Urban Growth and Managing the Solid Waste: A Study in Environmental Sanitation Of Shillong Urban Agglomeration

ABSTRACT

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THESIS
SUBMITTED IN FULFILLMENT
OF THE REQUIREMENT OF THE DEGREE OF
DOCTOR OF PHILOSOPHY IN GEOGRAPHY

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May, 2009.

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1. Introduction:

Accelerated urbanisation in recent decades in developing countries has serious implications on the abilities of Third World cities to sustain urban services and maintain urban infrastructure. The problem is twofold: (a) First, the acceleration is quick, i.e., the proportion of urban population has nearly doubled in many developing countries within a span of 2 to3 decades--many countries are reaching the 50 percent level of urbanisation. This has manifested in size and number growth in towns and cities, due largely to rural-urban migration. Since, the per capita infrastructure investment needed in the urban areas are many times more than in the rural areas, many of these countries find it extremely difficult to sustain urban infrastructure and municipal services. (b) Second, increasing incomes of the population in many of these countries result *in more than proportionate increase in consumption*, both food and non-food consumer durables in the initial transitional phase. This results in accelerated waste generation, coupled with modern packing technology and high use of plastics (polymers), metal cans, glasses and papers etc that adds to the problem of waste management of the urban local bodies (ULB) in these developing countries. India, of course, is no exception to the scenario narrated above.

The generation of solid waste in metro-cities of the country has gone up by many - fold. Delhi and Bombay generate roughly 4500 and 5500 tons of garbage daily. Further, the character of solid waste has changed from degradable materials to largely non-degradable materials like plastics, glass and metals containers. Thus the older strategy of dumping the

waste outside the city limits at designated dump-yards to allow for natural degradation and bio-chemical decomposition have been rendered in-fructuous. Moreover, the ULBs are unable to cope up with the increased volume of waste to be disposed. Most of the Indians ULBs, e.g., do not have enough resources even to lift the garbage out of the streets. This also has resulted in serious health hazards and spread of mass-killers. The 1992 out-break of plague of Surat in Gujarat and 1996 out-break of dengue at Delhi are pointers in that direction.

2. Review of Literature:

Though a large number of studies are available on the failure of civic services in India, and equally, extensive literature on various civics authorities (ULBs) including the nature of urban finance and management, there are little direct studies on environmental sanitation and degradation of the urban environment, more specifically on the urban waste management. Flintoff's (1974) study under the aegis of WHO was perhaps, the first detailed study on urban waste management on Asia, with extensive coverage on the problem, and the waste management systems adopted in different countries including India. However, the study covers only the large metro-cities and practically has no datum on North-Eastern Indian cities. Second, the study is three decades old and the quantum, quality and pattern of urban consumption in Asian countries and in India have, no doubt, drastically changed.

The other approaches explored in recent times are those of material recovery as well as recycling of wastes with varied degrees of successes. Walter (1976) and Wilson (1982) showed that the resource recovery systems being developed include the recovery of both materials and energy, which are currently receiving the greatest interest and attention in both the developed and developing countries. Henstock (1983) studied the methods of material recovery form solid

waste disposal in London. Mishra (1975) studied the recovery of energy in the urban solid waste on the international scale. Cointreau (World Bank 1982) has prepared solid waste management plants for Onitsha (Indonesia), Kanpur (India), Colombo and Tunisia. Interestingly, Shillong Municipal Board (SMB) in partnership with private sector has promoted an innovative waste collection and recycling plant at Mawiong, at the out-skirts of the city. Martin et al. (1994) suggest targeting waste reduction at the source that can be promoted to effect reduction of solid waste at source through community participation.

NIUA (1989) suggests, there is a strong case for comprehensive involvement of the private sector and encouraging it to invest in waste management in India. Vining and Ebreo (1990) suggest that environmental concerns have little practical utility in the prediction of specific classes of environmentally beneficial behaviour while specific attitudes are measured with the respect to particular behaviour of interest, better predicts conservation behaviour.

3. The Statement of the Problem:

Undoubtedly, urban solid waste and environmental sanitation have emerged serious challenges to urban managers both in developed as well as developing countries and India is no exception to that. With nearly 400 Class I cities (35 million+, 2001), India has a major problem at hand, even if we ignore small towns to be dealt with dumping system for the time being. For North East India, the region that is the least urbanised but by no means immune to the problem (with 245 towns in 2001) has no bench-marks for waste management studies by independent researchers. Shillong, both for its historical importance, the size (the UA is the second largest in the region after Guwahati) and its apparently cosmopolitan and consumerist culture appears as the best candidate for such a study.

What the problem constitutes is the extent of the problem, i.e. generation of solid waste from different sources like domestic, institutional, markets and specialised services like hospitals to provide benchmarks for planning. It is therefore intended to study the current waste management practices and system in the city, and to suggest more efficient civic services in urban environmental sanitation in the city. It may be noted that without an effective community participatory system urban solid waste management, as experience shows, will be no success.

4. Objectives:

The main objectives of the proposed study are as follows:

(a) To study the magnitude of solid waste generated in Shillong Urban Agglomeration from different sources; (House hold, Commercial, Institutional and Hospital waste etc.)

(b) To estimate quantum of urban solid waste by types of waste generated in the reference urban units of the SUA so that it can help in planning waste management;

(c) To assess the currents systems of waste handling and the likely difficulties faced by Shillong Municipal (Board) administration as well as selected census towns in reference to optimal utilisation of man-power and financial resources at their disposal; and

(d) To devise and suggest alternative mechanisms of solid waste management for the city based on the study conducted for the purpose, including community participation and public-private partnership systems.

5. Selection of the Study Area (Shillong Urban Agglomeration):

The state of Meghalaya is situated in the North-eastern part of India, between the Brahmaputra valley to the north and Bangladesh to the south. The total geographical area of the

state is 22,489 sq. Km and is divided in to seven administrative districts. It has a total population of 2.3 million (2001 census). Shillong is the Capital city of the state and is of great historical significance being the former Capital of the undivided state of Assam before 1972 Currently, the city that is an urban agglomeration of 7 urban units, two statutory (Shillong Municipal Board and Shillong Cantonment Board) and five census townships (Nongthymmai, Mawlai, Madanrting, Pynthorumkhrah and Nongmynsong), has a population of 268,000 as per Census 2001. (However, a recent sample survey carried out by Aus Aid (2004) puts the population figure closer to 400,000 excluding those of the paramilitary and defence establishments.)

The main purpose of selecting Shillong Urban Agglomeration for the current study is for the following reasons:

(a) The historical significance of the city and the general concerns expressed in preserving its quality of life.

(b) The size of the city that is not too small or too large, but with a growing problem of solid waste management, especially its peculiarity of management with a mix of modernity as well as the traditional Durbar system.

6. Sources of Data and Methodology:

Data for the study will be collected from both secondary as well as primary sources:

(a) Secondary data would be collected from published sources like Indian censuses, publications and reports from Government of Meghalaya relating to specific technical studies (like the TCS, NIUA, NEERI etc), on (legal) municipal provisions

and the methods and techniques of waste handling used by the Statutory ULB etc. Secondary data from other independent studies will also be evaluated and used.

(b) Primary data for the study will be collected from two sources:

(i) Selected samples on various aspects from SMB and four other census towns, namely Nongthymmai, Nongmynsong, Madanrting and Mawlai for the purpose.

(ii) The second source would be the extensive data generated by a detailed sample survey of the entire SUA carried out by Aus-AID in 2004 with due permission, since solid-waste management was one of the TOR of the project.

(c) The design of the study is broadly at three levels:

(i) The first level is the sources that contribute to generation of waste. These sources are: households, marketplaces, offices and institutions and hospitals. Households with different income levels and cultural attributes consume differently and generate SW differentially that need to be captured from field data.

(ii) The second level is the type of waste generated and quantity of waste generated from different sources and participants in the urban life, which needs to be captured in data collection. This can be done through sample study of a small sample of 125 households (structured) on an experiment basis as outlined below:

(iii)The sampling survey done for two weeks. The waste collected from 1-7 days will represent one week's production at the household level. The waste collection carry a supply of plastic bags one which should be handed at each families is replacement of the full one collected. For calculating of total weight

and volume generated in each house, it is used based on the proportion of the population (individual family, joint family, etc). In most cases, sample collected in this way would also be used for physical analysis. Collection of samples can be taken from communal containers.

(iv) Data on income levels, ethnicity, occupation and education will help in assessing various elasticities to consumption and thus waste generation.

(v) Samples from market places, selected offices and educational institutions and hospitals will be collected for estimation of total as well as category-wise waste generated.

(vi) Detailed information of municipal SW management practice as well as the system used in non-statutory townships will be used in assessing and suggesting improvements in the systems.

7. Organization of the Study:

The study will be organised into seven chapters.

Chapter One deals with Introduction to the statement of the problem, location of the study area its scope and methodology adopted. An attempt has been made to survey the existing literature as well as the limitation faced in the present study.

Chapter Two: Research frame work and Methodology: Primary data on selected samples were collected on various aspects from SMB and four other census towns, namely Nongthymmai, Nongmynsong, Madanrting and Mawlai for the purpose. These sources are: households, marketplaces, offices and institutions and hospitals. Households with different income levels and cultural attributes consume differently and generate SW differentially that

need to be captured from field data. Secondary data: Secondary data would be collected from published sources like Indian censuses, publications and reports from Government of Meghalaya relating to specific technical studies (like the TCS, NIUA, NEERI etc).

Chapter Three: Deals with Shillong urban agglomeration growth and dynamic of change. After the creation of the state of Meghalaya in 1972, how the Shillong urban Agglomeration has been growing over the space and impact of population growth, density pressure has been highlighted.

Chapter Four deals with source of solid wastes from households, commercial establishments like shops wholesalers etc, office, educational institution and hospitals etc. An attempt has also been made to study the methods of disposal and the efficiency of conservancy service with in Shillong urban agglomeration has been highlighted.

Chapter Five deals with the types and quantity of solid waste in SUA from the different sources, as is it generated on a day to day basis and on the basis of sample data collected from selected localities. Types refer to classification of waste by material types are paper, plastic, glasses, tin and etc. The huge quantity of waste production and improper methods of waste disposal were found to be causing environmental pollution.

Chapter Six deals with current Municipality solid waste management practice in Shillong. A general over all municipality management and their manpower, conservancy service, method of collection and transportation of refuse discussed. Lastly due to lack of man power, dust bin, public awareness regarding the necessity of proper disposal garbage the municipality unsuccessful her service and facing the problems.

The last chapter deal with the summery, finding and recommendation. On the basis of the findings certain suggestion and recommendations have been forwarded to minimize the disposal of garbage problem by the municipality.

Chapter Seven: Summary of finding

With accelerating urbanisation in India, the country may witness significant changes in the manner in which the urban centres of the twenty-first century are organised, both quantitatively as well as qualitatively. As a high-density, large-populated country, the choice for greater urbanisation both by way of rural transference of population as well as a by-product of industrial/service sector growth, is but inevitable and in a way necessary to unburden huge rural masses without either a resource base or economic opportunities for a better life in rural areas. Part of this process will bring in positive results in life-style changes in the population and part of it will be a number of negative consequences arising out of this surge in urban population--the crucial question, inevitably, will be the quality of the urban environment.

The current study precisely tries to address the issue of urban environment, particularly the problem of solid waste management in the sprawling urban agglomeration of Shillong in the State of Meghalaya, India, perched at an altitude of 5000' above the MSL and spread over a vast sprawl of 74 sq. Km. area with an estimated current population (2009) over 500,000. The city consists of 7 urban units including two statutory townships of Shillong. The city was known for its salubrious climate and cleanliness during earlier days. With rapid rise of population (of the UA) and major part of the urban agglomeration being outside the statutory townships, the quality of urban environment has deteriorated visibly—a major component of which has been the issue of solid waste management of the city. This study, therefore, tries to

identify the seriousness of the problem, its causative factors as well as the management practice, which undoubtedly need substantial improvements

The broad findings of the study can be summarised as follows

i. One of the issues that comes to the fore is the gross under-enumeration of population of the UA, particularly the Shillong Municipality during 2001 population census (Chapter III). Once the overall population indicated is far below the actual, the Municipal authorities and the concerned (state) Government departments allocate funds and work accordingly on a lower scale, which results in poor quality and management of solid waste that is to be properly disposed

ii. In Chapter V, the study indicates even the estimates of per capita solid waste generation/ day (NEERI study, e g) is a gross under estimation (270 gram/day) as against the actual estimates (based on field works) of 450 grams/day, which leads to a far larger quantity of solid waste generated in the city

iii. Further, the estimates of income elasticities of solid waste generation indicate that as income rises, there is a disproportionate rise in solid waste generation by households. Therefore, taken together the three points above, the municipal and government managers provide gross under estimations of solid wastes generated and the type of resources and management conditions required, leading to serious under performance of the concerned agencies

iv. Being the State Capital, it is the busiest administrative centre in the state. It also serves as one of the main commercial and institutional centre of the entire North Eastern Region. At present, the development of residences has spread in all the three directions

along the major arteries namely, towards Mawiong in the north, upper Shillong to the southwest and towards Madanrting in the southeast (Table 3.2).

v. Among the residents of Shillong, majority of the people (43 percent) dispose off their household waste at least once in a day whereas 48 percent dispose off twice a day (Table 4.12). As regards the nature of disposal of waste, bulk of the respondents (54.4 percent) disposes off its waste in the open space (Table No 4.16) of the backyard of their houses.

vi. Only 27 percent of the citizens state that the Municipality collects wastes on a daily basis. In all probability, this section of respondents (Table 4.17) lives in the main residential areas. Interestingly a significant 23 percent of the respondents have no regular access to this service whereas 21 percent availed the same only once in a week.

vii. Most of the solid wastes (63 percent) is generated from the households, particularly food wastes. According to the study, 261 Kg of wastes are generated from a total of 125 sample households whose population is 583. This amounts to nearly 450 grams per person per day. This is more than the average waste generated by an Indian, which is 370 Gram (World Bank, 1982) per person per day

viii. From the Table 4.21, it has been observed that more than 50 percent of the respondents burn the yard waste, especially several times a year during the dry season, while about 31.72 percent dump the waste either in the backyards of their houses or nearby nullahs and natural drainages, in which city abounds, leading to shrinkage of the drains and pollution of the limited water bodies. It should be checked

ix. The table 4.23 shows that an overwhelming 84 percent of the respondents think that the problem of solid waste management in Shillong is a serious one and that it requires better management.

x. The efficiency of conservancy services in the city is also reported to be poor or very poor (81 percent). Conversely, only 19 percent appears to be satisfied with the services (Table 4.24).

xi. The Table 4.33 shows that most of the commercial waste (100 percent) is dumped at some nearest points or simply left in front of the shops to be lifted by the conservancy staff next morning. There appears to be no specific municipal by-laws in management of solid waste in commercial areas at Shillong.

xii. Most of the institutions widely use different types of containers like plastic bucket, tin, bamboo made basket, cardboard for storage (Table 4.45). Plastic container accounts for 79.6 percent, followed by tin 18.5 percent. The size of the containers ranges from 5 to 20 litres.

xiii. Most of the Educational Institutions follow different methods of disposal of their solid waste (Table 4.46); 54 percent by burning and 46 percent dumping the waste at designated places.

xiv. Most of the hospitals dispose their waste in different ways: 38.46 percent dispose at common storages in the hospital, 15.38 percent at curb-side collection points, 15.38 percent at street-side bins and 30 percent at open spaces around the hospitals (Table 4.55).

xv. Medical residues/wastes are generally mixed with other wastes, which are contaminants (Table 4.56). 57.14 percent of the waste removed by the hospital authorities, 28.57

percent of the waste is removed by the municipality, and only 14.29 percent waste is removed by the Cantonments Board (Military Hospital).

xvi. It was observed during the fieldwork that among the different tribes and non-tribes of the majority people comes under different income groups. The share of 20.8 percent Scheduled caste 20.8 percent, 29.2 percent of scheduled tribe and others 50 percent of the people comes under Non-tribes.

xvii. Table 5.2 shows that nearly 75 percent of the food wastes are generated from the (households) low-income group, as well as 62.60 percent of the high-income group, but middle-income group produce only 58.7 percent only. Regarding non-food waste nearly15.80 percent high income group, 12.08 percent middle income group and 10.9 percent of low income group generate Non-food waste.

xviii. Regarding the commercial waste, it is an important component of municipal solid waste disposal system. There is no data available regarding the exact amount of commercial waste generated with in Shillong. The waste generated ranges from 2 to 86 kilograms. In about 8.52 percent of the establishments, it is in between 10 kg to 20 kg /day. However the amount of solid waste generated in the whole market is approximately 12-24 metric tons per day. Hence 50 percent of the waste generated per day is not being disposed of by the municipal authorities.

xix. Regarding disposal and management of bio-medical wastes, it is causing a serious impact of our surrounding environment. There are 12 hospital / nursing homes, 20 dispensaries/clinics/ pathological laboratories and one veterinary hospital in the city. The amount of bio-medical waste generated is calculated according to the standard norms, i.e., per bed/patient/day basis assuming that each patient would generate on an

average about 1 kilogram of waste per day, of which, 25 percent consists of infectious, pathological and anatomical waste (Table 4.46). Various category of hospital generate 570 Kg of waste per day in Shillong (CPCB manual 2000).

xx. Non-governmental organization can play an important role in effectively projecting the community's problems and highlighting its basic requirements for urban services. They could help in organising the ragpickers into waste – management associations / groups under the supervision of the urban local body and the relevant residents association etc.

xxi. The municipal administration of the city remains much desired. Under Section 195 of the Municipality Act, the Shillong municipality must provide dustbins in each ward and areas, but the ground reality does not show total compliance.

xxii. The disposal system of the municipality leaves much desired. There is only one type of open body truck without facilities for collection of solid waste in the city. The transportation system, generally handles only 60 percent of the refuse. As a result, the remaining 40 percent remains accumulating at collection points for days, often for moths. The open trucks while carrying the waste often spill on onto the street that may cause severe health hazards, air pollution, and spillage, creating an unpleasant sight. Shillong Municipality does not have proper tipping platform; the refuse is transferred manually to the trucks.

xxiii. The suburban townships (non-municipal) of Shillong Municipality areas do not have proper disposal facilities. So the local resident's dump the refuse directly into the nearest dumping site (or) in unauthorised low lying areas, thereby creating serious sanitation problem.

xxiv Better refuse treatment and processing techniques are needed to improve the efficiency of the operations and to recover usable materials and energy at the source

xxv The shortage of manpower and vehicles, especially smaller vehicles for narrow roads has mostly hampered the day-to-day work of the Board resulting in the unsuccessful implementation of the existing system Lack of scientific disposal technique has caused severe environmental degradation and has deprived the Municipal Board from generating revenue from the garbage collected

8. Conclusion:

In some respect, what one observes as the solid waste management system in Shillong UA is not very different from any other Indian cities or even South Asian cities However, larger cities and city corporations have devised systems including out-sourcing of work However, many of them could do so, because their revenue base is bigger and better In case of Shillong, (i) the city is fragmented into seven units with only two having municipal authorities and therefore, lacks any central authority and command structure Moreover, the traditional laws (under provisions of Sixth Schedule of the Indian Constitution) severely limits the powers of the elected State Government into the management of the non-municipal townships. (ii) Second, practically there is no revenue base of the city and all municipal activities are carried out with grants from State Government or from Central Government funding Therefore, it is nearly impossible for the urban administration to invest in better management practices in the city (iii) A more serious problem arises, as pointed out earlier is the very estimation of population of the city and the quantum of solid waste they generate/day, thereby causing a huge under estimation of the task of solid waste management by as much as at least 3 times. If there

is no true picture of the problem presented, it is obvious no management practice can be adopted to deal with the situation, even if there is no funding or man-power constraint. (iv) Further, there is an absolute lack of citizen's participation in the municipal affairs, since for political reasons, municipal elections for SMB have not been held after 1967 (!) How does one ensure accountability and feedback from the grass-roots level, if there are no representatives at the municipal level. This has become a critical issue. The solution to this, of course has to be a political one. (v) It is imperative that the city presents an integrated management of solid-waste, water supply and drainage where the plans and resources could be deployed over the entire seven townships, even though their civic administration remains independent for whatever reasons. (vi) It is important also that NGOs, CBOs and other non-governmental agencies including companies develop partnership with the government agencies for more effective management of the city. Some start in this regard was initiated, but over a decade it remains where it was. Without an effective self-governance system, it is not possible to see an improved urban management system.

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MAY 28, 2009

I, N. Ambikapathy, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any other research degree in any other University/Institute.

This is being submitted to the North-Eastern Hill University for the degree of Doctor of Philosophy in Geography.

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ACKNOWLEDGEMENT

I am deeply indebted to my supervisor, Professor A C Mohapatra, Department of Geography, NEHU, Shillong for his stimulating guidance, constant encouragements and untiring help throughout the course of the study

My heartfelt thanks go to all the teaching and non-teaching staff of the Department of Geography, NEHU, Shillong for much assistance provided to me and to the University for providing necessary facilities in the Department

I am deeply indebted to Mr. S Muthtamilselvan's family, who initially encouraged me to use his computer to work for my data analysis Mr K Rajendran, Father of the Mawlai Theological College, Mawlai, Mr M Arularasu, Father Christ King College, Shillong and also Mr. S. Isias, Teacher, St Mary's Higher Secondary School, Shillong who initially helped me to collect field data in Mawlai area

I also would like to thank Mr B Dutta, Director, Department of Urban Affairs Government of Meghalaya, Shillong for providing with needful statistical information for my research work on Shillong

My heartfelt thanks are to Dr S Jeeva, Department of Botany, Scott College, Nagarcoil and Dr. A Murugan, Department of Chemistry, Chennai who had helped me at various stages of my research work. Mr Joseph Jeremiah, Mr Hanns J. Freddy, Mr. K T. Prasad, and Mr. A. Venkateshwara Rao, research scholars in NEHU, Shillong, who were always ready to help me as and when I needed their help during the present research work

without their support and cooperation it would have not been possible to complete my research work.

My special thanks goes to the Principal, Mrs. Lalitha Ramachandran and all the staff of K.V. No.1, Naval Base School, Kochi for their support and co-operation from time to time during the course of my research work.

My great pleasure and gratitude goes to Dr. N.P. Goel, Lecturer, CACE, NEHU, Shillong for his constant help and encouragement throughout the course of my work.

I express my sincere gratitude to my beloved parents and brothers for their support, encouragement and inspiration in completing this research work. I also express my gratitude to my wife, A. Vani and my daughter for their patience, tolerance and prayers without which my thesis would not have been completed

N. Ambikapathy.

N. AMBIKAPATHY

SHILLONG dated 28 May, 2009

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CHAPTER-I

Introduction

1.1 General Introduction:

The contemporary world is constantly moving towards greater urbanization, especially the developing countries, the developed ones having, more or less, fully or substantially urbanized. Currently, of the over six billion-world population over 50 percent live in towns and cities and by 2025, probably two-thirds of the population will live in towns and cities, much of this would arise from urbanization of the third world countries (UN, 1985).

In the process of this fast urbanizing third world within which we locate India, is not about a substantially large number of people who live in towns and cities, big and small, but is a gigantic social and economic churning that facilitate this process. One important characterization of urban society is its location nucleation of large number of people, staying and working in close proximity, unlike the rural habitations, which are not only small, but are dispersed over larger areas. The close geographical proximity of large numbers of people entail a number of problems, procurement of large amounts of food and other necessities, procurement and transportation of intermediate good, finished products for consumption, construction materials and so on, development of housing, civic infrastructure, water and power utilities etc. Consumption leads also generation of a variety of wastes, in a variety of

ways, with equally a variety of problems associated with such wastes. The wastes may arise from domestic sources, industrial activities, commercial centres, health infrastructure, and laboratories and so on. The wastes may be in liquid, semi-liquid (sewage), solid, further, metallic, glasses, plastics, papers, informs of degradable or non-degradable nature. They may accumulate at different locations within the city. They would cause a variety of health hazards if not dealt with adequately and efficiently. Every city, ancient, medieval or modern had devised ways of disposing these huge mounds of wastes, with which large population cannot live, but which never the less originate in the multiplicity of human consumption and activities. Waste, in a manner is an ugly side of development and progress. The more developed we are, the more are the wastes. These are to be dealt with, in promptness and efficiency and in manner commensurate with environmental safety and sustainability.

Waste disposal is one of the major tasks of every civic body through out the world, though the standards and practices may differ. In Indian situation, the Urban Local-Self Governments are primarily the state subject; therefore, the municipal bye-laws are defined for each of the state governments through appropriate legislative measures. However, except for specific governance structure for larger cities for which specific legislative measures were undertaken, urban governance, by and large, had no constitutional status. This was provided by the 74th Constitutional Amendments (1992), a central facilitating enactment entitles "The Nagar Palika Act". The Act provides for a regulated urban governance and administration with appropriate three tier administrative system, regular popular elections at five-year intervals conducted by the state election commissions and a set of duties and responsibilities of the urban local bodies (ULB), within which, urban sanitation and waste

disposal is one of the important functions. Except areas under the *Sixth Schedule of the Constitution of India*, including many areas and states in the North Eastern region of the country, the Act is applicable to the whole of the Union of India.

1.2 Review of literature

A search of literature on the geographical analysis of solid waste management has revealed little that was pertinent to the subject. Though numerous studies have been made by geographers in the field of environmental pollution and environmental management studies on the problems of solid waste management are very limited.

Civil, sanitary and environmental engineers have made significant contribution in this field of urban solid waste management. However, the few studies by geographer have also been reviewed ,which include the known comprehended study on solid waste in geography published by Cargo (1974) who found that in Chicago the income, expenditure, family size and the type of dwelling unit have strong relationships with the solid waste generation of an area. Berry et al (1974, 1977) have analysed the solid waste management and pollution control in relation to the community attitudes towards solid waste disposal in Chicago and has found that though solid waste disposal is a pressing urban problem, polluting both air and water, people perceived it as serious only after the water and air had become contemned.

There are symptoms of impending shortage in many areas of our natural resources. These shortage are generally not caused by nature by mans pollution and misuse. The main problem is that there are population explosion and the massive resultant effects our species,

all requiring more of the material things of life. Beginning of the 19th century development of medicine, there has been a relaxation in mans struggle for simple survival along with a rapid drop in death rates all over the world resulted high birth rate.

The environmental engineer has been directly involved in the reduction of death rate, especially in the under developed countries, one of the first programs available through the United Nations has been in the area of preventive medicine. This includes a safe water supply and sanitary means of waste disposal. Environmental pollution is related to the number of people, but population control is not the entire answer. Population concentration is also a leading factor. More importantly, the degree of pollutions depends upon the standard of living and the state of technological development.

Gunasekaran (1987) had undertaken a detailed comprehensive study on solid waste management for the city of Chennai. The study analysed the spatial pattern of solid waste generation, physical and chemical characteristics, temporal variation of solid wastes etc. the study examined the existing public solid waste disposal methods in residential, commercial, industrial, institutional and in hospital etc. further, the study critically analysed the various environmental problems associated with it. Significantly, this is the first study, which identified the alternatives for collection, transfer and disposal sites by projecting the further solid waste generation. In India few geographers like Singh (1981, 1986) Gopalakrishan (1984) Eswarappa (1987) and Joseph, Jaiprakashnarain (1998) have made some small attempts to study solid waste disposal in the cities of Varanasi, Madurai, Bangalore and Chennai, respectively.

On the international scene, the studies carried out by the American Public Works Association (1961, 1966) on municipal refuge disposal, collection and practice were the first detailed and comprehensive studies brought out in the USA. The U.S Environmental Protection Agency estimates that as a nation, the US generates 195.7 million tons of solid waste per year, more than double the nation's 88 million tons waste output in 1960. The total volume is the 195 million-plus tons of solid waste generated annually in the U.S (or) the 222 million tons experts predicted for the year 2000. It was followed by the national survey of community solid waste disposal practice by the United States Public health service (1968), considered to be a classic study, still form the basis for all later studies.

The technical report prepared by WHO (1971) on the solid waste disposal and control is also considered to be an important document, which gave an insight in to the global problem of solid waste disposal. Flintoff (1976a) and Cointreau (1982) have studied solid waste management in Developing Countries and made valuable contribution to the understanding on the subject in the Developing World.

Flintoff (1976a, 1977, 1978a, 1978b, 1978c, 1980a) studied and prepared solid Waste Management plans for Calcutta, Jakarta, Cairo, Surabaya (Indonesia) and Ghana. Cointreau (1980a, 1980b, 1981a, 1982) prepared solid waste management plans for Onitsha (Indonesia), Kanpur (India), Colombo (Sri Lanka) and Tunisia.

In India, there are many studies on various cities. Among them, Bhinde, of the National Environmental Engineering Research Institute (NEERI: Bhinde 1971a, 1975b, and 1975c) has made a significant studies on solid waste management in thirty-four selected

Indian cities. Ramanathan (1998) and many others have made a significant attempt to study the solid waste management in Chennai city.

Malina (1972), Walter (1976) and Wilson (1982) showed that the resources recovery system being developed include the recovery of both materials and energy, which is currently receiving the greatest interest and attention in both the developed and developing countries.

Drobng et al (1971), Kligshira and Albrecht (1981) and Henstock (1983) studied the methods of material recovery, and Mishra (1975) studied the recovery of energy from urban solid waste. Further, Singh (1974) Banerji (1977) and Dewalle (1978) have studied the generation and utilisation of gaseous fuel from municipal solid wastes. Studies by Henstock (1983) and Philpot (1983) found that resources recovery technology have potential markets. Veziroglu (1979) studied clean energy research from the solid wastes. Allan (1975) studied the resource recovery and recycling from the solid waste. Clark, Thomas (1971) studied the economic realities of reclaiming natural resources in solid waste. Bundi and Wasmer (1976) studied the factors influencing recycling from the solid waste. Wood and Jones (1997) had carried out environmental impact assessment (EIA) in U.K, an anticipatory environmental management tool, which is designed to affect decision about project. Leonard (1984) studied the method and approach of environmental planning and decision-making. Further, Karia (1990) studied an approach to zero solid waste. Kevin and Chandler (1996) both had carried out study on recycled plastic from the household waste and finally Folmer and Gabee (2000/2001) had carried out a tool for Cost-Benefit Analysis. In general these studies shows that there is no 'best' or most Economic resources recovery technology and every

community facing a resource recovery decision must consider its own unique set of factors. When selecting a course of action, such as available markets and local prices, capital and operating costs, technological risk and management alternatives related to different systems. Okfar and Amzat (2007) studied the perception of disease is related to a person's social – cultural reality (their social role and expected behaviours) to shape both behaviour and ability to respond to disease. (Jones and Williams, 2004) It is further observed that it is the interaction between the expected behaviour and perceptions of disease. Obabori et al (2007) as a matter of solid waste management policy, infrastructural facilities should be provided in already existing settlements. In case of emerging settlements, the location is relevant: This decision will help reduce hardship faced by inhabitants in checking development of an area or city. Kaundal et.al (2007) man is behind every development endeavour. The large-scale production and in proper disposal of solid waste has become a source of pollution and further accumulation of garbage has resulted in serious deterioration in quality of life and the ecological balance. Many diseases like cholera and gastro-enteritis have been reported due to lack of proper collection and disposal of solid waste, in sanitary condition and unsafe drinking water Saxena and Prakash (2006). Jones and Williams (2004) had undertaken a detail study of malaria as a social burden of South African people due to stagnation of sewerage water in their localities. An emphasis needs to be given to systematic waste management, cost effective and environmentally safe methods (Marudachalam, 1990). To achieve any meaningful and effective environmental planning in any cities, there is a need for people oriented and community involvement as the centrepiece of planning Oduwaye (2006). The condition of environment is of vital concern for mankind, since it is directly

linked with human welfare. The sheer size of many cities and their runaway growth rate makes the growth rate alarming of waste by Sonu and Veena (2005). Bharti (2007) pointed out development and pollution has a positive relationship, and may affect the life of human beings. The natural ecosystem may be disturbed due to these anthropogenic activities, and both are essential in the present context. Baber (2007) said importance of environmental impact assessment with "special reference to ecological restoration of Chilika Lake", emphasized on the environmental impact assessment (EAS) system, which is vital to conform socio economic development projects to environmental safety and thereby ensure sustainable economic development. Junjie (2006) studied a metropolitan area inhabited by households with different income groups has important implication for community structure. Malueg and Yates (2006) have studied a large literature compares the performance of these regulation with respect to various criteria including cost- effectiveness, the incentive to adopt new pollution control technology, and the cost of enforcement. Krishnakumar et al (2005) said the quality of air is worsening due to traffic congestion, poor housing, sanitation, drainage and garbage accumulation. Major source of contamination is the storage of waste material in excavations, which are dumped, spilled, spread or stored on the land surface eventually, may infiltrate, so groundwater are contaminated by several ways Mishra et.al (2005). Ceric and Hlupic (1993) studied modelling a solid waste processing system significantly reduce the volume of waste by mechanical and thermal, so that the waste is chemically transformed. Such processes solve one of the most serious problems of large urban population, waste disposal; hence, their design is an important task and modelling can significantly help by discrete event simulation. Shafik (1994) stated that the types of

environmental degradation that occur depend on the composition of out put ,which changes with income .some income levels are often associated with the increase in certain polluting activities. Lakshmi et.al (1999) observed that a close relationship between the income of the household and the types of diseases they suffer. Charles and Choguill (1996) studied that infrastructure is an essential elements if urban sustainability is to be achieved. In order to provide infrastructure to low –income group settlements in such cities, it is necessary to design programmes, which involve the progressive improvement of on site facilities. Joardar(1998), Goel and Patel (2002) had undertaken a detail study of measures through which the natural and man made resource and assimilative capacities of urban areas with respect to water supply, drainage and solid waste disposal can be assessed in quantitative and qualitative terms. Agarwal and Goel (2002) carried out water resource management and water for human survival. Ammukutty (1982), Sreebha and Sobha (2001) carried out problem of solid waste collection and disposal in kerala towns, the serious adverse effect on environment is disposal of human waste. The pit latrine and septic tank system being very common in Indian cities. Adamowicz. et.al (1993) carried experiments on the difference between Willingness To Pay (WTP) and Willingness To Accept (WTA) respectively, should be similar in magnitude for the area cleanup. Rajkumar and Balasundaram (1997) have studied the incidence and prevalence of communicable diseases among the Paliyan tribe(s) in Tamilnadu, due to lack of sanitation facilities. American Public Health Association (APHA) carried out standard methods of examination of water and wastewater in Washington DC (1998). Mukherjee (2002), Sobhasri and Sanjeevayya (2006), Goel and Patel (2002) carried out studies on environmental management and scientific awareness

issues, particularly in regards to solid wastes. According to surveys carried out in 174 Class I cities in India by NEERI, the total solid waste generated was estimated at 60,000 tons per day in 1991 (). Lemay and Harrison (1974) studied the provisions regarding collection and treatment of solid waste that have to be based on each municipality's ability to raise revenue. NEERI indicated that the per capita generation rate increases with the size of the city and varies between 300 to 600 grams per day. In the metropolitan areas, values up to 500 grams per capita per day have been recorded. NEERI estimates indicate an annual increase in per capita waste quantity by about 1.33 percent per year (2001). Carried out a study on the mode of solid waste disposal used by urban families that indicates about 350-400 grams of per capita per day solid waste is generated in an average Indian town. Collection and disposal of solid waste alone consumes up to 50 percent of some municipal operating budget, and only 50-70 percent of the solid waste is usually collected (and by implication, half to one-third of the solid-waste is not collected!) (Kala and Khan, 1994). Organic waste is the components of the solid waste which when left un-removed causes various infectious diseases (Jensen, 1990). Accumulation of solid wastes on streets (65.0 percent) may cause blockage of drains and passages during rainy season (60.0 percent). Inadequate number of waste collection bins (40.0 percent) were some of the other problems reported (Jensen, 1990). The earlier reports (Gandhi, 1996; Fadel, 1997; Dhingra, 2000) supported the findings of Jensen. Ali (1991, 1992) emphasised on proper training programmes for the municipal staff for proper disposal of solid waste. It was noticed that, disposal of solid waste of domestic origin, often disposed in polythene bags has more chances of choking of drains (Patial, 2001). The foul smell emitted by accumulated solid

waste pollutes the environment, and puts the citizen in heath risks that was pointed out in Shimla (Sharma, 2002). The solid waste dumps were posing health and environmental hazard for million of people residing in Delhi (Malik, 1995). Mahajan (1997) observed that solid waste from commercial and domestic sources was a problem in Shimla town. Sundari and Saradha (2001) observed that placement of community bins at appropriate distances from the residential areas prevent foul smell emitted from the waste thrown therein. There is a need for creating separate community bins for biodegradable and non-biodegradable waste material to solve the drudgery in segregation at source (Anonymous, 2001).

