REPORT

OF

COMMITTEE ON URBAN WASTES

REPORT—PART I

AND

APPENDICES—PART II

GOVERNMENT OF INDIA

MINISTRY OF WORKS AND HOUSING

NEW DELHI

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COMMITTEE ON URBAN WASTES

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25. In view of the fact that dumping of wastes in water constitutes a definite health hazard, it should be prohibited by law. (Para 4.03)

26. Local authorities have to be pursuaded to employ the methods of composting and sanitary land-fill in accordance with the local needs keeping in view the objective of re-cycling of the wastes for maintaining soil fertility. (Para 4.04)

27. Incineration of wastes should be prohibited generally wherever it is being practised, excepting in hospitals. (Para 4.05)

28. In the interest of sanitation and public health, the local authorities should invariably ensure carriage of refuse in covered vehicles particulary the slow moving ones. (Para 4.14)

29. Steps should be taken to make the local bodies to comply fully with the instructions on the supply of protective equipment to sanitation workers. (Para 4.15)

30. Steps should be taken by the local authorities to ensure necessary precautionary measures at the disposal sites. (Para 4.16)

31. The State Governments should reiterate the instructions and orders to the local authorities about disposal of night soil by sanitary methods. (Para 4·17)

32. This aspect should also be studied in depth by the Director of Local Bodies during periodical inspections as is done in case of general administration and audit and accounts. (Para 4.19)

33. Efforts to educate people about sanitation problems and advantages of cleanliness should be stepped up through mass media, educational institutions, voluntary agencies, social organisations, seminars, periodical campaigns, etc. (Para 4.20)

Chapter V—COMPOSTING

34. Keeping in view the necessity of recycling wastes for manurial purposes, composting may be made obligatory on the part of local authorities. (Para 5.21(1))

35. Depending on the local conditions, all compostable material should, as far as possible, be utilised for composting and the remaining material disposed of by sanitary land-filling. (Para 5.21(1))

36. The present practice of dumping night soil with city refuse should be banned. Night soil should be utilised either for composting with due health safeguards or it should be trenched properly. (Para 5.21(2))

37. Appropriate rules and bye-laws on composting be framed for the guidance of the local authorities. (Para 5.21(3))

38. The State Governments should revitalise the scheme of urban composting and provide financial and technical assistance for the purpose to the local authorities. (Para 5.21(4))

39. In the sewered cities, the sludge may be utilised with city wastes for composting. For this purpose, the composting grounds should be situated as near the sewage disposal works as possible. (Para 5.21(5))

40. Steps should be taken to ensure quality of the compost. The extraneous materials (like brick pieces, iron, glass pieces, leather, rags, etc.) should as far as possible be sorted out of the refuse before composting. Depending on the volume of work, mechanical sieving plants be set up in large cities. (Para 5.21(6))

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SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Chapter I—INTRODUCTION

1. The Government should take adequate steps to ensure proper implementation and follow-up of the recommendations made by the Committee. (Para 1.11)

Chapter II—PRESENT STATUS

2. While some of local authorities were not contributing adequate finances to the basic service of wastes disposal, some other were spending high proportion of their income leaving very little for other services. This reduces the status of the local authorities to more or less 'limited sanitation authorities' in place of their being fullfledged municipal authorities performing wide range of services. (Para 2.09)

3. Less than 25% of the available potential for preparing agricultural manure is being exploited at present. (Para 2.18)

4. In monetary terms, the value of the manure prepared from the city refuse should be tremendous and if tapped properly it can prove to be a stable source of income to the local authorities. (Para 2.19)

5. The refuse bins may be made of special design and affixed at such places where the house-holders could conveniently deposit the refuse into them and also guard against their theft. (Para 2.23)

6. There is a strong case for dealing with the whole question of storage, collection, transportation, disposal, etc. of refuse at the national level and in an integrated manner keeping in view the following basic objectives :—

(a) cleanliness of the cities and environmental pollution control through a well designed and equipped system of collection, removal and disposal of city garbage;

(b) eradication of degrading practice of manual handling of night soil and other urban refuse by provision of suitable handling equipment to the sanitary staff; and

(c) making available enriched compost for agricultural production. (Para 2.24)

7. The services of public cleansing, mechanised transportation and proper disposal of the urban wastes should be put under unified control of a qualified public health engineer supported by qualified junior staff in different disciplines. To begin with, all local authorities in cities with population over one lakh could implement this suggestion. (Para 2.26)

Chapter III—COLLECTION AND TRANSPORTATION OF URBAN WASTES

8. In our climatic conditions lesser than daily frequency for collection of refuse will not be suitable. (Para 3.05)

9. The designs of standardised receptacle developed by NEERI etc. should be well publicised amongst the local bodies for adoption. (Para 3.06)

10. The local bodies may supply the bins to house-holders whose annual income is less than Rs. 6000/-, at subsidised cost for which they may be reimbursed in full by the State and Central Governments. (Para 3.06)

11. The local bodies may enact bye-laws laying down standards for size and shape of bins and to enforce their installation by the house-holders on the lines of powers available to the Bombay Municipal Corporation. (Para 3.07)

12. Effective steps should be taken to do away with the practice of manual handling of night soil and its carriage as head-loads by sweepers as soon as possible. (Para 3.10)

13. Certain types of wheel barrows recommended in the Report of the Transportation and Workshop Group (Appendix IX) and also the models developed by NEERI and CPHEEO should be publicised for wider and effective use. The Government should provide assistance to the local bodies upto 50% of the cost of wheel barrows needed. (Para 3.10)

14. The sweepers be educated and oriented to increasing use of wheel barrows. (Para 3.10)

15. The Government may provide assistance to the extent of 50% of cost of wheel barrows needed in Class I cities. (Para 3.12)

16. We would stress the necessity of properly constructed collection sites and their proper location on the basis of a scientific survey. (Para 3.12)

17. Government should work out a scheme for subsidising or substantially assisting the construction of collection sites. (Para 3.12)

18. An efficient night soil service on the model of Singapore may be introduced in certain selected areas of the cities on a pilot basis during the fifth plan to be extended to cover all non-sewered areas of the cities/towns during the Sixth Plan, till the objective of conversion of dry latrines into sanitary ones is achieved. (Para 3.17)

19. Local authorities should pay special attention to the areas like markets where bulk refuse is generated. By levying a special charge for collection, as is done in a number of countries, they should be able to improve the system of collection as well as removal. (Para 3.18)

20. Where the scale of commercial operations, narrowness of roads, etc. are severe constraints for an efficient removal service, the municipal authorities should consider transferring such markets to alternative sites. Other cities will do well to emulate the example of Delhi in this regard. (Para 3.18)

21. We commend the recommendations made in the report of the Transport and Workshop Group (Appendix IX) on different aspects for adoption by concerned authorities. (Para 3.26)

22. Since switch over to mechanised transport will take time, the transportation of refuse by other means should be made hygienic and less tedious for the workers by providing necessary facilities and precautions. (Para 3.27)

23. (a) A phased programme be prepared, depending on local conditions, for change over to mechanised transport. (Para 3.28)

(b) The selection of vehicles be made keeping in view all relevant factors. (Para 3.29)

(c) In metropolitan and other large cities, the transportation service be developed on operational research methods. (Para 3.30)

(d) The entire operation of transport should be carefully systematised and timed so as to achieve the aim of keeping the city clean and tidy causing least annoyance, inconvenience and nuisance to the citizen and avoiding friction to and obstruction of normal traffic. (Para 3.31)

Chapter IV—SYSTEM OF CITY GARBAGE DISPOSAL

24. To convert dumping into sanitary land-fill does not involve high cost and looking to the health and environmental aspects, we would urge that the local bodies be prevailed upon to adopt sanitary methods of dumping. (Para 4.02)

41. The Ministry of Agriculture and the Ministry of Petroleum and Chemicals may get studies regarding efficacy of enriching the organic manure by admixture of rock phosphate/pyrites conducted early and take steps to put the process in use, if found advantageous. (Para 5.21(7))

42. Procedure for acquiring land for composting grounds should be simplified and if necessary special powers should be given to officers responsible for acquisition of land for the purpose. (Para 5.21(8))

43. In the town planning schemes, specific areas should be earmarked for composting grounds. (Para 5.21(9))

44. Since composting will be advantageous for agricultural operations, the State Agriculture Departments should look into the possibility of providing assistance particularly for transport needed for compost distribution; including loan and subsidy on a temporary basis till the profitability is built up. (Para 5.21(10))

45. The State Governments should encourage exchange of experience in this respect among the local bodies in the State as well as with local bodies in other States who have been able to launch the composting programme successfully and economically. (Para 5.21(11))

46. The State Governments should make a detailed study of economics of composting and provide the local authorities with detailed guidelines for making composting a self-paying proposition. (Para 5.21(12))

47. The present system of selling compost by auction in heaps or cart/truck loads should be replaced by sale by weight and at fixed prices. (Para 5.21(13))

48. The Central and State Governments and the local authorities should take steps to popularise compost through mass media, Farmers' Forums, Cooperatives, etc. (Para 5.21(14))

Chapter VI—MECHANISATION IN COMPOSTING

49. Composting processes and extent of mechanisation should be carefully selected to suit our conditions. (Para 6.17)

50. Where land is available in plenty, it may be desirable to follow a system of windrow composting suitably adopted to local conditions. Where space is limited but skilled manpower is available, it may be desirable to adopt one of the enclosed cell composting methods. (Para 6.20)

51. The location and size of the plants should be so designed as to balance between the haulage of wastes and the economics of size. (Para 6.21)

52. There is an immediate need for assessing and evaluating the utility of available equipments and for introducing new equipments for materials handling. (Para 6.24)

53. We commend the guidelines on mechanisation prepared by the NIDC (Appendix XIII) for adoption by concerned authorities keeping in view certain specified aspects. (Para 6.30)

54. The Committee recommend addition of sewage/sullage to the refuse, keeping in view certain requirements. (Para 6.31)

55. The ideal size for standardisation would be approximately 100-150 tonnes per day/capacity plant. A large capacity upto 300-450 tonnes per day can be provided by providing multiple units at one location. If the population of the city is more than 10 lakhs and the area is more than 100 Sq. Km. then provision of more than one composting plants should be considered. (Para 6.39)

56. Research and development work should be taken up by the institutions for evolving suitable tools and equipments for bridging the existing gap and introducing innovations. (Para 6.40)

57. The concerned Ministry may maintain a list of approved consultants who may be employed by the local authorities for setting up mechanical composting plants. (Para 6.41)

58. (a) The setting up of compost plants and their operations should either be entrusted to the Agro-Industries Corporations or be a joint venture of the local bodies and the Agro-Industries Corporations. (Para 6.43)

(b) Large local authorities who are willing to take the responsibility of setting up and operating these plants may be encouraged subject to certain arrangements. (Para 6.43)

59. It will be cheaper to manufacture compost mechanically than chemical fertilisers on an equal plant nutrient basis. The favourable economics plus the additional advantage of compost being a good soil conditioner should make it popular among the farmers. (Para 6.47)

60. We reiterate the recommendations made in the interim report regarding financial pattern and the management of the scheme at the Central Government level. (Para 6.48)

61. Project Management Group may evolve detailed guidelines to be followed by the State Governments and the local authorities. (Para 6.48)

Chapter VII—MUNICIPAL SEWAGE UTILISATION FOR IRRIGATION

62. In all cities/towns where underground drainage system has been laid, efforts should be made to cover the entire city. (Para 7.14(1))

63. The local bodies should draw up and implement a phased programme to make surface drains 'pucca' as early as possible. A part of the assistance provided to local bodies for general purposes should be earmarked for this purpose. (Para 7.14(2))

64. While formulating National Water Supply and Sanitation schemes specific allocations be earmarked for underground sewerage so that specified targets are achieved. (Para 7.14(3))

65. A self-contained scheme of utilisation of sewage on land may be considered for inclusion in the National Water Supply and Sanitation programme. (Para 7.14(4))

66. The selection of sites and soils for sewage farming be made through close liaision between the State Public Health Engineering and Agriculture Departments. (Para 7.14(4))

67. In the town planning schemes, specific areas should be earmarked for setting up of sewage farms by the local bodies. (Para 7.14(5))

68. The Ministry of Health may lay down standards regarding sewage farming practices in consultation with the Ministry of Agriculture to make the process hygienic and free from health hazard. (Para 7.14(6))

69. The guidelines prepared by the CPHEEO on use of sewage for irrigation purposes may be adopted by the field authorities. (Para 7.14(7))

70. The municipal authorities may supply sewage to the farmers at their fields on usual payment. (Para 7.14(8))

71. Sewage should be adequately diluted to make it less hazardous and also for covering larger areas for irrigation through it. (Para 7.14(9))

72. A special survey should be undertaken jointly by the State Public Health Engineering and Agriculture Departments to study the scope for full utilisation of sewage and to formulate suitable schemes. (Para 7.14(10))

73. The State Governments should make adequate provision in their plans for providing long term loans to the local bodies to undertake sewage utilisation schemes. (Para 7.14(11))

74. Sludge wherever available should be digested to get combustible gas. Raw sludge should be made use of for compost making where it is established that its mixing with compost will improve its quality. (Para 7.14(12))

Chapter VIII—LEGISLATION

75. Since the existing municipal legislation is found to suffer from the following inadequacies in so far as disposal of urban wastes is concerned, the need for comprehensive and coherent law is not only self-evident but is fully justified :—

(a) These Acts are not uniform and differ in emphasis and detail from State to State.

(b) The provisions therein are so scattered that their importance is diluted.

(c) Enforcement on the part of the local authorities is not adequate.

(d) It does not deal with the subject in its proper perspective, treating it as a minor branch of public health to be regulated by rules and regulations or administrative orders.

(e) This function needs to be dealt with as distinct function under coherent legislation.

(f) The definition, classification and methods of disposal of wastes are not enumerated in them.

(g) These laws are only 'enabling' in nature, they do not demand certain specified minimum standards from different partners of the game.

(h) They are somewhat narrow and restricted.

(i) They deal with the problem from the angle of prevention of nuisance, without taking into account vital aspects of scientific and hygienic disposal including recycling.

(j) The laws do not provide for overall control and coordination of whole range of operations. (Para 8.11 to 8.18)

76. (a) It is recommended that the Central Government may discuss with the State Governments the possibility of enacting a central law and after securing their consent proceed to do the needful. In case this course of action is not found feasible, the Central Government should take steps to get a model law prepared for the guidance of the State Governments. (Para 8.20)

(b) A broad frame-work and main attributes of the proposed comprehensive law are indicated. (Para 8.21 to 8.23)

PART I

REPORT

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CHAPTER I

INTRODUCTION

Brief Background

1.1 The collection and disposal of refuse and other wastes is one of the pressing problems of city life which has assumed great importance. With the growing urbanisation as a result of planned economic growth and industrialisation, it is becoming acute and calls for immediate and concerted action. The proper disposal of urban wastes has not only the dimension of preservation and improvement of public health to it but it has great utility and value for agriculture purposes as well. The Ministry of Agriculture had estimated that the city communities which form one-fifth of the population of the country were generating over 12 million tonnes of wastes every year in the form of katchra, night-soil and slaughter house wastes which if properly treated could help in agricultural production immensely.

1.2 While in advanced countries, the entire process of collection, transportation and disposal of urban wastes has been mechanised, in our country we are still far behind even in mechanisation of collection and transportation of city refuse. With rapid increase in population in cities, the city environs have been deteriorating progressively endangering the health of the citizens. Further deterioration will not only aggravate the situation but is likely to create other problems. It was, however, necessary to study the problem in the entirety and devise appropriate methods before a concerted programme could be launched.

1.3 Considering the urgency of the problem, the Ministry of Health and Family Planning (Department of Health) who were then concerned and dealing with the matters relating to city administration and public health and environmental engineering set up a broad-based Committee of experts and administrators under the Chairmanship of Shri B. Sivaraman, Vice-Chairman, National Commission on Agriculture and Member, Planning Commission, to look into the problem in depth and make recommendations for effective and economical ways and means to tackle the problem, under the Government of India Resolution No. Q-13016/9/71-PHE dated the 6th May 1972 (*vide* Appendix I).

Composition of the Committee

1.4 Besides the Chairman, the Committee at present consists of the following members :—

1. Shri N. K. Sreenivasan,
   Joint Secretary,
   Ministry of Petroleum and Chemicals.
2. Shri M. M. Suri,
   formerly Member, National Committee on Science and Technology.
3. Dr. A. K. Ghosh,
   Additional Secretary,
   Ministry of Industry and Civil Supply,
   New Delhi.
4. Dr. A. D. Joshi,
   Director,
   Indian Agriculture Research Institute.
5. Shri Ashok Parthasarathy,
   Secretary,
   Electronic Commission and
   Ex-officio Joint Secretary
   to the Government of India,
   Department of Electronics.
6. Prof. N. Majumder,
   Director,
   N.E.E.R.I.,
   (formerly C.P.H.E.R.I.),
   Nagpur.
7. Shri V. D. Desai,
   Deputy Municipal Commissioner,
   (Special Engineering),
   Municipal Corporation, Bombay.
8. Shri P. S. Mazumdar,
   Joint Secretary,
   Planning Commission.
9. Dr. Daroga Singh,
   Director,
   Indian Institute of Agriculture Statistics.
10. Shri T. S. Swamy,
    Adviser (PHEE),
    Ministry of Works and Housing.
11. Dr. B. C. Ghoshal,
    Deputy Assistant Director General,
    Directorate General of Health Services.
12. Shri Satish Kumar,
    Special Assistant to Minister of State
    for Home Affairs, Personnel and AR and
    Parliamentary Affairs.

1.5 The Committee were authorised to constitute Sub-Committees as necessary and coopt experts to help in carrying out the study. The Committee accordingly coopted the undermentioned persons, who have considerable experience and knowledge of different aspects of the problems entrusted to the Committee for study :—

1. Shri J. M. Dave,
   Deputy Director,
   National Environmental Engineering
   Research Institute, Nagpur.

2. Shri H. K. Khan,
Managing Director,
Gujarat Agro Industries Corporation,
Ahmedabad.

3. Shri L. S. Yadava,
Deputy Commissioner (Manure),
Ministry of Agriculture.

4. Dr. J. S. Kanwar,
Deputy Director General,
ICAR.

5. Shri N. Dutta,
Scientist, Delhi Zonal Laboratory,
NEERI.

1.6 With a view to undertaking detailed examination of different aspects of the problems under study, the Committee constituted the under-mentioned Sub-Committees/Groups :

1. *Sub-Committee on Material on Urban Wastes Disposal*
   (a) Dr. J. S. Kanwar (Convener)
   (b) Shri M. M. Suri
   (c) Shri J. M. Dave
   (d) Shri L. S. Yadava.
2. *Group on Mechanical Compost Plants*
   (a) Chairman
   (b) Shri Ashok Parthasarathy
   (c) Shri H. K. Khan
   (d) Shri Satish Kumar
   (e) Officials concerned with the projects to be studied.
3. *Transport and Work-Shop Group*
   1. Shri N. Dutta (Convener)
   2. Shri A. H. Gandhi
   3. Shri D. N. Khurana
   4. Shri S. R. Rane
   5. Shri V. D. Ravi Kumar
   6. Shri M. M. Gupta
   7. Shri R. J. Acharya.

Terms of Reference

1.7 The terms of reference of the Committee are :

1. To study the problem of disposal of city refuse and night-soil and present methods of disposal thereof in this country, keeping in view the extent of environmental pollution caused by existing methods and the practice and usage in other countries. Also to study the present and future planning for the utilisation and disposal of such wastes.
2. To determine the extent to which the urban waste can be used in the form of organic manure as a supplement to chemical fertilizers and the precautions to be taken to prevent any adverse effect on public health in its use.
3. To study the methods for mechanical composting, the cost of establishment of plants and transportation and suggest most suitable methods for conditions obtainable in this country.
4. To estimate the order of investment required and the economic viability of such programme, keeping in view the need for agricultural purposes and other social benefits.
5. To find out an idea of the estimated cost of compost at delivery point *vis-a-vis* the cost of chemical fertilizers and the capacity of the agriculturists to meet this cost and subsidies, if any, recommended to popularise this compost.
6. To suggest modifications, if any, required in public health policies and other State or Central enactments to enable maximum composting of this resource.
7. To recommend a plan of action to implement the policies and proposals made by the Committee.

1.8 The Committee noted that the first three items of the terms of reference determined the scope of the study to be undertaken by the Committee. Having studied the problem extensively, the Committee, as per items 4, 5 and 6 were required to go into the financial, legislative and other aspects and indicate the lines on which the policies relating to public health, composting etc. could be modified. Finally, item 7 desired the Committee to prepare a plan of action to facilitate implementation of the policies and proposals charted out by the Committee. The terms of reference of the Committee were, thus, comprehensive covering all aspects; administrative, financial, legislative, organisational, engineering etc.

1.9 The Committee, however, felt that as per the name of the Committee as also the terms of reference, they were concerned with the problems of city refuse and night-soil (including both solid and liquid wastes) pollution problems arising out of their generation, collection, transportation and disposal and in the context of cleansing up the cities, their utilisation for agricultural purpose. The Committee were of the view that they need not go into the aspect of industrial wastes as it would not seem to be covered by the term urban wastes as such. Moreover, under the law of land already in force, the industries were prohibited from discharging untreated industrial wastes into public water courses or lands. The Committee's study is therefore circumscribed to that extent.

1.10 We may mention here the efforts made in the past by the Central Government to get these problems examined by Expert Committees. As far back as in 1958, the Ministry of Home Affairs had set up a Committee(1) to look into some of these problems. A Panel of experts was also set up by the above Committee and in its Report the panel laid emphasis on building of a sound organisation for collection, storage and transport of urban wastes. The scope and possibilities of intensifying the compost manufacturing programme was studied by another Committee(2) set up by the Planning Commission. The Ministry of Health and Planning Commission had also together set up a Committee to report on the problems of storage and disposal of urban wastes and to lay down broad specifications for the design of storage and disposal containers. The Health Ministry set up another Committee(3) on the problems of transportation of city wastes and specification of transport vehicles. The different aspects of utilisation of agricultural and industrial by-products and wastes were studied by the Working Group set up by the Committee on Natural Resources of the Planning Commission in 1963. In 1964, the Building Projects Team(4) of the Committee on Plan Projects submitted a detailed report on collection and disposal of refuse. However, the question of disposal of urban wastes was not treated in all its aspects in these reports. It is for the first time that the Committee on Urban Wastes have been assigned the task of examining the different aspects of urban waste collection and disposal in a comprehensive way.

1.11 While there have been investigations and studies in the past as indicated above, one of the problems has been the weak implementation of the recommendations of those Committees and absence of vigorous and systematic follow-up action. Perhaps the absence of suitable organisational structure to implement these recommendations is a major factor for those studies having not been given adequate importance and attention. We would, therefore, like to urge the Government to take adequate steps to ensure proper implementation and follow-up of our recommendations.

Term of the Committee

1.12 The Committee were initially appointed for a period of six months which was later extended to one year. Considering, however, the fact that the terms of reference required extensive study the term was extended till the end of 1974. Since the visit of the Sub-Committee to some of the Far-East Asian countries materialised only towards the end of 1974, the Committee asked for further extension of six months for submitting the final report. Finally, the term of the Committee was extended till 31st December, 1975. As already indicated, the Committee were set up by the Ministry of Health & Family Planning. In February 1973 the work relating to Urban Local Government (City Administration) and Public Health and Environmental Engineering was transferred to the Ministry of Works & Housing under a Presidential Order. Since then the Committee have been functioning under the auspices of that Ministry.

Methodology of the Study

1.13 Keeping in view the nature and extent of the study, the Committee adopted different methods of examination *i.e.*, issue of Questionnaire for eliciting data from the field implementing authorities, detailed examination of the material already published in the country and in certain foreign countries, discussions with experts, State Government officers and implementation authorities, visits to the administrative and field units, first-hand study of practices in certain foreign countries in Far-East Asian region encountering similar problems and case studies in a few selected places.

1.14 *Questionnaire* : A detailed questionnaire (Appendix II) asking for information on different aspects was drawn up and circulated among 341 urban local authorities in first five classes of towns and cities (*i.e.*, those having population of 5000 and above) on the basis of stratified sample. The questionnaire was however not sent to the metropolitan cities *viz.* Ahmedabad, Bombay, Calcutta, Delhi and Madras as in these cities the problem had been studied in detail in the past and the schemes prepared were already under consideration of the State and Central Governments. The Committee are glad to record that the response to the questionnaire was very satisfactory as 230 local authorities (more than 67%) responded *vide* list given at Appendix III. The data received has thrown up revealing and interesting information which has been related in subsequent chapters.

1.15 *Visits in India* : The Committee as a whole did not visit any place in the country. In view of the need for strict economy, it was decided that the Chairman and the members of the Committee could devote particular attention to the relevant problems of the concerned cities while visiting them in connection with their normal duties. In this way, several cities were visited by the Chairman and certain members and on-the-spot study made. The cities so visited are listed in Appendix IV.

1.16 *Visit to Foreign Countries* : The Chairman, Shri B. Sivaraman, the Member-Secretary, Shri Satish Kumar and Sarvashri J. M. Dave and L. S. Yadava were deputed to visit Thailand, Singapore, Japan, Hong Kong and Philippines to make a first-hand study of urban public cleansing service and also the operation

(1) Report of the Scavenging Conditions Enquiry Committee (Malkani Committee), Ministry of Home Affairs, 1958.
(2) Report of the Committee on the Scope and Possibilities of Intensifying Compost Programme, Planning Commission, 1966.
(3) Report of the Committee on Mechanisation of Transport of Community Wastes and Public Cleansing Operations, Ministry of Health & Family Planning, 1969.
(4) Report on Collection and Disposal of Refuse, Building Projects Team, Committee on Plan Projects, Planning Commission, 1964.

of the mechanical composting system in those countries. The Chairman, however, returned to India after visiting Thailand and Singapore only. The visit was sponsored by the Government of India and the World Health Organisation. A brief report on the visit is contained in Appendix V.

1.17 *Collection of Material* : Besides the information on the questionnaire, the Committee collected material from the Central Ministries, the State Governments, various organisations in the field of Public Health Environmental Engineering and Composting, the National Industrial Development Corporation, the World Health Organisation and a number of Foreign Missions. The material received was very useful and has been utilised in describing the problem, concretising the proposals and specifying the solutions in the chapters that follow.

1.18 *Meetings and Discussions* : The Committee and the Sub-Committees met a number of times to discuss and crystallise the problems under study, the progress of work, the recommendations to be made and the steps to be taken to implement the same. The Chairman and Members also held discussions with officials, experts, etc. at various places. The details of the meetings and discussions held are given in Appendix VI.

1.19 *Interim Report* : As the Fifth Five Year Plan was to be launched before the Committee could complete its study and make a report, Government desired that an interim report be submitted so that suitable schemes be included in the Plan and preparatory steps taken to implement the same. The world oil crises had led to rise in the price of the chemical fertilisers and added dimension of urgency to the setting up of the mechanical composting plants so that the agricultural production was not affected adversely. Moreover, recycling of city wastes was essential for the maintenance of soil fertility as the compost made therefrom had been found to be superior soil conditioner. The Committee accordingly submitted an interim report (*vide* Appendix VII) in August, 1973 and note with satisfaction that a separate scheme called the 'Urban Wastes Disposal Scheme' with a provision of Rs. 19 crores (Rs. 10 crores in the plan of the Ministry of Works and Housing and Rs. 9 crores in the plan of the Ministry of Agriculture) has been included in the Fifth Plan. For the purpose of reviewing the progress of the scheme from time to time, a Project Management Group headed by the Chairman of the Committee and consisting of the representatives of the Ministry of Works and Housing, Ministry of Agriculture, Planning Commission, the Council of Scientific and Industrial Research etc. has been set up. On the basis of the decisions of the Project Management Group, action to set up the mechanical composting plants at Ahmedabad, Madras, Calcutta, Delhi and Bangalore has already been initiated. Suitable steps have also been taken through the State Governments to get detailed projects prepared for setting up of the plants in several other cities in different States.

Appreciation and Acknowledgement

1.20 We would like to express our thanks to the Ministries of Health and Family Planning and Works and Housing for their interest in our work and for rendering all the support needed by us. During the study, we received valuable help from the Ministry of Agriculture, the Planning Commission, the State Governments and urban local authorities for which we are grateful to them. Thanks are also due to the World Health Organisation and the Government of India for sponsoring the visit abroad by a study group of the Committee which proved very useful and advantageous. We wish to record our appreciation of the help rendered by the Council of Scientific and Industrial Research, the National Industrial Development Corporation, the National Environmental Engineering Research Institute, the Gujarat Agro-Industries Corporation, the Central Public Health and Environmental Engineering Organisation, the All India Institute of Hygiene and Public Health, Calcutta, the Indian Agriculture Research Institute, and Department of Science and Technology by providing valuable material to us and by conducting depth studies on certain aspects on our behalf.

1.21 We would like to place on record our high appreciation of the assistance and expert advice received from the coopted members and the Conveners and members of the Working Groups. The assistance rendered by S/Shri L. S. Yadava and N. Dutta is appreciable. Shri P. K. Ghai, Junior Analyst worked assiduously for providing administrative support to the Committee and for collection and analysis of material and data received from various sources. In his work, he was assisted by Shri G. K. Sharma, Statistical Assistant and Km. C. M. Saroja, Stenographer. We thank them for hard work put in for the Committee.

1.22 Shri L. G. Keswani, formerly Research Officer (Local Self Government and Urban Community Development) in the Ministry of Works and Housing and at present Senior Analyst in the Department of Personnel and A. R. rendered valuable help in organising the work of the Committee in initial stages and in the preparation of the Questionnaires and technical notes. Subsequently, he was entrusted with the task of preparing the report of the Committee which he, with his long experience and background in urban administration and development, has done, in addition to his heavy normal work in the Ministry/Department and without any extra remuneration, exceedingly well. We highly appreciate and acknowledge his contribution.

1.23 The Chairman and other members of the Committee wish to express their special thanks to Shri Satish Kumar, IAS, Member-Secretary for his role in and devotion to the work of the Committee. His vast knowledge and experience which is amply reflected in the text of the report, was an asset to the Committee. Shri Satish Kumar has discharged his onerous duties to the Committee competently in spite of heavy burden he had to bear as a Senior Officer in the Central Government. The successful culmination of the work of the Committee is the result of his unremitting toil and extra strain borne by him.

CHAPTER II

PRESENT STATUS

Distribution of Urban Population

2.01 The degree of urbanisation in a country is considered to be an index of industrial development. In spite of the fact that significant progress has been achieved in the direction of industrialisation over the past three decades, India still continues to have a large rural population. Over four-fifths of its population lives in what is known as rural India. Even with about 110 million city dwellers, India occupies a fairly low position in the degree of urbanisation in the world. In terms of the percentage of the total population, India's 19.87 per cent urban population is quite low when compared with some other countries, for example U.K. (78.87 per cent), Canada (73.58 per cent), France (69.97 per cent), U.S.A. (69.80 per cent), Japan (68.09 per cent), U.S.S.R. (55.85 per cent) and even U.A.R. (41.64 per cent).

2.02 Nevertheless, urbanisation in our country has certain unique features. In absolute numbers, our urban population exceeds the total population of each of the above mentioned countries excepting U.S.A. and U.S.S.R. While the rural population is spread over vast area of our country located in more than half a million villages, the urban dwellers are concentrated in just 2921 places of six different sizes and varying areas individually. It is also significant that more than 57 million of city people i.e. 52.41 per cent, live in 142 urban agglomerations and cities classified as Class I places having population of 100,000 and over each. Among these Class I cities, there are 9 metropolitan centres, each containing over one million population; in themselves accounting for about half of the population of Class I places and more than one-fourth of entire urban population. The Class II towns (with population between 50,000 to 99,999) number 198 and have just 12.15% of the urban population. The remaining one-third of the urban population lives in 2581 towns of the other four classes indicated below :

TABLE 1

NO. OF TOWNS, POPULATION AND PERCENTAGE

Class	Population Range	No. of towns	Total Population	Percentage to urban population
III	20,000 to 49,999	617	18,885,483	17·36
IV	10,000 to 19,999	931	13,097,780	12·04
V	5,000 to 9,999	758	5,697,716	5·24
VI	Below 5,000	277	866,535	0·80

2.03 Yet another unique feature of urbanisation here is the rate of growth witnessed in larger cities and towns. While the general decennial growth rate of urban population during 1961-1971 was 37.83, the Class I places registered a growth rate of 49.45. In the case of Class II places, it was 40.86. This trend clearly indicates that large cities and towns are growing at a faster rate. This could be attributed to certain factors like availability of reasonably developed infra-structure, increased employment potential, better educational and recreational facilities and growing trade and commercial opportunities in such places. This trend also points to the fact that there is uneven distribution of urban population with varying degrees of growth potential among different classes of cities and towns.

2.04 It would also be relevant here to have an idea of the urban situation in different States. Maharashtra is the most urbanised State where a third of its population—31.20 per cent—resides in 289 towns. This is closely followed by Tamil Nadu (having highest number of towns at 443) with 30.28 per cent and Gujarat (217 towns) having 28.13 per cent. West Bengal with 137 towns and Karnataka with 231 towns are fairly close to 25 per cent mark. Uttar Pradesh, the most populous State of the country, stands second in number of urban centres at 293 but occupies 18th place among the 29 constituent units of the country (at the time of 1971 census), with urban population at 14 per cent only. This analysis shows that the process of urbanisation depends primarily upon the degree of industrialisation. It is the industrial cities in Maharashtra, Tamil Nadu and Gujarat, with larger population concentration that give these States a higher rate of urbanisation.

Administration of Cities and Towns

2.05 The administrative institutions are created to meet certain requirements and needs of a society. The structure of such an institution is modelled after taking into consideration the duties and functions to be assigned to each unit, the capacity of the people to generate local financial resources for meeting the obligations and local potential to throw up the requisite leadership to shoulder the responsibility of manning the institution and serving the citizens. The matters of education, public health, housing etc. are matters of local importance and their performance in the local areas can best be attended to by a local authority. For this purpose, the State Governments set up such authority under the law promulgated by the State Legislature. The urban local authorities, popularly known as 'Municipal' authorities are classified into two major categories, the Municipal Corporation, headed by elected Mayors, consist of three main executive authorities i.e. (i) elected General Council of the Corporation; (ii) the Standing and Functional Committees; and (iii) the Commissioner who is the Chief Executive of the Corporation. Such an institution is established under a specific State enactment for major and important cities and is bestowed

with a certain degree of independence and autonomy in mobilising resources and providing local services. The other category is the Municipal Council/Board set up under the State Municipal Laws which functions under an elected President who is assisted by a number of Committees. All elected members of municipality constitute its general body which discusses and decides all questions of policy and important details of local administration. At present there are 32 Municipal Corporations and about 1500 municipalities situated in various States and Union Territories. For smaller areas there are town area and notified area Committees which look after the civic functions to a limited extent. There are also Cantonment Boards for civil areas of the Cantonments set up under a Central law for performing civic functions in their jurisdictions.

Functions of Municipal Authorities

2.06 The Municipal Acts lay down exhaustive lists of functions which are classified into obligatory and optional or discretionary functions covering wide sphere of activities such as medical and public health services, sanitation, water supply and drainage, education, housing, town planning, municipal trading, recreation, roads, etc. The public cleansing constitutes the most important function entrusted to the local authorities. These authorities spend a substantial portion of their income on this service every year. The table below gives the proportion of expenditure devoted to the public health and sanitation services in some of the municipal authorities.

TABLE 2

EXPENDITURE ON CONSERVANCY SERVICES

(Cities with population above 5 lakhs)

(1971-72)

Name of the Local Body		Population of the Local Body ('000)	Total Municipal Expenditure (Rs. in '000)	Expenditure on Public Health and Sanitation (Rs. in '000)	Percentage of expenditure on P. H. & Sanitation to the total expenditure	Per capital expenditure on P. H. & Sanitation
1.	Hyderabad	1,608	38,868	13,525	34·79	8·41
2.	Indore	573	20,389	5,940	29·13	10·37
3.	Nagpur	867	36,763	7,611	20·70	8·77
4.	Poona	857	64,602	22,024	34·9	25·70
5.	Bangalore	1,541	142,727	9,100	6·37	5·90
6.	Madurai	549	48,966	832	1·69	1·51
7.	Kanpur	1,273	58,927	12,848	21·80	10·09
8.	Agra	638	22,551	6,557	29·07	10·28
9.	Varanasi	681	24,309	4,431	18·22	6·50

State of Sanitary Facilities in our Cities

2.07 The water supply and sewerage systems are the important factors which contribute to the cleanliness of cities to a great extent. Yet these are the facilities in which our cities are still very backward barring a few exceptions. Out of 2921 urban places identified in the 1971 Census report, only 1535 have developed the system of protected water supply so far. The supply of water is, however, far below the satisfactory level and coverage in many cases is inadequate. It is found that only 830 lakh citizens are served by urban water supply system as against a total urban population of 1091 lakhs. No city or town has yet been fully sewered. So far only partial sewerage system has been provided in 190 towns covering a population of 371 lakhs only. 'Surface and manual disposal' is therefore the most widespread system prevalent in our cities for the disposal of all types of urban wastes generated there. The system of collection, transport and disposal of the city wastes is, however, yet to be mechanised fully with the result that our cities and towns still continue to be in a very unsatisfactory state of cleanliness. Moreover, 'the wastes' which could be used for preparing valuable manure are not utilised fully for the purpose.

2.08 It may also be emphasised that insanitary disposal and utilisation of wastes results in high incidence of illness and death from faecal borne diseases. The faecal-borne bacterial diseases are bacillary dysentery, typhoid fever, enteritis and cholera. The faecal-borne protozoan diseases are amoebic dysentery, balantidial and flagellate diarrhoea. The faecal-borne helminth diseases are bilharziasis, fascioliasis, oxyuriasis, trichuriasis and paragonomiasis. From experiments it is evident that adequate composting of faecal and other wastes can control these diseases which are so widespread in faeces used as manure without the practice of sanitary measures.

Expenditure on Conservancy Services

2.09 Before we go into characteristics and types of urban wastes and system of their management in our cities, it may be relevant to refer to an important aspect of conservancy services i.e. expenditure incurred and staff employed for the purpose. The Committee had elicited information on these aspects through the Questionnaire referred to in para 1.14 from 341 local authorities. 165 local authorities, however, furnished

information about the expenditure incurred by them on conservancy services. The table below contains the analysis of the data received :

TABLE 3

VARIATION IN EXPENDITURE ON CONSERVANCY SERVICES

Class of cities/ towns	No. of local bodies to whom questionnaire was sent	No. of local bodies who responded to this particular point	Percentage variation in expenditure on conservancy services to the total expenditure	Mean Average (percentage) of expenditure on conservancy to the total expenditure
I	132	89	7 to 80	26·3
II	68	24	9 to 75	32·76
III	72	30	11 to 88	30·95
IV	34	13	10 to 61	27·35
V	35	9	2·3 to 76	31·30
TOTAL	341	165		

It will be noted that percentage of expenditure on conservancy to the total expenditure in case of Class I cities varies between 7 to 80. This percentage in case of Class II towns ranges between 11 to 88. This indicates that while some of the local authorities were not contributing adequate finances to this basic service, some others were spending higher proportion of their income leaving very little for other services. Moreover, this reduces the status of the local authorities to more or less limited 'sanitation authorities' in place of their being fullfledged Municipal authorities performing wide range of services. Even then the per capita expenditure on these services as indicated in Table 2 above ranges between Rs. 5.90 to Rs. 25.70. The conclusion that can be drawn from this is obvious.

Conservancy Staff

2.10 Table 4 below shows the details of staff employed on conservancy services in different types of local authorities. It is significant that percentage of staff on conservancy services in case of first four classes is quite high on the face of it. In terms of persons employed per 1000 population, however, the cities would seem to be inadequately staffed as the last column of the table reveals.

TABLE 4

STAFF EMPLOYED ON CONSERVANCY SERVICES

Class of cities/ towns	No. of Local Bodies to whom questionnaire was sent/ No. of Local Bodies from whom replies were received	Total Municipal Staff	Staff employed on conservancy			Total	Percentage of conservancy staff to total staff	Average range of staff employed on conservancy per thousand of population
			Cleaning	Transportation	Disposal			
I	132/94	1,16,041	64,771	8,470	3,894	77,135	66·5	5·5
II	68/33	10,118	5,375	1,029	983	7,387	73	7·5
III	72/42	7,408	3,424	493	363	4,280	57·7	4·8
IV	34/19	1,427	677	94	93	864	60·5	4·8
V	35/12	604	187	31	50	268	44·3	4·6
TOTAL	341/200	1,35,598	74,434	10,117	5,383	89,934	66·3	

Types of Urban Wastes

2.11 Urban wastes are discarded organic or inorganic substances in the form of solid, semi-solid, liquid and gases which are residues or derivatives of human, vegetable material and industry. These wastes are broadly classified as under :—

(i) *Household Wastes* : Consisting of human excreta, waste created in preparation and consumption of food, generally termed as garbage, ash, etc;

(ii) *City Wastes* : All the matter derived from the maintenance of streets, roads, parks and schools, paper, dry leaves, animal wastes, sludge, carcasses of small animals, street and drain mud, slaughterhouse wastes, etc :

(iii) *Commercial Wastes* : Resulting from activity in office buildings, stores, markets, theatres, hospitals and restaurants. These include a high proportion of paper, card boards, plastics, etc.;

(iv) *Industrial Wastes* : Iron and ferro alloy ores shipped to mills, other metal ores processed, construction materials and other non-metals including lime, mineral, fuels used as petrochemical feed stocks and for other non-fuel purposes e.g. asphalt, tar, lubricant and waxes;

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(v) *Liquid Wastes*: Domestic sewage, factory effluents;

(vi) *Gaseous Wastes.*

As per terms of reference, the scope of study of the Committee is restricted to the wastes enumerated at (i) to (iii) and domestic sewage under (v) above.

