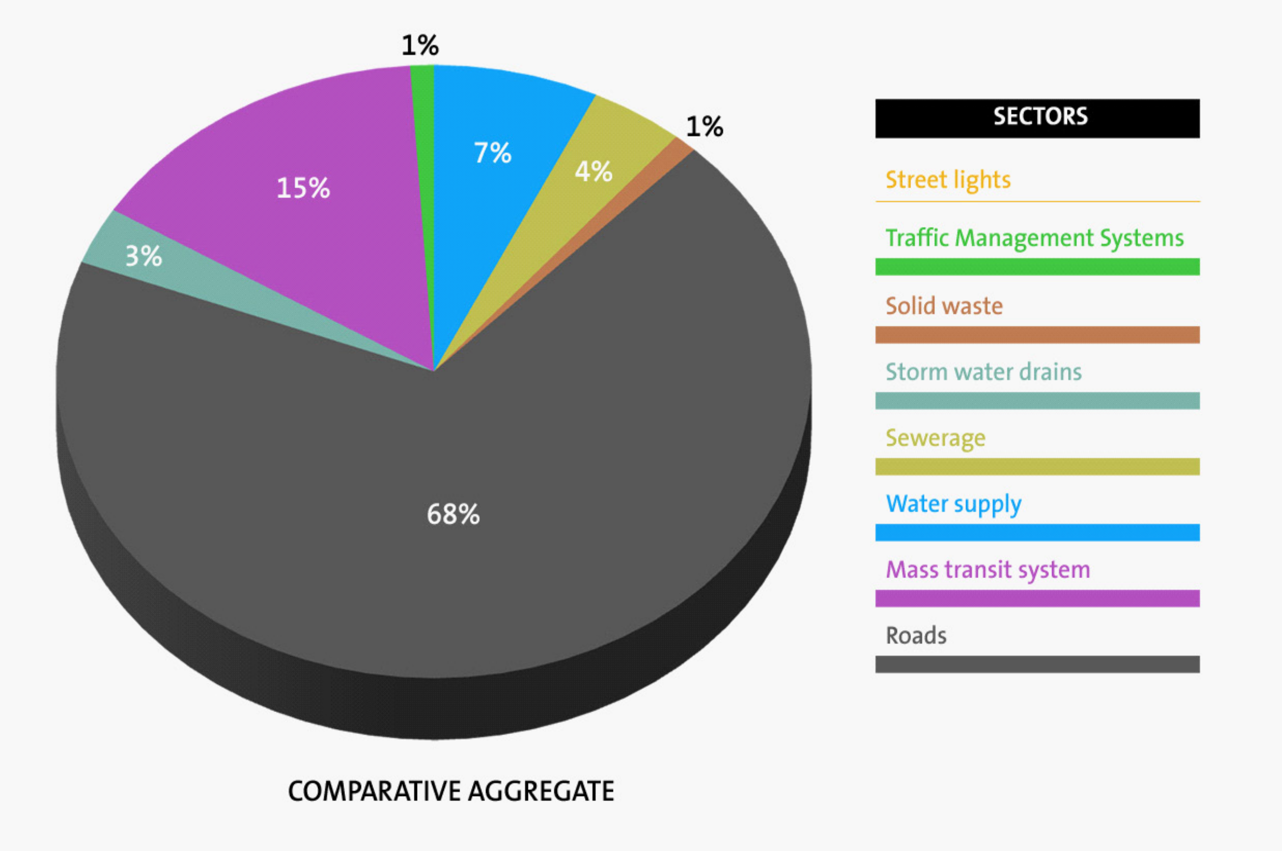
The grand aggregate for all services estimated for India for the period of 2006-2031 has emerged to be 71620 billion rupees at 2009 prices and for the period of 2009-2031 71250 billion rupees at 2009 prices.

As presented in the figure below roads alone constitute 68 per cent of the investment followed by Mass Transit Systems which would require 15 per cent of the total investment and water supply needing 7 percent and sewerage another 4 per cent.

Table 3: Capital Finance requirements 2006 -2031 and 2009-2031, in 2009 prices

Sectors	All Cities (Rs. Billion)	JNNURM Funding 09 till 09(Rs Billion)	2009-2031 reqm (Rs Billion)
Water Supply	5299	178	5120
Sewerage	3006	67	2938
Solid Waste	803	22	780
Roads	48845	32	48812
Street Lights	89		89
Mass Transmit Systems	10682	48	10634
Traffic Management Systems	654		654
Total	**71620**	**370**	**71251**

Figure 1: Comparative distribution of sector-wise aggregates



Operations and Maintenance Finance requirements

Operations and Maintenance expenditure on a per capita basis is presented in the table below. With regard to Operations and Maintenance the Total aggregate O&M finance requirements would be 10030 billion rupees. The main contributors to the O&M finance requirements are the sectors of city roads, mass transit systems and solid waste management, followed by sewerage and water supply. [A more detailed analysis of O&M requirements will be presented in the final paper]

Table 4: Per Capita O&M requirements per sector and city size

		Water Supply	Sewerage	Solid Waste	Total Roads	Storm water drains	Street Lights	Mass Transit Systm	Traffic Mang	TOTAL
	O&M %	9%	9%	40%	3%	2%	9%	9%	9%	
Class I A	PCIC	5458	2111	569	57483	722	103	51945	200	118591
	O&M cost	491	190	228	1724	16	9	4675	18	**7352**
Class I B	PCIC	2760	2454	249	83160	1213	141	16678	800	107455
	O&M cost	248	221	100	2495	27	13	1501	72	**4676**
Class I C	PCIC	2215	3626	782	80520	940	167	0	800	89049
	O&M cost	199	326	313	2416	21	15	0	72	**3362**
Class II	PCIC	2215	3626	782	96283	940	185	0	0	104031
	O&M cost	199	326	313	2888	21	17	0	0	**3764**
Class III	PCIC	2215	3626	782	96283	940	185	0	0	104031
	O&M cost	199	326	313	2888	21	17	0	0	**3764**
Class IV +	PCIC	2215	3626	782	96283	940	185	0	0	104031
	O&M cost	199	326	313	2888	21	17	0	0	**3764**

Table 5: Aggregate O&M finance requirements across sectors, 2006-2031

Sectors	All cities	Comparative %
Water Supply	491169303340	5 %
Sewerage	607349140435	6%
Solid Waste	978962011970	10%
Roads	5192823897337	52%
Storm water drains	44365007648	0 %
Street Lights	28640088342	0 %
Mass Transit Systm	2624148273710	26%
Traffic Mang Systm	63333613902	1%
TOTAL	**10030791336682**	

Financing and Institutional implications

The total Capital expenditure requirements for the period 2006 to 2031 will be Rupees 71….. billion and the cumulative operations and maintenance expenditure will be Rupees 10030 billion. These numbers reflect the true extant of urban infrastructure finance requirements for India in the period between 2006 to 2031. As discussed earlier these requirements reflect the higher standards of service delivery and new technologies in urban transport and waste management that is now the accepted policy in India. The Government of India total revenue receipts of Rs. 5621.73 billion in 2008-09[3] represents less than 8 percent of the capital expenditure requirements for the period 2009-2031 ie. 71250 billion rupees.

The intention of this exercise is not just to estimate the macro numbers but to draw out the contours of the mega requirements for urban infrastructure and bring forth some of the most important implications on financing mechanisms within the principles of fiscal federalism and on institutional arrangements and capacities required to deliver this growing requirement.

The first question that emerges on seeing these huge requirements of funds that need to flow into the urban sector is –

- do we have the institutional capacity to raise, transfer/ direct and absorb such high level of funds into urban areas?

- Is JNNURM the appropriate vehicle to manage these significant investments and critical sector transformations given that it has so far funded approximately seven percent of the financial requirements only. If it is how can its scale and scope be enhanced o make it a more robust agent for change?

- Is there a need to rethink the appropriate level of urban services that can reasonably be provided, especially in different city sizes?;

- Decisions on increasing the autonomy of local governments and opening up access tp new fiscal handles with a view to improve their financial position to meet this large investment demand and decisions on restructuring the fiscal transfers not just between state and local governments, but also potentially across union-state-local levels;

- Choices and support mechanisms for the use of public-private-partnerships for the creation of urban infrastructure

These questions are urgent as impact of these choices are not only going to determine the shape and form of the urbanization process that is to emerge but will have a profound impact on the economic growth of the country itself, which is now significantly dependent of urban areas to drive its growth and the poor availability and quality of urban infrastructure and services are emerging as a major hindrance. The authors hope that this paper therefore servers a utility beyond the pure estimation exercise and help provide the backdrop for better informed urban policy dialogue on issues central to sustaining India's economic development.

The next sections of the paper present sector specific models developed for the 2006 to 2009 UIFEE. They describe the policy context and methodology used in the estimation exercises and then go on to discus the results thrown up in each sector.

3 Revised estimates for 2008-09, Union budget 2009-10

5 Urban Water Supply Finance Requirements Estimation

While the section above describes the general methodology for the estimation exercise the first part of this section describes the special issues related to water supply sector which drove the structure of the calculations for water supply. The second part of this section presents and describes the results of the projection exercise for the water supply sector.

Special Water Supply Methodology issues

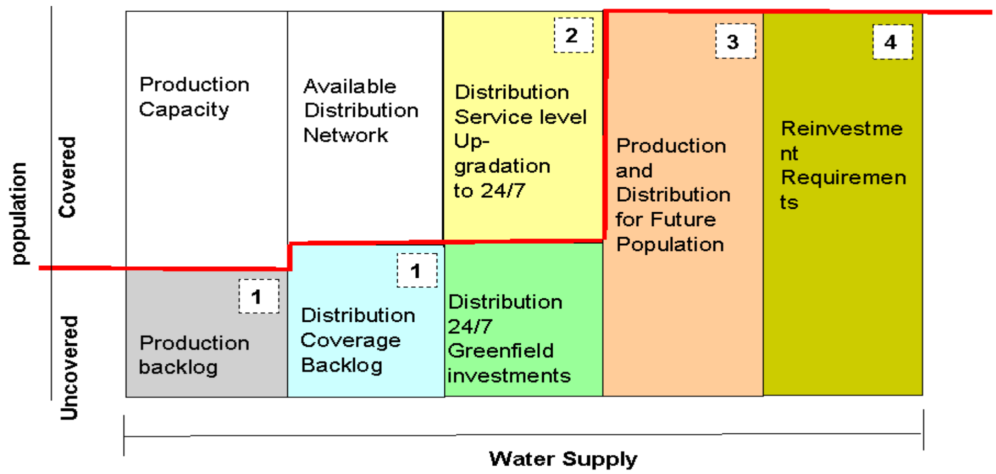
As well documented in literature, drinking water delivery in India is among the weakest in comparison to other countries globally. A large number of underdeveloped countries too are known to have higher standards of drinking water delivery. Most blatantly no city in India today provides 24/7 safe drinking water. This has been a focus of various training programs and policy debates and with the adoption of the Standard Service Level Benchmarks of the Ministry of Urban Development, it is now articulated as a policy goal. Most city governments and water supply agencies have accepted this service goal and are taking steps in that direction. Even in situations with sever water source shortages are prevalent in cities like Chennai, there is an acceptance of the value of 24/7 provision inspite of challenging circumstances.

The primary structuring of the water supply model is driven from the understanding that all urban areas are to be provided with 24/7 water supply and that all new projects post the year 2011 will be approved only if they aim to provide 24/7 standards to the users. Other than this the model also assumes that the same standards of water service delivery will be available to citizens in all tiers of urban areas in India.

Description of the model

The model is split into a number of Capital Cost boxes for projecting capital requirements for residential use as in the chart 1. Other than this separate capital requirement estimates for industrial and commercial use also are added to arrive at the overall capital requirements for the sector. Operation and Maintenance costs, which are not capital costs have also been estimated in the same model and are added to arrive at the sum total of financing requirements from 2009-2031 for the sector across city class sizes. Three different Per Capita Investment Costs (PCIC) have been calculated based on projects in the sector. The components in each project as well as the project objectives have been used to categorize the projects into the various PCIC categories. The data has been sourced primarily from 102 approved water supply projects under JNNURM, but also have been supplemented by a clutch of projects funded in India across a set of World Bank projects. The PCICs that are used in the water model are:

Chart 1: Graphic description of the Water Supply Capital Investment Projection model (projections for household requirements)



a. *Per Capita Production Costs (PCPC)*: This is derived out of the number of people served in the projects aimed at increasing water production in each city class size.

b. *Per Capita 24/7 Greenfield Costs (PC24/7GC)*: This is derived out of a small sample of proposed or ongoing 24/7 projects in India. This PCIC is the project cost divided by the number of people served in the projects aimed at providing 24/7 services in previously uncovered areas across each city class size.

c. *Per Capita 24/7 Up-gradation Costs (PC24/7UC)*: As detailed above it is a well documented fact that no city provides 24/7 service across the city in India today. As per policy however the country would like to work towards this goal. This PCIC is calculated from a small set of new generation up-gradation projects, which aim to bring current systems in line with standards required for 24/7 service.

Another PCIC which is not directly created but is essentially the sum of PCPC and the PC24/7GC is being called the WSPCIC (Water Supply PCIC). This is essentially the PCIC that is used for new population that would be added to cities. The PCICs calculated above then are used appropriately to arrive at the investment projections for each of the relevant categories. The Chart No 1 has been prepared to give an outline of the various relevant categories in the water supply projection model. Such calculations have been undertaken for each city size category separately. These have been presented as boxes in the chart and the sum of all the totals of each of the boxes, for each city size category will make up the total capital expenditure requirements for the water supply sector in India from 2009 to 2031.

Results

This section discusses the results of the water supply model. It initially describes the key elements of each component of the model, before summarizing the output numbers.

1. Investment for Backlog population

Table 6: Investment for Backlog population : Urban water supply

Table **: Investment for Backlog population: Urban water supply		
Per Capita Investment Costs (PCICs)		
	Production	**Distribution**
Class I A	3421	2037
Class I B	1436	1837
Class I C	1901	1931
Class II	1901	1931
Class III	1901	1931
Class IV +	1901	1931
Backlog percentage as per CDPs		
	Production	**Distribution**
Class I A	0.18	0.094
Class I B	0.14	0.296
Class I C	0.21875	0.37625
Class II	0.21875	0.37625
Class III	0.21875	0.37625
Class IV +	0.21875	0.37625
Backlog population, 2006		
	Production	**Distribution**
Class I A	16024146	8368165
Class I B	5135724	23642555
Class I C	17472328	30052404
Class II	7997657	13755969
Class III	9777674	16817600
Class IV +	7271775	12507453
Investment for Backlog population 2006		
	Production	**Distribution**
Class I A	54821362485	17047498845
Class I B	7376609896	43432868058
Class I C	33211884974	58044294056
Class II	15202167531	26568774495
Class III	18585674088	32482116953
Class IV +	13822391068	24157344045
Sub Total	*143020090041*	*201732896452*
Aggregate		**344752986493**
TOTAL (Rs in 2006 prices)		**344752986493**
Corrected to 2009 prices		**448178882440**

The calculation for meeting the backlog in terms of coverage, estimates the capital investment requirements for the meeting the unserved/under served population in the year 2006 as documented by the cities themselves in the CDPs. Most CDPs have provided backlog numbers for production and distribution separately, so the calculations take this into account and calculate production and distribution backlog in terms of infrastructure coverage separately. This backlog does not include the high levels of service level backlog that is faced in Indian cities today. The basic formulae used is :

WSIBP = WSPCIC * BP
where

WSIBP is the Investment required to cover backlogs in 2006;
WSPCIC is the Water Supply PCIC;
BP is the Backlog population or the unserved/under served population in the year 2006

The detailed description of the Backlog population is placed in Annex 1.

As per the calculations in the table above the investment requirements for the unserved/under served or the Backlog population for water supply alone will be Rupees 448 Billion (Rupees 44,817 crores) or US$ 9.9 Billion.

2. Investment for 24/7 Service Level Upgrade

As mentioned before the Per Capita 24/7 Up-gradation Costs (PC24/7UC) as before is a specially arrived at PCIC given the strong policy need and demand for upgadation of service delivery standards. Also as discussed before this policy objective of improving service standards has had an important impact on the water supply model itself and makes it different form other sectors. The main assumption for the calculation is that by 2011 all users with have upgraded water supply services. The basic formulae used is :

WSIF24/7SLU = WSPC24/7UC * PU

where

WSIF24/7SLU is the Investment required to upgrade the service levels to all the population in the year 2011;
WSPC24/7UC is the Water Supply PCIC;
PU is the population due for upgrade i.e aggregate population till 2011.

The detailed description of the ***Per Capita 24/7 Up-gradation Costs (PC24/7UC)*** is placed in Annex 2.

As per the calculations in the table 7 the investment requirements for the service level upgrade for water supply alone will be Rupees 618 Billion (Rupees 61,842 crores) or US$ 13.7 Billion.

Table 7: Investment for 24/7 service level upgrade: Urban water supply

Table **: Investment for 24/7 Setvice Level Upgrade: Urban water supply		
Per Capita 24/7 Upgrade Costs (PC24/7UCs)		
		Distribution
Class I A		2200
Class I B		1500
Class I C		900
Class II		900
Class III		900
Class IV +		900
Upgarde population		
	2006	**2011**
Class I A	89023034	9729561
Class I B	36683741	7696520
Class I C	79873498	6912580
Class II	36560716	3806917
Class III	44697939	4654212
Class IV +	33242399	3461394
Investment for 24/7 Upgrade population 2006 & 2011		
	2006	**2011**
Class I A	195850674696	21405033598
Class I B	55025611844	11544779511
Class I C	71886148328	6221321586
Class II	32904644553	3426225054
Class III	40228144993	4188790979
Class IV +	29918158976	3115254617
Sub Total	*425813383390*	*49901405345*
Aggregate		**475714788735**
TOTAL (Rs in 2006 prices)		**475714788735**
Corrected to 2009 prices		**618429225356**

3. Investment for additional population

The calculation for additional population, estimates the capital investment requirements for the period between 2009 – 2031. The basic formulae used is :

WSIAP = WSPCIC * IDP

where

WSIAP is the Investment for additional population;
WSPCIC is the Water Supply PCIC;
IDP is the Incremental decadal population.