In Nigeria, poor urban colonies get unhygienic source of water, water borne diseases are common (Onibukun, 1990). National Institute of Urban Affair (NIUA, 1991) India is no exception; high infant mortality reflects the poor state of public health and environmental hygiene in urban areas caused by water borne diseases like diarrhoea and dysentery. Solid waste management is another aspect of sanitation, that is neglected in most of the urban localities; nearly, 27 percent of the urban solid waste generated cannot be collected and disposed of by the municipalities (NIUA, 1989).The responsibility of providing basic services such as water supply ,sewerage, sanitation and solid waste disposal lies with the state government (Kundu, 1993).In the provision of water supply, sewerage, sanitation and solid waste disposal facilities, developmental and maintenance responsibilities have been separated and assigned to different agencies (Kundu, Amitabh, 1990). The institution of municipal government has suffered a great decline over the years. This is due to the indifferent attitude of state government(Gangadhar Jha ,1993).Municipality with in the trust

area has to contribute one percent per quarter of the annual reteable valuations of holdings to the trust. This is also one of the main sources of income of the trust (Singh 1978).

1.3 Statement of the problem:

Shillong Urban Agglomeration (SUA) constitutes of seven townships, i.e. Shillong municipality (Board), Shillong cantonment (Board), the statutory townships and five Census towns of Mawlai, Nongthymmai, Pynthorumkhrah, Nongmynsong, and Madanrting. It is one of the largest urban agglomerations in the north eastern states with a current estimated population of about half a million. It generates about 120 MT of solid waste daily. A good part of the waste output is left uncollected and consequently it accumulates in drains, courtyards and on open ground, backside of the houses, on street corners and provides breeding ground for diseases and vectors, which is a serious concern to the health and wellbeing of the citizens. The prevailing practices of throwing the domestic wastes on the sides of the roads and streets, near commercial establishments and market centres further aggravates the problems of solid waste in the city, particularly in the absence of an organised system of collection and disposal of the solid waste, especially in the five census towns. Further, keeping of milch cattle in large numbers in outlying areas like Pynthorumkhrah, Nongmynsong and Mawlai adds to public hygiene animals and as many cattle's and buffalo contribute to the solid waste generation in the city. Apart from the problem of partial collection of solid wastes, the problems further aggravate due to inadequate collection facilities and insufficient workers, unsatisfactory transportation due to vehicular shortages. There is no centralized treatment facility for city's solid wastes for

converting them into a stable form prior to final disposal[1]. The waste is disposed-off by crude methods of landfill without concern for the problems of pollution and water logging in surrounding areas. The existing systems of waste collection and disposal practices are old and have not been thoroughly adjusted to the changed situations of the city, which makes it one of the many impediments to solid waste management of cities. As a result, air, water and soils are polluted in the surrounding environment of cities, contaminating groundwater sources, chocking natural drainages etc. Thus, the three operations, viz. collection, transportation and disposal of waste have to be considered as 'integral components of solid waste management' system. The vital aspects of solid waste disposal make the study very important in that the problems of partial collection and disposal of waste is likely to become worse in the coming years. A (projected) population of about 1,40, 550 in 2011 (SMB) is expected to generate 51 tonnes of waste per day and at the present rate of collection and disposal only half of it will be collected. At present, the spatial arrangement of waste disposal facilities are not adjusted to the waste generation patterns. Hence, there is an involvement of high haulage distance/costs that adds to aggravating environmental problems.

Further, information on solid waste generation in terms of quantity and quality which varies widely within the city have not been recorded source-wise and location-wise to enable an effective solid waste management plan. Thus, an investigation on the solid waste generation, disposal practices, both of community and municipal administration and waste

[1] A system of "public private partnership" was experimented around 5 years back, with a private company, M/s Andersons Ltd that partially collects and converts the Solid Waste to bio-fertiliser at its Mawiong facility on the northern outskirts of the city, on the GS Road (Guwahati-Shillong Road, NH.40). However, the company has yet to break even, though receives some subsidy from the SMB. This incidentally, has been one of its first experimental facilities in the entire seven states of the North East region.

management practices in terms of collection, transportation and disposal may make a comprehensive assessment of the problem. Thus, the components of solid waste management such as collection, transportation and disposal have to be necessarily considered as integral parts of a spatial-temporal system of waste disposal. The problem of solid waste management system of Shillong city can therefore be described as an integrated system optimization in which assessment of the existing conditions of waste generation; disposal and management are the principle concerns.

1.4 The Objectives:

Solid waste disposal is a social problem, primarily because it varies not only with the level of urbanization but also with the technological progress of the society. In fact, the various aspects of the society must be an over riding factor of importance because this decide in more than just a technical sense, the practice of solid waste disposal of the people. It is also a location problem because of the aspects of distance and quantity and therefore the resulting disposal varies with locations. Hence, the objectives must be primarily in accordance with the realization of these two facts of solid waste disposal.

The objectives of the present study are as follows:

(a) To study the magnitude of solid waste generated in Shillong Urban Agglomeration from different sources;

(b) To estimate quantum of urban solid waste by types of waste generated in the reference urban units of the SUA so that it can help in planning waste management;

(c) To assess the currents systems of waste handling and the likely difficulties faced by Shillong municipal (Board) administration as well as selected census towns in reference to optimal utilisation of man-power and financial resources at their disposal; and

(d) To devise and suggest alternative mechanisms of solid waste management for the city based on the study conducted for the purpose, including community participation and public-private partnership systems.

It is assumed that the present study will help to understand the existing system of solid waste management and the various dimensions of the problem, the identification of relationships between the socio-economic factors and people's attitudes towards the solid waste disposal may provide grater insights into the problem and the needed solutions. The study will draw from attention on the danger to health and the permanent environmental damage caused by water pollution from improper disposal sites. Finally, it is hope that the present study may help to evaluate planning alternatives for a better waste management system.

1.5 Research Issues/ Questions:

Provisionally, the study does not intend testing of hypotheses but has the following research issues in mind to investigate:

(a) Municipal solid wastes are generated from different sources like households, bazar (markets), offices and institutions like educational and others and especially the medical services that generate SW which are highly contaminated. Without a

disaggregate estimate of wastes by source and the magnitude of waste generated in the city, no proper planning methodology can be carried out. So the intention is to carry out a source-wise estimate of SW in the city.

(b) A study carried out for the Government by NEERI (National Environmental Engineering Research Institute) put the per capita SW generated/ day at .2799 gm (1991). This coupled with a lower population estimate for the city provides for a substantially lower estimate of SW to be handled by the SMB. This needs resolution, since the standard used by NEERI is about 30% lower than the WHO standard (for developing countries)—no reason was assigned and the estimate was not based on sample or other survey tools.

(c) The two statutory townships of SMB and SCB have legal responsibilities as well as conservancy staff and system to deal with waste handling within their jurisdictions. However, in the other non-statutory census townships under "dual management" of the district council (KHDC) and the durbars have neither statutory responsibilities nor resources nor man power to deal with the situation, with over 50% of the population of the Urban Agglomeration living in these townships. This requires a critical appraisal for an appropriate system of management.

(d) The issue of assessing of Command and Control (CAC) approach to SW management, if the most appropriate management system or there are other alternative systems available will also be dealt with.

1.6 Selection of the City:

The state of Meghalaya is situated in the northeastern part of India, between the Indian state of Assam to the north and Bangladesh to the south. The total geographical area of the state is 22,489 sq. Km and divided in to seven administrative districts. It has a total population of 2.3 million (2001 census). Shillong is the Capital city of the state and is of great historical significance being the former Capital of the undivided state of Assam before 1972.

Shillong urban agglomeration is a premier city (second largest urban concentration after Guwahati, Assam) of the north eastern region of India, that was established over a century in 1866 (David Scott) and was made first a "station" then, HQ of the Commission rate and further as the provincial capital of undivided state of Assam till, 1972 when Assam's capital moved to Dispur (Guwahati). The current population of the Greater Shillong urban region is arguably, nearer to half a million. The city, because of its role during colonial times and even after Independence, or now and its central role in development administration of the entire region, being HQ of the North Eastern Council (under DONER), enjoys a premier position in the region. Scores of central organisations, key educational centres that had catered to educational needs of children from the length and breadth of the region and beyond, and finally, the local culture of the Khasi and the other tribes, and a lifestyle of cosmopolitanism make the city, in many senses, a unique Indian city. However, with population growth and lack of a modern civic administration have led to continuous decline in the city environment that constitutes the prime motive for undertaking this study.

Currently, the city that is an urban agglomeration of 7 urban units, two statutory (Shillong Municipal Board and Shillong Cantonment Board) and five census townships (Nongthymmai, Mawlai, Madanrting, Pynthorumkhrah and Nongmynsong), has a population of 268,000 as per Census 2001.[2]

The main purpose of selecting Shillong Urban Agglomeration for the current study is for the following reasons:

(a) The historical significance of the city and the general concerns expressed in preserving its quality of life.

(b) The size of the city that is not too small or too large, but with a growing problem of solid waste management, especially its peculiarity of management with a mix of modernity as well as the traditional *Durbar* system.

The prevailing unsatisfactory state of solid waste management in Indian towns and cities need urgent attention. A systematic study of the problems in one of the Indian cities will help to find out how to improve conditions there and elsewhere. This study will be socially relevant. Shillong city has chosen for the present study because it will give ample scope for fieldwork and make it possible to collect data in the field, which are not available in the Municipal records and publications. It may also be pointed out that so far no such detailed study has made in Shillong (municipality) city. Though solid waste is being generated everywhere, its disposal creates a problem primarily in large urban areas like Shillong city. Keeping these in view, Shillong city has chosen for the present investigation.

[2] However, a recent sample survey carried out by AusAid (2004) puts the population figure closer to 400,000 excluding those of the paramilitary and defence establishments, which could be an additional population of 50,000, being a family station.

1.7 Organisation of the Study:

The study has been organised as follows:

In the first chapter deals with the introduction, the statement of the problem, review of literature connected with urban solid waste management, and objectives and research question/ issues have been discussed. The Second chapter deals with the problem and the procedures of data collection and methodology of the study including the sample design. Chapter three describes the physical setting of Shillong urban agglomeration, growth of the city, its dynamics, and the geographical characteristics of the study area that becomes inevitable in relation to various aspects of the solid waste management.

The fourth, fifth and sixth chapters constitute the main body of the study. Chapter four deals with sources of solid waste, from households, commercial, institutions and hospital etc, and their characteristics.

The fifth chapter deals with the types and quantum of solid waste and finally the estimates of quantum of solid waste generated in the SUA, based on types activities and population densities.

The six chapter deals with current solid waste management practices, identifies the problems including costs of current management by different agencies, both by collection of the waste, its transportation and disposal system. The study also tries to focus on alternatives available for more cost effective and environment friendly management systems.

Finally, chapter seven summarises and concludes the study with policy and practical implications. It also indicates to the extent the study has been successful and where it might have limited success and as to why it could not fulfil what it stated out to carry out.

CHAPTER – II

Research Framework and Methodology

2.1 Introduction:

Urban solid waste research world over, as indicated from literature, centres around improvements in collection, possibly waste separation on-site, transportation to disposal sites and appropriate system of disposal, several of which is indicative of the trend of moving away from traditional "dumping" disposal system—largely a management system that can be responsive to changing needs in urban areas, increasing per capita waste production by individuals and civil institutions and communities and keep the urban environment clean and healthy.

Shillong Urban Agglomeration is a large conglomerate of seven townships now with an approximate current population close to half a million covering 104 sq. Km. area sits on hills, an inherently fragile ecosystem. Of the seven townships only two are under statutory municipal system and thus have some form of local self governance, though the last election to Shillong Municipal Board was conducted in 1970, 37 years ago, before the State came into being. Naturally, without urban self governance, without the integration of the seven townships under one urban administration, there lurks the fear of collapse of the management of such a large urban system.

Thus, the study intends to gather detailed facts from field as well with other published and unpublished sources to analyse sources, quantum and contents of solid waste and project the future increases by both growth in population of the township as well changes in consumption pattern of the citizens and thereby to suggest appropriate planning methodology for management of solid waste in the city.

2.2 Sources of Data:

The present study depends on both primary and secondary sources of information.

Secondary sources:

(a) *Published sources*:

(i) Data related to the area, occupational structure and demographic characteristics have been compiled from the Registrar General of Census, Govt of India, through various publications from 1971 to 2001.

(ii) Data relating to land use, social amenities, city development and information regarding the city infrastructure have been collected from Urban Affair Department, Government of Meghalaya, Shillong.

(iii) Evolution of the solid waste management system in Shillong (Municipality) city have been traced out from the Annual Administrative Report of Municipality, SMB (from 2000 - 2005).

(b) Unpublished sources:

(i) Data regarding the existing solid waste management system such as divisionwise, manpower, frequency of collection and dustbin distribution have collected from Municipal Office. Data pertaining to the amount of solid waste collected from collection zones, disposal sites etc. trucks/vans and their frequency of trips have been collected from municipal records (of SMB).

(ii) Data such as relief, geology and land use pattern have been collected from urban affair department. Seasonal variation of solid waste characteristics like physical and chemical characteristics were collected from Annual Reports of State Pollution Control Board, Meghalaya, as well as from All India Class-I cities of Solid Waste Management Committee report June 1998-1999. Other related (general) information on solid waste management have been collected from NEERI, Nagpur, Sanitary Engineering and Centre for Environmental Studies in Anna University, Guindy (Chennai), United States Environmental Protection Agencies, Environmental Resources Management, Oxford and publications in journals and books.

(c) Primary data:

(i) Four different interview schedules were used for primary data collection (Appendix 2.1 to 2.4). The first one, the household interview schedules were used to collect accurate information from sample residents on waste disposal practices, socio-economic conditions of the households and also to find out their

attitude towards solid waste problem in the city. The remaining three different schedules were used to record the solid waste disposal practices in sample commercial establishments, institutions and hospitals.

(ii) Through intensive fieldwork, the primary data was collected by a system of random sampling from both municipal and non-municipal (Census towns) areas.

(iii) Data on spacing between dustbins, disposal system and collection of waste have been collected through intensive fieldwork.

2.3 Sampling Design for Primary Data Collection:

Solid waste management is a complex problem and hence samples selected for primary data collection must be able to represent this complexity. In selecting samples, two procedures have been adopted; (i) identifying sample (land uses) that generate solid wastes; and (ii) second, 'random selection of sample's that would, as far as possible, make them representative of the uses or activities. The uses/activities are broadly considered in terms of (a) residential (households), (b) commercial (shops/ markets etc), (c) institution (educational or government offices) and (d) hospitals and healthcare institution that generate special category of solid waste and thus requires separate treatment. Residential land uses have been given prominence over other uses for several reasons. It is here that the maximum number of persons per unit area will be exposed for the maximum period every day and thus, to the risks of infections to the inefficiently handled wastes. The infective potentiality of the waste generated of other areas like from commercial or institutional areas are limited to exposure of clientele or workers only during the working hours. Third, the residential areas actually

occupy a large proportion of the total area (15.30 percent to total area) of Shillong. Therefore, the proportion of the samples allotted to it is larger than in the case of other land uses. In any case, the urban sanitation programmes including handing of disposal of solid waste arises in connection with the health and welfare of the citizens of the city, i.e. households and families. Household surveys have been selected by (a thin) random samples of only 125 households both from the municipal and non-municipality areas. Streets in the concerned localities surveyed have taken as base, because the collection of solid waste is constrained largely by the street patterns. The samples represent social classes, composition and the range of waste generation practices. From the commercial establishments, 11 samples (purposive) taken from municipal areas in the city. The institutional (purposive) samples (educational as well as administrative unit) were selected 10 institutions. This is essentially because institutional forms are several- offices, educational institutions, bank etc. and it is impossible to include all categories into the sample. However it may be noted that for both household surveys (users) as well for non-households, data has been supplemented by selective input from the Kellog—Brown & Roots survey in 2004 for the AusAid Ganktok and Shillong project[1], where the coverage was 5 percent households (3400), but the solid-waste data was limited to broad parameters only as against detailed procedures carried out by the researcher in the current study—ditto for, the non-domestic sources.

[1] The domestic user survey was carried out under the overall supervision of Prof. A.C. Mohapatra, Department of Geography, North-Eastern Hill University, and Shillong by the AusAid ,Gangtak and Shillong Water Supply and Environmental Sanitation project with understanding that the data generated could be used by Prof A.C. Mohapatra, after the completion of the project for academic purposes. The researcher acknowledges thanks to KBR, Adelaide, and Prof A.C. Mohapatra for the use of only some relevant primary data from this source.

Finally, among the health units all over Shillong city 6 samples (hospitals) were taken into the purposive sample. Among the six, two are (3) from Govt. hospital, and 1 Military Hospital (under Shillong Cantonment) and two (2) private hospitals/ dispensaries.

The break up of the samples by areas as per the details below:

(a) ***Household samples***: 125 (10 Localities of, Laitumkhrah, Rynjah, Umpling, Nongmynsong, Happy valley, Nongthymmai, Motinagar, Madanrting, Mawlai, Laban with a minimum of 10 sample households from each locality at 5 percent (1 in 20), recurring on a continuous scale at equal intervals).

(b) ***Shops and commercial establishments***: Total 11 establishments (4 Wholesale dealers and 7 Retailers) the areas of Laitumkhrah, Rynjah, Umpling, Happyvalley, Nongthymmai, Motinagar, Barabazar and police bazar etc.

(c) ***Institutions/ Offices***: Total 10 (4Central Governments Institutions, 2State Governments office and 4 private etc. They are located at Laitumkhrah, Happy Valley, Rynjah, and Laitkor)

(d) ***Hospitals:*** Six (6): They are as follows: Civil Hospital (Govt), GaneshDas Hospital (Govt. Maternity Hospital), Military Hospital (Govt. Cantonment Area), Nazareth Hospital (Laitumkhrah), Ramakrishna Mission Charitable Dispensary and Bethany Hospital (near Fire Brigades).

2.4 Research Framework:

The broad research framework could be referred to be based on liberal normative planning perspective, i.e., to keep in view the community of the city in focus of the planning

activities or orientation of the study, contributing to that end. Whereas, urban planning methods can use tools with some universal applicability, a 'community normative perspective' treats each city as a unique community; therefore, solutions to the problems of the community must be tailor-made to the needs and possibilities of the specific context. The flow diagram that follows provides an overview of the methodological perspective as well as the components that have been studied in the present piece of research:

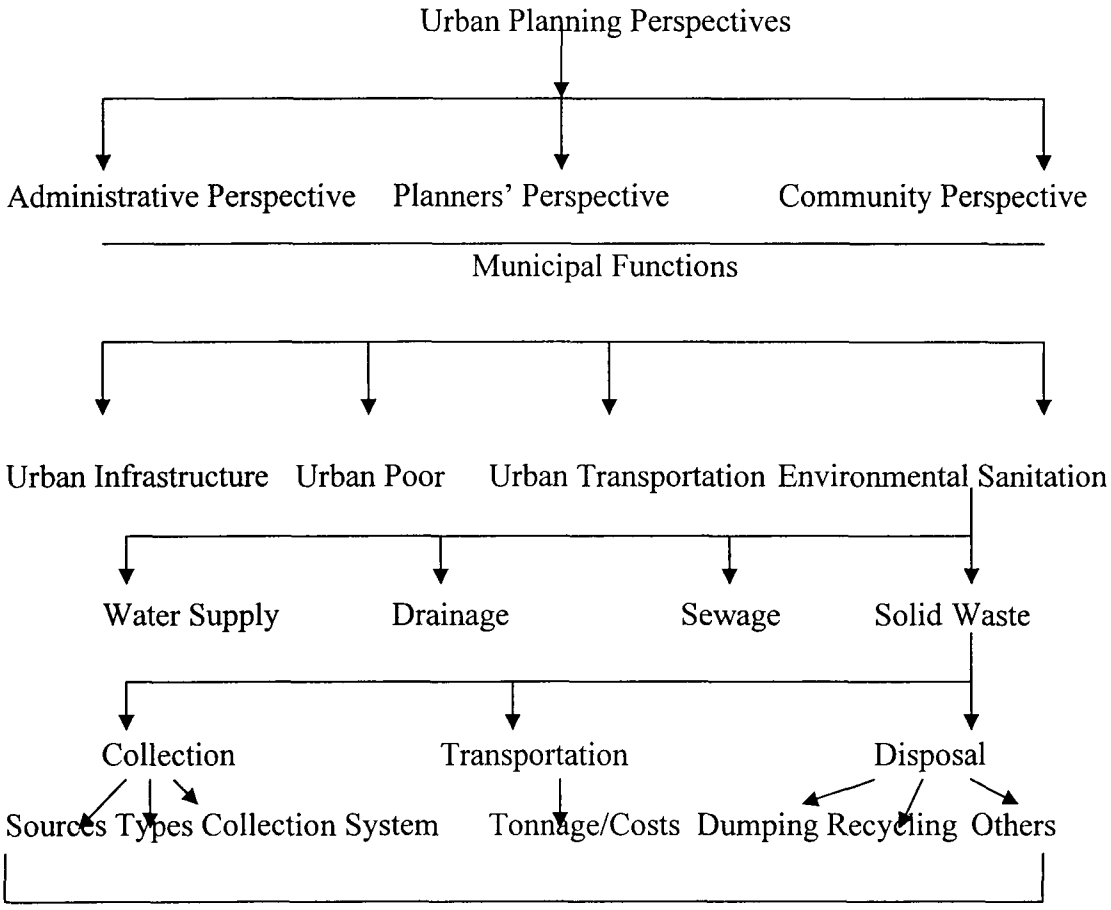

Fig. 2.1: Urban Management System (SUA)

2.5 Methods and Tools of Data Analysis:

In the present study, two different sets of techniques namely analytical and descriptive have adopted. The first set is essentially of the mathematical nature which involves some estimation and waste generation models with the help of computer (excel and SPSS package), the second set is exclusively descriptive and include mostly cartographic techniques.

Data for the study will be collected from both secondary as well as primary sources:

a) Secondary data would be collected from published sources like Indian censuses, publications and reports from Government of Meghalaya relating to specific technical studies (like the TCS, NIUA etc), on (legal) municipal provisions and the methods and techniques of waste handling used by the Statutory ULB etc. Secondary data from other independent studies will also be evaluated and used.

b) Primary data for the study will be collected from two sources:

   (i) Selected samples on various aspects from SMB and two other census towns, namely Nongthymmai and Mawlai for the purpose.

   (ii) The second source would be the extensive data generated by a detailed sample survey of the entire SUA carried out by Aus-AID in 2004 with due permission, since solid-waste management was one of the TOR of the project.

(c) The design of the study is broadly at three levels:

   (i) The first level is the sources that contribute to generation of waste. These sources are: households, marketplaces, offices and institutions and hospitals. Households

with different income levels and cultural attributes consume differently and generate SW differentially that need to be captured from field data.

(ii) The second level is the type of waste generated and quantity of waste generated from different sources and participants in the urban life, which needs to be captured in data collection. This can be done through sample study of a small sample of 15-20 households (structured) on an experiment basis as outlined below.

(iii) The sampling survey will be done for two weeks. The waste collected from 1-7 days will represent one week's production at the household level. The waste collection carry a supply of plastic bags one, which should be handed at each family, is replacement of the full one collected. For calculating of total weight and volume generated in each house, it is used based on the proportion of the population (individual family, joint family, etc). In most cases, sample collected in this way would also be used for physical analysis. Collection of samples can be taken from communal containers.

(iv) Data on income levels, ethnicity, occupation and education will help in assessing various elastic ties to consumption and thus waste generation.

(v) Samples from marketplaces, selected offices and educational institutions and hospitals will be collected for estimation of total as well as category-wise waste generated.

(vi) Detailed information of municipal SW management practice as well as the system used in non-statutory townships will be used in assessing and suggesting improvements in the systems.

2.6 Sample Selection:

Solid waste management is a complex problem and hence samples selected for primary data collection must be able to represent this complexity. In selection samples, two procedures have been adopted. One, identifying samples (land use) that generate solid wastes; and two, random selection of samples that would, as far as possible, make them representative of the uses (or) activities. The uses /activity are broadly considered in terms of residential, commercial, institutional and hospital. The actual procedures followed are indicated in fig 2.1

Residential use is given prominence over other uses for several reasons. It is here that the maximum number of persons per unit area will be exposed for the maximum period everyday and thus to the risks of infection to the inefficiently handled wastes. The ineffective potentiality of the waste generated in the residential area will be far greater than that of other areas. Thirdly, the residential areas actually occupy a large proportion of the total area of Shillong town. There fore the proportion of the samples allotted to it is larger than in the case of other land use

Seven wards have been selected by random, street in the wards have been taken as the base because the collection of solid waste is constrained largely by the street patterns. From the 10 selected locality. One sample was taken from the each street. These samples also represent, as we will later, social classes, composition and the range of waste generating practices. From the commercial establishment one was randomly chosen in each selected area only. For institution, official classification and followed 6 hospitals were selected from

each of the zones in the town. They include both small and large units and also different products.

The Institutional samples were selected random sample procedure. This is done essentially because institutional forms are several; offices, educational institutions, banks etc, and it is very difficult to have every one of them represented in the sample. Additionally, the schedules for data collection would require special designing and it would be necessary to have special schedules and not a common one. Therefore keeping in view the different forms of institutions to certain extent, 10 samples have been selected

The hotel and industry is perhaps the one that generates enormous quantities of solid wastes and these wastes contain nutrients that alter their characteristics. This data taken from the secondary data of Aus Aid Project

Finally, in all 152 samples were taken for the present study, with 125 households (residences) 11 commercial establishments, 6 institutional samples and 6 hospital units.

2.7 Limitations:

Solid waste includes a wide variety of materials. It is not possible to study all types of wastes and their disposal in any detailed manner in a single study. Shillong city does not have separate methods of refuse. All sorts of solid wastes are collected by a combined refuse collection system. Owing to the limited resources and time, the present study is therefore based on the wastes generated by the people and the waste collected by the Municipality within the town limits. Importance has been given for the residential (domestic) solid wastes, as nearly 70 per cent of the down is occupied by residential uses. However, attempts

also have been made to study the disposal methods of commercial, industrial, institutional and hospital wastes.

As already indicated, research in solid waste is handicapped by alack of the most basic information. The Shillong municipality, which handles the collection and disposal of solid waste, does not keep uniform records using standard definitions or maintain meaningful measures of the amount collected and dumped. In other words, there is not an overall data system that would enable an effective solid waste management plan to be developed. From collection to disposal, much of the information necessary to planning is simply non-existant. Since, so little comprehensive information exists on solid waste generation, collection and disposal, the study has to severe out whatever data available from the different sources. Hence, wherever it was necessary data have been estimated using the available techniques.

Appendix 2.1

Urban growth and managing the solid Waste: A Study in Environmental sanitation of Shillong Urban Agglomeration

Household Survey

Sample No. | | | |

Address

Area

A. **General Information**

1. Name (Head of the household):

2. Age | | | 3. Sex | | |

4. Religion | Hind | Christia | Muslim | Others |

5. Nationality | India | Others |

6. (a) Educational Level | P | M | S | C | Prof. | Tech |

(b) Others (specify) | | | |

7. Family Size (i) Single | | (ii) Joint | |

8. Occupation

(a) Salaried | Govt. | Private. |

(b) Executive | Professiona | Technic |

(c) | Self | Daily |

(d) Others (specify) | |

9. Subsidiary Occupation, if any | |

10. Income (monthly) | | | | | | |

B.

1. Family Details

Sl. No.	Relationship with the Head of the Household	Sex	Age	Education	Occupation	Gross monthly Income	Remarks
1							
2							
3							
4							
5							
6							
7							
8							

1. Type of Family

Nuclear	Joint

C. Housing

1. Living Area
   - (a) Slum
   - (b) Residential
   - (c) Commercial
   - (d) Industrial
   - (e) Others (specify)

2. Ownership
   - (a) Own House
   - (b) Rented House
   - (c) Others (Specify)

3. Dwelling Type and Socio-Economic (Income) Group

Dwelling Type	Economic Group		
	Low	Medium	High
Single Unit Size			
Multiple Low/High Size			

4. If it is an multiple dwelling type, the number of living families [ ][ ]

D. **Household Refuse/Waste Disposal Nature of Cleaning**

1. (a) Frequency of cleaning daily [Once][Twic][Thric]

(b) Time of cleaning [Morning][Noon][Afterno][Evenin]

2. When and how do you dispose of your refuse/ waste

(a) Immediately after cleaning [ ]

(b) At the end of the day [ ]

(c) Others (Specify) [ ]

3. What type of container do you use for collection?

(a) Basket [ ] (d) Plastic Bucket [ ]

(b) Cardboard Box [ ] (e) Plastic Bin [ ]

Expandable Plastic Sacks [ ] (f) Others [ ]

4. Size of the container [ ] m^3

5. How many times do you fill the container per day [ ][ ]

6. Nature of dust bins

(a) Do you have your own dust bins? [Yes][No]

(b) If yes, what is the size? [ ] m^3

(c) Exact location of your dustbin

(d) Do you feel that the size of the dustbin is enough For your refuse collection per day | Yes | No |

7. (a) Do you know the Meghalaya Municipality Act 1973? | Yes | No |

8. Nature of refuge/waste disposal
Where do you dump your home refuse (single unit dwellings)

(a) Open space – front of the house ☐

(b) Open space – backyard of the house ☐

(c) In the street/dustbin ☐

(d) Own dustbin ☐

(e) Outside collection point ☐

(f) Chute/Waste hopper ☐

(g) Others (Specify) ☐

9. Nature of waste disposal in Multiple/high rise dwellings

10. Location of dumping site (distance in meters) ☐

11. Demolition/construction site waste disposal
(in case of constructional, repairs/renovation of own dwelling)

(a) Did you dispose of ☐

(i) Building materials: Brick and aggregates

(ii) Building refuse: wooden materials ☐

(iii) Plastics

(iv) Others (specify) ☐

(b) Means of disposal

(i) by self ☐ private agency ☐

(ii) Hired labour ☐ public agency ☐

(c) Type of vehicle used

(i) Trailer ☐

(ii) Lorry ☐

(iii) others (specify) ☐

(d) Cost of disposal (Rs.) ☐☐☐☐☐

12. Frequency of refuse collection (by public agency)

(a) Daily ☐

(b) Alternative day ☐

(c) Once in a week ☐

(d) Once in a month ☐

(e) No regular collection ☐

13. Vehicle used for refuse collection in your area

Van	Lorry	Dumper	Other

14. Time of cleaning

Morning	Afterno	Evening	Not

E. **Health and Sanitation**

(i) What diseases are prevalent in your area?