Characteristics and Composition of City Refuse

2.12 The industrial development and advancement and betterment of living standards bring profound changes in the character, composition and quantum of city refuse. The other factors that influence the character, etc. of city refuse are geographic location, weather, seasonal conditions, social, occupational and economic character of the community and the general character of the city. Only a few local authorities in India carry out regular analysis of the refuse collected and as such authentic information regarding composition of refuse in cities in general is not available. It is noted that community wastes collected in India towns are made up of heterogeneous materials. These contain articles and things of various sizes and types from the dust of the roads to large metal containers; from vegetable leaves to fragments of wood; from pieces of waste paper to large paper-board cartons; from glass bottles to worn out tyres; from fragments of bones to carcasses of domestic animals; from bits of clothing to bundles of cotton wool or dressing gauze; etc. These also contain night-soil. During certain seasons of the year, considerable quantities of the residue of fresh fruits like mangoes, melons, bananas, oranges etc. form part of the refuse of the most of the cities. Besides, coastal towns' refuse contains coconuts from which milk has been extracted. Broken crockery pieces discarded by shopkeepers are also found in the refuse of some towns. In other words, the community wastes include everything that a man rejects or that emanates from his activity at the place where he lives, works or moves for recreation and other purposes and what has to be removed for disposal as a civic service. The analysis of samples of refuse taken in eight cities situated in different regions of the country *vide* Appendix VIII indicates wide variation in its characteristics and composition.

Quantum of Community Wastes

2.13 It is reported that the refuse of Bombay contains more paper and straw than that of Calcutta. Because of the inclusion in it of the street sweepings, the town refuse in India is much heavier than that generated in the cities of Western countries. It is estimated that one cubic yard of refuse collected in Bombay weighs as much as 360 to 400 lbs. whereas weight of the same quantum of refuse in Calcutta goes up to 1000 lbs. generally.

2.14 On the basis of the data collected at different Municipal Centres it is estimated that output of urban refuse amounts to about 0.3 kg. of katchra (household refuse, city wastes and commercial wastes) and 0.2 kg. of night-soil and 0.8 kg. of urine per head per day. There is however considerable variation from centre to centre, depending upon local factors such as industrial activities, dilution of night-soil, ablution water, etc. In general, the quantity of dry refuse tends to be higher in the big units; and in cities like Bombay and Calcutta it is about 0.5 kg. per capita per day. The density of city refuse varies from 395 kg. to 840 kg. per cubic metre. Refuse quantity data is available for certain towns in different parts of the world. The refuse per capita varies from 0.5 kg. to 1.2 kg. The maximum of 1.2 kg. is, obtained in the U.S.A. The average quantity obtained in our country is, however, very low as compared to other countries. But the individual value in respect of Madras, Calcutta and Bombay compare well with other countries except U.S.A.

2.15 In addition to the two major groups of refuse noted above viz. katchra and night-soil, there are others of lesser magnitude but which assume importance in bigger cities e.g. cattle wastes, slaughterhouse wastes, sullage water, sewage, sludge, etc. In bigger cities, where a large number of cattle chawls are being maintained in order to supply milk to the urban population, the by-products of cattle namely dung, litter, and urine often find their way to the municipal refuse depots especially in the monsoon season.

2.16 In overall terms it is estimated that the refuse collected from urban areas is of the order of 33000 tonnes/daily. The annual output of the refuse would thus come to about 12 million tonnes. As regards sewage, sullage it is calculated that its volume would be about 800 MGD (million gallons per day) or about 36.2 lakh m^3/day, as only 33 million people are served with sewers as against total population of 110 million. The unsewered population of the urban sector is about 76 million which is estimated to contribute sewage water of the order of about 960 MGD (47.4 lakh M^3/day). Only about 7.5 per cent of the population of the country is served with sewerage system. A very small percentage is served with septic tanks. A majority of urban population above 80 million, therefore, depends on dry conservancy system. The night-soil collected from this population is estimated to be about 22,000 tonnes/day.

Manurial Value

2.17 The manurial value of such huge quantities of the city wastes is immense. The Ministry of Agriculture has estimated that the per-capita production per day of refuse and night-soil comes to about 0.30 kg. In addition, considerable quantities of slaughterhouse wastes are generated everyday. The chemical contents of each unit of wastes indicated above are as under :

TABLE 5

CHEMICAL CONTENTS

Material	Weight per capita day on dry matter basis (in kg.)	%age on even dry material			
		Nitrogen	P_2O_5	K_2O	Calcium
1. Refuse	0·25	0·7-0·8	0·4-0·5	1·2-1·4	5·0-6·0
2. Night-soil	0·05	5·5-6·0	4.4-4·5	2·0-2·5	4·5-5·0
3. Slaughterhouse wastes	(per kg.)	8·0-10·0	3·0-3·5	2·0-2·5	3·0-3·25

Based on this analysis, the manurial/chemical value of the different constituents of the wastes generated by entire urban population (108.7m.) in a year would be as given in the following Table :

TABLE 6

MANURIAL VALUE

(Tonnes)

Class of refuse	Dry matter	Nitrogen	Phosphoric acid (P_2O_5)	Potash (K_2O)	Calcium (CaO)
Katchra (dry Refuse)	10,117,252	75,880	45,530	131,525	556,450
Night-soil	1,983,775	114,070	84,310	44,635	94,230
Slaughterhouse wastes	250,000	22,500	8,125	5,625	8,125
TOTAL	12,351,027	212,450	137,965	181,785	658,805

The Ministry observes that such chemically rich urban wastes can be transformed into superior farm yard manure containing about 1% each of nitrogen, phosphoric acid and potash.

Present Position about Production of Manure

2.18 It has been estimated that potential for preparing 18 million tonnes of agricultural manures per annum from urban wastes exists in the country. With the rapid growth of urban population, which we are witnessing at present, this potential will also increase. By 1981, the output of refuse is estimated to go up by about 15%. However, in 1970-71, an estimated quantity of nearly 4 million tonnes of compost was produced at nearly 3100 compost centres (2300 in urban areas). Thus less than 25% of the available potential is being exploited at present. Further, the compost now produced is generally of poor quality and the total nutrient content may not be more than 1%. In a studied case of Ahmedabad, the nutrient value of the compost is expected to be of N : P : K : ratio of 0.65 : 0.48 : 0.5 giving a total of 1.63% whereas properly prepared compost can give a much higher nutrient value of nearly 3%. A properly prepared compost can give a substantial amount of plant nutrient in the shape of nitrogen, phosphorus, potash and, in addition, humus and soil conditioners of the nature of calcium not provided by chemical fertilisers.

Monetary Value of Compost

2.19 In monetary terms, the value of the manure prepared from the city refuse should be tremendous and if tapped properly it can prove to be a stable source of income to the local authorities, whose finances are known to be very weak. Moreover, this income will go on increasing with further rise in urban population and as a result of developmental efforts. It is calculated that if this potential is fully and properly harnessed it can generate an income to the tune of Rs. 100 crores every year. Even at present the compost has been fetching good prices in certain centres due to high demand as a result of intensive agricultural activities like Ganganagar (Rajasthan)—Rs. 48 per tonne, Burhanpur (Madhya Pradesh)—Rs. 35 per tonne, Ludhiana (Punjab)—Rs. 35 per tonne, Jullundur (Punjab)—Rs. 40 per tonne, etc. It is, nevertheless, a fact that in certain municipal areas the compost is sold at throw-away prices sometimes as low as Re. 1/- per tonne. There is, however, no doubt that the municipal authorities have as yet not been taking full advantage of this source of income.

Need for Agriculture

2.20 There is an important relationship between sanitation and agriculture. Since our economy, as already observed, is still agriculture-based, the importance of city compost for our agricultural operations can hardly be over emphasised. Humus from night-soil, garbage, sewage sludge and slaughterhouse wastes contains nitrogen, phosphorus, potash and trace elements which are vital to the continuing fertility of the soil and optimum plant growth. Moreover the organic colloids formed during the metabolic breakdown of organic materials increase the availability of nutrients due to 'chelation' effect. A good supply of humus maintains the physical and biological conditions in the soil. Humus is especially important in heavy clay soils, in loose sandy soils, in saline and alkaline soils and in poorly aggregated soils. Scientists have now discovered that plants appear to absorb nitrogen from the soil in much larger doses than fertilisers added. In this connection, certain facts of a macro nature analysed by the National Commission on Agriculture on plant absorption and fertiliser application become relevant. For example, it has been noted that in 1973-74, as against 15.02 m. tonnes of nutrients removed through the soil of which nitrogen was 4.79 m. tonnes, the chemical fertiliser applied was only 2.78 m. tonnes of which nitrogen was 1.84 m. tonnes. It is obvious that plants are absorbing from the atmosphere a good deal of nitrogen which goes to build up the crops. Similarly, from the soil they are getting much more P_2O_5 and K_2O than added by chemical fertilisers. How this is done is a subject for close analysis by scientists. But it is known that the soil contains various bacteria which seem to help in the process of fixing nitrogen in the soil in a form which may easily be absorbed by the plant. Thus plant wastes and urban wastes arising out of processed and absorbed agricultural produce contain nitrogen, phosphorus and potash taken out of the air and soil by the plants. A properly prepared compost can as such give a substantial amount of plant nutrient in the shape of various properties described above some of which are absent in chemical fertilisers.

The consumption of fertilisers during the first year of the fifth plan i.e., 1974-75 was 27.30 lakh tonnes (N+P+K) against the production of only 15.12 lakh tonnes. Although steps have been taken to step up the production, the gap between the demand and the production will persist for quite some time. In addition, the manure prepared from the city waste has been found to be a better soil conditioner and easily assimilated by the plants. In view of this, we can ill-afford the wastage of plant nutrients for lack of proper composting of wastes to the maximum extent. These facts emphasise the urgent need of recycling of urban wastes so as to derive an inexhaustible store for the maintenance of soil fertility.

Urban Wastes Management

2.21 The public cleansing work is at present attended to by the local authorities with the powers vested in them under the Municipal laws. The work is mainly entrusted to the Health Officer who is assisted by a number of Sanitary Inspectors. In certain major Corporations, this work is being carried out by the Engineering Departments.

2.22 How is this work being attended to by these authorities ? Normal practice is that the house owner collects the refuse at his place and dumps the same in a bin located nearby on the street-side; while in some specific areas house to house collection of garbage is made by the civic staff. Mostly the garbage is collected by the Municipal employees from these bins and carried away to the place of disposal by means of mechanised or other transport. In certain cases, there are arrangements for the transfer of garbage from the bins located in the narrower streets by the civic personnel in wheel barrows to the large bins on the main roads from where the trucks collect the same. In market areas and public places, the sweepers on the pay-roll of the municipal authorities collect the garbage from the place of origin to a central bin, from where it is transported away. The transport of garbage from the bins to the disposal sites is often done in open trucks. In smaller municipal areas, this work is done on bullock carts. Special types of trucks like tippers and compactors are rarely used for garbage collection. In most cases the disposal is done by dumping in low lying areas in the outskirts of the cities or at some land specially earmarked for the purpose. With the pressure on land and with growing urbanisation, such areas are becoming more and more rare. The growth of the towns also poses problems regarding continued use of these disposal sites. Mechanical composting has so far been rarely used but in some municipal areas, composting by natural process is being adopted. Incineration or scientific land-filling are not much practised. As most of the urban areas are still without sewerage system, the human wastes there are collected from service latrines which are manually cleaned and collected in covered tankers. These are carried by bullock carts or by mechanical transport and disposed of by trenching. In many cases such trenching is done along with the garbage.

2.23 The survey conducted by the Committee revealed that the 2.8 persons employed per 1000 population in 341 cities and towns of different sizes, were put on the following jobs :

(i) Cleaning	2.3 persons per 1,000
(ii) transportation	0.3 persons per 1,000
(iii) dumping	0.2 persons per 1,000

The survey also brought out the fact that between 55 to 75% of local bodies have to employ staff for collection of the refuse from houses to the bins. The present system is thus revealed to be more biased towards collection of garbage upto the bins. This is not desirable as this part should primarily form the duty of the individual citizen. The municipal service should put more stress on collection from the bins and proper, adequate and fruitful disposal. In order to help the citizens to contribute in this function, the placement of bins at suitable points on the roadside for collection by the municipal staff has to be emphasised. This is the system predominantly used in the Western countries

and there is no reason as to why it cannot be adopted by us to the advantage of all concerned. Once this finds acceptance, a sizable staff now engaged in cleaning operations will be available for other duties. This will lead to improved performance. The local authorities have to be oriented towards making more and more profitable use of the city wastes. We would, however, suggest that as a precaution against the pilferage of dust bins, these may be made of special designs and affixed at such places where the householders could conveniently deposit the refuse into them and also guard against their theft.

Integrated System of Wastes Collection and Disposal

2.24 It would thus be seen that the disposal and utilisation of urban wastes for useful purposes cannot be viewed only as a local or regional problem. Today, the whole environment is being polluted by the accumulation of liquid and solid wastes due to increasing population, rapid urbanisation and industrial growth. An effective solution to the problem of storage, collection, treatment, conversion, re-use and disposal of city wastes involves not only complex and challenging technical questions but also difficulties of political, financial, legal and administrative dimensions. Failure to deal with the ever increasing flow of these wastes effectively and in time constitutes an alarming threat to public health and human well-being. There is thus a case for dealing with the whole question at the national level. Further, the approach will have to be to develop a system whereby the collection, transportation and disposal are attended to in an integrated manner, keeping in view the undermentioned basic objectives :—

(1) cleanliness of the cities and environmental pollution control through a well designed and equipped system of collection, removal and disposal of city garbage;

(2) eradication of degrading practice of manual handling of night-soil and other urban refuse by provision of suitable handling equipment to the sanitary staff; and

(3) making available enriched compost for agricultural production.

Management at the Local Level

2.25 In an earlier paragraph, we have pointed out that the function of public cleansing in the local bodies is being performed on different patterns. This situation is hardly satisfactory and calls for immediate remedial measures.

2.26 The main considerations in the methods employed for separation of public cleansing services are cost, health, sanitation convenience and aesthetics. An engineering solution of all these factors is called for to determine as to which method(s) would be advantageous and profitable. This service has also to be treated as a major material handling project, where industrial engineering methods, techniques and practices based on time and motion studies have to be employed for increasing efficiency and reducing costs. To achieve these objectives the Committee recommend that the services of public cleansing, mechanised transportation and proper disposal of the urban wastes should be put under the unified control of a qualified Public Health Engineer supported by qualified junior staff in automobile engineering, public health engineering and sanitation. The Committee appreciate that smaller local authorities may not find it feasible to do so straightway due to various reasons. The Committee would, therefore, suggest that to begin with all the local authorities in cities with population over one lakh could implement this suggestion.

2.27 The role of the State Governments and the Central Government in this vital task has been discussed elsewhere.

CHAPTER III

COLLECTION AND TRANSPORTATION OF URBAN WASTES—PROBLEMS

3.01 As already indicated, domestic refuse constitutes the bulk of the urban wastes in most of our towns. Markets and slaughter houses can be identified as the other major source of non-industrial wastes. In addition, various industries generate their own refuse both liquid as well as solid. Since the focus of our study is on non-industrial urban wastes, our enquiries have been directed at obtaining information generally on the following points :

(i) the manner of storage of domestic waste by house-holders;

(ii) the method of carrying the domestic refuse to the collection sites;

(iii) storage of wastes—public and communal places like market, etc.;

(iv) the present condition of collection sites and their deficiencies;

(v) collection of night-soil and its disposal in non-sewered areas; and

(vi) problems of sanitation and health hazards involved in the process of collection and subsequent transportation.

3.02 We have already described methodology adopted in obtaining information from the municipalities of various categories of towns. We will now proceed to give statistics on various items which will give an idea of the existing conditions and then enable us to make suitable recommendations for improvements in the systems now in use. We have also been guided by the experience of sub-group of the Committee led by the Chairman and later by the Member-Secretary which visited a few countries in the South-East Asia where the climate, socio-economic conditions of the people and food habits are more or less similar to our own with the result that their wastes in the cities are similar to ours. Without always mentioning specifically, we have drawn upon the experiences of the team.

Collection of Domestic Wastes

3.03 *Refuse storage methods* : We consider the proper storage of refuse by house-holders and its regular collection two very important steps in level of hygienic living. We had a specific question on the manner in which domestic refuse is stored by house-holders and also whether receptacles are standardised. The table below explains the position :

TABLE 7

REFUSE COLLECTION METHODS

(BINS)

Class of cities/ towns	No. of local bodies addressed/No. of local bodies responded.	No. & percentage of local bodies where the domestic waste is stored by the house-holders in the house in bins provided/specified by the local body.		No. & percentage of local bodies where the domestic waste is stored by the house-holders in the house in unstandardised receptacles of their own.		No. & percentage where the domestic waste is stored partly in bins provided by the local bodies and partly in unstandardised receptacles of their own.	
I	132/101	45	44·55	46	45·54	10	9·91
II	68/31	20	64·51	10	32·25	1	3·24
III	72/40	24	60	12	30	4	10
IV	34/17	8	47·06	7	41·17	2	11·77
V	35/10	4	40	6	60	—	—
TOTAL	341/199	101		81		17	

3.04 It will be noted that in 101 towns, the domestic wastes are stored in bins provided/specified by the local bodies against 81 Urban Centres where unstandardised receptacles are in use. In 17 local bodies both the practices are prevalent. The method of emptying the domestic wastes directly into public or communal dust bins is not prevalent in any of the local bodies who responded to our questionnaire on this particular point. We can safely assume that this is not a practice prevalent in this country.

3.05 *Frequency of refuse collection* : Since the domestic wastes cannot be removed from the houses as soon as it is produced, proper storage assumes crucial importance in relation to proper hygiene. We are, however, gratified to note that by and large the domestic refuse is removed from the houses daily, as it should be in our country, where due to hot climatic conditions organic matters decompose very fast. The table below gives a picture about average frequency of collection :

TABLE 8

FREQUENCY OF REFUSE COLLECTION

Class of cities/ towns	No. of local Bodies who responded	No. of local Bodies with average frequency of collection	
		Daily	Bi-weekly
I	106	103	3
II	37	37	—
III	41	41	—
IV	20	20	—
V	12	12	—
TOTAL	216	213	3

Daily collection is generally practised in the country. In our climatic conditions lesser frequency will not be suitable.

3.06 Although nearly 45% of the local bodies have reported either providing or specifying the bins in which domestic refuse is to be collected but general experience is that quite a large percentage of population, particularly, in the lower and weaker income groups still continues to use unstandardised receptacles or just collects the refuse in a corner of the house. Discussions with local authorities revealed that in a number of households the receptacles provided by the local bodies are used for storing of grain, etc. Whereas we would like to stress that the bins should be standardised and preferably provided or subsidised by local bodies to popularise their use, we would also like to caution that every scheme should take into account the practical aspect of its likely misuse of the type mentioned above. A proper design should render such misuse unlikely. Proper education of the citizen would also be helpful in popularising the right use of the standardised receptacles. We understand that NEERI have developed designs of standardised receptacles and we would commend that these designs should be well-publicised amongst the local bodies for adoption. A scheme providing for supply, to house-holders in the lower income groups by way of meeting part of the cost of the standardised receptacles, may be worked out. We would suggest that the local bodies may supply the standardised receptacles to house-holders at subsidised cost. This benefit may be restricted only to economically weaker sections say families with income of less than Rs. 6000/- per annum. The cost of this subsidy should be provided to the local bodies in full by the State and the Central Governments as the local bodies would not be in a position to bear this expenditure out of their own resources. We estimate such subvention would cost not more than Rs. 5 crores in Class I cities.

3.07 The Bombay Corporation has the power to lay down the standards as regards the size and shape of the receptacles and also to enforce their installation by the house-holders. These bins are provided by the house-holders and not by the Corporation. We would commend the adoption of this provision. In other words, the local bodies may enact law to have the powers to lay down standards as regards size and shape of the bins and to enforce their installation by the house-holders.

3.08 *Refuse collection methods* : The next important step is the collection of refuse from the house-holders and its carriage to an intermediate storage point prior to transportation for disposal. In most local bodies, the domestic refuse is brought to a convenient point, a few of which are provided in each locality, where it is stored till transported. Relevant information on this process is given in the table below :

TABLE 9

REFUSE COLLECTION METHODS

Class of cities/towns	No. of local bodies addressed/No. of Local bodies responded	No. & percentage of local bodies in which the domestic waste is carried from the house to the collection site by the Municipal staff		No. & percentage of local bodies in which the domestic waste is carried from the house to the collection sites by the house - holder / by sweeper employed by the house-holder		No. & percentage of local bodies in which the domestic waste is carried by the Municipal staff as well as the house-holder	
		No.	%	No.	%	No.	%
I	132/104	57	54·8	43	41·3	4	3·9
II	68/28	16	57·1	12	42·9	—	—
III	72/42	31	73·8	10	23·8	1	2·4
IV	34/18	10	55·5	8	44·5	—	—
V	35/12	8	66·6	4	33·4	—	—
TOTAL	341/204	122		77		5	

3.09 It will be noted from this table that in 122 local bodies the domestic waste is carried from the house to the collection site by the municipal staff; in 77 it is carried by the house-holders and only in 5 local bodies both the systems are in vogue simultaneously.

3.10 By and large, the sweepers carry the domestic wastes and sometimes the night-soil in unstandardised receptacles as headloads. In big cities, the Corporations have, of course, provided wheel barrows to the sweepers, but either their number is not adequate or the sweepers, by sheer force of long habit, are disinclined to make use of the wheel barrows. At places the inconvenient design of the wheel barrow particularly when it is heavy and not easy to push, has also discouraged its adoption. The result is that the obnoxious practice of manual handling and carriage of refuse and night-soil persists in almost all the cities. This has been very adversely commented upon by numerous forums as a practice degrading of human dignity. The Estimates Committee in their 69th Report on the Backward Classes Welfare have also denounced this practice and recommended its early eradication. The Central Council of Local Self Government have also reiterated this view a number of times as also the All India Council of Mayors and the Conferences of Municipal Corporations. Taking note of sentiment on this subject, we recommend that effective steps should be taken to do away with this practice as soon as possible. In view of the finances involved, no doubt its eradication will be possible progressively over a period of time. But more important would be to evolve as well as publicise a good model of wheel barrow which could conveniently be handled by the sweepers. In the portion relating to the transportation, we are recommending certain types of wheel barrows for this purpose, but we understand that both NEERI and the CPHEEO of the Ministry of Works & Housing have developed suitable models for the wheel barrows. What remains to be done is to put the wheel barrows to wider and effective use. In addition, the sweepers will have to be educated and oriented for making use of the wheel barrows. Roughly computing the deficiency in number of wheel barrows at 50% and allowing the 50% assistance on the cost, a sum of Rs. 1.5 crores will be needed for Class I—V cities.

3.11 *Collection sites* : Properly constructed collection sites will also contribute to the cleanliness of the city. Information received on this point is given in the following table :

TABLE 10

CONSTRUCTION OF COLLECTION SITES

Class of cities/towns	No. of local bodies addressed/ No. of local bodies responded	No. & percentage of local bodies where collection sites are properly constructed.		No. & Percentage of local bodies where the refuse is dumped in open.		No. & Percentage of local bodies where collection sites are constructed and the refuse is thrown in the open partially.	
I	132/105	51	48·50	39	37·14	15	14·29
II	68/32	14	43·75	14	43·75	4	12·50
III	72/37	20	54·05	16	43·24	1	2·71
IV	34/18	7	38·9	11	61·1	—	—
V	35/11	2	18·18	9	81·82	—	—

3.12 It goes without saying that dumping of refuse in open or in partly constructed sites is unhygienic, creates insanitary conditions and poses health hazards of various kinds. We would, therefore, stress the necessity of properly constructed collection sites. These should be so constructed as to ensure easy loading and should be cordoned of. Their siting should also be carefully planned keeping in view the hygienic and sanitary requirements of the area, easy accessibility to the users, and proper situation on a road for removal. A scientific survey of the city is recommended for proper location of collection sites to satisfy the requirements mentioned above. The capital expenditure involved would naturally be non-remunerative and, therefore, the Government should work out a scheme for subsidising or substantially assisting the construction of such collection sites.

3.13 *Collection of night-soil* : As already mentioned, not more than 199 out of nearly 3,000 urban centres in the country are sewered; almost all of them partially. Large pockets of urban population are outside the coverage of sewer system in most of the sewered cities. Sewerage has not been able to keep pace with rapidly expanding cities and that is why we cannot cite a single case of fully sewered city or town. Night-soil collection would, therefore, continue to be important for quite sometime in most of the urban centres of the country. Its proper collection and disposal can contribute to a great extent to the cleanliness of the city. The following table gives an idea about the present practices of night-soil collection and removal :

TABLE 11

REFUSE AND NIGHT-SOIL COLLECTION

Class of cities/ towns.	Total No. of local bodies addressed/No. of local bodies who responded	No. & Percentage of local bodies where refuse and night-soil are dumped together		No. & Percentage of local bodies where refuse and night-soil are dumped separately	
I	132/106	27	25·5	79	74·5
II	68/33	9	27·3	24	72·7
III	72/36	17	27·2	19	52·8
IV	34/16	13	81·2	3	18·75
V	35/11	6	54·5	5	45·5

3.14 In about 1/3rd of the local bodies who responded to the questionnaire, the refuse and night-soil are dumped together. This practice evidently is most insanitary. The collection of night-soil and its disposal should be separated from that of the domestic refuse. Here we would like to mention a good and sanitary system of night-soil collection and disposal practised in Singapore. About 85% of the city is fully sewered and Government has banned construction of dry latrines in new buildings. In the uncovered 15% of the city there are nearly 13500 dry latrines. The Public Cleansing Department of the Ministry of Environment has a separate unit entrusted with the task of night-soil removal. The unsewered parts of the city have been divided into 6 zones each serviced by a collection centre, well-equipped with transportation vehicles and collection and maintenance staff. The system works somewhat as follows :

3.15 The house-holders are provided with standardised receptacles which are collected and replaced daily. The charge for daily night-soil removal service is S$ 3.25 (nearly Rs. 9/- per month). A specified number of houses are entrusted to a team provided with a motorised collection van and consisting of four collection staff and one driver. They go on circuit daily and after collecting night-soil from the designated houses, the vehicle is taken to specified treatment plant for discharging the collected night-soil. The charges and other economics are as follows :

The cost of the night-soil removal service during March 1975 was as under :

Supervisory Staff	S$ 43,610
Subordinate Staff	122,260
Other (e.g. replacement and maintenance of vehicles, equipment and materials) operational expenditure	35,220
Computed charges for pumping and treatment of night-soil by sewerage Department.	34,500
TOTAL	S$ 235,590

In this month, the revenue received was S$ 40,363 and thus the subsidy amounted to S$ 195,227.

3.16 Even after deducting the charges for pumping and treatment, the deficit comes to S$ 1.60 lac per month. This amounts to a subsidy of nearly S$ 12 per month per dry latrine. In terms of our currency, it would amount to almost Rs. 35 per month. However, in Indian conditions such a service could be operated at much less cost.

3.17 The capital cost of providing sewerage these days is very high. For Indore, it has been worked out at Rs. 120/- per capita. The cost for Bhopal is estimated at Rs. 135/- per capita. The cost average, however, would range between Rs. 100/- and Rs. 150/- in most of the cities. Taking average of Rs. 125/- per capita, the capital cost for providing sewerage service for one family would be roughly of the order of Rs. 600/-. The annual interest on this amount would be about Rs. 60/- per annum per family, that is, roughly about Rs. 5/- per month. The maintenance cost of sewerage varies from Rs. 9/- to Rs. 15/- (figures supplied by C.P.H.E.E.O.) per capita per annum *i.e.* about Re. 1/- per month per capita. The choice, therefore, is between providing a well-organised sanitary night-soil removal service at a relatively high operational cost or pay substantial amount by way of interest on the capital cost of introducing sewerage. This analysis is strictly in economic terms though from the point of view of health and environmental cleanliness, sewerage is much superior and there can be no two opinions about introducing it, should the finances permit. But looking to the high capital cost involved, it appears unlikely that we will be in a position to cover the entire urban population with sewerage in the foreseeable future, namely, the next two to three decades. Even if the subsidy on operating the night-soil cleansing service of Singapore style were of the order of Rs. 10 per family per month, we should better go in for it. We would, therefore, suggest that an efficient night-soil service on the model of Singapore may be introduced in certain selected areas of the city on a pilot basis for the remaining period of the Fifth Five Year Plan to be enlarged on the basis of experience of 5th Plan to cover the entire non-sewered areas in the Sixth Plan. We, therefore, wish to make it clear that this recommendation is made on the assessment that conversion of all dry latrines into sanitary ones—which we feel should continue to be the ultimate objective—will take time and till that objective is achieved a clean and sanitary method for night-soil removal should be operated.

Collection of Street Sweepings and Market Refuse

3.18 Although almost all the cities are having special collection sites for market refuse etc. the system is not functioning well with the result that most of markets dealing with food, vegetables and other perishable items are the worst insanitary areas of any city. This needs to be improved. The municipal authorities by levying a special charge for collection as is done in a number of countries, should improve the system of collection as well as removal. The main snag lies in the absence of properly constructed central collection sites. The second is the difficulty in removal, particularly, from narrow lanes and by-lanes where such markets are generally located in most of our cities and towns. We would, therefore, recommend special attention of local authorities in construction of proper collection sites in such markets where bulk refuse is generated. In addition, small vehicles like auto-rickshaws may be introduced by the local bodies for the collection of refuse from narrow streets and congested markets, where these have not been introduced already. Where the scale of commercial operations, the narrowness of roads etc. are severe constraints for an efficient removal service, the municipal authorities should seriously consider constructing such markets particularly for sale of vegetables at alternative sites. The health of the urban community as a whole and traders and users of markets in particular obligates such a step

on a priority basis. Delhi has recently shifted its highly congested and insanitary wholesale vegetable market to a new site. Other cities will do well to emulate this example.

Transportation

3.19 Transportation of City refuse from the collection points to the disposal sites constitutes a key stage in an overall 'collection and disposal' system. The cleanliness of the area in particular and tidy appearance of the city in general are closely linked with efficient functioning of the transportation system. Unless timely removal of the city garbage from the collection points which are situated all over residential, marketing and other areas is ensured, the refuse depots can become a source of great nuisance and annoyance to the residents of the locality. Besides, the conveyance of the wastes from these points to the disposal points has to be organised in such a way, keeping in view the various factors such as mode and type of transport, their capacities, frequency of use, time of plying etc. as to cause the least nuisance en route. The service has also to be planned to function in the most economical way. Yet another factor which has to be reckoned with in any situation particularly, is that no *one* mode of transport can prove effective, economical and efficient due to congestion and narrow lanes and streets in any cities. We have, therefore, to use various types of vehicles from hand drawn thellas/trollies to modern mechanised vehicles.

3.20 The questionnaire circulated by the Committee had also sought information on various aspects of the transportation system referred to in the earlier paragraph. In all 203 local authorities in different categories furnished the information. The information relating to the quantum of refuse generated and the number of vehicles employed for its removal, both mechanised as well as non-mechanised, is summarised in Table 12 given below. The particulars in regard to average distance to be covered for the purpose, adequacy and otherwise of the fleet and maintenance facilities available are given in Table 13.

TABLE 12

TOTAL REFUSE VERSUS NO. OF VEHICLES

Class of cities/towns	Total No. of local bodies addressed/No. of local bodies who responded	Total Number of		Total Refuse (In Tonnes)		Total
		Mechanised vehicles	Un-mechanised vehicles	Night-Soil	Refuse and other wastes	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
I	132/99	1468	1363	10,541·51	14,253·97	24,795·48
II	68/31	128	187	246·81	1,259·65	1,506·48
III	72/44	99	454	191·41	290·73	482·14
IV	34/17	28	78	28·06	87·88	115·94
V	35/12	12	36	5·10	21·21	21·25
TOTAL	341/203	1735	2118	11,012·89	15,908·34	26,921·23

TABLE 13

TRANSPORTATION AND WORKSHOP FACILITIES

Class of cities/towns	Average distance from collection site to disposal site	No. of local bodies who have		No. of local bodies who have	
		Adequate vehicles	Inadequate vehicles	Workshop facilities	No workshop facility
(1)	(2)	(3)	(4)	(5)	(6)
I	17·6 Kms	18/109	91/109	73/107	34/107
II	10 Kms.	12/37	25/37	9/38	29/38
III	8 Kms.	14/42	28/42	2/40	38/40
IV	6·4 Kms.	7/19	12/19	3/16	13/16

3.21 It will be observed from these tables that while the large cities are using mechanised transport more, the medium and small cities have obviously to depend more on unmechanised and conventional transport. The haulage distances it will be observed are also quite high particularly in the case of Class I and Class II cities/ towns.

3.22 As regards adequacy of vehicles needed for the purpose, it is noted that all cities are experiencing shortage of transport vehicles. It is significant that in the case of Class I cities which among themselves envelope more than half of urban population of the country and would, no doubt be generating huge quantities of city garbage, as many as 91 out of 109 have inadequate transport fleet. Similarly, two-thirds of Class II, III and IV towns also suffer from this type of shortage. One can easily imagine the standard of sanitation, such local authorities could be expected to maintain in the circumstances.

3.23 In regard to transportation of domestic wastes including night-soil the position in our cities would not seem to be happy, as this is done by unmechanised system to a larger extent.

3.24 The efficiency of transport fleet depends considerably on its timely servicing and proper maintenance. It is however observed that quite a large number of municipal bodies have not been able to develop their own workshop facilities. This could lead to under-utilisation of the fleet capacity due to delay in repairs and may also involve more expenditure. In the places, where the fleet is inadequate already, the breakdown of even one vehicle would result in delay of removal of garbage thereby keeping a particular area in insanitary condition.

3.25 Considering the importance of transportation of the city refuse in the Public Cleansing System, the Committee had set up a separate Group to make a detailed study of various problems connected thereto, comprising the Municipal Engineers and an Environmental Engineering Scientist. The report of the Group is given at Appendix IX.

3.26 In its report, the group has dealt with different aspects of the problem, administrative as well as technical, including, types of vehicles required, their specifications, workshop and depot facilities, machinery and equipment, organisation and staff, etc. We commend these recommendations for implementation by the concerned authorities. We would, however, like to make here certain general observations and recommendations for the guidance of the implementing authorities.

3.27 As indicated earlier, howsoever, we may wish them away, the conventional and unmechanised transport will have to continue for quite some time to come due to peculiar nature of our cities and towns with small and narrow lanes and alleys. It would not be possible to ply auto transport in the congested core areas of the cities. Then there is the question of relative economics. While the mechanised transport is more capital oriented, the unmechanised and conventional mode of transport is more labour oriented. Due to difficult financial position it would not be possible, therefore, to completely switch over to mechanised transport for some more time. What is, however, necessary is that the transport operations by even old modes could be made more hygienic and less tedious for the workers employed. We would like to impress upon the local authorities the need for various steps to be taken in this direction as recommended in earlier paragraphs.

3.28 It has to be remembered that animal driven vehicles can prove useful and economical for short haulage only say 1-2 miles. Beyond this, the use of mechanised transport has to be encouraged as far as possible. The analysis of data referred to in para 3.20 indicates that in certain cases the haulage distance were quite long. In such cases a phased programme should be prepared depending on the local conditions for change over to mechanised transport ultimately.

3.29 The selection of vehicles should be made carefully keeping in view certain basic requirements. First, the speedy and trouble-free loading and discharge of refuse because any undue and avoidable delay will ultimately lead to wastage of time and money. Secondly, the capacity and operational capability of the vehicles. Thirdly, the durability and suitability of vehicles for refuse collection and carriage operations which are special in nature. It is possible that all these requirements may not be fulfilled by one type of vehicles; consequently, compromise has to be made in selecting suitable vehicles meeting these requirements as far as possible.

3.30 We would suggest that in metropolitan and other large cities, this service should be developed on operational research methods which would increase loading capacity, reduce trip frequencies and raise optimum utility of the fleet.

3.31 The entire operation of transport of refuse will have to be systematised and timed in such a way as to cause least annoyance, inconvenience and nuisance to the citizen and to ensure that there is no friction with and obstruction of normal traffic in the city; the aim being to keep and maintain the city clean and tidy.

CHAPTER IV SYSTEM OF CITY GARBAGE DISPOSAL

Present Methods

4.01 *General* : As per item one of the terms of reference, the Committee was required to study *inter alia* present methods of disposal of city refuse and night-soil in the country keeping in view the extent of environmental pollution caused by existing methods and practice and usage in other countries. Disposal is normally the last operation in the handling of refuse but it is never the least. In fact, in the organisation of an integrated refuse handling system, it has to be planned first since it has an important influence on both storage and collection. Moreover, disposal has direct effect on the cleanliness and pollution of the environments in the city. As explained in earlier chapter, however, the disposal of refuse in a scientific and hygienic way has not so far been given due importance and this phase of the refuse handling system continues to be neglected in most of the cities in our country.

4.02 Due to heterogeneity of the city refuse, no one method of disposal serves the purpose adequately and satisfactorily. Several methods are therefore being widely used in the various parts of the world. Most prominent of these are : Dumping, Sanitary Land-fill, Incineration and Composting. Excepting Incineration, all the other methods are being practised in the country as will be evidence from the table appearing below :

TABLE 14

SYSTEM OF DISPOSAL OF WASTES

Class of cities/towns	No. of local bodies addressed/ No. responded	No. of local bodies where almost entire substantial refuse is disposed of by composting		No. of local bodies where the refuse is disposed of by dumping on land and sanitary land-filling		No. of local bodies where the refuse is disposed of by dumping, sanitary land-filling and composting		No. of local bodies where waste is disposed of by other methods	
(1)	(2)	(3)		(4)		(5)		(6)	
I	132/96	37	39%	17	18%	39	41%	3	2%
II	68/32	17	53%	4	13%	11	34%	—	
III	72/40	20	50%	9	23%	8	20%	3	7%
IV	34/15	4	26%	6	40%	3	20%	—	
V	35/9	2	22·2%	4	44·4%	3	33·4%	—	

While the details about different methods have not been indicated separately, majority of local authorities are known to be adopting dumping widely for obvious reasons. With the growing awareness of the dangers of indiscriminate and uncontrolled dumping and demand for improving environments and sanitary conditions, the local authorities will have to adopt sanitary methods increasingly. To convert dumping into sanitary land-fill does not involve high cost and looking to the health and environmental aspects, we would urge that the local bodies be prevailed upon to adopt sanitary methods of dumping.

Dumping

4.03 *Dumping in Water* : This method being the easiest, was practised on a large scale in the coastal and river-side cities. Due, however, to increasing danger of pollution of water and the nuisance created by the refuse being floated back to the shores, thereby endangering public health, this method is being abandoned in the advanced countries. In our country, however, this method still persists and is practised in some small and medium sized cities and towns. With the adopting of the Water (Prevention and Control of Pollution) Act, 1974 by most of the States, it is hoped that this practice will be a matter of the past in our country also before long. We would, nevertheless, recommend that in view of the fact that dumping of wastes in water constitutes a definite health hazard, it should be prohibited by law.

4.04 *Open Dumping* : The practice of open dumping is resorted to extensively in India, because it is cheap and needs no planning. Generally the low-lying areas and outskirts of the towns and cities are used for the purpose. The open dumps are, however, a menace to the health of the residents of the nearby areas. These dumps become source of objectionable smoke and

odours and serve as breeding grounds for flies and mosquitoes. Even though cost consideration in disposal of refuse is important, the health hazards cannot be ignored. There are however two points for considerations. First, certain proportion of the refuse contain earth, bricks, stone and other material which are not compostable. Such material is, therefore, best buried in the land. Secondly, there are low-lying areas in every city which pose health problems of their own—being prone to collection of stagnant water and thus serving as breeding ground for mosquitoes and flies. Besides, people of nearby areas use these for attending to calls of nature. In many cases these areas can be high value estate in the heart of the city if properly developed. It would, therefore, be desirable for city governments to develop these areas and there is no cheaper way of doing it, than using the solid wastes for filling up these areas. While therefore open dumping is undesirable and should be stopped, sanitary filling of land with refuse is a necessity and would have to continue. Local authorities have, therefore, to be persuaded to employ the methods of composting and sanitary land-filling in accordance with the local needs keeping in view the objective of recycling of the wastes for maintaining soil fertility.

4.05 *Sanitary Land-fill* : This method is widely practised in some Western countries but in India it has found only limited application and even then, it is not being done on scientific lines. The questionnaire data reveals that only 20% of local bodies were practising sanitary land-filling but the experience of the Ministries of Agriculture and Works and Housing indicates that most of these local authorities resort to 'dumping' only in the name of sanitary land-filling.