The detailed description of the ***Incremental decadal population is placed*** in Annex 1 ***while the Water Supply PCIC*** is presented in Annex 2.

Table 8: Investment for additional population : Urban water supply

Table **: Investment for additional population: Urban water supply				
Per Capita Investment Costs (PCICs)				
	Production	Distribution	Consolidated	Water supply
Class I A	3421	2037		5458
Class I B	1436	1837	2153	2760
Class I C	1901	1931	1460	2215
Class II	1901	1931	1460	2215
Class III	1901	1931	1460	2215
Class IV +	1901	1931	1460	2215
Additional population				
	2006	2011	2021	2031
Class I A	-	9729561	21057587	25825675
Class I B	-	7696520	17915519	23782900
Class I C	-	6912580	23577137	32019101
Class II	-	3806917	11697489	20360061
Class III	-	4654212	14300968	24891546
Class IV +	-	3461394	10635803	18512144
Investment for additional population				
	2006	2011	2021	2031
Class I A	-	53107415359	114939828100	140965753972.02
Class I B	-	21242805228	97789297914	129815559353.60
Class I C	-	15308990764	65074155648	174771682953.86
Class II	-	8432320550	25905921621	56194854538.20
Class III	-	10309080020	31676643824	55126229717
Class IV +	-	7666987751	23558303916	41004399906
Sub Total	-	*116067599672*	*358944151022*	*597878480440*
Aggregate				***1072890231135***
TOTAL (Rs in 2006 prices)				**1072890231135**
Corrected to 2009 prices				**1394757300475**

As per the calculations in the table above the investment requirements for additional urban population for water supply alone will be Rupees 1394 Billion (Rupees 1,39,475 crores) or US$ 30.9 Billion.

4. Finance for Reinvestment requirements

The calculation for meeting the finance requirements for reinvestment are related to replacement of past production infrastructure only. This, because the assumption is that the distribution infrastructure will be renewed during the 24/7 up gradation exercise by 2011 and there would be no direct reinvestment required for the period till 2031. The production investments will need renewal and an average life span of 30 years has been assumed for that purpose.

The basic formulae used is :

WSRF = WSPCIC * PRP

where

WSRF is the reinvestment finance requirements ;
WSPCIC is the Water Supply PCIC related to production;
PRP past population that qualified for reinvestment.

As per the calculations in the table…….. the reinvestment requirements for the period 2006 to 2031 will be Rupees 318 Billion (Rupees 31,883 crores) or US$ 7 Billion.

Table 9: Investment for production reinvestment : Urban water supply

Table **: Investment requirements for Production reinvestment : Urban water supply				
Per Capita Investment Costs (PCICs)				
	Production	Distribution	Consolidated	Water supply
Class I A	3421	2037	0	5458
Class I B	1436	1837	2153	2760
Class I C	1901	1931	1460	2215
Class II	1901	1931	1460	2215
Class III	1901	1931	1460	2215
Class IV +	1901	1931	1460	2215
Past population				
	1976	1981	1991	2001
Class I A	13112000	39549075	58275323	78129009
Class I B	4768000	12570708	18522862	28967998
Class I C	11920000	30880217	45501814	71127476
Class II	7600000	22000000	28800000	34451537
Class III	7200000	26900000	35300000	42119326
Class IV +	5200000	25700000	29400000	31324653
Backlog percentage as per CDPs (2006)				
	Production	Distribution		
Class I A	18%	9%		
Class I B	14%	30%		
Class I C	22%	38%		
Class II	22%	38%		
Class III	22%	38%		
Class IV +	22%	38%		
Investment for additional population				
	2006	2011	2021	2031
Class I A	8074513673	24354754726	35886584373	48112702169
Class I B	958781051	2527801300	3724699988	5825077191
Class I C	4956408297	12840181686	18919930364	29575236051
Class II	3160126095	9147733434	11975214677	14325158225
Class III	2993803669	11185183153	14677954101	17513471121
Class IV +	2162191539	10686215875	12224698316	13024980727
Sub Total	22305824325	*70741870174*	*97409081819*	*128376625484*
Aggregate				*318833401802*
TOTAL (Rs in 2006 prices)				318833401802
Corrected to 2009 prices				414483422343

5. Investment for Industrial/Commercial requirements

The calculation for meeting the needs of industrial and commercial uses in the city is driven from the GDP contribution of each city class size. The assumptions related to the GDP contribution and its decadal growth, and the share of manufacturing and service sectors and the resultant water demand are presented in Annex 2. The table below presents the calculations assuming the production backlog for industrial / commercial water to be the same as that for residential water presented in the CDPs. The basic formulae used is :

WSIFPI/C = WSIMLDC * WSIMLDC

where

WSIFPI/C is the Investment required for water production to cover requirements of the industrial / commercial sectors in urban India;
WSIMLDC is the incremental cost to produce an additional MLD of water;
WSIMLDC is the incremental demand for industrial and commercial purposes

As per the calculations in the table 10 the investment requirements for industrial / commercial water alone for the period 2006 – 2031 will be Rupees 2423 Billion (Rupees 242302 crores) or US$ 53 Billion.

Table 10: Investment for Industrial / Commercial requirements : Urban water supply

Table **: Investment for Industrial/Commercial requirements: Urban water supply				
MLD per City type				
	2006	**2011**	**2021**	**2031**
Class I A	7563	12181	31593	81945
Class I B	1493	2194	4736	7055
Class I C	1303	1744	3124	4227
Class II	1323	1689	2750	3455
Backlog Percentage				
	2006			
Class I A	18%			
Class I B	14%			
Class I C	22%			
Class II	22%			
Incremental MLD Costs (Rs. in Lakhs)				
	2006	**2011**	**2021**	**2031**
Class I A	221.0	221.0	221.0	221.0
Class I B	93.4	93.4	221.0	221.0
Class I C	123.6	123.6	93.4	221.0
Class II	123.6	123.6	123.6	93.4
Incremental MLD Demand				
	2006	**2011**	**2021**	**2031**
Class I A	1361.4	4617.4	19412.7	50351.6
Class I B	209.0	700.7	2542.4	2318.4
Class I C	285.1	440.8	1379.4	1103.3
Class II	289.4	365.5	1061.9	704.7
Investment for Industrial / Commercial Water Production (Rs. in Lakhs)				
	2006	**2011**	**2021**	**2031**
Class I A	300831	1020335	4289745	11126495
Class I B	19515	65420	561808	512309
Class I C	35228	54468	128786	243803
Class II	35757	45161	131202	65792
Sub Total	*393336*	*1185385*	*5111542*	*11948399*
Aggregate (in Rs)				***1863866119985***
TOTAL (Rs in 2006 prices)				**1863866119985**
Corrected to 2009 prices				**2423025955980**

6. Operations and Maintenance Costs

The calculation for determining the Operations and Maintenance requirements for the period 2009 – 2031 are calculated on the over all stock of investment based on the average O&M costs reflected in the JNNURM DPRs reviewed. The basic formulae used is :

WSO&MC = WSIS * PO&M

where

WSO&MC is the overall O&M finance requirements for the period 2009-2031;
WSIS is the overall Water Supply investment stock ;
PO&M is the average percentage of O&M costs related to project costs

As per the calculations in the table 11 the Operations and Maintenance requirements for water supply alone will be Rupees 491 Billion (Rupees 49,116 crores) or US$ 10.9 Billion.

Table 11: Operations and Maintenance Costs : Urban water supply

Table **: Operation and Maintainence Costs : Urban water supply				
Cumulative Population				
	2005	**2010**	**2020**	**2030**
Class I A	87157856	96891528	117471372	142839068
Class I B	35337266	42602621	60314000	83339285
Class I C	78608784	85139131	106879992	139412822
Class II	35894253	39352632	50633991	69834329
Class III	43883143	48111245	61903465	85377172
Class IV +	32636425	35780916	46038358	63496037
Per Capita Investment Costs				
	2006	**2011**	**2021**	**2031**
Class I A	3,421	3,421	3,421	3,421
Class I B	1,436	1,436	3,421	3,421
Class I C	1,901	1,901	1,436	3,421
Class II	1,901	1,901	1,901	1,436
Class III	1,901	1,901	1,901	1,901
Class IV +	1,901	1,901	1,901	1,901
Water Supply Stock				
	2006	**2011**	**2021**	**2031**
Class I A	298182029484	331482597948	401889788182	488677043236
Class I B	50756083936	61191553404	206344577531	285118040262
Class I C	149421756063	161834821347	153515266393	476955265438
Class II	68228791501	74802574774	96246493839	100305355519
Class III	83414294684	91451187659	117667823549	162287295487
Class IV +	62036221895	68013356603	87510986447	120695028492
O&M percentage on stock				
	2006	**2011**	**2021**	**2031**
Class I A	9%	9%	9%	9%
Class I B	9%	9%	9%	9%
Class I C	9%	9%	9%	9%
Class II	9%	9%	9%	9%
Class III	9%	9%	9%	9%
Class IV +	9%	9%	9%	9%
O&M costs calculated on stock				
	2006	**2011**	**2021**	**2031**
Class I A	26836382654	29833433815	36170080936	43980933891
Class I B	4568047554	5507239806	18571011978	25660623624
Class I C	13447958046	14565133921	13816373975	42925973889
Class II	6140591235	6732231730	8662184445	9027481997
Class III	7507286522	8230606889	10590104119	14605856594
Class IV +	5583259971	6121202094	7875988780	10862552564
Sub Total	*64083525981*	*70989848256*	*95685744235*	*147063422559*
Aggregate				**377822541031**
TOTAL (Rs in 2006 prices)				**377822541031**
Corrected to 2009 prices				**491169303340**

Summary of Results – Water Supply

Total Aggregate Costs for water supply incl. O&M for the period 2006-2031 is 5790 billion rupees. Out of this total amount 5298 billion rupees are towards various capital expenditure requirements while the rest of approximately eight percent is for operations and maintenance of these assets.

6 Urban Sewerage Finance Requirements Estimation

Like the Water Supply section above this section discusses the special methodology issues in the sewerage sector before discussing the results of the sewerage estimation exercise.

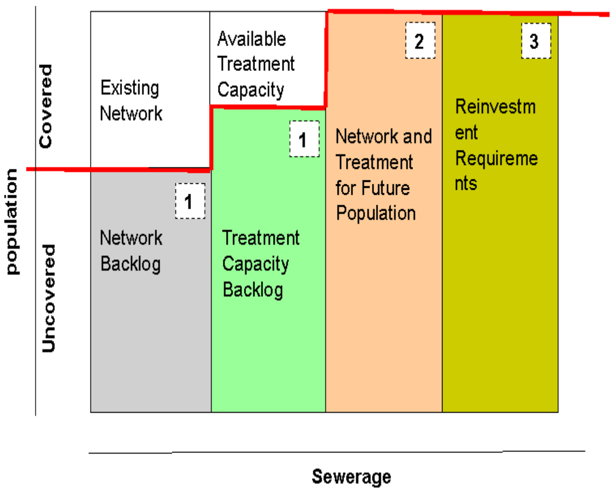
Special Sewerage Methodology issues

As per the SSLBs and the backlog data available in the CDPs, underground sewerage systems seem to be the preferred option for service delivery, inspite of the urban sanitation policy that recommends cities to look at alternative models. Also as evident from our discussions with sector experts and as supported by the CDP data most cities have a limited coverage of sewerage services and treatment capacity. The main issues in the sector arise out of improper planning and implementation as the technology and secondary treatment standards are prevalent for decades and is well known to municipal and parastatal agency engineers.

Description of the model

Since the technology and the outcome standards in this sector has been considered to have not changed significantly there are only four Capital Cost boxes for projecting capital requirements for residential use as in the chart 2 below. There were 47 sewerage projects reviewed.

Chart 2: Graphic description of the Sewerage Investment Projection model (projections for household requirements)



There are only two PCICs that have been derived and used in the sewerage model, these are

a. Per Capita Sewerage Network Costs (PCSNC): is derived as the weighted average of the project costs of network expansion projects and the number of people that they serve.

b. Per Capita Sewerage Treatment Costs (PCSTC): is derived as the weighted average of the project costs of sewerage treatment projects and the number of people that they serve as per the relevant city size DPRs.

1. The PCICs calculated above then are used appropriately to arrive at the investment projections for each of the relevant categories. The Chart No 2 has been prepared to give an outline of the various relevant categories in the sewerage projection model. Such calculations have been undertaken for each city size category separately. These have been presented as boxes in the chart and the sum of all the totals of each of the boxes, for each city size category will make up the total capital expenditure requirements for the sewerage sector in India from 2006 to 2031.

Results

1. Investment for Backlog population

The calculation for meeting the backlog in terms of coverage, estimates the capital investment requirements for the meeting the un-served/under served population in the year 2006 as documented by the cities themselves in the CDPs. Most CDPs have provided backlog numbers in many cases for network and treatment separately, so the calculations take this into account. The basic formulae used is :

SIBP = SPCIC * BP

where

SIBP is the Investment required to cover backlogs in 2006;
SPCIC is the Sewerage PCIC;
BP is the Backlog population or the unserved/under served

population in the year 2006

The detailed description of the Backlog population is placed in Annex 1.

As per the calculations in the table above the investment requirements for the unserved/under served or the Backlog population for sewerage alone will be Rupees 606 Billion (Rupees 6,0662 crores) or US$ 13.5 Billion.

Table 12: Investment for Backlog Population : Urban Sewerage

Table **: Investment for Backlog population: Urban Sewerage		
Per Capita Investment Costs (PCICs)		
	Network	**Treatment**
Class I A	926	679
Class I B	782	344
Class I C	2176	1450
Class II	2176	1450
Class III	2176	1450
Class IV +	2176	1450
Backlog percentage as per CDPs		
	Network	**Treatment**
Class I A	34%	35%
Class I B	65%	58%
Class I C	36%	59%
Class II	65%	59%
Class III	65%	59%
Class IV +	65%	59%
Backlog population, 2006		
	Network	**Treatment**
Class I A	30623924	31514154
Class I B	23905571	21184861
Class I C	28594712	47125364
Class II	23825400	21570823
Class III	29128157	26371784
Class IV +	21662963	19613015
Investment for Backlog population 2006		
	Network	**Treatment**
Class I A	28354050499	21412442356
Class I B	18701462417	7292034623
Class I C	62209667621	68349541706
Class II	51833716664	31285823869
Class III	63370211040	38249027635
Class IV +	47129193964	28446265411
Sub Total	*271598302206*	*195035135600*
Aggregate		**466633437806**
TOTAL (Rs in 2006 prices)		**466633437806**
Corrected to 2009 prices		**606623469147**

2. Investment for additional population

The calculation for additional population, estimates the capital investment requirements for the period between 2009 – 2031. The basic formulae used is :

SIAP = SPCIC * IDP

where

SIAP is the Investment for additional population;
SPCIC is the Sewerage PCIC;
IDP is the Incremental decadal population.

The detailed description of the Incremental decadal population is placed in Annex 1 *while the Sewerage* PCIC is presented in Annex 3. .

As per the calculations in the table 13 the investment requirements for additional urban population for sewerage alone will be Rupees 988 Billion (Rupees 98,841 crores) or US$ 21.9 Billion.

Table 13: Investment for additional Population : Urban Sewerage

Table **: Investment for additional population: Urban Sewerage				
Per Capita Investment Costs (PCICs)				
	Network	**Treatment**	**Consolidated**	**Sewerage**
Class I A	926	679	2448	2111
Class I B	782	344	2749	2454
Class I C		293	3996	3626
Class II				3626
Class III				3626
Class IV +				3626
Additional population				
	2006	**2011**	**2021**	**2031**
Class I A	-	9729561	21057587	25825675
Class I B	-	7696520	17915519	23782900
Class I C	-	6912580	23577137	32019101
Class II	-	3806917	11697489	20360061
Class III	-	4654212	14300968	24891546
Class IV +	-	3461394	10635803	18512144
Investment for additional population				
	2006	**2011**	**2021**	**2031**
Class I A	-	20536504152	44446942879	54511103055.47
Class I B	-	18888212022	37814875926	50199350797.87
Class I C	-	25064615128	57861211634	67583770896.35
Class II	-	13803660706	42414419408	49966109261.29
Class III	-	16875905267	51854485496	90255311577
Class IV +	-	12550815274	38564809313	67123969068
Sub Total	-	*107719712549*	*272956744656*	*379639614656*
Aggregate				***760316071861***
TOTAL (Rs in 2006 prices)				**760316071861**
Corrected to 2009 prices				**988410893419**

3. Finance for Reinvestment requirements

The calculation for meeting the finance requirements for reinvestment are related to replacement of past infrastructure. The investments will need renewal at an average life span of 30 years has been assumed for the sewerage sector. The basic formulae used is :

SRF = SPCIC * PRP

where

SRF is the reinvestment finance requirements ;
SPCIC is the Sewerage PCIC including both PCSNC as well as PCSTC;
PRP past population that qualified for reinvestment.

As per the calculations in the table 14 the reinvestment requirements for the period 2006 to 2031 will be Rupees 1410 Billion (Rupees 1,41,071 crores) or US$ 31 Billion.