Sl. No.	Type of Diseases	Occasional	Frequently
1	Hepatitis A		
2	Malaria		
3	Fileria		
4	Cholera		
5	Typhoid		
6	Viral fewer		
7	T.B.		
8	Skin disease		
9	Gastroenteritis		
10	Any others (specify)		

15. Source and quantities (approximately) of waste (in Kegs.)

Sl. No.	Items	Kgs	%
1	Food wastes (Trimming and residues of vegetables)		
2	Non-food wastes (paper)		
3	Glass, ceramics		
4	Metals		
5	Plastics		
6	Leather, rubber		
7	Cloth (textiles)		
8	Straw		
9	Yard waste (motor)		
10	Miscellaneous		
11	Total waste		

16. How do you dispose off household wastes?

Sl. No.	Items	Discard	Sales	Reuse	Others (specify)
1	News print				
2	Old clothes				
3	Plastic container/bottles				
4	Scrap metal/ old utensils, etc.				
5	Others (specify)				

17. Disposal of Garden/yard waste: How do you dispose your yard/garden waste?

(a) Dumping ☐ (c) Burning ☐

(b) Composting ☐ (d) Others (specify) ☐

18. If you dispose your yard/garden waste by dumping method exact location of dumping

_____

19. How often do you collect your yard/garden waste?

(a) Daily ☐ (d) Once in a month ☐

(b) Alternative day ☐ (e) Not regularly ☐

(c) Twice in a week ☐

20.

(i) How do you feel about solid waste problem in general?

(a) Very serious

(b) Serious

(c) Somewhat serious

(d) Not much serious

(e) Not serious

(ii) Are your neighbors and friends concerned at all of solid waste disposal problem?

Yes	No

(iii) What do you feel about the efficiency of street cleaning?

Very	Poor	Satisfactorily	Very good

(iv) Do you think that the frequency of street cleaning is adequate? Yes/No

If no, how often should this be done? ☐

(v) Do you think the number/size of the dustbin provided in your area is sufficient? Yes/No

(vi) At any time do you reported this refuse/waste disposal problem to the concern authority? Yes/No

If yes, when _____ if no, why _____

(vii) Normally where will you report this?

(a) to the headman ☐

(b) in your municipality office ☐

(c) others (specify) ☐

(viii) What is your opinion about the response/ co-operation of the Municipal authorities?

(a) immediate response ☐

(b) little late response ☐

(c) late response ☐

(d) no response ☐

(ix) Do you know any dumping ground? Yes/No

If yes, mention a few

_____

_____

_____

_____

21. How do you feel about the sanitary condition of your neighbourhood?

Very	Poor	Satisfacto	Good

22. Due to waste disposal, are you suffering from any of the following problems?

Sl. No.	Problems	Yes	No
1	Mosquitoes		
2	Flies		
3	Rodent birds/street dogs		
4	Dust		
5	Odour		
6	Other (specify)		

23. Attitude of the public

Sl. No.	Type of perception	Very high	High	Moderate	Low	Very low
1	Crowded					
2	Very genie					
3	Dirty					
4	Dusty					
5	Water logging					
6	Disease prone					
7	Any other (specify)					

24. Do you think that these dumping grounds are located in appropriate places?

Yes	No

25. What are the things you specially dislike about living in this part of the city?

(a) Whether it is highly congested ☐ (b) roads are bad ☐

(c) Sanitary condition ☐ (d) any other (specify) ☐

26. What are the things you specially like about living in this part of the city?

(a) Good environment ☐ (c) good sanitation ☐

(b) Less crowded ☐ (d) any other (specify) ☐

Annexure 2.2

Commercial Waste

Sample No. | | | |

Location

Name of the Firm/Shop

Road/Street
Division
Area

A. **General Information**

1. Nature of trade

Wholesa	Retai	Others (specify)

2. Category of the trade articles (list out specifically)

(a) (b) (c)

(d) (e) (f)

3. Total number of workers

4. Daily working hours

(a) Starting in the morning (time) AM

(b) Closing in the evening (time) PM

5. Number of customers per day

6. Nature of building (with space)

(a) Single unit

(a) Multistory

(b) Part of Shopping complex

(c) Others (specify)

7. Ownership of building

(a) Owned ☐

(b) Rented ☐

8. Land use of your area

(a) Residential ☐ (d) Administration ☐

(b) Commercial ☐ (e) Recreational ☐

(c) Industrial ☐ (f) Others (specify) ☐

B. **Commercial Waste Disposal**

9. Nature of cleaning (Frequency and Disposal)

Time	Morning	Afternoon	Evening	Night	Alternative day	Total Frequency
Frequency						

10. How do you dispose of you refuse/waste

(a) Dumping ☐

(b) Burning ☐

(c) Composting ☐

11. What type of containers do you use for collection

(a) Basket ☐ (e) Steel bins ☐

(b) Plastic bucket ☐ (f) Sacks ☐

(c) Steel bucket ☐ (g) Plastic bins ☐

(d) Cardboard box ☐ (h) Others (specific) ☐

12. Size of the container ☐ litre /m^3

13. How many times do you fill the container per day ☐

14. Nature of dustbins

(a) Do you have your own dustbins ☐ Yes ☐ No

If yes, what is the size ☐ m^3

(b) Exact location of your dustbin _____

(c) Do you feel the size of your dustbin is enough for your refuse collection per day.

☐ Yes ☐ No

15. Nature of refuse/waste disposal

Where do you dump your shop refuse?

(a) Open space in front ☐

(b) Open space at the back ☐

(c) Street dustbin ☐

(d) Own-common storage dustbin ☐

(e) Outside collection point ☐

(f) Others (specify) ☐

16. Distance from the shop of

(a) Municipality Corporation street dustbin ☐ in metres

(b) Curbside collection point ☐

17. Source of waste and quantity (approximately)

Source of Waste _____ Quantity ☐☐

Major components of waste (list out)

Sl. No.	Source of waste	Kg	%
(a)			
(b)			
(c)			
(d)			
(e)			
(f)			
(g)			
	Total waste		

18. Do you have a separate sweeper for cleaning

Yes	No

If yes,

Part time	Full time

Salary paid _____ Rs. /month

If no, what are the alternatives _____

19. Removal of waste by

Own	Municipality	Private	Other

20. Cost of removal

User fees	Cost	Term
Municipality		
Other costs		

21. Vehicles used for collection in your area

UMB	Trolle	Tiller	Lorry	Other (specify)

22. Time of cleaning

Morning	Afternoon	Evenin	Night	No regular

23. Frequency of refuse collection (by SMC/JMC)

(a) Daily _____ (d) Once in a fortnight _____

(b) Alternative days _____ (e) Once in a month _____

(c) Once in a week _____ (f) No regular time _____

24. Do you sell or reuse any of your waste?

Yes	No

If yes, what are they? (List out)

Sl. No.	Items	Resale	Reuse
1			
2			
3			
4			
5			
6			
7			

25. Your general comments on problems about the waste disposal in your area (list out problems and comments)

(a) (d)

(b) (e)

(c) (f)

26. Your suggestions to improve the waste disposal efficiency.

(a) (d)

(b) (e)

(c) (f)

Annexure 2.3

Institutional Waste

Sample No. ☐☐☐ Location

Name of the Firm/Institution Area/Address

A. General Information

1. Type of institution
   (a) Central Govt. ☐ (c) Private ☐
   (b) State Govt. ☐ (d) Others (specify) ☐

2. Function of institution

   (a) Educational ☐
   (b) Administrative ☐
   (c) Medical/Health ☐
   (d) Others (specify) ☐

2. Structure of the institution

   (a) Single unit ☐
   (b) Multistory ☐
   (c) Office complex ☐
   (d) Campus ☐
   (e) Others (specify) ☐

4. If it is a campus, number of buildings ☐

5. Institutional working hours ☐

6. Total number of working staff

7. (a) Total number of student

(b) Total number of rooms/halls

8. Do you have yard/Garden

Yes	No

9. Time and frequency of cleaning (day)

Time/Area	Morning	Noon	Afternoon	Evening	Total Frequency
Inside building					
Outside building					

10. How do you dispose your refuse?

(a) Dumping

(b) Burning

(c) Compositing

(d) Other (specify)

11. Do you have dustbins? (Tick whatever applicable)

(a) Separate dustbin for each table

(b) Common dustbin for each section

(c) Common dustbin for each building

(d) Separate dustbin for each room

(e) Common dustbin outside building

12. Type of container/dustbin used for storage of refuse (mention with size and total number)

Sl. No.	Unit/item	Type of container/dustbin	Size	Total number
1				
2				
3				
4				
5				

13. Place of disposal/dumping

(a) Open space in front ☐

(b) Open space at the back ☐

(c) Street dustbin ☐

(d) Own common storage dustbin ☐

(e) Curbside collection point ☐

(f) Others (specify) ☐

14. Available waste disposal facilities

(a) Incinerator ☐

(b) Common storage dustbin for the whole dustbin ☐

If yes, Size ☐

(c) Others (specify) ☐

15. No. of persons employed for waste collection/disposal (like sweepers, attendant, etc.).

16. Removal of waste by

(a) Institution labour ☐

(b) Municipality ☐

(c) Private agency ☐

(d) Others (specify) ☐

17. Cost of disposal

Sl. No.	Agency	Cost	Term
a)	Institution		
b)	Corporate		
c)	Private agency		
d)	Municipality		
e)	Others (specify)		

18. Mode of transport (1: Trolley, 2: Lorry 3: Others) ☐

19. Frequency of refuse removal

(a) Daily	☐	(d) Alternative days	☐
(b) Once in a week	☐	(e) Once in a month	☐
(c) Once in a fortnight	☐	(f) No regular removal	☐

20. List out the source and quantity of wastes per day (approximately)

Sl. No.	Source of waste	Kg	%
a)			
b)			
c)			
d)			
e)			
f)			
	Total		

21. Type of waste

22. General performance and problem of solid waste disposal (list out)

Sl. No.	Performance	Problem

23. Any other information

24. Suggestions in general

(i) Private institutional role

(ii) Government role

(iii) Individuals role

Annexure 2.4

Hospital Waste

A. **General Information**

Sample No. ☐☐☐ Location

Name of the Hospital/Clinic

Name of the street/Road
Division
Area

B. **Type of Health Service**

1. Name of the hospital

(a) Govt. Hospital	☐	(e) Private nursing home	☐
(b) Charity hospital	☐	(f) Private clinic	☐
(c) Private hospital	☐	(g) Polyclinic	☐
(d) Govt/Corporation clinic	☐	(h) others (specify)	☐

2. Structure of Hospital

(a) Single unit ☐

(b) Multistory building ☐

(c) Building complex ☐

3. Total number of buildings ☐

4. Yard/ Garden facilities

Yes	No

5. Staff in position

(a) Doctors ☐ (d) Administrative staff ☐

(b) Nurses ☐ (e) Technical ☐

(c) Attendants ☐ (f) Waste disposal staff ☐

6. Patients and bed capacity

(a) Total number of wards/units ☐

(b) Total number of beds ☐

(c) No. of in-patients per day ☐

(d) Average number of patients per day ☐

7. Investigation/ diagnostic/ treatment facilities available

(I) Heavy Care Unit (ICU)

(a) General surgery ☐ (g) Chest ☐

(b) Neuro surgery ☐ (h) Burns ☐

(c) Cardiovascular ☐ (i) Maternity new born ☐

(d) Urology ☐ (j) Orthopedic ☐

(e) Eye ☐ (k) Intensive care ☐

(f) Recovery ☐ (l) others (specify) ☐

(II) Light Care Unit

(a) Metabolic ☐ (e) Gynaecology ☐

(b) Psychiatric ☐ (f) Neurology ☐

(c) General medicine ☐ (g) ENT ☐

(d) Pediatrics ☐ (h) any other (specify) ☐

(III) Special Unit

(a) X-ray	☐	(d) Clinical laboratories	☐
(b) Radiation therapy	☐	(e) Out patient clinic	☐
(c) Emergency room	☐	(f) Physiotherapy	☐

(IV) Support Unit

(a) Administrative office	☐	(e) Cafeteria	☐
(b) Dietary office	☐	(f) Laundry	☐
(c) Kitchen	☐	(g) Pharmacy	☐
(d) Patient/visitor reception	☐	(h) Central supply	☐

(V) Total number of available facilities (I+II+III+IV) ☐

8. Hospital/ clinic waste disposal

Nature of cleaning

Time and frequency of cleaning

Place/Area	Time	Morning	Noon	Afternoon	Evening	Night	Frequency

9. Nature of dustbins (tick whatever applicable)

(a) Individual dustbin for every bed	Yes	No
(b) Common dustbin for every bed	Yes	No
(c) Common dustbin for every section/ wing	Yes	No
(d) Common dustbin outside building	Yes	No

10. Type of containers/ dustbins used for storage of refuse (mention size and number)

Sl. No.	Unit	Type of container	Size (m^3)	Total number
1	Beds			
2	Wards			
3	Wing/ section			
4	Outside building			
5	Yards			

11. Place of disposal

(a) Open space front ☐

(b) Open space back ☐

(c) Street dustbin ☐

(d) Curbside collection point ☐

(e) Common storage dustbin ☐

12. What are the waste disposal facilities do you have?

(a) Incinerator ☐

(b) Chute ☐

(c) Common storage dustbin (for whole hospital) | Yes | No |

If yes, size ☐ m^3

(d) Others (specify) ☐

13. Removal of waste by

(c) (a) Hospital authority ☐ (c) Private agency ☐

(b) Municipality ☐ (d) Others (specify) ☐

14.

(a) If the waste removed by Municipality/Private agency, are you paying for the disposal?

Yes	N

(b) If yes, Cost of removal

Sl. No.	Agency	Cost	Term
a)	Municipality		
b)	Private agency		

15. Special procedures of disposal, if any, to avoid contamination/ contagion

(a)
(b)
(c)

16. Mode of transport and trips

Mode of transport	Number of trips per week
Van/Lorry	
Dampers	
Tiller	
Others (specify)	

17. Frequency of refuse removal

(a) Daily ☐ (d) Once in a fortnight ☐

(b) Alternative days ☐ (e) Once in a month ☐

(c) Once in a week ☐ (f) No regular removal ☐

18. Source and quantities (approximate)

Sl. No.	Types/ source of waste	Kg	%
a)	General nursing stations		
b)	Surgical		
c)	Maternity		
d)	Laboratories		
e)	Administrative and other facility including yards		
f)	Dietary facilities		
g)	Mixed, other and unknown		
h)	Total waste		

19. What are the problems in removal/ disposal of waste of your institution/ clinic/ hospital?

a)
b)
c)

20. Suggestions for redressing problems

a) waste disposal staff

b) in-patient/ out-patient role

c) Individual of institution

Signature of the Enumerator

Name:

Place & Date:

CHAPTER – III

Shillong Urban Agglomeration: Growth and Dynamics of Change

3.1 Location and Size:

Shillong, the capital of the State of Meghalaya (carved out in 1972 from the State of Assam with two hill districts of United Khasi and Jaintia Hills, and Garo Hills), is situated in the midst of the Khasi Hills of the Meghalaya Plateau. The altitude of the city varies between 1400-1900 m. above the mean sea level (MSL). The state has seven districts and Shillong is the headquarters of East-Khasi Hills district, as well as the Capital city of the State. The natural drainage channels of the city are two, viz., the Umkhrah and Umshyrpi, which join together downstream at Bijon-Bishop Falls and drain into the Umiam river system.

National Highway 44 connects the city from the south and NH 40 towards the north to Guwahati. The capital is also linked with the other district headquarters of the state, by state highways and other major roads.

Originally, 1866 Col. Henry Hopkinson, Commissioner of Assam and Agent to the Governor General of India had strongly advocated in favour of Shillong as the future headquarters' of Assam. Accordingly, on March 20, 1874 (by the Government notification No 49) Shillong was declared the capital of the Assam Province with effect from that date.

Therefore, Shillong is essentially the creation of British and its growth depended closely with the growth of administration. The British established Shillong as a hill-station to sustain a few thousand of population only. Over a century, this tiny settlement has grown to a flourishing city (urban agglomeration) and has undergone radical changes from an administrative and resort town during the British-days to a multi-functional large urban settlement now. At present, Shillong Municipality is the only Class I city (Census of India, Population 2001: 1, 32, 876) of the State. The population (Census 2001) of the Shillong Urban Agglomeration (SUA: Seven townships) is 2, 67, 881[1], sharing a major chunk of urban population of the state (about 72 percent). Being the State Capital, it is the busiest administrative centre in the state. It also serves as one of the main commercial and institutional centres of the entire North Eastern Region. Shillong Urban Agglomeration (Fig. 3.1) consists of seven urban units, i.e., Shillong Municipality and Shillong Cantonment, Nongthymmai, Madanrting, Mawlai, Pynthorumkhrah and Nongmynsong the former two being statutory townships and the rest five, being census towns only.

[1] This is an arguable issue. A recent detailed sample survey carried out by Kellog Brown & Roots (Adelaide) implementing the Shillong Water Supply and Sanitation Project (SWSSP), under Aus AID funding, puts the population in June 2004, at between 380-420,000, approximately.

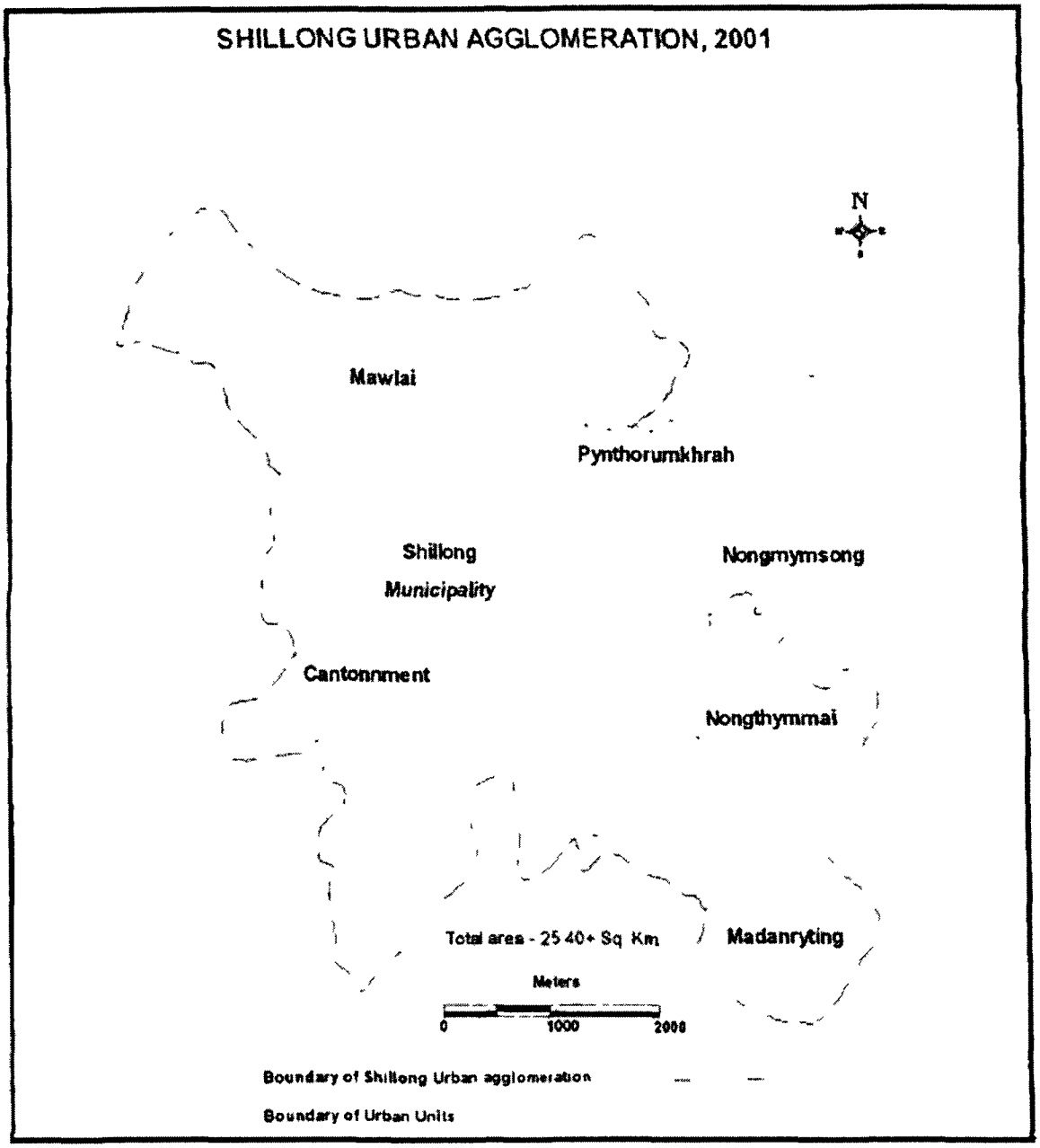

Fig. 3.1: Shillong Urban Agglomeration, 2001

Source: Census of India, 2001, Provisional Population Totals Meghalaya Series 14.

By 1897, Shillong had started becoming important educational centre, with its 'boarding schools' catering to the needs of the region and elsewhere. This history of the city continues even today with a large number of public schools (privately run missionary and non-missionary schools), about 30 under-graduate colleges, a Central University (NEHU, 1973). North Eastern Indira Gandhi Regional Institute of Medical Sciences (NEIGRIMS), Indian Institute of Management, Shillong (IIM-S) and many offices Central Government organisations and autonomous bodies.

Shillong was officially a station for the British administration with the police and army regiments. It was connected with Bengal (now, Bangladesh) to south rather than to north and the Brahmaputra valley. By 1910, Shillong station was declared a Municipality with ten wards (Census 1911 Population was13,639). Inroads into the forest rich areas continued with the expansion of railways in Assam, and Shillong continued to thrive as a urban centre as a colonial out-post. This situation continued more or less unhindered till the two World Wars when exploitation of resources improved the road linkage mainly between Shillong and the other border-states and huge inflow of capital gave a sudden boost to the city with an estimated 43.93 percent rise in the urban population.

Table 3.1: Population of Shillong Municipality (1901-2001)

Year	Population of Shillong municipality	% Decadal Variation	Population of Shillong UA	% Decadal Variation
1901	9621	-	No UA	-
1911	13639	41.76	-do-	-
1921	17203	26.13	-do-	-
1931	26536	54.25	-do-	-
1941	38192	43.93	-do-	-
1951	58512	53.20	-do-	-
1961	72438	23.80	102398	-
1971	87659	21.01	122752	19.87
1981	109244	24.62	174703	42.32
1991	131719	20.57	223366	27.85
2001	132876	0.88	267662	19.83

Source: Census of India, Meghalaya Series No.18, 2001.

3.2 Situation after the Independence:

Shillong experienced a new thrust in horizontal and vertical expansion after independence due to large immigration, expansion of residential areas, available vacant lands in Laitumkhrah, Laban, and Malki, were occupied in 1951. Shillong Agglomeration had only two townships – the municipality and the cantonment in 1951, which by 1961, expanded to Nongthymmai and Mawlai townships (census towns), Pynthorumkhrah was added in 1981, Madanrting in 1991 and Nongmynsong in 2001.

3.3 Land Use Pattern of Shillong:

Quality of urban life and functional efficiency of a city is dependent on proper disposition of activities and the inter-relationship it offers between different activities. In order to understand and analyse systematically, the functional relationship between various

land uses, particularly the people of work, living and recreational areas, a detailed land use survey of the city was conducted (Table 3.2).

Table 3.2: Land Use of Shillong Urban Agglomeration

Land use	Area (ha)	Area in percent	Total Developed Area in percent
Residential	15.23	0.09	48.47
Commercial	56.62	0.33	1.03
Institutional	2283.23	13.12	18.60
Organised Open Space	118.31	0.68	2.16
Grave Yards	61.75	0.35	1.12
Security	779.33	4.48	14.18
Industrial	10.00	0.06	0.18
Others	12689.26	72.93	14.26
Total	17400.00	100.00	100.00

Source: Directorate of Urban Affairs, Government of Meghalaya, Shillong 1911-2011.

In order to understand the problem of land uses in the Shillong UA the existing land use has been classified as follows:

3.3.1 *Residential:*

Almost half of the total developed area covered by the Master Plan is under residential use. It is 2662.78 hectares (15.23percent of the total Master Plan area). The residential development of the city has grown much beyond the municipal limits due to non-availability of build able land within the municipality area. At present, the development of residences has spread in all the three directions along the major arteries namely, towards Mawiong in the north, upper Shillong to the southwest and towards Madanrting in the southeast.

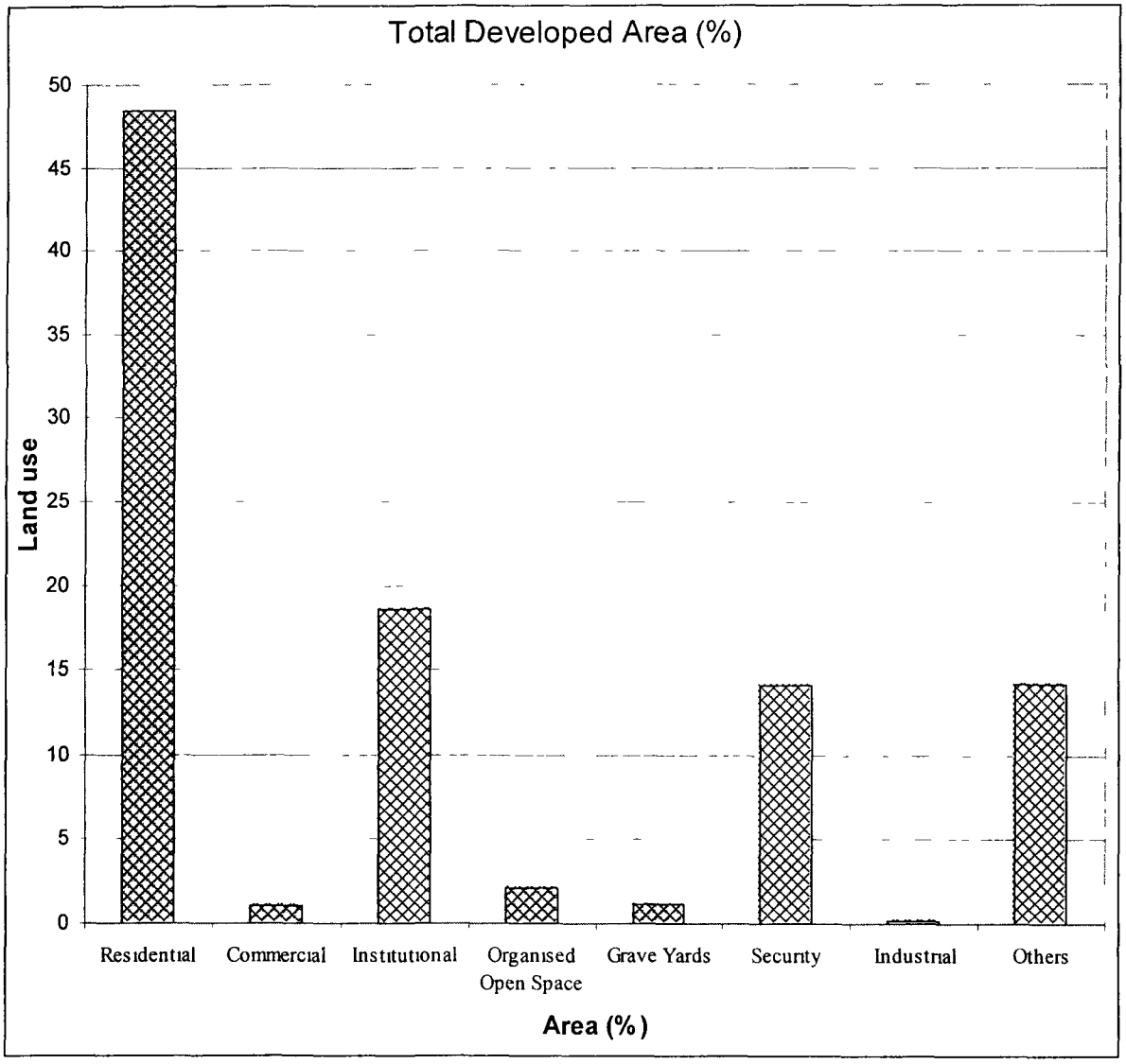

Fig 3.2: Land use Total Developed Area (%)

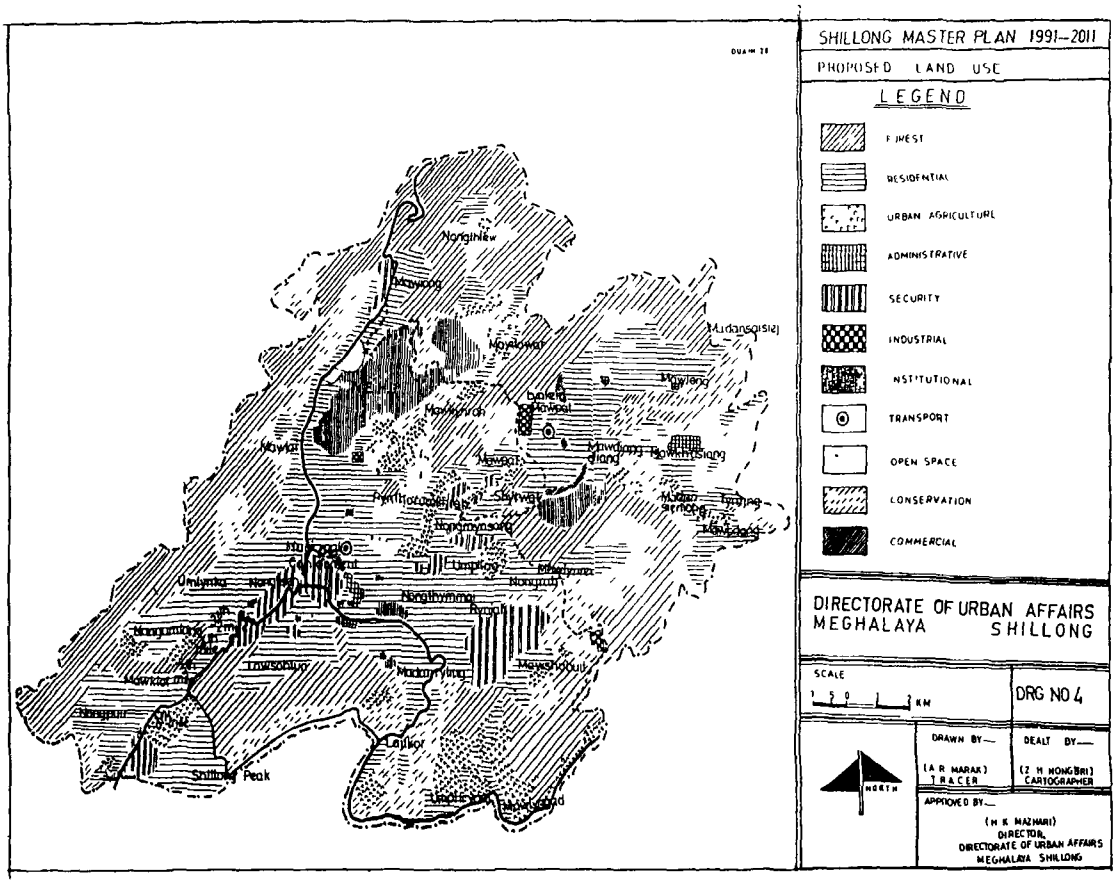

Fig 3.3: Shillong Master Plan Map (1911-2011)

3.3.2 *Commercial:*

Though Shillong is one of the main commercial centres of the north eastern region, it has only 56.62 hectares, i.e., 0.33 percent of the total Master Plan area under commercial use. The commercial area of the city, with its core in Barabazar and Police Bazar have been found to be extending along the major roads due to the lack of space. Increased activities in the main commercial areas has created problem of traffic jams due to increased traffic volume and non-expansion of the road network (Fig.3.4), particularly lack of widening of

the roads. The situation is further aggravated due to the existence of warehouses in and around this area with no proper parking, loading and unloading facilities. Hence, the commercial areas are inadequate and congested for efficient transaction.