4.06 *Incineration* : Although this method is being increasingly adopted in developed countries, in India it has been used in only a few places. We feel that this method is expensive besides being wasteful. It is also likely to lead to pollution of air if adequate precautions are not taken. We, therefore, recommend that incineration of wastes should be prohibited generally wherever it is being practised, excepting in hospitals.

4.07 *Composting* : This is an important method of disposal of city refuse and has a vital bearing on agricultural development in our country. It has therefore been dealt with at length in a separate chapter.

4.08 *Recycling* : Recycling, in simple words, means salvaging certain discarded non-perishable materials from city garbage and returning them to industry for refuse. The city wastes contain among other things such heterogeneous material like paper, rags, glass, steel, copper, brass, etc., which can with advantage, be put to reuse. This system, to some extent, also helps in solving the problem of finding land for the deposit of solid wastes. In fact, this is already being done extensively in developing countries including India. The advantages of 'salvage' however depend on relationship between the labour cost of extracting these materials and their market value. Recycling is likely to assume importance for two main reasons in a none-too-distant future. These are : increasing shortage of sites for disposal in some areas and the need for conserving supply of certain raw materials.

4.09 It will however be necessary to devise improved methods of extraction or separation than depend on hand picking, which is becoming costly and unpleasant besides being hazardous and which may be considered degrading by some. Then markets will have to be created for these materials and economic imbalances corrected. Finally, it would have to be recognised that recycling could have profound influence on the basic raw material industries such as forestry for paper production. Recycling in our country is however being practised not for those reasons but mainly as an economic proposition and weaker sections of the society engage themselves in sorting and collection of discarded material like paper, glass, tins, and even coal bits which fetch them some price.

4.10 Recycling has another context also. The important relationship between sanitation and agriculture is self evident all over the world much more so in agricultural countries like India. The recycling of urban wastes so as to provide an inexhaustible store for maintenance of soil fertility assumes great importance in these cases. The National Committee on Science and Technology (Department of Science and Technology) had prepared a sectoral status report on community wastes in which this aspect has been dealt with at length in 'an overall review of recycling of urban wastes especially for agricultural applications'. This review is reproduced in Appendix X.

Environmental Aspects

4.11 It would be relevant here to discuss the environmental aspects of the waste disposal system in various categories of the local authorities in the country. As already discussed, the disposal system can be divided in three main stages *i.e.*, (i) collection and depositing at refuse depots; (ii) transfer from refuse depots to disposal sites, and (iii) final disposal. The problems relating to (i) have been dealt with at length in Chapter III. In this chapter therefore only (ii) and (iii) are being discussed from the angle of environmental cleanliness and relative problems with reference to the situation obtaining at present as revealed from the information furnished on the questionnaire.

4.12 *Carriage of Refuse* : The table below gives the information about the system of carrying the wastes from the collection points to disposal points in the local authorities of different sizes :

TABLE 15

SYSTEM OF CARRYING DOMESTIC WASTES FROM COLLECTION POINTS TO DISPOSAL POINTS

Class of cities/ towns	No. of local bodies addressed/ No. responded	No. of local bodies in which totally mechanised systems are used	No. of local bodies in which partially mechanised systems are used	No. of local bodies in which totally un-mechanised systems are used
I	132/108	69	38	1
II	68/37	22	14	1
III	72/45	21	20	4
IV	34/19	9	5	5
V	35/13	6	2	5

4.13 It will be observed that in the case of cities and towns with population above 50,000 each (Class I & II), only 2/3rd of them have mechanised the transport system so far. In the case of other categories only about 50% of them have been able to change over to mechanised transport. It is significant to note that in 38 Class I cities the refuse is also transported by the old modes of transport. There is one city which has not started using mechanised transport for the purpose so far. The position in the case of towns in other classes would seem to be still more unsatisfactory. The advantages to and effect on sanitation of fast moving mechanical transport in comparison to slow moving old type vehicles with much less capacity need hardly be elaborated.

4.14 *Covering of Vehicles* : While the means of carriage of the refuse are no doubt important, it is equally necessary to ensure that this exercise does not create nuisance en route. The bye-laws and regulations therefore enjoin on the local bodies to ensure proper covering of the refuse while it is being transferred to the disposal sites. The analysis of the questionnaire *vide* table below however indicates that more than 50% of towns in Class I category—56 out of 107—do not employ properly covered vehicles for the purpose. In other categories also the position is more or less the same.

TABLE 16

WHETHER CITY REFUSE IS PROPERLY COVERED WHILE BEING TRANSPORTED FROM COLLECTION TO DISPOSAL SITES

Class of cities/ towns	No. of local bodies addressed/ No. responded	No. of local bodies using covered vehicles	No. of local bodies using uncovered vehicles	No. of local bodies using covered vehicles partially
I	132/107	51	53	3
II	68/37	19	16	2
III	72/46	23	22	1
IV	34/21	14	6	1
V	35/11	8	3	—

It has to be remembered that while covering of refuse does not involve heavy expenditure, its absence does present unsightliness and create nuisance through bad smell that emanates from uncovered vehicles and the refuse that falls on the streets and roads on the way. In the interest of sanitation and public health we would stress upon the local authorities to ensure carriage of refuse in covered vehicles particularly the slow moving ones; by even using tarpaulins.

4.15 *Protective Equipment to Workers* : The workers employed on sanitation work have to handle obnoxious wastes manually and expose themselves to health hazard constantly. The local bodies are therefore required to provide protective equipment and material to such staff. Table below gives information on this point :

TABLE 17

WORKERS HANDLING CITY REFUSE/NIGHT-SOIL PROVIDED WITH PROTECTIVE EQUIPMENT

Class of cities/ towns	No. of local bodies addressed/No. responded	No. of local bodies providing protective equipment	No. of local bodies who do not provide protective equipment	No. of local bodies providing protective equipment partially
I	132/107	80	21	6
II	68/37	21	13	3
III	72/46	27	15	4
IV	34/20	8	11	1
V	35/10	4	4	2

There is no doubt that in majority of municipal authorities, the workers are provided with protective materials but the number of the local bodies where this is not done is also significant. Generally the Class I cities are considered better off in the matter of finances and progressive in outlook. It is however noted that as many as 27 local bodies out of 107 in the category have been neglecting this important measure. The local bodies in other categories also have taken no steps to provide protection to their staff in performing the difficult and dirty duties full of risk to their health. We feel that this situation is not satisfactory and steps should be taken to make the local bodies to comply with instructions on the subject as provision of gloves, gum boots, soap, etc. to the sanitary workers does not involve heavy expenditure.

4.16 *Problems at Disposal Sites* : The measures to control flies, cordoning of the disposal areas and regular covering of the refuse with earth layers are important environmental steps connected with the disposal sites. Three separate tables given below provide information on these aspects :

TABLE 18

MEASURES TO CONTROL FLY NUISANCE

Class of cities/ towns	No. of local bodies addressed/No. responded	No. of local bodies who are taking measures to control flies	No. of local bodies who do not take any measures to control flies, etc.
I	132/97	72	25
II	68/28	14	14
III	72/32	20	12
IV	34/15	8	7
V	35/10	4	6

TABLE 19

CORDONING OF THE SITES

Class of cities/ towns	No. of local bodies addressed/No. responded	No. of local bodies where disposal sites are properly cordoned	No. of local bodies where disposal sites are partially cordoned	No. of local bodies where disposal sites are not cordoned
I	132/105	37	3	65
II	68/33	10	—	23
III	72/42	19	—	23
IV	34/18	6	—	12
V	35/11	3	—	8

TABLE 20

PROBLEMS AT DISPOSAL SITES

Class of cities/ towns	No. of local bodies addressed/ No. responded	No. of local bodies where the city refuse at the dumping ground is properly covered with earth layer regularly	No. of local bodies where the city refuse at the dumping ground is not properly covered	No. of local bodies who have water facilities for drinking and washing purpose at the disposal sites	No. of local bodies who do not have water facility for drinking and washing at the disposal sites
I	132/106	73	33	57	49
II	68/36	23	13	34	12
III	72/45	31	14	13	32
IV	34/19	12	7	6	13
V	35/12	8	4	7	5

These tables in themselves are revealing. Almost one-third of the local bodies, including those in Class I, would be found to have failed to take appropriate sanitary measures at the disposal sites. Such sites can in the long run prove dangerous and steps should be taken to ensure urgent necessary measures on the part of the local authorities.

4.17 *Disposal of untreated sewage* : It is common knowledge that due to weak financial position most of our municipalities have not so far been able to set up sewage treatment plants to utilise this waste profitably. These local bodies, therefore, allow the untreated sewage to flow over to the fields around or discharge it into nearby water courses. Table 21 contains information as to the practice prevalent in different classes of municipal authorities in this regard.

TABLE 21

DISPOSAL OF SEWAGE

Class of cities/ towns	No. of local bodies addressed/No. responded	No. of local bodies in which sewage is disposed of for irrigation	No. of local bodies in which sewage is disposed of by discharge into water courses/or on land	No. of local bodies in which sewage is disposed of both for irrigation and by discharge in water courses on land
I	132/46	17	21	8
II	68/13	5	7	1
III	72/23	6	13	4
IV	34/10	2	6	2
V	35/4	1	3	—

Out of 341 local bodies to whom the questionnaire was sent, only 96 have furnished information on this point. It is observed that 31 of them are utilising untreated sewage for irrigation purposes. As many as 50 local bodies allow this sewage to flow into the water courses thereby creating the problems of environmental sanitation and water pollution.

4.18. *Dumping of Night-Soil* : The absence of sewerage system in most of our cities results in manual handling of night-soil. It is well known that in our cities, night-soil is mixed with other refuse and carried to disposal sites. The following table gives the details of methods adopted for dumping the night-soil at the disposal sites. There is no doubt that in majority of cities and towns, the dumping of night-soil and city refuse is done on separate sites. Out of 202 local bodies who had supplied the information, however, as many as 72 continue with the practice of dumping the night-soil and the refuse at the same site thus making the environments dirty on the one hand and losing the advantage of making valuable compost out of the refuse and night-soil on the other.

TABLE 22

METHOD OF DUMPING OF NIGHT-SOIL

Class of cities/ towns	No. of local bodies addressed/No. responded	No. of local bodies in which the refuse and night-soil is dumped at the same site	No. of local bodies in which the refuse and night-soil is not dumped at the same site.
I	132/106	27	79
II	68/33	9	24
III	72/36	17	19
IV	34/16	13	3
V	35/11	6	5

4.19 The application and adoption of sanitary methods for disposal of urban wastes, particularly for various stages, discussed in preceding paragraphs does not in our opinion involve investment of funds beyond the capacity of local bodies. We feel that it is the lack of understanding and awareness of the problems and the will to tackle them that are responsible for unsatisfactory performance on the front of sanitation and environmental cleanliness. The lack of stress on the part of the State Governments would also seem to be responsible to some extent. We therefore recommend that the State Governments should reiterate the instructions and orders to the local bodies and invite their attention to the bye-laws and regulations. To ensure adequate implementation this aspect should also be studied in depth together with general administration and audit and accounts during periodical inspections by Director of Local Bodies.

4.20 *Public Relations* : In any programme affecting general public, the public relations aspect becomes crucial in educating people and enlisting their co-operation in implementation. We have to step up our efforts in this direction, through mass media, educational institutions, voluntary agencies, social organisations, seminars, periodical campaigns, etc.

CHAPTER V

COMPOSTING

5.01 The process of returning of wastes to soil for enriching its productive capacity has been practised all over the world for ages. The methods used in the past were however unscientific and unhygienic. Compost was made by forming layers or heaps of waste material and turning the heap occasionally in order to introduce oxygen for the biological breakdown of the material. Over the past three decades or so, composting technology has been developed considerably and as a result less rigorous modern methods are now employed for the purpose. These methods fall in two broad categories *i.e.* manual and mechanical. In our country, manual composting methods are used widely.

Advantages of Composting

5.02 The system of compost making for disposal of refuse and other wastes is being adopted increasingly as it is an easy method and does not suffer from the drawbacks of dumping and land-filling. The main advantages of this system are :

(i) Instead of adopting different methods of disposal of kutchra, night soil, slaughter house wastes and sullage, this can be achieved by a common method whereby all the wastes could be disposed of at the same spot and on the same day these are collected.

(ii) This method provides a hygienic and sanitary method of disposal of refuse, since vigorous microbial activity and high temperature (above 60°) which develop in the compost mass in a day or two and persist for some weeks, serve effectively to destroy all elements of small pathogenic organisms, fly larvae, weed seed and obnoxious constituents present originally in city wastes.

(iii) The proportion of dry refuse to the liquid portion (night-soil or sullage) is so adjusted that the compost mass is solid enough to permit walking over it even on the first day of the trench filling.

(iv) There is complete control over smell and fly nuisance and as such the compost depots could be situated at a few furlongs from the town, as against the present system of carrying the refuse several miles away. In this way, the transportation expenses can also be reduced.

(v) By this method, the agricultural areas within and around the city which supply food, vegetables and other products to city dwellers are helped to revive and augment their soil fertility in cyclic way.

(vi) It can prove to be a profitable venture to local authorities and help them to meet to some extent the growing expenditure on sanitation.

Compost Schemes

5.03 Considering the scope, need, value and importance of conversion of city refuse into organic manure in the interest of both agriculture and sanitation, the Indian Council of Agricultural Research of the then Ministry of Food and Agriculture prepared a scheme to be launched in cities and towns way back in 1943-44. Later on, the Ministry took over the responsibility to supervise and guide the implementation of the scheme introduced in different States. The Municipal authorities were required to ensure compost making and making the same available to the agriculturists of the surrounding areas.

Indore Process

5.04 Indore city was the first to embark upon a project of composting on a hygienic basis and the process adopted is known as Indore process. The basic structure used in this process is a shallow, open masonry pit; two to three feet deep, ten to twelve feet wide and about 100 ft. long. Night-soil and mixed street sweepings and domestic refuse are placed in the pit in alternative layers, each about three inches thick to a depth upto five feet. This material is placed along the length of the pit but only on half width, in the order to permit subsequent turning. Daily loadings in the pit are marked by small dated stakes. When the pit is filled along its entire length, another pit is used.

5.05 The material contains house fly eggs and adult flies on arrival at the disposal site. The fly problem, at this stage, is efficiently controlled by a single application of a 2.5 per cent solution of benzene hexachloride containing 6.25 per cent gammaisomer in the technical grade material. Thereafter, composting action takes care of the fly problem. The material is turned in the pit every two weeks for a period of eight weeks, then stored on the ground beside the pit for another month without turning.

5.06 The composting action is mixed aerobic and anaerobic with the aerobic action predominating, following each turning. Including placement in the pit and final removal, this process requires six complete handlings of the compost by manual labour.

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Bangalore Process

5.07 In the light of the experience gained, a modified process was developed by the Bangalore city administration now known as 'Bangalore process' which is now widely adopted by the municipal authorities throughout the country. The first step in this process is the construction of a series of earth trenches, each 30 ft. long, 4 ft. wide and 4 ft. deep. The fresh material is placed in layers as in the 'Indore' process to a height of about 18" above ground level and then eventually covered with a six inch layer of earth. The material is not turned but is digested under essentially anaerobic conditions and is complete in four to five months. Fly control is achieved by the earth cover and also by the heat of decomposition. In this process, two handlings only are involved. The earth trenches are aroused many times with a gradual loss of cross section.

5.08 The average nitrogen value of the compost by this process on dry solid basis is 2% as against 1% of the Indore process. The difference is due to variations in the composition of refuse and night-soil collected from different areas of the city, rather than due to the difference between the two processes.

5.09 In this process, attempts to increase aeration and turning of compost mass are not made as it increases the cost of the ultimate product which the Indian farmer in view of his limited resources cannot afford to pay. Though the process avoids turnings altogether, it lays great emphasis on the initial C/N ratio of the compost heap and initial moisture content. The compost made through this method is free from pathogenic organisms and contains 1.5% nitrogen, 1.1% phosphoric acid (P_2O_5) and 1.5% potash (K_2O) on dry basis and proves a valuable nutrient to the soil.

5.10 During the first, second and third five year plans, it was a centrally aided scheme. The financial assistance was provided mainly in the form of loan to be advanced to the municipal authorities for being utilised on the purchase of vehicles needed for production and distribution of the compost. With the launching of the Fourth Plan, the pattern of Central assistance was changed from scheme-wise allocation to block grants and loans and the State Governments were free to utilise the same as per priorities and pattern considered appropriate by them. The result was that this scheme was accorded a very low priority and excepting a few States, no provision was made for the scheme in the 4th Plan. Even in the case of the States which had allocated funds for the purpose in their draft plans the provisions were either dropped or curtailed drastically subsequently. The special staff appointed for implementation of the scheme earlier was disbanded or transferred to other jobs. For these reasons, the urban compost scheme which had made steady progress in the earlier plan periods received a severe set-back.

Legal Obligation

5.11 *Present Position* : It would be relevant here to review the present position as obtaining in various classes of cities in regard to preparation of compost on the basis of information furnished on the questionnaire circulated by the Committee. The questionnaire contained a question whether making of compost was obligatory. Further, whether detailed guidelines and rules had been framed for the purpose. The replies received are summarised below :

TABLE 23

LEGAL REQUIREMENTS

Class/No. addressed	No. of local bodies where composting is obligatory/discretionary			No. of local bodies where rules have been framed		
	No. who replied	No. where compulsory	No. where not compulsory	No. who replied	No. where rules framed	No. where rules not framed
I/132	97	48	49	94	35	59
II/68	33	14	19	29	15	14
III/72	41	23	18	38	10	28
IV/34	18	9	9	18	4	14
V/35	8	3	5	7	1	6
	197	97	100	186	65	121

It is clear that in case of more than 50% of local bodies compost making is still discretionary. Similarly, in regard to framing of rules and guidelines about 2/3rd of local bodies have yet to do so. An important point to note is that it is not only the smaller local bodies who are lagging behind but even some of those cities which have population above 1 lakh have yet to appreciate the importance of compost making.

Preparation of Compost

5.12 From Table 14 (para 4.02), it will be noticed that 47.4% of local bodies in five classes of cities and towns were utilising substantial proportion of the refuse for making compost, individual classwise percentage ranging from 22.2 in the case of Class V towns to 53 in the category of Class II towns. Significantly among Class I cities only 39% of them are using a substantial portion of refuse for compost making although the total number of cities making compost to some extent is higher *i.e.,* 94 out of 107. The table given below indicates the number of local bodies preparing compost, the process adopted and the range of annual out put.

TABLE 24

PREPARATION OF COMPOST

Class of cities/ No. addressed	No. of cities which replied	No. of cities preparing compost			Range of out-put per annum (Tonnes)
		Indore Process	Bangalore Process	Other method	
I/132	109	4	86	4	60-160000 (Warrangal) (Poona)
II/68	36	—	34	—	50-8480 (Purulia) (Karur)
III/72	45	1	35	2	95-6935 (Alwaye) (Roorkee)
IV/34	18	1	9	4	120-1617 (Nargund) (Sehore)
V/35	11	—	7	—	60-1100 (Sarangarh) (Kannod)

It will be observed that there are several cities and towns which are not utilising refuse for preparing compost even at present; as many as 15 out of 109 in Class I category alone. Another fact which emerges is that the efforts made by different cities in the same class as also in comparison with other classes vary considerably. It is significant that the minimum annual out put in case of Class III and IV towns is more than the minimum of a Class I city. It is also noteworthy that Poona with population of about 8½ lakhs produces 1,60,000 tonnes annually whereas Warrangal with 2.07 lakhs population makes only a nominal quantity of compost per annum. Nargund town with 17,000 population only is able to produce double the quantity of Warrangal which has over 12 times more population than the former.

Economics of Composting

5.13 *Expenditure and Income* : In the table given below, we have studied the economics of composting. Taking up the expenditure incurred on and income derived from composting, we find that if the scheme is operated with due care, it can be a source of substantial income. There are cities and towns which are able to make an annual income of Rs. 2 lakh (Class I) and more than Rs. 1.25 lakhs (Class II) from composting. As regards expenditure, the maximum amount

spent over a year in one of Class II towns is Rs. 2.60 lakhs and the same in case of a Class I city is Rs. 2.197 lakhs. Moreover, quite a substantial proportion of local bodies are doing this work out of their own resources and do not get any assistance from the State Governments. Full details may be seen in the following table :

TABLE 25

EXPENDITURE ON AND INCOME FROM COMPOSTING AND WHETHER ASSISTANCE RECEIVED

Class/No. addressed	No. who replied	Minimum to Maximum		Whether any assistance received		
		Expenditure Rs.	Income Rs.	No. who replied	No. who get assistance	No. who get no assistance
I/132	75	2,000 to 2,19,174	155 to 2,00,000	104	17	78*
II/68	27	1,560 to 2,60,220	420 to 1,25,555	31	4	25
III/72	34	450 to 1,00,000	15 to 54,100	39	10	24
IV/34	12	500 to 12,000	65 to 4,809	19	4	11
V/35	8	1,700 to 10,000	50 to 3,500	12	2	5

(*remaining local bodies are not making compost at present).

5.14 *Production cost, sale price, methods of sale* : We had also collected statistics about the cost of production per unit, its sale price and the method of sales. These self-explanatory figures may be seen in the table hereunder :

TABLE 26

PRODUCTION COST OF COMPOST, SALE PRICE AND METHOD OF SALE

Class/ No. addressed	Cost of production		Sale price		Method of sale		
	No. who replied	Cost per tonne varies from	No. who replied	Sale price per tonne varies from	By weight	By auction	By both methods
I/132	59	Re. 0·30 to Rs. 30·00	79	Re. 0·50 to Rs. 35·00	62	22	4
II/68	21	Rs.1·54 to Rs. 27·00	28	Rs. 3·00 to Rs. 34·00	20	10	1
III/72	23	Re. 1·00 to Rs. 30·00	28	Re. 0·68 to Rs. 27·00	16	16	1
IV/34	6	Rs. 8·00 to Rs. 26·00	10	Rs. 3·12 to Rs. 19·00	15	7	—
V/35	3	Rs. 9·60 to Rs. 28·00	4	Rs. 2·75 to Rs. 5·00	4	4	—

These details are revealing. The difference in the minimum and maximum cost of production per tonne would justify the inference that there is considerable scope for making this service more economical. Moreover by improving the sales system, the income from compost can be stepped up considerably. There could perhaps be no justification in the present situation to sell compost at so low a price as 50 paise or 68 paise per tonne.

5.15 *Self-paying proposition* : We had also requested the local bodies to indicate whether the compost making was a self-paying venture or the local body had to contribute towards a share of its cost of production. From the table below, we find that quite a good number of local bodies have succeeded in making it a self-paying proposition. We feel that with the demand for compost rising, the other local bodies should be able to make composting at least a self-paying if not a profitable service.

TABLE 27

COMPOSTING SELF-PAYING PROPOSITION

Class of cities/towns	No. of local bodies addressed/ No. responded	No. of local bodies where composting is not done	No. of local bodies in which the composting is self-paying		No. of local bodies in which the composting is not self-paying	
I	132/85	9	27	36%	49	64%
II	68/26	2	7	29%	17	71%
III	72/28	5	3	12%	20	88%
IV	34/16	4	2	17%	10	83%
V	35/8	5	—	—	3	100%

5.16 The table given in Appendix XI contains the details of annual production, production cost and the sale price of the compost per tonne obtainable in various Class I and Class II cities. It will be noted that in 18 Municipal bodies compost is fetching a price higher than the cost price. There are 8 municipal authorities who are able to sell the compost at the cost price. However, as many as 29 municipalities are incurring a loss on this service as the sale price there is less than the production cost. Whereas the difference between the cost price and the sale price in the case of first category of Municipalities ranges between 25 paise to Rs. 11.35 per tonne, the same in the case of third category varies between 25 paise to Rs. 34/- per tonne. The fact that about 50% of local authorities are able to make the compost at much lower cost than the sale price indicates that with better management, this service can be an economically viable venture in most of the local bodies.

5.17 Besides income from sale of compost, the local bodies also derive some income from the digested sludge which is useful for agriculture. It will be noticed from the table given below that there is scope for developing this source of income by local authorities.

TABLE 28

ANNUAL QUANTITY AND ANNUAL INCOME FROM THE SALE OF DIGESTED SLUDGE

Class of cities/towns	No. of local bodies addressed/ No. responded	No. of local bodies in which digested sludge is being sold directly	No. of local bodies in which digested sludge is not being sold directly	Variation in annual quantity sold	Variation in annual income
I	132/54	10	44	Rs. 133 to 15000 tons	Rs. 500 to Rs. 39,324
II	68/16	1	15	Upto 3165 tons	Upto Rs. 1,25,555
III	72/24	3	21	176·2 to 2715 tons	Rs. 1,200 to Rs. 3,258/-
IV	34/9	1	8	No reply	Rs. 500/-
V	35/6	—	6	—	—

5.18 *Management* : In an earlier chapter we have referred to the fact that no set pattern has so far been developed for managing the function of urban wastes disposal under the local bodies. This is being looked after by persons from different disciplines; health, agriculture and others, as will be noted from the table given below :

TABLE 29

DEPARTMENTS RESPONSIBLE FOR DISPOSAL OF COMPOST

Class of cities/towns	No. of local bodies addressed/ No. responded	No. and designation of the officers who look after the work			
		Health Officer	Sanitary Inspector	Compost Officer/ Inspector	Officers having other designation
I	132/94	38	30	7	19
II	68/30	5	17	3	5
III	72/38	3	23	2	10
IV	34/15	—	11	1	3
V	35/10	1	3	1	5

It is obvious that in a limited number of local authorities, this function is being looked after by the Health Officer or Compost Officers/Inspectors. In a majority of local bodies either Sanitary Inspectors have been made responsible for it or some other officers look after it, presumably in addition to other duties. Such an arrangement will hardly prove to be conducive to efficiency and economy. It is necessary that the State Governments should examine this aspect in detail and ensure the management of composting on scientific and hygienic lines by qualified personnel.

5.19 *Drawbacks* : The analysis made in the proceeding paragraphs brings out the fact that the function of composting has not been given the attention, importance, support and lead it deserves from the local authorities as well as the State Governments. In brief the undermentioned difficulties have come in the way of our taking full advantage of converting city wastes into valuable manure.

(a) Apathy and lack of interest due to inertia or wrong interpretation of the costs on the part of Municipalities.

(b) Lack of legal sanction.

(c) Inability of the local authorities to meet the non-recurring and recurring expenditure on compost apparently due to weak financial position generally.

(d) Lack of support and guidance from the State Governments.

(e) Delay in acquisition of suitable lands for composting grounds.

(f) Inadequate arrangement for removal of city refuse.

(g) Local bodies utilising the solid wastes for land-filling.

(h) Lack of transport facilities for carrying the compost to nearby fields and its unfavourable economics.

(i) Poor quality of compost.

(j) Lack of trained supervisory staff both at local as well as State levels.

5.20 *Enriching manure with rock phosphate* : In the context of the present high prices of chemical fertilisers, the need to bring about widespread utilisation of the indigenously available rock phosphate (as also pyrites) either by direct application to the soil or by admixture with organic manures had understandably attracted considerable attention. The Ministry of Petroleum and Chemicals have been considering the matter for some time in consultation with the Ministry of Agriculture. While the efficacy of admixture of rock phosphate/ pyrites with organic manures has yet to be established fully, the preliminary studies have indicated that this process can enrich the manure considerably.

5.21 The Committee have estimated that with an urban population of over 109 million, it should be possible for the local authorities to prepare compost upto 18 million tonnes per year. Against this, however, the present production is barely 4 million tonnes; less than 25% of what we can produce normally. There is, therefore, scope for not only stepping up the utilisation of city wastes for composting and enhancing the production of compost in the country by the existing manual system, but also for setting up mechanical composting plants in large cities for obtaining full advantage from the city wastes. We would like to make the following recommendations here for manual composting, as mechanical composting has been dealt with in the subsequent chapter.

(1) Composting and sanitary land-fill are the generally recommended practices for refuse disposal in this country. Keeping in view the

necessity of recycling wastes for manurial purposes, composting may be made obligatory on the part of local authorities. Depending on the local conditions, all compostable material should, as far as possible, be utilised for composting and the remaining material disposed of by sanitary land-filling.

(2) The present practice of dumping night soil with city refuse should be banned. Night soil should be utilised either for composting with due health safeguards or it should be trenched properly.

(3) Appropriate rules and Bye-laws be framed for the guidance of the local authorities.

(4) The State Governments should revitalise the scheme of urban composting and provide financial and technical assistance for the purpose to the local authorities.

(5) In the sewered cities, the sludge may be utilised with city wastes for composting. For this purpose, the composting grounds should be situated as near the sewage disposal works as possible.

(6) Steps should be taken to ensure quality of the compost. The extraneous materials (like brick pieces, iron, glass pieces, leather, rags, etc.) should as far as possible be sorted out of the refuse before composting. Depending on the volume of work, mechanical sieving plants be set up in large cities.

(7) In view of the high potential of enriching the organic manure by admixture of rock phosphate/pyrites, it is necessary to carry out detailed studies in regard to the efficacy of the process. The Ministry of Agriculture and the Ministry of Petroleum and Chemicals may get such studies conducted early and take steps to put the process in use if found advantageous.

(8) Procedures for acquiring lands for composting grounds should be simplified and if necessary special powers should be given to officers responsible for acquisition of land for the purpose.

(9) In the town planning schemes, specific areas should be earmarked for composting grounds.

(10) Since composting will be advantageous for agricultural operations, the State Agriculture Departments should look into the possibility of providing assistance particularly for transport needed for compost distribution, including loan and subsidy on a temporary basis till the profitability is built up.

(11) The State Governments should encourage exchange of experience in this aspect among the local bodies in the State as well as with local bodies in other States who have been able to launch the composting programme successfully and economically.

(12) The State Governments should make a detailed study of economics of composting and provide the local authorities with detailed guidelines for making composting a self-paying proposition.

(13) There is need for change in the method of sale. The present system of selling compost by auction in heaps or cart/truck loads should be replaced by sale by weight and at fixed prices.

(14) The Central and State Governments and the local authorities should take steps to popularise compost through mass media, farmers' forums, cooperatives, etc.

CHAPTER VI

MECHANIZATION IN COMPOSTING

6.01 *Developments in mechanization of composting* : Mechanization in composting has been introduced with the objective of speeding up the processes of aeration and bacterial breakdown of materials and production of a quality compost. This aims at providing congenial conditions of aeration, moisture and temperature for bacteria, moulds, fungi and other forms of life to flourish and perform their task in de-composition of wastes under rapid pace.

6.02 *Composting systems* : Composting systems fall basically into two categories; *i.e.* (a) windrow composting; and (b) composting in enclosed cells. Though strictly speaking, only the latter could be termed as mechanical composting system, a certain amount of mechanization has been introduced in the former also. With the aim of recommending systems suitable for adoption in Indian conditions, the Committee, therefore, appreciated the need for reviewing both the above systems under the category of "mechanical composting".

6.03 *Review of composting systems* : The Committee had requested the National Industrial Development Corporation to carry out a study of the mechanical composting systems patented in the West and for which representation was available in the country, to enable the Committee to understand the basic concepts of mechanised composting. Four systems have been studied by the NIDC in detail. Extracts from the report of the NIDC are given in Appendix XI. In addition, the Committee has been able to get a list of mechanised systems prevalent in different countries. This list may be seen at Appendix XII. These systems have mostly been developed for urban waste material generally prevalent in the Western urban centres. They have also been developed substantially for the Western conditions in which labour is costly. Any adoption of these processes to Indian conditions is likely to be both over-capitalised and over-designed. The urban wastes generally available in the Indian towns have substantial vegetable matter and very little of the hard plastic and metal matter which are found in the urban wastes of the West. Moreover, labour is cheap in our country.

6.04 Differences in the various systems occur in the method of digestion, in the amount of preparation of raw-refuse and finishing of digested refuse and the extent of mechanization or use of mechanised materials handling equipments.

6.05 Windrow composting has in the past undergone lot of improvements with introduction of a variety of mechanized materials handling equipment. Ground refuse or pre-sorted and ground refuse is tipped in windrows, sometimes inocculated with special cultures and then after a period of fermentation during which mechanical turning is employed, may be fed into mechanical separation, grinding and screening plants.

6.06 The fully mechanized processes in the form of enclosed cells may involve revolving cylinderical drums or provision of static steel and concrete digestors or vertical silos having tilting floors or moving belt conveyors, with or without facilities for forced aeration.

6.07 Whereas the windrow composting system requires higher land and labour, the enclosed cell systems have more power and a smaller, but highly skilled labour requirements.

Experiences abroad

6.08 *United States and Europe* : Though the problems of marketing compost restricted the use of mechanized composting as a method of disposal in U.S.A. and Great Britain, this has found favour in many other European countries where such plants are being operated successfully.

6.09 *Asian countries* : The Study Team's impressions of visits to 5 Far-East Asian countries have been stated in Appendix V. It would be seen that the experience in mechanical composting plants in the countries visited has been none too happy.

6.10 *Thailand* : In Bangkok, none of the four plants is working properly. In fact, the only plant which has operated for sometime is the one at Dindaeng. It has capacity of over 350 tons per 8-hour shift. At the time of the visit the plant was, however, not operating as certain parts were awaiting replacement and certain sections were reported to be under repairs. Such breakdowns were reported to be frequent. The following reasons were given to the Team for improper functioning of this plant and non-functioning of the other three.

(a) The economics of production and sale are not favourable.

(b) There is not much of demand for the compost in and around Bangkok city. The demand is only in north where transportation in the chief bottleneck. Further due to long distances, carrying compost to needy areas is not economically feasible.

(c) Poor quality of compost with low content of plant nutrients and high content of plastics.

(d) Because of the large capacity of plants from 350 to 500 tonnes the feeder areas have to be considerably widespread. The traffic conditions in Bangkok city (Area 1550 sq. kms, population 3.7 million; over 100,000 cars and other commercial vehicles) are rather chaotic. In

peak hours, traffic jamps are a common feature. The turn-around time of the transportation vehicles of garbage to and from the plant is therefore too high.

(e) Setting up of the plants on the periphery of the city is also responsible for very long routes for the transportation of garbage.

(f) Upkeep and maintenance of the sophisticated plant has not been up to the mark.

(g) Because of the unfavourable economics, there is reluctance on the part of the Bangkok Metropolis to operate the plants. It was mentioned that losing interest on capital investment was less burdensome than the losses that would be involved in composting the garbage with attendant problems of marketing it in an area of no or very little demand.

(h) Although labour is cheap, the plants are highly mechanised.

6.11 *Singapore* : In Singapore, disposal of all the wastes is through sanitary landfill. Only recently feasibility studies have been initiated for setting up incinerators and that too because land for refuse disposal has become extremely scarce (total area 584.3 Sq. Km.; total population 21,85,100). However, on an experimental basis a small mechanical composting plant of about 25 tonnes capacity employing Dano process has recently been set up. Trial runs were going on when the team visited the plant. Since agricultural needs of the predominantly industrialised and commercial community of Singapore are very limited (as very little land is available for agriculture) the need for compost is not being felt much. It is only for horticultural purposes that the composting plant has been established. We have not much to compare with the conditions in Singapore.

6.12 *Hong Kong* : In the small territory of Hong Kong again the agricultural activities are limited and, therefore, no mechanical composting plant is operating there.

6.13 *Japan* : Japan had over 20 MCPs about 15 years back but these are now more or less on the way out. We were informed that not more than two or three plants were functioning at that time (Nov. 1974). Japanese agriculture is based on very intensive utilisation of land and high use of chemical fertilisers. Japanese farmer no more favours the low-nutrient compost. The compost plants have consequently lost their place. There again is not much to gain from the Japanese experience as the conditions in the field of agriculture in India are so dissimilar to those in Japan.

6.14 *Philippines* : Philippines has also made only an experimental attempt on the introduction of mechanical composting. In Manila, a small hammer-mill has been set up for shredding of the refuse after pre-screening and through Dr. Snell's process compost is being made in windrows fed by air for accelerated decomposition. The Committee were informed that no project report is yet envisaged on the basis of this experimental plant.

6.15 However, a project is being thought of for in-place composting as a part of the comprehensive integrated project for disposal of the urban wastes of the city of Manila. It was reported that consultants have already prepared initial reports on the subject which have not yet been considered. The idea is, therefore, in a very preliminary stage.

Lessons to be drawn from experience abroad

6.16 From the Asian experience described above the following lessons can be drawn :

(1) Compost plants should not be operated with a profit motive. Whereas it actually costs money to treat sewage or to reduce water pollution and air pollution, the desire that solid wastes disposal should bring any "profit" is not correct. India's vast agricultural needs call for full exploitation of the soil conditioning and manurial values of compost and with suitable marketing arrangements, the compost plants in India will definitely be self-supporting, if not bring in profit.

(2) The advantages of mechanization should be made use of but, turnkey projects of patented processes developed for conditions in the West requiring high degree of skills in operation and maintenance may not be suitable.

(3) Standardisation of plant design for adoption in the entire country may not be feasible.

(4) The quality of compost and its easy marketability should be ensured.

(5) To tide over the teething troubles which all mechanised compost plants face in the beginning the State Governments may have to give necessary assistance to the local authorities.

Choice of Processes

6.17 Indian refuse differs to a great extent from the wastes generated in other countries like U.S.A. and Europe and local conditions like availability of land, skilled manpower, etc., are also widely different from other countries. Composting processes and extent of mechanization should, therefore, be carefully selected to suit our conditions.

6.18 Unskilled labour is cheap in this country. Highly skilled labour which can properly maintain and run highly mechanised system is not easy to find. Any mechanical system to suit the conditions in this country should, therefore, provide for inducting unskilled labour in sections where movement of material is desirable. The mechanical part of the system should also be sturdy and easily maintainable so that with the technical competence generally available it can be made to work without breakdowns. High capital costs of mechanical equipment can be avoided by inducting labour at various sections of the process. Even in highly industrialized countries it has been found that fully mechanised plants are expensive to provide and operating costs are also very high. Our systems will therefore have to be developed keeping these basic facts in view.

6.19 Indian refuse as compared to the refuse in the Western countries is more amenable to economical composting because of its composition. Further, as already explained, recycling of our wastes is essential for keeping up the productivity of our agriculture. Labour is also cheap.

6.20 Windrow composting requires space and the process is time-consuming. The process is however simple to handle. Enclosed cell composting, on the other hand, reduces the time factor and also reduces requirement of space. But the requirements of capital and skilled manpower are high. Where land is available in plenty, it may be desirable to follow a system of windrow composting suitably adapted to local conditions. Where space is limited but skilled manpower is available, it may be desirable to adopt one of the enclosed cell composting methods modifying systems suitably to maximise use of unskilled labour.

6.21 The location and the size of the composting plants will have to be designed so as to balance between the haulage of wastes and the economics of size.

Guidelines for mechanized composting

6.22 *Windrow composting* : Pre-treatment of refuse using hammer-mills, etc. may not generally be necessary for Indian refuse. Elimination of grinding will aid aeration and grinding to too fine a particle size will impede the diffusion of oxygen to and carbon dioxide from the heaps. Particles size of 2 to 3" is suitable for windrow composting though larger particles can also be composed satisfactorily and they also provide more entrapped oxygen. It is clear that less of paper cartons, glass, plastics, etc. as compared to refuse in other countries make Indian refuse more amenable to easy composting, avoiding grinding, etc.

6.23 Even screening for removal of fine earth and ash may be eliminated. The fine earth may contain in addition to phosphorus and potash useful minerals which are of importance in compost. Fine earth and ash also help in adjusting the moisture content wherever necessary and production of a stable humus.

6.24 *Digestion in windrows* : Proper turning to aerate the mass is essential and mechanized materials handling equipment need to be introduced. Turning may be accomplished by a variety of mechanical devices. Some of the equipments which have been successfully used elsewhere are front end loader clam-shell bucket on crane, self-propelled over cab loader, tractors with open prong or forks, mobile cranes—drag lines with buckets, rotary plough devices, rotating drums with teeth, etc. There is, however, an immediate need for assessing and evaluating the utility of available equipments and for introducing new equipments for this purpose.

6.25 Aeration could also be achieved by provision of tile-drains in open joint brick base offering ventilation at bottom, cyclinderical chimney of perforated wiremesh placed at intervals, etc., and provision for forced aeration as in "modified windrowing" or "area composting". Care should be taken to adjust the frequency of turning and to provide adequate amount of aeration which are governed by the moisture content and type of material.

6.26 *Upgrading* : The material after digestion from windrows is normally well-stabilized but immature. The length of maturing period depends on several factors like constituents of refuse, weather conditions, season of year, type of crops to be sown, etc. Though compost can be applied with little curing to fields which will not be planted for some months, the immature compost shall rob the soil of nitrogen. The Committee feel that maturing should not be left to the responsibility of the farmers which may result in indiscreet application with resulting ill effect and thus in turn may lead to an adverse attitude by the farmers to utilize the produce from the compost plant. It is, therefore, recommended that after the digestion, the material be cured depending on conditions from some weeks to few months to ensure maturity.

6.27 The material, if necessary, may finally be ground and screened depending on its marketability for specific purposes.

6.28 *Storage* : Where use of compost is seasonal, sufficient storage capacities are needed and it may be possible to combine maturing period with the storage period.