Table 14: Investment requirement for reinvestment : Urban Sewerage

Table **: Investment requirements for reinvestment: Urban sewerage				
	Per Capita Investment Costs (PCICs)			
	Network	Treatment		
Class I A	926	679		
Class I B	782	344		
Class I C	2176	1450		
Class II	2176	1450		
Class III	2176	1450		
Class IV +	2176	1450		
	Past population			
	1976	1981	1991	2001
Class I A	13112000	39549075	58275323	78129009
Class I B	4768000	12570708	18522862	28967998
Class I C	11920000	30880217	45501814	71127476
Class II	7600000	22000000	28800000	34451537
Class III	7200000	26900000	35300000	42119326
Class IV +	5200000	25700000	29400000	31324653
	Backlog percentage as per CDPs (2006)			
	Network	Treatment		
Class I A	34%	35%		
Class I B	65%	58%		
Class I C	36%	59%		
Class II	65%	59%		
Class III	65%	59%		
Class IV +	65%	59%		
	Investment required towards reinvestment			
	2006	2011	2021	2031
Class I A	7329993434	22109095289	32577618721	43676412629
Class I B	3378526555	8907397374	13124996371	20526248351
Class I C	19484131926	50476025972	74376120197	116263182217
Class II	17278340641	50016249223	65475817165	78324394686
Class III	16368954291	61156232005	80253345344	95756849792
Class IV +	11822022544	58428072956	66839896689	71215529714
Sub Total	*75661969390*	*251093072819*	*332647794488*	*425762617387*
Aggregate				*1085165454084*
TOTAL (Rs in 2006 prices)				1085165454084
Corrected to 2009 prices				1410715090309

4. Operations and Maintenance Costs

The calculation for determining the Operations and Maintenance requirements for the period 2009 – 2031 are calculated on the over all stock of investment based on the average O&M costs reflected in the JNNURM DPRs reviewed. The basic formulae used is :

SO&MC = SIS * PO&M

where

SO&MC is the overall O&M finance requirements for sewerage for the period 2009-2031;
WSIS is the overall Sewerage investment stock ;
PO&M is the average percentage of O&M costs related to project costs

The detailed description of the O&M Calculations is in Annex 3.

As per the calculations in the table 15 the Operations and Maintenance requirements for sewerage alone will be Rupees 607 Billion (Rupees 60,734 crores) or US$ 13.4 Billion.

Table 15: Operations and Maintenance Costs : Urban Sewerage

Table **: Operation and Maintainence Costs : Urban water supply				
	Cumulative Population			
	2005	2010	2020	2030
Class I A	87157856	96891528	117471372	142839068
Class I B	35337266	42602621	60314000	83339285
Class I C	78608784	85139131	106879992	139412822
Class II	35894253	39352632	50633991	69834329
Class III	43883143	48111245	61903465	85377172
Class IV +	32636425	35780916	46038358	63496037
	Per Capita Investment Costs			
	2006	2011	2021	2031
Class I A	2,111	2,111	2,111	2,111
Class I B	2,454	2,454	2,454	2,454
Class I C	3,626	3,626	3,626	3,626
Class II	3,626	3,626	3,626	3,626
Class III	3,626	3,626	3,626	3,626
Class IV +	3,626	3,626	3,626	3,626
	Swerage Stock			
	2006	2011	2021	2031
Class I A	183966955813	204512138291	247950693180	301495124221
Class I B	86722025375	104552105590	148018022310	204524921128
Class I C	285030921323	308709584508	387540691025	505502860746
Class II	130150493574	142690377673	183595933656	253215251517
Class III	159117747587	174448600802	224458399098	309572705946
Class IV +	118337797306	129739538643	166932431730	230232973274
	O&M percentage on stock			
	2006	2011	2021	2031
Class I A	9%	9%	9%	9%
Class I B	9%	9%	9%	9%
Class I C	9%	9%	9%	9%
Class II	9%	9%	9%	9%
Class III	9%	9%	9%	9%
Class IV +	9%	9%	9%	9%
	O&M costs calculated on stock			
	2006	2011	2021	2031
Class I A	16557026023	18406092446	22315562386	27134561180
Class I B	7804982284	9409689503	13321622008	18407242901
Class I C	25652782919	27783862606	34878662192	45495257467
Class II	11713544422	12842133991	16523634029	22789372636
Class III	14320597283	15700374072	20201255919	27861543535
Class IV +	10650401758	11676558478	15023918856	20720967595
Sub Total	*86699334688*	*95818711096*	*122264655390*	*162408945315*
Aggregate				467191646488
TOTAL (Rs in 2006 prices)				467191646488
Corrected to 2009 prices				607349140435

Summary of Results for Sewerage Infrastructure

Total Aggregate Costs for sewerage incl. O&M for the period 2006-2031 is 3613 Billion rupees in 2009 prices. Out of this total amount 3005 billion rupees are towards various capital expenditure requirements while the rest of approximately eight percent is for operations and maintenance of these assets.

7 Urban Solid Waste Management Finance Requirements Estimation

Like the Water Supply and Sewerage sections above this section discusses the special methodology issues in the solid waste management sector before discussing the results of the solid waste management estimation exercise.

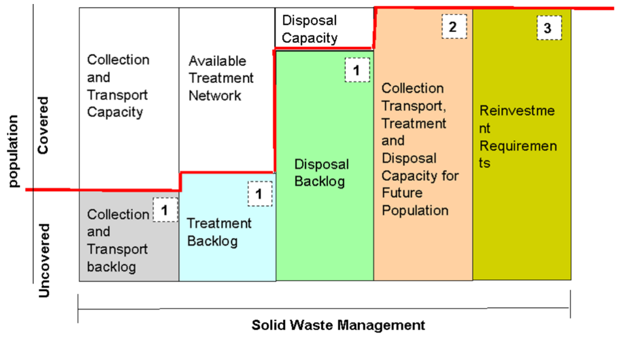
Special Solid Waste Methodology issues

The Solid Waste Management sector has seen a significant change in the policy and regulatory context. The Municipal Waste (Management and handling) Rules 2000, a new environmental regulation has propelled the waste management sector from being a city cleanliness services to maturing into the provision of integrated waste management services. Compliance criteria for this service has seen a high degree of scientific development and cities are actively pursuing the implementation of these upgraded standards. The more recent solid waste management SSLBs also complement the environmental regulation and so there is a definitive set of goals laid out for the cities today. The backlog data available in the CDPs, also address the backlog on similar lines. Also as evident from our discussions with sector experts and as supported by the CDP data while most cities have achieved some success with primary door to door collection and transport, treatment of waste is still lagging and safe and scientific disposal of waste is still to be undertaken in a significant manner in most cities. The main issues in the sector arise out of improper planning and implementation as the technology and treatment standards are now better known and accepted.

Description of the model

Since the technology and the outcome standards in this sector has been well laid out there are six Capital Cost boxes for projecting capital requirements for residential waste management in the chart 3 below. There were 22 solid waste management projects reviewed to arrive at the PCICs for the sector.

Chart 3: Graphic description of the Solid Waste management Investment Projection model



There are three PCICs that have been derived and used in the solid waste management model, these are

a. Per Capita SWM Collection and Transport Costs (PCSWMC&TC): is derived out of a distribution, derived from the project components and cross referred with suggestions from technical experts of the overall integrated project costs of integrated projects and the number of people that they serve.

b. Per Capita SWM Treatment Costs (PCSWMTC): as in the above a distribution based on project components as well as expert opinion has been applied to the integrated PCICs derived from the DPRs.

c. Per Capita SWM Disposal Costs (PCSWMDC): as in the above a distribution based on project components as well as expert opinion has been applied to the integrated PCICs derived from the DPRs. There are just a sanitary disposal facilities currently in India.

The PCICs calculated above then are used appropriately to arrive at the investment projections for each of the relevant categories. The Chart No 3 has been prepared to give an outline of the various relevant categories in the solid waste management projection model. Such calculations have been undertaken for each city size category separately. These have been presented as boxes in the chart and the sum of all the totals of each of the boxes, for each city size category will make up the total capital expenditure requirements for the solid waste management sector in India from 2006 to 2031.

Results

1. Investment for Backlog population

The calculation for meeting the backlog in terms of coverage defined in the new service standards reflected in the SSLBs and the MSW Rules (O&M) 2000. The Backlog numbers have been reflected in the CDPs in the categories of collection and transport and treatment and recycling. We are also aware that there are very few sanitary landfills, as per the new disposal norms in India today, leading us to assume a high backlog number for disposal. It is also a well documented fact that other than the JNNURM projects providing capital finance to the sector the XIIth Finance Commission has directly allocated fund to the SWM sector till 2010 and that much of the investment driven across the states esp. in smaller local bodies is due to the availability of these funds. The basic formulae used is :

SWMIBP = SWMPCIC * BP

where

SWMIBP is the Investment required to cover backlogs in 2006;
SWMPCIC is the SWM PCIC ;
BP is the Backlog population or the unserved/under served population in the year 2006

As per the calculations in the table 16 the investment requirements for the unserved/under served or the Backlog population for solid waste management alone will be Rupees 136.7 Billion (Rupees 13,676 crores) or US$ 3 Billion.

Table 16: Investment for Backlog Population : Urban Solid Waste

Table **: Investment for Backlog population: Urban Solid Waste			
Per Capita Investment Costs (PCICs)			
	Collection and Transport	**Treatment**	**Disposal**
Class I A	190	190	190
Class I B	83	83	83
Class I C	261	261	261
Class II	261	261	261
Class III	261	261	261
Class IV +	261	261	261
Backlog percentage as per CDPs			
	Collection and Transport	**Treatment**	**Disposal**
Class I A	18%	9%	90%
Class I B	14%	30%	100%
Class I C	22%	38%	100%
Class II	22%	38%	100%
Class III	22%	38%	100%
Class IV +	22%	38%	100%
Backlog population, 2006			
	Collection and Transport	**Treatment**	**Disposal**
Class I A	16024146	8368165	80120731
Class I B	5135724	10858387	36683741
Class I C	17472328	30052404	79873498
Class II	8043358	13893072	36560716
Class III	9833547	16985217	44697939
Class IV +	7313328	12632112	33242399
Investment for Backlog population 2006			
	Collection and Transport	**Treatment**	**Disposal**
Class I A	3040860209	1588004776	15204301047
Class I B	426663147.5	902087797.5	3047593910
Class I C	4556215895	7836691339	20828415520
Class II	2097446553	3622862228	9533847970
Class III	2564269732	4429193173	11655771508
Class IV +	1907078477	3294044642	8668538533
Sub Total	*14592534014*	*21672883957*	*68938468488*
Aggregate			**105203886459**
TOTAL (Rs in 2006 prices)			**105203886459**
Corrected to 2009 prices			**136765052397**

2. Investment for additional population

This segment estimates the capital investment requirements for the period between 2006 – 2031, for the new population that would be agglomerating in urban areas. The basic formulae used is :

SWMIAP = SWMPCIC * IDP

where

SWMIAP is the Investment for additional population;
SWMPCIC is the Solid Waste Management PCIC;
IDP is the Incremental decadal population.

The detailed description of the Incremental decadal population is placed in Annex 1 while the Solid Waste Management PCIC is presented in Annex 3. .

As per the calculations in the table ….. the investment requirements for additional urban population for solid waste management alone will be Rupees 344 Billion (Rupees 34,441 crores) or US$ 7.6 Billion.

Table 17: Investment for Additional Population : Urban Solid Waste

Table **: Investment for additional population: Urban Solid Waste				
Per Capita Investment Costs (PCICs)				
	Collection and Transport	Treatment	Disposal	Solid Waste
Class I A	190	190	190	569
Class I B	83	83	83	249
Class I C	261	261	261	782
Class II	261	261	261	782
Class III	261	261	261	782
Class IV +	261	261	261	782
Additional population				
	2006	2011	2021	2031
Class I A	-	9729561	21057587	25825675
Class I B	-	7696520	17915519	23782900
Class I C	-	6912580	23577137	32019101
Class II	-	3806917	11697489	20360061
Class III	-	4654212	14300968	24891546
Class IV +	-	3461394	10635803	18512144
Investment for additional population				
	2006	2011	2021	2031
Class I A	-	6231442180	16783381269	23230127162
Class I B	-	2158000977	6251182265	9365406533
Class I C	-	6083695191	25822237829	39576829986
Class II	-	3350431029	12811366225	25165811407
Class III	-	4096127676	15662758406	30766900050
Class IV +	-	3046339796	11648583251	22881716446
Sub Total	-	*24966036850*	*88979509246*	*150986791583*
Aggregate				***264932337679***
TOTAL (Rs in 2006 prices)				**264932337679**
Corrected to 2009 prices				**344412038982**

3. Finance for Reinvestment requirements

The calculation for meeting the finance requirements for reinvestment are related to replacement of past infrastructure. The investments will need renewal at an average life span of 10 years for the solid waste management sector. The basic formulae used is :

SWMRF = SWMPCIC * PRP

where

SRF is the reinvestment finance requirements ;
SWMPCIC is the SWM PCIC ;
PRP past population that qualified for reinvestment.

As per the calculations in the table 18 the reinvestment requirements for the period 2006 to 2031 will be Rupees 320 Billion (Rupees 32,086 crores) or US$ 7.1 Billion.

Table 18: Investment requirements for reinvestment : Urban Solid Waste

Table **: Investment requirements for reinvestment: Urban Solid Waste				
Per Capita Investment Costs (PCICs)				
	Collection and Transport	Treatment	Disposal	Solid Waste
Class I A	190	190	190	569
Class I B	83	83	83	249
Class I C	261	261	261	782
Class II	261	261	261	782
Class III	261	261	261	782
Class IV +	261	261	261	782
Past population				
	1996	2001	2011	2021
Class I A	53812000	78129009	9729561	21057587
Class I B	19568000	28967998	7696520	17915519
Class I C	48920000	71127476	6912580	23577137
Class II	28800000	34451537	3806917	11697489
Class III	35300000	42119326	4654212	14300968
Class IV +	29400000	31324653	3461394	10635803
Backlog percentage as per CDPs (2006)				
	Collection and Transport	Treatment	Disposal	
Class I A	18%	9%	90%	
Class I B	14%	30%	100%	
Class I C	22%	38%	100%	
Class II	22%	38%	100%	
Class III	22%	38%	100%	
Class IV +	22%	38%	100%	
Investment requirements for reinvestment				
	2006	2011	2021	2031
Class I A	11988608826	19581884927	3034666183	7412340377
Class I B	2334448812	3887844867	1285465234	3376948195
Class I C	20347013051	33281595460	4025152996	15493957513
Class II	12016168184	16170916726	2223693483	7711222337
Class III	14728150587	19770035250	2718615110	9427488869
Class IV +	12266505022	14703214818	2021867005	7011337728
Sub Total	73680894482	*107395492049*	*15309460011*	*50433295019*
Aggregate				***246819141562***
TOTAL (Rs in 2006 prices)				**246819141562**
Corrected to 2009 prices				**320864884030**

4. Operations and Maintenance Costs

The calculation for determining the Operations and Maintenance requirements for the period 2006 – 2031 are calculated on the over all stock of investment based on the average O&M costs reflected in the JNNURM DPRs reviewed. The basic formulae used is :

SWMO&MC = SWMIS * PO&M

where

SWMO&MC is the overall O&M finance requirements for sewerage for the period 2009-2031;
SWMIS is the overall SWM investment stock ;
PO&M is the average percentage of O&M costs related to project costs

As per the calculations in the table 19 the Operations and Maintenance requirements for solid waste management alone will be Rupees 978 Billion (Rupees 97,896 crores) or

US$ 21.7 Billion.

Table 19: Operations and Maintenance Costs : Urban Solid Waste

Table **: Operation and Maintainence Costs : Urban Solid Waste				
Cumulative Population				
	2005	**2010**	**2020**	**2030**
Class I A	87157856	96891528	117471372	142839068
Class I B	35337266	42602621	60314000	83339285
Class I C	78608784	85139131	106879992	139412822
Class II	35894253	39352632	50633991	69834329
Class III	43883143	48111245	61903465	85377172
Class IV +	32636425	35780916	46038358	63496037
Per Capita Investment Costs				
	2006	**2011**	**2021**	**2031**
Class I A	569	640	903	1,427
Class I B	249	280	395	625
Class I C	782	880	1,241	1,961
Class II	782	880	1,241	1,961
Class III	782	880	1,241	1,961
Class IV +	782	880	1,241	1,961
Solid Waste Stock				
	2006	**2011**	**2021**	**2031**
Class I A	49619153604	62055623270	106083170697	203806741336
Class I B	8807196326	11945204010	23844844672	52057489632
Class I C	61495857332	74930135781	132630323319	273341909304
Class II	28080168100	34633875689	62833113025	136921757895
Class III	34329897469	42342246567	76817714200	167396074449
Class IV +	25531560808	31490441938	57130265042	124494489322
O&M percentage on stock (40%)				
	2006	**2011**	**2021**	**2031**
Class I A	40%	40%	40%	40%
Class I B	40%	40%	40%	40%
Class I C	40%	40%	40%	40%
Class II	40%	40%	40%	40%
Class III	40%	40%	40%	40%
Class IV +	40%	40%	40%	40%
O&M costs calculated on stock				
	2006	**2011**	**2021**	**2031**
Class I A	19847661442	24822249308	42433268279	81522696534
Class I B	3522878531	4778081604	9537937869	20822995853
Class I C	24598342933	29972054312	53052129327	109336763722
Class II	11232067240	13853550275	25133245210	54768703158
Class III	13731958988	16936898627	30727085680	66958429780
Class IV +	10212624323	12596176775	22852106017	49797795729
Sub Total	*83145533456*	*102959010902*	*183735772382*	*383207384775*
Aggregate				**753047701515**
TOTAL (Rs in 2006 prices)				**753047701515**
Corrected to 2009 prices				**978962011970**

Summary of Results

Total Aggregate Costs for solid waste management incl. O&M for the period 2006-2031 is 1781 Billion rupees in 2009 prices. Out of this total amount 802 billion rupees are towards various capital expenditure requirements while the rest of approximately fifty four percent is for operations and maintenance of these assets.

8 Urban Roads Finance Requirements Estimation

This section describes the special methodology issues in estimating finance requirements for urban roads before discussing the results of the estimation exercise. As mentioned earlier while the core methodology is similar to the other sectors, there is some variation as there are not enough comprehensive JNNURM projects that can inform the development of the PCIC.