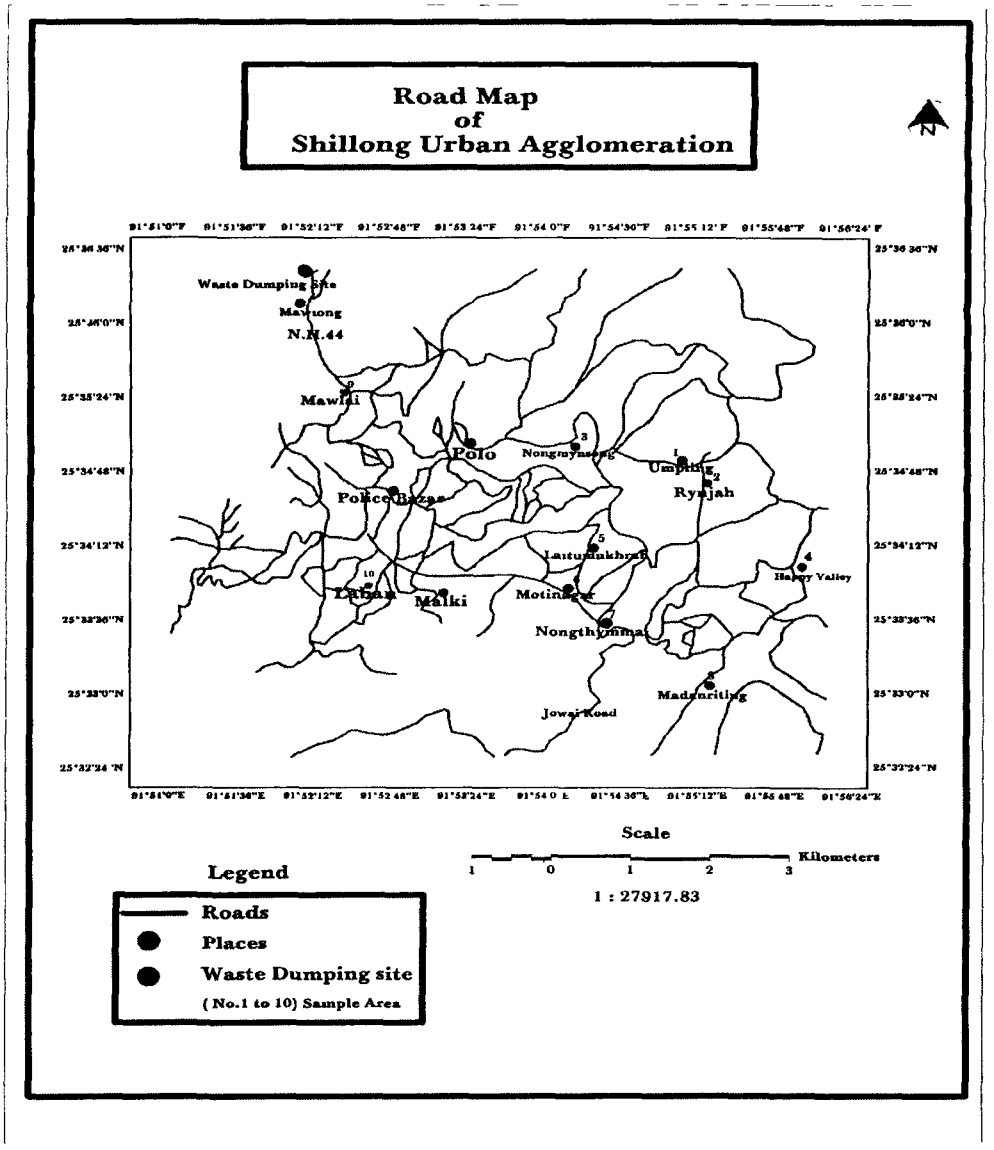

Fig 3.4: Shillong Road Map

3.3.3 *Public and Semi-Public Land Uses:*

(a) *Administrative Uses:*

The total area under administrative use is 117.93 hectares or 0.68 percent of the total M.P. area. The administrative area is concentrated in localities around Barik, IGP, Lower Lachaumiere (European Ward), etc. (better known as the secretariat complex). Apart from offices of the state level and district level, the regional office of various central government and semi-government offices are also located here and elsewhere in the city, like the Survey of India, Geological Survey of India, Botanical & Zoological Surveys, Anthropological survey of India, HQs of Central Para-military Forces, like the Assam Rifles, the BSF, the CRPF, the Border Roads Organisation, apart from the Army and other Central Govt organisations like the North-Eastern Council, GSI, ZSI, ASI, Survey of India, BSI, NCERT, ICAR, ICSSR and NESAC and so on. The above organisations have been expanding in their activities that provide further impetus to the population and activities of the city.

(b) *Institutional Uses:*

Activities such as educational institutions, hospitals, cultural and social institutions, religious institutions, etc. have a total area under this use is 903.20 hectares or 5.19 percent of the total plan area.

3.3.4 *Organised Open Space and Parks:*

This use includes area devoted to play-field, parks, lakes, golf course, stadium, etc. The total area under this use is 118.13 hectares or 0.68 percent of the total Plan area.

3.3.5 *Graveyard:*

The total area under this use is 61.75 hectares or 0.35 percent of the total Plan area. This use includes burial and cremation grounds.

3.3.6 *Industrial:*

The total area under industrial uses is only 10 hectares or 0.10 percent of the total Master Plan area. This clearly reflects that industrially Shillong has not made any headway, though there is enough potential for development of cottage and small-scale industries in and around Shillong. The existing industries are haphazardly located mainly along the major traffic entries thereby creating traffic congestion.

3.3.7 *Security:*

Area under police, military, air force, Para-military, central reserve police, border security force, cantonment area has been termed as a security use. The total area under such use is 779.33 hectares or 4.48 percent of the total M.P. area.

3.3.8 *Circulation:*

Area under circulation includes all types of roads, parking lots, etc. The land occupied by this category of land use is 783.36 hectares or 4.50 percent of the total master plan area and 14.26 percent of the total developed land and which, indicates that the land under this use is inadequate. Narrow roads, areas without vehicular roads, missing links and inadequate parking and terminal facilities explain this low percentage.

3.3.9 Vacant Land:

A vast amount of the total master plan area is without any activity weather urban or agriculture. These are the areas with poor accessibility, steep slopes etc. However, provided with proper services and facilities much of these areas may be brought under development. The total area under vacant land is 6650-90 hectors or 38.23 percent of the total master plan area.

3.3.10 Urban Agriculture:

All land under agriculture, horticulture, dairy farming etc., are covered under this category of land use. Within the master plan, there are big chunks of land devoted within use. The total area under this use is 803.07 hectares or 4.62 percent of the total master plan area.

3.3.11 Forest and Water Bodies:

About 4451.93 hectares or 25.59 percent of the total master plan area is under forest and water bodies.

Table 3.3: Land Use by Degree of Development

Land use	Area (ha)	Percent to total area
Developed Area	5494.10	31.58
Underdeveloped Area	1573.88	9.04
Developable Area	5075.02	29.18
Urban Agriculture	803.07	4.62
Forest and Water Bodies	4451.93	25.58
Total Area	17400.00	100.00

Source: Annual Report of Directorate of Urban Affairs, Govt. of Meghalaya, Shillong, 2001.

As per the directorate of urban affairs, of the total area of 17400 hectares of which 5494.10 hectares or 31.58 percent of the total area is developed area, 1573.88 hectares or 9.04 percent of the total area is underdeveloped area. Owing to excessive slope and height of the land, 803.07 hectares or 4.62 percent of the total area is under Urban Agriculture, and 4451.93 hectares or 25.58 percent is under forest and water bodies of the total plain area, while 5077.02 hectares or 29.18 percent is developable area as has been depicted in Table 3.2. In the entire set up, almost half of the total area is under residential use. It account for about 2662.78 hectares or 15.30 percent of the total municipal area. The residential development of the city has grown much beyond the municipal limits due to non-availability of build able land within the municipal area.

3.4 Growth of Population:

Population of the state according to the 1991 Census was 17.60 lakh with an average density of 78 persons per Sq. Km. This was 0.21 percent of the country's total population and 5.61 percent of population of the Northeastern regions. According to 2001, the total population of the State of Meghalaya increased to 23.06 lakhs, with an average density of 126 persons per Sq. Km. The percentage of urban population in the state was 8.41 percent, but in the recent census 2001, the level of urbanisation has increased to 19.63 percent, nearly 9 percent below the national average.

The jurisdictional area of Shillong Municipal Board (SMB) is 10.36 Sq. Km (Fig. 3.5) only that contains a population of about 1.33 lakhs (Census, 2001) with a floating population of about 40,000. The population of the Shillong municipality during 1981, 1991

and 2001 were 109244, 131719 and 132876, respectively. The decadal growth of population is showing a decreasing trend since 1981, which is unusual for a city that appears to be growing substantially.

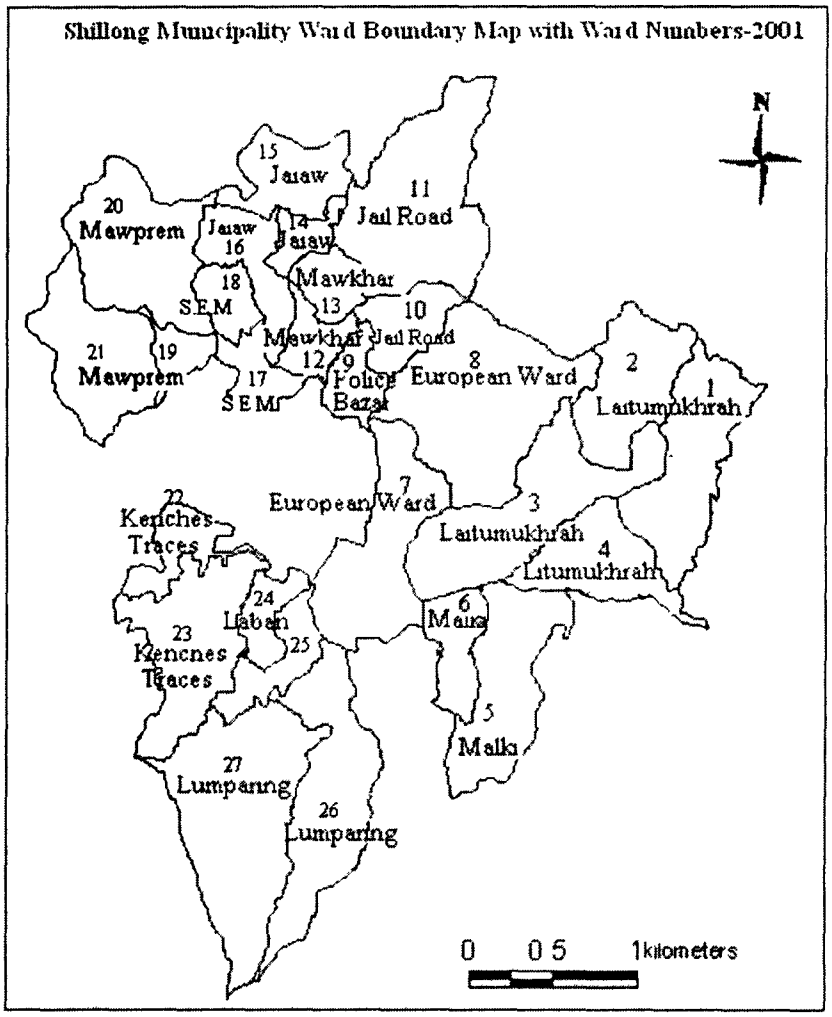

Fig. 3.5: Shillong municipality ward boundary map with ward numbers - 2001

Source: Shillong Municipality Board, 2001

Table 3.4 indicates the distribution and density of population of the SMB. The Shillong Municipality (Fig.3.5) which is the largest statutory city within the SUA has a total of 27 wards covering the total of its 10.36 sq.km jurisdictional area. The (3) wards of Mawprem reports the highest population density in the municipal area (even if we go by accepting the Census figures), i.e. 121/ha (12100/ sq. Km.) followed by (4 wards) of Laitumkhrah, i.e. 101/ha. In an absolute sense, for a hill station the density figures appear to be quite high, since there has been hardly any vertical growth of the city—therefore, people tend to live in unusually cramped quarters within the municipal areas. The overall density for the municipal area is over 70/ha which is also quite high.

Table 3.4: Ward-wise Population Distribution and Density in Shillong Municipality During 1971 to 2001

Wards	Area (Sq. Km)	Population				Density (Persons /ha.)			
		1971	1981	1991	2001*	1971	1981	1991	2001*
Laitumkhrah	1.87	11726	15620	18960	19127	63	84	101	102
Ward I		-	-	7656	7723	-	-		
Ward II		-	-	2177	2196	-	-		
Ward III		-	-	5291	5337	-	-		
Ward IV		-	-	3836	3870	-	-		
Malki	0.6	6956	8804	10225	10315	37	47	55	55
Ward V		-	-	3699	3731	-	-		
Ward VI		-	-	6526	6583	-	-		
European	1.5	5626	7604	9115	9195	30	41	49	49
Ward VII		-	-	4615	4656	-	-		
Ward VIII		-	-	4500	4540	-	-		
Police Bazar	0.1	3141	2629	2936	2962	17	14	16	16
Ward IX		-	-	2936	2962	-	-		
Jail Road	1.42	5371	8235	9898	9985	29	44	53	53
Ward X		-	-	5244	5290	-	-		
Ward XI		-	-	4654	4695	-	-		

Mawkhar	0.31	6820	8869	10208	10298	36	47	55	55
Ward XII		-	-	3606	3638	-	-		
Ward XIII		-	-	6602	6660	-	-		
Jaiaw	0.57	8991	10207	12482	12592	48	55	67	67
Ward XIV		-	-	4626	4667	-	-		
Ward XV		-	-	3898	3932	-	-		
Ward XVI		-	-	3958	3993	-	-		
S.E. Mawkhar	0.29	7060	8549	10180	10269	38	46	54	55
Ward XVII		-	-	4798	4840	-	-		
Ward XVIII		-	-	5382	5429	-	-		
Mawprem	1.09	13113	18408	22612	22811	70	98	121	122
Ward XIX		-	-	3557	3588	-	-		
Ward XX		-	-	9299	9381	-	-		
Ward XXI		-	-	9756	9842	-	-		
Kench's Trace	0.67	3659	6266	7712	7780	20	34	41	42
Ward XXII		-	-	1990	2007	-	-		
Ward XXIII		-	-	5722	5772	-	-		
Laban	0.34	5882	5903	6989	7050	31	32	37	38
Ward XXIV		-	-	3412	3442	-	-		
Ward XXV		-	-	3577	3608	-	-		
Lumparing	1.6	7334	8150	10402	10493	39	44	56	56
Ward XXVI		-	-	6731	6790	-	-		
Ward XXVII		-	-	3671	3703	-	-		
Total	10.36	85659	109244	131719	132876	45.8	58.4	70.4	71.1

* Source: Census of India Meghalaya series 18, paper 1 2001

The growth of Shillong Urban Agglomeration is towards the fringe of the municipality, i.e., the township of Nongthymmai, Mawlai, Pynthorumkhrah, Madanrting and Nongmynsong, which is evident from Table 3.5. For inexplicable reasons, the municipal population of SMB grew only by less than 1% for a decade (1991 to 2001)! Even, by an average of 2% a year the population of SMB should have grown by at least 20%--which implies that there was a serious under enumeration, even non-enumeration, which has not

been explained by the Census authorities. Everyone, who stays in the city understands that the city (core area, i.e., the SMB) has grown substantially, by population, due to large immigrant population from adjoining areas within the state, but also large inter-state migration. A simple linear interpolation on census population figures was carried out (from 1901 to 1991) to arrive at a projected figure for 2001 of Shillong municipality that yielded a figure of 132428 (!) only about a couple of hundred less than that provided by the Census 2001! So, was the Census 2001 was ever carried out? or the figures suppressed for other reasons and what was provided was a projected figure without going into any complications and controversies? Whatever may be the reason, one thing is certain—the Census figures for Shillong for 2001 cannot be trusted.

Table 3.5: Population and Growth Rate of Shillong Urban Area (1971-2001)

Urban Units	Total Population				Decadal Change in %			
	1971	1981	1991	2001	1961-71	1971-81	1981-91	1991-2001
Municipality	87659	109244	131719	132876	21.01	24.62	20.57	0.88
Cantonment	4730	6620	10076	12385	58.32	39.96	52.21	22.92
Nongthymmai	16103	21558	30964	34209	67.21	33.88	43.63	10.48
Mawlai	14260	20405	26938	38241	56.69	43.09	32.02	41.96
Madanrting	-	6165	8987	16700	-	-	45.77	85.82
Pynthorumkhrah	-	10711	13682	22108	-	-	27.74	61.58
Nongmynsong	-	-	-	11362	-	-	-	-
Total	122752	174703	222366	267881	19.88	42.32	27.28	20.47

Source: Census of India, Meghalaya Series, 2001.

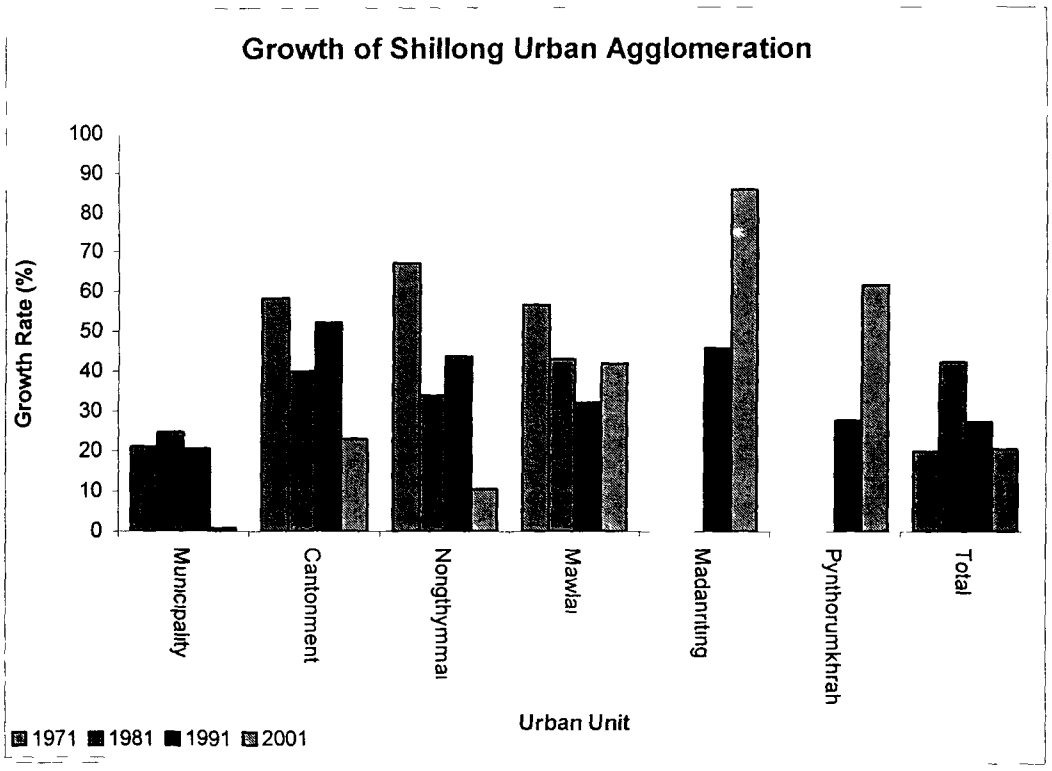

Fig 3.6: Growth of Shillong Urban Agglomeration

Table 3.5 shows that the growth decadal of Shillong Municipality is declining (0.88 percent in 2001), whereas the other non-municipal townships are enjoying a healthy growth, especially Madanrthing, Mawlai and Pynthorumkhrah, all the three towards the fringe of the main urban area.

Due to faulty enumeration and/or serious under reporting during the Census 2001, Shillong Urban Agglomeration does not show any remarkable growth as pointed out earlier, which is not what is experienced on the ground. Only for a period, between 1971-81 when the state capital of Assam moved out of Shillong leading to a serious out-migration of many state employees and their families, there appears to be no reason why the city should be not

growing fast! In deed, during 1971-81, the SUA had a reasonably sound growth figure, despite a defendable reason (Fig. 3.1 & 3.6).

3.5 Population Projection:

Population projection are made to ascertain the type and intensity of population change in future for a region or a country or a city, so that appropriate planning interventions and policy measures could be designed to deal with either an expanded population or even a depleted population as witnessed in many developed countries which also creates a different set of problem. Even if national populations are assumed to be stable, the population of towns and cities undergo differential changes, some observing stable, some slow but many growing at fast speed. It is often the fast growing urban centres that require accurate projection in medium and long-term in order to make appropriate provisioning of public utilities like water, power etc and public services like environmental sanitation, i.e. sewage, drainage, solid-waste and sanitation systems.

The NEERI study (1992) referred to earlier, makes a population projection based on two assumptions: (i) city population grow at arithmetic manner (linear trend) and (ii) between 1901 and 1991, there has been no perceptible driver of population change for the region as well as the city itself. Under such assumptions, if acceptable they arrive at very low population growth figures of 2001, 2011 and 2021.

Table 3.6: Future Population Projection

Year	Projected Population
2001	132876
2011	140550
2021	143390

Source: NEERI, 1992

We consider three reasons why the NEERI figures could not be trusted: (i) population growth, accepted worldwide, takes place "instantaneously", a standard practice demographers use for projections ($P_t = P_0e^{rt}$); (ii) there were two significant drivers of population growth, first after Independence of India (1951) and the second, Meghalaya becoming a separate state (1972); and (iii) the third aspect is that once a city reaches a threshold population, its growth momentum accentuates and normally, it is well accepted for India is about 100,000, which Shillong achieved in 1981. Under these assumption a fresh set of projections have been provided for Shillong Municipality as well as Shillong Urban Agglomeration and the results appear dramatically different from those of the NEERI Report at one hand, but more importantly appears to be closer to the reality (the unpublished, AusAid Report, 2004).

Table 3.7: Projected Population Figures for Shillong Urban Agglomeration

Year	Actual	Estimated
1951	65687	69599
1961	102398	139198
1971	122752	208797
1981	174703	278395
1991	223366	347994
1996	-	382794
2001	*	417593
2006	-	452393
2011	-	487192
2016	-	521991
2021	-	556791
2026	-	591590
2031	-	626390

* 2001 figure ignored. The estimated r = +0.2982

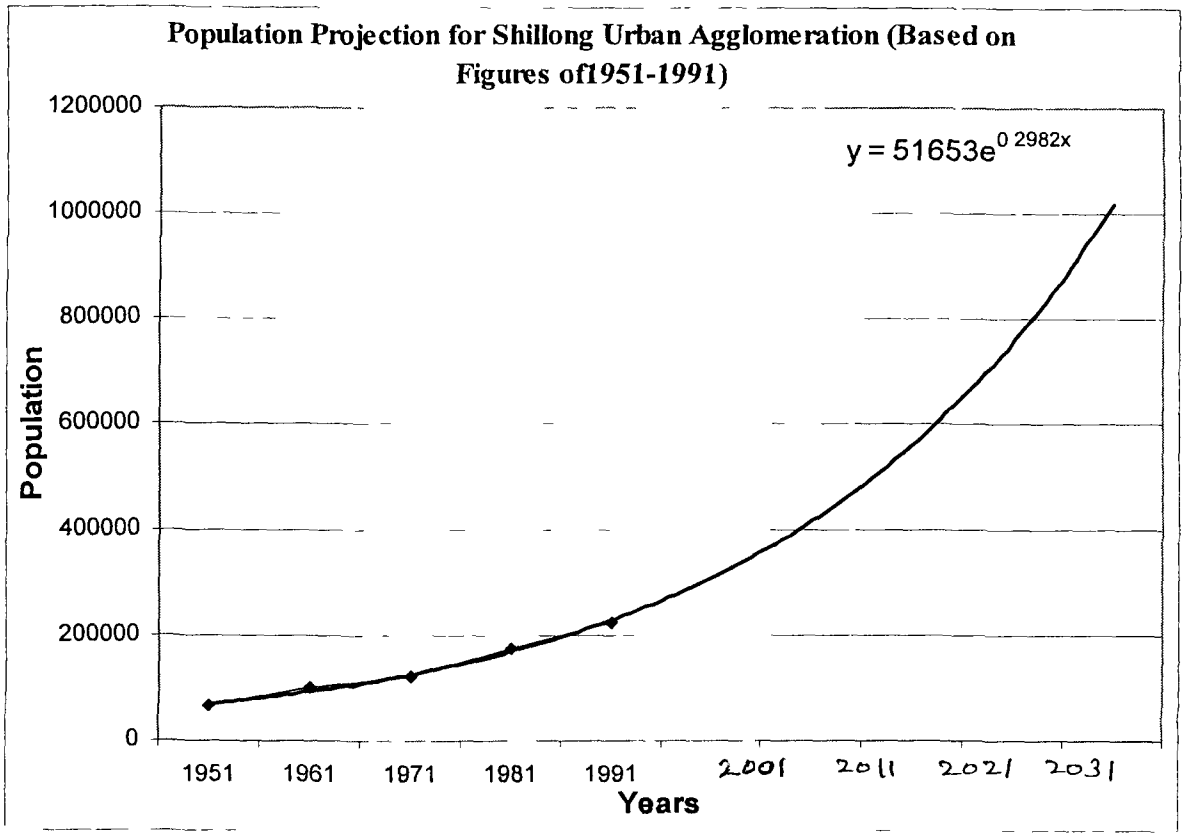

Fig. 3.7: Population Projection for Shillong Urban Agglomeration (Based on Figures of 1951-1991)

Table 3.8: Projected Population Figures for Shillong Municipality

Years	Actual	Estimated
1951	58512	58746
1961	72438	71997
1971	87659	88237
1981	109244	108140
1991	131719	132532
1996	-	146720
2001	-*	162426
2006	-	179814
2011	-	199064
2016	-	220374
2021	-	243965

* Figures for 2001 ignored Estimated r = +0.2034

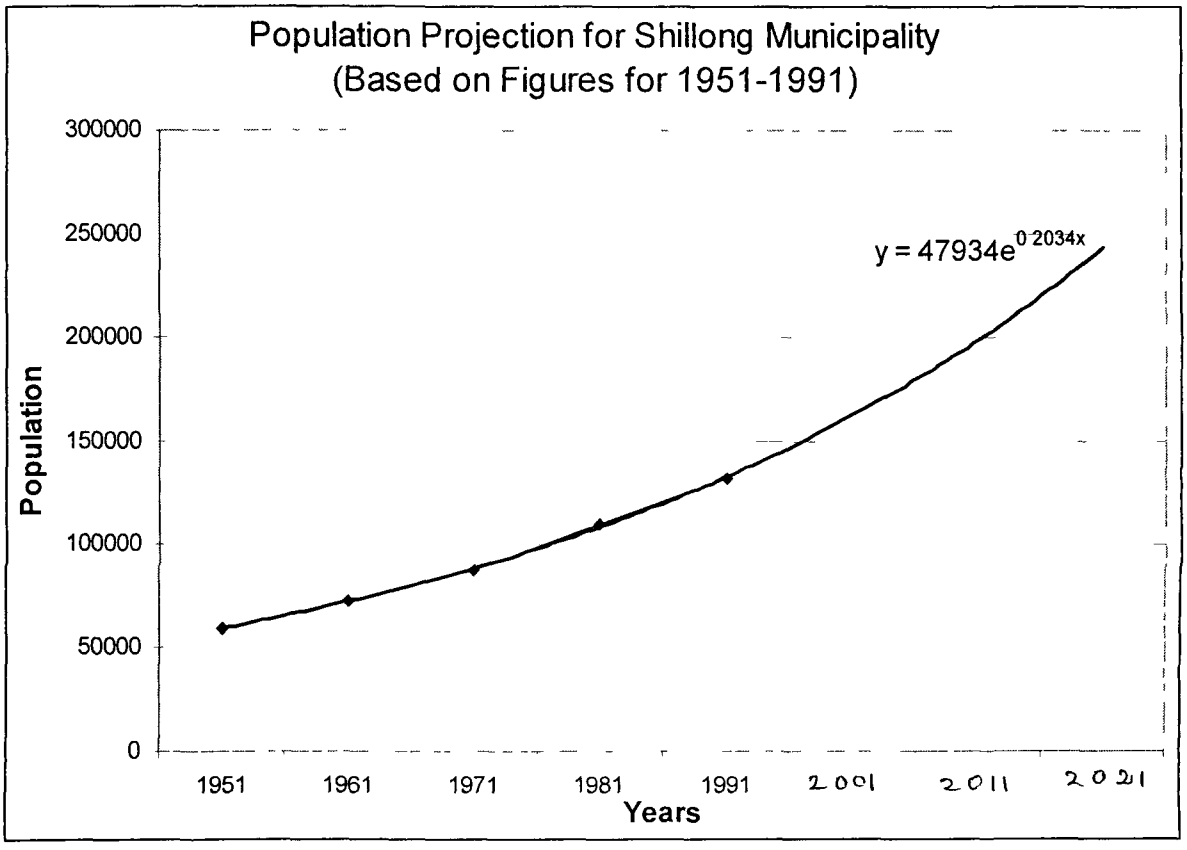

Fig. 3.8: Population Projection for Shillong Municipality (Based on Figures for 1951-1991)

It appears amply clear from Table 3.7 and 3.8 as well as the two graphs indicating the projected population trends till 2031 and 2021 respective, that the projected figures derived for 2001 for SUA (417593) is quite realistic since it falls within the probability range of AusAid data (380-420,000 excluding the defence and para-military areas). With a (natural log) growth factor of +0.3 (the parameter β of the curve), this figure is likely to reach 487,000 and 556,000, respectively for 2011 and 2021, which does not appear to be unrealistic. In deed, the Greater Shillong urban area (beyond the Agglomeration) by various estimates enjoys a population figure well in excess of half-a-million currently (2008). Similarly, the projected figures for the Shillong Municipality is 162426 for 2001 which is fairly realistic than the one carted out by the Cencus of India 2001. The projected figures for 2011 and 2021 are 199,000 and 244,000, respectively, which appears to be on the lower-side, since the β multiplier is only +0.2, much lower than the SUA.

3.6 Summary of Finding:

1) Shillong is essentially the creation of British and its growth depended closely with the growth of administration. During the colonial days, inroads made into the forest rich areas continued with the expansion of railways in Assam, and Shillong continued to thrive as an urban centre as a colonial out-post. This situation continued more or less unhindered till the two World Wars when exploitation of resources improved the road linkage mainly between Shillong and the other border-states gave a sudden boost to the city with an estimated 43.93 percent rise in the urban population.

2) Being the State Capital, it is the busiest administrative centre in the state. It also serves as one of the main commercial and institutional centre of the entire North Eastern Region. At present, the development of residences has spread in all the three directions along the major arteries namely, towards Mawiong in the north, upper Shillong to the southwest and towards Madanrting in the southeast (Table 3.2).

3) Shillong is one of the main commercial centres of the North Eastern Region. It has only 56.62 hectares, i.e., over 5 percent of the Municipal area under commercial use. The total area under administrative use is 117.93 hectares or over 10 percent of the total municipal area. The administrative area is concentrated in localities around Barik, IGP, Lower Lachaumiere (European Ward), etc. (better known as the Secretariat Complex).

4) The growth of population in the entire Shillong urban agglomeration is towards the fringe of the municipality, i.e., the township of Mawlai, Pynthorumkhrah and Madanrting which has been provided in Table 3.5.

5) The population projections for the Shillong Urban Agglomeration (SUA) as well as the Shillong Municipality were prepared that amply indicate the under-enumeration of the city population carried out by the Census of India, especially during the 2001 Census. The realistic urban population of the SUA is closer to half-a-million today than what has been provided by the Census 2001 (268,000), which is difficult to be used for a realistic city planning exercise, since what one plans for will be for half the population and thus, the city suffers from a perpetual shortage in water, sanitation as well as other essential services.

CHAPTER – IV

Sources of Solid Waste in Shillong Urban Agglomeration

4.1 Introduction:

Shillong Urban Agglomeration (SUA) is a combination of seven contiguous urban units (2001). The Shillong Municipality and the Shillong Cantonment are statutory bodies and the other five namely, Mawlai, Nongthymmai, Madanrting, Pynthorumkhrah and Nongmynsong, are only census towns without any local authority (ULB). The village committees (Durbars) within the units manage the census towns, with limited assistance from the Khasi and Jaintia Hills District Council, as well as the state government through the Department of Urban Affairs. The total population of SUA is 268,000 as per the 2001 Census, arguably a gross under-enumeration.[1] The rapid growth of population in SUA over the last decade has brought the functions of the state authority as service providers under a lot of strain. The five townships for example, have no local authorities; therefore, there is no accountability for sanitation. In townships of the Municipality and the Cantonment, the situation is no different although shade better, since the Government and concerned departments are directly responsible for the maintenance of sanitation. The Cantonment Board areas in the defence establishments are better off and relatively well managed despite the fact that modern methods are not applied in solid waste management. However, in the

[1] A recent household survey carried out AusAID (2004) puts the population figure in excess of 400,000! See Chap.III for projection and details on the subject.

civilian areas of Mawprem, Jhalupara and Barapathar the conditions could be the best described as appalling.

The objective of this chapter is to assess the ground situation on the basis of field data based on a study carried out on the theme. The data relates to a household survey of 125 households from different municipal and non-municipal areas to assess the nature, quantum of solid waste generated and the manner in which it is disposed by households and the town authorities.

4.2 Solid Waste by Source:

Solid waste is generated in urban areas from a variety of sources, like households, commercial establishments like shops, wholesalers etc, offices and educational institutions, government and private offices, hospitals and medical laboratories, and industrial units. Of these, hospitals industrial units are important, as they are mainly responsible for releasing Potential Hazardous Chemicals (PHC's) into the environment. It is mentionable here that industrial units have not been considered in this study, since Shillong has very few industries most of which are small or medium sized and their capacity for pollution is limited. Different sources produce different kinds of solid wastes and in varying quantities. Four categories were identified which are as follows:

(a) Households: 125

(b) Commercial Establishments: 11

(c) Institutions (Schools) / Offices: 10

(d) Hospitals: 6

The broad summaries of the types and quantities of waste, cost of management etc. have been provided under separate headings.