6.29 *Fully Mechanized Plants* : We have already suggested that standardising plant designs for the entire country would not be feasible. We have, however, another apprehension. In the absence of any guidelines, the local authorities may be lured into accepting the turn-key projects which apart from being costly may not be suitable for our conditions. In these circumstances, we felt that it would be desirable to have broad guidelines prepared for setting up the mechanical composting plants that will suit varying local conditions. At our instance, the NIDC, the Gujarat Agro-Industries Corporation and the NEERI have prepared detailed guidelines keeping in view :

(i) machinery available in the market and its suitability or otherwise under given conditions;

(ii) general criteria regarding use or otherwise of any particular item of machinery in the process; and

(iii) replacement of machinery by labour in certain processes and its relative economics and practicability.

6.30 We commend the guidelines at Appendix XIII for adoption by the concerned authorities. We would also stress that the following aspects be taken into consideration while deciding on setting up of such plants :

(a) suitable location of plants so as to effect saving in haulage costs;

(b) minimizing the complexity of equipment;

(c) incorporation of labour intensive facilities especially to pre- and post- digestion phases;

(d) selection of equipment to reduce operational costs and to ensure easy repairs;

(e) ensuring availability of spare parts;

(f) overcoming teething troubles during setting-in period; and

(g) availability of skilled labour.

Enrichment of Compost

6.31 *Addition of Sewage Sludge* : The need for adding sewage/sludge has to be evaluated on the basis of the type of refuse. In other countries like U.S.A. and Europe, the carbon-nitrogen ratio with refuse being very high, they have resorted to adding sludge to increase the nitrogen at the same time utilizing its manurial value. The carbon-nitrogen ratio generally encountered in Indian refuse varies between 25 and 40 which is the optimum range for composting. Since sewage/sludge possesses valuable nutrients, its addition in appropriate quantities depending on the type and composition of refuse will enhance the manurial value of compost. Addition of night-soil will also produce the same effect. Further by addition of de-watered sludge the required moisture content can also be adjusted or maintained at desirable levels. Although the merits of addition of sewage sludge/night-soil are self-evident, the Committee recommend their addition subject to the following aspects being taken into consideration for such operations :

(i) composition and type of refuse

(ii) conditioning of sludge to desirable levels

(iii) problems associated with handling of sewage sludge/night-soil and health precautions connected therewith.

6.32 Addition of rock phosphate of low grades (which is unfit for production of phosphatic fertilisers) to refuse is also suggested to enrich the compost in phosphatic content if the efficacy of such admixture is established by research studies, as already recommended by us in para 5.21.

Plant Size

6.33 The capacities of compost plants are governed by the volume of wastes available at present and estimated future quantities as well as by the market which will absorb the product.

6.34 Selection of size of individual units, however, depends on several factors like process limitations, plant size availability, plant requirements, etc. Local conditions like transportation distance, land availability, aesthetic requirements, vicinity of plant, marketing area, etc., are also important in selecting the size of a plant.

6.35 Collection routes and transportation distance to the disposal site are important factors and careful analysis of the transportation costs is necessary when determining the site and size of the plant. The fact that transportation costs are likely to rise faster than plant operating costs and will in future become higher as a proportion of the total has to be borne in mind.

6.36 To get a general idea of typical situation information relative to 14 average-size cities was studied. The population of these cities is 4 lakhs persons or more. Data relative to their population, estimated refuse quantity, area in square kilometres and minimum transportation distance is presented in the following table :

TABLE 30

TYPICAL CITIES AND ESTIMATED TRANSPORTATION DISTANCES

City	Population in lakhs	Estimated Refused Qty. in tonnes/day	Area in Sq. Kms.	Minimum transport distance Km.
1. Hyderabad	16·0	480	207	14·4
2. Poona	8·5	255	86	9·3
3. Bangalore	15·0	450	122	11·1
4. Madurai	5·5	165	23	4·8
5. Kanpur	12·75	382	261	16·2
6. Patna	4·75	142	80·7	9·0
7. Indore	5·75	140	29	5·4
8. Nagpur	8·7	261	217·6	14·7
9. Cochin	4·4	132	83·5	9·15
10. Srinagar	4·0	120	83	9·12
11. Baroda	4·66	140	75	8·7
12. Jodhpur	3·0	90	125	11·2
13. Gwalior	4·0	120	47·2	6·7
14. Amritsar	4·0	120	33·6	5·7

6.37 Estimated refuse quantity was determined by assuming per capita contribution of 0.3 kg. per day. Minimum transportation distances indicated in the table were derived by assuming that the city area is a perfect square. This is generally not true but this assumption would give a minimum distance. The actual distances from the farthest point in the city to the disposal site may be much more. It may be noted that for almost all cities the transportation distance derived is 5 km. or more. Some of the cities with smaller refuse load have vast areas and, therefore, transportation distances are more.

6.38 In such cases, it may be desirable to have more than one smaller size mechanical composting plants. From the point of view of idle electrical load requirements also a smaller capacity plant will be much more economical. When the quantity of refuse to be handled is more, the plant can be operated for more than one shift and thereby take maximum benefit of the capital investment.

6.39 It can be summarized from the above discussions that the ideal size for standardisation would be approximately 100—150 tonnes per day capacity plant. A large capacity up to 300—450 tonnes per day can be provided by providing multiple units at one location. If the population of the city is more than 10 lakhs or the area is more than 100 square kilometres then provision of more than one composting plants should be considered. We recommend accordingly.

6.40 Innovations in arriving at suitable mechanized materials handling equipment for composting operations need to be promoted. Though some firms who supply the patented fully-mechanized processes have been identified, great effort is to be put in to locate suppliers offering similar equipment in other fields, who will be in a position to adapt these equipment for use in composting processes suitable to our conditions. The firms already engaged in marketing patented equipments could be encouraged to supply modified equipment to suit the process. It is recommended that research and development work should be taken up by institutions for evolving suitable tools and equipment which will contribute extensively in bridging the existing gap.

Consultancy Service

6.41 Plants are to be set up depending upon local conditions as well as regional conditions. Introduction of mechanization in composting being a new venture in the country, available expertise in the field will need to be identified and utilised. Since the local authorities and the State Governments have yet to gain experience and develop the requisite expertise they will have to seek, in the beginning, expert assistance from other sources. The Committee find that the NIDC and to some extent the Gujarat Agro-Industries Corporation have developed competence in the line and are now in a position to provide consultancy services for the purpose. The Committee recommend that the concerned Ministry may maintain a list of approved consultants who may be employed by the local authorities for this purpose.

Institutional Management

6.42 The disposal of wastes is a local function and ordinarily the management of the mechanical composting plants should vest with the local body concerned. It is, however, to be appreciated that this being a comparatively new venture requires expert handling. Moreover, it is necessary to ensure prompt sale of the product in the field.

6.43 In view of the fact that the Agro-Industries Corporations in the States with their vast network of the field units possess the potential for efficient marketing of the compost, the Committee recommend that the setting up of compost plants and their operation should either be entrusted to the Agro-Industries Corporations or be a joint venture of the local bodies and the Agro-Industries Corporations. In case any large local authority considers that it can, on its own, set up and operate the plant efficiently, it should be encouraged to do so provided adequate arrangements for marketing the end-product have been made by it. The local body concerned will, however, have to do so in consultation with the appropriate institution who can provide necessary consultancy services and guidance as recommended earlier.

Economics of Mechanical Composting

6.44 For any enterprise the cost of the end-product is very important and its ultimate success will be directly affected by it. In this case, the price of compost will mainly depend on the proximity of market, attitude of the farmers, cropping pattern and prices, availability of fertilisers and quality of the compost. The compost is necessarily a high-volume-low-value product and cannot be sold in distant markets. The NIDC study has recommended that distribution beyond a 30 mile radius may not be favourable.

6.45 Taking all relevant factors into accounts, we are of the opinion that it should be possible to produce good quality compost (with at least 2% NPK value) at an approximate price of Rs. 60 per tonne (1975 price). This estimate is corroborated by the figures available about the cost of production at the only operating mechanical compost plant at Ahmedabad. In the areas around large cities, where vegetables and fruits are grown, the compost may fetch as much as Rs. 70 to 80 per tonne or even more. It is understood that digested sludge (with lower NPK value of about 1.5%) is fetching Rs. 72 per tonne in Ahmedabad and Rs. 100 per tonne in Baroda.

6.46 Taking Rs. 60 as a general index, compost will be able to compete with chemical fertilisers favourably. In the compost with 2.0% NPK value, the share of N, P_2O_5 and K_2O nutrients will be 0.8, 0.6 and 0.6 respectively. On this basis one tonne of compost will contain plant nutrients as under :—

N	P_2O_5	K_2O	
8.0 Kg	6.0 Kg	6.0 Kg	= 20 Kg

On the basis of the current prices, the cost of nutrients contained in one tonne of compost will come to Rs. 82 as indicated below :

N	8× Rs. 4/25	Rs. 34.00
P_2O_5	6× Rs. 6/-	Rs. 36.00
K_2O	6× Rs.1/95	Rs. 11.70
		Rs. 81.70 or Rs. 82/-

6.47 In other words, it will be considerably cheaper to manufacture compost mechanically than chemical fertilisers on an equal plant-nutrient basis. Even if the sale price of compost is fixed at about Rs. 80 per tonne, it should find a ready-market. This is amply demonstrated by the prices which digested sludge is getting in Ahmedabad and Baroda. These favourable economics plus the additional advantage of it being a good soil conditioner should make compost popular among the farmers.

Central guidance and financial assistance— the Central Scheme

6.48 We have already made detailed recommendations in our Interim Report (Appendix VII) regarding the pattern of financial assistance to be provided by the Central Government for the integrated scheme of urban wastes disposal. We have also suggested the manner in which the scheme should be managed at the Central Government level. We reiterate those recommendations. We are glad to note that a Central Scheme has already been initiated in pursuance of the recommendations made in the interim report. We should, however, suggest that the inter-ministerial Project Management Group may evolve detailed guidelines to be followed by the State Governments and local authorities for implementing the Projects sanctioned under the Central Scheme.

CHAPTER VII

MUNICIPAL SEWAGE UTILISATION FOR IRRIGATION

Need and Scope

7.01 Municipal Sewage is waste-water from a community, which is primarily domestic sewage but may also contain a significant volume of industrial liquid wastes. The sewage is carried through a system of drains, underground or surface, lift stations and manholes for collection of waste water to a suitable point of disposal. The sewage is disposed of in two ways i.e. (i) by broad irrigation on the land with or without any treatment, and (ii) by discharge into the nearest river, stream or sea. However, the practice of discharging sewage or sullage into the river or stream not only causes pollution of water with consequent danger to the people and animals who use this water for drinking but also deprives the agricultural lands of good manure and water of which our soils are in dire need. The sewage irrigation benefits the crops by providing additional supply of water and valuable plant nutrients and soil conditioner.

7.02 Although the advantages of sewage utilisation are being increasingly appreciated, we are not yet utilising its potential fully. In our country, about 200 cities and towns are having complete or partial sewerage system. Besides, there are 700 towns which have surface drainage system (open drains) which carry the sewage to outer areas. The sewage sullage available in these cities and towns is estimated at about 800 million gallons per day. It is, however, understood that at present only 200 million gallons of sewage or sullage are being utilised daily for irrigation in 223 cities and towns. The area receiving sewage irrigation is about 24,000 hectares, *vide* Statewise distribution given in Appendix XIV. Raw sewage with or without screening and grit removal is the commonest form used in most of these farms. In number of cases, raw sewage is used in combination with canal water or well water to secure best results from point of view of economic use of nitrogen for crop production. The type of sewage used and the dilution practised is given in Table 31 for 10 sewage farms. Table 32 shows the analysis of sewage in six cities.

TABLE 31

APPLICATION OF RAW OR DILUTED SEWAGE IN VARIOUS SEWAGE FARMS

Sewage Farm	Type of Sewage	Dilution Ratio
1. Nagpur	Raw sewage and sullage	No fixed Proportion
2. Hyderabad	Settled sewage from septic tanks diluted with river-water	1 : 1·5
3. Madurai	Raw sewage and sullage diluted with percolated farm effluent	——
4. Poona	Plain sedimented sewage diluted with fresh water when available	1 : 1
5. Ahmedabad	Raw sewage	——
6. Kanpur	Raw sewage diluted with fresh water from Ganges	1 : 1
7. Lucknow	Raw sewage with river water	1 : 1
8. Allahabad	Raw sewage	——
9. Delhi	Raw sewage, clarified sewage and completely treated sewage effluent	——
10. Jaipur	Raw sewage	——

TABLE 32

ANALYSIS OF INDIAN SEWAGE

Constituents	Ahmedabad	Poona	Madurai	Nagpur	Hyderabad	Lucknow
1	2	3	4	5	6	7
1. Total solids	1748·0	—	1740	2200	1708	2240
2. Sus. Solids	148·0	1098	420	800	985	1710
3. Dissolved Solids	1600·0	—	1320	1400	723	530
4. Ammonical Nitrogen	22·5	57·6	—	34·0	24·8	62·4
5. Alluminoid Nitrogen	4·8	52·8	4·0	43·0	26·1	23·0
Total Nitrogen	27·3	110·4	4·0	77·0	50·9	85·4
6. Biochemical Oxygen Demand at 20°C	133·0	234·0	480·0	232·0	339	—
7. Oxygen observed from $KMnO_4$ in 4 hour	67·0	123·0	88·2	161	—	—
8. Chlorides as O_1	300	—	280	120	104	60
9. Phosphates	—	—	—	—	—	16·0
10. PH	7·5	7·0	7·5	7·2	7·4	7·5

(*Source :* Reports of Municipal Corporations)

Sludge utilisation

7.03 In addition to sewage, considerable quantities of sludge which contain the suspended solids of the sewage deposited in tanks or basins of any system of sewage treatment, are generated in our cities. It includes all types of sludge like primary, settled and vacuum filtered and dried on sludge beds or primary digested sludge, combined primary and secondary (including activated sludge) digested and dried in drying beds. The principal values inherent in sludge that can be recovered practically include manure, combustible gas and grease. Sludge is an excellent manure and soil conditioner.

Analysis of sludge in some of our cities is given in the table below :

TABLE 33

APPROXIMATE ANALYSIS OF SLUDGE FROM VARIOUS SOURCES

Analysis on dry basis %

Name of City	Type of Sludge	Volatile Matter	Total Nitrogen	Phospherus as P_2O_5	Potash
1	2	3	4	5	6
1. Delhi	Activated, Dried	40—50	2·9—4	1·5—2·4	——
2. Bombay	Activated, Digested	——	2·5	1	——
3. Calcutta	Primary, Digested Dried	40—50	2·9—3·5	1·5—2·5	——
4. Patna	Activated, Digested and Dried	70	3·5	2·3	——
5. Nagpur	Primary settled, air dried	——	1·6	0·89	0·64
6. Madurai	Sludge scrappings from fields	32·5	1·08	2·8	2·28
7. Ahmedabad	Scrappings from filter beds	22·2	0·45	0·15	0·7

7.04 The quantity of 800 million gallons of sewage/sullage per day can produce 60,000 tons of N P_2O_5 and K_2O in a year, valued at Rs. 12 crores. In terms of irrigational value, 800 m.g.d. of sewage is equivalent to a flow of 1600 tube wells. The additional produce resulting from full utilisation of sewage is estimated at 6 lakhs tonnes per annum; valued at Rs. 60 crores. The under-utilisation of the sewage/sullage to the extent of 75% is, therefore, resulting in huge national loss besides causing pollution hazards.

Plan Scheme

7.05 During the Second Five Year Plan, the State Governments were provided with central assistance by way of loans for implementing sewage utilisation schemes. In the Third Plan, however, no provision could be made even by the State Governments under Agriculture Sector of their plans with the result that practically no scheme could be taken up as a plan scheme. Later, however, realising the importance of the scheme and considering the financial limitation of the State Governments and the local authorities, the Ministry of Agriculture evolved a fresh sewage utilisation scheme under the special Development Programme for Agriculture (Crash Programme) launched during the last two years of the Third Plan. Under the scheme cent per cent assistance was provided of which 25% was treated as grant and 75% as loan. Thirty-nine schemes costing about Rs. 150 lakhs were completed in various States.

7.06 In the Fifth Plan, the Central assistance has been revived and the Municipal authorities which take up the schemes are provided grant-in-aid to the extent of 33% of the capital cost of the scheme. The rest of the cost has to be borne by the local authorities either from their own resources or by raising loans from the nationalised banks, State Governments and Life Insurance Corporation. The criteria for grant of Central assistance and the conditions to be fulfilled for being eligible for it are given in Appendix XVI.

Benefit from Sewage Utilisation

7.07 It is reported that during the financial year 1974-75, 40 schemes were sanctioned and a sum of Rs. 33.63 lakhs was released to the local bodies as grant-in-aid for the purpose. In the current year (1975-76), 85 schemes costing Rs. 2.70 crores and involving assistance of Rs. 89 lakhs have already been approved. It is estimated that during the fifth plan period over 250 schemes benefitting 20,000 hectares of land will be completed. The quantity of plant nutrients that will become available for crop production will be of the order of 15,000 tonnes leading to a saving of foreign exchange worth Rs. 3 crores on fertilizer import. This much plant-nutrient will bring in extra yield of 1.5 lakhs tonnes of foodgrains per year; valued at Rs. 15 crores.

7.08 In the Questionnaire circulated by the Committee, the local authorities were requested to furnish information on various aspects of sewage-utilisation in their cities. Brief analysis of the information received is given here :

TABLE 34

APPROXIMATE QUANTITY OF SEWAGE/SLUDGE GENERATED PER DAY

Class/No. of local Bodies addressed/ No. responded	Variation in Quantity generated per day	Utilisation of Sewage		
		No. Responded	No. using for irrigation	No. discharging into water canals and on land
1	2	3	4	5
I/132/ 66 Sewage	500 gallons to 40 million.	49	17	32
64 Sullage	1,200 gallons to 75 „	Information not furnished.		
65 Sludge	7·5 tons to 15,000 tons.			
II/68/ 21 Sewage	20,000 to 1·4 million gallons.			
23 Sullage	30,000 to 10 million gallons.			
25 Sludge	Upto 3·18 tonnes.			
III/72/ 37 Sewage	20,000 gallons to 3 millions gallons.			
37 Sullage	30,000 gallons to 75,000 gallons.			
36 Sludge	272 Tons to 2 Tons.			
IV/34/ 14 Sewage	300 gallons to 20,000 gallons.			
14 Sullage	400 gallons to 2·5 million gallons.			
13 Sludge	Nil.			
V/35/ 6 Sewage	Upto 3 lakhs gallons.			
6 Sullage	Upto 1 lakhs gallons.			
7 Sludge	Upto ·25 tons.			

7.09 It will be noted that while huge quantities of sewage are being generated in various classes of local bodies, about 2/3rd of local bodies in Class I are not utilising the sewage for irrigation and are allowing it to be discharged into water courses and/or on land, etc, as a waste.

7.10 The following table gives the information relating to sewage farms established and sewage utilised there :

TABLE 35

SEWAGE FARMS

Class/No. of local bodies addressed	No. of local bodies				Sewage utilised on farms	
	Who replied	Who have no farms	Who have farms	Variation in total area of farms	No. of local bodies	
					Who replied	Variation in Quantity utilised
I/132	92	62	30	0·5 acres to 7600 acres	18	0·012 mgd. to 45 mgd.
II/68	30	24	6	3·13 acres to 125 acres	2	0·5 mgd. to 1·4 mgd.
III/72	44	39	5	2 acres to 84 acres	2	0·013 mgd. to 8 mgd.
IV/34	19	18	1	25 acres	1	0·1 mgd.
V/35	12	11	1	18 acres	1	0·3 mgd.

The table above is self-explanatory. One can easily see that there is enormous scope for developing sewage farms and utilising the sewage, which is at present wasted, for irrigation in all the classes of cities and towns.

7.11 That the sewage can be a rich source of income to local bodies, is revealed from the information given in the table below. The maximum income derived by a Class I City is about Rs. 4 lakh per year and that in case of Class III town is as much as Rs. 35,000/- per annum.

TABLE 36

SEWAGE SUPPLIED TO FARMERS—AREA RECEIVING SEWAGE/SULLAGE IRRIGATION—ANNUAL INCOME FROM THE SEWAGE/SULLAGE IRRIGATION

Class of cities/towns	No. of local bodies addressed/ No. responded	No. of local bodies in which sewage is supplied directly to the farmers	No. of local bodies in which sewage is not supplied directly to the farmers	Variation in the total area receiving sullage irrigation	Variation in annual income from the sewage sullage irrigation
I	132/82	28	54	5·45 to 3600 acres	Rs. 122 to Rs. 4 lakhs
II	68/26	4	22	3·35 to 100 acres	Rs. 450 to Rs. 625
III	72/39	7	32	4 hectares to 254 acres	Rs. 900 to Rs. 35000
IV	34/15	3	12	200 Bighas to 140 acres	Rs. 200 to Rs. 4500
V	35/8	1	7	Upto 18 acres	Upto Rs. 40,000

Public Health Aspects of Sewage Irrigation

7.12 It is perhaps necessary to deal with public health aspects of sewage irrigation here. Edible crops both eaten raw and eaten after being cooked have been grown by sewage irrigation for decades. While there is no proof of any serious epidemic out-break in such localities due to consumption of vegetables grown on sewage, such practice can be dangerous from public health point of view, for sewage carries pathogenic organisms which are likely to survive on edible parts and cause infection. There are possible dangers from other non-bacterial pathogens also. There is, therefore, a great need for comprehensive investigations, on utilisation of sewage from agricultural as well as sanitary points of view. The investigations would have to cover various aspects such as need for simple and effective treatment of sewage at stabilization ponds, survival of pathogens, bacterial, virus, and parasites optimum doses for different crops, dilution of sewage, accumulation of salts and sewage sickness, fertility of soil, its texture and correlation with sewage irrigation.

7.13 We have considered various aspects of the sewage utilisation for irrigation and have come to the conclusion that not only there is scope for stepping up the utilisation by way of increasing supply of the sewage/sullage to farmers for enriching their fields but

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also the local authorities, particularly Class I cities can set up their own sewage farms for fuller utilisation of sewage and developing them as stable source of income.

7.14 For ensuring maximum utilisation of sewage/sullage potential in our cities, the following recommendations are made :

(1) In all cities/towns where underground drainage system has been laid, efforts should be made to cover the entire city. This will benefit the city in many ways. First, the degrading and abnoxious practice of manual handling of night-soil will be eliminated. Secondly, it will lead to better sanitation and environmental cleanliness and thirdly, the sewage disposal will be better managed.

(2) Similarly, open drainage systems meant for carrying sullage should cover the entire city and should be fully linked to enable to take maximum advantage. It is understood that more than one-third or even one-half of such drains are still kutcha. The local bodies should draw up and implement a phased programme to make surface drains pucca as early as possible. A part of the assistance provided to local bodies by the State Governments for general purposes should be earmarked for this purpose.

(3) At present most of the funds allotted under the National Water Supply and Sanitation Scheme are utilised on Water Supply Schemes and a meagre provision is left for underground sewerage/drainage schemes. As the provision is inadequate the drainage schemes remain incomplete. It is recommended that while formulating National Water Supply and Drainage Schemes specific allocations must be earmarked for the underground sewerage schemes so that specified targets are achieved.

(4) A self-contained scheme of utilisation of sewage on land may be considered for inclusion in the National Water Supply and Sanitation Programme of the Ministry of Works and Housing. For preparing such schemes, the Public Health Engineering Departments should develop close liaison with the State Agriculture Departments, so that the selection of sites and soils for sewage farming is made on proper lines.

(5) In the town planning schemes, specific areas should be earmarked for setting up of sewage farms by the local bodies.

(6) The Central Ministry of Health may lay down standards regarding sewage farming practices in consultation with Ministry of Agriculture to make the process hygienic and free from health hazards.

(7) The CPHEEO of the Ministry of Works and Housing have prepared a manual on use of sewage for irrigation purposes. The guidelines contained therein may be adopted by the field authorities concerned.

(8) Sewage irrigation requires large areas of land which it may be difficult for a municipality to find from its own lands or acquire from the cultivators. In such cases the Municipal authority can supply the sewage to the farmers at their fields on usual payment.

(9) It is recommended that sewage should be adequately diluted to make it less hazardous and also for covering larger areas for irrigation through it. Since this can be a perennial source of irrigation facility, it should be utilised fully in the areas around for continuous or relay cropping.

(10) A special survey should be undertaken jointly by the State Public Health Engineering Department and the State Agriculture Department to study the scope for full utilisation of sewage in different cities and towns and devise suitable schemes for implementation.

(11) The sewage utilisation programme is essentially a local programme but benefits both agriculture and sanitation. The local bodies may however not find it possible to finance the schemes from their own resources. It is, therefore, recommended that the State Governments should make adequate provision in their plans for providing long-term loans to the local bodies to undertake such schemes.

(12) Sludge wherever available should be digested to get combustible gas. The digested sludge should be supplied to the farmers on subsidized transport basis. Raw sludge should be made use of for compost making as well, where it is established that mixing sludge with compost would improve its quality.

CHAPTER VIII

LEGISLATION

8.01 Effective and satisfactory performance of any function by a public authority depends on five factors i.e. (i) Supporting Law; (ii) Sound Structure; (iii) Organisational and technical capability including machinery and equipment; (iv) Adequate Finance; and (v) Public Cooperation. We have discussed these aspects in different contexts in the preceding chapters. We, however, feel that it will be relevant and also advantageous to examine the adequacy or otherwise of the existing law on this matter and identify the future course of action to be taken to strengthen the legal frame-work for efficient performance of the vital function of disposal of urban wastes.

8.02 It has been noted earlier that the Municipal law promulgated by the State Legislatures regulates the functioning of the local authorities in the country. While the basic approach and policy are common, in the matter of detail and emphasis, there are wide variations in the Municipal laws of the different States. Till recently, the Municipal authorities in a majority of States were administered under the laws enacted several decades back. Even at present, the Municipal authorities in the States of Uttar Pradesh, Punjab, Bihar, Tamil Nadu and West Bengal function under the statutes passed as far as back as in 1916, 1911, 1922, 1920 and 1932 respectively. These acts were promulgated at a time when the problem of urban wastes had not assumed the dimensions of today. There is, therefore, no provision in them enjoining on the local authorities to ensure scientific and hygienic treatment and disposal of urban wastes. Even the Municipal Acts passed after Independence, do not enumerate in detail the steps to be taken for final disposal of the wastes. These laws lay emphasis only on storage at generating points, collection therefrom and transportation to the disposal venues. The matters relating to the final disposal of the wastes are left to be taken care of by the rules and bye-laws.

8.03 Even where appropriate provisions have been incorporated in the Acts for removal etc. of the rubbish and garbage, the local authorities have seldom shown awareness and firmness for strict application and enforcement of such provisions, for the reason that they themselves are not able to adhere to the rules strictly. They are, therefore, lax in enforcing them in the case of citizens. Some of the Municipal Acts contain specific penalty for indiscriminate throwing of rubbish and littering of streets. But how many municipalities have ever invoked these provisions for preventing such nuisance.

8.04 In Appendix XVII, Chapterwise composition of eight Municipal Corporations Acts and four Municipalities Acts has been given. A glance at this statement will bring out clearly the variations that exist in the 'composition' of these Acts. No doubt, there is a fair degree of identity in the chapters relating to administrative aspects, but in respect of the functions and their performance, every act follows its own frame-work. The Rajasthan and the Madhya Pradesh Municipalities Acts contain the least number of chapters while the Madhya Pradesh Municipal Corporation Act and the Calcutta Municipal Act contain a larger number of chapters, 40 and 38 respectively. Whereas most of the acts contain separate chapters on different Municipal services and functions, the Rajasthan and Madhya Pradesh Municipalities Acts have dealt with all the functions in the chapter on 'Primary and Secondary functions' and 'Duties of Council' respectively. 'Nuisances' constitutes a subject-matter of separate chapters in four Acts. These Acts also contain a chapter on 'Municipal Powers and Offences' which finds a place in two more Acts. No Act contains a chapter relating to final disposal of wastes as such. Public Health and Sanitation has been dealt with separately in some Acts in the chapters with different titles like 'Scavenging', 'Sanitary Provisions', 'Sanitation,' 'Conservancy' etc. The regulation of public and private streets has been incorporated in a separate chapter in all but 3 Acts. These details point to the fact that the various Acts differ in content, emphasis and details of the provisions, which often leads to variation in degree of performance.

8.05 The Municipal Acts enjoin on the Chief Executive to provide receptacles, dust bins, depots or places for temporary deposit of rubbish etc. at convenient situations and require the occupier of a premises to deposit the rubbish in such places. Any contravention of these provisions would attract penalities. Some Acts even empower the Chief Executive to specify and supply receptacles for depositing rubbish near the premises at the cost to be recovered from the occupiers. In spite of such specific provisions, it is well known that the householders, the traders, etc. do not observe the provisions of the law and throw the rubbish on the streets indiscriminately.

8.06 Some of the Acts specify that adequate provisions shall be made by the local authority for preventing the refuse depots etc. from becoming sources of nuisance. It is a common sight, however, that the rubbish at such places is dug in and spread out by vagrants and animals before its removal by the Municipal Staff spoiling the surroundings and creating nuisance for the houses around. While in some cases the laxity on the part of the local authority could be said to be responsible for such a situation, lack of specific provisions to that effect in certain Municipal Acts could also be a reason.

8.07 In the chapter on Markets and Slaughter Houses, one would naturally expect provisions for licensing, regulating, up-keep and maintenance of these places. However, a glance at the provisions relating to such places reveals that they relate to licensing and regulation mainly. The aspects of up-keep and maintenance have not been fully touched upon and given the importance needed. In our cities, market places and bazars present a very untidy and dirty appearance from the beginning of the day. In the interest of cleanliness and health, there ought to be specific provisions with prescribed penalty against littering the roads and lawns by shopkeepers, hawkers, vendors and consumers, which should be enforced strictly.

8.08 Similarly, the provisions in respect of factories and trades are mere regulatory. In the matter of storage, collection and disposal of rubbish, etc., such consumers are treated at par with householders, as no separate provisions exist in majority of Municipal Acts. The Municipal Corporation Acts of Madras and Delhi contain a provision under which the manufacturing and trade concerns which generate bulk rubbish or filth may be required by the Commissioner to make arrangements for carriage of the rubbish to the appointed places. In the event of failure on their part, the Commissioner can arrange for compliance of the directions and to recover the cost from the concerned party. Non-existence of such provisions in other Acts and administering such cases under the general provisions can hardly prove effective.

8.09 The collection and transportation of rubbish and other wastes to the disposal points, as already discussed, are of crucial importance as environmental cleanliness depends on efficient performance of these functions. Whereas all the Municipal Acts contain separate provisions for the purpose, in certain cases the frequency and time of collection is not specified and the executive authority is required to ensure efficient scavenging and cleansing of all streets and premises and removal of rubbish etc. as per rules and bye-laws made in this behalf.

8.10 All the Municipal Acts do not include provisions for transfer of rubbish in covered vehicles and proper sanitary control of the dumping grounds, with the result that transportation through busy roads and thoroughfares often becomes a source of nuisance and annoyance. These operations, being the responsibility of the Municipal authorities, are the subject-matter of the administrative instructions and orders which require use of covered vehicles and provision of tarpaulins for covering open vehicles. There are also instructions for proper covering of the refuse at the dumping grounds by a layer of earth to avoid nuisance. Many a local authorities, are, however, not able to adhere to such instructions for various reasons.

8.11 From these details some important facts emerge. First, the provisions in the Acts are not uniform and differ from State to State not only in emphasis but also in detail. Secondly, the provisions are so scattered as their importance has got diluted and thirdly, the enforcement on the part of local authorities is not adequate. The present laws also suffer from other drawbacks as discussed in the following paragraphs.

8.12 The existing legislation does not deal with the control and disposal of wastes in their proper perspective. It is treated as a minor branch of public health administration and is sought to be regulated mainly by rules and regulations or administrative orders. The fact, however, is that the problems of wastes collection, processing, utilisation and disposal are sufficiently homogeneous and important to demand a unified system of control and management. As the problems grow and public awareness and concern increases with them, these will have to be dealt with as a separate function under a distinct and coherent legislation.

8.13 Again, the Municipal laws do not contain any definition or classification of wastes. It is time that there is law which enumerates broad classification and also the different methods to deal with them.

8.14 Another weakness in the existing law is that it is 'enabling' in nature. Although it provides legal powers to the local authorities to perform the 'sanitation' functions effectively, it does not go far enough to demand certain specified minimum standards from all partners of the game *i.e.*, the people, the local authorities, the State Governments and even the Central Government. It is well known that the standards of performance vary considerably from place to place and from locality to locality. The stage has reached when minimum standards as to the nature of the service tendered, its minimum frequency and above all the methods of disposal are specified by law and it should no longer be discretionary for any authority to decide as to the necessity and details of this essential service.

8.15 Fourthly, the present municipal laws are somewhat narrow and restricted as these lay emphasis only on domestic, and to some extent trade refuse. There is, therefore, need for enlarging the scope of the law to take care of the whole gamut of wastes including domestic, commercial, agricultural, trade and industrial wastes.

8.16 Yet another noticeable shortcoming is that the existing laws deal with the problem of wastes from the angle of prevention of nuisance. These do not take into account the most vital aspect of scientific and hygienic processing and disposal including recycling of wastes, which has its obvious advantage.

8.17 Then, the existing legislation fails to provide for overall control and coordination of the whole range of operations of 'wastes disposal' with the result that this aspect does not receive due consideration.

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(7) Rights and obligations of trade, industry and commerce in the field of wastes disposal and sanitation.

(8) Organisation of waste disposal programme and planning and development at local, State and Central levels and inter-relationship.

(9) Finances, including levy of fees, charges, State grants, loan etc.

(10) Institutional arrangements for training and research and collection and dissemination of information and exchange of experiences.

B. SIVARAMAN
Chairman

N. K. SREENIVASAN	M. M. SURI	A. K. GHOSH
A. B. JOSHI	ASHOK PARTHASARATHY	N. MAJUMDER
V. D. DESAI	P. S. MAZUMDAR	DAROGA SINGH
T. S. SWAMY	B. C. GHOSHAL	SATISH KUMAR *Member-Secretary*

NEW DELHI,
Dated the 29th December 1975

PART II

APPENDICES


सत्यमेव जयते

APPENDICES

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सत्यमेव जयते

APPENDIX I
(*Para* 1·3)

NO. Q-13016/9/71-PHE

GOVERNMENT OF INDIA

MINISTRY OF HEALTH & FAMILY PLANNING

(Department of Health)

New Delhi, dated the 6th May 1972

RESOLUTION

No. Q-13016/9/71-PHE.—The problem of the disposal of urban waste and night-soil has assumed greater importance due to progressive growth of urbanisation and has also become a source of health hazard particularly in important cities in this country. It has thus become necessary to consider the problem in detail and also find out the utilisation of such waste for agriculture purposes. For this purpose the Government of India have decided to set up a Committee on Urban Wastes. The Committee shall consist of :—

1. Shri B. Sivaraman, Vice-Chairman, National Commission on Agriculture, New Delhi. — *Chairman*
2. Shri N. K. Sreenivasan, Joint Secretary, Ministry of Petroleum and Chemicals, New Delhi. — *Member*
3. Shri M. M. Suri, National Committee on Science and Technology, New Delhi. — *Member*
4. Dr. A. K. Ghosh, Economic Adviser to the Government of India, Ministry of Industrial Development, New Delhi. — *Member*
5. Director, Indian Agriculture Research Institute, Pusa, New Delhi. — *Member*
- *6. Dr. S. R. Barooah, Commissioner (Fertilizer Promotion), Department of Agriculture, New Delhi. — *Member*
7. Shri Ashok Parthasarthy, Special Assistant on Science and Technology to the Prime Minister. — *Member*
- †8. Director, National Environmental Engineering Research Institute, Nagpur. — *Member*
- ‡9. Dr. A. K. Malhotra, Member, National Committee on Science and Technology. (C/o Engineers India Limited, New Delhi.) — *Member*
10. Shri V. D. Desai, Deputy Municipal Commissioner, (Special Engineering), Municipal Corporation, Bombay, Bombay. — *Member*
11. Shri P. S. Mazumdar, Chief (Agriculture), Planning Commission, New Delhi. — *Member*
12. Dr. Daroga Singh, Deputy Agriculture Census Commissioner, Ministry of Agriculture, New Delhi. — *Member*
- **13. Adviser (PHE), Ministry of Works and Housing, New Delhi. — *Member*
14. Dr. B. C. Ghoshal, Deputy Assistant Director General, Directorate General of Health Services, New Delhi. — *Member*
15. Shri Satish Kumar, Deputy Secretary, Ministry of Works and Housing, New Delhi. — *Member-Secretary*

*Amended *vide* Ministry of Works and Housing Resolution No. Q-13016/8/PHE Vol. II (C.U.W.) dated the 15th October, 1973. Dr.Barooah has since retired.

†Amended *vide* Government of India (Ministry of Works and Housing) Resolution No. Q-13016/9/71/-PHE Vol. II (C.U.W.) dated the 19th April, 1975.

‡Dr. Malhotra ceased to be member of the N.C.S.T. and did not, therefore, participate in the deliberation of the Committee.

**Amended *vide* Government of India (Ministry of Works and Housing) Resolution No. Q-13016/9/71/PHE Vol. II (C.U.W.) dated the 9th July, 1975.

2. The terms of reference of the Committee shall be—

(a) To study the problem of disposal of city refuse and night-soil and present methods of disposal thereof in this country, keeping in view the extent of environmental pollution caused by existing methods and the practise and usage in other countries. Also to study the present and future Planning for the utilisation and disposal of such wastes.

(b) To determine the extent to which the urban waste can be used in the form of organic manure as a supplement to chemical fertilizers and the precautions to be taken to prevent any adverse effect on public health in its use.

(c) To study the methods for mechanical composting, the cost of establishment of plants and transportation and suggest most suitable methods for conditions obtainable in this country.

(d) To estimate the order of investment required and the economic viability of such programme, keeping in view the need for agricultural purposes and other social benefits.

(e) To find out an idea of the estimated cost of compost at delivery point *vis-a-vis* the cost of chemical fertilizers and the capacity of the agriculturists to meet this cost and subsidies, if any, recommended to popularise this compost.

(f) To suggest modifications, if any, required in public health policies and other State or Central enactments to enable maximum composting of this resource.

(g) To recommend a plan of action to implement the policies and proposals made by the Committee.

3. The Committee will have the powers to constitute Sub-Committee(s) and coopt experts to facilitate its working.

4. The Committee will hold its meeting as and when necessary and at such places as the Chairman may consider necessary.

*5. The Committee will submit its report within a period of six months.

A. B. MALIK

Joint Secretary to the Govt. of India
Ministry of Health and Family Planning
(Department of Health)

ORDER

ORDERED that this Resolution be communicated to :—

(i) Lok Sabha Secretariat, (ii) Rajya Sabha Secretariat, (iii) Prime Minister's Secretariat, (iv) Cabinet Secretariat, (v) Planning Commission, (vi) Private and Military Secretaries to the President, (vii) Comptroller and Auditor General of India, (viii) All Ministries and Departments of the Government of India, (ix) All State Governments/Union Territories, (x) A.G.C.R., New Delhi, (xi) Department of Atomic Affairs, (xii) Indian Council of Medical Research, New Delhi, (xiii) Council of Scientific and Industrial Research, New Delhi, (xiv) Central Public Health Engineering Research Institute, Nagpur, (xv) All India Institute of Hygiene and Public Health, Calcutta, (xvi) Central Public Health Engineering Organisation and (xvii) Director General of Health Services, New Delhi.

ORDERED that the Resolution be published in the Gazette of India.

A. B. MALIK

Joint Secretary to the Govt. of India
Ministry of Health and Family Planning
(Department of Health)

*The term of the Committee was finally extended upto the end of December, 1975.

APPENDIX II
(*Para* 1.14)

GOVERNMENT OF INDIA

MINISTRY OF HEALTH & FAMILY PLANNING

(Department of Health)

COMMITTEE ON URBAN WASTES

QUESTIONNAIRE

I. GENERAL

1. Name of Local Body (with District & State) . . . _____
2. (*a*) Population (1971 Census) . . . . . _____
   (*b*) Area (Sq. Kms.) . . . . . _____
3. *Expenditure incurred in* 1971-72
   (*a*) Total . . . . . Rs. _____
   (*b*) Public Health & Sanitation including Sewerage. . . (*i*) Establishment Rs. _____
   (*ii*) Works & Equipment. Rs. _____
   (*iii*) Others Rs. _____
   Total Rs. _____
4. *Staff Employed*

	Permanent	Temporary	Works Charged	Part-time	Total
(*a*) All Deptts.					
(*b*) P.H. & Sanitation Department . .					
(*i*) Staff on cleansing					
(*ii*) Staff on Transportation . . .					
(*iii*) Staff on disposal					

5. No. of houses within the Municipal Area . _____
6. No. of seats in public latrines :

Water-borne	Others	Total No. of seats

7. No. of seats in private latrines :

Water-borne	Others	Total No. of seats

8. Is the scavenging of private latrines done through the local body or privately? . . . . . .
9. (*i*) No. of scavengers employed on cleaning of public latrines . . . . . .
   (*ii*) No. engaged in cleaning of private latrines . .
   (*iii*) No. of sweepers employed on cleaning of streets .
   TOTAL . . . . . _____
10. (*i*) Annual income from special levy like Scavenging/Latrine/Conservancy Tax or Cess, if any . . .
    (*ii*) Percent of total tax revenue . . . . .