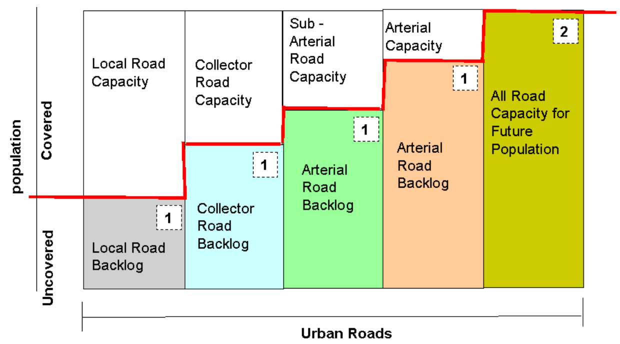
Special Urban Roads Methodology issues

Unlike in the other sectors above, the road estimation exercise is based on a theoretical model of road requirements for particular density ranges and city population. Much of the parameters have been developed from the *"Urban Development Plans Formation and Implementation Guidelines"* of the Governmnet of India. Detailed explanation of the methodology for ariving at the estimated road requirement, across the different types and the costs per unit of road length for differnct city sizes is presented in Annex 5.

The Backlog calculations although have relayed on city level data, unlike in other sectors the data is not presented as backlogs for various types of roads by most cities in the CDPs. Therefore assumptions have been made on the basis of less number of data points compared to other sectors. It is interesting to note that although cities while they are of a particular size may have adequate roads, but the main challenge facing them is to increase the road length and upgrade the road type from collector streets to sub-arterial roads and arterial roads as both densities and city sizes increase.

Description of the model

Chart 4: Graphic description of the Urban Roads Investment Projection model



The PCICs that have been derived and used in the urban roads are

a. Per Capita Arterial Urban Road Costs (PCAURC): is derived out of the per capita road length and the unit costs for the road type.
b. Per Capita Sub Arterial Urban Road Costs (PCSAURC): as in the above is the cost of the unit of length of sub arterial road required for that city class multiplied by the unit cost of construction derived from the construction cost of that road type.
c. Per Capita Collector Urban Road Costs (PCCURC): as above for collector roads.
d. Per Capita Local Urban Road Costs (PCLURC): as above for local roads.
e. Per Capita Special Road Infrastructure Costs (PCSRIC): which are defined as grade separators and other high volume and speed management infrastructure.

The PCICs calculated above then are used appropriately to arrive at the investment projections for each of the relevant categories. The All Roads PCIC is the sum of PCAURC, PCSAURC, PCCURC and PCLURC. This summary PCIC is used while projecting investment requirements for additional city population. The Chart No 4 has been prepared to give an outline of the various relevant categories in the urban road projection model. Such calculations have been undertaken for each city size category separately. These have been presented as boxes in the chart and the sum of all the totals of each of the boxes, for each city size category will make up the total capital expenditure requirements for the urban roads sector in India from 2006 to 2031.

Results

1. Investment for Backlog population

The calculation for meeting the backlog in terms of coverage defined in the new standards of road availability. The available road length and the Backlog in each category of road are not easily available even for the mission cities of the JNNURM. A handful of examples have been used to make informed assumptions based on some CDP data and some data from a Wilber Smith undertaken urban transport study for the government of India. The basic formulae used is :

CRIBP = CRPCIC * BP

where

CRIBP is the Investment required to cover backlogs in 2006;
CRPCIC is the summary of the various PCIC including PCAURC, PCSAURC, PCCURC and PCLURC;
BP is the Backlog population or the unserved/under served population in the year 2006, which is assumed for each category of road separately.

As per the calculations in the table 20 the investment requirements for the under served or the Backlog population for city roads alone will be Rupees 18.6 trillion or US$ 414 Billion.

Table 20: Investment for Backlog population : Urban Roads

Table **: Investment for backlog population: Urban Roads				
Per Capita Investment Costs (PCICs)				
	Arterial	Sub Arterial	Collector	Local
Class I A	17915	10676	14493	14400
Class I B	27408	16014	21739	18000
Class I C		22842	31140	26537
Class II			63472	32811
Class III			63472	39374
Class IV +			63472	39374
Backlog percentages				
	Arterial	Sub Arterial	Collector	Local
Class I A	83%	77%	42%	0%
Class I B	83%	77%	42%	0%
Class I C	0%	47%	26%	79%
Class II	0%	0%	70%	44%
Class III	0%	0%	70%	44%
Class IV +	0%	0%	70%	44%
Backlog population 2006				
	Arterial	Sub Arterial	Collector	Local
Class I A	73889118	68547736	37389674	0
Class I B	30447505	28246481	15407171	0
Class I C	0	37540544	20767110	63100064
Class II	0	0	25592501	16086715
Class III	0	0	31288557	19667093
Class IV +	0	0	23269679	14626655
Investment for backlog population				
	Arterial	Sub Arterial	Collector	Local
Class I A	1323694981749	731801921522	541870602009	0
Class I B	834494087992	452330668732	334933107668	0
Class I C	0	857501108943	646697135556	1674495400247
Class II	0	0	1624397006722	527828103939
Class III	0	0	1985934788247	774366504855
Class IV +	0	0	1476963770527	575905754584
Sub Total	*2158189069741*	*2041633699196*	*6610796410729*	*3552595763626*
Aggregate				***14363214943293***
TOTAL (Rs in 2006 prices)				**14363214943293**
Corrected to 2009 prices				**18672179426281**

2. Investment for additional population

This segment estimates the capital investment requirements for the period between 2006 – 2031, for the new population that would be agglomerating in urban areas. The basic formulae used is :

CRIAP = CRPCIC * IDP

where

CRIAP is the Investment for additional population;
CRPCIC is the all per capita investment costs for all urban roads PCIC;
IDP is the Incremental decadal population.

The detailed description of the Incremental decadal population is placed in Annex 1 while the City road related PCICs are presented in Annex 5. .

As per the calculations in the table 21 the investment requirements for additional urban population for all categories of city roads alone will be Rupees 30 Trillion or US$ 670 Billion.

Table 21: Investment for additional population : Urban Roads

Table **: Investment for additional population: Urban Roads				
Per Capita Investment Costs (PCICs)				
	All Roads	Spl Road Infra	Total	
Class I A	56650	833	57483	
Class I B	81374	1786	83160	
Class I C	80520	0	80520	
Class II	96283	0	96283	
Class III	96283	0	96283	
Class IV +	96283	0	96283	
Additional population				
	2006	**2011**	**2021**	**2031**
Class I A	-	9729561	21057587	25825675
Class I B	-	7696520	17915519	23782900
Class I C	-	6912580	23577137	32019101
Class II	-	3806917	11697489	20360061
Class III	-	4654212	14300968	24891546
Class IV +	-	3461394	10635803	18512144
Investment for additional population				
	2006	**2011**	**2021**	**2031**
Class I A	-	559283690604	1210451889287	1484535569968
Class I B	-	640043455698	1489856613070	1977788712145
Class I C	-	556598090198	1898421434409	2578164985765
Class II	-	366541471980	1126269621786	1960328304518
Class III	-	448121513103	1376940089071	2396632722769
Class IV +	-	333273400297	1024047032047	1782404801879
Sub Total	-	*2903861621881*	*8125986679670*	*12179855097045*
Aggregate				***23209703398597***
TOTAL (Rs in 2006 prices)				**23209703398597**
Corrected to 2009 prices				**30172614418176**

3. Operations and Maintenance Costs

The calculation for determining the Operations and Maintenance requirements for the period 2006 – 2031 are calculated on the over all stock of investment based on the average O&M costs determined after speaking to sector experts. The city roads sector unlike other sectors does not have a reinvestment category and all post construction costs have been incorporated into the O&M costs. The basic formulae used is :

CRO&MC = CRMIS * PO&M

where

CRO&MC is the overall O&M finance requirements for sewerage for the period 2006-2031;
CRMIS is the overall city road stock ;
PO&M is the average percentage of O&M costs related to project costs

The detailed description of the O&M Calculations is in Annex 5.

As per the calculations in the table 22 the Operations and Maintenance requirements for city roads alone will be Rupees 5192 Billion in 2009 prices or US$ 115 Billion.

Table 22: Operation and Maintenance costs : Urban Roads

Table **: Operation and Maintainence Costs : Urban Roads				
Cumulative Population				
	2005	**2010**	**2020**	**2030**
Class I A	87157856	96891528	117471372	142839068
Class I B	35337266	42602621	60314000	83339285
Class I C	78608784	85139131	106879992	139412822
Class II	35894253	39352632	50633991	69834329
Class III	43883143	48111245	61903465	85377172
Class IV +	32636425	35780916	46038358	63496037
Per Capita Investment Costs				
	Arterial	Sub Arterial	Collector	Local
Class I A	17915	10676	14493	14400
Class I B	27408	16014	21739	18000
Class I C	0	22842	31140	26537
Class II	0	0	63472	32811
Class III	0	0	63472	39374
Class IV +	0	0	63472	39374
Urban Road Stock				
	2006	**2011**	**2021**	**2031**
Class I A	3714127808973	5569609249581	6752599066814	8210808642475
Class I B	2134787069055	3542838829071	5015719137224	6930504440803
Class I C	4681565779811	6855368186828	8605933400435	11225463684362
Class II	2937801038629	3788990629575	4875193994134	6723860647845
Class III	3752924994958	4948016069737	6366481362548	8780642072988
Class IV +	2791095802270	3679899518472	4734829347805	6530269926545
O&M percentage on stock				
	2006	**2011**	**2021**	**2031**
Class I A	3%	3%	3%	3%
Class I B	3%	3%	3%	3%
Class I C	3%	3%	3%	3%
Class II	3%	3%	3%	3%
Class III	3%	3%	3%	3%
Class IV +	3%	3%	3%	3%
O&M costs calculated on stock				
	2006	**2011**	**2021**	**2031**
Class I A	111423834269	167088277487	202577972004	246324259274
Class I B	64043612072	106285164872	150471574117	207915133224
Class I C	140446973394	205661045605	258178002013	336763910531
Class II	88134031159	113669718887	146255819824	201715819435
Class III	112587749849	148440482092	190994440876	263419262190
Class IV +	83732874068	110396985554	142044880434	195908097796
Sub Total	*600369074811*	*851541674498*	*1090522689269*	*1452046482451*
Aggregate				**3994479921028**
TOTAL (Rs in 2006 prices)				**3994479921028**
Corrected to 2009 prices				**5192823897337**

Summary of Results

Total Aggregate Costs for city road infrastructure incl. O&M for the period 2006-2031 is 54037 Billion rupees in 2009 prices. Out of this total amount 48844 billion rupees are towards various capital expenditure requirements while the rest of approximately ten percent is for operations and maintenance of these assets.

9 Storm Water Drains Finance Requirements Estimation

Like the sections above this section discusses the special methodology issues in the storm water sector before discussing the results of the estimation exercise.

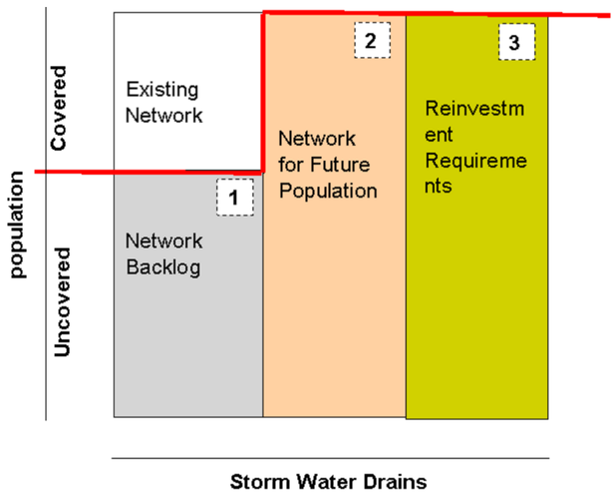
Special Storm Water Methodology issues

Storm water drains have not seen any major technological or standard up-gradation in recent policy. Much of the shallow storm water drains that are the typical ingredient of a road cross section have been covered in the PCIC of the city road network. However, storm water drains also include natural nallahs and drains, some underground links etc. As per the SSLBs approved by the Government of India, length of storm water drains are typically 130 per cent of the city road length. However, we have calculated the investment requirements based on the PCIC derived from thirty four JNNURM projects. The backlog data has not been available in the CDPs, therefore we have used the same backlogs as we have for the city roads to ensure some consistency.

Description of the model

Since the technology and the outcome standards in this sector has been well laid out there are three Capital Cost boxes for projecting capital requirements for storm water drains as in the chart 5 below.

Chart 5: Graphic description of the Storm Water Drain Investment Projection model



With regard to storm water drains there is only one PCICs that has been derived and used in the model, which is

Per Capita Storm Water Drain Costs (PCSWDC): is derived from the project components and cross referred with suggestions from technical experts of the overall integrated project costs of integrated projects and the number of people that they serve.

The PCICs calculated above then are used appropriately to arrive at the investment projections for each of the relevant categories. The Chart No 5 has been prepared to give an outline of the various relevant categories in the model. Such calculations have been undertaken for each city size category separately. These have been presented as boxes in the chart and the sum of all the totals of each of the boxes, for each city size category will make up the total capital expenditure requirements for storm water drain in India from 2006 to 2031.

Results

1. Investment for Backlog population

As mentioned above due to the lack of good data in most of the CDPs backlog has been assumed to be the same as roads. This is based on the hypothesis that normally storm water drains and city roads are build together. The basic formulae used is :

SWDIBP = SWDPCIC * BP

where

SWDIBP is the Investment required to cover backlogs in 2006;
SWDPCIC is the Storm water drain PCIC ;
BP is the Backlog population or the unserved/under served population in the year 2006

As per the calculations in the table …. the investment requirements for the unserved/under served or the Backlog population for storm water drains alone will be Rupees 593 Billion or US$ 13 Billion.

Table 23: Investment requirements for Backlog population : Storm water drains

Table **: Investment for backlog population: Storm Water Drains				
Per Capita Investment Costs (PCICs)				
Class I A	722			
Class I B	1213			
Class I C	940			
Class II	940			
Class III	940			
Class IV +	940			
Backlog percentages				
	Arterial	Sub Arterial	Collector	Local
Class I A	83%	77%	42%	0%
Class I B	83%	77%	42%	0%
Class I C	0%	47%	26%	79%
Class II	0%	0%	70%	44%
Class III	0%	0%	70%	44%
Class IV +	0%	0%	70%	44%
Backlog population 2006				
	Arterial	Sub Arterial	Collector	Local
Class I A	73889118	68547736	37389674	0
Class I B	30447505	28246481	15407171	0
Class I C	0	37540544	20767110	63100064
Class II	0	0	25592501	16086715
Class III	0	0	31288557	19667093
Class IV +	0	0	23269679	14626655
Investment for backlog population				
	Arterial	Sub Arterial	Collector	Local
Class I A	53347943327	49491465496	26995344816	0
Class I B	36932823832	34262981146	18688898807	0
Class I C	0	35288111479	19521082946	59314059720
Class II	0	0	24056951240	15121512208
Class III	0	0	29411243784	18487067521
Class IV +	0	0	21873498451	13749056169
Sub Total	*90280767159*	*119042558120*	*140547020043*	*106671695619*
Aggregate				***456542040941***
TOTAL (Rs in 2006 prices)				**456542040941**
Corrected to 2009 prices				**593504653224**

Table 24: Investment requirements for additional population : Storm water drains

Table **: Investment for additional population: Storm Water Drains				
Per Capita Investment Costs (PCICs)				
Class I A	722			
Class I B	1213			
Class I C	940			
Class II	940			
Class III	940			
Class IV +	940			
Additional population				
	2006	**2011**	**2021**	**2031**
Class I A	-	9729561	21057587	25825675
Class I B	-	7696520	17915519	23782900
Class I C	-	6912580	23577137	32019101
Class II	-	3806917	11697489	20360061
Class III	-	4654212	14300968	24891546
Class IV +	-	3461394	10635803	18512144
Investment for additional population				
	2006	**2011**	**2021**	**2031**
Class I A	-	7024742845	15203578060	18646137547
Class I B	-	9335878365	21731524628	28848658139
Class I C	-	6497824768	22162508341	30097955052
Class II	-	3578501723	10995639213	19138457043
Class III	-	4374959467	13442909794	23398053233
Class IV +	-	3253710378	9997654935	17401415762
Sub Total	-	*34065617545*	*93533814972*	*137530676774*
Aggregate				***265130109291***
TOTAL (Rs in 2006 prices)				**265130109291**
Corrected to 2009 prices				**344669142078**

2. Investment for additional population

This segment estimates the capital investment requirements for the period between 2006 – 2031, for the new population that would be agglomerating in urban areas. The basic formulae used is :

SWDIAP = SWDPCIC * IDP

where

SWDIAP is the Investment for additional population;
SWDPCIC is the Storm water drain PCIC;
IDP is the Incremental decadal population.

The detailed description of the Incremental decadal population is placed in Annex 1 while the Storm water drain PCIC is presented in Annex 6. .

As per the calculations in the table 24 the investment requirements for additional urban population for storm water drains alone will be Rupees 344 Billion or US$ 7.6 Billion.

3. Finance for Reinvestment requirements

The calculation for meeting the finance requirements for reinvestment are related to replacement of past infrastructure. The investments will need renewal at an average life span of 30 years for the storm water drains. The basic formulae used is :

SWDRF = SWDPCIC * PRP

where

SRF is the reinvestment finance requirements ;
SWDPCIC is the Storm water drain PCIC ;
PRP past population that qualified for reinvestment.

As per the calculations in the table 25 the reinvestment requirements for the period 2006 to 2031 will be Rupees 1305 Billion (Rupees 130,592 crores) or US$ 29 Billion.