4.3 Solid Waste from Households:

Solid wastes from urban residential households is referred to as 'domestic waste' which is a by-product the of consumption activities of households, viz., shopping that generates package discards, food preparation and resultant vegetable waste, actual food consumption, house-keeping and kitchen-gardening etc. Further, consumption of durables may result in some periodic waste generation, including plastic packaging, wooden crates, cans and bottles that crop up in daily usage of processed food products. They also include periodic accumulation of old clothing and furnishings, damaged appliances, packaging and paper, books and reading materials.[2] Traditionally, the urban solid waste in developed countries contains a large proportion of paper and cellulose, and plastics used in packaging and an appreciable quantity of glass and metals from processed food consumption. Conversely, the composition in developing countries generally constitutes of degradable food residue and wet-waste (sewage). However, this may be changing in these countries as well. In recent times due to changes in income levels, food habits in urban areas have also changed significantly from home-cooked food to package and fast food. There has been a more than perceptible shift with respect to packaging from "utilitarian", to "promotional"

[2] A household may generate other types of wastes in nature of sewage and faecal materials through piping or pits into the environment and immediate neighbourhood, the soil and water bodies or even the local aquifer, which strictly does not come under solid waste and thus, are beyond the scope of the present study.

(advertisement) packaging. The salesperson's motto goes, "....what is packaged best, sells best."

4.4 Profile of the Households Surveyed:

A total of 125 households covering about 10 localities, were selected both from municipal as well as non-municipal (census towns) areas. This may be a relatively small sample compared to the population of nearly 70,000 households of the SUA. But suitably addresses the constraints on the researcher's time and resources. The sample selection is based on a broad, two-stage stratification. (a) Scheduled Caste and Scheduled Tribe population and the general population, and (b) by income stratification in terms of:

(i) the poor with annual household incomes below Rs.24000, conforming roughly to the official poverty line (BPL), (ii) the middle-income classes with annual income between Rs.24001-100000 and (iii) the high income classes with annual income above Rs.100000/-.

4.5 Sources of Solid Waste:

The solid waste generation depends on a number of factors such as income level, food habits, cultural traits, degree of modernisation of the society and level of urbanisation. Further, solid wastes vary widely in terms of their sources, viz., residential, commercial (including medical institutions) and industrial.

It is generally, agreed that higher (family) incomes strongly correlate with more than proportionate generation of waste. A number of factors were considered for primary data collection. Firstly, the household interview schedule was used to note down residents waste

disposal practices in relation to their socio-economic conditions and also find out their attitude towards solid waste disposal.

The data have been collected using random sampling method for 125 households from the following areas of Shillong Urban Agglomeration. These are Umpling, Happy Valley, Rynjah, Nongthymmai, Laitumkhrah, Motinagar, Laban, DonBosco Square, (Shillong Municipality), LalchandBasti (Nongmynsong) Madanrting and Mawlai (Non-Municipality).

4.6 Socio-Economic Background of the Respondents:

Table 4.1: Religious Background of the Respondents

Religion	Percent to total respondents
Hindu	56.00
Christian	40.80
Muslim	3.20
Total	100.00

Source: Data collected by the author, 2003-04

The above table reflects that majority of the respondents are Hindus (56percent) who are mainly distributed in Umpling, Happy Valley, Laitumkhrah, Motinagar, Laban, LalchandBasti. Christians come second (40.8 percent), most of who reside in Mawlai, Mawkhar, Nongthymmai, Pohkseh, Rynjah, DonBosco Square, Lachaumiere, Madanrting and Nongrim Hill. Muslims reflect a small share of respondents (3.2 percent) only.

Table 4.2: Community Background of Sample Households

Community	Percent to total respondents
Scheduled Caste	9.60
Scheduled Tribe	35.20
Others	55.20
Total	100.00

Source: Data collected by the author, 2003-04

Table 4.2 reveals that 35.2 percent of the total respondents were Scheduled Tribes while others were a majority, i.e., 55.2 percent. The Scheduled Caste population of the respondents is very small, i.e. only 9.6 percent.

Table 4.3: Family Type of Sample Households

Family Size	Percent to total respondents
Single	89.60
Joint	10.40
Total	100.00

Source: Data collected by the author, 2003-04

Out of the total of 125 respondents, the respondents believed that nuclear family system is best while only 10.4 percent favoured joint family system.

Table 4.4: Age Classification Respondent Household Members

Age-Group	Percent to total respondents
0-5	6.60
6-10	12.50
11-15	9.40
16-20	15.40
21-25	9.40
26-30	10.40
31-35	5.40
36-40	9.60
41-45	6.80
46-50	5.40
51-55	2.50
56-60	2.50
> 60	3.40
Total	100.00

Source: Data collected by the author, 2003-04

Of the 583 (total members of households surveyed) of the sampled respondents households, 19.1 percent were under the age 10, adolescents stood at 24 percent and 3.4 percent were more than 60 year's age group. It reveals that about 67 percent are in the working age group (here, between 21 and 60 years), which demographically a heartening situation, i.e. the Dependency Ratio is over 2 (DR = Population in working age-group to non-working population) (Table 4.4).

Table 4.5: Sex Ratio

Sex	Percent to total respondents
Male	46.8
Female	53.2
Total	100.00

Source: Data collected by the author, 2003-04

Table 4.5 shows that about 46.8 percent are males and 53.2 percent of them are females in the sampled households indicating that the sex ratio is 1184 females per 1000 males.

Table 4.6: Educational Qualification

Educational level	Percent to total respondents
Primary	17.40
Middle	19.50
Secondary	15.60
College	26.00
Professional	3.60
Illiterate	17.60
Total	100.00

Source: Data collected by the author, 2003-04

Table 4.6 reveals that of the total population of the surveyed households 17.6 percent are illiterate and 17 percent have studied up to primary level constituting around 35 percent of the population. Persons with Tertiary (college) education (26 percent) and professional education constitute 30 percent of the total population. Taken together, the bulk of the population (82 percent) of these households is literate, which is not unexpected in an urban situation in a city famous for its colonial linkages and various missionary organisation that traditionally have contributed to educating the local population.

Table 4.7: Occupational Structure

Occupations	Percent to total respondents
Government Service	43.60
Private Service	33.30
Professional	1.80
Technical	0.00
Self Employed	12.80
Daily Wage	8.50
Total	100.00

Source: Data collected by the author, 2003-04

Table 4.8: Annual Household Income

Income classes (Rs.)	Percent to total respondents
< 24000 (Below PL)	19.2
24001-100000 (Middle Income)	43.2
> 100000 (High Income)	37.6
Total	100.00

Source: Data collected by the author, 2003-04

Table 4.9: Income Classes of Respondents

Income Classes	Number of respondents	Percent to total respondents
Low Income (<24000/Yr)	24	19.2
Middle Income (24001-100000)	54	43.2
Higher Income (>100000)	47	37.6
Total	125	100.00

Source: Data collected by the author, 2003-04

Comparing Table 4.7 the largest occupational group comprises of government servants (43.6 percent). It conforms to the euphemistical reference that in the North East the largest industry is the Government. The second largest occupational group consists of those in private services (33.3 percent). This indicates that 87 % of the heads of the households are in some way connected with service occupations whether in private or government sectors. About 13 percent are self-employed. However, no one in the sample is employed as technician, but (1.8 percent) respondents have reported that they work as professional. It has been observed that a big segment of the households are daily wage earners (8.5 percent) whose annual income is less than Rs. 24000 (especially, in Nongmynsong) Table 4.8.

Tables 4.8 and 4.9 indicate that a bulk of the respondent households fall in the middle-income group (43.2 percent). The poor constitute around 20 percent and the about 37 percent in the high-income group (whose annual income is more than Rs. 100,000). Two things must be mentioned here: (i) we refer to household incomes and there may be more than one individual contributing to the household income, which is not unusual in the contemporary urban India; and (ii) in Government sectors, wherein about $1/3^{rd}$ of the respondents appear to be working (Table 4.7), even a grade-D employees may be receiving an annual salary over Rs.100,000 a year, after putting in 5-10 years of service. So, the income profile is not as unrealistic as it may appear at the first glance.

Table 4.10: Area of Residences

Living area	Percent to total respondents
Slum	20.80
Resident	79.20
Total	100.00

Source: Data collected by the author, 2003-04

Living conditions of the people mainly depends on their income and purchasing power. Table 4.10 shows that 79.2 percent of the respondents live in residential areas of Mawlai, Laitumkhrah, Umpling, Nongthymmai, Motinagar, Happy Valley, Laban etc.; only 20.8 percent live in slum areas of lower Laban, some areas of Laitumkhrah, Madanrting Umpling, Rynjah and LalchandBasti (Nongmynsong). This section of the people largely belongs to the low-income group and lives in very poor conditions and in unhealthy surroundings. Although there is rarely any serious residential segregation in the city, but none of the respondents were enumerated in commercial areas and there are no industries and therefore, no industrial area in the SUA.

Table 4.11: Ownership of Residences

Ownership	Percent to total respondents
Own house	40.00
Rented house	56.00
Others	4.00
Total	100.00

Source: Data collected by the author, 2003-04

Table 4.11 shows that, nearly 40 percent of the respondents reside in their own houses. Since, after the Land Transfer Special Act of Meghalaya, 1979 was brought into the statute books, non-tribal population under normal circumstances cannot by land in the state, except certain areas of the city, like (a) the European Ward, Kanche's Trace, Police Bazar and the Jail Road areas, that were technically purchased by the British the Syiem of Milliem and therefore, are "Crown Areas", beyond the purview of the Sixth Schedule of the constitution and (b) areas that are notified by the Govt for public purposes including setting up of industries by private companies, under the amended provisions to the above Act (1992). Consequently, a majority of the respondents (56 percent) live in rented houses. Small shares (4 percent) of the respondents are in other category, largely in official quarters.

4.7 Sanitary Methods Used by Households:

Table 4.12: Frequency of Cleaning in the Households

Frequency of leaning	Percent to total respondents
Once	43.00
Twice	48.00
Thrice	8.80
Total	100.00

Source: Data collected by the author, 2003-04

Among the respondents, large parts (43 percent) dispose off their household wastes at least once in a day whereas the majority (48 percent) dispose off twice a day. Interestingly, there are a small percentage of houses (8.8 percent) that clean their house, even thrice a day. None reported that they did not clean the houses every day.

Table 4.13: Time of Cleaning of Residences

Cleaning time	Percent to total respondents
Morning	54.80
Noon	2.30
After noon	11.40
Evening	33.30
Total	100.00

Source: Data collected by the author, 2003-04

The respondents have also displayed particular preferences with regard to the time of disposing their household wastes. Majority (54.8 percent) of the respondents reported that they clean their household in the morning followed by those who clean in the evening (33.3 percent). A negligible percent of the respondents clean the residences during mid-day (2.3 percent) and a further 11.4 percent, during the afternoons.

Table 4.14: Method of Disposal of Household Waste

Methods	Percent to total respondents
Immediately	56.00
End of the day	40.00
Other	4.00
Total	100.00

Source: Data collected by the author, 2003-04

From the Table 4.14 it is clear that a majority of 56 percent dispose off their waste immediately after cleaning the house whereas another 40 percent reported that they dispose off the waste only at the end of the day, when all the wastes have already been collected from the house.

Table 4.15: Type of Containers used for Collection of Waste

Containers	Percent to total respondents
Basket	20.80
Cardboard	4.00
Plastic bucket	36.80
Plastic bin	30.40
Others	7.20
Total	100.00

Source: Data collected by the author, 2003-04

Respondents also differ in terms of their selected mode of waste disposal (Table 4.15). About 36.8 percent of the respondents reported that they use plastic buckets for collection of their household (solid) waste; 30.4 percent reported use of plastic bins and about 20.8 percent use (bamboo) baskets for collection of household waste.

Table 4.16 indicates that nearly 64 percent of the respondent households have their own dustbins, used for daily collection and disposal of their domestic solid waste. The remaining 36 percent do not have their own containers for waste collection and use community or municipal bins/ collection points.

Table 4.16: Designated Places for Waste Disposal

Places	Percent to total respondents
Open space in front of the house	8.80
Open space backside of the house	54.40
Own waste bins	0.80
Sub-total (Self)	*64.00*
Street-side bins	7.20
Outside collection points	21.60
Waste hopper	1.60
Others	5.60
Sub-total (Public facility)	*36.00*
Total	100.00

Source: Data collected by the author, 2003-04

In some localities like Mawkhar and Laban, private agencies are engaged in the collection of household wastes. The private scavenging service providers dispose of the household wastes for a nominal monthly payment. On the other hand, the Municipality offers its services by periodically sending small trucks and disposal vans for removing the waste from the Municipal collection points. However, the system of collection of solid waste is confined to the Municipal area (and the defence areas of the Shillong Cantonment Board). Only after the AusAid project interventions (2003-05) that on experimental basis and with donation of 7 tractors with double trailers (by the project) that the Urban Affairs department extended the services (once or twice/ week) to the non-municipal townships, with designated collection time and points. This certainly has been a positive movement in disposal of the solid-waste of the city.

Table 4.17: Frequency of Collection by Public Agency (Municipality)

Collection	Percent Respondents
Daily	26.90
Alternative Day	26.90
Once in a week	21.10
Once in a month	1.90
No regular collection	23.00
Total	100.00

Source: Data collected by the author, 2003-04

Table 4.17 According to nearly 27 percent of the respondents, the Municipality collects wastes on a daily basis. By all means, these respondents live in the main residential areas of the city. Another 27 percent reported municipal solid-waste disposal service on alternate days. Twenty-three percent of the respondents report no regular access to this service, whereas another 21 percent are availed the same only once a week. In deed, prior to 2005, there was no public municipal waste disposal system in the non-municipal townships. In most of the cases (76 percent), Lorries are used for collection of the solid waste while in about 9 percent cases, it is the van only (Table 4.18). It may be mentioned that Shillong boasts of the first major PPP (Public Private Partnership) project in the entire North-East region for urban solid-waste management, with a private company, Andersons who have been running a waste processing plant at Mawiong with a degree of success, producing usable high quality organic manure, for which there is good demand by the local farmers. The interesting part is that they also have a waste collection system from the city in selected non-municipal areas, free of cost.

Table 4.18: Vehicles used for Solid-Waste Collection

Vehicle	Percent to total respondents
Van	9.10
Lorry	76.00
Dumper	3.00
Other	12.10
Total	100.00

Source: Data collected by the author, 2003-04

Table 4.19: Time of Cleaning by Public Agency

Time	Percent to total respondents
Morning	73.70
After Noon	7.90
Evening	2.60
Irregular	15.80
Total	100.00

Source: Data collected by the author, 2003-04

In the city, the Municipality does most of its cleaning in the morning as is claimed by majority of the respondents (73.70 percent), before the working hours start. The rounds are conducted in two shifts: one in the morning between 6 a.m. to 10 a.m. and one at noon around 12 noon. Most of the workers are permanent employees in the Conservancy Department (of Shillong Municipal Board or Shillong Cantonment Board). A small proportion of the workers are daily wage labourers or part-timers/ contract workers, since there are government moratoriums on regular recruitments of grade-D staff.

4.8 Solid Waste Disposal by Households:

Nearly 90 percent of the households recycle waste in some manner or other; some sell the waste, especially newspapers, bottles and metallic wastes, bought by a whole self-

employed group of people known as "kabadwallah" or waste-buyer, a term prevalent the whole length and breadth of India, without exception, who move around the lanes and by-lanes of towns and cities, from morning till evening, even into neighbouring rural areas, at one hand providing a recycling service to the city, and on the other, generating incomes. Though no accurate information is unavailable, but estimates indicate the recycling industry in India may run into around Rs.10000/- crores (US$ 2 billion). In case of metal/old utensils, 78.5 percent of the respondents sell the waste and about 20.4 percent discard it. In terms of cloth wastes, 51.3 percent recycle and reuse them while nearly 4 percent discard them. As regards the management of plastic/bottle, most of the respondents (75.5 percent) generate some income by selling them, while 21.3 percent discard them totally (Table 4.20).

Table 4.20: Uses of Domestic Solid Waste

Items	Discard	sale	reuse	Total
	percent	percent	percent	percent
Newsprint	2.80	89.60	7.50	100.00
Old Clothes	4.00	44.60	51.30	100.00
Plastics/Bottles	21.30	75.50	3.00	100.00
Metal/Old Utensils	20.40	78.50	1.00	100.00

Source: Data collected by the author, 2003-04

Residents of Shillong city love gardens in their houses, a tradition inherited from the Raj days and partly, the salubrious climate allows healthy growth of a variety of tropical and temperate flowers, fruiting trees and vegetables to grow around the year, with the exception of the winter three months (December to February). Much care is taken of their gardens and flower plants. Table 4.21 shows the distribution of waste disposal from the gardens (yard-waste).

Table 4.21: Disposal of Yard Waste

Methods	Percent to total
Dumping	31.72
Composting	14.48
Burning	53.79
Total	100.00

Source: Data collected by the author, 2003-04

From the Table 4.21, it has been observed that more than 50 percent of the respondents burn the yard waste, especially several times a year during the dry season, while about 31.72 percent dump the waste either in the backyards of their houses or nearby *nullahs*[3] and natural drainages, in which city abounds, leading to shrinkage of the drains and pollution of the limited water bodies. But, still about 15 percent of the households use green materials and yard wastes for composting, recycling them as manure for flower or vegetable plants, a very healthy practice worth emulation by others as well. Naturally, such practices are not possible for tenants as well as residents in densely populated areas.

Table 4.22: Collection of Yard Waste

Frequency of Collection	Percent to total
Daily	3.95
Alternative-days	6.58
Twice in a week	55.26
Once in a month	21.05
Not regular	13.16
Total	100.00

Source: Data collected by the author, 2003-04

[3] These are minor natural drainage lines/ stream within the city, now *de facto* converted to storm-water drains.

Majority (55.26 percent) of the residents collect their yard wastes on a bi-weekly basis, followed by those (21.05 percent), who collect it once in a month. A significant 13.16 percent of the people are not regular in disposing while about 6.58 percent have reported that they collect the garden waste on alternate days and a small section (4 percent) of the respondents collect their garden waste daily.

Table 4.23: General Attitude of Respondents towards the Problem of Solid Waste

Degree of Seriousness	Percent to total
Very serious	51.20
Serious	32.80
Somewhat serious	11.20
Not much serious	3.20
Not serious	1.60
Total	100.00

Source: Data collected by the author, 2003-04

The table 4.23 shows that an overwhelming 84 percent of the respondents think that the problem of solid waste management in Shillong is a serious one and that it requires better management. They expect a more sensitive attitude of government authorities to deal with this problem.

Table 4.24: Efficiency of Conservancy Services

Degree of Efficiency	Percent
Very poor	42.15
Poor	38.84
Satisfactory	19.01
good	0
Total	100.00

Source: Data collected by the author, 2003-04

The efficiency of conservancy services in the city is also reported to be poor or very poor (81 percent). Conversely, only 19 percent appears to be satisfied with the services (Table 4.24).

Table 4.25: Municipal Provisions for Collection Points

Collections points/ bins provided	Percent
Provision available	4.92
Not available	95.08
Total	100.00

Source: Data collected by the author, 2003-04

Almost the entire respondents (95.08 percent) report no access to dustbins/ dumping site in close proximity within the localities provided by the municipality. It's only a dismally low 4.92 percent of the people who report of availing this facility. This reveals the slack of attitude of the municipal regarding the issue of sanitation (Table 4.25). Whereas the public agencies clearly have not provided an adequate number of dustbins in many areas, the residents often do not make proper use of the dumping sites.[4]

Table 4.26: Response of Municipal Agencies

Response of Municipal Agencies	percent
Immediately	0
Little late	28.97
Late	34.58
No response	36.45
Total	100.00

Source: Data collected by the author, 2003-04

[4] It may be noted that the Aus Aid project did create a large number of dumping points as well as redesigning and construction of dumping platforms, largely prior to the surveys were conducted.

Respondents of complain about the apathy of public agencies in providing with conservancy services, even after repeated complaints from localities directly under their jurisdictions. Table 4.26 indicates that in more than one-third cases, there is no response, but in another one-third response is late. On the other hand, there is no immediate response to conservancy complaints.

4.9 Commercial Waste:

Quality of urban life and functional efficiency of towns are dependent on proper disposition of activities and the interrelationship between various functions. Shillong Urban Affair Department, Government of Meghalaya, Shillong[5] conducted a detailed land use survey to identify the incompatible activities influencing the city life.

The commercial area of the city with its core in Barabazar and Policebazar extend along the major roads due to lack of space. Increased activities in the main commercial areas has created problem of traffic congestion. Many parts of the commercial centres lack any organised system of disposal of solid wastes and most shopkeepers dump commercial wastes on the street corners, sewer lines and adjacent *nullahs* etc clogging the city drainages.

Solid wastes that are generated from commercial establishments are of diverse nature. In order to assess the nature and magnitude of commercial wastes a separate schedule was used in the primary survey which covered 11 commercial establishments of different categories throughout the city, on a purposive sample basis[6].

[5] Master Plan of Greater Shillong, 1991-2011, Dept. of Urban Affairs, Govt. of Meghalaya, Shillong, P.15

[6] No random or stratified random sampling was possible, since no secondary information is available on the number of such commercial establishments or the type of commodities dealt by them.

The type, size, structure and function of these establishments are quite important since these directly influence the amount of solid waste generated[7]. The primary survey of 11 establishment surveyed reveal that they are of different sizes and types. There are Groceries, Stationers, Vegetable vendors, Hardware stores, Medical retailers and others. (Table 4.27), 36.4 percent (4 samples) are wholesale's and the remaining 54.5 percent (6 samples) retailers, and (1 sample) 9 percent of the commercial are individual units.

Table 4.27: Types of Trade of Commercial Establishments

Nature of trade		percent
Wholesale	04	36.36
Retail	06	54.55
Others	01	9.09
Total	11	100.00

Source: Data collected by the author, 2003-04

4.9.1 Category of Articles Traded:

There are different commercial articles ranging from wholesalers, provision storekeepers, vegetable vendors and drugs and pharmaceutical stores etc (Table 4.28).

Table 4.28: Trade Articles

Number of trades		Percent
Grocery cum stationery	05	45.54
Vegetable	02	18.18
Hardware	01	9.09
Medical	02	18.18
Others	01	9.09
Total	11	100.00

Source: Data collected by the author, 2003-04

[7] Environmental Protection Agency (EPA), Sept.'93 reporting on *Management of Solid Waste a Local Issue* (Incomplete reference!!)

The shops covered are in different types of buildings; two-thirds are in single storied buildings and the rest are in shopping complexes (Table 4.29).

Table 4.29: Nature of Buildings

Nature of building	percent
Single storied units	66.70
Shopping complexes	33.30
Total	100.00

Source: Data collected by the author, 2003-04

Table 4.30: Ownership of Properties

Properties	Percent
Owned	20.00
Rented	80.00
Total	100.00

Source: Data collected by the author, 2003-04

4.9.2 Land Use in the Commercial Areas:

In the designated main commercial areas, the land use is also mixed, i.e. 56 percent of the land use is of commercial type and the rest devoted to residential purposes (Table 4.31); there are no industrial or other activities, except repair establishments of various types.

Table 4.31: Land Use

Land use	No.	Percent
Residential	7	43.75
Commercial	9	56.25
Total	16	100.00

Source: Data collected by the author, 2003-04

4.9.3 Schedule of Conservancy Services in Commercial Areas:

The frequency of cleaning varies with the type of commercial activity. Table 4.32 shows that, 47.6 percent of the responding units cleans in the morning, 24 percent in the evening, 19 percent afternoon and 9.4 percent of commercial establishments clean their respective commercial wastes at night. It may be noted, that the cleaning cycles in commercial establishments will differ depending on the type of goods and services dealt with; where as some type of activities may require once-a-day cleaning, others like restaurants and hotels may need several cycles of conservancy services, by their own staff.

Table 4.32: Schedule of Conservancy Services

Nature of cleaning	Percent
Morning	47.60
Afternoon	19.00
Evening	24.00
Night	9.40
Total Frequency	100.00

Source: Data collected by the author, 2003-04

Disposal of commercial waste varies in methods of dumping, burning and composting etc. The table 4.33 shows that most of the commercial waste (100 percent) is dumped at some nearest points or simply left in front of the shops to be lifted by the conservancy staff next morning. There appears to be no specific municipal by-laws in management of solid waste in commercial areas as the Municipal By-laws of Assam were adopted into-to by the State of Meghalaya in 1971, that definitely are dated and need amendments so as to make them responsive to current situation in the cities.

Table 4.33: Methods of Disposal of Commercial Waste

Disposal method	Percent
Dumping	100.00
Burning	NA
Composting	NA
Total	100.00

Source: Data collected by the author, 2003-04

Table No 4.34: Type of Container for Collection of Waste

Containers	Percent
Basket	18.1
Card-board box	63.6
Sacks	9.1
Plastic- bin	9.1
total	100.00

Source: Data collected by the author, 2003-04

Collection of solid-waste by the municipality services in commercial areas appears to be a free of cost service. For a few large establishments, the conservancy services is provided on monthly payment of a fixed sum of money. The containers used for collection and storage of the solid waste are not very different from those used in residential areas. Card board boxes are preferred by 63.3percent of units, 18.2 percent use baskets; the establishments make their own arrangements, as per their own convenience (Table 4.34).

4.9.4 Disposal of Commercial Waste:

Most of the shops & establishments dump refuses in open spaces–in front of the establishments or behind it or at the nearest bins and collection points or use common storages or collection points outside the immediate area (Table 4.35). Almost 36.3 percent dump garbage in collection points outside their immediate locale, 27.3 percent of the units

Plate No-3 Road Side Dumping Site, Paltan Bazaar

Plate No-4 Road Side Dumping and Burning Site, Pohkseh

choose the open space behind their establishments, 18.2 percent use street dustbins. There is apparently no system of accountability on part of the owner/management of the commercial establishment for collection and disposal of the solid-waste, nor any specified method that addresses the issue.

Table 4.35: Dumping of commercial waste

Dumping sites	percent
Open space in the front	9.1
Open space-backside of the unit	27.3
Street side dust-bin	18.2
Common storage	9.1
Outside collection	36.3
Total	100.00

Source: Data collected by the author, 2003-04

4.9.5 Sanitation in Commercial Establishments:

Different commercial establishment have part-time and/or full time sweepers/ cleaning staff (Table 4.36); of the 11 sample establishments of commercial establishments surveyed 8 (62.5 percent) had full time cleaning staff on rolls and the balance (3 samples) part-time staffs.

Table 4.36: Staff for Sanitation of Establishments

Staff	**percent**
Part time	37.50
Full time	62.50
Total	100.00

Source: Data collected by the author, 2003-04

Most of the commercial wastes are removed by the municipal services as well as labourers engaged by the shopkeepers (Table4.37); 64.3 percent cases, the waste are

removed by labourers of the commercial establishment and in 35.71 percent case by the municipal conservancy services.

Table 4.37: Removal of Solid Waste

Removal of waste	Percent
Own labourers	64.30
Municipality	35.70
Private agency	0
Others	0
Total	100.00

Source: Data collected by the author, 2003-04

Solid Waste collection and disposal services in commercial areas appear to be a free service by the municipal conservancy department; only in a few large establishments this is carried out on payments.

Table 4.38: Schedule of Cleaning

S No	Time of cleaning	Percent
1	Morning	53.00
2	Afternoon	29.40
3	Evening	17.60
4	Night	0
5	Total	100.00

Source: Data collected by the author, 2003-04

The schedule and frequency of cleaning varies at different times of a day (Table 4.38); 53 percent in the morning, 29.41 percent in the afternoon, and the rest, in the evening by the local authority. In 90 percent cases the commercial establishments report daily collection of commercial solid waste by the local authorities and in 10 percent of cases; the collection is on alternative days (Table 4.39). This is amazing, considering the overall dismal picture of solid-waste collection in residential areas of the city! Discrete enquiry

reveal, the obvious—the system works because the shop keepers regular pay "incentives" to the conservancy staff—reason enough for reasonably prompt services rendered.

Table 4.39: Frequency of Collection of Commercial Waste

Frequency	Percent
Daily	90.00
Alternative-day	10.00
Total	100.00

Source: Data collected by the author, 2003-04

In 20 percent of the commercial establishments, the waste is re-traded/ recycled, especially of metallic materials, cardboards and other packaging materials depending on the natures of goods and services dealt by the particular establishment (Table 4.40).

Table 4.40: Recycling Waste by Commercial Establishments

Recycling	Percent
Yes	20.00
No	80.00
Total	100.00

Source: Data collected by the author, 2003-04

4.10 Institutional Waste:

Institutions mean here, educational, private and the Government administrative institutions of the Shillong. The city has a large number of educational institutions from schools for children to higher secondary schools (earlier known as Boarding Schools during the British times), about 25 colleges, the University, many private computer and coaching schools, large number of State and Central Government offices, many missionary organisations, theological societies and their offices etc—in deed, it will be fairly safe to say, Shillong is a city of institutions. These institutions contribute a considerable amount of

Plate No-5 Road Side Dumping Waste, Rynjah

Plate No-6 Throwing the Waste in the Umkhrah River

solid waste to the total wastes generated by the city. Among the 10 (purposive) sample institutions chosen for study, 4 samples are of Central Government organisations, 2 samples from the State Government and the balance 4 samples belong to private organizations. The institutions are mostly educational and research institutions with a minimum of staff strength of 32. Solid waste generation varies with the (user) size of the institution, between 5 to 120 Kg./day.

4.10.1 The Buildings and Premises:

The buildings of the institutions studied depend upon their user-sizes and functions they perform (Table 4.41). About 20 percent of the institutions studied are in single unit buildings and the rest of the 80 percent are in (40 percent multi-storeyed and 40 percent with independent premises) multi-storeyed, independent premises.

Table 4.41: Buildings & Premises

Type of Structure	Percent
Single Unit	20.00
Multi-storeyed	40.00
Office complex	0
Campus	40.00
Total	100.00

Source: Data collected by the author, 2003-04

Staff strength of the institutions varies from 09 to 30 and more than 60 (Table 4.42), as well as the student's strength, depending on if they are schools or colleges.

Table 4.42: Staffs and Students Strength

Institutions	No of staff	percent	No of students	percent
St. Edmund's College, Jowai Rd.	60	9.4	1600	20.7
K.V. Happy Valley	65	10.2	1500	19.4
St. Mary Girl School, Don-Bosco Point	65	10.2	2500	32.3
St. Thomas School, Nongthymmai	60	9.4	1300	16.8
K.V.Laitkor	25	3.9	820	10.6
S.B.I, Laitumkhrah	60	9.4	NA	NA
NEIGRIMS, Mawpat	170	26.7	NA	NA
Urban Affair Dept., IGP	92	14.4	NA	NA
Second Meghalaya N.C.C	09	1.4	NA	NA
DonBosco-technical Institute,	30	4.7	NA	NA
Total	636	100	7720	100

Source: Data collected by the author, 2003-04

4.10.2 Time and Frequency, Collection and Disposal of Solid Waste:

The frequency of cleaning inside the buildings varies from institution to institution depending on the timings of principal activities. In 50 percent of cases the cleaning is carried out in the morning, 35 percent cases, in the evening and for the rest, during the afternoons. (Table 4.43) as well as outside the building 50 percent cleaning in the evening, 40 percent cleaning in the morning and rest of 10 percent only afternoon only.

Table 4.43: Cleaning Schedule and Frequency in the Institutions (inside and outside)

Time of cleaning	Inside the building	Out side the building
	Percent	Percent
Morning	50.00	40.00
Noon	5.00	0
Afternoon	10.00	10.00
Evening	35.00	50.00
Total	100.00	100.00

Source: Data collected by the author, 2003-04

Around 61percent of the educational institutions are provided with one dustbin for each classroom. Common dustbins for each building are found 30 percent of cases and but, only in 1.27 percent cases that there are any adequate system of SW collection for the whole building (Table 4.44)—this is quite amazing considering that even public institutions are insensitive to effective solid waste management within their own premises, leave aside the city as a whole!

Table 4.44: SW Collection System within the Premises of Institutions

Dust bins/ Bins	Percent
Separate dust bin in each table	1.27
Common dust bin for each section	6.35
Common dust bin for each bldg.	30.00
Separate dust bin for each room	61.00
Common dust bin outside bldg.	1.27
Total	100.00

Source: Data collected by the author, 2003-04

Most of the institution use widely different types of containers like plastic buckets, tin-bins, bamboo-baskets and cardboard boxes (Table 4.45). The number of containers varies with the size of the institution and is proportional to the number of staff/ workers/ users in it. Plastic containers are popular because they last long, lighter in weight and easy to clean and reuse, accounting for 79.6 percent of the containers. The sizes of the container range from 5 to 20 litres, which is too small for offices and bigger premises, the prescribed norms are 500 l. containers.

Table 4.45: Container Used

Type of containers	Percent
Plastic bucket	79.60
Tin-bins	18.50
Bamboo Baskets	1.45
Cardboard Boxes	0.36
Total	100.00

Source: Data collected by the author, 2003-04

Most of the Educational Institutions follow different methods of disposal of their solid waste (Table 4.46); 54 percent by burning and 46 percent dumping the waste at designated places.

Table 4.46: Method of Disposal of Solid Waste

Disposal methods	Percent
Dumping	46.20
Burning	53.80
Total	100.00

Source: Data collected by the author, 2003-04

Table 4.47: Method of Disposal

Disposal method	Percent
Dumping at open space in front	10.00
Dumping at open space at back side	10.00
Street-side Bin	20.00
Own dumping site/ storage facility	50.00
Others	10.00
Total	100.00

Source: Data collected by the author, 2003-04

Of the total 10 institutions surveyed, 50 percent dispose-off the solid waste in their own facility and others use a mix of a variety of inexpensive, but thought- less method to dispose the solid waste (Table 4.47).

The 10 institutions studied engaged a total of 36 staff, 20 full-time sweepers/cleaners and the rest as attendants for cleaning and disposing of the solid waste within the premises in addition to other duties as well (Table 4.48). It appears that more than 90 percent of cases the SW management is entirely dealt by the institutions themselves with limited access to the public/ municipal agencies. However, it may be noted that majority of the institutions studied are located in non-municipal areas.