II. SEWERAGE SYSTEM

11. (*a*) Has the city been provided with sewerage system? . Not yet/Partly/Fully.

(*b*) If so, total area covered by sewerage system. . .

(*c*) No. of houses connected to sewerage system with approximate population. . . . . .

(*d*) No. of houses coming within sewerage facility but not connected to the system so far. With approx. population. . . . . .

(*e*) Does the Municipal Act/Rule contain provision for making it obligatory on the householders to connect their houses to sewer system in the sewered areas? (Please enclose extracts) . . . . . .

(*f*) Does the municipality provide any incentive to householders for conversion & connecting to the sewer ? (Please give details) . . . . . .

12. In unsewered towns/portions of towns, state how the waste water (sullage) is disposed of—

(i) for irrigation

(ii) by discharge into water courses, ponds, etc.

13. What are the plans to bring unsewered areas undersewerage system? Please give details stating the approximate date by which the city/town will be fully sewered.

III. METHOD OF COLLECTION

14. (A) *Domestic Wastes—Collection*

(i) Types and quantities per day (weight or volume) of domestic wastes handled : (Pl. specify)

(a) Night soil

(b) Refuse

(c) Any other like animal waste, carcass, market waste, street sweeping, etc.

(ii) How is the domestic waste stored by the individual householders in the houses? (Please tick against the applicable).

(a) in bins provide by the local body;

(b) in unstandardised receptacles of their own.

(iii) How is the domestic waste carried from the houses to the 'collection site'? (Please tick against applicable)

(a) by the municipal staff;

(b) by the householder/sweeper engaged by the householder.

(iv) No. of the 'collection sites' in the city/town.

(v) Is the domestic refuse and the night-soil dumped at the same 'collection site'? If not, explain how are these dumped separately.

(vi) Are these 'collection sites' suitably demarcated or the domestic wastes is collected at various unspecified points to the convenience of the domestic sweepers?

(vii) Are the 'collection sites' properly constructed or whether the waste is just dumped in open? (Please give a description of the collection site).

Transportation

(i) What is the method of carrying domestic wastes from collecting points to disposal points?

(ii) No. and types of vehicles employed for the purpose.

(iii) Average capacity of each type of vehicle.

(iv) No. of trips made by each vehicle per day.

(v) Average distance from collection points to disposal point.

(vi) Please give particulars of disposal points, their number, description, capacity/area, etc.

(vii) Frequency of transportation from 'collection site' to the disposal site. (Mention whether daily, bi-weekly, etc.)

(viii) Mention whether the No. of transport vehicles is adequate/inadequate, state additional No. of vehicles required for adequate transportation.

(ix) State the type of workshop facilities you have for maintenance/repair of vehicles.

(B) *Industrial Wastes*

(i) Types of industrial wastes generated in your city/town.

(a) Solid wastes Names———

(b) Liquid wastes Names———

(ii) System of their collection from individual industry, carriage to collection points and transportation to the final disposal sites.

(iii) Approximate quantity of industrial wastes collected daily, type-wise.

(iv) How are different wastes treated or disposed of ?

IV. DISPOSAL OF SOLID URBAN WASTES

(including domestic & industrial wastes, city refuse, etc.)

15. *Solid Wastes*

(i) Total quantity of solid wastes collected each day.

(ii) Percentage of contents as :

(a) Compostable;

(b) Non-compostable.

(iii) Please indicate the system of disposal of different types of wastes indicated above.

Dumping on land/sanitary land filling/ inineration/composting/any other. (specify)

(iv) (a) Whether compostable/non-compostable material is separated at the 'collection site' in the town ?

(b) In case all the wastes are dumped together at the *disposal site,* what are the measures undertaken to separate compostable materials from other materials?

(v) Is compost preparation work undertaken in your city ? If so, please give the following information :—

(a) Methods of compost preparation adopted;

(b) Quantity of compost prepared every year;

(c) Is any assistance received by the local body for compost making from the State/ Central Government ? Please give details.

(d) How far is compost making self-paying proposition ?

(e) (i) State total annual expenditure on compost making at the composting ground (excluding cost of transportation of wastes from the city to the composting ground).

(ii) Annual income from sale of compost.

(f) (i) What is average production cost of compost per ton including cost of transportation.

(ii) What is the element of transportation cost in (e)(i) above.

(g) Sale price of compost per ton.

(h) Method of sale—by auction of trucks or by weight.

(i) How is the compost transported from the Composting Ground to the fields :

(i) by the farmers themselves.

(ii) by transport provided by Municipality/Govt.

(j) State if any subsidy is allowed on transport of compost to distant areas. Please give details.

V. SEWAGE/SLUDGE/SULLAGE UTILISATION

16. Approximate quantity of generated per day. (Mention units);

(a) Sewage

(b) Sullage*

(c) Sludge**

17. *Disposal of Sewage* :

(a) Whether sewage is treated ? Yes/No

(b) Whether after treatment sewage is utilised for irrigation ?

(c) If reply to (b) is 'No' how is it disposed of;

(d) If sewage is not treated how is it disposed of;

(i) whether by irrigation;

(ii) discharge in water courses on land.

18. (i) Whether any sewage farm has been set up ? If so :—

(a) the area of the farm.

(b) the quantity of sewage/sullage utilised for irrigation at the farm.

(ii) (a) Is any quantity supplied directly to farmers ?

(b) If so, the total area receiving sewage/ sullage irrigation.

(c) Annual income from this source.

19. (i) Whether sludge is being used for preparation of the compost ? If so :—

(a) What is the quantity used for this purpose ?

(b) percentage of the utilisation for compost *vis-a-vis* total sludge produced in the city;

(c) In what percentage is it being mixed with the refuse ?

(d) Is the compost prepared by mixing sludge with refuse fetching better market price ? Give details.

(ii) Is the digested sludge being sold directly :

(a) Annual quantity sold.

(b) Annual income.

*Sullage means waste water carried in open drains

**Sludge means settled solids of sewage in settling tanks of sewage plants.

VI. LEGAL REQUIREMENTS

20. Is compost making obligatory under the Municipal Act ? Please quote.

21. Have any bye-laws or rules been framed by the local body regulating the collection and disposal of city refuse ? Please enclose a copy thereof.

22. Have any rules/guidelines been framed for preparation and sale of compost ? If so, a copy thereof may please be enclosed.

23. (a) Have the scavengers in your city/town any Customary /JAJMANI rights over the night-soil and refuse collected by them ?

(b) How do they dispose it of ? (State whether by sale or otherwise).

(c) What is the percentage of solid waste taken away by the scavengers under this customary right ?

VII. ENVIRONMENTAL ASPECTS

(1) Whether the city refuse is properly covered while being transported from the collection sites to the disposal sites ?

(2) Whether the workers handling the refuse/night-soil are provided with protective equipment like gloves, gum-boots, washing and bathing facilities, etc. ?

Problems at disposal sites

(1) Is the disposal site located near some permanent water course ?

(2) Distance from the nearest habitation.

(3) Whether during rains or at the time of washing, etc., the water from the disposal site is prune to flow into a water course ? Is there any drinking water supply intake down stream of such a water course ?

(4) State the measures, if any, taken to control flies, worms etc.

(5) Whether the disposal site is properly cordoned against vagrants, animals, etc. ?

(6) Whether the city refuse at the dumping ground is properly covered with earth layer regularly or not ?

(7) Facilities of protected water for drinking and washing purposes at the sewage farm/refuse disposal sites provided.

Yes or No.

VIII. MANAGEMENT

24. (1) Indicate the designation of the officer who looks after the following functions in your Municipal Corporation/Board :

(i) Collection and transportation of city refuse.

(ii) Disposal of city refuse.

(iii) Disposal of compost.

(iv) Maintenance of sewerage system.

(2) If these functions are entrusted to different officers indicate how coordination is achieved ?

(3) Is there any proposal to keep these functions under unified control of one officer ?

IX. MISCELLANEOUS

25. What are your suggestions for :—

(a) improving the system of collection and disposal of city refuse;

(b) making the composting system self-paying;

(c) assistance, if any, from the State/Central Government in the matter; and

(d) any other relevant points.

APPENDIX III
(*Para* 1·14)

LIST OF 230 LOCAL BODIES WHO RESPONDED TO THE QUESTIONNAIRE

CLASS I

1. Hyderabad, M. C.
2. Vishakhapatnam
3. Vijayawada
4. Guntur
5. Warrangal
6. Rajhamundry
7. Kakinada
8. Kurnool
9. Nellore
10. Eluru
11. Nizamabad
12. Machilipatnam
13. Tenali
14. Patna, M. C.
15. Ranchi
16. Bhagalpur
17. Muzaffarpur
18. Baroda, M. C.
19. Rajkot, M. C.
20. Bhavnagar
21. Jamnagar
22. Nadiad
23. Rohtak
24. Ambala Cantt.
25. Faridabad
26. Srinagar
27. Jammu
28. Cochin, M. C.
29. Trivandrum, M. C.
30. Calicut, M. C.
31. Alleppey
32. Quilon
33. Indore, M. C.
34. Jabalpur, M. C.
35. Gwalior, M. C.
36. Bhopal, M. C.
37. Ujjain, M. C.
38. Raipur, M. C.
39. Sagar
40. Ratlam
41. Burhampur
42. Nagpur, M. C.
43. Poona, M. C.
44. Sholapur, M. C.
45. Kolhapur, M. C.
46. Amravati
47. Malegaon
48. Nasik
49. Thana
50. Akola
51. Ulhasnagar
52. Dhulia
53. Nanded
54. Ahmedanagar
55. Sangli
56. Jalgaon
57. Bangalore, M. C.
58. Hubli Dharwar, M. C.
59. Mysore
60. Mangalore
61. Belgaum
62. Davangere
63. Bijapur
64. Shimoga
65. Cuttack
66. Rourkela (Steel Township)
67. Berhampur
68. Amritsar
69. Jullundur
70. Patiala
71. Jaipur
72. Jodhpur
73. Ajmer
74. Kota
75. Bikaner
76. Udaipur
77. Alwar
78. Madurai, M. C.
79. Coimbatore
80. Salem
81. Tiruchirapalli
82. Tuticorin
83. Nagercoil
84. Vellore
85. Dindigul
86. Singanallur
87. Tiruppur
88. Kumbakonam
89. Kancheepuram
90. Tirunelveli
91. Erode
92. Cuddalore
93. Kanpur, M. C.
94. Lucknow, M. C.
95. Agra, M. C.
96. Varanasi, M. C.
97. Allahabad, M. C.
98. Meerut
99. Bareilly
100. Aligarh
101. Gorakhpur
102. Saharanpur
103. Jhansi
104. Rampur
105. Shahjehanpur
106. Muzaffarnagar
107. Furrukhabad
108. Faridabad
109. Durgapur
110. Chandigarh

M. C. stands for Municipal Corporation.

1. Vizianagarani
2. Cuddapah
3. Guntakal
4. Chittor
5. Ongole
6. Dhanbad
7. Navasari
8. Surendranagar
9. Simla, M. C.
10. Trichur
11. Bilaspur
12. Khandwa
13. Chhindwara

1. Srikakulam
2. Bopatla
3. Chilakaluripet
4. Gudur
5. Tandur
6. Suryapet
7. Buxer
8. Kapadvanj
9. Rajpipla
10. Rewari
11. Sunder Nagar
12. Alwaye
13. Shartalai
14. Ollur
15. Vidisha
16. Sehore

1. Giddalur
2. Rajan
3. Sihor
4. Mahendergarh
5. Nahan
6. Kunnamkulam
7. Piparia

1. Patri
2. Sarangarh
3. Virajpet
4. Padampur
5. Dhariwal

CLASS II

14. Gondia
15. Miraj
16. Chandrapur
17. Wardha
18. Satara
19. Parbhani
20. Raichur
21. Ganganagar
22. Rajapalayam
23. Polachi
24. Karur
25. Ootacamund
26. Virudunagar

CLASS III

17. Panvel
18. Hindoli
19. Osmanabad
20. Buldhana
21. Bhadravati
22. Kolar
23. Nippani
24. Arsikere
25. Rourkela (Civil Township)
26. Balasore
27. Ferozepur
28. Malerkotla
29. Khanna
30. Pali
31. Banswara
32. Paramakudi

CLASS IV

8. Katoal
9. Ramdurg
10. Nargund
11. Chalkakore
12. Dhankanal
13. Ropar
14. Dungarpur

CLASS V

6. Mount Abu
7. Khetri
8. Adhutrai
9. Annamali
10. Chirgaon

27. Neyveli
28. Ambur
29. Srirangam
30. Pallavarem
31. Bulandashehar
32. Kharagpur
33. Siliguri
34. Midnapore
35. Purlia
36. Jalpaiguri
37. Pondicherry
38. Agartala

33. Arkonam
34. Udmalpet
35. Coonoor
36. Arcot
37. Tiruvallur
38. Thuralyur
39. Roorkee
40. Modinagar
41. Varindaban
42. Nainital
43. Kalpi
44. Rayganj
45. Raniganj
46. Port Blair
47. Karaikal

15. Pilani
16. Colachel
17. Padmanabhapuram
18. Vellalore
19. Mussoorie
20. Murshidabad
21. Daman

11. Kharar
12. Ranbirsinghpura
13. Diu
14. Kannod

APPENDIX IV
(*Para* 1.15)

LIST OF THE CITIES VISITED BY THE CHAIRMAN AND MEMBERS OF THE COMMITTEE

Cities visited by the Chairman

Ahmedabad
Madras
Sabarkantha

Cities visited by the Member-Secretary

Calcutta
Bombay
Thana
Jaipur
Baroda
Ahmedabad

Cities visited by the Experts attached to the Committee

(Shri L. S. Yadava)

Patna
Bhubaneshwar
Cuttack
Lucknow
Varanasi
Kota
Udaipur

The Working Group on Mechnical composting met at Nagpur and visited the old conventional composting site and NEERI's experimental mechanical compost plant.

Some experts of the NEERI (formerly CHERI) and NIDC also visited a number of cities in connection with the work of the Committee.

APPENDIX V
(*Para* 1.16)

REPORT OF THE STUDY TEAM ON VISIT TO FAR-EAST ASIAN COUNTRIES

Introduction

The Government of India in the Ministry of Health & Family Planning (Department of Health) set up an Expert Committee under the Chairmanship of Shri B. Sivaraman, Member, Planning Commission and Vice-Chairman, National Agriculture Commission and comprising senior administrators, Engineers, Scientists, experts, etc., to study the problems of urban wastes in all their aspects and need and utility of mechanised composting in the context of recycling the wastes for agricultural purposes.

2. The terms of reference of the Committee included *inter-alia* study of 'the problems of disposal thereof (urban wastes) in India keeping in view the extent of environmental pollution caused by the existing methods and the practice and usage in other countries'. The Committee had also to go into 'the present and future planning for the utilisation and disposal of such wastes'. The Committee, besides collecting information and data from the local authorities in the country, approached the Indian Missions in a number of countries largely having similar conditions and also some developed countries to collect all relevant material and make it available to the Committee. International agencies were also requested to make available whatever material they could. It was noted that in some Far-East Asian countries some useful work had been done in this respect. It was, therefore, felt that for better appreciation of the methods and practices adopted in some of these countries, first-hand acquaintance by the Chairman and three to four other members would be helpful to the Committee in making practical recommendations. The W. H. O. was accordingly approached to look into the possibility of arranging such a visit for 4 to 5 weeks.

3. The W. H. O. in consultation with the countries concerned arranged the study-tour as per following itinerary :

1. Thailand	26—30 October 1974
2. Singapore	31 October to 5 November 1974
3. Japan	6—18 November 1974
4. Hong Kong	19—23 November 1974
5. Philippines	23—29 November 1974

4. The Far-East Asian region was selected for on the-spot study because of identity of certain characteristics like climate, food habits, level of economic development (excepting of course Japan), problems of city wastes disposal, need for recycling of wastes for agricultural purposes, etc.

5. The Study Team was headed by Shri B. Sivaraman, Chairman of the Committee and included :

1. Shri Satish Kumar,
   Member Secretary
2. Shri J. M. Dave,
   Deputy Director, NEERI
3. Shri L. S. Yadava,
   Deputy Commissioner (Manure),
   Ministry of Agriculture.

Shri Sivaraman, however, returned to India after visiting Thailand and Singapore and in his absence Shri Satish Kumar acted as leader of the Team. The detailed programme is given in Annexure.

THAILAND

6. The Team stayed in Thailand from 26th to 30th October, 1974. During its stay in Bangkok, the Team held discussions with the officers of the Government of Thailand, the W.H.O. Representative and officers, Representative of the Bangkok Metropolis and visited a number of works and plants. The Team also participated in the Regional Seminar on Urban Wastes organised by the W.H.O. at the Asian Institute of Technology, Bangkok. Brief description of the discussions and visits is given in subsequent paragraphs.

7. Dr. R. Chical of the Ministry of Public Health apprised the Team of the functions of the Ministry in the field of pollution control, food control, preventive health and Rural Community Water Supply. The urban water supply is looked after by the Public Works Department. The disposal of urban wastes is a local function and is, therefore, attended to by the local Government institutions.

8. Shri G. Rodriguez, W.H.O. Sanitary Engineer, briefed the Team on the working of the Mechanical Compost Plant at Dindaeng (Bangkok), reported to be the world's largest. The plant set up in 1961 at a cost of Rs. 1.50 crores has the capacity to handle approximately 400 tons of refuse per day. The finished product turned out comes to about 60,000 tonnes. It was planned to treat more than 20% of the garbage generated in Bangkok. In the beginning, the plant authorities had planned to dispose of the manure at the plant at nominal profit but the farmers would not come forward to take the manure. Even after reduction of the price at little below cost price, which comes to about Rs. 35/- per tonne, it was not possible to sell the compost. The authorities had, therefore, to reduce the price further to almost one third of the production cost to attract the purchasers. Even this did not produce any appreciable demand.

9. The Team was further informed that learning from the experience of the working of Din Daeng mechanical composting plant the authorities established three more mechanical composting plants in different parts of the city. The Team visited one of these located at On Nuj. This plant is situated at the periphery of the city and quite near to the farms. It also has an incinerator unit attached to it. The location, we were told was planned with a view to ensure easy disposal of the compost. Sufficient land is available near the compost plant for dumping the garbage in case it cannot be composted or for dumping the compost should it not find buyers. The incinerator is meant to dispose of non-compostable refuse which can be burnt. It was also explained that in the event of compost not finding buyers most of the refuse would be incinerated. The Team could not obtain project reports and the background in which the three new mechanical compost plants were established after the Dindaeng Unit failed to achieve the objectives set for it. We were told that none of the new plants was being operated since the Bangkok Metropolis found it less expensive to keep the plants closed than to operate the plants and produce compost which had no buyers. The result is that almost the entire city refuse is being disposed of by land-filling and dumping.

10. The Team was informed of the following main grounds for which the mechanical composting plants have not fulfilled the objectives for which they were set up :

(i) The main bottleneck has been the disposal of the compost. Practically there are no buyers. Even when the price was reduced to one-third of the cost of production the product failed to attract buyers. The only users are the city government for horticulture and some use is found on the King's extensive Estates. We were informed that the present state of agriculture around Bangkok is such that compost is not being preferred by the farmers. The progressive farmers have largely taken to the chemical fertilizers and the others are either raising a single crop or sticking to green manure produced locally. Taking the compost to the farms is also not easy because of the lack of a proper road system.

(ii) Because of the large capacity of the plants, the feeder area is very extensive. With over 300,000 vehicles in the city of Bangkok, in peak hours traffic jams are a common feature. The road system of the city is unable to cater to this heavy traffic with the result that the vehicles transporting refuse to the plants are not able to make many rounds. This ultimately results in adverse economics of the cost of production apart from inadequate garbage reaching the plants.

(iii) The mounting stocks of undisposed of compost and lack of space for its storage have worked as great disincentives for further production, At the Dindaeng plant we could see huge heaps of the undisposed of compost. This has also made the surroundings insanitary and smelly.

(iv) The percentage of plastic materials in the end product is very high. These make the compost unattractive for users.

(v) Transportation of garbage through private contractors was also tried but did not succeed for the reasons that the private transporters are not prepared to give their vehicles for the purpose of transportation of refuse as the vehicles become dirty and smelly and unfit for any other use.

Economic of mechanised composting:

11. In 1972, the quantity of garbage used was of the order of 41.6 m.cu meters of which 166 thousand cu. meters compost was made. The total cost of operating the plant was about Bh. 6.6 m. bringing the cost per cu. meter to Bh. 40. The collection and transportation expenses were calculated at Bh. 87.18 per tonne (including Bh 40.46 on labour charges). The NKP content in the compost was stated to be as under :

N	1·5
K_2O	0·9 to 1·0
P_2O_5	1·2
	3.7

These figures relate to the compost plant at Dindaeng, which employed 120 persons and is under charge of an Engineer. However, even at a third of the production cost, the compost has failed to get buyers.

City Cleaning Service

12. Shri Lert Chainarong, Director, Bangkok Metropolis gave general details about the functioning of the local authority. The Bangkok metropolis comprising the Bangkok Municipality and Dhonburi Municipality has an area of 1549 Sq. Km. and its population is 3.7 million, which rises at the rate of about 1,00,000 per year. The total annual budget of the Metropolis in 1972 was to Bh. 661 million, of which about 6% *i.e.* Bh. 38 million, was spent on public health (one Bhat is equivalent to about 40 paise). The budget estimates of expenditure for 1975 are of the order of Bh. 1000 million and it was proposed to spent Bh. 200 m. on public cleaning and about 100 m. on public health. About 60% of the budget will be devoted to public works. Education in Bangkok is compulsory upto 7th class and upto 4th class elsewhere. The Bangkok Metropolis is headed by a Governor who is assisted in administration by a City Clerk.

13. Shri Chareon Antarikarnanda, Adviser, Cleaning Service, informed the Committee about the operation of City Cleaning Service. The entire metropolis is divided into 24 districts. The City Cleaning Service is provided only in metropolitan core covering 15 districts with an area of about 300 Sq. Km.—239 Sq. Km. in the Eastern Bangkok and 61 Km. in Western Bangkok.

In another 5 districts, town areas alone are covered by cleaning service; the remaining areas are looked after by the local administration. The City Cleansing Department is under charge of the City Clerk and has 8 wings :—

(i) the Secretariat

(ii) Sanitation Engineering Division

(iii) Cleansing Service Division (Street & Drainage Cleaning)

(iv) Drainage and Sewerage Division

(v) Four Refuse Disposal Works at :

(a) Dindaeng (composting plant)

(b) On Nuj (dumping, composting and incineration)

(c) Dhonburi (composting plant)

(d) Ram Intru (composting plant)

14. *Collection of Garbage* : The house owners deposit the garbage in the bins outside the houses from where the Municipal staff collects it daily and takes to the collection sites situated at convenient places numbering about 600. This is done either by hand or by wheel barrows. The poor people salvage the saleable material from garbage at the collection sites. The refuse trucks then carry the garbage to four specified dumping grounds. The daily collection comes to about 40,000 cum. metres. The department has 315 such trucks of which about 230 are in operation daily. The labour force employed for the purpose is 1700 including 274 truck drivers. About 50% of the trucks are more than 10 years old. One truck makes 1 trip generally but sometimes it is used for two trips. For cleaning streets and drains about 18000 workers are employed. Minimum salary per day is Bh. 24. The Metropolis levies a fee of Bh. 4 per house per month upto 20 litres refuse and Bh. 2 per every additional 20 litres. Hotels and other commercial establishments are charged higher rates.

15. *Night Soil Disposal* : The city is not yet sewered. The latrines are connected to soakage pits or septic tanks. In certain slum areas there are dry latrines also, although by law all houses have to be provided with septic tanks. The municipal authorities arrange for removal of sewage and charge a fee of Bh. 50 per cu. metre. The night soil so collected is dumped in open spaces.

SINGAPORE

16. The visit to Singapore commenced from 31-10-1974 A.N. on arrival of the Team from Bangkok and lasted till 5-11-1974 when the Team left for Manila en route to Japan. During its stay in Singapore, the Team held discussions with the officers of the Ministry of Environments, Anti-Pollution Unit of the Prime Minister's Secretariat, officers incharge of public cleaning service, night-soil collection service, mechanical sweepers unit, Refuse Disposal Wing and also visited vehicles workshop, Refuse Disposal Sites, Sewerage Treatment Works, etc. Brief account of the discussions and visits is given below :

17. Singapore is an island nation consisting of the main island of Singapore and 54 small islands. About 23 million people live in an area of 584 Sq. Km.

Environmental Health Administration

18. Discussion with Dr. Kob Thong San, Commissioner Public Health, Ministry of Environment revealed that for environment health administration the island is divided into seven districts and divisions. The public health administration is governed by the Environmental Public Health Act which takes care of matters like public cleansing (including night soil removal), markets, hawkers, food establishments, public nuisances, sanitation, buildings, general health requirements, offensive trades, etc. The Act is a comprehensive piece of legislation and takes care of all public health, sanitation, environmental pollution and other allied matters. It envisages establishment of a Public Health Authority for administering the provisions of the Act. The Act prescribes penalties for various offences including throwing litters on the streets. The shopkeepers and house owners are required to keep the surroundings clean and free from litter, otherwise they can be prosecuted and fined. Detailed regulations have been framed under the Act for markets and Hawkers.

Public Cleansing Service

19. The Department keeps a labour force of about 6000 which collects about 1300 tonnes of refuse per day. Besides manual sweeping, 13 mechanical sweepers are now employed for street cleaning. A fleet of 300 refuse vehicles transports the garbage from bin centres to three dumping grounds where the refuse is disposed of by sanitary land filling. For collection of refuse from the houses, the administration charges a fee of S$1 per household per month and a little higher fee from trade and commercial establishments.

Mechanical Sweepers

20. Mechanical sweepers were introduced mainly due to shortage of sanitation workers. In all 13 units are at present functioning in two shifts of six hours each. 541 miles of arterial highways and secondary roads on 22 routes are serviced by mechanical sweepers. Sweeping time for a length of 4 to 6 miles is about one hour. The cost of one mechanical sweeper is roughly S$65000 and is operated by one driver only. These vehicles, however, need regular cleaning of certain parts and maintenance. It was reported that operating cost per mile works out at about 1 dollar. Each vehicle replaces about 24 labourers and saves 1.2 men per mile. The average daily wage per worker is S$ 7/-. The department proposes to replace manual sweepings by mechanical sweepers ultimately.

Disposal of refuse—Sanitary land fiill and incineration

21. The Team visited Jampines Dumping Ground, largest of the three in the city and spread over an area of 83 acres. It serves one rural and 3 urban districts and gets about 1000 tonnes of refuse everyday. Garbage is covered every alternative day. 23 compactors and 4 refuse trucks are used for the purpose. The staff employed included 70 persons on regular monthly salary and 75 persons on daily wages basis. So far four layers of 10 inches each have been fixed in the last seven years and the 5th and last one is in progress. A small incinerator with 2 tonnes capacity has also been installed here for disposing of the material which cannot be used in land filling. The fly nuisance has been controlled through various measures.

22. The Government is actively considering the question of setting up incinerators as the sanitary land fill cannot continue indefinitely due to shortage of suitable sites. It was mentioned that there was proposal to set up an incinerator with three units of 400 tonnes capacity each. Such a plant will involve an investment of 80-90 million dollars. This incinerator could be used for power generation also and it was estimated that the plant when used to the capacity would be able to generate 11 megawatts of power. The operation and maintenance of such a plant was, however, very expensive, about 3 to 4 times of the land fill operations. Since however land was scarce, there was no other alternative.

Environmental Pollution (Water Pollution)

23. Water pollution is prevented and controlled under two enactments. The Environmental Public Health Act Controls discharge into water courses. The Local Government Integration Act regulates the flow of polluted water into the sewers. Many industries are recycling the waste water and effluents for their own refuse. Sewage is also being recycled for industrial and flushing purpose after treatment. The unwanted effluents duly treated are then discharged into the sea. The discharge is however, regulated strictly so that pollution of sea water does not become a hazard to the coastal population and neighbouring countries.

24. As a rule, sludge is not allowed to enter the sewer system. It is treated and disposed of separately by drying it in fields and then disposed of for use as a soil conditioner. It is, however, noted that the industries are finding it increasingly difficult to treat the effluents upto required standard for various reasons. Firstly, such an exercise is a costly affair and adds to overhead costs of the produce and secondly, land is scarce and the industries are not able to find adequate space for treating their effluents. The Ministry is considering the proposal to set up a Central Sewage treatment plant so that industries can be allowed to discharge their effluents with lower standards, for further treatment and disposal. The industries can then be charged moderate fees for the purpose.

Pollution Control

25. The administration attaches considerable importance to the problems of pollution. An anti-pollution Unit has been set up under the Prime Minister's Secretariat and has 9 Engineers, 2 Chemists and 6 Technicians on its strength. Besides, the legislation discussed above Singapore has a separate Act for air pollution control called the Clean Air Act 1971 for prevention and reduction of air pollution and matters connected therewith. As many as 17 monitoring stations have been set up with modern and sophisticated equipment. The unit also pays visit to the industries to ensure that they observe the standards and safeguard stipulated for the purpose. Emission tests are also carried out periodically. Besides, the unit is consulted before grant of licences for industries and allocation of sites. An Industry and Environment Committee has been set up with representatives of various departments and statutory bodies and is consulted on all important matters involving major economic and environmental implications. The Unit also conducts air-pollution control training courses for technicians from various government departments and the public health inspectors of the Ministry of Environment.

Environment Vehicles Workshop

26. This is essentially a maintenance and servicing station. Every vehicle is brought here for servicing once in 40 days. About 20% of vehicles remain there for servicing and repairs. About 450 vehicles were serviced and repaired last year. The workshop has about 100 persons on its rolls including 40 mechanics. It functions for one shift of eight hours daily.

Sewerage Department

27. It is nderstood that only 60% population is covered by sewerage. The rest of population is covered by latrines connected to cess pools or septic tanks. Water supply is still inadequate as against designed capacity of 60 gallons per capita per day only 40 gallons are at present available. The sewerage department manages two treatment works where on an average about 2,53,000 cubic metres of sewage flow is treated daily. The extension of inlet works at one of the works is in progress. The effluent water from these works is used for parks and trees in the city.

Night Soil Removal and Disposal

28. As about 40% of the city is still unsewered, there are about 13500 dry latrines in the city. Singapore has a unique system of night soil collection. Every latrine is provided with a bucket which is removed by the Cleansing Department Staff everyday and replaced by a clean bucket. The buckets removed from the houses are then carried on the vehicles to one of the three disposal sites. One vehicle carries 80 buckets at a time and has, besides, driver and a Supervisor, five workmen. The Department charges 3.25 dollars per month per house for this service. While in urban areas this work is done by the Department solely, in rural areas it is done by the Department and private contractors who charge the house owner a fixed fee. In contrast to the system operating in our cities where dry latrines still persist, the system in Singapore

was found to be efficient, clean and free from health hazards. The Department also maintains four Mobile Toilets which are deployed in different localities. Fixed charges are levied for using these toilets.

29. As will be noted from the following figures, the expenditure on the night soil removal service during March, 1974 was S$2,35,590 :

(*i*) Supervisory Staff	SS43,610
(*ii*) Conservancy Staff	122,260
(*iii*) Operational Expenditure (Replacement and Maintenance of vehicles, equipments and materials) . .	35,220
(*iv*) Computed charges for pumping and treatment of night soil by Sewerage Department	34,500
TOTAL (SingaporeS) . . .	SS2,35,590

Against this expenditure, the Department was able to collect S$40,363 only. Thus, the service, was subsidised to the extent of 84% *i.e.,* by an amount of S$ 1,95,227. Even if charges for pumping and treatment are reduced, the subsidy was of the order of 1.60 lakh dollars per month. This works out to a subsidy of about S$ 12 per month per latrine. In terms of our currency, it would amount to almost Rs. 35 per month. In view, however, of low labour costs and other factors, night soil removal service on the pattern of Singapore can be operated at much less cost in our country.

Mechanical Composting Plant

30. At the time of the visit of the Team, a small mechanical composting plant of about 25 tonnes capacity which has been set up recently, was being given trial runs. The plant has been set up with Dano equipment. Since Singapore is essentially an industrial and commercial community, agriculture is not so important. The community, therefore, does not need to use the garbage for agricultural purpose extensively. The compost produced from this small plant would be used for horticultural purposes only. Subject to favourable economics, marketing compost across the straits in Malaysian territory was under consideration.

JAPAN

31. The Team visited Japan from 6th to 18th November, 1974. The programme in Japan included discussions with the officers of the Ministry of Industry and Trade and Ministry of Public Health, and officials of city governments of Tokyo, Kawasaki, Tochigi, Mitaka, Osaka and Kobe. The Team also visited incineration plants, composting units, sanitation services and facilities at various places.

Public Cleansing Services

32. The Metropolis of Tokyo occupies an area of 2,141 sq. km. and its population in April, 1974 was 11,550,821. This metropolis is divided in three main categories *i.e.,* (i) Special Wards mostly comprising core urban areas; (ii) suburbs consisting of municipalities (*i.e.,* cities, towns and villages) and (iii) islands on the Pacific Ocean. The Tokyo Metropolitan Public Cleansing Bureau is responsible for collection, transportation and disposal of the urban wastes. From the 23 special wards, the Bureau collected 4.5 m. tons of solid wastes and about 1.44 m. kl. of excrements (excluding those from flush toilets connected to the city sewers) in the year 1973. The refuse discharged from about 2864 thousand households amounts to approximately 15 thousand tons everyday. The Bureau expects that considering the rapid pace of industrialisation and other factors, the daily average of household refuse is likely to go up to 20 thousand tons by 1978. The disposal of such huge quantities of wastes would create collosal problems.

33. In December, 1970, the national Government had promulgated a new law on 'Disposal of Solid Wastes and Public Cleansing' classifying waste matter into 'Ordinary Waste' (mostly from households) and 'industrial wastes' and putting specifically the responsibility for disposal of the former on the municipalities and the latter by the enterprise which generates it. As a rule the public cleansing service is the responsibility of the local administration of the city, town or village. They, however, receive financial as well as technical aid from the higher authorities *i.e.,* the prefecture and the State. In the special wards area, the service is provided on a unified system by the Bureau because of its special characteristics and needs.

Collection of Wastes

34. Each household is expected to keep a portable synthetic resin container with a lid for storing the refuse. The residents bring out the receptacles to the specified places at specified dates and hours. The refuse collectors transfer the refuse from the receptacles to the refuse vehicles. This procedure has become very popular with the citizens. Apart from this regular collection work, the Bureau collects bulky solid wastes (including discarded pieces of furniture, T. V. sets, refrigerators, large containers etc.) twice a month. To avoid mixing of combustible and incombustible wastes, the people are requested to keep their wastes in two groups *i.e.,* special wastes and ordinary wastes to be collected on different days. The frequency of collection is three times a week but in certain areas it is done everyday.

35. While this service is mainly free, a small fee is levied at the rate of Y7,000 per ton from those who put out on an average more than 10 kg. per day or more than 200 kg. at a time. If the consumer brings such wastes to a metropolitan disposal centre, a 3% rebate is allowed.

Transportation of Wastes

36. Most of the wastes are carried by container type vehicles to the disposal sites. For efficient and quick transportation, a mobile floating dock complete with 4 lighters and two pushers has now been set up. Stationed at a suitable wharf, the 'dock' receives the garbage from the vehicles and transports it to the destination with the aid of lighters powered by pushers.

Disposal of Wastes

37. The solid wastes are disposed of mainly through incineration and land reclamation. The wastes are thoroughly sterilised through 'Sandwich System' before being covered by earth for land filling to avoid occurrence of flies and other pesterers. Incineration is also resorted to extensively. 11 incineration plants are already functioning in the core areas and many more are planned as incineration is considered an ideal method hygienically. Moreover, the incinerator can be a source of power supply also.

Disposal of Industrial Wastes

38. According to a survey conducted by the Bureau in 1972, the solid wastes discharged by industrial plants manufacturing, construction, transportation and other industries were of the order of about 6 m. tons. As per law indicated above, the generators have been made responsible for proper disposal of their wastes themselves. The Bureau through its field units ensures proper compliance by them.

Collection and Disposal of Night Soil

39. Out of 28,64,000 households, as many as 12,00,000 houses (roughly 42%) are still not connected to sewerage system and have to depend on their own faecal reservoirs serviced by the Municipal collection squads. The collection system is, however, completely motorised and it is done through vacuum cars equipped with suction pumps. The collection is made twice or thrice a month and is carried to the disposal point either directly or through relay system depending upon the distances to be covered.

40. The final disposal is carried out by ocean dumping and digestion. Six dumping vessels are maintained for the purpose which carry the night soil to outer sea for dumping. About 65% of the matter is disposed of in this way. For 'digestion', the night soil is mixed with sewage sludge at the ratio of 80 to 20 and is heated in digestive tank where it is decomposed into gasses, water and sludge through anaerobic bacterial action. The gasses thus generated are utilised as a fuel for heating the tank and the sludge resulting from the digestive action is dried up and used as a manure for horticulture. At present 20 such digestion tanks are in operation.

Street and River Cleaning

41. The roads in Japan are classified into national, prefectural and municipal roads and the responsibility for cleaning and upkeep of these roads rests with the respective authorities. The cleaning of roads in special wards is carried out by mechanical sweepers and also labourers. River cleaning is mostly done by special vessels.

Public Relations

42. Popularising public cleansing programmes and inculcating sense of cleanliness in the minds of the people is one of the important functions of the Bureau. For this purpose, the Public Relations Department of the Bureau distributes pamphlets, leaflets, posters, bills and other publicity material. The importance of cleanliness is propagated through mass media, cooperative groups, guidance cars etc. Free rides are arranged for the people to visit public cleansing facilities, disposal plants, reclamation sites to see for themselves the huge tasks that the authorities have been performing in this particular area of civic services.

Composting

43. Dr. Seigi Yoshizaki, Director of Sanitation Facilities Division informed the Team of the reasons why composting had not proved successful. As the manurial value of the compost was very often low, the farmers preferred chemical fertilisers. Moreover, transportation cost was prohibitive both for transport of the refuse to the composting sites as well as distribution of the end product to the users. The production and use of compost was considered obnoxious and was, therefore, unacceptable socially.

44. The national Government has been assisting in the urban wastes disposal programme in two ways. First, a subsidy up to 33% for night soil disposal and upto 25% for solid waste disposal is given by the national government. Secondly, an intensive five year programme has been launched for setting up incineration plants in various parts of Tokyo Metropolis and other cities. The incinerators already set up in Tokyo, Osaka and Kawasaki have been functioning satisfactorily for several years.

45. The Team paid a visit to the city of Kawasaki on 12-11-1974 and *inter-alia* observed the functioning of the incineration plant there. This city has a population of about one million and generates over 1200 tonnes of garbage per day. The city has five incinerators in all and this incinerator was burning of about 33% of the city's garbage daily. The plant has three units with capacity of 200 tonnes each and was set up 3 years back. The plant was installed at a cost of 21 m. Yens of which 18.8 m. Yens were spent on machinery alone. Each unit works for about 60 days whereafter it is closed for cleaning and maintenance which takes about 20 days. In this way, two units function continuously. The plastic content of the garbage was of the order of about 8% only against paper content of 30% and as such there was no problem in its disposal. The cost of incineration per tonne was stated to be 3500 Yens against total cost of 10,000 Yens per tonne for collection, transportation and disposal. The plant generates about 1100 K. W. of power and thus meets 85% of its power needs locally. The size reduction of the garbage goes up to 80% and 80 tonnes of ash so produced each day is used for land filling. The plant works for 3 shifts and each shift is managed by 12 workers. The total staff strength was stated to be 87 only.

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Tochigi Prefecture

46. The Team was taken to the town of Kanuma in Tochigi Prefecture on 13-11-1974. The town has a population of 80,000. The prefecture is maintaining one compost plant and one night soil treatment plant. The mechanical composting plant was set up on Dano model with biostabiliser in 1961. The designed capacity of the plant is 20 tonnes per day. However, the plant is processing only 5 tonnes of refuse per day producing about 600 Kg. of fine compost. The compost is sold to the farmers at 3000 Yens per tonne and to outsiders in the town at 4000 Yens per tonne. This price was fixed in 1961 and has not been changed since then. The cost of production was estimated as Yen 7500 per tonne. As against this the incineration of refuse involves an expenditure of about Yen 3100 per tonne. Obviously, the compost production is costly and the prefecture authorities are not interested in production of compost. Moreover, the popularity of chemical fertilisers has reduced the demand for compost. The city is producing about 60 tonnes of waste of which 45 tonnes are disposed of through incineration, 5 tonnes by compost making and the rest is taken care of by the householders themselves. The refuse contains about 84% compostable material and only 16% of non-compostable material. Though there is vast scope for composting, it is not being attempted as there is no demand for it.