Table 25: Investment requirements for Reinvestment : Storm water drains

Table **: Investment requirements for Reinvestment: Storm Water Drains				
Per Capita Investment Costs (PCICs)				
Class I A	722			
Class I B	1213			
Class I C	940			
Class II	940			
Class III	940			
Class IV +	940			
Past population				
	1976	**1981**	**1991**	**2001**
Class I A	13112000	39549075	58275323	78129009
Class I B	4768000	12570708	18522862	28967998
Class I C	11920000	30880217	45501814	71127476
Class II	7600000	22000000	28800000	34451537
Class III	7200000	26900000	35300000	42119326
Class IV +	5200000	25700000	29400000	31324653
Backlog percentage as per CDPs (2006)				
	Arterial	Sub Arterial	Collector	Local
Class I A	83%	77%	42%	0%
Class I B	83%	77%	42%	0%
Class I C	0%	47%	26%	79%
Class II	0%	0%	70%	44%
Class III	0%	0%	70%	44%
Class IV +	0%	0%	70%	44%
Reinvestment Requirements				
	2006	**2011**	**2021**	**2031**
Class I A	19123065280	57679952420	84991062422	113946471773
Class I B	11682839680	30801502899	45385828971	70979127973
Class I C	17031296000	44121654611	84042608885	101626938155
Class II	8144160000	23575200000	33199555888	36918267529
Class III	7715520000	28826040000	40647953143	45135069508
Class IV +	5572320000	27540120000	32301076501	33567498207
Sub Total	69269200960	*212544469931*	*320568085809*	*402173373145*
Aggregate				***1004555129845***
TOTAL (Rs in 2006 prices)				**1004555129845**
Corrected to 2009 prices				**1305921668798**

4. Operations and Maintenance Costs

The calculation for determining the Operations and Maintenance requirements for the period 2006 – 2031 are calculated on the over all stock of investment based on the average O&M costs reflected in the JNNURM DPRs reviewed. The basic formulae used is :

SWDO&MC = SWDIS * PO&M

where

SWDO&MC is the overall O&M finance requirements for sewerage for the period 2009-2031;
SWDMIS is the overall Storm water drain investment stock ;
PO&M is the average percentage of O&M costs related to project costs

The detailed description of the O&M Calculations is in Annex 6.

As per the calculations in the table 26 the Operations and Maintenance requirements for sewerage alone will be Rupees 44 Billion or US$ 0.9 Billion.

Table 26: Operations and Maintenance Costs : Storm water drains

Table **: Operation and Maintainence Costs : Storm Water Drains				
Cumulative Population				
	2005	**2010**	**2020**	**2030**
Class I A	87157856	96891528	117471372	142839068
Class I B	35337266	42602621	60314000	83339285
Class I C	78608784	85139131	106879992	139412822
Class II	35894253	39352632	50633991	69834329
Class III	43883143	48111245	61903465	85377172
Class IV +	32636425	35780916	46038358	63496037
Per Capita Investment Costs				
Class I A	722			
Class I B	1213			
Class I C	940			
Class II	940			
Class III	940			
Class IV +	940			
Storm Water Drain Stock				
	2006	**2011**	**2021**	**2031**
Class I A	62927971915	69955683279	84814330855	103129807338
Class I B	42864103786	51676979241	73160882061	101090552351
Class I C	73892256905	80030783403	100467192013	131048052888
Class II	33740597907	36991474454	47595951462	65644268806
Class III	41250154293	45224569907	58189257550	80254541550
Class IV +	30678239678	33634060739	43276056064	59686275195
O&M percentage on stock				
	2006	**2011**	**2021**	**2031**
Class I A	2.2%	2.2%	2.2%	2.2%
Class I B	2.2%	2.2%	2.2%	2.2%
Class I C	2.2%	2.2%	2.2%	2.2%
Class II	2.2%	2.2%	2.2%	2.2%
Class III	2.2%	2.2%	2.2%	2.2%
Class IV +	2.2%	2.2%	2.2%	2.2%
O&M costs calculated on stock				
	2006	**2011**	**2021**	**2031**
Class I A	1384415382	1539025032	1865915279	2268855761
Class I B	943010283	1136893543	1609539405	2223992152
Class I C	1625629652	1760677235	2210278224	2883057164
Class II	742293154	813812438	1047110932	1444173914
Class III	907503394	994940538	1280163666	1765599914
Class IV +	674921273	739949336	952073233	1313098054
Sub Total	*6277773139*	*6985298123*	*8965080740*	*11898776959*
Aggregate				**34126928960**
TOTAL (Rs in 2006 prices)				**34126928960**
Corrected to 2009 prices				**44365007648**

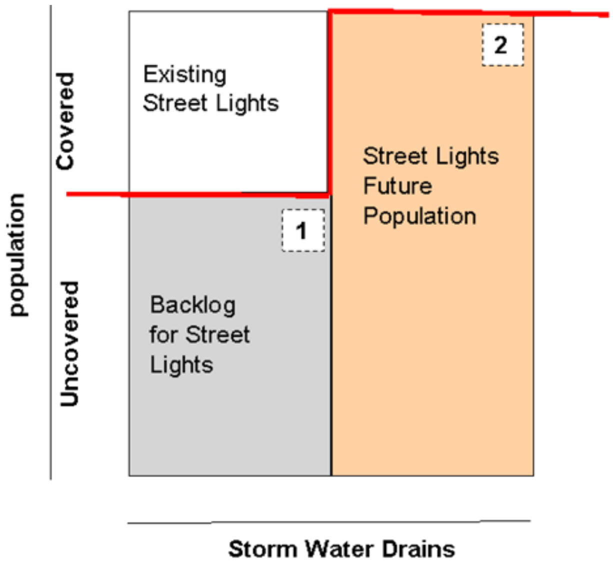
Summary of Results

Total Aggregate Costs for storm water drains incl. O&M for the period 2006-2031 is 2288 Billion rupees in 2009 prices. Out of this total amount 2244 billion rupees are towards various capital expenditure requirements while the rest of approximately two percent is for operations and maintenance of these assets.

10 Street Lighting Finance Requirements

Like the other sectors too, street lights have been calculated on the basis of per capita investment cost norms and not in terms of its more prevalent method of calculating it in relation to road length. One of the main findings have been that the road availability has to be significantly strengthened in the near future in India's urban areas. Street lights will also have to follow close suit.

Chart 6: Graphic description of the Street Lighting Investment Projection model



There is only one PCIC for street lights which was derived out of a discussion of the per capita type of road that the street light was to lighten.

Results

1. Investment for Backlog population

The calculation for meeting the backlog in terms of coverage has been arrived at similar to roads and storm water drains. The CDPs themselves did nt have adequate information on street lighting backlogs and so the backlog has been assumed to be the same as that in the city road sector. The basic formulae used is :

SLIBP = SLPCIC * BP

where

SLIBP is the Investment required to cover backlogs in 2006;
SLPCIC is the SL PCIC ;
BP is the Backlog population or the unserved/under served population in the year 2006

As per the calculations in the table 27 the investment requirements for the unserved/under served or the Backlog population for street lighting alone will be Rupees 31 Billion or US$ 0.7 Billion.

Table 27: Investment requirements for Backlog population : Street Lights

Table **: Investment for backlog population: Street Lights				
Per Capita Investment Costs (PCICs)				
	Arterial	Sub Arterial	Collector	Local
Class I A	18	18	15	52
Class I B	27	27	23	65
Class I C		38	33	96
Class II			67	118
Class III			67	118
Class IV +			67	118
Backlog percentages				
	Arterial	Sub Arterial	Collector	Local
Class I A	83%	77%	42%	0%
Class I B	83%	77%	42%	0%
Class I C	0%	47%	26%	79%
Class II	0%	0%	70%	44%
Class III	0%	0%	70%	44%
Class IV +	0%	0%	70%	44%
Backlog population 2006				
	Arterial	Sub Arterial	Collector	Local
Class I A	73889118	68547736	37389674	0
Class I B	30447505	28246481	15407171	0
Class I C	0	37540544	20767110	63100064
Class II	0	0	25592501	16086715
Class III	0	0	31288557	19667093
Class IV +	0	0	23269679	14626655
Investment for backlog population				
	Arterial	Sub Arterial	Collector	Local
Class I A	1314709080	1219669869	573408044	0
Class I B	812628691	753884448	354426569	0
Class I C	0	1429168515	684335593	6028183441
Class II	0	0	1718938631	1900181174
Class III	0	0	2096333334	2320716987
Class IV +	0	0	1559068507	1725945349
Sub Total	*2127337770*	*3402722832*	*6986510678*	*11975026951*
Aggregate				***24491598231***
TOTAL (Rs in 2006 prices)				**24491598231**
Corrected to 2009 prices				**31830539709**

2. Investment for additional population

This segment estimates the capital investment requirements for the period between 2006 – 2031, for the new population that would be agglomerating in urban areas. The basic formulae used is :

SLIAP = SLPCIC * IDP

where

SLIAP is the Investment for additional population;
SLPCIC is the Street Light PCIC;
IDP is the Incremental decadal population.

The detailed description of the Incremental decadal population is placed in Annex 1 while the ***Solid Waste Management*** PCIC is presented in Annex 3. .

As per the calculations in the table 28 the investment requirements for additional urban population for street lighting alone will be Rupees 57.2 Billion or US$ 1.2 Billion.

Table 28: Investment requirements for additional population : Street Lights

3. Operations and Maintenance Costs

Table **: Investment for additional population: Street Lights				
Per Capita Investment Costs (PCICs)				
Class I A	103			
Class I B	141			
Class I C	167			
Class II	185			
Class III	185			
Class IV +	185			
Additional population				
	2006	**2011**	**2021**	**2031**
Class I A	-	9729561	21057587	25825675
Class I B	-	7696520	17915519	23782900
Class I C	-	6912580	23577137	32019101
Class II	-	3806917	11697489	20360061
Class III	-	4654212	14300968	24891546
Class IV +	-	3461394	10635803	18512144
Investment for additional population				
	2006	**2011**	**2021**	**2031**
Class I A	-	1002144755	2168931496	2660044553
Class I B	-	1085209274	2526088188	3353388951
Class I C	-	1154400783	3937381801	5347189887
Class II	-	704279594	2164035377	3766611226
Class III	-	861029257	2645679055	4604936009
Class IV +	-	640357893	1967623578	3424746719
Sub Total	-	*5447421557*	*15409739496*	*23156917345*
Aggregate				***44014078397***
TOTAL (Rs in 2006 prices)				**44014078397**
Corrected to 2009 prices				**57202958212**

The calculation for determining the Operations and Maintenance requirements for the period 2006 – 2031 are calculated on the over all stock of investment based on the average O&M costs reflected as presented in ………….. The basic formulae used is :

SLO&MC = SLIS * PO&M

where
SLO&MC is the overall O&M finance requirements for sewerage for the period 2009-2031;
SLIS is the overall Street Light investment stock ;
PO&M is the average percentage of O&M costs related to project costs

As per the calculations in the table 29 the Operations and Maintenance requirements for sewerage alone will be Rupees 28 Billion or US$ 0.6 Billion.

Table 29: Operation and Maintenance Costs : Street Lights

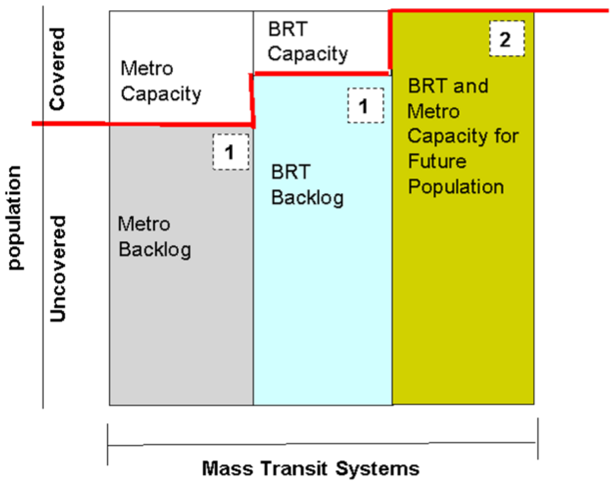
Table **: Operation and Maintainence Costs : Street Lights				
Cumulative Population				
	2005	**2010**	**2020**	**2030**
Class I A	87157856	96891528	117471372	142839068
Class I B	35337266	42602621	60314000	83339285
Class I C	78608784	85139131	106879992	139412822
Class II	35894253	39352632	50633991	69834329
Class III	43883143	48111245	61903465	85377172
Class IV +	32636425	35780916	46038358	63496037
Per Capita Investment Costs				
	Arterial	Sub Arterial	Collector	Local
Class I A	18	18	15	52
Class I B	27	27	23	65
Class I C		38	33	96
Class II			67	118
Class III			67	118
Class IV +			67	118
Urban Road Stock				
	2006	**2011**	**2021**	**2031**
Class I A	7669351805	9956767209	12071593168	14678428340
Class I B	4206220050	6014765837	8515311469	11766090233
Class I C	7160076143	14180481800	17801564939	23220121682
Class II	4785190458	7291525577	9381813042	12939383252
Class III	5839968652	8900580248	11452141114	15794776794
Class IV +	4343255464	6619469401	8517096140	11746766927
O&M percentage on stock				
	2006	**2011**	**2021**	**2031**
Class I A	9%	9%	9%	9%
Class I B	9%	9%	9%	9%
Class I C	9%	9%	9%	9%
Class II	9%	9%	9%	9%
Class III	9%	9%	9%	9%
Class IV +	9%	9%	9%	9%
O&M costs calculated on stock				
	2006	**2011**	**2021**	**2031**
Class I A	690241662	896109049	1086443385	1321058551
Class I B	378559804	541328925	766378032	1058948121
Class I C	644406853	1276243362	1602140845	2089810951
Class II	430667141	656237302	844363174	1164544493
Class III	525597179	801052222	1030692700	1421529912
Class IV +	390892992	595752246	766538653	1057209023
Sub Total	*3060365631*	*4766723107*	*6096556788*	*8113101051*
Aggregate				**22036746577**
TOTAL (Rs in 2006 prices)				**22036746577**
Corrected to 2009 prices				**28640088342**

Summary of Results

Total Aggregate Costs for street lights incl. O&M for the period 2006-2031 is 117 Billion rupees in 2009 prices. Out of this total amount 89 billion rupees are towards various capital expenditure requirements while the rest of approximately twenty four percent is for operations and maintenance of these assets.

11 Mass Transit Finance Requirements Estimation

Chart 7: Graphic description of the Mass Transit Investment Projection model



Special Methodology issues related to Mass Transit

As mentioned in the roads section a theoretical model has been developed to arrive at per capita requirement of roads. In the case of mass transit too the DPR and CDP data is not useful and so we have gone by popular interpretation of policy prevalent today. The basic policy assumption is that mass transit systems will be required only in million plus cities and while cities with a population above five million as per the 2001 cencus will have both a rail based metro as well as a Bus Rapid Transit system, other million plus cities will have only Bus Rapid Transit Systems. The construction costs have been derived based on public works department norms. This is the first time that Metro and BRT systems are being incorporated into a municipal infrastructure projection exercise in India.

There are two PCICs that have been derived and used in the mass transit system model, these are

a. Per Capita Metro Costs (PCMC): is based on typical construction costs of metro systems, derived from the project components and cross referred with suggestions from technical experts.

b. Per Capita BRT Costs (PCBRTC): is the per capita costs for construction of a BRT system.

The PCICs calculated above then are used appropriately to arrive at the investment projections for each of the relevant categories. The Chart No 7 has been prepared to give an outline of the various relevant categories in the mass transit projection model. Such calculations have been undertaken for each city size category separately. These have been presented as boxes in the chart and the sum of all the totals of each of the boxes, for each city size category will make up the total capital expenditure requirements for the solid waste management sector in India from 2006 to 2031.

Results

1. Investment for Backlog population

The calculation for meeting the backlog in terms of coverage defined in these new services are based on the understanding that only a part of the arterial road length in each city will require mass transit arrangements .The basic formulae used is :

MTIBP = MTPCIC * BP

where

MTIBP is the Investment required to cover backlogs in 2006;
MTPCIC is the PCMC and the PCBRTC ;
BP is the Backlog population or the unserved/under served population in the year 2006

As per the calculations in the table …. the investment requirements for the unserved/under served or the Backlog population for mass transit systems alone will be Rupees 5788 Billion or US$ 128 Billion.

Table 30: Investment requirements for Backlog population : Mass Transit

Table **: Investment for backlog population: Mass Transit		
Per Capita Investment Costs (PCICs)		
	BRTS	Metro
Class I A	7924	44021
Class I B	16678	
Class I C		
Class II		
Class III		
Class IV +		
Backlog percentages		
	BRTS	Metro
Class I A	100%	80%
Class I B	100%	0%
Class I C	0%	0%
Class II	0%	0%
Class III	0%	0%
Class IV +	0%	0%
Backlog population 2006		
	BRTS	Metro
Class I A	89023034	71218427
Class I B	36683741	0
Class I C	0	0
Class II	0	0
Class III	0	0
Class IV +	0	0
Investment for additional population		
	BRTS	Metro
Class I A	705404255605	3135130024912
Class I B	611804175528	0
Class I C	0	0
Class II	0	0
Class III	0	0
Class IV +	0	0
Sub Total	*1317208431133*	*3135130024912*
Aggregate		**4452338456045**
TOTAL (Rs in 2006 prices)		**4452338456045**
Corrected to 2009 prices		**5788039992858**

2. Investment for additional population

This segment estimates the capital investment requirements for the period between 2006 – 2031, for the new population that would be agglomerating in urban areas. The basic formulae used is :

MTIAP = MTPCIC * IDP

where

SWMIAP is the Investment for additional population;
MTPCIC is the relevant metro and BRT PCICs ie PCMC and the PCBRTC;
IDP is the Incremental decadal population.

As per the calculations in the table 31the investment requirements for additional urban population for solid waste management alone will be Rupees 4893 Billion or US$ 108 Billion.