Table 4.48: Staffs Engaged for Waste Collection

No of person employed	No	Percent
Sweeper	20	55.56
Attendant	16	44.44
Total	36	100.00

Source: Data collected by the author, 2003-04

4.11 Hospital Waste:

Bio-medical wastes (from hospitals and diagnostic centres) includes both solid and liquid wastes generated during diagnosis, treatment or immunization of humans or animals or in research pertaining thereto or in the production of testing thereof. As per prescribed norms of IMC and other supervising bodies and appropriate laws[8] in this regard, such waste must be handled, stored and disposed with utmost care since any improper handling or disposal may create a public health hazard, especially in cities where a large number of people live in close proximity of each other.

There are 11 hospital/nursing homes, 20 dispensary clinics/pathological laboratories, and (1) one veterinary hospital in Shillong. Inventory of bio-medical waste generation from

[8] The Bio-medical waste (Management and Handling), Rules 1998 and (Bio-medical waste disposal rule made by the ministry of environment and forests under the Environmental Protection Act 1986, vide Notification No.SO.746 (E), dated 16th October 1997.

hospitals/nursing homes are estimated on the basis of number of beds and assuming the average generation of infectious bio-medical waste of 250 grams per bed per day as shown in Table (4.49).

Table 4.49: Number of Beds and Estimated Quantity of Bio-medical Waste in Shillong

Name of hospital/Nursing home	Estimated Quantity of Bio-medical waste generation (Kg/day)	Percent
R.P Chest Hospital	54.25	9.52
Civil Hospital	100.00	17.50
Ganesh Das Hospital	100.00	17.50
K.J.P. Synod Hospital	87.00	15.26
Military Hospital	74.25	13.00
Nazareth Hospital	87.50	15.35
Woodland Hospital	30.00	5.26
Bethany Hospital	7.50	1.32
Sankar Hospital	16.25	2.95
Park View Hospital	5.50	0.96
NENGRIMS Hospital	7.50	1.32
Total*	569.75	100.00

Source: Meghalaya Pollution Control Board, Hospital Management Manual, Shillong 2000,
* the Mental Hospital was left out since no data was reported)

Both secondary and primary data were analyzed and compared, after categorizing the waste and after a thorough understanding of the amount, nature and method of bio-medical waste management by the city hospitals/ nursing-homes. (Table 4.49) shows that different hospital /nursing homes are producing different amount of wastes.

The researcher studied in detail 6 of the 12 hospitals/dispensaries in regards to the solid waste management systems they use. The hospitals are: Civil Hospital, Military Hospital, Nazareth Hospital, Ramakrishna Mission Charitable Dispensary, Bethany Hospitals and Ganesh Das Hospital.

4.12 Staff in Position:

The number of staff working in various levels in the surveyed hospitals have been summarized in Table 4.50 and during the survey it has been observed that the number of wards, number of beds, and in-patients and outpatients. The number of wards varies from one to 13.

Table 4.50: Total Staffs Strength in Surveyed 6 Hospitals

Staffs Strength	No.	Percent
Doctors	119	19.07
Nurses	230	36.86
Attendant	133	21.31
Administrative	41	6.57
Technical	41	8.57
Waste disposal	60	9.62
Total	624	100.00

Source: Data collected by the author, 2003-04

It has been observed that the Table 4.50 that 19.07 percent are Doctors, 36.86 percent, nurses, 21.31 percent attendants, 8.57 percent Technical staff, 6.57 percent administrative staff, and the balance 9.62 percent are sanitary and conservancy staff in the hospitals surveyed

Table 4.51: Bed Capacity of Hospitals

Bed Capacity	No.	Percent
Civil Hospital	400	24.14
Military Hospital	297	17.92
Nazareth Hospital	400	24.14
Bethany	100	6.03
Ganesh Das	460	27.76
Ramakrishna Mission Disp.*	0.0	00.0
Total	1657	100.00

Source: Data collected by the author, 2003-04

* Not hospital with in-patients

All the Government hospitals (including military hospital) and private hospitals have bed capacity varies from 100 to more than 400. Among the 6 sample of hospitals three have more than 400 beds, two have 297 & 100 beds, respectively and one is not a hospital but has out-patient facility only (Table 4.51).

4.52: Average No of In-Patients and Out-Patients/day

Name of the Hospitals	No. of in-patient		No. of out patient per day	
	No	Percent	No	Percent
Civil Hospital	500	40.32	300	22.72
Military Hospital	40	3.22	120	9.09
Nazareth Hospital	250	20.16	300	22.72
Bethany	50	4.03	100	7.57
Ganesh Das	400	32.25	200	15.15
Ramakrishna Mission Dispensary	00	00	300	22.72
Total	1240	100.00	1320	100.00

Source: Data collected by the author, 2003-04

Number of inpatient varies from 3 to 4.03 percent (40 to 50 patients) in Military Hospital and Bethany Hospital, 40.32 percent (500 patients) in civil hospital, 32.25 percent (400 patients) Ganesh Das Hospital, 20.16 percent (250 patients) Nazareth hospital (Table 4.52), variation depending on the hospital size, available facilities, bed capacity and staff. In addition, number of in-patient/out-patients, and numbers of health services available in hospitals are also important in the assessment of waste generation.

4.13 System of Solid Waste Management in Hospitals:

Most of the hospitals use different times for cleaning; 42.8 percent cleaning in the morning, 28.57 percent evening 21.43 percent afternoon, and only 7.14 percent at night (Table 4.53).

Table 4.53: Frequency of Internal Cleaning in the Hospitals

Time & frequency	Percent
Morning	42.83
Noon	0
Afternoon	21.43
Evening	28.57
Night	7.14
Total	100.00

Source: Data collected by the author, 2003-04

Hospital wastes are stored in many kinds of receptacles, waste paper baskets, garbage bins, empty oil drums, laundry hampers, plastic buckets and even, on the floor. The study has found that 93.3 percent of the (Table 4.54) hospitals use plastic containers for refuse storage and others use tin and metal bins and concrete bin for outside refuse storage. Central storage of solid waste is generally kept outdoors. In addition, storage areas at many hospitals are unsightly, highly soiled and accessible to insects and rodents. A majority of the hospitals have only one central storage location. Carrying waste by hand is the primary means of waste disposal and in most of the hospitals mechanical system of refuse handling is very rare. In 93.3 percent cases, plastic and plastic buckets were used as container to storage of refuse. In wards and along beds tin containers are kept (4.68 percent) and in 2.0 percent cases concrete bins are used for storage of refuse outside collection points (Govt. run hospitals like, the Civil Hospital, Ganesh Das Hospital and Military Hospital etc).

Table 4.54: Containers Used for Storage Refuse

Container	Percent
Plastic bin	83.96
Plastic bucket	9.35
Tin	4.68
Concrete bin	2.00
Total	100

Source: Data collected by the author, 2003-04

Table 4.55: Sites of Disposal

Place of disposal	Percent
Open space front	7.69
Open space back side	23.08
Street dust bin	15.38
Curb-side collection	15.38
Common storage	38.46
Total	100.00

Source: Data collected by the author, 2003-04

Most of the hospitals dispose their waste in different way: 38.46 percent at common storage in the hospital, 15.38 percent curb-side collection points, 15.38 percent street-side bins, 30 percent open space around of the hospitals (Table 4.55).

Practically, there is no processing of the solid waste prior to its final disposal and waste one simply dumped, against clear regulations in this regards and orders of Govt of India, Ministry of Environment and Forest and the health Ministry. However, the Civil Hospital, the Military Hospital, Ganesh Das Hospital have incinerator facilities. The private hospitals in the city have no incinerator facilities. Where ever, the incinerators exist, there are no operators, the operators are not skilled to use them, or they are simply not run, only kept as show pieces just for legal compliance, with no intention of the hospital management to use them for the purpose they were procured. There is also no inspection by the state

health officials, to the effect if recommended solid waste packages are being followed in the hospitals. In a general sense, there is apathy—no one cares, though this is fraught with danger for the entire city.

Table 4.56: Removal of Waste

Removal of waste by	No	Percent
Hospital authority	4	57.14
Municipality	2	28.57
Private	0	Nil
Cantonments Board	1	14.29
Total	7	100

Source: Data collected by the author, 2003-04

A variety of potentially hazardous waste generated in the hospitals are too often simply disposed off, mixed with other wastes, and hauled away without any care or concern for public health. Chemical wastes are generally intimately mixed with other wastes, which are present as a contaminant; 57.14 percent of the waste removed by the hospital authority 28.57 percent of the waste removed by municipality, and only 14.29 percent waste removed by the Cantonments Board (Military Hospital) (Table 4.56).

Except the Government hospitals, the private hospitals/nursing homes pay a minimum of Rs.200 to 400 rupees per month special fee to the Municipality. The local authorities collect solid waste from the hospitals on daily basis continuously rounds the clock. However, the remaining hospitals/dispensaries and health clinics, dentists chambers, diagnostic centres that deal with body fluids in one way or other do not conform to any municipal, health or environmental regulation and simply dispose the waste in street-side

bins or community bins or curb side collection points with complete disregard to threat to public health.

Table 4.57: Mode of Transport, Trip/Week

Health Units	Mode of *transport*	No. of *trips/week*	Percent
Civil Hospital	Lorry	21	45.6
Nazareth Hospital	Lorry	08	17.3
Military Hospital	Lorry	12	26.0
Ramakrishna Mission Dispensary	Lorry	03	6.5
Bethany Hospital	Lorry	01	2.1
Ganesh Das Hospital	Tractors	01	2.1
Total		46	100.00

Source: Data collected by the author, 2003-04

4.14 Method of Transport and Disposal:

There are different modes of transport used to carry hospital waste collection, disposing and treatment: in 83.3 percent cases, only lorry is used to carry the waste to disposal site, in 45.6 percent trip per week are made by Govt. Civil Hospital, 26.0 Percent by the Military Hospital, 17.3 percent Nazareth Hospital, 6.5 percent by Ramakrishna Mission charitable Dispensary. Both Ganesh Das and Bethany hospitals have poor management of handling the hospital waste.

4.15 Quantity of Waste by Source:

The sources of solid waste in hospitals are General nursing floors, surgical departments, pharmacy, laboratories, emergency, office including yards, dietary and service areas (Table 4.58), According to the report on "Planning for hospital sanitation" the average

wastes generated by a patient in major metropolitan city hospital was 1 to 1.5 kg/day, which is much lower than in western countries. Where, it is more than 4 kg/day. But Shillong city compared to our Indian cities, is producing only 250 gm/bed/day[9].

Table 4.58: Sources and Quantity of Waste in KG

Sources of waste	No. in KG.	Percent
General Nursing	20	5.97
Surgical	46	13.73
Maternity	62	18.51
Laboratory	50	14.93
Administration	68	20.3
Dietary	30	8.96
Mixed unknown	59	17.61
Total	335	100.00

Source: Data collected by the author, 2003-04

Administration account for about 20.3 percent of the total waste followed by maternity with 18.51 percent, laboratory about 14.93 percent, mixed unknown about 17.61 percent, surgical about 13.73 percent, dietary 8.96 percent and General Nursing only 5.97 percent generate solid waste. Solid waste generated not only varies with hospitals but also within the hospitals. For example, unit such as Administration, maternity and laboratory produce large quantities of wastes. Unit handling dietary, surgical and general nursing produce fewer amounts of wastes. The composition of waste is combustible rubbish amounts 25 percent of the total weight. Garbage waste discharged accounts for approximately 29 percent, followed by non-combustible rubbish about 9 percent. At most hospitals, combustible rubbish is probably associated with at least small amounts of microbiological and chemical contamination. Food wastes, on the other hand not

[9] Sources: Meghalaya state Pollution Control Board, *Hospital Management Manual*, Shillong 2000.

necessarily contaminated, although they can putrefy and attract insects and rodents. The various kinds of potentially hazardous wastes produced in hospitals pose special problems (Table 4.58).

Table 4.59: Present Practices of Treatment of Disposal of Bio-medical Waste in Shillong

Name of Hospital	Infectious waste	Non-infect-ious waste	Infectious	Non-infectious
R.P.Chest Hospital	Chemical disinfection shredding	NA	Opening burning and deep burial	Along with municipality SW
Civil Hospital	-do-	NA	Deep burial	Along with municipal solid waste
Ganesh Das Hospital	Chemical disinfection	NA	Open burning & deep burial	-do-
K.J.P. Synod Hospital	-do-	NA	Sceptic tank	-do-
Military Hospital	Chemical disinfection, autoclaving, shredding	NA	Incineration & deep burial	-do-
Nazareth Hospital	Chemical disinfection	NA	Open burning deep burial	-do-
Woodland Hospital	Chemical disinfection, shredding	NA	-do-	-do-
Bethesda Hospital	Chemical disinfection, mutilation, autoclaving shredding	NA	Incineration & deep burial	Along with municipal solid waste
Sankar Eye Hospital	Chemical Disinfection	NA	Open burning & deep burial	Land filling
Park view Hospital	Chemical disinfection	NA	NA	Along with municipal solid waste
NEIGRIHMS	Chemical disinfection	NA	Open burning and deep burial	Land filling
Minhans(Mental hospital)	Not available	NA	N.A	N.A
Veterinary Hospital	Chemical disinfection autoclaving	NA	Deep burial	Along with municipal solid waste

Source: Meghalaya Pollution Control Board, Hospital Management Manual, Shillong 2000.

4.16 Summary of Finding:

The objective of this chapter was to assess the ground situation on the basis of field data based on a study carried out on the theme. The data relate to a household survey of 125 households from different municipal and non-municipal areas to assess the nature. Different sources produce different kinds of solid wastes and in varying quantities. Four categories were identified. They are a) Households 125, b) Commercial Establishments 11, c) Institutions (Schools and offices) 10 and Hospitals 6.

1) The sample selection (of households) is based on a broad, two-stage stratification. (a) Scheduled caste and scheduled tribe population and the general population, and (b) by income stratification in terms of: (i) the poor with annual household incomes below Rs.24000, conforming roughly to the official poverty line, (ii) the middle-income classes with annual income between Rs. 24001-100000 and (iii) the high income classes with annual income above Rs.100000/- (Table 4.8).
2) Among the residents of Shillong, majority of the people (43 percent) dispose off their household waste at least once in a day whereas 48 percent dispose off twice a day (Table 4.12). As regards the nature of disposal of waste, bulk of the respondents (54.4 percent) disposes off its waste in the open space (Table No 4.16) of the backyard of their houses. About 21.6 percent of the respondents use municipal or outdoor collection sites for disposal. This means that only about one-fourth of the respondents use facilities provided by Shillong Municipality for the collection of waste.
3) Nearly 27 percent of the respondents say the Municipality collects wastes on a daily basis. In all probability, this section of respondents (Table 4.17) lives in the main

residential areas. Interestingly a significant 23 percent of the respondents have no regular access to this service whereas 21 percent availed the same only once in a week.

4) Nearly 63 percent of the wastes generated from the households are food wastes. Miscellaneous articles form 17.95 percent of the wastes. About 13.42 percent of the total waste generated in the city is non-food waste. According to the author's study area, 261 Kg of wastes are generated from a total of 125 households whose population is 583. This amounts to nearly 450 grams per person per day. This is more than the average waste generated by an Indian, which is 370 Gram (World Bank, 1982) per person per day
5) From the Table 4.21, it has been observed that more than 50 percent of the respondents burn the yard waste, especially several times a year during the dry season, while about 31.72 percent dump the waste either in the backyards of their houses or nearby nullahs and natural drainages, in which city abounds, leading to shrinkage of the drains and pollution of the limited water bodies.
6) The table 4.23 shows that an overwhelming 84 percent of the respondents think that the problem of solid waste management in Shillong is a serious one and that it requires better management.
7) The efficiency of conservancy services in the city is also reported to be poor or very poor (81 percent). Conversely, only 19 percent appears to be satisfied with the services (Table 4.24).
8) Almost the entire respondents (95.08 percent) report no access to dustbins/ dumping site in close proximity within the localities provided by the municipality. It's only a dismally

low 4.92 percent of the people who report of availing this facility. This reveals the slack of attitude of the municipal regarding the issue of sanitation (Table 4.25).

9) The table 4.33 shows that most of the commercial waste (100 percent) is dumped at some nearest points or simply left in front of the shops to be lifted by the conservancy staff next morning. There appears to be no specific municipal by-laws in management of solid waste in commercial areas at Shillong. The containers used for collection and storage of the solid waste are not very different from those used in residential areas. Card board boxes are preferred by 63.3percent of units, 18.2 percent use baskets; the establishments make their own arrangements, as per their own convenience (Table 4.34).

10) Almost 36.3 percent of the establishments deposit the garbage in collection points outside their immediate locale, 27.3 percent of the shops choose the open space behind their establishments and 18.2 percent use street dustbins (4.35). There is apparently no system of accountability on part of the owner/management of the commercial establishments for collection and disposal of the solid-waste, nor any specified method that addresses the issue.

11) Most of the commercial wastes are removed by the municipality as well as by their own labourer (Table 4.37), 64.3 percent of the waste is removed by the commercial establishments and 35.71 percent by the municipality. Ninety percent of the refuse is collected daily and only 10 percent is collected on alternative days by the local authority (Table 4.39).

12) In 20 percent of the commercial establishments, the waste is re-traded/ recycled, especially of metallic materials, cardboards and other packaging materials depending on the natures of goods and services dealt by the particular establishment (Table 4.40).

13) Most of the institutions widely use different types of containers like plastic bucket, tin, bamboo made basket, cardboard for storage (Table 4.45). Plastic container accounts for 79.6 percent, followed by tin 18.5 percent. The size of the containers ranges from 5 to 20 litres.

14) Most of the Educational Institutions follow different methods of disposal of their solid waste (Table 4.46); 54 percent by burning and 46 percent dumping the waste at designated places.

15) Of the total 10 institutions surveyed, 50 percent dispose-off the solid waste in their own facility and others use a mix of a variety of inexpensive, but thought- less method to dispose the solid waste (Table 4.47).

16) The study has found that 93.3 percent of the (Table 4.54) hospitals use plastic containers for refuse storage and others use tin and metal bins and concrete bin for outside refuse storage. Carrying waste by hand is the primary means of waste disposal and in most of the hospitals mechanical system of refuse handling is very rare.

17) Most of the hospitals dispose their waste in different ways: 38.46 percent dispose at common storages in the hospital, 15.38 percent at curb-side collection points, 15.38 percent at street-side bins and 30 percent at open spaces around the hospitals (Table 4.55).

18) Chemical wastes are generally intimately mixed with other wastes, which are present as a contaminant (Table 4.56) 57.14 percent of the waste removed by the hospital authorities, 28.57 percent of the waste is removed by the municipality, and only 14.29 percent waste is removed by the Cantonments Board (Military Hospital).

CHAPTER – V

Type and Quantity of Solid Waste in Shillong Urban Agglomeration

5.1 Introduction:

Chapter-V deals with the types and quantity of solid waste in SUA from different sources, as it is generated on a day-to-day basis and on the basis of sample data collected from selected localities. Types refer to classification of waste by material types are principally, (a) Paper and allied products, (b) Plastics, (c) Glasses, (d) Tins and (e) Miscellaneous materials. Quantity refers to the amount of waste generated by sources, like (a) households, (b) commercial establishments, (c) institutions and (d) hospitals & medical centres (as special cases, because the waste they generate are contaminated and needs careful and specific handling by law).

5.2 Characteristics and Types of Solid Waste:

Density is one of the characteristics of solid waste that refers to the total volume of waste/cubic metre (v/m^3), when the refuse is disposed in sanitary landfill or open dump-yards. It is important to measure the density of solid waste for different part of a city or a locality. This helps to estimate the life of the disposal area (Eswarappa, 1981). The density of solid waste is mainly affected by, its constituents that vary markedly with geographical location, seasons of the year, and length of time in storage (Bhinde, 1975).

A study for solid waste management for Shillong was carried out by NEERI, in 1991[1]. In this study, they arrived at a per capita waste generation of 0.2799 Kg/capita/day (1991) in Shillong Municipality. The study also shows that the quantity of waste generated increases at the rate of 1.33 percent per year. The NEERI arrived at per capita waste being disposed off in Shillong Municipality was 0.2799 kg/capita/day based on the total waste transported for landfill by the SMB/day divided by the population of the Shillong Municipality![2]

5.3 Estimates of Total Quantity of Solid Waste Generated:

The World Bank (Cointreau, 1982) had estimated the per capita solid waste generation of Indian cities was in 370 grams (per capita estimate for India 370 grams/person/day)[3]. It is not understood why for example, Shillong should generate less solid waste per capita/day, that NEERI estimates after a decade. By adopting NEERI estimate (0 28 Kg./capita/day for Shillong, 1991) the total solid waste generation for SMB has been estimated at 49 tons/ day. Since, the population of Shillong Municipality did not increase during 1991-2001 decade (as per the Census, 2001, the increase was 0.88% for the decade!), the figure for 2001 is around 50 tons per day, a highly unlikely figure (considering that in 50% of the municipal localities the solid waste is not lifted daily, left often to be

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[1] NEERI (1991) Final report on planning for Solid Waste Management Shillong, sponsored by Urban Affair Dept Govt of Meghalaya

[2] One has to admit this is a very strange way of making any realistic estimation for planning purposes On the other hand, even a cursory household sample would have yielded better results Taking the SMB's claim of lifting the entire solid waste from all the localities on the basis of which a per capita estimate could be arrived at, is highly unprofessional way of carrying out the job

[3] World Bank (Cointreau, S J , 1982) *Environmental Management of Urban Solid Waste in Developing Countries,* A Project Guide, Urban Development Technical Paper No 5, Washington The World Bank

washed away by the rain!), the 10-15 truck-loads at an average weight factor of 5 tons (due to low compaction of the solid waste when transported) yields anything between 50-70 tons at 50% weight factor in solid waste transportation. In other words, the SMB may be generating solid waste well in excess of 100 tons per day. This is corroborated by the average per capita household solid waste generated at 447 grams/day (sample study of 125 households), it would yield for the municipality[4] 81 tons, plus waste generated from commercial areas plus offices and institutions may put a figure safely around 110 tons of solid waste per day, that appears to be reasonably realistic.

For the SUA, the task is even more daunting. With an estimated population of 452,000 (2006 projection) at a per capita rate 0.447 Kg./ day would yield a total of 202 tons (from household sources) plus 1/3rd from commercial and institutional sources yields a total figure of approximately 270 tons of solid waste a day (about 50 truck loads/day), way larger than what the local bodies bargain for.

5.4 Types and Quantity of Solid Waste from Households:

A major part of the household wastes constitute of food residue, 63 percent (Table 5.1). This is in conformity with other studies (WB e.g.) that in Developing Countries, generally food-waste constitute of two-thirds of all solid waste from households. Generation of SW depends on a number of factors such as level of income and cultural traits like food habits and occupation related preferences. The degradable components largely constitutes of food residues, vegetable wastes, paper and woody substances etc. The table also indicates

[4] 180,000 (our projected population for SMB for 2006X 0.447 Kg.=81 tons)

miscellaneous articles from 17.95 percent of the wastes; about 13.42 percent is non-food-waste. Although plastic waste is very low (0.25 percent), it is potentially hazardous for the city because even small quantities of it may block drainages. From the study area, 261 Kg of wastes are generated from a total of 125 households/day with total population of 583. This amounts to 447 grams of solid waste per person per day. This is more than the average waste generated by an Indian, which is 370 gram per person per day as per World Bank study.

Table 5.1: Types and Quantity of Solid Waste

Type of waste	Quantity of waste (Gram)	percent
Food waste	164500	63.07
Non-food waste	35000	13.42
Glass, ceramics	6735	2.58
Metals	760	0.29
Plastic	651	0.25
Leather	250	0.10
Clothes	300	0.12
Straw	5600	2.15
Yard waste	200	0.08
Miscellaneous	46805	17.95
Total	260801	100.00

Source: Data collected by the author, 2003-04

5.5 Income Classes and Generation of Solid Waste:

The data was collected for 125 households from the following localities of Shillong Urban Agglomeration: these are, Laitumkhrah, Motinagar, Laban, (Shillong Municipality), Lalchand Basti (Nongmynsong), Umpling, Happy Valley, Nongthymmai, Rynjah (Nongthymmai), Madanrting and Mawlai (Non-Municipal).

Table 5.2: Income Classes by Ethnicity Status (ST/SC or General)

Low income group (< Rs. 24000)			Middle income group (Rs. 24001-100000)		High income group more than (Rs. 100000)	
Ethnic classes	No	Percent	No	Percent	No	Percent
Scheduled caste	5	20.80	6	11.20	4	8.50
Scheduled tribe	7	29.20	18	33.30	21	44.60
Others	12	50.00	30	55.50	22	46.80
Total	24	100.00	54	100.00	47	100.00

Source: Data collected by the author, 2003-04

As regards the income of the respondents, the author has divided into three broad categories of income groups, i.e., less than Rs. 24000, Rs. 24001 to Rs. 100000 and more than Rs. 100000 (see, Chapter II, methodology). Table 5.2 shows the three income classes of households by ethnicity divisions (SC, ST and General populations). The share of Scheduled Caste 20.8 percent in low-income class, 29.1 percent of Scheduled Tribes and other 50 percent constitute from other non-tribal population. The middle-income (Rs. 240001-100000) class constitutes of 11.1 percent Scheduled Castes, 33.3 percent of Scheduled Tribes and the balance 55.5 percent, falls under the general category of population. It is clear from the table that as one moves up on the income scale the relative share of the SC and the ST households decline dramatically. This conforms to the expected income distribution among the households among the city, assuming no sampling bias, but contrary to the general perception that the STs especially, are generally in the upper income brackets.

Table 5.3: Type and Quantity of Household Waste by Income Classes

Sl. No.	Classes of materials in household solid waste	High Income >Rs.100000	Medium income Rs.24001-100000	Low income <Rs. 24000	Total Overall
1	Food waste	62.60	58.7	75.1	63.07
2	Glass	4.70	1.03	3.05	2.58
3	Metal	0	0.65	0	0.29
4	Plastic	0.25	0.24	0.26	0.25
5	Leather	0.14	0.06	0.26	0.10
6	Clothes	0.19	0.06	0	0.12
7	Yard waste	0	4.97	0	2.23
8	Unclassified waste	32.00	34.08	21.04	31.03
	Total	100.00	100.00	100.00	100.00

Source: Data collected by the author, 2003-04

The solid waste generation depends on a number of factors such as level of income for families, food habits etc. The degradable components largely include food residue, paper and woody substances and other degradable materials. Overall, as indicated in Table 5.3, two-thirds of the solid waste generated in the sample households studied constitutes of food-waste, in general conformity with other studies on urban solid waste in developing countries, the balance one-third constitutes of other recyclable materials like metals, glasses and paper etc and host of amorphous (unclassified) materials. The table further shows that nearly two thirds (75 percent) of the food wastes are generated from the low-income households, 58.7 percent from middle-income group and 62.60 percent from the high-income class. The distinction between the middle income and high income households are not significantly different, but for the low income households, the consumption pattern generally veers around the basic needs, i.e. food—therefore, the predominance of food/vegetable waste in the residue profile.

It is generally agreed that higher (family) incomes do strongly correlate with more than proportionate generation of waste. In other words, change in income results change in consumption pattern of households—that conversely results in production of domestic solid waste. This refers to in economic terms "income elasticity of consumption". Though, theory tells us that generally, the income elasticity for basic goods consumption is relatively "inelastic", in effect (a) consumption baskets undergoes change along with change in household incomes and (b) for low income households the "inelasticity" principle, especially for developing countries may not be strictly valid. Therefore, a rise in household incomes may result in a surge in consumption of basic goods, i.e. food related articles and thus, production of still more food-waste.

How can we measure the income elasticity of solid waste production at household level? Income elasticity of consumption (solid waste) is measured by the change in solid waste out-put in respect to change in income. The primary data that was collected is for one point of time and therefore, any time series changes are difficult to measure. However, one may use the inter-class changes in solid waste generation to income differences as a surrogate measure in the absence of time series information, which remains a problem for all survey based data for a single point of time.

Therefore, Income Elasticity of Solid Waste can be expressed by:

$$IE_i = (SX_i - SX_{i-1}) / (IX_i - IX_{i-1})/IX_m \quad \text{..... (f. 5.1)}$$

Where, IE_i refers to income elasticity of the ith inter-income class, SX refers to per capita/day solid waste generated for the ith household class and IX refers to mean household/ per capita income and i and i-1 refer to a higher income group and one lower

one, respectively and IX_m is the weighted mean income[5]. This principle is defendable on the ground to generally expect a low income household to move to the next higher income class over time under normal conditions, *certeris paribus*.

Table 5.4: Income Classes and Generation of Solid Waste (Kg./household/day)

Income Classes	Assumed Mid-point of annual household incomes	Food Waste	FW % to Total SW	Total Solid Waste
Low Income	15000	1.19	74.11	1.61
Medium Income	62000	1.11	53.21	2.08
High Income	150000	1.41	63.16	2.24

Source: Estimated by the author on the basis of field data of 2003-04

On the basis of the Table 5.4, surrogate income elasticities of solid waste can be estimated by formulae (f.) 5.1, as follows:

IE_1 = (2.08-1.61)/ ((62000-15000)/84280) = 0.8428

IE_2 = (2.24-2.08)/ ((150000-62000)/84280) = 0.1532

What the income elasticities mean in real terms? Since the income denominator is in 10,000, it means that when a low income household increases its annual income by Rs.10,000/-, it is likely to generate 0.84 Kg of additional solid waste per day (marginal change in consumption in respect to marginal change in income) and it is only 0.15 Kg, when a medium income family adds Rs.10,000/- to its annual income. The reason is, the medium income household's income elasticity of consumption will decline for basic goods and may increase for non-basic goods, but into higher incomes, the propensity to save and invest will increase. While looking at these figures one must also take precaution that (a) this is a surrogate measure in absence of time series data and (b) the income classes are

[5] Weighted Mean Income = Rs. 84280

broad—the picture may smoothen out if the income classes are increased to 7 or 9. But, the finding is in general conformity with economic theory on consumption behaviour.

5.6 Sanitation Condition in Localities:

Table 5.5: Respondents in Localities

Living area	Number of respondents	Percent to total respondents
Slum areas	26	20.8
Non- Slum Residential localities	99	79.2
Total	125	100.00

Source: Data collected by the author, 2003-04

Table 5.5 shows that 79.2 percent of the sample households live in residential areas of Mawlai, Laitumkhrah, Umpling, Rynjah, Nongthymmai, Motinagar, Happy Valley, Madanrting and Laban etc.; only 20.8 percent of the households live in slum areas of Lalchand Basti (Nongmynsong), Umpling, Rynjah and narrow lane of Madanrting and Lower Laban.

Table 5.6: Prevalence of Diseases in the Study Localities

Type of disease	Occasional	Frequently
	percent	percent
Hepatitis A	5.10	0.00
Malaria	24.00	19.94
Filarial	0.60	0.00
Cholera	1.10	0.00
Typhoid	7.30	8.28
Viral Fever	7.30	35.28
TB	2.30	0.00
Skin Disease	37.00	2.45
Gastroenteritis	7.30	34.50
Other	7.90	0.00
Total	100.00	100.00

Source: Data collected by the author, 2003-04

Table 5.6 indicates the reported incidence of diseases related to sanitation and environmental hygiene, especially incidence of three diseases reportedly the most frequent, i.e. Malaria, Viral fever and Gastroenteritis (19.94, 35.28 and 34.50 percents respectively). Skin infections are common but only occasionally. It is quite clear from the table that once water and sanitation issues are addressed in the city to some degree of satisfaction, perhaps 75 percents of health issues could be reasonably covered.

The situation is especially precarious in slum areas, where most of the poor of the city (SUA) reside. A very large segment of the city's poor reside in non-municipal townships like Pynthorumkhrah (not covered in the study), Lalchand Basti (Nongmynsong) and along the MaCabey road along the Umkhrah river from Nongmynsong point to Polo-bazar, a stretch of 3 Km. Shillong Municipality has a slum improvement programme right from 1971 (10 Point Programme of Mrs. Indira Gandhi, the then Prime Minister of India), the Environmental Improvement of Urban Slums (EIUS) that subsequently became a state sector programme. However, this is operative in "notified slums" within the municipal limits (24 localities)[6], like Naspatigarhi, Bara Pathar and Upper and Lower Lumparing etc, which are principally mixed-localities, old localities. But, the non-municipal slums have no access to funds under schemes under EIUS or other central sector poverty alleviation programmes.

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[6] Singh, Nandini C. (2008). *Dimensions of Urban Problems in North-East.* Delhi, Himalayan Publisher, Table 4.1, p.122.

5.7 Sanitation Issues and Public Opinion:

Table 5.7: Public Opinion on Environmental Hygiene

Public Opinion	V. High	High	Moderate	Low	V. Low	Total	Total Response
Crowded	1.63	24.39	65.04	4.07	4.88	100.00	123
Hygienic	1.67	4.17	27.50	31.67	35.00	100.00	120
Dirty	2.52	8.40	26.05	26.05	36.97	100.00	119
Dusty	2.56	10.26	12.82	32.48	41.88	100.00	117
Water logging	8.00	12.00	40.00	20.00	20.00	100.00	125
Disease	11.20	42.40	29.60	4.00	12.80	100.00	125

Source: Data collected by the author, 2003-04

Table 5.7 shows that (33 percent) of public says that moderate hygienic condition i.e. 42 of the public having very low hygienic condition and 44 of the public says very low dirty condition of locality and 3 of the locality having very high dusty conditions and 18 percent of the local public facing water logging problems to their areas. Due to unhygienic and water logging problem 34 percentages of the total area affected by disease prone. These are the problem given by the public opinion.