Osaka City

47. The Osaka city is spread over an area of 330 Sq. Km. and has a population of 3 millions. The total population of greater Osaka region is about 8 millions. The city generates over 4800 tonnes of wastes everyday, of which 70% is incinerated and 30% is used for sanitary land fill. At present 3 sites are used for land fill purposes. The Team visited Highsiodo Incineration Plant with the capacity of 600 tonnes per day. Figures for cost of incineration were not available. The cost of collection ranges between Yen 6 to 7 thousand per tonne. There was no power generation as it is used for cooling the gases produced in the process. This is the only plant which has Soda Washing arrangements, set up at the cost of Yen 400 m. out of total investment of Yen 3100 millions. This special arrangement was necessitated by the high plastic content of over 11% in the refuse which produces HCL gas which has to be neutralised with Soda Caustic. It was mentioned that composting has never been tried in Osaka city so far. In incineration, the volume-reduction to the extent of 75% is achieved.

Night Soil Disposal

48. The city is sewered to the extent of 60% only. The night soil from the rest of 40% households is collected through vacuum cars and is then let out into the sewers to be carried to the sewage treatment plant. The city government has set up a Press Plant for brickett making from the garbage at the cost of Yen 900 million. This plant makes about 500 tonnes of bricketts per day, which are coated with asphalt and then used for land filling.

Hyogo Prefecture

49. A visit to this prefecture was arranged on 18-11-1974. The prefecture has an area of 8300 Km. and covers 5 Districts with 21 cities and 74 towns. Its total population is 5 million. The prefecture has 1 million sq. metres of farm land which support a population of about 700 thousands. It was mentioned that till about 3 years back, three mechanical composting plants were functioning in this prefecture but these have since been closed down as there is no demand for compost. This prefecture generate over 5600 tonnes of garbage everyday of which about 60% is incinerated and the rest 40% used for land fill. There are as many as 109 incinerators with the total capacity of over 600 tonnes/day situated in different places. 6 more incinerators with total capacity of about 400 tonnes per day are under construction. Land-fill operations are being carried out at 50 sites.

HONG KONG

50. The Team visited Hong Kong from 9th to 23rd November, 1974 and held discussions with the officers of the Departments of Environment and Urban Services and their field officers. The Team also visited various service sites for gaining first hand knowledge of functioning of these services.

Refuse Collection and Disposal

51. The city of Hong Kong has a population of 4 million and occupies an area of 1046 sq. km. The collection of refuse in the city is the responsibility of the Urban Services Department and the disposal of refuse is attended to by the Development and Airport Division of the Department of Environment. No charges are levied for collection of domestic refuse. The refuse from the commercial and industrial concerns is, however, collected and transported by a private company at their cost. The total quantity of refuse collected daily comes to about 3700 tonnes (about 920 gms per capita which, by any standard, is quite high). While about one third of refuse is disposed of by incineration, about 2500 tonnes are used for land-filling which is termed as 'controlled tipping'. For incineration of garbage two plants, each with a capacity of 600 tons per day have been set up. One more incinerator is under construction. The incinerated ash is mixed with earth and used as cover for garbage for controlled tipping. The controlled tipping is being done at 3 sites; one in core areas of Hong Kong and Kowloon and two in new areas. It was mentioned that disposal of refuse by incineration was very expensive involving HK $ 60/- per tonne, against an average cost of HK $ 12/- per tonne by controlled tipping. As land is very scarce in this city, controlled tipping has its limitation. The Team was informed that the administration was studying the effect of land fill operations and the extent of settlement of wastes on the selected sites. The Administration had some time back set up a mechanical composting plant but it has since been

closed down as there was practically no demand for compost. The farmers preferred chemical fertilisers to compost due to its poor quality.

Night Soil Disposal

52. The entire city area is sewered and entire sewage and industrial effluents are dumped into sea untreated, with limited screening at certain places as the seas around the colony have far most part good currents and conditions for accepting and absorbing such discharges.

Environmental Pollution

53. For controlling air pollution and regulating discharge of industrial effluents, a comprehensive law has been enacted. There is, however, no law yet for controlling water pollution. To educate people about the dangers of pollution and insanitation, the Government had organised "Clean Hong Kong" campaign in 1972 which proved very successful as people now extend greater cooperation in keeping the environments clean and tidy. The administration have engaged private consultants for studying the various problems of growing industrial solid wastes and effluents.

PHILIPPINES

54. The Team devoted the last week of the study-tour *i.e.*, 23rd to 29th November, 1974 to the study of the municipal services and facilities in Manila. Manila city has population of 1.5 million and is spread over 14 Sq. miles. The city is divided into 4 political districts for administrative purposes.

Solid wastes disposal

55. The city produces about 900 tons of wastes per day. These wastes are disposed of by 'Salvage' and 'land fill' methods. The paper and plastics are retrieved for recycling. 30% of the city refuse is handled by private scavangers and the rest by municipal staff. Two dumping areas are being worked at present, one is located in the city taking as much as 85% of refuse and the other outside, at a distance of 15 Km. from the city. The refuse is not being used for composting. The city administration has set up a 10-ton plant for incineration on an experimental basis.

Water Supply and Sewerage

56. Only 12% of area of the metropolitan region is at present sewered. In all other areas, the houses have septic tanks. In squatter areas, where weaker sections of the society live, public toilets have been provided. In certain squatter areas, dry latrines also exist. The entire sewage (about 60 mgd) is discharged into the sea.

57. The city is served by extensive water supply system developed with the aid from the Asian Development Bank. There are about 3 lakh connections and 72000 public hydrants. The total water supply comes to about 310 mgd. The domestic water supply is charged at the rate of P. 0.50 per cu. metre. The water supplied to industries is charged at P. 0.60 per cu. metre. The water supply is managed by 'Board of Trustees' consisting of the Chairman, Vice-Chairman, an Engineer, a Lawyer and an Administrator or Economist. The day-to-day administration vests in the General Manager.

58. The Administration is working on a comprehensive solid wastes disposal plan for the entire greater Manila region having 4-5 million population. Consultants have been engaged for the purpose. The disposal will be a combination of composting, land-fill and incineration.

59. The Team was also shown an experimental composting plant based on Dr. Snell's process. Although experiment was initiated over 5 years ago, the results have not been made use of. It was perhaps linked up with the Integrated Scheme of disposal under preparation.

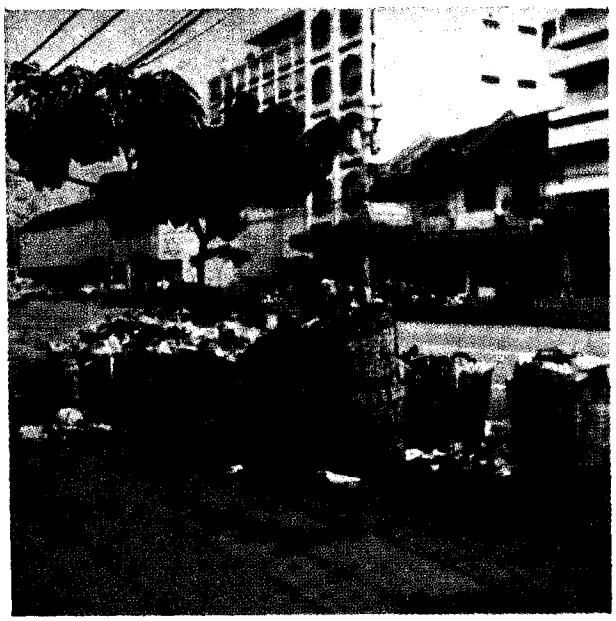
Relevance for India

60. The visit on the whole was very useful and educative. The Team was able to discuss various problems of solid waste disposal with the authorities concerned. The visits to various service site, plants, workshops, etc. provided an opportunity to understand the functioning of these services in depth.

61. The Team noted that the night soil removal service in Singapore has a special relevance for India. This method can be employed and worked in our country at a much lower cost. This will help in eliminating the unhygienic practice of manual handling of night soil. The night soil removal will then be a clean job and the social stigma attached to it will be gradually removed.

62. Another field in which Singapore provides guidance is legislation. In our country, municipal legislation being a State responsibility, does not present a comprehensive and integrated approach to the problems of urban wastes disposal. Moreover, in certain States these laws were enacted several decades back so that the present day realities and problems created by industrialisation, urbanisation, social changes, economic growth etc. can not be tackled with these laws. Singapore has a comprehensive law on environmental pollution, public health, etc. We, in India, can also think in terms of such an "all-inclusive" legislation to tackle the problems vigorously.

63. The Team observed the functioning of mechanical composting plants in several places. Although in some places compost is not able to compete with chemical fertilisers successfully, in our country for different reasons opposite will be the case if sufficient safeguards and measures are taken. Our agricultural needs are vast and extensive and compost will continue to be in demand for a good time. The experience in these countries has also indicated that the patented equipment need not be adopted *in toto*. On the basis



An Example of refuse dumping on main Streets—B a n g k o k

Garbage compacting—
B a n g k o k


सत्यमेव जयते

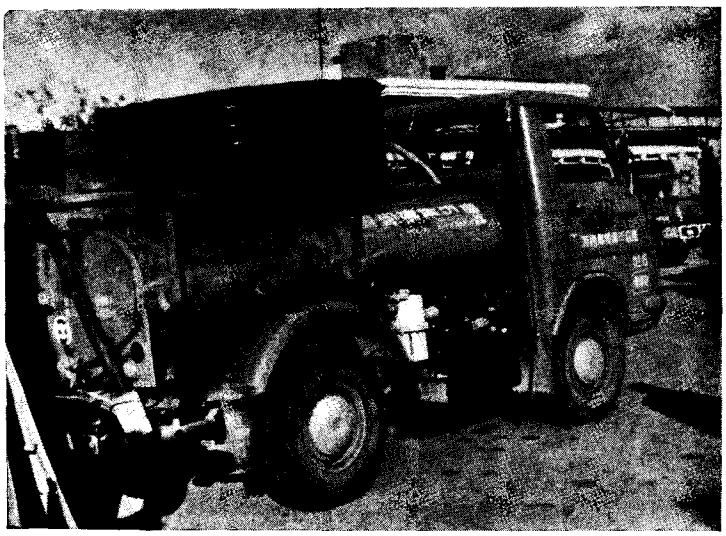
'SALVAGING' AT DUMPING SITES BANGKOK

People picking resaleable articles from the dumps

Salvaged materials awaiting transportation back to city markets


सत्यमेव जयते

PUBLIC CLEANING SERVICES, IN SINGAPORE

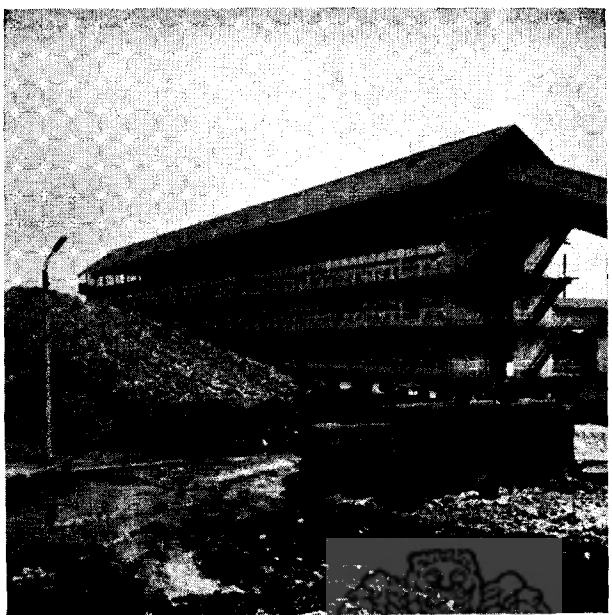


Mechanical Sweeper—More than 540 miles of arterial high ways and secondary roads are swept daily with 13' such vehicles

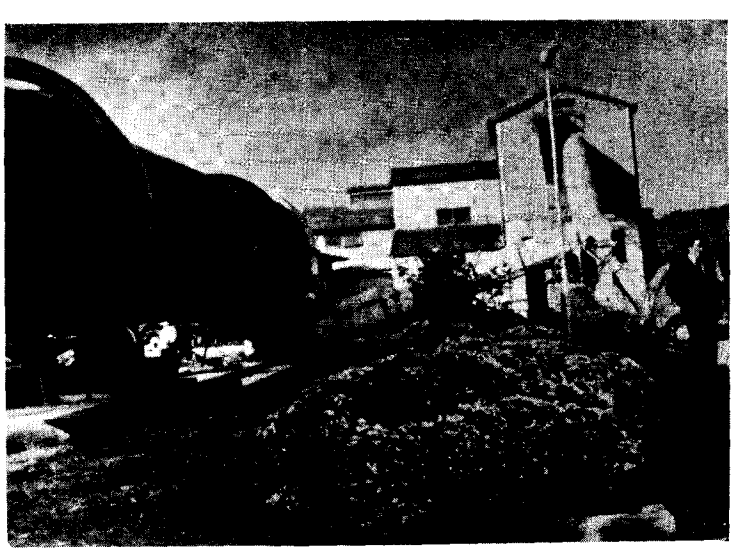
Mobile Toilets are deployed at market places, fairs and other congregations—users are charged a small fee


सत्यमेव जयते

MECHANICAL COMPOSTING PLANTS



Dindaeng, Bangkok

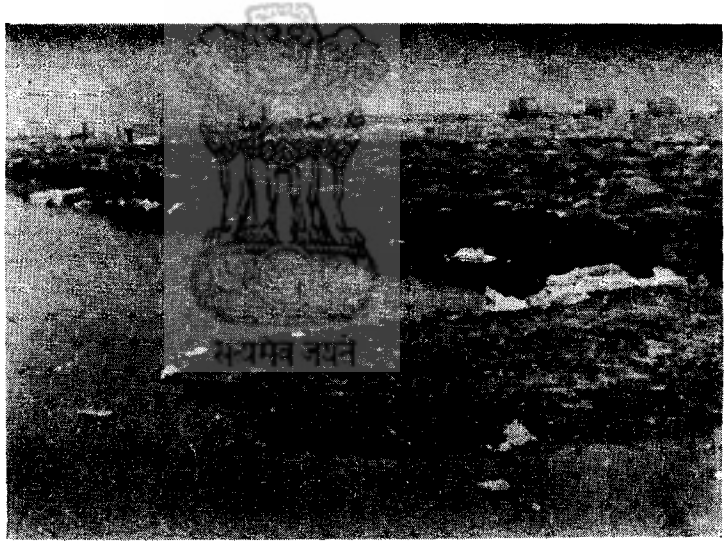


Kamuna City, Tochigi Prefecture, Japan

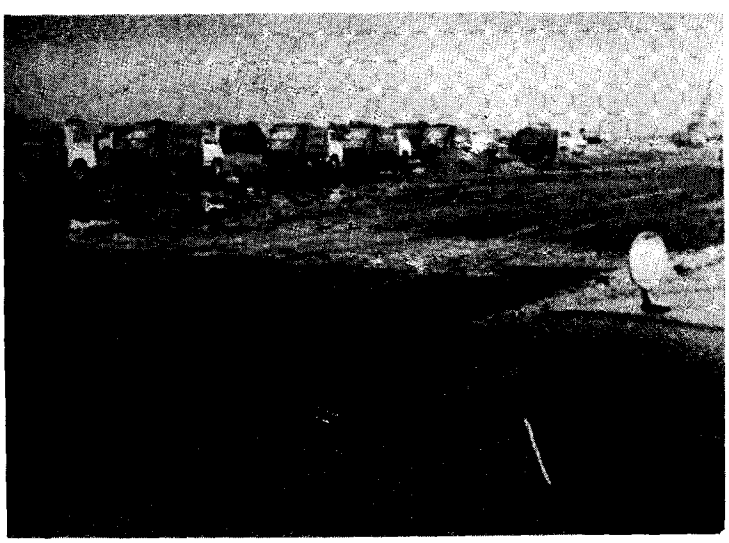

सत्यमेव जयते

SOLID WASTES PUT TO PURPOSEFUL USE— JAPAN

Osaka City makes about 500 tons bricketts per day which after asphalt coating are used for land filling



Reclamation of land from sea



Reclamation in progress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of the refuse composition we can have modified versions of the plant and thereby save a lot of investment which in its turn will lower the production cost. Moreover, certain steps in the process can be done by labour instead of machines thereby giving economy in the production costs and providing employment.

64. In our Municipal areas, the collection, transport and disposal of wastes is being attended in an *ad hoc* and isolated manner. The Team could see that these problems if tackled in an integrated manner could be solved efficiently and economically.

65. It was noted that for the main reason of scarcity of land, incineration was being practised extensively in these countries although this process was very expensive. Our objectives ought to be to recycle the wastes. Incineration, therefore, does not appear to be an answer for our conditions.

66. The Team also observed the advantages of mechanisation of various processes of collection, transportation and disposal of solid wastes. Through mechanisation, we can achieve speed, efficiency and economy in the long run.

67. The Team also noted the interest being taken in these matters by the higher levels of the Government in different countries. The local authorities are helped by the higher levels of Government financially as well as technically in solving the problems of solid waste disposal. In our country it is only recently that the Central and State Governments have shown their awareness about their own part in these matters. Much more efforts and assistance will have to be devoted to these problems if we have to achieve our aim of making our cities and towns, cleaner, tidier and livable.

68. It was found that public relations aspects were given much more importance in these countries and they had achieved considerable success in their campaigns in enlisting public cooperation. We, will also have to step up our efforts in this direction, through mass media, schools, voluntary agencies, social organisations, seminars, periodical campaigns, etc.

ANNEXURE
(Appendix V)

PROGRAMME OF VISITS AND DISCUSSIONS

THAILAND—BANGKOK	Arr. 26-10-1974 Dep. 31-10-1974
26-10-1974	Meet the Regional Representative of the World Health Organisation.
28-10-1974	Discussions with Regional Representative W.H.O. Ministry of Public Health and Bangkok Metropolis. (i) Dr. R. Chical, WHO, Regional Office. (ii) Mr. G. Rodriguez, WHO, Sanitary Engineer. (iii) Mr. Suwanrat Simvat, Dy. Director (Water), Ministry of Public Health. (iv) Dr. Check, Chief of Health, Bangkok Metropolis. (v) Mr. Lert Chainarong, Health Department, Ministry of Public Health. (vi) Dr. Opas Dhamvanij, Chief Health Promotion Division, Bangkok Metropolis.
29-10-1974	Attend Regional Seminar on Urban Wastes
30-10-1974	Visit to the Chief Engineer's Office, Bangkok Metropolis. Discussions with Mr. Chareon Antarikarnanda, Adviser to Cleansing Services Division, Bangkok Metropolis.
SINGAPORE	Arr. 31-10-1974 Dep. 5-11-1974
31-10-1974	Meet Dr. Koh Thong Sam, Commisisoner, Public Health, Ministry of Environment. Visit to Vehicle Depot and meet Mr. George Yeo, Asstt. Commissioner, Public Health.
1-11-1974	Meet Mr. Loh Check Hiong, Night-Soil Collection Service. Field visits—Night-Soil Collection Divisional Centres, mobile toilets.
2-11-1974	Meet Mr. Philip Armstrong, Mechanical Sweepers Wing. Field visits—seen operation of mechanical sweepers. Meet Mr. F. X. Poothamby and Mr. Phang Wien Yen, Refuse Disposal Wing.

	Visit Tampines Dumping Ground.
	Meet Mr. Tan Teng Huat, Refuse Disposal and Water Pollution.
3-11-1974	Visit to Environment Vehicle Workshop.
	Discussions with Mr. Wee Kim Hin, Engineer Incharge—Discussions with Mr. Koh Hee Song, Mechanical Engineer, Engineering Services Deptt.
4-11-1974	Visit to ULU PANDAN Sewage Treatment Works.
	Discussions with Mr. T. K. Pillai, Deputy Head Sewerage Department.
5-11-1974	Visit to Private Purification Works.
MANILA	Transit halt 5/6-11-1974
JAPAN	Arr. 6-11-1974
	Dep. 18-11-1974
8-11-1974	Visit to Ministry of Health & Welfare.
	Discussions with Dr. Seigi Yoshizaki, Director, Sanitation Facilities Division.
	Discussion with Mr. Y. Kobayashi, Deputy Head, Planning Division.
11-11-1974	Visit to Tokyo Metropolitan Government Office.
	Visit to Yumaroshining Landfill Site.
	Visit to Shinagawa Refuse Processing Plant.
	Visit to Refuse Incineration Plants
12-11-1974	Visit to Kawasaki City Office and Kanagawa Prefecture Office.
	Discussions with Mr. Takao Oishi and Mr. Kumagai, Bureau of Waste Disposal.
	Visit to Rinko Incineration Plant.
	Discussion with Mr. Matsumoto, Chief Incineration Plant.
	Visit to Japan Environmental Sanitation Centre and Discussions with Mr. Akira Shimasaki, Director Research & Training.
	Visit Sewage Treatment Plant.
	Discussions with Mr. Yogeme, Chief and Mr. Kato of Ministry of Health and Welfare.
13-11-1974	Visit to Techigi Prefectural Government Office.
	Discussions with Mr. Inemata and Mr. Eiichi Fujimoto, Deputy Head (WW).
	Visit to Prefecture Composting Plant and Night-Soil Treatment Plant
	Visit to Composting Plant in Kanuma Town.

14-11-1974	Visit to Ministry of Trade and Industry. Discusisons with Mr. Sato, Senior Officer, Development Department and Mr. H. Sakai, Member, Research and Development Project.
	Discussions with Mr. Shoichi Hariu, Consulting Engineer, Mitaka City Government.
	Visit to Tobu Sewage Treatment Plant and Fujimino Wastes Treatment Plant.
15-11-1974	Visit to Living Environment Department of Osaka Prefectural Government.
	Discussions with Mr. Masalino Fushitani of Osaka Municipal Sanitation Bureau.
	Discussions with Mr. Sumumu Fujiwara of Osaka Prefectural Sanitation Bureau.
	Discussions with Mr. Kazusi Iwataki, Director, Higasiodo Plant, Osaka.
18-11-1974	Visit to Hyogo Prefectural Government Office.
	Discussions with Mr. A. Nonaka, Chief Environmental Bureau, City of Kobe.
HONG KONG	Arr. 19-11-1974
	Dep. 23-11-1974
20-11-1974	Discussions with Mr. K. C. Wong.
	Visit to Controlled Tipping Site.
	Visit to Lai Chi Kok Incinerator and Composting Plants.
21-11-1974	Discussions with Mr. A. T. Short, Mr. Gilford and Mr. J. D. Watson (Consultants for Sewage Treatment Plant).
22-11-1974	Discussions with Mr. Chan Yen and Mr. K. T. Chan, Senior Engineer, Drainage Works Division and Field Visits to drainage works, Pumping Station and Screening Plant.
PHILIPPINES—MANILA	Arr. 23-11-1974
	Dep. 29-11-1974
25-11-1974	Courtesy call on Mayor of Manila and Introduction of City Officials.
	Briefing on operations of the Department of Public Services by Mr. Robario C. Alcantara, Asstt. City Public Service Officer and Mr. M. Suarez, Dy. Chief, Department of Public Services.
	Study tour of City Service Operations (Composting Plants, Balut, Tonde, Mla.)
26-11-1974	Observation of Dump Operations.
	Observation tour and study of Garbage Collection Operations.
27-11-1974	Briefing at Manila Water and Sewerage Services Deptt. by Mr. Oscar I. Illustre.
	Field trip to water and sewerage plants.
28-11-1974	Briefing at the Office of the City Engineer.
	Field trip to Public Works and Drainage Works.

APPENDIX VI
(*Para* 1.18)

DETAILS OF MEETINGS AND DISCUSSIONS

Meetings of the Committee	Place	Date
1st Meeting	New Delhi	1st July, 1972
2nd Meeting	New Delhi	10th November, 1975
3rd Meeting	New Delhi	25th November, 1975
4th Meeting	New Delhi	16th December, 1975
5th Meeting	New Delhi	29th December, 1975
Group on Mechanical Composting Plant		
1st Meeting	New Delhi	1st August, 1972
2nd Meeting	New Delhi	7th November, 1972
3rd Meeting	New Delhi	4th January, 1973
4th Meeting	New Delhi	15th January, 1973
5th Meeting	New Delhi	24th and 25th March, 1974
6th Meeting	New Delhi	17th August, 1974
Transport and Workshop Group		
1st Meeting	New Delhi	8th May, 1974
2nd Meeting	New Delhi	31st May, 1974
3rd Meeting	Ahmedabad	13th & 14th June, 1974
4th Meeting	Bombay	15th & 16th July, 1974
5th Meeting	New Delhi	11th, 12th and 13th September, 1974

APPENDIX VII
(*Para* 1.19)

INTERIM REPORT

It has been estimated that potential for preparing 18 million tonnes of agricultural manures per annum from urban wastes exists in the country. In Annexure I is given the manurial value of urban wastes in India based on an urban population of 108.7 millions (1971). However, in 1970-71, an estimated quantity of nearly 4 million tonnes of compost was produced at nearly 3100 compost centres (2300 in urban areas). Much of the potential, therefore, remains to be tapped. Further the compost now produced is generally of poor quality and the total nutrient content may not be more than 1%. In a studied case of Ahmedabad, the nutrient value of the compost is expected to be N. P. K. ratio of 0.65 : 0.48 : 0.5 giving a total of 1.63% whereas properly prepared compost can give a much higher nutrient value of nearly 3%. Even then the compost has been fetching good prices in certain centres where agricultural demand is high like Ganganagar (Rajasthan) (Rs. 48 per tonne), Burhanpur (M.P.) (Rs. 35 per tonne), Ludhiana (Punjab) (Rs. 35 per tonne), Jullundur (Punjab) (Rs. 40 per tonne) etc. On the other hand, there are many municipalities selling compost at much lower prices, the lowest reported being Re. 1 per tonne. A properly prepared compost can give a substantial amount of plant nutrient in the shape of nitrogen, phosphorus, potash and in addition humus and soil conditioners of the nature of calcium not provided by chemical fertilisers. With the demand of fertilisers estimated at about 45 lakh tonnes in terms of N.P.K. value at the beginning of the 5th Plan annually against estimated production of 24 lakh tonnes, we can ill-afford the wastage of plant nutrients for 1 lakh of proper composting of the waste to the full.

For fully tapping the potential of urban wastes for compost, it will be necessary to ensure that wastes are properly collected and transported to composting sites. The system can be so devised that the pollution effect of waste can also be eliminated or reduced. Generally, the urban wastes contain not more than two-thirds of compostable matter. The balance one-third will still be available for land reclamation operations of municipalities which are financially attractive propositions. In order to attract municipal bodies to undertake composting, the process would have to be made economically viable particularly in view of the high premium on reclaiming land. An integrated approach and consequently an integrated scheme for urban wastes collection, transportation and their disposal, including composting, seems to be the answer.

The conventional methods now in use known as the Bangalore system or the Indore system are insanitary, require lot of land for trenching operation, do not work in rainy months and take nearly 4—6 months to prepare the compost of a low nutrient value. Any method of composting that we advocate must be sanitary, quicker and at the same time must reduce the demand on urban land which is already scarce. Modern mechanical methods of composting appear to be the answer. These require lesser space, can operate in all seasons, the period of composting can be reduced to about 4 weeks against 4—6 months in the conventional processes. Not only that, a well designed plant can utilise sewage sludge which, when mixed with refuse, would increase the nutrient value of compost. In designing the plants, the extent of mechanisation to be introduced should have a regard to the need for creating larger employment potentials within the economics of operation and demands of sanitation. In addition if the designs of the plants are standardised for various economy sizes, the time element in preparation of individual project reports can be considerably curtailed. The modern mechanical compost unit to be economical, must have the capacity of utilising more than 10000 tonnes compostable urban waste per annum. It would, therefore, be desirable to take within the ambit of the 5th Plan only those urban centres where it is possible to ensure the aforesaid quantity of urban wastes. Based on statistics collected from different parts of the country, it is felt that a dividing line of 1 lakh population would be a fair level to identify the towns to be brought within such development programme in the 5th Plan period. *103 such cities have been identified from the 1971 census. About 80 of these are fully or partially sewered. In the sewered cities sludge from the sewerage system and in others night-soil could be mixed with other wastes in the mechanical composting units to enhance value of compost.

As stated before, the mechanical composting units will have to be economically viable in order to be popular with the municipal bodies. In the project report of a mechanical composting unit for Ahmedabad city, which can be taken as a fair model, the cost of production has been estimated at Rs. 47.30 per ton. Assuming free transport up to 20 miles, the sale price has been suggested at Rs. 30 per ton rising up to Rs. 60 by annual increment of Re. 1 per ton. This compost will have 1.63% nutrient value. For a good compost the farmer should be willing to pay a fair price according to the nutrient content of the compost, and knowledgeable farmers can even pay something more for the town compost than for the chemical fertilisers. However, the fact remains that the market for the compost will have to be developed. Therefore,

*Since revised to 45 cities.

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some amount of promotional subsidy to put large quantity in the field will be necessary. For a properly prepared compost with good nutrient value it would be reasonable to expect the initial sale price at Rs. 35 per ton for delivery within 20 miles of the township. This price can be increased gradually over ten years to Rs. 50 per ton without difficulty. One unit of N or P_2O_5 is priced at not less than Rs. 20 in most of the chemical fertilisers in the market. For a compost with nutrient value of 2.5 to 3% NPK this pricing would be fair and acceptable to farmers.

The model estimate for Ahmedabad shows that out of annual expenditure of Rs. 10.25 lakhs, the establishment expenditure is of the order of about Rs. 1.5 lakhs. and the depreciation and interest on fixed capital almost Rs. 6 lakhs. The quality of the compost will justify the end price provided both urban waste and sewage sludge are mixed in the compost. It is the experience that it takes some time to introduce this material into the field. It is the initial teething troubles of production and promotion which may cause some difficulties in recovering expenditure during the initial years. We can put the period of difficulty of the municipal authorities and corporations as the first five years. It should be possible to help them by giving them the management subsidy for the substantial part of the establishment expenditure on the technical personnel connected with the scheme. It should be possible to allow for the further help in the nature of one of the three alternatives shown below :—

(a) Allow a subsidy in the capital investment itself. But, this will mean full subsidy for all times, which is not warranted.

(b) Invest in the share capital of the enterprise through the Central or State authority. Subsidise the distribution of the fertiliser, per ton, based on certain minimum production requirements, thereby building an incentive for better production and at the same time penalising poor production. Such a subsidy can be for the period of difficulty.

(c) Take over the fertiliser at cost for the period of difficulty and bear the subsidy of distribution through Government channels.

For the remainder of nearly 2000 towns composting by conventional methods will have to continue. However, to improve quality of compost mechanical sieves and such other implements for sanitary handling of the waste at composting sites should be available. Grants to municipalities for this purpose would be necessary. With this small input, considerable quantity of good quality compost can be prepared.

To fully utilise the urban waste, the local bodies will have to be assisted for purchase of suitable trucks and wheel barrows, etc. To maintain these transport vehicles properly non-recurring grants for improvement workshop facilities may also be suggested. The collection of garbage in cities is in a deplorable condition. The public health demands that proper collecting sites are constructed in the cities. By non-recurring grants for construction of collection sites, this purpose should be achieved. Without these grants it will be difficult to induce municipalities to organise an efficient system of collection and transportation of urban wastes.

For operating this scheme which may be initiated in the Central Sector of the Plan, the following management set-up may be envisaged at the Central level.

A project formulation group consisting of experts in sanitary engineering, economics, workshop facilities, transportation etc. may be established for selecting most suitable processes of mechanical composting for conditions of the country, standardisation of plants and preparation of detailed individual project reports. The National Industrial Development Corporation with suitable assistance from CSIR could perform this role. The NIDC will also provide consultancy services to the local bodies for construction, erection and start-up of plant, including its annual check-up. The Central Public Health Engineering and Research Institute of the CSIR could perform this role. The NIDC will also provide consultancy services to the local bodies for construction, erection and start-up of plant, including its annual check-up. The Central Public Health Engineering and Research Institute of the CSIR could be associated with the task of conducting surveys, investigation and field studies, in respect of 103 selected towns. For an effective management of the Programme, it would be necessary to locate the final responsibility of operating the integrated scheme in one Ministry. This could be the Ministry of Works and Housing because of the fact that they are in charge of the subject of Urban Development, Local Govt., sanitation and environment pollution control. The Ministry of Agriculture, the Planning Commission and the CSIR may also be associated appropriately. The organisations will have to be suitably strengthened for this task.

MANURIAL VALUE OF URBAN WASTES IN INDIA

(Urban Population : 108·7 millions)

(Tonnes)

Per Year	Dry matter	Nitrogen	Phosphoric acid (F_2O_5)	Potash (K_2O)	Calcium (CaO)
Katchra (dry refuse)	10,117,252	75,880	45,530	131,525	556,450
Night-soil	1,983,775	114,070	84,310	44,635	94,230
Slaughter-houses wastes	250,000	22,500	8,125	5,625	8,125
TOTAL	12,351,027	212,450	137,965	181,785	658,805

APPENDIX VIII
(*Para* 2.12)

AVERAGE PHYSICAL ANALYSIS OF CITY REFUSE

(Percentage by weight)

Name of city	Paper and card	Metals	Glass	Textiles	Plastic leather & rubber etc.	Wooden Matter Hay & Straw	Bones etc.	Stones	Fine earth & ash earth etc.	Fermentable	Density of refuse Kg/Cum
Lucknow	1·66	3·2	0·66	2·91	4·2	—	0·18	5·27	1·59	60·31	407·6
Kanpur	1·35	0·18	0·38	1·57	0·66	—	0·21	18·38	25·93	53·34	500·0
Madras	5·9	0·7	—	7·07	—	—	—	13·74	16·98	56·24	—
Delhi	5·88	0·59	0·31	3·56	1·46	0·42	—	5·98	22·95	57·71	—
Calcutta	0·14	0·66	0·24	0·28	1·54	—	0·42	16·56	33·58	47·25	540·0
(*i*) Disposal site											
(*ii*) Source	3·18	—	0·38	3·60	0·65	—	—	—	—	45·14	470·0
Bangalore	1·5	0·1	0·2	3·1	0·9	0·2	—	6·9	12·0	75·2	578·0
Ahmedabad	5·15	0·80	0·93	4·08	0·69	1·50	0·12	8·77	38·86	48·95	—
Bombay	3·20	0·13	0·52	3·26	—	17·57	0·5	—	15·90	59·37	—

APPENDIX IX

(*Para* 3.25)

REPORT OF

THE TRANSPORT AND WORKSHOP GROUP

FORMED BY THE COMMITTEE ON URBAN WASTES

MINISTRY OF WORKS AND HOUSING

GOVERNMENT OF INDIA

ON THE

FACILITIES FOR COLLECTION AND TRANSPORTATION OF CITY GARBAGE AND TO RECOMMEND SUITABLE PATTERN FOR THE SAME

NEW DELHI

1974


सत्यमेव जयते

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सत्यमेव जयते

INTRODUCTION

1.1 **Constitution of the Transport & Workshop Group**

Government of India, Ministry of Health and Family Planning (Department of Health) *vide* their letter No. Q-13016/9/71-PHE dated 6th May, 1972 constituted an expert Committee on Urban Wastes which in turn has formed a Study Group known as Transport and Workshop Group *vide* letter No. 15020/10/70/CUW dated 5-3-1974.

The Transport and Workshop Group formed was as follows :—

1. Scientist, National Environmental Engineering Research Institute Delhi Zonal Laboratory (Shri N. Dutta — Convener
2. City Engineer, Ahmedabad Municipal Corporation — Member
3. Municipal Engineer, Municipal Corporation, Bombay — Member
4. Municipal Engineer, Municipal Committee, Meerut — Member
5. Executive Engineer (Auto) Municipal Corporation of Delhi — Member

1.2 **Terms of Reference**

The terms of reference to the Group were :—

To examine the existing facilities for the collection and transportation of city garbage and to recommend :—

(1) The type and quantum of the equipment and vehicles required for the proper collection and transportation of the city garbage;

(2) Workshop facilities required for the repair and maintenance of equipment and vehicles; and

(3) Personnel requirement for (1) and (2) above.

1.3.1 The first informal meeting attended by two members of the Group was held on 8-5-1974 at Nirman Bhavan, New Delhi and general details were discussed about the terms of reference for a city with a population of 3 lakhs and also for updating Shri T. Durairaj Committee's report published in 1969.

1.3.2 The Group was subsequently reconstituted and the second meeting was held on 31-5-1974 at Nirman Bhavan, New Delhi. The following members were present :

1. Shri N. Dutta	Scientist NEERI	Convener
2. Shri A.H. Gandhi	City Engineer, Ahmedabad Municipal Corporation.	Member
3. Shri D.N. Khurana	Superintending Engineer, Delhi Municipal Corporation.	Member
4. Shri S.R. Rane	Deputy Municipal Commissioner, Bombay Municipal Corporation.	Member
5. Shri V.D. Ravikumar	Executive Engineer (Automobile) Delhi Municipal Corporation.	Member
6. Shri M.M. Gupta	Municipal Engineer Meerut Municipal Board.	Member

1.3.3 Subsequent meetings of the Group were held at Ahmedabad, Bombay and New Delhi during May to September, 1974.

Shri R. J. Acharya, Plant Engineer, Ahmedabad Municipal Corporation who was associated with Shri T. Durairaj Committee of 1969 was co-opted as member at the meeting held at Ahmedabad and he participated in the subsequent meetings.

1.4 Information regarding types of vehicles and equipments in use for the collection and transportation of Refuse and Night-Soil and other details were collected from Corporations of Ahmedabad, Bombay, Delhi and also from Meerut Municipal Board. (Annexure I)

1.5 As a result of discussions and examinations of the data furnished by Municipal Corporations/Board, the Group discussed the transport and workshop facilities for collection and transportation of Refuse and Night-Soil and proceeded to set forth its recommendations in this regard.

2.1 **Existing facilities**

In all of the Metropolitan Cities visited by the Group it was observed that they have got following types of vehicles/equipments for refuse/night-soil removal and disposal.

(i) Trucks—Some of them are fitted with tipping arrangement.

(ii) Tractor-Trailers—Some of them are fitted with tipping arrangement.

(iii) Night-soil and waste water collecting vehicles (Vacuum type, pump operated type, Manual operated).

(iv) Dumper placer.

(v) Front end loaders.

(vi) Bull-dosers of various capacities.

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It was also observed that these places have got well equipped and organised Central and Zonal workshops for repairs and maintenance of the above vehicles and machineries. However, it has been observed that the smaller Municipalities *viz.* Meerut Municipal Board do not have adequate vehicles for the transportation of refuse and night-soil and are using even bullock carts etc. for supplementing their collection and transportation requirements. Meerut Municipal Board does not possess sufficient workshop and parking facilities.

2.2 The Group during the visits noticed that washing/servicing facilities provided are adequate in case of few Corporations whereas these are deficient/lacking in certain Corporations/Municipal Boards.

It was also reported that private agencies do not entertain refuse removal/night-soil vehicles for washing/servicing. Deficiency in respect of this facility deteriorates the life of vehicles/equipment.

2.3 It has been reported that trucks having covered body with sliding doors on the top are not giving satisfactory results whereas it has been observed that the use of tarpaulin/tat-pallie (Hassain cloth) to cover the open truck carrying garbage is working satisfactorily and should be insisted upon.

2.4 The removal of refuse from streets/lanes is being done by open wheel-barrows to the approved collection sites/dust bins. The night-soil is transported in closed bucket type wheel-barrows/bullock carts to the nearest dumping/disposal sites. Adequate wheel-barrows both open and closed types are available with Municipalities.

Ahmedabad and Bombay Municipal Corporations have got mechanised/manual arrangement of collection of night-soil. Transportation is then carried out by vehicle to the disposal sites.

2.5 Generally it has been observed that there are mixed fleets *viz.* vehicles of different makes running on diesel/petrol. The Group feels that there should be standardised fleet of diesel vehicles which will be beneficial due to the following reasons :—

(i) Easy procurement of spare parts and reduction in inventory control.

(ii) Training of technicians.

(iii) Standardised tools and equipments for repairs etc.

(iv) Operational economy.

2.6.1 It has been observed that following makes of indigenous trucks for Refuse and Night-Soil vacuum cars are in use :—

(*i*) T.M.B.	3 to 7 ton capacity
(*ii*) Leyland	5 to 10 ton capacity
(*iii*) Dodge	3 to 7 ton capacity
(*iv*) Bedford	5 to 7 ton capacity
(*v*) Metador	2 to 4 ton capacity
(*vi*) Lambretta Scooter 3 wheeler	1/2 ton capacity
(*vii*) Tractors (Escorts, Ferguson Zeter, International etc.)	
(*viii*) Trolleys for above Tractors (two/four wheeled with/without tipping arrangements) . .	2 to 5 ton capacity.

2.6.2 For collection and transportation of Night-Soil and waste water, tanks of 4,000 to 7,500 litres capacity mounted on T. M. B., Dodge and Bedford chassis of suitable wheel-base are in use.

2.7 The tipping gears which were previously imported are manufactured in India by Messrs Usha Telehoist Ltd., Messrs Hyderabad Allywn Metal Works Ltd. and Messrs Tata. Extra cost involved in fitting the tipping devices is compensated by more turn-out due to expeditious unloading.