Table 31: Investment requirements for additional population : Mass Transit

Table **: Investment for additional population: Mass Transit Systems				
Per Capita Investment Costs (PCICs)				
	BRTS	Metro	Total	
Class I A	7924	44021	51945	
Class I B	16678		16678	
Class I C				
Class II				
Class III				
Class IV +				
Additional population				
	2006	**2011**	**2021**	**2031**
Class I A	-	9729561	21057587	25825675
Class I B	-	7696520	17915519	23782900
Class I C	-	6912580	23577137	32019101
Class II	-	3806917	11697489	20360061
Class III	-	4654212	14300968	24891546
Class IV +	-	3461394	10635803	18512144
Investment for additional population				
	2006	**2011**	**2021**	**2031**
Class I A	-	505403702811	1093839990685	1341519137107
Class I B	-	128361031777	298791481032	396646504963
Class I C	-	0	0	0
Class II	-	0	0	0
Class III	-	0	0	0
Class IV +	-	0	0	0
Sub Total	-	*633764734588*	*1392631471718*	*1738165642070*
Aggregate				***3764561848376***
TOTAL (Rs in 2006 prices)				**3764561848376**
Corrected to 2009 prices				**4893930402889**

3. Operations and Maintenance Costs

The calculation for determining the Operations and Maintenance requirements for the period 2006 – 2031 are calculated on the over all stock of investment based on the average O&M costs as have emerged from discussion with sector experts as there are no JNNURM DPRs in this sector. The basic formulae used is :

MTO&MC = MTIS * PO&M

where

MTO&MC is the overall O&M finance requirements for sewerage for the period 2009-2031;
MTIS is the overall investment stock available in the mass transit sector ;
PO&M is the average percentage of O&M costs related to project costs

As per the calculations in the table 32 the Operations and Maintenance requirements for the mass transit system in million plus cities alone will be Rupees 2624 Billion or US$ 58 Billion.

Table 32: Operations and Maintenance Costs : Mass Transit

Table **: Operation and Maintainence Costs : Mass Transit Systems				
Cumulative Population				
	2005	**2010**	**2020**	**2030**
Class I A	87157856	96891528	117471372	142839068
Class I B	35337266	42602621	60314000	83339285
Class I C	78608784	85139131	106879992	139412822
Class II	35894253	39352632	50633991	69834329
Class III	43883143	48111245	61903465	85377172
Class IV +	32636425	35780916	46038358	63496037
Per Capita Investment Costs				
	BRTS	**Metro**		
Class I A	7,924	44,021		
Class I B	16,678			
Class I C				
Class II				
Class III				
Class IV +				
Coverage percentages 2005				
	BRTS	**Metro**		
Class I A	0%	20%		
Class I B	0%	0%		
Class I C	0%	0%		
Class II	0%	0%		
Class III	0%	0%		
Class IV +	0%	0%		
Mass Transit Stock				
	2006	**2011**	**2021**	**2031**
Class I A	767360981230	5033047065811	6102070611575	7419799934628
Class I B	0	710518080405	1005904955085	1389916095282
Class I C	0	0	0	0
Class II	0	0	0	0
Class III	0	0	0	0
Class IV +	0	0	0	0
O&M percentage on stock				
	2006	**2011**	**2021**	**2031**
Class I A	9%	9%	9%	9%
Class I B	9%	9%	9%	9%
Class I C	9%	9%	9%	9%
Class II	9%	9%	9%	9%
Class III	9%	9%	9%	9%
Class IV +	9%	9%	9%	9%
O&M costs calculated on stock				
	2006	**2011**	**2021**	**2031**
Class I A	69062488311	452974235923	549186355042	667781994117
Class I B	0	63946627236	90531445958	125092448575
Class I C	0	0	0	0
Class II	0	0	0	0
Class III	0	0	0	0
Class IV +	0	0	0	0
Sub Total	*69062488311*	*516920863159*	*639717800999*	*792874442692*
Aggregate				**2018575595161**
TOTAL (Rs in 2006 prices)				**2018575595161**
Corrected to 2009 prices				**2624148273710**

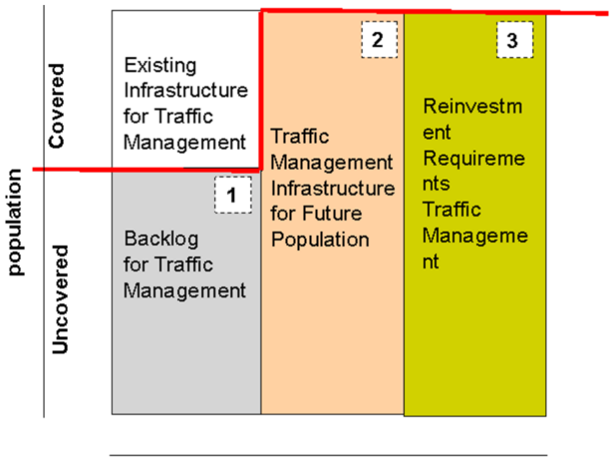
Summary of Results

Total Aggregate Costs for mass transit incl. O&M for the period 2006-2031 is 13306 Billion rupees in 2009 prices. Out of this total amount 10681 billion rupees are towards various capital expenditure requirements while the rest of approximately twenty percent is for operations and maintenance of these assets.

12 Urban Traffic Management Systems Finance Requirements Estimation

State of the art Traffic management systems are a new input into city management in India. It is clear that the need and reliance on smart traffic management systems will only increase in the future. For the purpose of the UFIEE the authors have assumed that smart traffic management system will be introduced in all census 2001 Class I cities.

Chart 8: Graphic description of the Urban Traffic Management system Investment Projection model



The PCIC has been derived out of a sample project in Bangalore and some other smaller cities. The PCIC calculated is used to arrive at the investment projections for each of the relevant categories. The Chart No 8 give an outline of the various relevant categories in the new traffic management system investment projection model. Such calculations have been undertaken for each city size category separately.

Results

1. Investment for Backlog population

The calculation for meeting the backlog in terms of coverage of smart traffic management systems is based on the formulae below :

TMSIBP = TMSPCIC * BP

where

TMSIBP is the Investment required to cover backlogs in 2006;
TMSPCIC is the traffic management system PCIC ;
BP is the Backlog population or the unserved/under served population in the year 2006

As per the calculations in the table 33 the investment requirements for the unserved/under served or the Backlog population for smart traffic management systems t alone will be Rupees 144 Billion or US$ 3 Billion.

Table 33: Investment requirements for Backlog population : Traffic Management Systems

Table **: Investment for backlog population: Traffic Management System	
Per Capita Investment Costs (PCICs)	
Class I A	200
Class I B	800
Class I C	800
Class II	0
Class III	0
Class IV +	0
Backlog percentages 2006	
Class I A	100%
Class I B	100%
Class I C	100%
Class II	0%
Class III	0%
Class IV +	0%
Backlog population 2006	
Class I A	89023034
Class I B	36683741
Class I C	79873498
Class II	0
Class III	0
Class IV +	0
Investment for backlog population	
Class I A	17804606791
Class I B	29346992983
Class I C	63898798514
Class II	0
Class III	0
Class IV +	0
Sub Total	*111050398288*
Aggregate	***111050398288***
TOTAL (Rs in 2006 prices)	**111050398288**
Corrected to 2009 prices	**144326804605**

2. Investment for additional population

This segment estimates the capital investment requirements for the period between 2006 – 2031, for the new population that would be agglomerating in urban areas. The basic formulae used is :

TMSIAP = TMSPCIC * IDP

where

TMSIAP is the Investment for additional population;
TMSPCIC is the Traffic Management System PCIC;
IDP is the Incremental decadal population.

As per the calculations in the table 34 the investment requirements for additional urban population for traffic management system alone will be Rupees 131 Billion or US$ 2.9 Billion.

Table 34: Investment for additional population : Traffic Management Systems

Table **: Investment for additional population: Traffic Management Systems				
Per Capita Investment Costs (PCICs)				
Class I A	200			
Class I B	800			
Class I C	800			
Class II				
Class III				
Class IV +				
Additional population				
	2006	2011	2021	2031
Class I A	-	9729561	21057587	25825675
Class I B	-	7696520	17915519	23782900
Class I C	-	6912580	23577137	32019101
Class II	-	3806917	11697489	20360061
Class III	-	4654212	14300968	24891546
Class IV +	-	3461394	10635803	18512144
Investment for additional population				
	2006	2011	2021	2031
Class I A	-	1945912145	4211517468	5165135054
Class I B	-	6157215739	14332415253	19026320290
Class I C	-	5530063632	18861709227	25615280895
Class II	-	0	0	0
Class III	-	0	0	0
Class IV +	-	0	0	0
Sub Total	-	*13633191517*	*37405641948*	*49806736239*
Aggregate				*100845569705*
TOTAL (Rs in 2006 prices)				100845569705
Corrected to 2009 prices				131064084942

3. Finance for Reinvestment requirements

The calculation for meeting the finance requirements for reinvestment are related to replacement of past infrastructure. The investments will need renewal at an average life span of 10 years for the traffic management systems. The basic formulae used is :

TMSRF = TMSPCIC * PRP

where

TMSRF is the reinvestment finance requirements ;
TMSPCIC is the Traffic Management System PCIC ;
PRP past population that qualified for reinvestment.

As per the calculations in the table 35 the reinvestment requirements for the period 2006 to 2031 will be Rupees 378 Billion or US$ 8.4 Billion.

Table 35: Investment requirements for reinvestment : Traffic Management Systems

Table **: Investment requirements for reinvestment: Traffic Management Systems		
Per Capita Investment Costs (PCICs)		
Class I A	200	
Class I B	800	
Class I C	800	
Class II	0	
Class III	0	
Class IV +	0	
Past population		
	2011	2021
Class I A	98752595	119810182
Class I B	44380261	62295780
Class I C	86786078	110363214
Class II	40367633	52065121
Class III	49352151	63653119
Class IV +	36703793	47339596
Investment required towards reinvestment		
	2021	2031
Class I A	19750518936	23962036404
Class I B	35504208723	12459155994
Class I C	69428862146	88290571373
Class II	0	41652097137
Class III	0	0
Class IV +	0	0
Sub Total	*124683589805*	166363860908
Aggregate		*291047450712*
TOTAL (Rs in 2006 prices)		291047450712
Corrected to 2009 prices		378361685926

4. Operations and Maintenance Costs

The calculation for determining the Operations and Maintenance requirements for the period 2006 – 2031 are calculated on the over all stock of investment. The basic formulae used is :

TMSO&MC = TMSIS * PO&M

where

TMSO&MC is the overall O&M finance requirements for sewerage for the period 2009-2031;
TMSIS is the overall traffic management system investment stock ;
PO&M is the average percentage of O&M costs related to project costs

As per the calculations in the table 36 the Operations and Maintenance requirements for traffic management systems alone will be Rupees 63 Billion or US$ 1.4 Billion.

Table 36: Operations and Maintenance Costs : Traffic Management Systems

Table **: Operation and Maintainence Costs : Traffic Management Systems			
Cumulative Population			
	2010	2020	2030
Class I A	96891528	117471372	142839068
Class I B	42602621	60314000	83339285
Class I C	85139131	106879992	139412822
Class II	39352632	50633991	69834329
Class III	48111245	61903465	85377172
Class IV +	35780916	46038358	63496037
Per Capita Investment Costs			
Class I A	200	200	200
Class I B	800	800	800
Class I C	800	800	800
Class II	0	0	800
Class III	0	0	0
Class IV +	0	0	0
Urban Road Stock			
	2011	2021	2031
Class I A	19378305617	23494274475	28567813667
Class I B	34082096779	48251200040	66671427766
Class I C	68111305024	85503993203	111530257777
Class II	0	0	55867462813
Class III	0	0	0
Class IV +	0	0	0
O&M percentage on stock			
	2011	2021	2031
Class I A	9%	9%	9%
Class I B	9%	9%	9%
Class I C	9%	9%	9%
Class II	9%	9%	9%
Class III	9%	9%	9%
Class IV +	9%	9%	9%
O&M costs calculated on stock			
	2011	2021	2031
Class I A	1744047506	2114484703	2571103230
Class I B	3067388710	4342608004	6000428499
Class I C	6130017452	7695359388	10037723200
Class II	0	0	5028071653
Class III	0	0	0
Class IV +	0	0	0
Sub Total	*10941453668*	*14152452095*	*23637326582*
Aggregate			**48731232345**
TOTAL (Rs in 2006 prices)			**48731232345**
Corrected to 2009 prices			**63333613902**

Summary of Results

Total Aggregate Costs for traffic management systems in class I cities incl. O&M for the period 2006-2031 is 717 Billion rupees in 2009 prices. Out of this total amount 653 billion rupees are towards various capital expenditure requirements while the rest of approximately nine percent is for operations and maintenance of these assets.

12 Conclusions

Undertaking this huge exercise over this short period of time has been challenging as well as rewarding, for the authors. The challenges were mainly around data sourcing and developing a realistic understanding of sector outcomes and policy prescriptions based on research and interactions with sector experts. The rewards were essentially around the sense of satisfaction being able to pull together a variety of sectors into a consistent and robust projection framework which lays out the broad envelope for financing requirements in twenty five years.

The paucity of implementation level data in an environment were such significant amounts of investment are flowing into the sector is startling and the authors would like to recommend that the government develop a consolidated system to track input costs and the outputs and outcomes, in the sector going forward. A transparent system in which the cities and implementation agencies take responsibility of maintaining and providing the data on an ongoing basis would have enormous benefits to policy formulation, implementation and monitoring, of interventions such as the JNNURM. The authors would also like to recommend that such projection exercises are undertaken from time to time so that the various assumptions and uncertainties inherent to such exercises can be cross checked and updated from time to time.

ANNEXURE 1

METHODOLOGY NOTES AND ASSUMPTIONS ON POPULATION PROJECTIONS AND CITY CATEGORIES

1. Classification of Cities

All cities for which the data is available (sample cities), are classified into the following six categories on the basis of their population as per the 2001 Census for making the projections separately for each class size:

Table 1: Classification of Cities, Population

Class I.A	Mega-cities(>5million)
Class I.B	1 – 5 million
Class I.C	100,000 – 1 million
Class II	50,000 – 100,000
Class III	20,000 – 50,000
Class IV	< 20,000

In terms of the spatial distribution, the majority of smaller cities in the sample are from the southern region, as shown in Table 2. This is because the data has been collected from States where the World Bank has ongoing projects.

Table 2: Spatial Distribution of Sample Cities

	East	West	North	South
Class IA	Kolkata	Greater Mumbai; Ahmedabad	Delhi	Bangalore; Chennai; Hyderabad
Class IB		Jaipur; Nashik; Surat; Pune; Vadodara ; Indore	Faridabad; Lucknow; Agra; Kanpur; Allahabad;; Varanasi; Jabalpur	Vishakhapatnam; Vijayawada;
Class IC		Nanded; Ajmer-Pushkar; Puducherry	Srinagar; Jammu	Thiruvananthapuram; Thoothukkudi; Dindigul; Vellore; Tiruvannamalai; Salem; Cuddalore; Ambattur; Pallavaram; Kancheepuram; Tiruvottiyur; Coimbatore
Class II				Thiruvarur; Ramanathapuram; Dharmapuri; Namakkal; Virudhunagar; Udhagamandalam; Theni; Krishnagiri; Madhavaram; Nagapattinam
Class III				Chinnamanur; Sivaganga; Perambalur; Tiruvallur
Class IV				

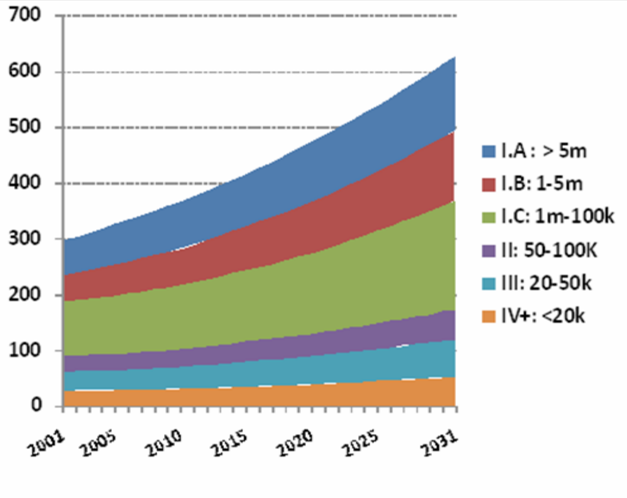
2. Urban Population Forecasts

Indian urban population is expected to double in size from 2001 to 2031. Based on UN estimates, the population of Indian cities is expected to reach 627 million by 2031, equivalent to 40 percent of the Indian population.[4] Over the same period, the population of Indian megacities (with population above 5 million) is estimated to double, from 61 million in 2001 to 133 million in 2031. The second largest category of Indian cities (with population between 1 and 5 million) is expected to record the highest absolute increase in urban population, from 46 to 126 million over the 30-year period. As a result, the share of Indian urban population residing in cities with 1-5 million population is expected to increase from 15 to 20 percent over the period 2001-2031 (see Figure 1 and 2).[5]

4 The 2001 urban population of India is estimated at 196 million, based on UN estimates.

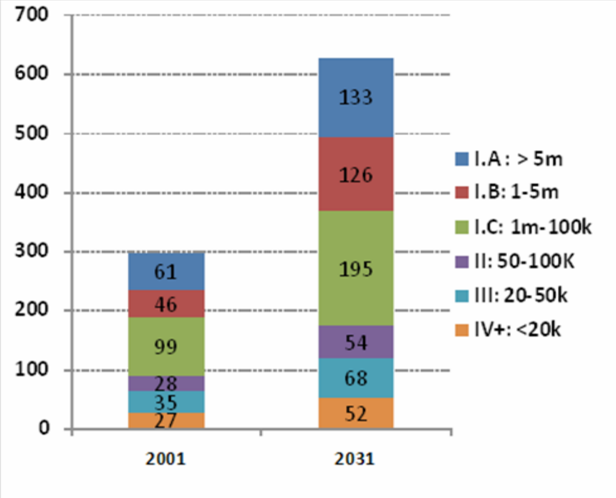
5 Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The

Figure 1: Urban Population by Class Size (million), 2001-2031



Source: World Urbanization Prospects 2007 and Census of India.