5.8 Commercial Waste:

Table 5.8: Solid Waste from Non-household Entities[7] (Amount of Waste Produced)

Entities grouped by quantity of waste produced/day	Number of commercial or institutions	Percent to total
1-5	253	58.16
6-10	49	11.26
11-20	41	9.43
21-50	19	4.37
51-100	66	15.17
101-250	3	0.69
251-500	0	0.00
501-1000	3	0.69
1001+	1	0.23
Total	435	100.00

Source: Courtesy AusAid Project, 2004-05 (unpublished)

Table 5.9: Source of Commercial Waste

Response Classes	Frequency	Percent
1 market/Tea stall	16	3.68
2 Small industries	21	4.83
3 Institute other than Education	12	2.76
4 Educational institution	25	5.75
Total (Exclud 33, 55)	74	
33 Hotel and restraunt	1	0.23
55 Hospital lab	360	82.76
All Total	435	100.00

Source: Courtesy AusAid Project, 2004-05 (unpublished)

The amount of solid waste generated from the non- house hold less than 5 kg to more than100 kg per day. 58.16 percent of solid waste produced less than 5 kg. 15.17 percent

[7] AusAid project on Gangtok and Shillong Water and Sanitation Project generated data though large scale surveys in 2004 on household and non-household sources and covered a total of 435 non-household entities and about 3500 households covering the entire SUA. The Department of Geography, NEHU, Shillong along with Department of Economics and Centre for Environmental Studies carried out the surveys for the AusAid.

produced 50 to 100 kg, 11.26 percent produced 6 to 10 kg, 9.43 percent produced 6 to 10 kg, and 4.37 percent produced 21 to 50Kg, of solid waste produced from non - house hold.

Compare to over all solid waste generation 77.14 percent waste generate less than 5 kg from market and tea stall, 59.04 percent of the waste produced by educational institution, less than 5kg, 54.09 percent produced by the small industries/garage, 49.23 percent of waste generated from other than educational institution,40 percent of the waste generated from hospital and lab only, hotel and restaurant generate19.05percent and 17.34 percent respectively. Maximum waste generation over 100 kg in a day in only 15.17 percent of market and tea stall.

Unsafe material of waste from the various institution are heterogeneous inorganic substances produced in hospital, educational institution and small industries/garage to organic substance from the consumer products which may include hazardous unsafe materials. (Table5.9) shows the details of the unsafe materials produced from the hospital are 82.76 percent infectious materials and 8 percent acids and chemicals respectively. 5.75 percent and 2.76 percent of acid and chemical waste produced from educational institution and institution other than education respectively. 4.83 percent and 3.68 percent oil/ grease of waste produced from the small industries/garage and market/tea stall respectively.

There are different categories of commercial establishments, throughout the city (Table 5.10). which produce different type of waste, like paper, plastic, wooden box, paper box/card board, food grain, tin and others etc.

Table 5.10: Types of Commercial Waste

Items	Weight in KG	Percent
Paper	21.50	10.32
Plastic	24.50	11.76
Wooden box	58.00	27.84
Paper/card board box	1.75	0.84
Food grains	09.00	4.32
Tin	07.00	3.36
Others	86.60	41.56
Total	**208.00**	**100.00**

Source: Data collected by the author, 2003-04

The present survey reveals that the waste generated varied with the size of the establishments and the types of business. The waste generated ranges from 2 to 86 kilograms approximately in about 8.52 percent of the establishment it is in between 10 kg to 20 kg /day.

Table 5.10 shows that nearly 41.56 percent of the miscellaneous/others waste are generated from the commercial,27.84 percent woodenbox,11.76 percent plastic, 10.32 percent paper and followed by (8.52 percent) food grain ,Tin and cardboard box etc. total 208 Kg of non-food waste generated from the commercial units in my study area (municipality and non- municipality) in the city. Though plastic waste is very low (11.76 percent) still it is dangerous for the city because it blocks all the drainage system of the city. From the study area, 208 Kg of wastes generated from the total of 10 commercial areas.

Table 5.11: Solid Waste from Commercial Areas, Institutions and Hospitals

(percent)

Waste type	Commercial	Institutional	Hospital
Paper (Administration)	10.32	27.45	20.30
Plastic	11.76	0	0
Wooden box	27.84	0	0
card board box	0.84	0	0
Food waste/(cafeteria)	4.32	3.27	8.96
Tin	3.36	0	0
Corridors (Soil/ dust)	0	36.60	0
Kitchen (Cafeteria)	0	0	NA
General Nursing	0	0	5.97
Surgical	0	0	13.72
Maternity	0	0	18.51
Laboratory	0	0	14.93
Mixed waste/others	41.56	32.68	17.61
Total	100.00	100.00	100.00

Source: Data collected by the author, 2003-04

Table 5.11 shows that different establishments are produce different amount of solid wastes. It varies from one institution to the other institutions. Both educational institution/institution and hospitals are produce 27.45 and 20.3 percent of paper waste. They are using more number of papers for various purposes, only 10.32 percent of the paper waste produced from the commercial establishments. Commercial institutions are using paper as a packing material. Compare to other different institutions commercial establishment only produce 11.76 percent of plastic, which is used as a carry bags, it is non-degradable and dangerous to the environment. 27.84 percent of the wooden box and 0.84 percent of the card board box produced by commercial establishment. 8.96 percent, 4.32 percent of the food waste produced from hospital and commercial establishment, only 3.27 percent institutions are sharing.4.32 percent of tin waste produced by commercial establishments, which is used

as packing materials.36.6 percent of the soil or dust generated from the educational institutions. 53.13 percent of the hospital waste from general nursing, maternity and laboratory sharing the total wastes (53.13 percent). 5.97 percent, 13.72 percent, 18.51 percent and 14.93 percent of the mixed waste produced by commercial, institutions and hospitals respectively.

5.9 Removal of Waste:

Most of the commercial waste removed by the municipality as well as own labour of the shopkeeper (Table 5.12) 64.29 percent of the waste removed by own labourers of the commercial establishment and 35.71 percent was removed by the municipality.

Table 5.12: Removal of Waste

S .No	Removal of waste	No	Percent
1	Own labour	9	64.30
2	Municipality	5	35.70
3	Private agency	0	0
4	Others	0	0
5	Total	14	100.00

Source: Data collected by the author, 2003-04

5.10 Time of Cleaning:

The frequency of cleaning varies at different timing in a day (Table 5.13). 53 percent morning, 29.41 percent Afternoon, and 17.65 percent cleaned at evening by the local authority.

Table 5.13: Time of Cleaning

Time of cleaning	No.	Percent
Morning	9	53.00
Afternoon	5	29.40
Evening	3	17.60
Night	0	0
Total	17	100.00

Source: Data collected by the author, 2003-04

5.11 Frequency of Refuse Collection by SMC:

90 percent refuse collected daily and 10 percent collected only Alternative days collection by the local authority (table 5.14).

Table 5.14: Refuse Collection

Frequency	No.	Percent
Daily	9	90.00
Alternative-day	1	10.00
Fortnight	0	0
No regular time	0	0
Total	10	100.00

Source: Data collected by the author, 2003-04

5.12 Institutional Waste: Source and Quantity of Waste per day:

Sources and quantity of waste generated at different source from government office, private firm and educational institution, like classroom, corridors (mud and earthen materials) kitchen waste (Cafeteria) and others (Table 5.15). About 3.9 percent of the institutions have Cafeteria facilities and food waste generated the earthen material (mud's and other non-compostable material accounts for 44.4 percent and 29.3 percent respectively and 22.2 percent having compostable.

Table 5.15: Source of Quantity of Waste per day

Source	No in Kg	Percent
Class room(paper)	42	27.45
Corridors (mud)	56	36.60
Kitchen(Cafeteria)	5	3.27
Others	50	32.68
Total	153	100.00

Source: Data collected by the author, 2003-04

From the educational institution and other office produce 27.45 percent of paper waste and cafeteria produce 3.27 percents of waste from the kitchens and rest of the others produce unconsolidated waste (mud and others).

5.13 Hospital Waste:

The sources of solid waste in hospitals are General nursing floors, surgical departments, pharmacy, laboratories, emergency, office including yards, dietary and service areas (Table 5.15), According to the report on "Planning for hospital sanitation" the average wastes generated by a patient in major metropolitan city hospital was 1 to 1.5 kg/day, which is much lower than in western countries. Where, it is more than 4 kg/day.

Table 5.16: Sources and Quantity of Waste in KG

Sources of Waste	No. in Kg.	Percent
General Nursing	20	5.97
Surgical	46	13.73
Maternity	62	18.51
Laboratory	50	14.93
Administration	68	20.30
Dietary	30	8.96
Mixed unknown	59	17.61
Total	335	100.00

Source: Data collected by the author, 2003-04

But Shillong city compared to our Indian cities is producing only 250 gram/bed/day. (Sources: Secondary data CPCB 2000). Administration account for about 20.3 percent of the total waste followed by maternity with 18.51 percent, laboratory about 14.93 percent, mixed unknown about 17.61 percent, surgical about 13.73 percent, dietary 8.96 percent and General Nursing only 5.97 percent generate solid waste. Solid waste generated not only varies with hospitals but also within the hospitals. For example, unit such as administration, maternity and laboratory produce large quantities of wastes. Unit handling dietary, surgical and general nursing produce fewer amounts of wastes. The composition of waste is combustible rubbish amounts 25 percent of the total weight. Garbage waste discharged accounts for approximately 29 percent, followed by non-combustible rubbish about 9 percent. At most hospitals, combustible rubbish is probably associated with at least small amounts of microbiological and chemical contamination. Food wastes, on the other hand not necessarily contaminated, although they can putrefy and attract insects and rodents.

The various kinds of potentially hazardous wastes produced in hospitals pose serious problems.

5.14 Summary of Findings:

Chapter-V deals with the types and quantity of solid waste in SUA from different sources, as it is generated on a day-to-day basis and on the basis of sample data collected from selected localities. Types refer to classification of waste by material types, principally, (a) Paper and allied products, (b) Plastics, (c) glasses, (d) Tins and (e) Miscellaneous materials. Quantity refers to quantity of waste generated by sources, like households,

commercial establishments, institutions and hospitals & medical centres as special cases, because the waste they generate are contaminated and needs careful and specific handling by law. It is important to measure the density of solid waste for different part of a city or an area. Density of solid waste refers to the total volume of refuse estimated for one cubic meter (m^3) when refuse in disposed off in sanitary landfill or open dump.

This helps to estimate the life of the disposal area (Eswarappa1981). The density of solid waste is mainly affected by, its constituents that vary marked with geographical location, seasons of the year, and length of time in storage (Bhinde, 1975). In General, the cities of the developing countries record higher density values than the cities of the developed countries and Shillong UA is no exception to this study. The World Bank (1984) has estimated the per capita waste generation of Indian cities was in 0.370 gram/person/day. The study also shows that the quantity of waste generated increases at the rate of 1.33 percent per year.

NEERI (1991) adopting the standard method to estimate the density of waste and arrived at a per capita waste generation of 0.2799 kg /capita/day (1991) in Shillong Municipality. Based on the above norms it have been estimated that Shillong municipality generated on an average 49 metric tonnes of solid waste per day in 1991 and it is 50 tonnes per day in 2001. But according to the author sample study arrived 0.450 gram /per person/day, Shillong municipality generated 60 metric tons per day in 2001.

1) The household interview schedule was used to note down residents waste disposal practice in relation to their socio-economic conditions and also find out their attitude towards solid waste disposal in municipality and non municipality areas. It is

generally, agreed that higher (family) incomes do strongly correlate with more than proportionate generation of waste (Table 5.1)

2) Field study observed that among the different tribes and non-tribes of the majority people comes under different income groups. The share of 20.8 percent Scheduled caste 20.8 percent, 29.2 percent of scheduled tribe and others 50 percent of the people comes under Non - tribes.

3) Table 5.2 shows that nearly 75 percent of the food wastes are generated from the (households) low-income group, as well as 62.60 percent of the high-income group, but middle-income group produce only 58.7 percent only. Regarding non-food waste nearly15.80 percent high income group, 12.08 percent middle income group and 10.9 percent of low income group generate Non-food waste.

4) a) The low income group people economically most backward and most of them not educated they depend on daily wages. Whose income annually falls under less than Rs 24000/- per annum. Due to backwardness of their economic condition, 29.8 percent are living such a low lying area where they are dumping their household waste into drain and sewerage.

   b) (Table 5.3) 79.2 percent of the both middle income and high income groups comparatively they are living better condition. They are some what educated and highly educated. They are living main residential areas of the city. Their living areas are not having sanitation facilities. Whose income annually falls under Rs 24000-100000/- and more than 100000 /- respectively.

5) As regards the nature of disposal of waste, (Table No.5.4) majority 54.4 percent of the respondents have reported that they dispose off their waste in the open space of the backyard of their houses. About 21.6 percent of the respondents have reported that they use municipal or outside collection point for disposal of their waste. It can be nearly ¼ of the respondents use facility provided by Shillong Municipality for collection of waste.

6) The table No5.6 the residents of Shillong given their opinion about, 95.08 percent of public not having proper dustbin facility, while 4.92 percent of the public only getting dustbin facility to their residents

7) The table 5.5 Shows the resident of Shillong have been reported that more than 51.2 percent of the resident feel very serious about solid waste management in Shillong. The 48.8 percent of the residents of Shillong has reported that they are facing solid waste management problems in and around city.

8) Regarding the commercial waste, it is an important component of municipal solid. There is no data available regarding the exact amount of commercial waste generated with in Shillong. 10.32 percent paper, 11.76 percent plastic, 27.84 percent wooden box, 4.32 percent food grain, 3.36 percent tin, 0.84 percent paper box/cardboard and 41.56 percent rest of others. Total production of different category of waste produced from 10 commercial establishments was 208 Kg of waste (table 4.47). The present survey reveals that the waste generated varied with the size of the establishments and the types of business. The waste generated ranges from 2 to 86 kilograms approximately in about 8.52 percent of the establishment it

is in between 10 kg to 20 kg /day. However the amount of solid waste generated in the whole market is approximately 12-24 metric tons per day. Hence 50 percent of the waste generated per day is not being disposed.

9) Regarding disposal and management of Bio-medical waste is causing a serious impact of our surrounding environment. There are 12 hospital / nursing homes, 20dispensary clinics/ pathological laboratories and one veterinary hospital in the city. The amount of bio-medical waste generated is calculated according to the standard norms, i.e., per bed per patient per day basis assuming that each patient would generate on an average about 1 kilogram of waste per day of 25 percent consist of infectious, pathological and anatomical waste (Kerac 1992) (Table 4.46). Various category of hospital generate 570 Kg of waste per day in Shillong (CPCB manual 2000).

10) Administration account for about 20.3 percent of the total waste followed by maternity with 18.51 percent, laboratory about 14.93 percent, mixed unknown about 17.61 percent, surgical about 13.73 percent, dietary 8.96 percent and General Nursing only 5.97 percent generate solid waste. Solid waste generated not only varies with hospitals but also within the hospitals (Table5.16).

CHAPTER – VI

Current Solid Waste Management Practices in Shillong

6.1 Introduction:

The basis of effective solid waste management and decision-making is reliable, provided information is available on the existing system being managed (Shelat, 1976), Mukherjee (2002). A major requirement in the design and development of a satisfactory management system is an in-depth knowledge of existing management studies, it has a variety of uses relating to technical decisions, operation, and economic feasibility of alternatives, improved or unique system for collection, transportation, disposal and resource recovery (APWA, 1970). In this chapter, an inventory is being made to study the existing solid waste management and practices in Shillong city.

6.2 Development of Solid Waste Management System in Shillong City:

The municipality was constituted in 1910; the town is also the headquarters of one of the seven district of Meghalaya. The population of Shillong municipality area, which was 87,659 in 1971, rose to 1, 32,876 in 2001.The increase in three decade being 45,217. The total municipality of the area of the town is 10.36 sq. km. i.e. there is no extension of municipality boundaries, since thirties. In the pre independence period Syiem of Mylliem was against any extension of municipal limits and after independence the district council was chary of the protection of tribal lands. The affairs council, which is the deliberative

body, comprises of 13 elected and 4 nominated members in 1967. The last municipal election was held in1967 and the next election should have been held in 1971. But it was not held , in spite of repeated request by the board , election were not held on the ground of fresh delimitation of wards. It was dissolved in July 1973 and the municipality continues till today under the control of a chief executive officer. Taking the state of Meghalaya as a whole, there are 16 towns and one cantonment board. They are being re-organised on the basis of provisions in the Meghalaya municipal act, 1973. Out of a total population of 23.06 lakh population in Meghalaya in 2001, in that 19.63 percent live within urban areas. There is one municipality and sixteen small towns for providing civics amenities in the state.

The government control over the municipality is quite comprehensive. The appointment of the chairman, the executive officer and technical staff requires the approval of the government. Head of the district administration has been empowered to suspend any resolution of the municipality subject to approval by the state government. He has also been given the emergency power to pass order for the execution of any work, which the municipality is empowered, to executive under cover of safety of the public. In the matter of personal, the state Government has the right to ask municipality to suspend, warn or fine of its employees, if found neglecting official duties or abusing his power or position.

In the heart of the town lies the cantonment area, which functions as class II cantonment with 7 members. However, co-ordination is minimal between the two bodies except through the office of the deputy commissioner. At the state level, there is no directorate of municipality or municipal administration department in the secretariat, but there is one secretary of district council affair who is looking after the administration of

urban local Government. Thus, there is only co ordination at the state level and no agency at regional or local level.

A study in "micro-politics" by Bhattacharya.U (2001) the study shows that there has been both stagnation and status quo in the municipal administration of Shillong. Another feature of Shillong municipality is that no where in India civic election are not held for long thirty (30) years and the municipal administration is left entirely in the hands of bureaucrats, so there has been a poor performance of the municipality in almost every aspect of civic life. The only achievement it can be boasting of is in the sphere of collection of tolls and arrear taxes. The citizens of Shillong are therefore, looking forward to a responsible elected civic body rather than to the existing bureaucratic body.

The Shillong municipality is entrusted under Law with obligatory function of conservancy or public cleaning and scavenging work. An early attempt to manage conservancy (solid waste) in Shillong was made on 19th September; 1972.As the city size increased the refuse collection systems not expanded. The Governor of Meghalaya, in exercise of the powers conferred by Section 13 of the Meghalaya Municipal Act, 1973 (Assam Act XV of 1957 is pleased to divide the present Shillong Municipality) into 27 (twenty seven) separate wards, each with the boundaries specified in the Schedule below for the purpose of election of Commissioners and is further pleased to determine that the number of Commissioners to be elected from each of the wards. The Shillong Municipality was the earliest of its kind in Assam. In the beginning, only haphazard, traditional refuse collection was in practice. After Meghalaya Municipality Act 1973, a separate wing for conservancy was set up in the work of the municipality of Shillong under the Chief

These departments continued to function with the rising personal needs to improve the refuse collection; a large number of staff (drivers, sweepers and conservancy inspectors) was employed.

The existing manpower and infrastructure for Garbage Management available with the Board are:

Table 6.1: Staff Strength of Shillong Municipality and Cantonment Board

Staff	SMB	SCB
Supervisory Staff	13	03
Head Zamadar	09	03
Sweepers : Full Time	49	50
Daily Wages	174	00
Part Time	52	00
Mazdoors: Regular	47	02
Daily Wages	14	00
Trench Ground Mazoor		
Full Time	06	00
Part Time	04	00
Chowkidar	02	00
Mechanical Helper	02	00
Mechanics	03	00
Office Sweeper	00	00
Ants Electrician	01	00
Sanitary Inspector	03	01
Conservancy Supervisor	03	00
No. of Tippers	06	00
No. of Trucks	06	03
Septic Tanker	01	00
Drivers	12	03
Total	**409**	**65**

Source; Shillong Municipality Board and Cantonment board office record 2007-08.

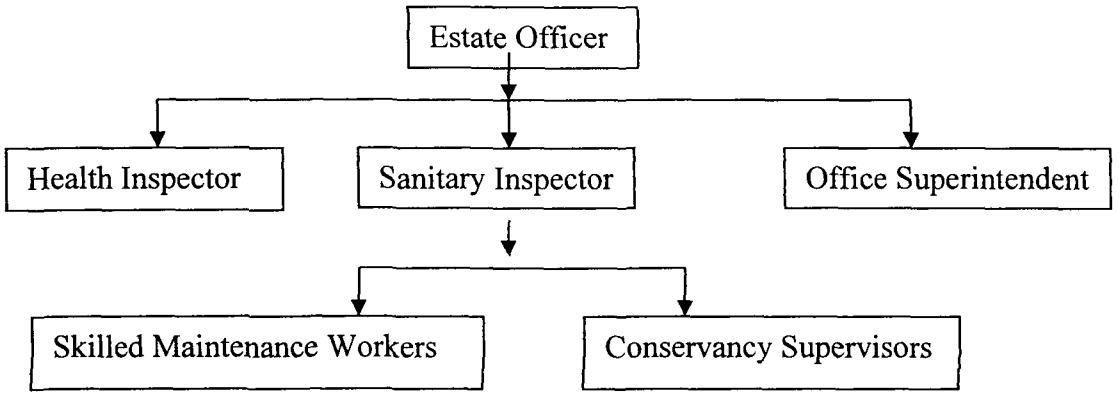


Figure 6.1 Cantonment Board

6.2 Administrative Set-up:

Chief Executive Officer, who is basically a sanitary Engineer, heads the solid waste management department in Shillong. The Municipality is broadly divided into Twenty Seven Wards (South and North), each under an Assistant Executive Engineer. On the basis of functions, the department consists of ten sections namely, Administrative (General) Department, Establishment (Building) Department, Collection Department, Licensing Department, Assessment Department, Birth and Death Registration Department, PWD, N.R. and U.P.A. Cell, Water Works Department, Health and Sanitary Department, etc (Table 6.1).

Table 6.2: Different Categories of Workers Involved in Refuge Collection

Sl.No.	Categories	No. of Workers
	Refuse Collection crews (sweepers, helper)	314
	Lorry/Truck Drivers	12
	Lorry Attendant full time	37
	Lorry Attendant part time	17
	Mazdoors full time	47
	Mazdoors daily wages	14
	Head Zamadar	07
	Skilled (Mechanic)	08
	Conservancy Supervisor	03
	Others	15
	TOTAL	474

Source: Shillong Municipality board and Shillong Cantonment board office record (2007-08).

The SMB and SCB engaged (409 +65) 474 persons (2003-04) distributing among the different categories as shown in table 6.2

6.3 Unit of Conservancy:

The city of Shillong is divided into five zones, each comprising of few divisions. A conservancy inspector manages the waste collections in each division. Under the responsibility of the concerned division's Junior Engineer. The conservancy inspectors inspect the work of the refuse collection crews and street sweepers. To coordinate the work, there is a conservancy supervisor at the unit level. 314 workers carry out (Table 6.2) the refuse collections in this zone/division, i.e., 61 percent of the total workers engaged in the city's solid waste management.

Table 6.3: Zone Wise Distribution of Dustbins within the Municipality in Ratio to Population (2001)

Zone	Ward Name	Number of bins	Open spot	Total population	Number of population in ratio to a dustbin
Zone A	Police Bazar, European ward, Nehru colony	35	7	20749	592.82 persons : 1 Dustbin
Zone B	Kenchestrace, bishnupur, Rilbong, Madanlaban, Lumbaring laban	30	9	26362	878.7 persons : 1 Dust bin
Zone C	Mawkhar, Wahinghdoh, Riatsumthiah, Jaiaw	14	6	19318	1379.8 persons : 1 Dust bin
Zone D	Laitumkhrah, Dhankheti, Malki, Cleeve colony	26	13	31498	1211.4 persons :1 dust bin
Zone E	Upper and Lower Mawprem, Quallapattey	00	00	34949	NA
Total		105	35	132876	1265 persons : 1 Dust bin

Source: Final report of NEERI (1991) "Planning for Solid Waste Management at Shillong "Sponsored by Department of Urban Affairs, Govt of Meghalaya.

6.3 (a) Unit Conservancy (Shillong Municipality area): collect the refuge at different zones under a supervisor,

Zone 'A' Consisting of Police Bazar, Jail road and Nehru colony. This zone having 35 dust bin and 7 open spots from where solid waste is being collected in daily basis. This zone supports a population of about 20749 persons hence on an average 592.82 person share a dust bin for disposing of the waste (Table 6.3).

Zone 'B' Consisting of Kenches' trace, Bishnupur, Rilbong, Madanlaban and Lumbaring laban. This zone has 30 community bins and 9 open spaces for dumping of its waste. This zone supports a population of 26362 persons hence an average 878.7 persons share a dustbin.

Zone 'C' Consists of Mawkhor, Wahingdoh, Riatsumthiah and Jaiaw Has 14 community bins and 9 open spots where all the types of solid wastes are disposed. This zone supports a population size of 19318 persons hence on an average 1379.64 persons share a dust bin.

Zone 'D' Consists of Laitumkhrah, Dhankheti, Malki, Cleeve colony having a population of about 31498 persons. This zone has 26 community bins and 13 open spaces for solid waste disposal. Hence an average 1211.4 persons share a dust bin.

Zone 'E' Consists of Upper and Lower Mawprem and Quallapattey with a population of 31498 persons has no access to dust bins within the localities. Due to lack of dust bin most of the localities finds dump the waste into the streams and drains of their area.

6.3 (b) Cantonment Board:

The Cantonment Board consists of 60 dust bins (40 dust bins with in the army area, 10 dust bins in the cantonment area and 10 dust bins in Jhalupara areas. Every day wastes are collected from approximately 30 dustbins hence every alternative day the dust bins are cleared. Shillong Cantonment Board maintaining their own expenditure. They have one open body lorry and two mini open body tempo lorry in which they are collecting their garbage and disposing to mawiong dumping site.

6.4 Truck Transport:

Shillong Municipality has 7 open bodied trucks and 9 hydraulic tippers and 2 three wheelers are used for waste collection and carrying it to the dumping sight. Truck transport is in the charge of mechanical engineers, to look after the workshop and truck traffic

administration. Two supervisors, who manage the maintenance of workshop, and traffic flow, assist the assistant mechanical engineers. The supervisors supervise the work of skilled workers and truck drivers. These 18 trucks together employ 11 truck drivers.

6.5 Disposal:

A separate Assistant Executive Engineer controls the disposal activities at disposal sites. Each one of these are looked after by a Junior Engineer. To assist and coordinate the work of these Junior Engineers, there is a team comprising of landfill supervisors, compost plant supervisors, technicians, skilled labourers and workers who unload the refuse. There are two landfill disposal sites at one compost plant in the city at present. The disposal sites are located at Mawiong and Marten and two aerobic compost plant capacity 100 TPD being in the existing dumping sites. These disposal sites are located outside of the Shillong Municipality. These disposal sites employ a total of about 30 skilled and unskilled workers.

6.6 Administrative Unit:

A Chief Executive Officer has been appointed under the direct control of the city solid waste management department, the superintendent who supervises all the clerical work involved in solid waste management of the city. About 27 clerical staff assists him, at the various stages of the administration.

6.7 Manpower:

During the last 30 years (1973 to 2003), the number of staff has marginally increased. At present they have roughly 314 sweepers (Table 6.2) only which compared to the national level is one of the least employed. It shows that poor manpower, which shows the shortage of manpower on the part of the Board, has also fallen short of the successful implementation of the existing system.

At zone-wise refuse collection, persons employed for refuse collection per 1000 population have been calculated, in order to arrive at the ratio of man power provision. On an average, the city employs 2 workers for refuse collection, which is much lower than the national average of 4 workers per thousand populations (CPHERI, 1974, Supreme court Interim report on SWM June 1998). Within the city, the ratio of manpower provision varies widely (Table 6.3), from less than one (0.5) person in one ward to as high as 2 persons in other ward. A general trend apparent is that the spatial pattern of man power provision closely resembles the pattern of refuse generated and pickup density. Man power provision is high in the densely populated, city core area and decreases towards the less densely peripheral zones. It is computed that over all municipality the refuse collection crew collects on an average 100 metric tonnes of refuse daily, which again is below the national average (250metric tons/day) the low average is mainly because nearly 50 percent of the waste generated in the city is left uncollected.

6.8 Cost and Finance:

Given satisfactory standards for the protection of health and environment, cost will always be the criteria of choice of waste disposal methods. It is necessary, therefore, to consider the probable, comparative cost of the main system. Since 1991, the Municipality has incurred 12 to 15 percent of its annual expenditure on solid waste management and it has always been the third largest item in its budget, after administrative management.

Table 6.4: Annual Expenditure of Shillong Municipality Board and Shillong Cantonment Board (2007-08)

Employers	SMB	SCB
Drivers	1260875	216000
Lorry attendants	2977022	
Sweepers	9186818	2160000
Fulltime Mazdodar	3703436	120000
Parttime Mazondar	928416	Nil
Mechanics	292872	Nil
Head Jamadar	657995	Nil
Office Labours	1378020	504000
Sanitary Inspector/ conservatory supervisor	1477932	432000 144000
Vehicle maintenances	401922	150000
Total Expenditure	2,22,65,308	32,72,400
Revenue collections	2,18,18,693	Data not available
Deficit	4,46,615	Data not available

Source: Shillong Municipality board and Cantonment board office Record 2007-08

6.9 Refuse Storage:

All the steps in solid waste management are related to the efficiency and effectiveness of collection are interrelated to the methods of household (or) communal storage (Cointreau, 1982). Briefly, two types of storage are common in Shillong (a) household storage and (b) communal storage.

6.9 (a) Household Storage:

Household storage refers to the waste generated by a household and stored in a container within the house premises. In Shillong households, a combined system of collection is in practice, and all kinds of refuse are stored in a variety of containers such as cardboard cartons, plastic bags, bamboo baskets, tin, iron (or) plastic buckets are mostly in use. The method of storage, the type and capacity of containers used by different socio-economic groups are dealt within detail in Chapter (IV) Four.

6.9 (b) Communal Storage:

Quite, commonly the household waste one thrown indiscriminately into the street most part of the city is not having proper communal storage bin. Therefore, people are throwing along the roadside. These communal storage sites are a nuisance to the people who live nearby but they could be eliminated only with the universal use of household bins, a solution that may not be practical in some areas.

Only one type of stationary widely used in Shillong. The municipality only in few areas that are either masonry built at selected points, or cylindrical reinforced cement concrete tubs without bottoms provides stationary units. A majority of the community also uses concrete bins of various capacities.

In general, the stationary units are not advisable, because the wastes are quite often strewn around the site, by animals and people (rag pickers). Many residents do not properly deposit their household waste into them. Flies and other disease vectors often breed in them when the containers are left open.

6.10 Street Dustbin Storage:

Dustbins are essential if the waste generating behaviour is to be controlled (Bhinde, 1976). Metallic dustbins are not in use in Shillong, mainly because of the high moisture content of the refuse and because the rotting organic matter in the refuse leads to metallic corrosion. Hence only storage bin made of concrete and having a 100-litre capacity are generally used few selected area fixed. Municipality constructs all these cement structure, however, portable units such as large street drums containers which are liftable, are also used in marketing area, like Bara Bazar. The municipality do not provide bins to all the area, expect few places. Field investigation revealed that the placements of dustbins are often not within the reach of all the households for whom they are meant. Their spacing varies from division to division, ward to ward so most of the residents throw their household refuse near the street corner. Most of the areas do not have proper dustbin. There are fewer areas like Rynjah, Lower Rynjah, Nongmynsong, Happy valley, Assam Bazar, Madanrting, Nongthymmai, Mawlai and even the Municipality areas do not have dustbins at all. Usually people dump all the garbage along the roadside and burn them.

The inadequate provision of dustbins is mainly due to low production of dustbin by the Municipality Corporation. Under Section 195 of the Shillong Municipality Act, the municipality must provide dustbins in each ward and areas, but the response has been very poor. The mere provision of dustbins does not ensure their proper utilisation. In most part of the city, no receptacle for the storage of refuse was used. Stationary concrete dustbins were found damaged in many placed. Damaged dustbins formed a part of the refuse thrown indiscriminately around it and the very purpose for which the dustbins were provided has

been lost. Rag pickers collecting rags, paper, etc. take the refuse out of the dustbins and leave it outside after collecting whatever they want. It is also a common sight to see dogs, and cats seeking food crumbs from the garbage and they contribute their share in scattering the refuse. Where the dustbins are located on the sidewalks in business centres, the pedestrians avoid them and instead walk along the middle of the busy thoroughfares.

6.11 Waste Accumulation and Street Cleaning:

The streets are usually cleaned after the collection of wastes are swept and heaped or deposited into the dustbins nearby. However, the cleaning or sweeping of street is "a simple and humble occupation that rarely requires technical interest" (Flintoff, 1976 and Mukherjee.R 2002). Cities like Shillong spend nearly half their solid waste budget on street cleaning. Much of the cleaning work arises directly from failures in public behaviour, on the part of the people (public) such as indiscriminate littering of the streets. A high proportion of the street waste remains uncollected, due to the inefficient refuse collection (Subramanian, 1985). The street wastes of Shillong city are of three main categories (a) Natural wastes, (b) road traffic wastes, and (c) behavioural wastes.

Natural wastes include fallen leaves, blossoms and seeds of roadside trees and plants. Road traffic wastes include vehicular deposits of oil, rubber and mud and in-addition there is the accidental spillages of vehicular load. At large construction sites, the excavated soil or demolished materials is often, removed and dumped along the sides of nearby roads.