2.8 The Group has observed that there is no uniform pattern/scale in respect of clothing and other amenities due to various socio-economic and climatic conditions. The Group feels that it will not be advisable to lay down norms for the same. However, it is recommended that a pair of hand gloves and gum-boots must be issued to persons handling night-soil and persons deputed on dumping grounds and their regular use should be insisted upon.

2.9 The Group has observed that in most of the places there are no separate provisions for parking of the vehicles/equipments. The vehicles/equipments are parked within the premises of repair and maintenance workshop, without clearcut demarcation area for serviceable and repairable vehicles.

3. Recommendations

Having considered the problems and the existing facilities/practices in regard to collection and transportation of solid and liquid wastes, the Group makes the following recommendations :

3.1 Public cleansing can be taken at par in promotion of public health with provision of safe drinking water and hygienic disposal of human excreta and sullage water of the community. It would be desirable to place this service under the control of a qualified Public Health Engineer/Mechanical Engineer. This control, however, may continue to be under the existing authority in the respective local-bodies for a transitory period of about five years till suitable engineering incumbent is available and appointed.

3.2 Suitable collection sites shall be fixed by the local-body in consultation with its Health and Engineering Officers for the following purposes :—

(i) Places called Minor Collection Centres for the collection of the refuse brought by the wheel-barrows and scooter vans from the area and from where the refuse will be transferred to 5/7 ton refuse trucks/tractor trailers of suitable capacity.

(ii) Places for the construction of suitable underground tanks for the collection of night-soil brought by closed type wheel-barrows from the areas served by dry latrines and where from the night-soil will be transferred to vacuum cars and taken to the final disposal site.

(iii) Places for the final dumping and disposal of refuse and night-soil.

3.3 Closed type wheel-barrows as designed by CPHERI, Nagpur, now known as National Environmental Engineering Research Institute, for night-soil collection and transportation to underground tanks and open type wheel-barrows as per plan attached (Annexure 18, 19, 20) are recommended to be used by the scavengers and sweepers for collecting and transporting night-soil/refuse from streets and houses to the approved collection centres.

3.4. Small trailers of 2 to 5 ton capacity are also recommended to be used for direct collection of refuse from market places etc. This will be then towed by the tractors to the final dumping sites. The use of a tractor-trailer is recommended for localities where these will not become a traffic hazard/traffic problems.

3.5 For quick and easy unloading, it is recommended that all refuse trucks of capacity of 5 ton and above and tractor trailers of the capacity of 3 ton and above may be fitted with tipping equipment.

3.6 For fixing work load and staff, underground collection tanks and equipment for public cleansing work, reference is invited to Annexures 2 to 8 which give in details all the recommendations/norms for the purpose.

3.7 The Group recommends a regular pattern of maintenance of workshop for the vehicles/equipments which will include the layout of the workshop, parking place, filling stations administrative block etc. Reference is invited to Annexures 9, 10 and 11 in this connection.

3.8 As brought out in the Study Report, the Group recommends the following vehicles/equipments to achieve the standardisation of the fleets :—

(i) Refuse trucks of 5 to 7 ton capacity fitted with tipping arrangement on suitable chassis.

(ii) Refuse truck open type 3 to 5 ton capacity built on suitable chassis, preferably fitted with tipping arrangement.

(iii) Tractor-trailers open type preferably with tipping arrangement with a capacity of 2/5 ton of suitable make.

(iv) Scooter vans of 1/2 ton capacity.

(v) Vacuum car 4000 to 7500 litres capacity fitted with exhauster driven by a prime mover or power take off unit on suitable diesel truck chassis.

(vi) Wheel-barrows :

(a) Open type for refuse

(b) Closed type—capacity 25 litres for night-soil.

(c) Closed type—capacity 75 litres for night-soil.

NOTE : For specifications and drawing refer *Annexures* 12 *to* 20.

3.9 Keeping in view the peculiar strenuous conditions in which refuse/night-soil removal vehicles/equipments are to work, the Group recommends that regular replacement of these vehicles be ensured after a life of 6 years or 1,20,000 K. M. whichever is earlier. This is just a guideline. Further the physical fitness of the vehicle should be assessed by the competent authority for replacement. Necessary provisions for replacement be ensured by the authorities to have efficient working/outcome.

3.10 The Group is of the opinion that at the Central Government level, the matter should be taken up with all the manufacturers to evolve a standardised pattern of refuse removal vehicles and vacuum cars so that these standardised equipment/vehicles can be arranged as and when needed on priority basis.

3.11 The Group recommends that as refuse removal and night-soil removal and disposal is an essential service, it should receive the same priority in supply of vehicles/spares/tyre and tubes/batteries etc. as is received by Defence and other Transport services.

ACKNOWLEDGEMENT

The Group places on record their gratitude for the assistance received by them in conducting the Study from the officers of Ahmedabad, Bombay and Delhi Municipal Corporations and also from the Meerut Municipal Board.

1. Shri N. Dutta	Convener
2. Shri A. H. Gandhi	Member
3. Shri D. N. Khurana	Member
4. Shri S. R. Rane	Member
5. Shri V. D. Ravikumar	Member
6. Shri M. M. Gupta	Member
7. Shri R. J. Acharya	Member

TRANSPORT AND WORKSHOP GROUP

QUESTIONNAIRE FOR REFUSE REMOVAL AND NIGHT-SOIL DISPOSAL

	Ahmedabad	Bombay	Delhi	Meerut	Remarks
1. Population (1971)	15·86 lakhs	59·6 lakhs	40·65 lakhs	2·71 lakhs	
(Present approximate 1974)	19·00 lakhs	65·5 lakhs	47·00 lakhs	3·00 lakhs	
2. Area of the Corporation/Committee	93 Sq. KM	437 Sq. KM	1399 Sq. KM	13 Sq. KM	
3. Area of (*i*) Workshop (*ii*) parking	15,200 Sq. M	14,000 Sq. M (For suburban workshops and parking)	34,000 Sq. M	1,300 Sq. M	
4. Approximate cost of Plants & equipments for repairs, maintenance at Central Workshop and/or Zonal Workshop	Rs. 1,50,000/-	Rs. 2,30,000/-	Rs. 2,75,000/-	Rs. 5,000/-	
5. Quantity of vehicles (a) Tipper and/or trucks	(a) 42	(a) 122*	(a) 130	(a) 6	*This is excluding the number of hired vehicles.
(b) Night-Soil Vacuum car etc.	(b) 14	(b) 76	(b) Nil	(b) Nil	
(c) Any other special handling equipments, Levelling Machines etc.	(c) (*i*) Bull-dozers 2 Nos.	(c) (*i*) Bull-dozers 9 Nos.	(c) (*i*) Bull-dozers 9 Nos.	(c) (*i*) Tractor 2 Nos.	
	(*ii*) Front end loader 2 Nos.	(*ii*) Front end loader 2 Nos.	(*ii*) Front end loader 2 Nos.	(*ii*) Buffalow cars for refuse—87 for night-soil—29	
	(*iii*) Tractor 2 Nos.		(*iii*) Tractor 12 No.		
	(*iv*) Trailers 14 Nos.		(*iv*) Trailers 24		
6. Workshop facilities for repairs and maintenance of vehicles etc.	One Workshop for all types of repairs	2 Central Workshops for major repairs & Units	1 Central Workshop for engine overhauling	A very small workshop not capable to do any major repairs.	
		11 Zonal workshops	8 Zonal workshops for all other repairs.		
7. No. of Personnel :					
(a) Workshop	(a) 183	(a) 594	(a) 362		
(b) Transport					
(*i*) Driver	(b) (*i*) (6+1)/ truck	(b) (*i*) 869	(b) (*i*) 209		
(*ii*) Mazdoors (with truck etc.)		(*ii*) 454 cleaners and 3557 loaders.	(*ii*) 771		

DETAILS OF WORKSHOP, TRANSPORT, STAFF ETC. FOR A TOWN OF POPULATION OF THREE LAKHS TO DEAL WITH GARBAGE AND NIGHT-SOIL COLLECTION AND TRANSPORTATION

1. Quantity of Wastes, Solid and Liquid

The total quantity of refuse including garbage, sweepings, ash, horticultural refuse contributed at 0.5 kg. per capita per day would amount to 1,50,000 Kgs. or 150 tonnes per day.

The total quantity of liquid wastes for the ultimate conditions on the basis of 5 litres per capita per day would amount to 1,500,000 litres or 1500 Kilo litres. In the beginning when there are only dry latrines to be dealt with, the per capita contribution may be assumed to be 25% of the above quantity. Thus the total quantity comes out to be 1,500×0.25 *i.e.* 375 kilo litres.

2. Collection of Wastes

(a) *Garbage.*—The garbage etc. from houses is presumed to be dumped into the approved type of masonry dust bins located at several central places, by the household servants, or into the scooter vans when they come at specified hours. The road sweeping are also to be conveyed to the approved central dust bin places by means of the open type hand-wheel-barrows.

The garbage from houses located in narrow lanes etc. are to be collected by scooter vans and dumped at the approved central dust-bin-collection centres. The garbage thus collected by scooter vans can be used for filling nearby low lying area without creating any nuisance. The refuse from these local approved collection centres is then transferred or loaded to the trucks having tipping arrangements of capacity varying from 5 to 7 tonnes and conveyed directly to the disposal-dumping site.

(b) *Night-Soil.*—The night-soil from the several dry latrines, household as well as public latrines is to be collected by scavengers in closed buckets mounted on wheel-barrows and discharged into the several local semi-underground tanks. The semi-underground tanks may be provided with an enclosure and proper opening on top which will act as dumping chutes for discharging the night-soil. The detail of tank, the wash-out-drain-well and the plan layout of that local muster unit are shown in the Annexure 3, 4 and 5 respectively. An overhead tank with a tube-well and pump set may be provided for water supply for cleaning the buckets of the wheel-barrows and for adding water to night-soil, if necessary, for giving it more fludity. These tanks may be cleared once in two days by vacuum cars and flushed every week. The capactiy of the tanks may be 10 kilo litres, which will be nearly one and half times the capacity of a vacuum car, as full forward control vehicles are to be used. These tanks may be located in a number of convenient central locations for collecting the night soil. Adjoining the semi underground tank a shed for the storing of the wheel-barrows say about 20 for garbage and 20 for night-soil, may be constructed. An office room and a store room may also be provided for the Assistant Sanitary Inspector to take attendance of the staff members etc. A small out-house should also be constructed for watch-man. The vacuum car collecting the contents from there tanks will discharge them at the disposal site for making compost with the garbage which is also dumped and collected at the same place.

On experimental basis, along with the above arrangements, to reduce load on the local collection stations, for group of houses and/or chawls and/or Public Latrines of dry type which can be converted to water closet type forming a battery of latrines, the drain system for that locality can be laid down as shown in the Annexure 6. Here again an underground circular type reservoir tank of suitable capacity to collect night-soil and its wash-water will have to be constructed and to give fluidity nearby hydrant posts should be erected. This will serve multipurpose uses. From such tanks the vacuum cars can collect the contents daily and discharge them at the disposal site for making compost. Such layout may be useful in the long run when the city is to be given proper drainage system. The sullage water is not taken into account as it can be allowed to drain out in open drains and can be used for local gardening etc.

3. Details of Staff, Vehicles and Equipments

The Mechanical/Public Health Engineer of the Local Body should have the over-all control of the Workshop, transport and public cleansing work. He will be assisted by a full-time office Superintendent for Administrative and Accounts works. He will be assisted by a full-time Public Cleansing Officer to be designated as Chief Sanitary Inspector, who will be completely in charge of sweeping and public cleansing etc. who will be further assisted by three Sanitary Inspectors one for half of the City and second for other half of the City. The third one will be for the dumping, disposal and composting site. The first two Sanitary Inspectors in their respective areas will be assisted by three Assistant Sanitary Inspectors—ward-wise—one for dealing with solid wastes and the staff employed thereon and another for liquid wastes and the staff employed thereon. The third one for

general work, attendance, drain cleaning etc. One full-time supervisor (Mechanical) will be there for having control over all the Transport Vehicles, Workshop and staff employed thereon, and who will be responsible for efficient transport of garbage and night-soil from the approved sites only. The subordinate staff will be as per the recommendations in the report. The workshop shall also be looking for the repairs, maintenance of all hand wheel barrows and equipments thereto. The number of sweepers will be based on the area to be cleaned. On a rough basis, one sweeper for every 500 population has been provided including leave reserve. Likewise one scavenger for every 500 population has been provided including leave reserve.

One driver and 6 sweepers (Transport mazdoors) are allowed for each transport vehicle excluding the vehicle reserve. A leave reserve of 40% for the staff should be taken into account. For each vacuum-car and scooter-van and tractor one driver and one scavenger/sweeper has been provided respectively excluding vehicle reserve. A leave reserve of 40% for the staff should be taken into account. Now to make best use of the vehicles and to transport maximum amount of night-soil per day the work should be also done in the second shift by utilising 25 to 30% of the morning fleet to clear up any arrears of the morning 1st shift, and accordingly necessary staff will have to be engaged. The work of scavengers, sweepers and drain cleaners will be supervised by respective Assistant Sanitary Inspectors, on the basis of one Assistant Sanitary Inspector for every 40 personnel. The complete staff pattern and gradation are given in Annexure 7 and 8. The complete details of the vehicles and operational staff thereon are given in Annexure 9.

All the vehicles *viz.* Refuse Trucks, Vacuum cars, Tractor-trailer, Scooter-vans, etc. will be kept at the Central Depot during night hours which will have a maintenance and repair workshop attached to it, which will work according to the needs of the operational department. The typical lay-out of Depot and Workshop and the Offices is shown in Annexure 10.

The seating and working of the supervisory staff shall be as per details shown in the Annexure 7. The workshop should be capable to do proper washing and servicing and be capable to undertake all minor and major repairs of different units and minor body repair work. However, specialised repairs jobs, accident jobs etc. can be got done from outside agencies. It is advisable to keep certain major and minor assembly units in reserve so as to avoid the delay in putting the vehicle on road, *i.e.* to say the repairs etc. should be done on unit basis. All the vehicles which are used for the cleaning operation should be washed daily and kept on a slightly slopy surface so as to allow the washed water to drain off properly. The vehicles should invariably be serviced once in a month, irrespective of kilometres covered, as the vehicles are put to strenuous working conditions.

4. **Calculation**

(1) **Solid Waste**

(I) Transporting from approved dust bin sites to dumping and disposal sites by trucks and tractor-trailers :

(i) Total refuse per day .. 150 tonnes.

(ii) Assuming approximately 80% of the refuse to be lifted and transported in 1st shift and out of which 2/3 by trucks and 1/3 by tractor-trailers, 20% in the 2nd shift and out of which half is lifted and transported by truck and remaining by tractor-trailers *i.e.* to say the refuse lifted and transported by trucks and tractor-trailers in 1st shift will work out to be nearly 120 tonnes, out of which 80 tonnes by trucks and 40 tonnes by tractor-trailers. In the 2nd shift it will be 30 tonnes out of which 15 tonnes by truck and 15 tonnes by tractor-trailers. The 1st shift vehicles can be used in the 2nd shift thereby reducing the total number of trucks/tractors and in turn will reduce the initial capital investment.

(A) **Trucks**

(*i*) Number of trips for 5 tonnes load for the rated tonnage capacity of 7 tonnes per truck vehicle taking into account the volume of garbage etc. $= \frac{80+15}{5} = 19$

(*ii*) (a) Assuming 4 trips per vehicle per day of 8 hrs. working as the vehicles have to move more than 10 kilometres in each trip and there are six labourers number of vehicles needed in 1st shift. $= \frac{80 \times 1}{5 \times 4} = 4$

(b) On the same basis No. of vehicles in 2nd shift assuming 3 trips taking into account night-time. $= \frac{15 \times 1}{5 \times 3} = 1$

N.B. Only for considering drivers strength.

(*iii*) Allowing 25% reserve, total number of vehicles. $= 4 \times 1 \cdot 25 = 5$

(*iv*) Number of drivers one per vehicle 4 in 1st shift + 1 in 2nd shift excluding vehicle reserve, plus 40% leave & off reserve *i.e* operational staff with reserve. $= 5 \times 1 \cdot 4 = 7$

(*v*) Truck loaders *i.e.* sweepers mazdoors 6 per vehicle excluding vehicle reserve plus 40% leave and off reserve *i.e.* operational staff with reserve. $= 5 \times 1 \cdot 4 \times 6 = 42$

(B) **Tractor-Trailers**

(*i*) Number of trips for 3 to 5 tonnes trailer capacity for taking into account on average of 4 tonnes for calculation purpose. $= \frac{55}{4} = 13 \cdot 75 = 14$ (say)

(*ii*) (*a*) Assuming 5 trips per tractor per day of 8 hrs. working as the vehicle has to move not more than 10 k.m. in each trip, there is no wastage of time in loading as the trailers are positioned at various approved sites and are kept filled, tractors needed in 1st shift. $= \frac{40}{4} \times \frac{1}{5} = 2$

(*b*) On the same basis No. of tractors needed in 2nd shift assuming 4 trips taking into account night-time. $= \frac{15}{4} \times \frac{1}{4} = 0 \cdot 94 = \text{say } 1$

(*iii*) Allowing 30% of reserve, total No. of tractors. $= 2 \times 1 \cdot 3 = 2 \cdot 6 = \text{say } 3$

(*iv*) Number of drivers one per vehicle 2 in 1st shift + 1 in 2nd shift excluding vehicle reserve plus 30% leave and off reserve, *i.e.* operational staff with reserve. $= 3 \times 1 \cdot 3 = 3 \cdot 9 = \text{say } 4$

(*v*) Number of sweeper-mazdoor one per vehicle 2 in 1st shift + 1 in 2nd shift excluding vehicle reserve plus 30% leave and off reserve, *i.e.* operational staff with reserve. $= 3 \times 1 \cdot 3 = 3.9 = \text{say } 4$

(*vi*) It is assumed that the trailers are positioned at about 9 approved sites and keeping one as reserve for replacement etc. the total number of trailers needed. $= 9 + 1 = 10$

(*vii*) For each approved dust-bin site where the trailers are positioned for loading the trailers, the number of sweeper-mazdoors needed at 2 per site excluding vehicle reserve plus 40% leave and off reserve. $= 9 \times 2 \times 1 \cdot 4 = 25 \cdot 2 = \text{say } 25$

(II) Transporting from lanes etc. to dump at the central local dust-bin sites by scooter vans :

(*i*) Assuming 20% of the total garbage to come from the congested area, *i.e.* small lanes etc. the quantity of garbage to be transported. $= 30$ tonnes

(*ii*) No. of trips for ½ tonne load capacity of scooter vans. $= 60$ trips.

(*iii*) Assuming 10 trips per vehicle per day of 8 hours working as the vehicle has to move not more than 2 to 3 kilometre in each trip, there are better road conditions, the number of vehicles needed. $= \frac{60}{10} = 6$

(*iv*) Allowing 30% reserve, total number of scooter vans. $= 6 \times 1 \cdot 3 = 7 \cdot 8 = \text{say } 8$

(*v*) Number of drivers per scooter van excluding vehicle reserve plus 40% leave and off reserve, *i.e.* operational staff with reserve. $= 6 \times 1 \cdot 4 = 8 \cdot 4 = \text{say } 9$

(*vi*) Loader, *i.e.* sweeper-mazdoor one per scooter van excluding vehicle reserve plus 40% leave and off reserve, *i.e.* operational staff with reserve. $= 6 \times 1 \cdot 4 = 8 \cdot 4 = \text{say } 9$

(2) **Liquid Wastes**

(a) The quantity of liquid waste for the ultimate conditions at 5 litres per capita is equal to 1,500 kilolitres for a population of 3 lakhs. The rated tank capacity of the vacuum tank is taken as 6 kilolitres but the working capacity has been assumed to be 5 kilolitres.

(b) As the conversion of all dry latrines into water closet will be a phased work and will take some time for ultimate conditions, the night-soil collected from dry latrines has to be transported by hand-wheel-barrows in covered buckets to the semi-underground tanks.

(*i*) Assuming 25% of the ultimate condition of 5 litres, *i.e.* 1·25 litres per capita per day the total quantity of night-soil wastes to start with. $= \frac{15,00,000}{4}$ litres $= 375$ kilolitres

(*ii*) Number of trips for a working capacity of 5000 litres but rated capacity of 6000 litres tank. $= 375 \div 5 = 75$ trips

(*iii*) Assuming 6 trips per vehicle per day of 8 hours working as the vehicle has to move not more than 10 kilometres in each trip and there are better road conditions the number of vacuum-tank-vehicles needed. $= 75 \div 6 = 12 \cdot 5 = \text{say } 13$

(*iv*) Allowing 20% reserve, total number of vehicles. $= 13 \times 1 \cdot 2 = 15 \cdot 6 = \text{say } 16$

(*v*) Number of drivers one per vehicle excluding vehicle reserve plus 40% leave off reserve, *i.e.* operational staff with reserve. $= 13 \times 1 \cdot 4 = 18 \cdot 2 = \text{say } 19$

(*vi*) Sweeper-mazdoor one for every vacuum vehicle excluding vehicle reserve plus 40% leave and off reserve, *i.e.* operational staff with reserve $= 13 \times 1 \cdot 4 = 18 \cdot 2 = \text{say } 19$

NOTE :—In all the above calculations the reserve staff has been taken 40% more for leave, off and absenteeism, which generally is due to the socio-economic conditions of the working staff.

(C) **Semi-underground Tanks**

Assuming 1.25 litres per capita per day the total quantity of night-soil wastes to be collected, transported and to be disposed works out to be 375 kilolitres for a population of 3 lakhs.

(D) **Cleansing Staff**

(*i*) Sweepers at the rate of one per 500 population including leave reserve etc. $= 600$

(*ii*) Scavengers at the rate of one per 500 population including leave reserve etc. = 600

(*iii*) Drain cleaners at the rate of one per 1,500 population including leave reserve. = 200

(*iv*) Bistis for drain cleaning as above = 200

(*v*) Therefore the total staff for cleansing operation. =1600

(E) Assistant Sanitary Inspectors & Sanitary Inspectors

At the rate of one Assistant Sanitary Inspector for every 45 personnel, the number of such inspectors works out to be 1400÷45 say 35. The total number will be 1.1 × 35 *i.e.* 38.4 say 39 assuming leave reserve at 10% and the number of Sanitary Inspectors assuming one per 12 Assistant Sanitary Inspectors will be 35÷12 *i.e.* 2.92 say 3.

(F) Mukadams

The town is assumed to be divided into ten wards and as there are 30 semi-underground tanks and the local offices, for each ward there will be three mukadams. As such the total number of mukadams will be 30 for ten wards and adding 30% leave reserve and weekly off-relievers, the total number will be 30 × 1.3 *i.e.* 39.

(G) Watchman

(a) The number of watchmen for the local centralised depot will be 30 as there are 30 depots and adding 40% leave and off-reliever the total number will become 30 ×1.4 *i.e.* 42.

(b) For workshop, offices etc. the number of watchmen required will be 7 including leave and off-reliever.

(H) Masonry dust-bins

Assuming one masonry dust-bin for garbage for every 400 population the total number of such dust-bins will be 3,00,000÷400 *i.e.* 750 which will be located at approved, suitable places all over the city.

(I) Hand-Wheel-Barrows

The total number of open-type of hand-wheel-barrows for collecting the garbage etc. will be equal to the number of sweepers *i.e.* to say 600 and adding 25% reserve for replacement, repairs etc. it will come to 600 × 1.25 *i.e.* 750. The number of closed bucket type hand-wheel-barrows for collecting the night-soil etc. will be same as above *i.e.* 750.

(J) Repairs, maintenance

Repairs, maintenance of all the waterpumping sets, Hand-wheel-barrows etc. will be carried out by the workshop staff over and above the repair and maintenance work of the vehicles.

(K) Proper fire fighting equipments shall be provided at suitable places.

5. Estimated Cost for Installation

(A) *Building and structure (Capital Investment)*

(*i*) Central depot for vehicles etc. lump sum.	Rs. 1,00,000
(*ii*) Central maintenance & repairs workshop with Inspection and servicing ramp etc. lump sum.	Rs. 1,50,000
(*iii*) Office building, and store etc. attached to the workshop with proper sheds, cabins etc. lump sum.	Rs. 1,75,000
N.B. : For (*i*) to (*iii*) Annexure 10 may please be referred.	
(*iv*) Local Depots each consisting of one 10 kilolitres semi-underground tank, enclosure to house the dumping-chute, sheds for storing night-soil and garbage hand-wheel-barrows about 40 in numbers. An office room, tube-well with pumping set and overhead tank with pipe connection lighting accessories etc. for 30 numbers at the rate of Rs. 75,000 lump sum.	Rs. 22,50,000
	Rs. 22,50,000
N.B. : (Annexures 3, 4 & 5 may please be seen).	
(*v*) Local masonry dust-bins 750 numbers at the rate of Rs. 600 lump sum.	Rs. 4,50,000
TOTAL of A	Rs. 31,25,000

(B) *Equipments, spares, etc. (Capital Investment)*

(*i*) Central workshop, machines, accessories, tools, etc. (Annexure II).	Rs. 1,27,350
(*ii*) Vehicles	
(*a*) 5 numbers refuse 7 tonnes transport trucks with tipping arrangement, side flaps & back flap at the rate of Rs. 1,00,000.	Rs. 5,00,000
(*b*) 3 numbers tractors with hitching arrangements etc.	Rs. 1,50,000
(*c*) 10 numbers trailers 3 to 5 ton capacity with tipping arrangements.	Rs. 1,50,000
(*d*) 8 numbers scooter vans complete with body at the rate of Rs. 15,000.	Rs. 1,20,000
(*e*) 16 numbers of vacuum-tank trucks complete with 6 kilolitres capacity tank with necessary arrangements for S.S. 10 H.P. diesel pump-set. Allconnection etc. at the rate of Rs. 1,00,000.	Rs. 16,00,000
(*f*) One number medium breakdown vehicle 4 wheel drive with hoist arrangement etc. at the rate of Rs. 1,30,000.	Rs. 1,30,000
(*g*) 2 numbers committee station wagons 10 persons capacity Jeeps—4 wheel drive at the rate of Rs. 45,000.	Rs. 90,000
TOTAL	Rs. 27,40,000

(*iii*) Wheel-Barrows :

(*a*) 750 numbers refuse open type iron wheel Hand Barrows at the rate of Rs. 250. — Rs. 1,87,500

(*b*) 750 numbers night-soil iron wheel closed bucket-type hand-barrows at the rate of Rs. 300. — Rs. 2,25,000

TOTAL — Rs. 4,12,500

(*iv*) 6 water pump sets etc. to be kept as reserved at the rate of Rs. 4,000. — Rs. 24,000

(*v*) Stores requirement to be kept as investment spare parts, units etc. — Rs. 75,000

(*vi*) Stores for Hand-barrows, hard wares, paints, etc. — Rs. 25,000

(*vii*) General furniture, steel cup-boards, tables, chairs, fans, etc. — Rs. 50,000

(*viii*) Electric cables, lighting poles, lighting of workshop & buildings, premises main switch board etc. — Rs. 75,000

TOTAL 'B' — Rs. 35,28,850

TOTAL cost of the capital investment, *i.e.* total of (A) & (B) — Rs. 66,53,850

6. ESTIMATED COST FOR MAINTENANCE OPERATION ETC. (Running Expenses)

(A) Establishment (Staff)

Sr. No.	Designation	Grade	Average Pay Rs.	No. of post	Total Cost Rs.
(*i*) *Office Staff*					
1.	Mechanical/Public Health Engineer	400—950	675·00	1	675·00
2.	Office Supdt.	200—450	325·00	1	325·00
3.	Head Clerk & Accountant	150—330	240·00	2	480·00
4.	Sr. Clerk	140—250	195·00	2	390·00
5.	Jr. Clerk	100—210	155·00	8	1,240·00
6.	Peons	80—100	90·00	3	270·00
	TOTAL			17	3,380·00
(*ii*) *Sanitation Staff*					
1.	Chief Sanitary Inspector	250—500	375·00	1	375·00
2.	Sanitary Inspectors	220—360	290·00	3	870·00
3.	Asstt. Sanitary Inspectors	140—250	195·00	38	7,410·00
4.	Watchman Mukadams	80—100	90·00	81	7,290·00
5.	Sweepers, Scavengers, Drain cleaners, Dump Mazdoors, Bhistis	75—91	83·00	1640	1,36,120·00
	TOTAL			1763	1,52,065·00
(*iii*) *Store Staff*					
1.	Storekeeper	220—360	290·00	1	290·00
2.	Sr. Clerk	140—250	195·00	1	195·00
3.	Jr. Clerks	100—210	155·00	3	465·00
4.	Helper	90—120	105·00	1	105·00
	TOTAL			6	1,055·00
(*iv*) *Transport Staff*					
1.	Transport Inspector	220—360	290·00	1	290·00
2.	Asstt. Sanitary Inspector	140—250	195·00	1	195·00
3.	Drivers	110—180	145·00	43	6,235·00
4.	Workmen	100—210	155·00	1	155·00
5.	Pump Operator	90—120	105·00	1	105·00
6.	Refuse & N.S. Mazdoors	75—91	83·00	99	8,217·00
	TOTAL			146	15,197·00

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Sr. No.	Designation	Grade	Average Pay Rs.	No. of post	Total Cost Rs.
(v)	*Workshop Staff*				
1.	Mechanical Supervisor	250—500	375 ·00	1	375 ·00
2.	Foreman	220—360	290 ·00	1	290 ·00
3.	Garage Supervisor	185—350	262 ·50	1	262 ·50
4.	Mechanics, Electrician, Turner, Sr. Cl. (T.K.)	140—250	195 ·00	6	1,170 ·00
5.	Fitters, Tyre Fitter, Painter, Blacksmith, Welder-cum-Tinsmith	120—210	165 ·00	8	1,320 ·00
6.	Workshop Helper, Oil-man	90—120	105 ·00	18	1,890 ·00
7.	Peon	80—100	90 ·00	8	720 ·00
8.	Sweepers, Washers	75—91	83 ·00	5	415 ·50
			TOTAL	48	6,542 ·00

(B) Abstract of Establishment : (Staff)

(i) Office Staff (17)	3,380 ·00
(ii) Sanitation Staff (1763)	1,52,065 ·00
(iii) Store Staff (6)	1,055 ·00
(iv) Transport Staff (146)	15,197 ·00
(v) Workshop Staff (48)	6,542 ·50
TOTAL	1,78,239 ·50
Add for D.A., P.F., Contribution, Accident Insurance Fund, Conveyance Fund, Conveyance All. Bad-climate All. etc.	2,50,000 ·00
	4,28,239 ·50
Say	4,28,240 ·00

(A) Annual cost of Establishment	Rs.	51,38,880 ·00
(B) Maintenance of Building, Structure etc. lump sum.	Rs.	75,000 ·00
(C) Maintenance of workshop, vehicle depot, lump sum.	Rs.	25,000 ·00
(D) Spare-parts for vehicles, hand-barrows etc. lump sum.	Rs.	50,000 ·00
(E) Misc. Stores, contingency electricity water charges, taxes etc. lump sum.	Rs.	25,000 ·00
TOTAL cost of maintenance operation etc. per annum.	Rs.	53,13,880 ·00

7. Cost Per Capita

(i) Capital investment $\frac{66,53,850}{3,00,000}$ *i.e.* 22 ·18

(ii) Maintenance & repair operation. $\frac{53,13,880}{3,00,000}$ *i.e.* 17 ·71

DETAILS OF SEMI-UNDERGROUND TANK

The salient features of the semi-underground tank are shown in the attached sheet Annexure 4.

The semi-underground tank shall be of 3 M × 3 M × 1.25 M internal dimensions, having 80 cms. above the ground and 45 cms. below the ground level. This should be properly plastered from inside and the four corners should be rounded from inside so as to avoid any accumulation of H.S. at sharp corners. Inside and outside steps shall be provided as shown for stepping up the slab to remove the removable pre-cast R.C.C. slab 7.5 cms. thick on four corners for cleaning work of the tank from inside. The floor of the tank shall have a gradual slope towards the drain pit.

The covered portion on the top shall be of 10 cms. pre-cast R.R.C. slabs which will rest on the suitable beam-structure taken on the side walls and on four round pillars of 20 cms. diameter.

There shall be two pail-chutes as shown in the drawing. Here the night-soil wheel barrows should be able to come from over the ramps on both sides having a gradual slope of 1 in 6 and discharge the collected night-soil etc. in the tank, through the respective chutes. The night-soil wheel-barrows can then go down over the middle ramp after proper cleansing.

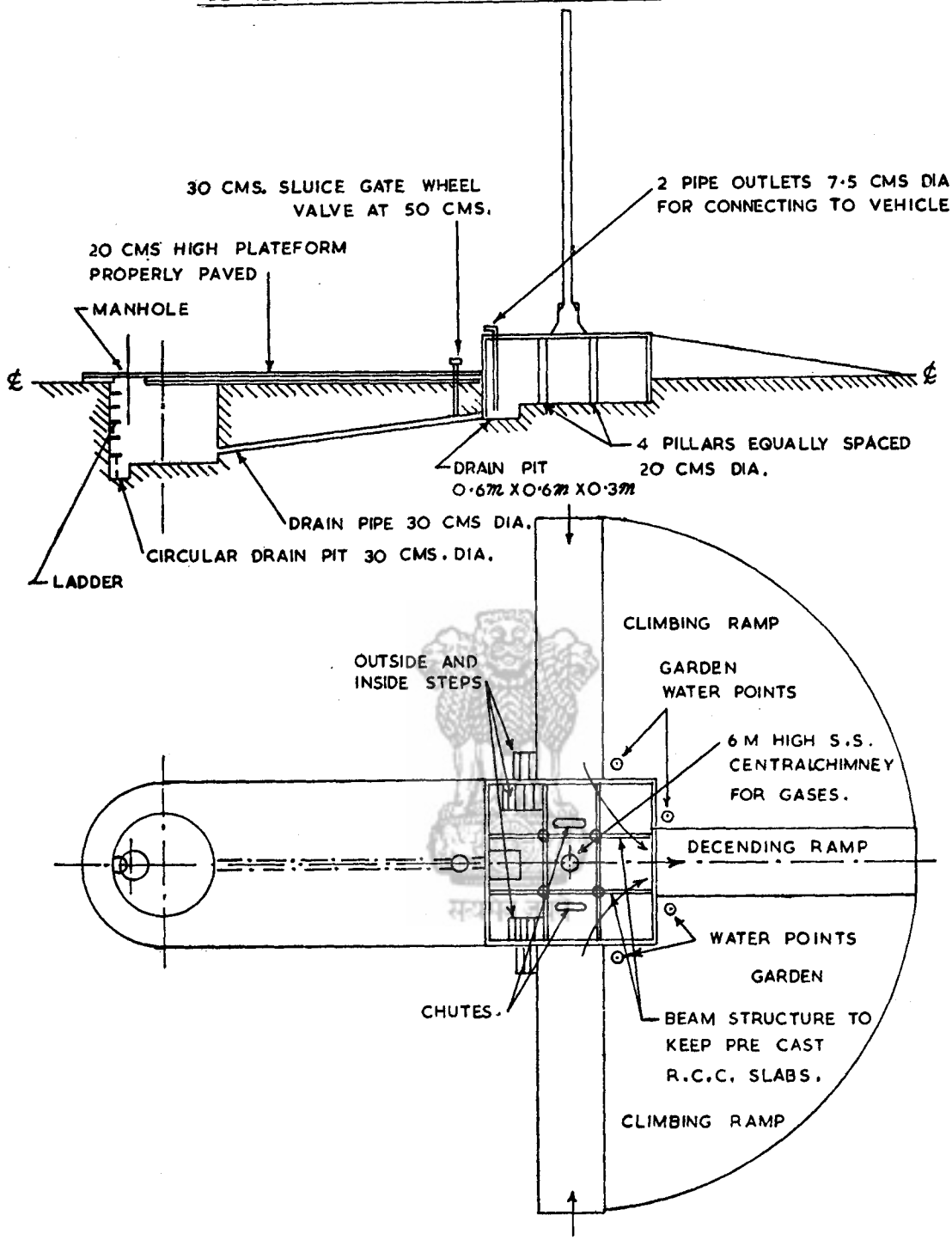
There shall be 60 cms. × 60 cms. × 30 cms. drain pit having drain connection to nearby wash-out drain well by means of 15 cms. diameter drain pipe. The wash-out drain well shall be 5 M. away from the walls of the semi-underground tank. There shall be a hand operated wheel type sluice valve of 15 cms. diameter. This drain pit and wash-out drain well are necessary for periodical cleaning of the tank.

The wash-out drain well shall be of 2 M. diameter and 1.5 M. deep with proper man-hole and ladder arrangements, and having a drain pit.

There should be 20 cms. high curbing as shown and the inside area will be paved. This will stop the vehicle from dashing the tank walls while taking reverse. The wash-out-water of the main tank can be drained to this well from where it can be sucked out. There shall be proper provision for making garden etc. on both sides of the middle ramp. The tank capacity will be nearly 11 kilo litres and with wash-out drain well it will be nearly 15 kilo litres but the combined working capacity can be taken as 12.5 kilo litres, and as such total number of such semi-underground tank and wash-out-well unit will be nearly 30 in number for 3 lakhs population.

ANNEXURE 4

DETAILS OF SEMI UNDERGROUND TANK WITH WASH-OUT DRAIN WELL



N. B. 1 ALL FOUR CORNERS PRECAST. R.R.C. SLABS SHOULD BE REMOVABLE 7·5 CMS. THICK, WITH PROPER LIFTING HOOKS.

2 THE CENTRAL AND OTHER FOUR PRECAST R.C.C. SLABS SHOULD BE FIXED 10 CMS THICK, WITH PROPER OPENING AS SHOWN.

3 SEMI UNDERGROUND TANK DIMENSIONS SHOULD BE 3M X 3M X 1·25 M AND 80 CMS. ABOVE GROUND LEVEL AND 45 CMS. BELOW ℄ C̄ DRAIN PIT.

4 WASH-OUT DRAIN WELL SHOULD BE CIRCULAR HAVING 2M DIA AND 1·5 M DEPTH AND DRAIN PIT. DRAIN PIPE 20 CMS. FROM BOTTOM.

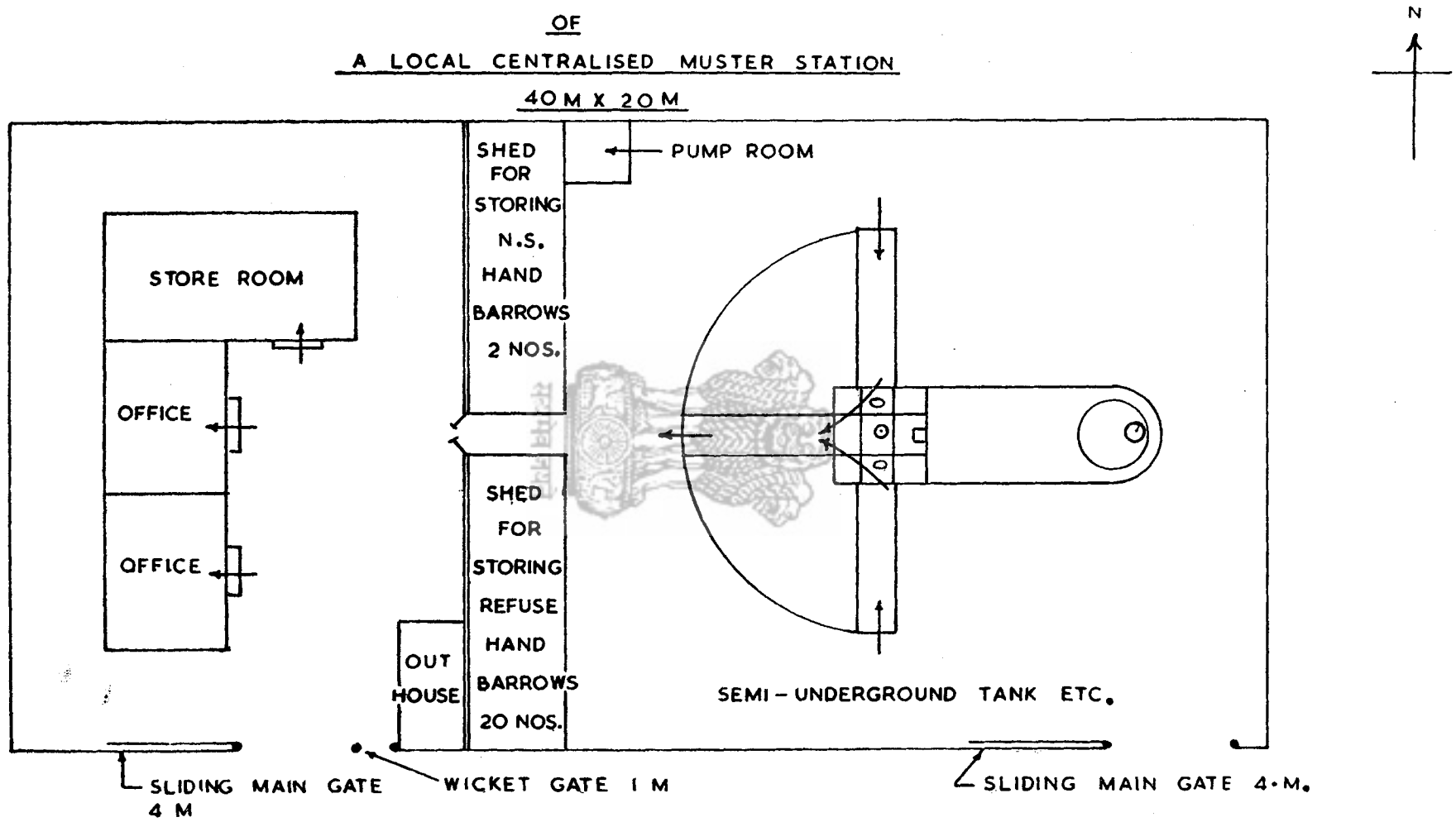
5 ALL RAMP 1 IN 6 SLOPE AND 1·25 M WIDE.