Figure 2: Urban Population by Class Size (million), 2001 and 2031

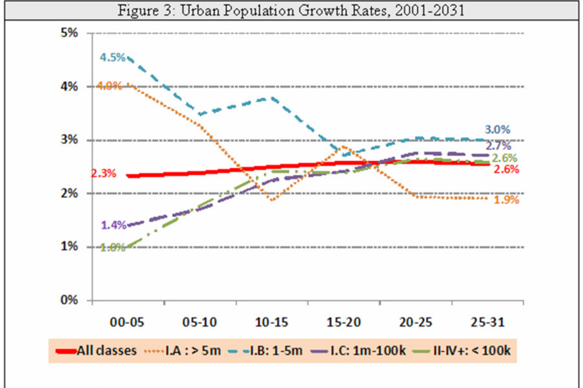


Source: World Urbanization Prospects 2007 and Census of India.

The annual population growth rate for urban India is expected to stabilize at about 2.5 percent per annum over the period 2001-31. The forecasted growth rate is in line with the population growth recorded over the period 1995-2000, although below the record growth of 3-4 percent registered in the previous decades. Cities with population between 1 and 5 million are expected to grow at a significant higher growth rate than the national average, of about 3.4 percent per annum. The growth rate of cities below 1 million, currently below national average, is forecasted to steadily increase to reach 2.6 percent by 2020. Megacities are expected to grow in line with the national average, although their growth rate will experience a decline from the current level of 4.0 percent to 1.9 percent in 2031. Unfortunately, the UN data available does not allow distinguishing the sources of population growth – i.e. re-classification (i.e. cities switching to a higher size class), natural population growth and migration. See Figure 3 and Table 1.

Figure 3: Urban Population Growth Rates, 2001-2031

Figure 3: Urban Population Growth Rates, 2001-2031



Source: World Urbanization Prospects 2007 and Census of India.

Table 3: Average Annual Growth Estimates, 2001-2031

Class/ Year		2001-05	2005-10	2010-15	2015-20	2020-25	2025-31	2001-31
Class I.A	> 5 m	4.0	3.3	1.9	2.9	1.9	1.9	2.6
Class I.B	1-5 m	4.5	3.5	3.8	2.7	3.0	3.0	3.4
Class I.C	1 m-100,000	1.4	1.7	2.3	2.4	2.8	2.7	2.3
Class II Class III Class IV+	50-100,000 20-50,000 < 20,000	1.0	1.8	2.4	2.4	2.6	2.6	2.2
All Classes		2.3	2.4	2.5	2.6	2.6	2.6	2.5

Source: World Urbanization Prospects 2007 and authors' calculations.

Notes: See Table 3 for assumptions.

2006 Revision and World Urbanization Prospects: The 2007 Revision, http://esa.un.org/unup.

Methodology

Population forecasts are based on estimates provided by the United Nations Population Division of the Department of Economic and Social Affairs (DESA) in its regular statistical publication, the World Urbanization Prospects (2007 revision).[6] The World Urbanization Prospects is a database of updated past, current and future urban population for each country in the world and their major agglomerations. The database is revised and updated every two years. The latest revision has been published in 2007. Being the most comprehensive database on urbanization currently available, the UN data is largely used and referred to for urban population trends and projections. The UN relies on data produced by national statistical offices, and adopts national definition of urban areas. Historical urban population trends are based on and fully consistent with Census of India statistics. Data classified according to the concept of urban agglomeration is used. The UN urban population projections are based on the assumption that with growing urbanization, urbanization slows down. A projection model is built based on the intrapolation and extrapolation of urban-rural growth differentials.

Population forecasts for urban India are based on 2001 population census figures and UN growth rate estimates by city class. For each city class, population is forecasted by applying the UN population growth rates to 2001 census population figures over the period 2001-2031. Unfortunately, there is no complete alignment between the Census of India city classes, as reported in this study, and the UN population classes (see Table 2 below). More specifically, the UN projection model provides estimates for only 5 broad city classes – the lowest class including all cities with population below 500,000. The Census of India classification, as adopted in this study, is more fine-grained, with the lowest class including all towns with population below 20,000.
As a result, the same growth rate is applied to all Indian cities with population below 100,000 given that forecasts for individual classes are not available.

Table 4: Census of India versus UN Classes

<table>
<tr><th colspan="2">Census Classes</th><th colspan="2">UN classes</th></tr>
<tr><td rowspan="2">Class I.A</td><td rowspan="2">> 5 m</td><td>Class UN.1</td><td>10 -5m</td></tr>
<tr><td>Class UN.2</td><td>> 5 m</td></tr>
<tr><td>Class I.B</td><td>1-5 m</td><td>Class UN.3</td><td>1-5 m</td></tr>
<tr><td rowspan="2">Class I.C</td><td rowspan="2">1 m - 100,000</td><td>Class UN.4</td><td>1 m - 500,000</td></tr>
<tr><td rowspan="4">Class UN.5</td><td rowspan="4">< 500,000</td></tr>
<tr><td>Class II</td><td>50 - 100,000</td></tr>
<tr><td>Class III</td><td>20 - 50,000</td></tr>
<tr><td>Class IV+</td><td>< 20,000</td></tr>
</table>

The forecasts are based on the following assumptions:

- 2001 census population for the two largest city classes (Class I.A and Class I.B) are taken from the World Urbanization Prospects database, given that there is a perfect match between these two census classes and the first three UN classes.[7] The population figures reported in the UN database are sourced from the Census of India 2001. For the other city classes that do not match the UN classes, 2001 population figures are sourced directly from the Census of India website.[8]
- An exponential growth rate is assumed to forecast urban population, in line with the methodology applied by the UN.
- For the period 2025-30, UN provides projections only for entire urban India, with no breakdown by city class. Given that the urban India population growth rate for the period 2025-30 is estimated to be the same as the growth rate for the period 2020-25, growth rates for individual classes are also assumed to be equal to the growth rates of the 2025-30 period.
- UN estimates are only available up to the year 2030. Population figures for 2031 are projected assuming the same annual growth applied to the period 2025-2030.

6 World Urbanization Prospects. The 2007 Revision. United Nations Department of Economic and Social Affairs (DESA) Population Division - Population Estimates and Projections Section. http://esa.un.org/unup/

7 http://esa.un.org/unup/

8 http://www.censusindia.gov.in/Census_And_You/area_and_population.aspx

ANNEXURE 2
NOTE ON WATER SUPPLY PCICS

1. Introduction

The objective of the exercise is to estimate the investment costs of providing 24/7 water supply to the entire urban Indian population upto 2031. The investment needs for water supply in urban India encompasses the capital costs of serving both the current backlog population and the incremental urban population over the period 2006-2031.

Water investment requirements are divided in the following two components:

a. Production costs: source augmentation, treatment, and transmission ;
b. Distribution costs (based on 24/7 standards): distribution, storage, and metering

The population to be served includes:

- Backlog Population
- Additional Population

There are three types of backlog for the current population, which are as follows:

- Production Backlog – This measures the water production deficit for the current urban population (based on a production norm of 150 liters/per capita/ day). For example, a backlog of 40 percent would imply that 40 percent of the current urban population in India does not have a production allocation of 150 liters/per capita/day.
- 24/7 Up-gradation Backlog – This is equivalent to the percentage of the current urban population that does not have access to water supply on a 24/7 basis. Given that virtually no city in India has access to 24/7 water supply, this backlog is equivalent to the entire Indian urban population connected to piped water supply.
- Distribution Extension Backlog – This measures the percentage of the current urban population in India that does not have access to piped water supply.

The incremental urban population over the period 2006-2031 would need investment in both production and distribution (based on 24/7 standards). The following three Per Capita Investment Costs (PCIC) are estimated to calculate the total investment requirements:

2. Model development steps

The step by step explanation of the development of the model is placed below:

Step I: Define sector targets
Setting service targets is the first step for estimating investment requirements. The service target for water supply is 24/7 piped water supply continuity for the entire Indian urban population by 2031. It has to be noted that the objective of this exercise is merely to estimate the investment requirements to achieve the specified sector targets. A discussion on the feasibility of achieving the target given the financial capacity of Indian cities is outside the scope of the study.

Step II: Classify cities and towns by class size
As explained in the Annexure 1.

Step III: Conduct data collection and compilation

Data has been collected from the following sources:

JNNURM data – 102 JNNURM projects have been studied. City Development Plans have been drawn upon to calculate backlog figures for JNNURM cities. Additionally a Data Collection exercise has been initiated with the World Bank in Karnataka, where the Bank has a water supply project under supervision. An effort is also ongoing to collect actual cost data for 24/7 pilot projects (e.g. three towns in Karnataka, Nagpur). Also, Water Supply and Sanitation Program (WSP)'s data – Benchmark reports from WSP have been utilized. Data collected included production requirements and leakage level. Table 2 provides the zonal distribution of the various cities from where data is being collected.

Table 2: Spatial Distribution of Sample Cities

	East	West	North	South
Class I.A	Kolkata	Greater Mumbai, Ahemdabad	Delhi	Bangalore, Chennai, Hyderabad
Class I.B		Rajkot, Surat, Vadodara, Indore, Pune, Bhopal	Varanasi, Allahabad	Kochi, Vishakha-patnam
Class I.C	Bhubaneshwar, Jamshedpur, Aizwal		Dehradun, Chandigarh	Coimbatore, Madurai, Mysore
Class II				
Class III			Nainital	
Class IV				

Step IV: Calculate the backlog percentage for production, 24/7 up-gradation and distribution extension

Backlog figures for water production and distribution are available from the City Development Plans, most of which were prepared around 2006 when JNNURM was launched. The backlog percentage for each of the six classes of cities is calculated as the average backlog for all cities in that category weighted by city population.

The backlog for 24/7 up-gradation is assumed equal to the entire urban population connected to water supply, given that virtually no city in India currently benefit from 24/7 water supply continuity.

Step V: Calculate 2006 backlog population and incremental urban population (2006-2031)

The backlog population is calculated by multiplying the backlog percentage by the 2006 population. Note that backlog percentages generally refer to the year 2006, when most of the CDPs were prepared. The incremental urban population is calculated as the additional urban population over the period 2006-2031.

Step VI: Estimate PCIC for water production

The unit production costs are computed by dividing total JNNURM production costs by the target beneficiaries. JNNURM data are complemented by estimates based on WSP benchmarking study.

Step VII: Identify Investments required to upgrade the distribution system to deliver 24/7 water supply to the connected population

Estimating the costs of upgrading the existing distribution network to achieve 24/7 water supply continuity is methodologically complex, given that virtually no Indian city has 24/7 water supply with the exception of a few pilot projects (e.g. Karnataka towns and Nagpur in Maharashtra). It is also complex because the solution to delivering 24/7 is a mix of rehabilitation of old assets (e.g. to fix leaks in old pipes and service connections), new assets (e.g. improved network layout, creation of district meter areas for leakage management), and (importantly) significantly improved distribution system management. Assumptions have therefore been made on the type of investment required to achieve 24/7 water supply across the various categories of cities and towns. The following three estimates have been calculated: (a) a lower bound estimate equivalent to the cost of reducing leakage to an efficient level; (b) a upper bound estimate based on the cost of replacing the distribution system and (c) the actual cost of 24/7 water supply continuity based on pilot projects.

Estimating the cost reducing leakage to an efficient level (lower-bound estimate). All Indian cities and towns would need to reduce system losses to an efficient level as a necessary condition to reach 24/7 water supply continuity. In some cities and towns, this measure will however not be sufficient. The cost of reducing leakage to an efficient level can therefore be assumed as a lower-bound cost estimate of achieving 24/7 continuity in water supply. The methodology is based on Kingdom et al. (2006) and involves estimating the level of water losses in a given city/town assuming that the water supply system is run on a 24/7 basis. [9]The costs of reducing leakage from its current level (assuming 24/7 water supply system) to an efficient level is estimated based on cost benchmarks available from a number of case studies. Based on Kingdom et al (2006), the unit cost of saving 1 m3 of water in developing countries is expected to range between \$215/m3 and \$500/m3. The average value of US\$ 356/m3 has been assumed for the model.

Estimating the cost of replacing the distribution system (upper-bound estimate). Many of the water distribution networks in Indian Cities are old and poorly constructed. An upper bound estimate for 24/7 up-gradation is calculated based on the assumption that the entire water distribution system needs to be replaced. The upper-bound investment estimates also include the costs of water meters and the cost of providing optimal storage capacity (equivalent to one third of daily water demand, as both investments are necessary conditions to achieve 24/7 water supply continuity. The cost

9 Bill Kingdom, Liemberger Roland and Philippe Marin (2006). "The Challenge of Reducing Non-Revenue Water in developing countries How the private sector can help: A look at performance-based service contracting". Water Supply and Sanitation Board Discussion Paper Series, Paper No. 8, December.

of replacing the distribution network is estimated on the basis of an average cost/km of distribution pipe (gathered from the data survey), the average density of distribution pipework (connections/km), and the current number of connections in a given city. The cost of water meters and storage are based on cost norms gathered through the data survey and expert estimates. In practice, the share of the distribution network that needs to be replaced varies from city to city. Indicators such as the portion of the distribution assets that are older than 10 years have been collected to gain a better understanding on the share of the distribution network that need to be replaced and the overall size of the investment. In the absence of such information, the upper-bound estimate is based on the assumption that 100 percent of the network needs to be replaced and 100 percent of storage requirements need to be provided to achieve 24/7.

Estimating the actual costs of achieving 24/7 water supply (actual costs). Very few JNNURM projects aim to achieve 24/7 water supply continuity. Nevertheless, a number of 24/7 water pilot projects have been carried out across cities in India. The actual or proposed costs for a small sample of 24/7 projects have been collected and included in the model. Depending on the type of investment made under the projects, the PCIC would fall under the lower-bound or upper-bound scenario. For example, the 24/7 pilot projects in the three Karnataka towns fall in the upper-bound scenario, as the replacement of the distribution network , installation of water meters and increase of water storage capacity was required.

Step VIII: Estimate the per capita costs for extending the distribution network (based on 24/7 standards)

Delivering 24/7 water supply to the current un-connected urban population as well as the incremental urban population requires expanding the existing distribution system, installing meters and building the optimal level of water storage capacity. The following methodological approach has been followed to calculate this PCIC for the sample cities. First, in a given city the distribution network length requirements are estimated based on the average length of the distribution network per connection for the connected population meet. Second, the total cost of extending the distribution network is estimated based on cost norms for water pipes. Third, the cost of water meters and water storage are added based on the methodology described above (see Estimating the cost of replacing the distribution system) as they are necessary conditions for the provision of 24/7 water supply. Fourth, per capita investment costs are calculated by dividing total costs by project beneficiaries.

Step IX: Project urban population by city class size

As in Annex 1.

Step X: Estimate total investment needs for the period 2006 – 31

The backlog population for production, 24/7 up-gradation and distribution extension are multiplied by the unit costs for the respective cost components. The three costs are then added to calculate the total investment costs for the backlog population.

To calculate the investment requirements for the additional urban population, the unit costs for production and distribution extension (24/7 standards) are multiplied by the incremental urban population over the period 2006-2031. The underlying assumption is that any additional urban population will need investment in both production and distribution.

To account for the fact the most JNNURM approved costs are expressed in 2006 prices, the total investment needs are then converted in 2009 prices. Operation and maintenance costs are estimated separately at 9 percent of investment costs.

3. Caveats and Limitations

The following are the main limitations of the model:

a. JNNURM project data was unavailable for small and medium towns (with population below 100,000). There is only one 24/7 JNNURM distribution project in the sample.
b. The model uses approved costs for projects, instead of actual costs. It is a known fact that for most projects, the actual costs differ significantly from approved costs due to cost escalation and unforeseen expenses that arise during project implementation. Therefore, the final investment projections of the model may have a downward bias.
c. The investment projections have been made on the assumption that most technology used in the sector will remain constant. However, if in the future, any new technologies are introduced which results in a reduction of costs, then the model will fall short of capturing such gains.
d. For the sake of simplicity, it was assumed that all JNNURM approved project costs are in 2006 prices. In reality, however, several JNNURM projects were prepared and approved after 2006.

The data taken from CDPs is not standardized. Though most CDPs were prepared around 2006, and the data taken represents current data at that time, there are discrepancies noticed among different CDPs. For simplicity purpose, it is assumed that data is representative of 2006.

ANNEXURE 3
NOTE ON SWERAGE PCICS AND STORM WATER DRAINS

1. Introduction

The objective of the exercise is to estimate the investment costs of providing sewerage collection and treatment and storm water drains to the entire urban Indian population over the period 2006-2031.

2. Model development steps

Step I: Setting Targets for Urban Sewerage and storm water drains

As a first step, the target for the urban sewerage sector is defined. The entire population should have access to the sewerage network, and all of the sewerage generated should be collected and treated.

Step II: Data Collection

For the costing exercise, data is collected from two sources. The first source pertains to projects that have been sanctioned under JNNURM for the sewerage sector (UIG window). The sample includes 47 sewerage projects sanctioned under JNNURM and spread a across 26 cities with population above 100,000. In addition, a data collection exercise has been undertaken in States where the World Bank has ongoing projects. These States include: (i) Tamil Nadu; (ii) Andhra Pradesh; and (iii) Karnataka. The JNNURM projects are mainly for cites with population greater than 100,000, so in the data collection exercise, efforts were made to collect data from small and medium towns as well. There were other than this another thirty four storm water drain projects evaluated to arrive at the storm water drain PCICs all from the JNNURM data base.

Step IV: Estimating PCICs

Unit costs are calculated by taking the approved JNNURM project costs and the beneficiary population covered by the projects. The approved costs are divided by the beneficiary project population to calculate 'Per Capita Investment Costs' (PCIC) for all projects. For cities with more than one sewerage projects, the unit costs are calculated by averaging out the PCIC for all projects within that city. For example, the unit cost for Greater Mumbai for consolidated projects was calculated by adding PCIC for all projects, then taking their average.

It must be noted that most of the projects in the sample are consolidated projects, and only a few projects are specialized in nature. In the JNNURM project data, there were only 4 network projects, 7 treatment projects, and 36 consolidated projects.