The main sources of street waste is litter thrown by pedestrians and households and shop wastes swept or thrown out of private premises instead of being stored in containers.

Human spittle and excrement of domestic pets also form a part of street wastes; dust contaminated by dried spittle and excrement is a serious health hazard. The cost of removing wastes scattered in the streets is much higher than the cost of collecting similar wastes placed in containers such as domestic dustbins (or) other containers.

6.12 Manual Street Cleaning:

The streets in Shillong city have two distinct paved surfaces. The highways for vehicular traffic and footpaths on the both sides for pedestrian. The footpaths are slightly elevated and are separated from the highway by a kerb and a channel, which is the lowest part of the road. The channel serves as a drainage outlet during rains; it is provided with drain for the water to reach the main underground drainage system. Generally, in a hilly place during rainy season, all the water drain to the lowland. The surface of the highway is seldom swept because the turbulence caused by fast traffic blows the dust and litter away from the crown of the road and deposits it in the channel. Thus, street sweeping in Shilling city has to be performed by cleaning both footpaths and channels. Footpath wastes are mainly light litter and a little dust in the channel, however, the proportion of dust and heavy wastes is usually greater.

In Shillong city, the Municipality employees and cantonment Board employees sweep 60 percent of the roads and streets manually. The sweepers are equipped with brooms and shovels. The brooms used in Shillong city are of two types: (a) those consisting of the midribs of the coconut leaflets and (b) long handled wooden brushes with the brooms. The

street wastes are collected into small heaps, which are then removed in baskets and dumped into the dumping site.

The sweeping is usually done by a team of 3 to 4 persons who adopt a division of labour between them – sweeping, collecting and dumping the refuse into the vehicle.

Mechanical sweeping is completely absent in Shillong city. The sweeping normally/generally precedes collection of waste, and is done during the daytime. Most of the city's main places like busy market and business areas are cleaned only during daytime. Sweeping is done in the day time in two shifts, i.e., 6 to 10 am and 12 to 2 pm due to lack of manpower ?. They are unable to cover all the areas in a day but in practice, only 50 to 60 percent of this length is covered because of inadequate manpower.

6.13 Collection Operation:

Solid waste collection, in the process of picking ups from many storage locations the discards of waste of a community and haul them to a processing or disposal site (Wilson, 1977, and Bhattacharya.U, 2001)). As the generation patterns become more widespread and the total quantity of wastes increases, the logistic problems associated with the collection become more complex.

Solid waste collection in the city can be divided into unit operation such as "pick up", "haul", "on-site" and "off-route"; together, they constitute the total labour requirement. In studying the collection operation, it is important to understand the various functional elements and infrastructure available for refuse collection and these include also the mobile

refuse collection squad, refuse collection vehicles, frequency of collection and collection hours and trips.

6.14 Refuse Collection Vehicles:

The refuse collection system in Shillong city has been only a slight improvement in the vehicles of refuse collection mainly due to the constraints imposed by socio-economic and physical conditions.

Two types of refuse collection vehicles are widely used. They are (a) 7 Ordinary open body truck (b) 9 hydraulic trucks and 2 Three-wheeler autos. All these municipality vehicles can pick up solid waste within the municipality area and carrying about 100 metric tons of solid waste to the dumping site at Mawiong. The cantonment board look after Civilian area of Jhalupara and defence area. Cantonment board has two trucks to handle the waste. The board collect the waste manually everyday and handle 15 -18 metric tons of waste every day disposing at mawiong. The trucks are used in the street and broad roads with the advantage and the truck are used where the vehicles can move quickly.

Trucks are used, to not only collect refuse from the roads, commercial and market areas but also carry the refuse collected by truck to the disposal sites. More than 60 percent of the collected refuse, is handled by trucks, either from the transfer stations (tipping platforms), or directly from the various divisions. There is only one type of open body without facilities used for collection of refuse in the city. Open body trucks handle more than 60 percent of the refuse.

At present 7 ordinary trucks, 9 hydraulic trucks and 2 Three wheelers are being used for refuse collections.

6.15 Frequency of Collection:

The frequency of collection is an important factor, which fixes the operational changes of the cleaning department. It has a direct relationship with cost. With more frequent collection of wastes, the cost of collection will also increase.

In cities like Shillong, solid waste cannot be stored for any length of time and therefore frequent collection is essential. The frequency of collection depends on whether it is a separate or combined system of refuse collection. In Shillong, the frequency of collection varies from once daily in some areas to once in a fortnight in a few others. The major areas and roads, markets and areas of commercial establishments like Police Bazar, Bara Bazar, Laitumkhrah and Cantonment areas are generally, cleaned once daily. In old residential areas with dense population such as Jail Road, Laitumkhrah, European Ward, Police Bazar, Mawprem and Mawkhar, the collection is once in a day.. In Institutional areas such as, Laitumkhrah, DonBosco, Fire Brigade and Laban, are alternative days. The frequency is very low in the peripheral zones (Non Municipality) of the city like Umpling, Rynjah, Nongmynsong, Mawlai, Madanrting, Nongthymmai, etc. These areas not come under municipality. After Aus-Aid project these areas are cleaned twice in a week with the help of Urban Affair Department. These areas are looked after by the local MLA /head man in these five urban units.

6.16 Collection Hours and Trips:

Every day 12 trucks from the truck depots roll out for refuse collection on all working days except on Saturdays, Sundays and some public holidays of national importance. When the crew work in the morning only, on an average, the trucks carry about 100 metric tonnes of refuse per day. The refuse collection crew collect the waste daily in a main busy place and other places they used to collect in alternative days. The crew may change the routes for their convenience. Hence, there is no systematic routing pattern. With the refuse collected, they go to the nearest tipping platform and transfer the refuse into the waiting trucks, which carry the refuse to the disposal sites. Open type trucks have mostly four (or) five men in the collection crews.

6.17 Pick-up Operation:

"Pick-up operation" refers to the process of lifting and loading the refuse heaps at the collection points on the refuse carrying vehicles. The pickup operation consists of two components – one is the pickup density and the other is the pickup time. Both are considered important as governing factors of refuse collection, for the efficiency of refuse collection in an area is measured by means of pickup density and pickup time.

The pickup density of an area may be, expressed by the number of containers (dustbins) for each kilometre of road or street length. In the absence of dustbins on all the roads and individual containers in household in Shillong, the number of houses for every kilometre of road length is taken as the measure of pickup density. This is based on the fact that each household collects its own garbage and dumps it at convenient points along the

roads or streets, from where the collection crew pickup for disposal. The spatial patterns pickup density within the city varies widely. In the very densely populated areas such as Laitumkhrah, Police Bazar, Bara Bazar market area, and Mawkhar etc. shows comparatively high pickup density. The sparsely populated areas of the city and peripheral zones have a low pickup density. The areas of high pickup density correspond closely with the areas of high population density and the areas of large quantities of solid waste collection and vice-versa. Broadly speaking, the high pickup density of the city core declines gradually towards the periphery as in the case of population density and the quantity of solid waste collected.

The pickup time is the length of time taken to remove the contents of the first dustbin at the first collection point to the last bin from the last collection point. The pickup time expressed in man – minutes per tonne of refuse collected (Wilson, 1977).

6.18 Haul Operation:

The haul operation is the conveyance of refuse from the collection route to the disposal site. It is a non-productive activity, which includes the 'haul distance', haul period' and 'off routes'.

The haul distance is the distance travelled by the vehicle from the depots to collection points and to disposal sites. The number of trips made by various types of collection vehicles is not the same as some make two trips and others only one trip in a day.

'Off route Operation' of the unit includes all the time spent by the collection crew on activities such as breakfast, coffee/tea, resting, minor repairs to the collection vehicles and discussions with supervisors and inspectors during either collection or haul operation.

6.19 Transport:

Shillong Municipality does not have proper tipping platform; the refuse is transferred manually to the trucks. The trucks carry the refuse from the disposal site to the dumping ground. Shillong Municipality and peripheral areas do not have proper disposal facilities. So the local residents dump the refuse directly into the nearest dumping site (or) in unauthorised low lying areas, Thereby creating serious sanitation problem.

6.20 Treatment and Disposal:

Better refuse treatment and processing techniques are needed to improve the efficiency of the operations and to recover usable materials and energy. Though a variety or techniques are currently available in the country, none of these are adopted in Shillong city. Materials and energy recovery is not done mainly because the city refuse contains a very low percentage of recoverable materials. The reason for this is that most saleable and recoverable materials are retained either at the sources or by the waste generators with the rag pickers handling most for reuse or resale. However, a part of the refuse is converted into compost. This is being the only refuse treatment method adopted in Shillong. The disposal system is still the conventional landfill dumping at marten in Mawiong; an area located about 6 km north of the city. In order to comply with the direction of the honourable Supreme Court, Aerobic Compost Plant of capacity 100 TPD is being set up in the existing dumping site.

Plate No-1 Open Dumping Site, Jhalupara

Plate No-2 MUNICIPALITY Open Dumping Site, Marten

6.21 Disposal Operation:

In the recent past, there have been many improvements in solid waste disposal methods, but in Shillong however, the dumping in open, low-lying areas remain the main method of disposal.

(i) Open Dumping:

Roughly, of the total 120 metric tonnes of solid waste collected, waste is now disposed in dumping grounds owned by Municipality Corporation at Marten in Mawiong, an area located about 6 km north of the city on the Shillong – Guwahati highway.

(ii) Composting

Composting is the biological conversion of organic solid waste to produce a brown, peaty stable material, the main constituent of which is humus. Organic matter is a major constituent of domestic refuse (44 %) which is therefore ideal for conversion into organic fertilizer by composting. This has long been in vogue in the city, as an economic method of refuse disposal.

6.22 Sanitary Facilities:

The Shillong Municipality Board has been in existence for more than 100 years. Garbage management is one of the obligatory functions of the Board within the Shillong Municipality area. The Board recently introduced the point to point collection system in order to do away with the immediate storage/dustbin system, whereas the disposal system is still the conventional land fill dumping at Martin in Mawiong.

6.23 Sewage System:

Due to the rugged terrain and undulating topography, underground sewage systems do not exist. The disposal of night soils are by way of individual or common household septic tanks and in some areas, pit latrines are still in use. The roadside drains take care of the storm water as well as sullage from the developed areas. These roadside drains convey the wastewater by way of gravity to the natural drainage channels of the area, which are usually the 2nd and 3rd order tributaries of the two stream of the city, viz., the Umshyrpi and Umkhrah streams.

6.24 Problems of Garbage Management in the City:

Due to lack of proper solid waste management plan, people's awareness and limited resources of the board, the problems of solid waste management still exist which can be outlined as follows:

6.25 Problems of Collection:

Lack of proper routing plan of the present system, resulting in mistiming between the general public and the Board's vehicles. Some areas are not covered regularly under the present system due to inaccessibility and narrow approaches, resulting in the use of dustbins. These intermediate storages are usually overflowing, as they are not serviced regularly.

People are still throwing their wastes (including infectious waste) in open areas, streets, nearby drains and streams resulting in choking, pollution and flooding of the drains or streams.

The shortage of manpower on the part of the Board has also resulted in the unsuccessful implementation of the existing system.

6.26 Problems of Transportation:

The garbage that is collected from the houses (or) dustbins are transported by trucks to the dumping place. All these do not cover the garbage during transportation causing severe health hazards, air pollution, and spillage and creating an unpleasant sight.

The shortage of vehicles and especial smaller vehicles for narrow roads has mostly hampered the day-to-day work of the Board and also leave many areas inaccessible by trucks uncovered under the present system.

6.27 Lack of Scientific Disposal:

Lack of scientific disposal technique has cause, severe environmental degradation and also deprives the Municipal Board from generating the revenue from the garbage collected.

6.28 Lack of Public Awareness:

Last but not the least, the lack of public awareness regarding the necessity for proper disposal of garbage in the past and present system of solid waste management proved in effective / inefficient.

6.29 Summary of Findings:

1) The basis of effective solid waste management and decision-making is reliable, provided information is available on the existing system being managed (Shelat, 1976), Mukherjee (2002). A major requirement in the design and development of a satisfactory management system is an in-depth knowledge of existing management studies. It has a variety of uses relating to technical decisions, operation, and economic feasibility of alternatives, improved or unique system for collection, transportation, disposal and resource recovery (APWA, 1970). In this chapter, an inventory is being made to study the existing solid waste management and practices in Shillong city.
2) The municipality was constituted in 1910. The population of Shillong municipality area, which was 87,659 in 1971, rose to 1, 32,876 in 2001, increase in three decade being 45,217. The total municipality area of the town is 10.36 sq. km., i.e., there has been no extension of municipality boundaries, for forty years. The last municipal election was held in 1967 and election has not been held on the ground of fresh delimitation of wards. The municipality continues till today under the control of a chief executive officer.
3) At the state level, there is a municipal administration department in the secretariat, and one secretary of urban affair who is looking after the administration of urban local Government.
4) A study in "micro-politics" by Bhattacharya U. (2001) shows that there has been both stagnation and status quo in the municipal administration of Shillong. Nowhere

in India can one find that the elections for the municipality has not been held for forty (40) years in Shillong municipality. It leads to a poor performance of the municipality in almost every aspect of civic life.

5) There was a large influx of population into the city between 1981 and 2001 (an increase of 65.2 percent) and also the inclusion of new sub-urban area within the city limits has increased the responsibilities of the municipality. There is a corresponding increase in the output of rubbish in the city and therefore, the municipality faces severe problems.

6) The municipality does not provide bins in all the areas. Field investigation revealed that the placements of dustbins are often not within the reach of all the households for whom they are meant. Their spacing varies from division to division, ward to ward; due to inadequate provision of dustbins most of the residents throw their household refuse in street corners. Most of the areas do not have proper dustbin.

7) Under Section 195 of the Municipality Act, the Shillong municipality must provide dustbins in each ward and areas, but the ground reality does not show total compliance.

8) The main sources of street waste are litter thrown by pedestrians and households and shop wastes swept or thrown out of private premises instead of being stored in containers. The cost of removing wastes scattered in the streets is much higher than the cost of collecting similar wastes placed in containers such as domestic dustbins (or) other containers.

9) There is only one type of open body truck without facilities used for collection of refuse in the city. It can handle only 60 percent of the refuse. The garbage that is collected from the houses (or) dustbins is transported by trucks to the dumping place. All these do not cover the garbage during transportation causing severe health hazards, air pollution, and spillage, creating an unpleasant sight.

10) Shillong Municipality does not have proper tipping platform; the refuse is transferred manually to the trucks.

11) Shillong Municipality and peripheral areas do not have proper disposal facilities. So the local resident's dump the refuse directly into the nearest dumping site (or) in unauthorised low lying areas, thereby creating serious sanitation problem.

12) Better refuse treatment and processing techniques are needed to improve the efficiency of the operations and to recover usable materials and energy at the source. Though a variety of techniques are currently available in the country, none of these has been adopted in Shillong city. The disposal system is still the conventional landfill dumping.

13) Lack of proper routing plan of the present system has resulted in mistiming between the general public and the Board's vehicles. Some areas are not covered regularly under the present system due to inaccessibility and narrow approaches, resulting in the use of dustbins. These intermediate storages are usually overflowing, as they are not serviced regularly.

People are still throwing their wastes (including infectious waste) in open areas, streets, nearby drains and streams resulting in choking, pollution and flooding of the drains

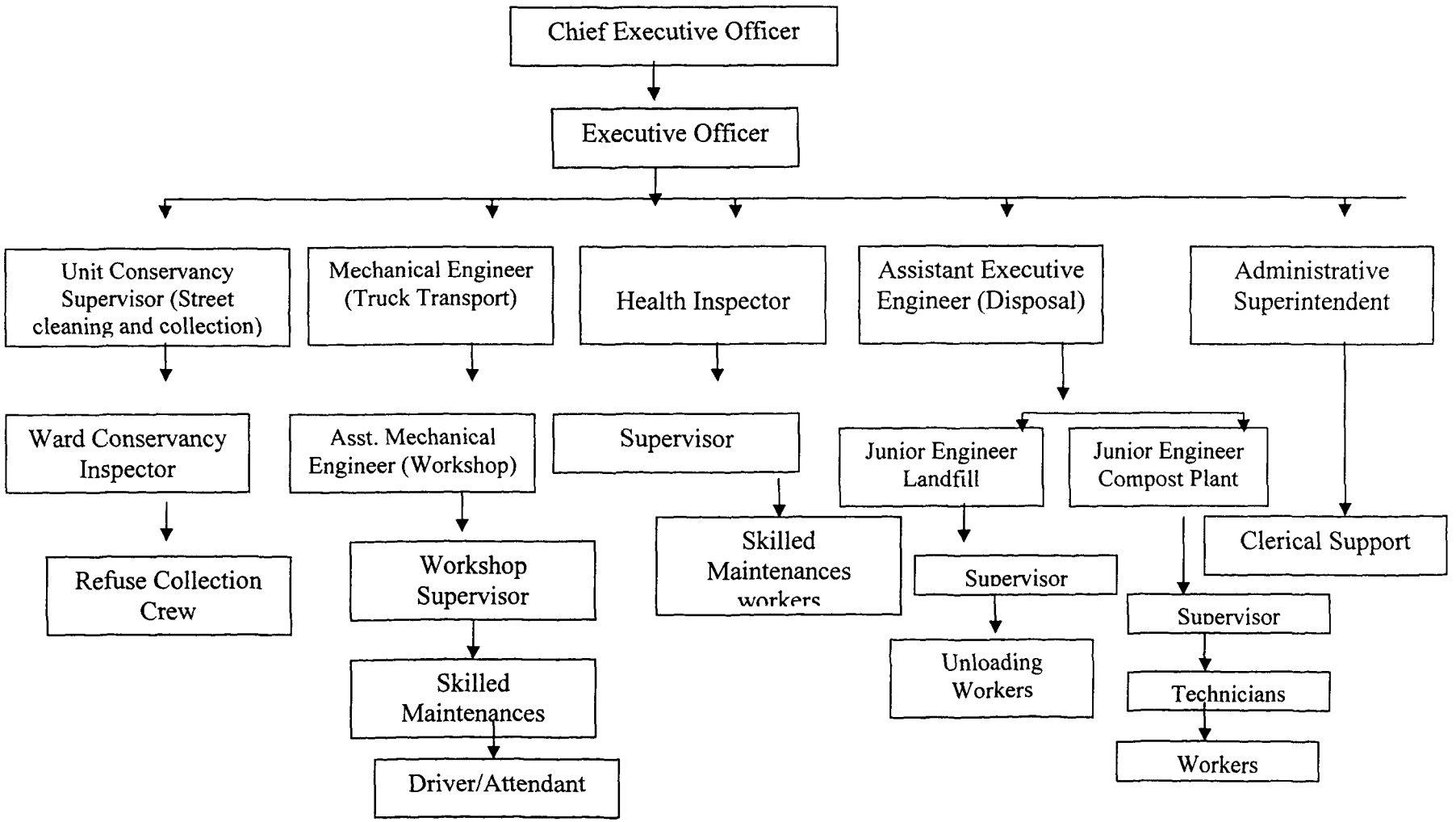
or streams. The shortage of manpower and vehicles, especially smaller vehicles for narrow roads has mostly hampered the day-to-day work of the Board resulting in the unsuccessful implementation of the existing system.

14) Lack of scientific disposal technique has caused severe environmental degradation and has deprived the Municipal Board from generating revenue from the garbage collected.

Figure 6.2

SHILLONG MUNICIPAL BOARD

Solid Waste Management Division – Administrative Structure



CHAPTER – VII

Conclusion

7.1 Summary:

With accelerating urbanisation in India, the country may witness significant changes in the manner in which the urban centres of the twenty-first century are organised, both quantitatively as well as qualitatively. As a high-density, large-populated country, the choice for greater urbanisation both by way of rural transference of population as well as a by-product of industrial/service sector growth, is but inevitable and in a way necessary to unburden huge rural masses without either a resource base or economic opportunities for a better life in rural areas. Part of this process will bring in positive results in life-style changes in the population and part of it will be a number of negative consequences arising out of this surge in urban population--the crucial question, inevitably, will be the quality of the urban environment.

The current study precisely tries to address the issue of urban environment, particularly the problem of solid waste management in the sprawling urban agglomeration of Shillong in the State of Meghalaya, India, perched at an altitude of 5000' above the MSL and spread over a vast sprawl of 74 sq. Km. area with an estimated current population (2009) over 500,000. The city consists of 7 urban units including two statutory townships of Shillong. The city was known for its salubrious climate and cleanliness during earlier days.

With rapid rise of population (of the UA) and major part of the urban agglomeration being outside the statutory townships, the quality of urban environment has deteriorated visibly—a major component of which has been the issue of solid waste management of the city. This study, therefore, tries to identify the seriousness of the problem, its causative factors as well as the management practice, which undoubtedly need substantial improvements.

The broad findings of the study can be summarised as follows:

1) One of the issues that comes to the fore is the gross under-enumeration of population of the UA, particularly the Shillong Municipality during 2001 population census (Chapter III). Once the overall population indicated is far below the actual, the Municipal authorities and the concerned (state) Government departments allocate funds and work accordingly on a lower scale, which results in poor quality and management of solid waste that is to be properly disposed.

2) In Chapter V, the study indicates even the estimates of per capita solid waste generation/ day (NEERI study, e.g.) is a gross under estimation (270 gram/day) as against the actual estimates (based on field works) of 450 grams/day, which leads to a far larger quantity of solid waste generated in the city.

3) Further, the estimates of income elasticities of solid waste generation indicate that as income rises, there is a disproportionate rise in solid waste generation by households. Therefore, taken together the three points above, the municipal and government managers provide gross under estimations of solid wastes generated and the type of resources and management conditions required, leading to serious under performance of the concerned agencies.

4) Being the State Capital, it is the busiest administrative centre in the state. It also serves as one of the main commercial and institutional centre of the entire North Eastern Region. At present, the development of residences has spread in all the three directions along the major arteries namely, towards Mawiong in the north, upper Shillong to the southwest and towards Madanrting in the southeast (Table 3.2).

5) The land use pattern of the city also indicates serious imbalances. Shillong municipality has only 56.62 hectares, i.e., over 5 percent of the Municipal area under commercial use. The total area under administrative use is 117.93 hectares or over 10 percent of the total municipal area. The administrative area is concentrated in localities around Barik, IGP, Lower Lachaumiere (European Ward).

6) Among the residents of Shillong, majority of the people (43 percent) dispose off their household waste at least once in a day whereas 48 percent dispose off twice a day (Table 4.12). As regards the nature of disposal of waste, bulk of the respondents (54.4 percent) disposes off its waste in the open space (Table No 4.16) of the backyard of their houses. About 21.6 percent of the respondents use municipal or outdoor collection sites for disposal. This means that only about one-fourth of the respondents use facilities provided by Shillong Municipality for the collection of waste.

7) Only 27 percent of the citizens state that the Municipality collects wastes on a daily basis. In all probability, this section of respondents (Table 4.17) lives in the

main residential areas. Interestingly a significant 23 percent of the respondents have no regular access to this service whereas 21 percent availed the same only once in a week.

8) Most of the solid wastes (63 percent) is generated from the households, particularly food wastes. According to the study, 261 Kg of wastes are generated from a total of 125 sample households whose population is 583. This amounts to nearly 450 grams per person per day. This is more than the average waste generated by an Indian, which is 370 Gram (World Bank, 1982) per person per day

9) From the Table 4.21, it has been observed that more than 50 percent of the respondents burn the yard waste, especially several times a year during the dry season, while about 31.72 percent dump the waste either in the backyards of their houses or nearby nullahs and natural drainages, in which city abounds, leading to shrinkage of the drains and pollution of the limited water bodies. It should be checked

10) The table 4.23 shows that an overwhelming 84 percent of the respondents think that the problem of solid waste management in Shillong is a serious one and that it requires better management.

11) The efficiency of conservancy services in the city is also reported to be poor or very poor (81 percent). Conversely, only 19 percent appears to be satisfied with the services (Table 4.24).

12) Almost the entire respondents (95.08 percent) report no access to dustbins/ dumping site in close proximity within the localities provided by the municipality. It's only a dismally low 4.92 percent of the people who report of availing this facility. This reveals the slack of attitude of the municipal regarding the issue of sanitation (Table 4.25).

13) The Table 4.33 shows that most of the commercial waste (100 percent) is dumped at some nearest points or simply left in front of the shops to be lifted by the conservancy staff next morning. There appears to be no specific municipal by-laws in management of solid waste in commercial areas at Shillong. The containers used for collection and storage of the solid waste are not very different from those used in residential areas. Card board boxes are preferred by 63.3percent of units, 18.2 percent use baskets; the establishments make their own arrangements, as per their own convenience (Table 4.34).

14) Almost 36 percent of the establishments deposit the garbage in collection points outside their immediate locale, 27.3 percent of the shops choose the open space behind their establishments and 18.2 percent use street dustbins (4.35). There is apparently no system of accountability on part of the owner/management of the commercial establishments for collection and disposal of the solid-waste, nor any specified method that addresses the issue.

15) Most of the commercial wastes are removed by the municipality as well as by their own labourer (Table 4.37), 64.3 percent of the waste is removed by the commercial establishments and 35.71 percent by the municipality. Ninety percent

of the refuse is collected daily and only 10 percent is collected on alternative days by the local authority (Table 4.39).

16) In 20 percent of commercial establishments, the waste is re-traded/ recycled, especially of metallic materials, cardboards and other packaging materials depending on the natures of goods and services dealt by the particular establishment (Table 4.40).

17) Most of the institutions widely use different types of containers like plastic bucket, tin, bamboo made basket, cardboard for storage (Table 4.45). Plastic container accounts for 79.6 percent, followed by tin 18.5 percent. The size of the containers ranges from 5 to 20 litres.

18) Most of the Educational Institutions follow different methods of disposal of their solid waste (Table 4.46); 54 percent by burning and 46 percent dumping the waste at designated places.

19) The study has found that 93.3 percent of the (Table 4.54) hospitals use plastic containers for refuse storage and others use tin and metal bins and concrete bin for outside refuse storage. Carrying waste by hand is the primary means of waste disposal and in most of the hospitals mechanical system of refuse handling is very rare.

20) Most of the hospitals dispose their waste in different ways: 38.46 percent dispose at common storages in the hospital, 15.38 percent at curb-side collection points, 15.38 percent at street-side bins and 30 percent at open spaces around the hospitals (Table 4.55).

21) Medical residues/wastes are generally mixed with other wastes, which are contaminants (Table 4.56). 57.14 percent of the waste removed by the hospital authorities, 28.57 percent of the waste is removed by the municipality, and only 14.29 percent waste is removed by the Cantonments Board (Military Hospital).

22) The types and quantity of solid waste in SUA from different sources, as it is generated on a day-to-day basis and on the basis of sample data collected from selected localities. Types refer to classification of waste by material types, principally, (a) Paper and allied products, (b) Plastics, (c) glasses, (d) Tins and (e) Miscellaneous materials. Quantity refers to quantity of waste generated by sources, like households, commercial establishments, institutions and hospitals & medical centres as special cases, because the waste they generate are contaminated and needs careful and specific handling by law. It is important to measure the density of solid waste for different part of a city or an area. Density of solid waste refers to the total volume of refuse estimated for one cubic metre (m^3) when refuse in disposed off in sanitary landfill or open dump.

23) It was observed during the fieldwork that among the different tribes and non-tribes of the majority people comes under different income groups. The share of 20.8 percent Scheduled caste 20.8 percent, 29.2 percent of scheduled tribe and others 50 percent of the people comes under Non-tribes.

24) Table 5.2 shows that nearly 75 percent of the food wastes are generated from the (households) low-income group, as well as 62.60 percent of the high-income group, but middle-income group produce only 58.7 percent only. Regarding non-

food waste nearly15.80 percent high income group, 12.08 percent middle income group and 10.9 percent of low income group generate Non-food waste.

25) As regards the nature of disposal of waste, (Table No.5.4) majority 54.4 percent of the respondents have reported that they dispose off their waste in the open space of the backyard of their houses. About 21.6 percent of the respondents have reported that they use municipal or outside collection point for disposal of their waste. It can be nearly ¼ of the respondents use facility provided by Shillong Municipality for collection of waste.

26) Regarding the commercial waste, it is an important component of municipal solid waste disposal system. There is no data available regarding the exact amount of commercial waste generated with in Shillong. The general composition of commercial waste is as follows: 10.32 percent paper, 11.76 percent plastic, 27.84 percent wooden box, 4.32 percent food grain, 3.36 percent tin, 0.84 percent paper box/cardboard and 41.56 percent rest of others. Total production of different category of waste produced from 10 commercial establishments was 208 Kg of waste/day (Table 4.47). The waste generated varies with the size of the establishments and the types of businesses. The waste generated ranges from 2 to 86 kilograms. In about 8.52 percent of the establishments, it is in between 10 kg to 20 kg /day. However the amount of solid waste generated in the whole market is approximately 12-24 metric tons per day. Hence 50 percent of the waste generated per day is not being disposed of by the municipal authorities.

27) Regarding disposal and management of bio-medical wastes, it is causing a serious impact of our surrounding environment. There are 12 hospital / nursing homes, 20 dispensaries/clinics/ pathological laboratories and one veterinary hospital in the city. The amount of bio-medical waste generated is calculated according to the standard norms, i.e., per bed/patient/day basis assuming that each patient would generate on an average about 1 kilogram of waste per day, of which, 25 percent consists of infectious, pathological and anatomical waste (Table 4.46). Various category of hospital generate 570 Kg of waste per day in Shillong (CPCB manual 2000).

28) The financial constraints, institutional programs within the departments, fragile links with other concerned agencies, lack of suitable staff, and other allied problems prevent the urban local bodies from delivering and maintaining the efficient waste management system in this context, if is also necessary to harness and integrate the role of three other emerging actors in this field–the private sector, NGO's and rag-pickers – into the overall institutional frame work.

29) Non-governmental organization can play an important role in effectively projecting the community's problems and highlighting its basic requirements for urban services. They could help in organising the ragpickers into waste – management associations / groups under the supervision of the urban local body and the relevant residents association etc.

30) The municipal administration of the city remains much desired. Under Section 195 of the Municipality Act, the Shillong municipality must provide dustbins in each ward and areas, but the ground reality does not show total compliance.

31) Another source of street waste are litters thrown by pedestrians and households and shops since there is no provision of larger container bins in busy commercial areas. The municipality provides 5 litre capacity way-side bins, which is full in an hours time and there is no one to empty them. In stead, there could be provision of large 200/400 litre bins which could be emptied once in the morning and once in the afternoon. Often citizens are blamed for not having good civic habits, which is partially true, but absence of alternatives make the shoppers and pedestrians to throw litter around the streets.

32) The disposal system of the municipality leaves much desired. There is only one type of open body truck without facilities for collection of solid waste in the city. The transportation system, generally handles only 60 percent of the refuse. As a result, the remaining 40 percent remains accumulating at collection points for days, often for moths. The open trucks while carrying the waste often spill on onto the street that may cause severe health hazards, air pollution, and spillage, creating an unpleasant sight. Shillong Municipality does not have proper tipping platform; the refuse is transferred manually to the trucks.

33) The suburban townships (non-municipal) of Shillong Municipality areas do not have proper disposal facilities. So the local resident's dump the refuse directly into

the nearest dumping site (or) in unauthorised low lying areas, thereby creating serious sanitation problem.

34) Better refuse treatment and processing techniques are needed to improve the efficiency of the operations and to recover usable materials and energy at the source. Though a variety of techniques are currently available in the country, none of these has been adopted in Shillong city. The disposal system is still the conventional landfill dumping.

35) The shortage of manpower and vehicles, especially smaller vehicles for narrow roads has mostly hampered the day-to-day work of the Board resulting in the unsuccessful implementation of the existing system. Lack of scientific disposal technique has caused severe environmental degradation and has deprived the Municipal Board from generating revenue from the garbage collected.

7.2 Conclusions:

In some respect, what one observes as the solid waste management system in Shillong UA is not very different from any other Indian cities or even South Asian cities. However, larger cities and city corporations have devised systems including out-sourcing of work. However, many of them could do so, because their revenue base is bigger and better. In case of Shillong, (i) the city is fragmented into seven units with only two having municipal authorities and therefore, lacks any central authority and command structure. Moreover, the traditional laws (under provisions of Sixth Schedule of the Indian Constitution) severely limit the powers of the elected State Government into the

management of the non-municipal townships. (ii) Second, practically there is no revenue base of the city and all municipal activities are carried out with grants from State Government or from Central Government funding. Therefore, it is nearly impossible for the urban administration to invest in better management practices in the city. (iii) A more serious problem arises, as pointed out earlier is the very estimation of population of the city and the quantum of solid waste they generate/day, thereby causing a huge under estimation of the task of solid waste management by as much as at least 3 times. If there is no true picture of the problem presented, it is obvious no management practice can be adopted to deal with the situation, even if there is no funding or man-power constraint. (iv) Further, there is an absolute lack of citizen's participation in the municipal affairs, since for political reasons, municipal elections for SMB have not been held after 1967 (!) How does one ensure accountability and feedback from the grass-roots level, if there are no representatives at the municipal level. This has become a critical issue. The solution to this, of course has to be a political one. (v) It is imperative that the city presents an integrated management of solid-waste, water supply and drainage where the plans and resources could be deployed over the entire seven townships, even though their civic administration remains independent for whatever reasons. (vi) It is important also that NGOs, CBOs and other non-governmental agencies including companies develop partnership with the government agencies for more effective management of the city. Some start in this regard was initiated, but over a decade it remains where it was. Without an effective self-governance system, it is not possible to see an improved urban management system.

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