Step VI: Determining the Backlog for Urban Sewerage and storm water drains

There are two types of sewerage sector backlog for the current urban population:

- Backlog in network coverage: this is measured by the percentage of the current urban population that does not have access to the sewerage network.
- Backlog in wastewater treatment: this is measured in terms of the total percentage of the current wastewater generated that does not get treated.

The backlogs for the JNNURM cities are collected from the City Development Plans, most of which were prepared around 2006 when JNNURM was launched. For most cities, the backlog figures for the network and treatment components are different. For example, in Hyderabad while 70 percent of the existing population was covered by the sewerage network, only 23 percent of the total wastewater that was generated was treated.

The average backlog percentage for each of the six classes of cities is calculated as the average backlog for all cities in that category weighted by city population. As expected, the backlog for smaller cities is higher than the backlog for larger cities, both with respect to network coverage and wastewater treatment.

The Backlog of storm water drains are not easily identifiable from the CDPs so we have assumed the same backlog for storm water drains as is the determined backlog for city roads, given that the drains run besides the road network.

Step VII: Determining Backlog and Additional Population

After determining the backlog percentages for all class of cities, the 2006 population for each class of cities is multiplied by the corresponding backlog percentages to calculate the total backlog population for both network and treatment components by class of cities.

Step VIII: Calculation of Total Investment Needs for the period 2006 - 31

To calculate the total investment required to cover the existing backlog in the urban sewerage sector, the backlog population for network and treatment components is multiplied by the unit costs for network and treatment projects respectively, and then the two costs are added.

To calculate the investment required to provide sewerage services to the additional population, the unit costs for consolidated projects is multiplied by the total additional population that will be added from 2006 onwards until 2031. Unit costs for consolidated projects are considered given that the incremental urban population will require both network and treatment investments.

The total investment requirements for both the backlog population and additional population are added to reach the final investment projections in the urban sewerage sector that will need to be made by 2031.

To account for the fact that most of the sanctioned JNNURM costs are in 2006 prices, the total investment needs are converted in 2009 prices.

3. Caveats and Limitations

a) The cost model is based on approved JNNURM project costs, instead of actual costs. It is a known fact that for most JNNURM projects, the actual costs differ significantly from approved costs due to cost escalation and unforeseen expenses that arise during project implementation. Therefore, the final investment projections of the model may have a downward bias.

b) The investment needs are calculated based on the assumption that there is no excess capacity in the system. Thus, the model assumes that any expansion in network coverage or treatment capacity in the sector will lead to additional costs. In reality, however, some cities may have excess capacity at least in their treatment plants.

c) The investment projections have been made on the assumption that the technology used in the sewerage sector will remain constant. However, if in the future, any new technology is introduced which results in a reduction of costs, then the model will fall short of capturing such gains.

ANNEXURE 4
NOTE ON SOLID WASTE MANAGEMENT PCICS

1. Introduction

The objective of the costing model is to estimate the solid waste investment requirements for Indian cities over the period 2006-2031.

Indian cities are classified in size classes based on population (in line with the census classification). For each size class of cities, the investment requirements are calculated based on specified service targets. The investment requirements cover the costs of serving the current backlog population (current un-served urban population) as well as the incremental urban population over the period 2006-2031. Operating and maintenance costs are calculated separately based on investment requirements.

2. Model development steps

Step I: Targets for Urban Solid Waste Management

The service target is to have 100 percent solid waste coverage, the entire urban population should have access to the solid waste management facilities, and all of the waste generated should be collected, treated and disposed.

Step II: Data Collection

For the costing exercise, data was collected from sanctioned JNNURM solid waste projects (UIG window). The sample includes 22 consolidated JNNURM waste projects spread across 21 cities with population above 100,000. Consolidated projects include network, treatment and disposal components. Information on existing backlog for the 21 cities was collected from the City Development Plans.

For cities with less than 100,000 inhabitants, for which no JNNURM project is available, assumptions had to be made to simulate the investment costs of meeting the 100 percent service targets.

Step III: Classification of Cities

As explained in the Annexure 1.

Step IV: Estimating PCIC

Unit costs are calculated by taking the approved JNNURM project costs and the beneficiary population covered by the projects. The approved costs are divided by the beneficiary project population to calculate 'Per Capita Investment Costs' (PCIC) for all projects. For cities with more than one project, the unit costs are calculated by averaging out the PCIC for all projects within that city.

It must be noted that the 22 JNNURM projects sampled for the costing exercise are consolidated projects, as they cover the entire cycle of solid waste management, namely (i) collection and transportation of solid waste (network coverage) and (ii) treatment/recycling of waste and sanitary disposal.

For small and medium towns (Class II to IV) for which no JNNURM projects are currently available, the Per Capita Investment Costs are assumed to be equal to the PCIC for Class I.C cities.

Step V: Estimating Total Urban Population in India

As explained in the Annexure 1.

Step VI: Determining the Backlog for Urban Solid Waste Management
There are three types of solid waste backlogs for the current urban population:

Backlog in waste collection and transport (network): this is measured by the percentage of the current urban population that does not have access to the waste collection and transport network. Backlog in waste treatment this is measured in terms of the total percentage of current waste generated that is not treated and Backlog in disposal, where in they are just a few early safe disposal projects in India currently so backlog has been taken as 100 percent.

The backlogs for the 21 JNNURM cities are collected from the City Development Plans, most of which were prepared around 2006 when JNNURM was launched. For most cities, the backlog figures for the network and treatment components are significantly different - for example, in Bangalore, while 94 percent of the population is covered by the collection and transport and only 35 percent of the population is covered by treatment. Due to lack of project data, it is assumed that Class II, III and IV cities (with less than 100,000 population) have 100 percent backlog for both (i) network and (ii) treatment and disposal.

The backlog percentage for each of the six classes of cities is calculated as the average backlog for all cities in that category weighted by city population. As expected, the backlog for smaller cities was higher than the backlog for larger cities, both with respect to network coverage and waste treatment/disposal.

Step VII: Determining Backlog and Additional Population
The 2006 population for each class of cities is multiplied by the corresponding backlog percentage to calculate the total backlog population for network, treatment and disposal for each class of cities for the year 2006.

Step VIII: Calculating Total Investment Needs for the period 2006-2031

To calculate the total investment required to cover existing backlog in the urban solid waste, the total costs of consolidated projects are broken down in the following components: (i) collection and transportation (40 percent of total project costs) and (ii) treatment /recycling 30 percent of project costs and (iii) disposal 30 percent of project costs).

The total investment requirements for both the backlog population and additional population are added to reach the final investment projections in the urban solid waste over the period 2006-2031.

To account for the fact the most JNNURM approved costs are expressed in 2006 prices, the total investment needs are then converted in 2009 prices.

O&M costs are calculated separately and assumed to amount to 40 percent of the investment costs.

3. Caveats and Limitations

The following are the main limitations of the model:

a. The investment projections have been made on the assumption that technology used or the cost of any technology change in the sector will remain constant, during the period of the projections. In addition, it is not clear what type of technology is proposed in the JNNURM projects and whether the proposed technology is the most appropriate to meet the development objectives of the sector. Because the model does not discriminate among technologies, it does not differentiate between high and low cost solutions. Moreover, treating the technology as constant over time does not factor in possible savings generated by technological innovation.
b. The model uses approved costs for projects, instead of actual costs. It is a known fact that for most projects, the actual costs differ significantly from approved costs due to cost escalation and unforeseen expenses that arise during project implementation. Therefore, the final investment projections of the model may have a downward bias.
c. Prices are in 2009 terms. Costs are calculated using 2006 as the base year and are then adjusted for inflation. According to the Reserve Bank of India, consumer prices increased of almost 30% in the last three years.
d. For the sake of simplicity, it was assumed that all JNNURM approved project costs are in 2006 prices. In reality, however, several JNNURM projects were prepared and approved after 2006.

ANNEXURE 5

NOTE ON URBAN ROADS PCICS, NOTE ON STREET LIGHTING PCIC/ MASS TRANSIT PCICS AND NOTE ON TRAFFIC MANAGEMENT SYSTEM PCICS

1. Per Capita cost for urban road construction

Various planning and land-use manuals and texts suggest a certain percentage of land area should be set aside for streets. However, to estimate actual cost required for building these roads we need to convert this into street length required for fulfill the need traffic needs.

Our estimate of per capita cost for streets in urban areas is based on UDPFI Guidelines for Developments (1996); however, some of the recommendations have also been modified to suit the ground realities of our cities. Population and densities, right-of-way widths, unit block size—spacing between roads form the core assumptions for estimating road requirements.

Population and Density

UDPFI Guidelines classify cities in four classes based on population size and also suggest density levels for these classes. A city with lower density would have less vehicular population and there would require fewer streets. As density reduces, the area required to be dedicated for streets should also decrease.

Table 1: UDPFI City Classification and Suggested Road Area percentage:

UDPFI City Class (population)	Suggested density per KM2	HPEC City Class
Metro city (10 Lakh to 50 Lakh)	17,500-12,500	Class I – A & B
Large city (5 Lakh to 10 Lakh)	10,000-15,000	Class II – A & B
Medium city (50,000 to 5 Lakh)	10,000-15,000	Class III
Small City (up to 50,000)	7,500-10,000	Class IV

Right-of-way (R-o-W)

Streets are generally classified in four categories based on function, which are Arterial, Sub-Arterial, Collector and Local streets. As their names suggest they function to move vehicles at different speeds and varying volumes, but also need to support non-motorised transport (NMT)—pedestrians and bicycles. Space allocation within each R-o-W is important for managing these movements and parking needs in residential and commercial corridors. Following are the R-o-W widths and space allocations considered in our estimate:

a. Arterial street– 48 m (3 lanes for thoroughfare with service lane, parking, bike lane and sidewalk on either side with a 4 m centre median)
b. Sub-Arterial street – 30 m (3 lanes, bike lane, sidewalk on either side with a 4 m centre median)
c. Collector street – 21 m (2 lanes, sidewalk, parking on either side)
d. Local street – 12 m (1 lane and sidewalk on either side with parking on one side)

Unit block size—Road spacing

Size of unit block is a function of spacing between streets. Smaller block size would require more roads, but smaller blocks also encourage NMT. In higher density areas, UDPFI Guidelines suggest having up to 17% of developed area to be dedicated for roads, and the percentage area is reduced to 12% for small cities.UDPFI Guidelines suggest minimum intersection spacing for each street category, which essentially gives a suggested minimum block size. Effective spacing between local streets should be 150 meters. Therefore, the smallest unit block in our estimate is 150 m X 150 m. Similarly, minimum spacing between collector streets should be 300 m, between sub-arterial streets 1 KM, and for arterial streets 2 KM. The spacing should increase as the population and density reduces.

Table 2: Suggested Road Area Percentage:

City Class (population)	Suggested Road %age of developed area
Metro city (10 Lakh to 50 Lakh)	15-17%
Large city (5 Lakh to 10 Lakh)	12-15%
Medium city (50,000 to 5 Lakh)	12-15%
Small City (up to 50,000)	10-12%

For estimating the road length required, using the assumptions above, we modeled a street layout with 36 blocks of size 150 m X 150 m. forming an unit area of approximately 1 KM2 (Class I and II Cities – 1,008 m X 1,008 m [1.016 KM2]; Class III and Class IV Cities – 994 m X 994 m [0.989 KM2]). In the model, 12-m wide local road is spaced at a distance of 150 m, and two collector streets bisect the block in the center. Sub-arterial streets on two sides and arterial streets on the other two sides bound the unit area. For a Class I city, a total of 11.09 KM of road is required, which cover 20.05% area of the developed area. Similarly, the road area coverage for other classes is as follows.

This layout was modified to remove the intersections of local streets with sub-arterial and arterial streets as per intersection spacing recommendations. The road length and percentage area from this modified layout is suggested for a City with 5 to 10 lakh population—Class II. The model layout for Class III and Class IV cities was further modified as population size and density is lower for these cities. Therefore, these smaller cities would not need as many arterial and sub-arterial streets as large cities. The street layout for these cities was modified, with unit area bounded by two sub-arterial and two collector streets.

Table 3: Unit Road length requirements

City Class (population)	Estimated Road Length Per KM^2	Estimated Road %age of developed area
Estimated Road %age of developed area	11.09 KM	20.05%
Large city (5 Lakh to 10 Lakh)	9.89 KM	18.64%
Medium city (50,000 to 5 Lakh)	9.10 KM	15.32%
Small city (up to 50,000)	5.79 KM	9.24%

Large cities with higher population would need certain additional infrastructure. As density goes higher and vehicular population grows, it is necessary to provide public transportation, grade separators, etc. For such infrastructure we made some assumptions:

Mass transit systems should be provided for cities with population higher than 5 lakh. For cities with population higher than 5 lakh should have bus rapid transit system and 10 lakh should also be served with metro or mono rail system in addition to BRT.

- Bus Rapid Transit – To provide better access to all if BRT can be provided on the entire arterial street network.
- Metro or Mono rail – Rail system can be established on major traffic corridors, on 1/3 of arterial street network.
- As traffic volume increases on major intersections, it needs to be managed by signalizing or providing grade separators. We estimated that in cities with large vehicular population one intersection in an area of 4 sq. km. would need a grade separator.
- We also considered that a traffic management center should be established in cities with population higher than 1 lakh.

Construction cost was calculated for street types with technical specifications from best practices. Current road construction practices in our urban areas provide us with roads that need frequent maintenance and rising street levels. Cost for such construction may look low upfront but there is a hidden cost of frequent maintenance cost. We need to adopt techniques and practices that do not require digging the carriageways for maintaining utilities such as storm sewers and water lines. For our calculations, we have taken scheduled rates Published by Public Works Department, Bangalore Circle. The rates vary by region depending on soil type, climate and terrain.

The cost for special infrastructure was collected from some of the local authorizes in various agencies implementing projects, such as the Bangalore Metro Rail, Bangalore Traffic Police, Bangalore Development Authority. Following tables show the total road lengths required for each class based on their population size and density.

Table 4: Road length requirements per city size

Class I City			
Urban road classification	Road Area in each sq. km. (sq. m.)	Road length (KM)	Percentage road area
Arterial	47,448.00	0.99	23
Sub Arterial	29,655.00	0.99	15
Collector	40,257.00	1.92	20
Local	86,400.00	7.20	42
Total	203,760.00	11.09	
Class II City			
Arterial	47,448.00	0.99	25
Sub Arterial	29,655.00	0.99	16
Collector	40,257.00	1.92	21
Local	72,000.00	6.00	38
Total	189,360.00	9.89	

Class III City			
Urban road classification	Road Area in each sq. km. (sq. m.)	Road length (KM)	Percentage road area
Sub Arterial	29,610.00	0.99	21
Collector	40,367.25	1.92	28
Local	74,304.00	6.19	51
Total	144,281.25	9.10	
Class IV City			
Collector	41,139.00	1.96	47
Local	45,936.00	3.83	53
Total	87,075.00	5.79	

Table 5 : Cost of special infrastructure

Special Infrastructure for cities with population above 5 Lakhs				BRT (runs on Arterial roads)			Mass Transit (runs on 1/3rd of Arterial streets)			Grade Separator (one in an area of 4 sq. km.)			Traffic Management Center (One per City)	
	Average Population (per UDPFI)	Density per Sq. Km.	Estimated City area (Sq. Km.)	BRT Length (KM)	Construction Cost/km (Cr)	Per Capita Cost	Metro/mono length (KM)	Avg cost per km (Cr)	Per capita cost	Grade Separators (No.)	Cost per number (Cr)	Per capita cost	Cost Per TMC (Cr)	Per capita cost
Metro city (10-15 Lakhs)	3,000,000	15,000	200	198	12	INR 7,923	66.03	200	INR 44,021	50	5	INR 833	INR 60	INR 200
Large City (5-10 Lakhs)	750,000	7,000	107	104	12	INR 16,677	34.75	200	INR 92,654	27	5	INR 1,785	INR 60	INR 800

In this final table, we have provided unit costs for construction of all types of roads along with the per capita road length and per capita cost of road infrastructure.

Table 6: Per Capita City Road Costs; Per Capita Metro Costs and Per capita BRT Costs

		Road length per KM^2 (KM)	Per Capita Road Length (KM)	Unit Cost	Per Capita cost	Special Infrastructure	Per Capita cost of Special Infrastructure
Class I	Arterial	0.99	0.00007	INR 259,200,000.00	INR 17,081.28	BRT	INR 7,923.84
15000	Sub Arterial	0.99	0.00007	INR 162,000,000.00	INR 10,675.80	metro/mon	INR 44,021.33
	Collector	1.92	0.00013	INR 113,400,000.00	INR 14,492.52	Grade separator	INR 833.33
	Local	7.20	0.00048	INR 30,000,000.00	INR 14,400.00	TMC	INR 200.00
	total	11.09			INR 56,649.60		INR 52,978.51
					INR 109,628.11		
Class II	Arterial	0.99	0.00010	INR 259,200,000.00	INR 25,621.92	BRT	INR 16,677.80
10000	Sub Arterial	0.99	0.00010	INR 162,000,000.00	INR 16,013.70	metro/mon	INR 92,654.46
	Collector	1.92	0.00019	INR 113,400,000.00	INR 21,738.78	Grade separator	INR 1,785.71
	Local	6.00	0.00060	INR 30,000,000.00	INR 18,000.00	TMC	INR 800.00
	total	9.89			INR 81,374.40		INR 111,917.97
					INR 193,292.37		
Class III							
7000	Sub Arterial	0.99	0.00014	INR 162,000,000.00	INR 22,842.00		
	Collector	1.92	0.00027	INR 113,400,000.00	INR 31,140.45		
	Local	6.19	0.00088	INR 30,000,000.00	INR 26,537.14		
		9.10			INR 80,519.59		
Class Iv							
3500	Collector	1.96	0.00056	INR 113,400,000.00	INR 63,471.60		
	Local	3.83	0.00109	INR 30,000,000.00	INR 32,811.43		
		5.79			INR 96,283.03		

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