6 TANK OF BRICK MASONARY CONSTRUCTION WITH PLASTER.

7 WATER POINTS ⊙

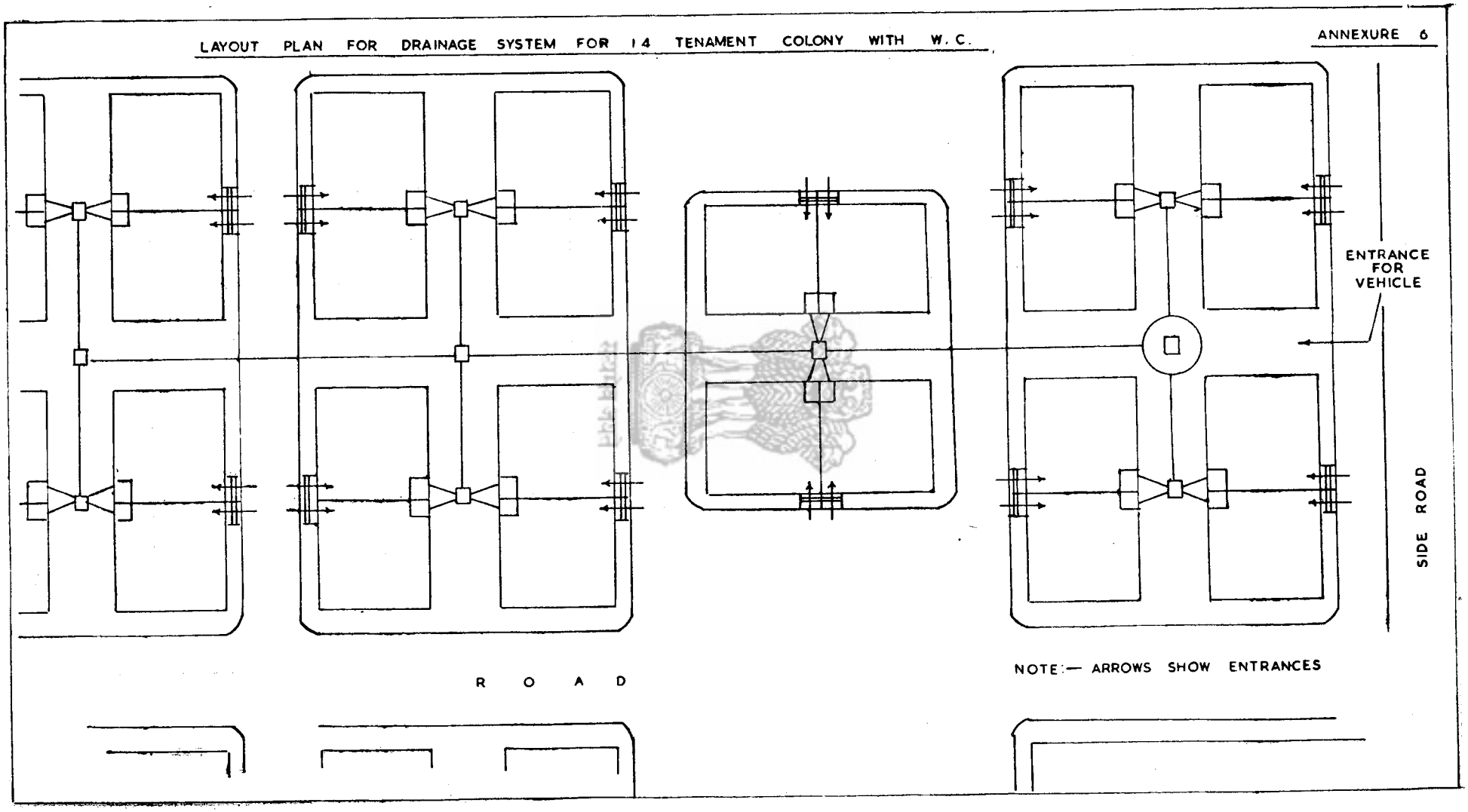
ANNEXURE 5

TYPICAL PLAN LAYOUT
OF
A LOCAL CENTRALISED MUSTER STATION
40 M X 20 M



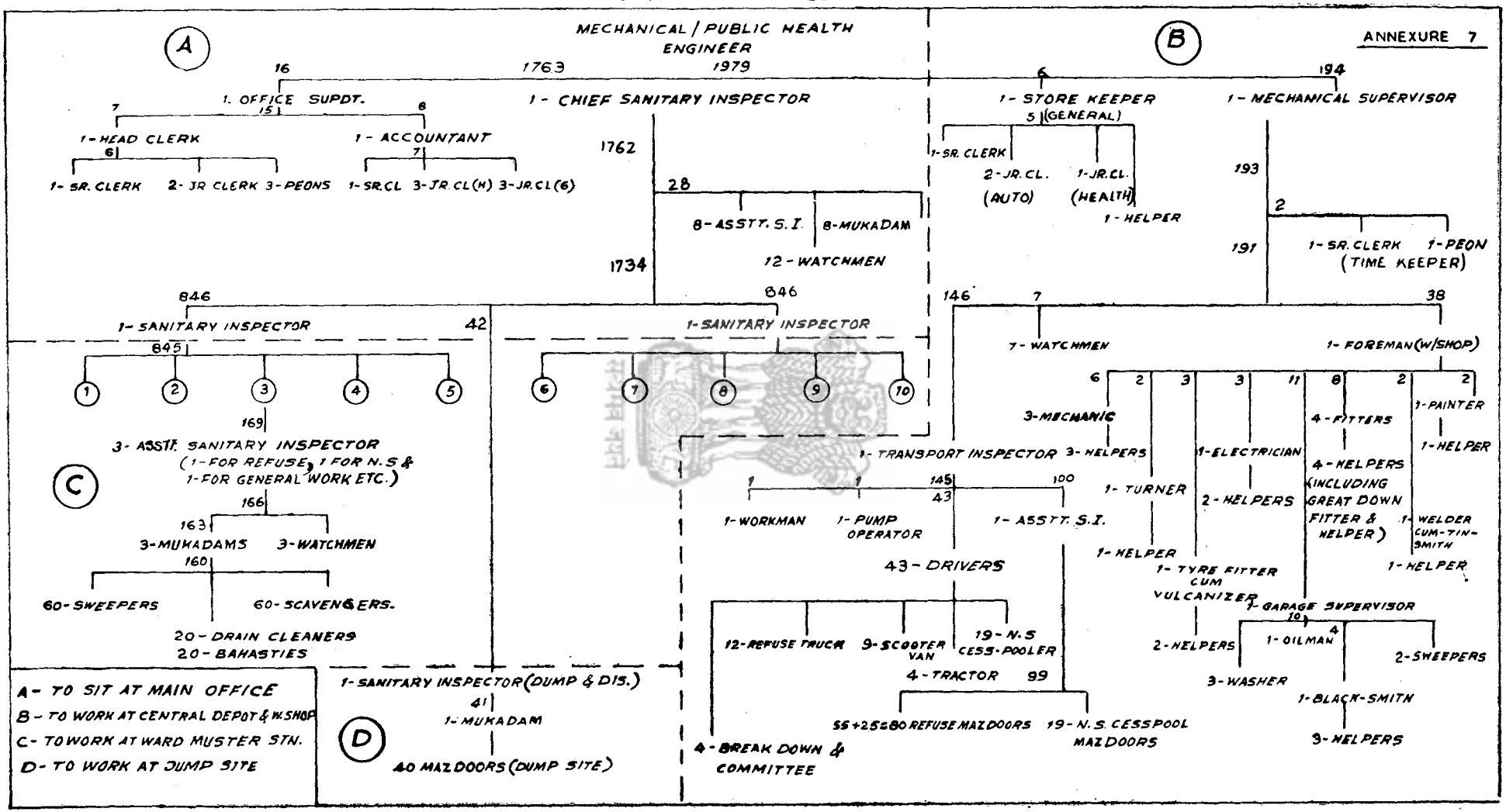
ANNEXURE 6

LAYOUT PLAN FOR DRAINAGE SYSTEM FOR 14 TENAMENT COLONY WITH W.C.



STAFF PATTERN 1980

ANNEXURE 7



ANNEXURE 8

BREAK-UP OF GRADATION

Sl. No.	Grade	Reaching max. in yrs.	Designation	No. of posts Break-up	Total
1.	400-25-600-40-800-50-950	16	Mechanical/Public Health Engineer	1	1
2.	250-15-400-20-500	15	Chief S.I. Mech. Sup.	1+1	2
3.	220-10-300-15-405	15	S.I. Tr. Ins. Foreman S.K.	3+1+1+1	6
4.	200-10-300-15-450	20	Office Supdt.	1	1
5.	175-10-275-15-350	15	Garage Supervisor	1	1
6.	150-8-230-10-330	20	Head Clerk, Acctt.	1+1	2
7.	140-8-220-10-250	13	Asstt. S.I., Elect., Mechanic, Turner, Sr. Cl.	39+1+3+1+4	48
8.	120-5-170-8-210	15	Fitters, Tyre Fitter, Painter, Blacksmith, Welder-cum-tinsmith	4+1+1+1+1	8
9.	110-5-180	16	Drivers	43	43
10.	100-5-170-8-210	19	Jr. Clerk, Workmen	11+1	12
11.	90-1½-105-3-120	15	W/Shop Helpers, Oilman, Store Helper, Pump-operators.	17+1+1+1	20
12.	80-1-88-1½-100	16	Watchman, Health & Workshop Mukadams, Peons.	42+7+39+4	92
13.	75-1-85-1½-91	16	Sweepers, Scavengers, Drain Cleaners, Dump Site Majoors Washers, Sweepers, Tr. Majoors Bhistis.	600+600+200+ 40+99+3+2+200	1744
			Total Staff Strength :		1980

N.B. : The pay scales are suggestive and can be modified as and when needed keeping in view the local circumstances.

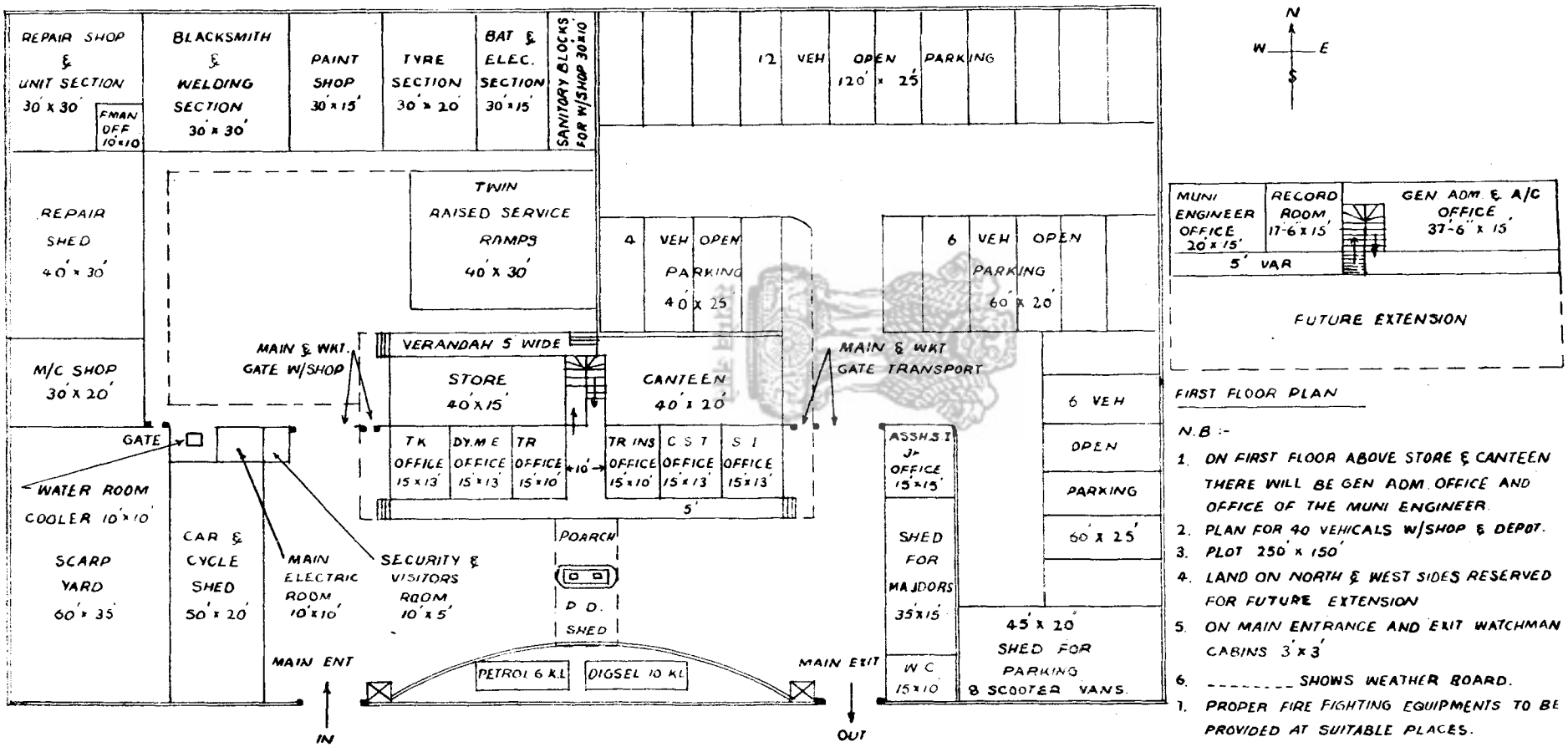
ANNEXURE 9

BREAK-UP OF THE DETAILS OF VEHICLES AND STAFF THEREON

Sl. No.	Kind of vehicle		Quantity of the material	Total No. of trips to be made	No. of trips to be made by each vehicle	No. of vehicles			No. of Drivers			No. of Tr. Majoors			Remarks
						Actual	Reserve	Total	Actual	Reserve	Total	Actual	Reserve	Total	
1.	7 tonnes refuse tipping type trucks.	1. 1st Shift	80	16	4	4	1	5	4	2	7	24	12	42	To collect refuse from Central local approved dust-bin sites and to transport to dumping sites 80% in 1st shift 20% in 2nd shift.
		2. 2nd Shift	15	3	3	1	—	—	1	—	—	6	—	—	
2.	(*a*) Tractors	1. 1st Shift	40	10	5	2	1	3	2	1	4	2	1	4	
		2. 2nd Shift	15	4	4	1	—	—	1	—	—	1	—	—	
	(*b*) Trailers		—	—	—	9	1	10	—	—	—	18	7	25	
3.	Scooter vans 1/2 tonne		30 tonnes	60	10	6	2	8	6	3	9	6	3	9	To collect refuse from lanes etc. assumed to be 20% of total refuse and to dump at Central local dust-bin site from where taken by the refuse trucks to dumping sites.
4.	Cess-pool Night-Soil-tankers 6000 litres capacity		375 KL	75	6	13	3	16	13	6	19	13	6	19	To collect from the semi-u/g tanks and take to dumping sites.
						3	—	3	3	—	3	3	—	3	
						It is advisable to send 20% of 1st shift vehicles in 2nd shift to clear up any arrears and to keep maximum-possible cleanliness—Drivers/ Majoors to be adjusted from the reserved staff.									
5.	Committee & Break-down vehicles		—	—	—	3	—	3	3	1	4	—	—	—	For Committee rounds Break down from reserved staff.
			TOTAL					45			43			99	

ANNEXURE 10

LAY-OUT PLAN FOR REPAIR, WORKSHOP, TR. DEPOT AND OFFICES



GROUND FLOOR PLAN

FIRST FLOOR PLAN

N.B :-

1. ON FIRST FLOOR ABOVE STORE & CANTEEN THERE WILL BE GEN ADM. OFFICE AND OFFICE OF THE MUNI ENGINEER.
2. PLAN FOR 40 VEHICALS W/SHOP & DEPOT.
3. PLOT 250' x 150'
4. LAND ON NORTH & WEST SIDES RESERVED FOR FUTURE EXTENSION
5. ON MAIN ENTRANCE AND EXIT WATCHMAN CABINS 3' x 3'
6. _____ SHOWS WEATHER BOARD.
7. PROPER FIRE FIGHTING EQUIPMENTS TO BE PROVIDED AT SUITABLE PLACES.

DETAILS OF MACHINERIES, EQUIPMENTS, ACCESSORIES, TOOLS ETC. FOR WORKSHOP HAVING A FLEET OF 40 VEHICLES

Sr. No.	Details	No.	Cost
(1) *Machine Shop*			Rs.
(i)	Lathe 6′ with accessories drive etc.	1	18,000·00
(ii)	Hack-saw m/c Reciprocating Type	1	3,000·00
(iii)	Drilling m/c 1″ capacity	1	2,500·00
(iv)	Bench type Grinder—two ended	1	1,500·00
(v)	Hand Shear m/c	1	2,800·00
(vi)	Bending m/c	1	3,500·00
(vii)	Tools, Tackles etc. lump sum		2,800·00
	TOTAL		34,100·00
(2) *Repair Shop*			
(i)	Portable Jib-crane 1 ton capacity	1	3,500·00
(ii)	Hydraulic Trolley Jack—5 ton capacity	1	7,000·00
(iii)	Pullers, Mechanics tools sets, spanner sets, tackles etc.	—	6,500·00
(iv)	Working benches etc.	—	3,000·00
	TOTAL		20,000·00
(3) *Blacksmith & Welding Section*			
(i)	Portable Electric Welding set with accessories	1	8,000·00
(ii)	Gas welding & cutting set with accessories.	1	7,000·00
(iii)	Flexible grinding m/c with accessories.	1	1,000·00
(iv)	Anvil and allied tools etc.	—	3,500·00
(v)	Chimney, Blower, Pipeline etc.	—	4,000·00
	TOTAL		23,500·00

Sr. No.	Details	No.	Cost
(4) *Paint Shop*			Rs.
(i)	Spray-painting equipments etc.	—	2,000·00
(ii)	Allied equipments tools etc.	—	500·00
	TOTAL		2,500·00
(5) *Tyre Section*			
(i)	Hot Patching m/c etc.	—	750·00
(ii)	Tools, tackles etc.	—	2,500·00
	TOTAL		3,250·00
(6) *Battery & Electrical Section*			
(i)	Battery charger-6-12V	1	4,000·00
(ii)	Small Benth Lathe with tools etc.	1	3,500·00
(iii)	Equipments, tools etc.	—	1,000·00
	TOTAL		8,500·00
(7) *Service Section*			
(i)	Air Compressor Heavy duty	1	7,500·00
(ii)	Car washing m/c with tube gun etc.	1	7,500·00
(iii)	Pneumatic Heavy duty grease gun with trolley, drum etc.	1	2,500·00
(iv)	Oil decanting Pump etc.	1	2,000·00
(v)	Press tools, tackles etc.	—	5,000·00
	TOTAL		24,500·00
(8) *General*			
(i)	Water cooler	1	7,000·00
(ii)	Punching m/c time Recorder	1	4,000·00
	TOTAL		11,000·00
	GRAND TOTAL OF MACHINERIES, EQUIPMENTS, ACCESSORIES, TOOLS ETC.		1,27,350·00

SPECIFICATIONS FOR DRIVER CABIN AND WORKMEN'S COMPARTMENT (COMMON FOR ALL TRUCKS)

1. General

The chassis will be supplied with the complete front show and the dash board. The heavy duty diesel truck chassis shall be of approved design fitted with dual rear 12 ply heavy duty tyres with complete spare wheel, battery, tool-kit, power, take off provisions, etc. The fabrications shall be such that renewals can be made without any disturbance to the general structure. The driver's cabin and the workmen's compartment shall be constructed of Mild Steel sheets of 18 B.S.G. (stamped). The driver's cabin shall be a full type and framed integral with the workmen's compartment. The structure shall be fabricated with proper 16 gauge M.S. pressed sections and all structural members shall be adequately fixed with suitable brackets and gussets securely rivetted with alloy rivets or bolted together with self-locking fastenings to ensure maximum tightness or welded. The cabins shall be built in to conform to the Motor Vehicle Rules of State Government Transport Authority. Handles outside the cab shall be provided for the Driver and co-driver as well as for workmen to enter in and to get out. Monogram shall be painted outward on both the doors.

2. Roof

Roof shall be of standard type and design and supported strongly. It shall be shaped properly to conform to the aesthetic appearance of the model. The roof joints shall be interlocked and so made that these are leak proof. Two coats of an approved paint shall be applied before fixing the roof inner canvas.

3. Steps

The steps for the driver's as well as the workmen's compartment shall be designed for rough wear and tear, and shall be made of one piece properly braced and covered with aluminium chequered plates wearing strips.

4. Flooring

The flooring for the driver's cabin and the workmen's compartment shall be made from 3 mm. thick aluminium floor plates. No alteration shall be done to the engine cover. However if any fittings are made, careful attention shall be paid to the fact that the opening arrangements of the engine cover is not disturbed. It shall be further seen that hand-brake and other gearing system is allowed free movements. All sheets shall be pressed and fixed to the channel section in such a manner that the joint is completely dust proof.

5. Doors

The doors shall be provided on both sides of the Driver's cabin. These two doors shall be hung upon stout steel hinges and shall be of mild steel, provided with a stop sector and suitable locking arrangements. The doors in the driver's cabin shall be provided with a quarter glass fixed in the front to divert flow of air into the cabin and the same should be capable of being adjusted and locked in a position flush with the door. The doors shall be provided with panels of 3/16" (4mm) thick toughened glass which can be moved up and down by a mechanical regulator. For workmen's compartment the door should open on the left side. On the right side, i.e., the driver's side there should only be an emergency door with proper locking arrangements. The glass shall be as above.

6. Seats

The driver's seat frame shall be of 25 mm. dia M.S. pipes duly framed with sufficient cross members to strengthen it with a movable seat on it which can be moved forward or backward by a screw type handle. The driver's seat shall be of foam cushion and of thickness not less than 10 cm. and the seat back shall be of 5 cm. thick foam cushion. Both will be covered with PVC cloth of approved quality. The seat shall be capable of being adjusted forward or backward with a play of 7.5 cms.

The Co-driver's seat and the seat for workmen in the workmen's compartment shall be made out of 25 mm dia M.S. pipes structure with 10 cm. thick coir jute.

The seat and the back shall be covered with PVC cloth of approved quality.

7. Lighting

Rear number plate light, auxiliary rear light, stop light, directional indicator light, workmen's compartment light and the Driver's cabin light shall be provided over and above the front head and side lights. Lighting controls shall be placed at convenient positions near the driver with individual fuses. Lights and reflector shall be of approved make. All light wiring shall be connected in positions to be run in approved rigid plastic conduits or troughing and so arranged that they can be readily inspected and renewed without unduly disturbing the interior finish of the vehicle. All cable shall be oil resisting, flame proof, braided and lacquered.

One hand lamp (break down light) with 7 metres wire should be provided with proper hook and fitted to the dash board in the driver's cabin so that it can be easily taken out when necessary.

8. **Painting**

The interior and under carriage of the driver's cabin and workmen's compartment shall be painted with two coats of anti-corrosive paint while the exterior shall be painted with synthetic enamel paint of approved shade and quality.

9. **Accessories**

(i) *Driver Signals.*—A hand-operated direction indicator made of 20 M.S. Sheet with embossed arrow, the entire area being painted white and the arrow in red, shall be fixed at convenient place so that the driver can operate it with ease while driving. A suitable light signal shall also be fixed if not provided with the chassis.

(ii) *Tool Box.*—As the vehicles will be operated by a Central Agency there is no need of a tool-box as the break-downs can be attended by the staff of workshop etc.

(iii) *Rubber-mattings.*—Rubber mat of good quality shall be provided in the driver's cabin as well as workmen's compartment.

(iv) *Glasses.*—In between the driver's cab and the workmen's compartment a sliding glass mounted on a rubber channel fixed inside a M.S. Channel and with proper locking arrangements with suitable handle shall be provided. At the back of the workmen's compartment a fixed glass with M.S. bars fixed on the outside should also be provided so that the driver can see through it. One rear view Mirror of 150 mm× 100 mm size of adjustable type shall be provided and positioned at appropriate place. The mirror should be preferably of convex type. All glasses used shall be of approved quality.

(v) *Bulb Horn.*—A good quality bulb horn shall be fitted in front under the engine bonnet and shall be operated from inside the driver's cabin.

(vi) *Battery-Box.*—A sturdy battery cradle of adequate size shall be properly fitted near or beneath the co-driver's seat made out of 35 mm × 35 mm × 6 mm angle iron and 10 B.S.G. (stamped) sheet with flap door in the front and top having suitable locking arrangements.

10. **Workmanship**

The following conditions with regard to the workmanship shall be observed by the Body builders :—

(i) All casting and metal fabrications must be truly formed.

(ii) All rivets and bolt holes shall be jig drilled (not punched) and filled with well fitting rivets or bolts. The rivets used shall be pop rivets, shall be well and truly formed and neatly finished. Before rivetting or bolting should any rivet or bolt hole not be fair and true with the work in its correct position, the piece shall be replaced by another with the holes, correctly drilled.

(iii) All joints shall have a coat of approved dielectric paint on both surfaces immediately before rivetting, bolting or screwing up.

(iv) All removable wood casing, etc. shall be secured by means of brass screws. All steel screws, bolts, nuts, rivets, etc, should be made rust proof by a recognised process.

(v) All paint and varnish work shall be done in a suitable paint shop which shall be well ventilated for an even temperature and free from all dirt and dust. Each coat must be allowed to dry and harden before the next is applied and the final coat should be allowed to harden and dry before the body, i.e. vehicle is removed from the paint shop.

(vi) When the vehicle is made complete all openings windows, doors, ventilators, roof, etc., shall be subjected to a water test.

(vii) All fittings and furnishings shall be capable of being operated with minimum inconvenience.

SPECIFICATIONS FOR REFUSE TRUCK BODY

General

The dimensions of the refuse truck body varies according to the wheel-base and the model of the vehicle, viz., full forward, conventional control, etc. However, body dimension should be kept as per the requirements conforming to the Motor Vehicle Rules of the State Governments/Transport Authority. Generally the breadth is 225 cms. and the depth is 60 cms. having proper fastening hooks or sliding doors arrangements. The length depends upon the type of vehicle, and its model. The body should be properly painted with two coats of synthetic enamel paint after applying proper primer coating. On the collapsible or fixed side doors monograms should be painted on both the sides.

Body.—The body shall be built of 10 B.S. Gauge (stamped) Mild Steel Sheet, and fabricated with proper sections of proper gauge. The flooring shall be of 10 B.S.G. M.S. sheet.

The refuse truck body shall be supported by two longitudinal M.S. Channels 15 cms. × 7.5 cm. of proper thickness having suitable member of cross bearers of M.S. Channel 10 cm.×5 cm. duly welded to form a frame work. The main body frame shall be made of 10 cm×5 cm. M.S. Channel of proper thickness. The construction of the sides varies according to the type of operation (i) fixed—which has got downward collapsible sides, as well as rear doors made of 35 mm × 35 mm × 6 mm angle iron frame and 10 gauge M.S. Sheets properly braced. (ii) Tilting—which has got fixed sides and the rear door shall be openable in flap manner with proper fulcrum arrangement at the rear top and of the sides. This rear door shall also be removable. This shall be of 35 mm × 35 mm × 6 mm angle iron frame and 10 gauge M.S. Sheet properly braced.

Rear Mud Guards.—The rear mud-guards shall be of 10 B.S.G. sheet and shall be fixed to the body above the rear wheels with proper shape.

(a) *Fixed type (Open).*—In this type of body, the body is completely fitted with the chassis with proper fasteners. The body has got suitable members of downward collapsible doors, two or three on each side and one at the rear.

The frame of the door shall be 35 mm × 35 mm × 6 mm angle iron duly covered by 10 B.S. gauge M.S. Sheets. The doors shall be suitable hinged to the main body frame. To facilitate the locking of side doors, and rear doors, M.S. round hook shall be provided suitably fixed with M.S. Chain. Proper hooks of M.S. Round 9 mm. dia. shall be provided on either side of the side doors and at the rear door. A suitable number of hooks shall be provided on either side of the side doors depending upon the length of the body and a minimum of four hooks shall be provided on the rear door.

(b) *Tilting Type.*—(i) Open : In this type of body the longitudinal channels should hinge at the rear of the body chassis which is cut at an angle to give proper angle of tilting. There shall be side guides on both sides of the main chassis so as to allow proper alignment when in normal use. The rear door shall be of such construction that it can be removed as well as it can flap out having fulcrum action on the both of the top ends.

Tipping Gear Kit.—The tipping gears of double barrel system—telescopic in nature shall be supplied to the body builder alongwith the chassis. This should be fitted under the body with the chassis, instead of at the rear of the workmen's compartment above the chassis. This should be observed so as not to reduce the length of the body. The tipping gear kit is to be assembled and fixed as per the manufacturer's instructions.

Painting.—The body shall be painted with two coats of synthetic enamel quality on properly applied primer surface. The under carriage parts and the chassis shall be painted with two coats of anti-corrosive rust proof black paint of approved quality.

SPECIFICATIONS FOR VACUUM CAR FOR COLLECTION OF LIQUID WASTES

General

The vacuum car comprises mainly of a cylindrical tank of suitable dimensions for the collection of the liquid wastes, mounted on a chassis of suitable make and fitted with necessary fitments with either :

(i) an independent engine coupled exhauster unit set, or

(ii) power-take-off exhauster unit.

(1) **Tank**

The tank shall be cylindrical type having overall dimensions as 400 cm. length 150 cm. diameter, made out of 10 mm. thick mild steel plate with dished ends of the same thickness. There shall be two compartments. One will be the main tank of 370 cm. long of 6500 litres (appx.) capacity for collection of the liquid wastes, provided with suitable openings for various connections, mountings, etc. The other auxiliary tank of nearly 30 cm. length of 500 litre capacity will be for storing clean water. This clean water is used by the exhauster for water sealing. The separating circular partition shall be of 5 mm. thick M.S. Sheet welded internally on both sides to make the inside leak-proof and the same shall be diagonally reinforced 35 mm $\times$ 35 mm cross section housed in a recess formed by two flats bare 30 mm $\times$ 25 mm continuously welded on the inside of the rear door. The surface against which the rubber ring is to rest shall be machined so as to help to maintain the joint vacuum tight. The door is to be closed by providing 30 mm diameter 8 screws properly placed in clamps made from M.S. and equally spaced and hinged along the circumference. There shall be an opening handle properly welded to the door. The bottom portion of the tank shall be provided with proper gussets and brackets prepared out of 10 mm M.S. sheets duly adjustable holders for fixing it to the chassis of the truck.

(2) **Exhauster or the Exhaust Pump Set**

The exhauster shall be of rotary type with ball bearings. It can either be driven by—(i) Power take off from the main truck engine through an extension shaft from the gear box or, (ii) directly coupled to a diesel engine (prime-mover) of 10 HP discharging exhaust gases through a separate silencer. The exhauster shall be of 50 mm size suitable to work at 1450 R.P.M. and capable of creating a vacuum equivalent to 56 cms. of mercury and discharging air at the rate of 2.7 cu. metres per minute with proper water seal and cooling arrangements.

(3) **Fittings**

(i) *Pipe.*—The air pipe from the top of the main tank and the water pipe from the bottom of the auxiliary tank are connected to the suction side of the exhauster on either side and the delivery from the pump is taken to the top of the auxiliary tank.

(ii) *Air Strainer.*—There shall be an Air Strainer incorporated in the suction pipe line and it shall be fitted in such a manner that it can be removed easily for periodical inspection and cleaning.

(iii) *Suction Valve and Pipe.*—The suction pipe connection on the left side of the vehicle on the tank shall be provided with a heavy duty 75 mm. size lever acting sluice type valve with suitable union to connect the flexible suction pipe. This valve should be located below the centre line of the tank of its periphery and the pipe continuing it should protrude inside upto about 5 cms away from the inside of the tank at an angle such that it is just near the top of the tank. This is necessary so as to prevent the sucked liquid being back flown through the suction pipe.

(iv) *Suction House.*—It shall be of reinforced type complete with round thread gun metal/cast iron couplings and hose-clips.

(v) *Discharge Valve.*—The discharge valve of heavy 10 cms. size lever acting sluice type shall be provided near the rear bottom of the tank.

(vi) *Gauge.*—A connection shall be provided near the rear top of the centre of the main tank for fixing the combined vacuum and pressure gauge of 10 cms. dial and 0 to 74 cm. range.

(vii) A connection for extraction of air from the main tank shall be provided on the rear top of the main tank.

(viii) A water inlet connection to the auxiliary tank shall be provided at the top for water coming out from the exhauster.

(ix) An outlet shall be provided to the auxiliary tank with 35 cm drain cock at the bottom.

(x) An air vent shall be provided at the top of the auxiliary tank.

(xi) An opening for filling clean water to the auxiliary tank shall be provided at the centre of the top with a 10 cms. hinged cap.

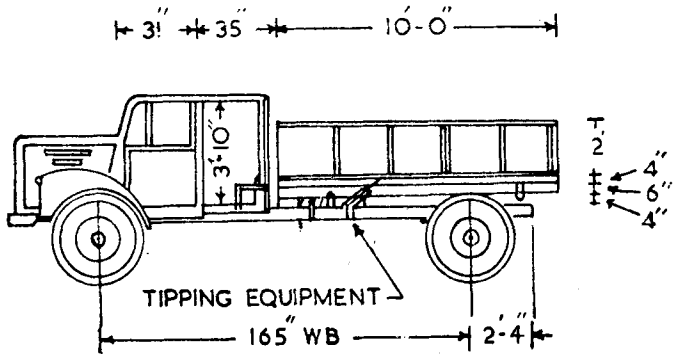
(xii) *Relief Valve.*—This shall be fitted on the top of the main tank.

(xiii) *Overflow Valve.*—An overflow valve which automatically cuts off the air outlet when the tank is full, shall be provided on the top of the main tank.

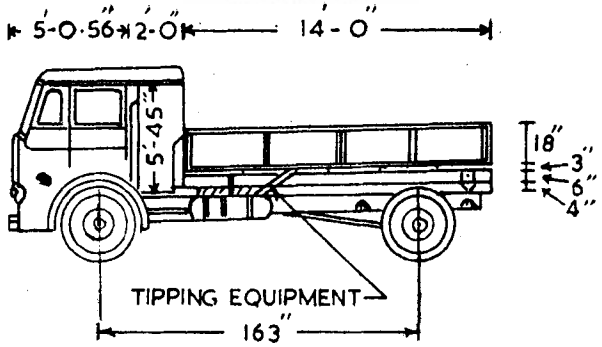
(xiv) Two wooden rest boards of full length of the vehicle behind cabins shall be provided on both sides of the tank, with proper locking device for putting the hose pipes. The wooden board shall be of 35 mm thick × 30 cms. good quality wood.

(xv) Proper railing on both sides of the tank shall be provided for easy grip while standing on wooden platforms for inspection or repair work of the tank, and its accessories.

(xvi) *Painting.*—The outside of the tank shall be painted with suitable synthetic enamel paint with two coats after following painting procedure. The inside of the tank shall be painted with double coat of anti-corrosive paint of suitable quality. The chassis and under carriage parts shall be painted with two coats of anti-corrosive black paint of appropriate quality.

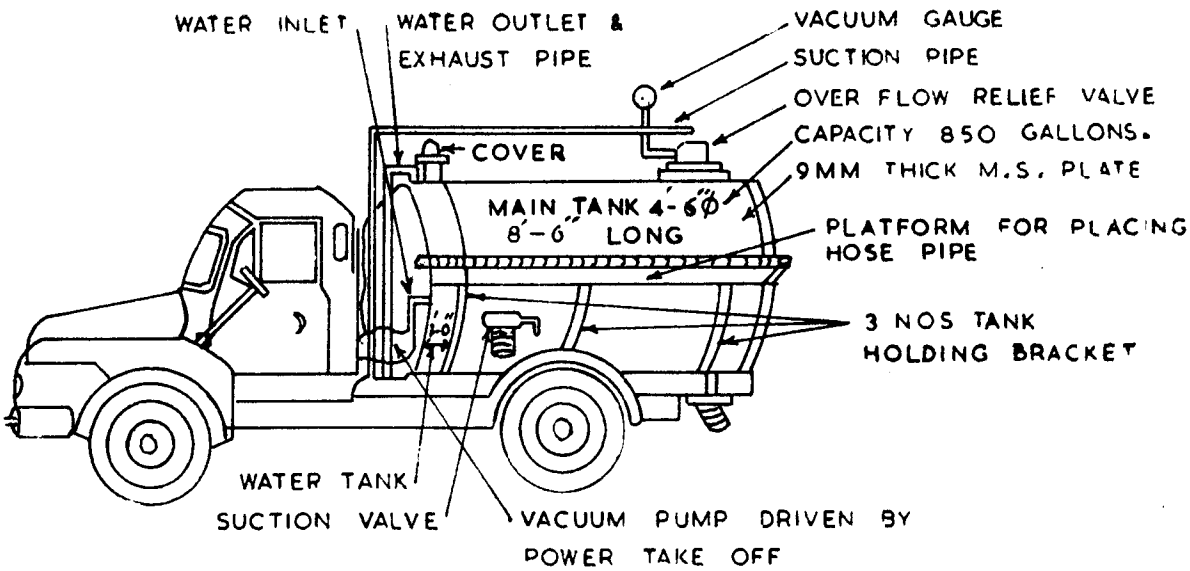


CONVENTIONAL CONTROL

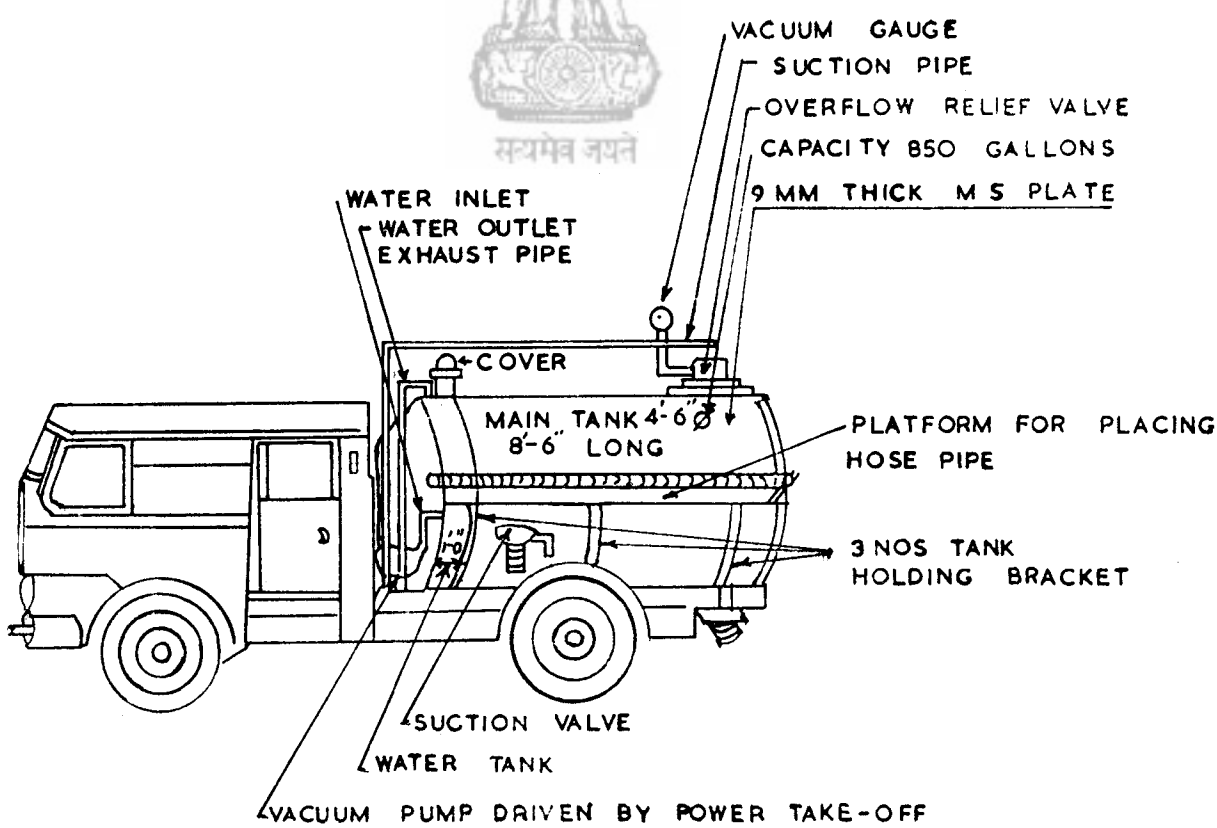


FULL FORWARD CONTROL

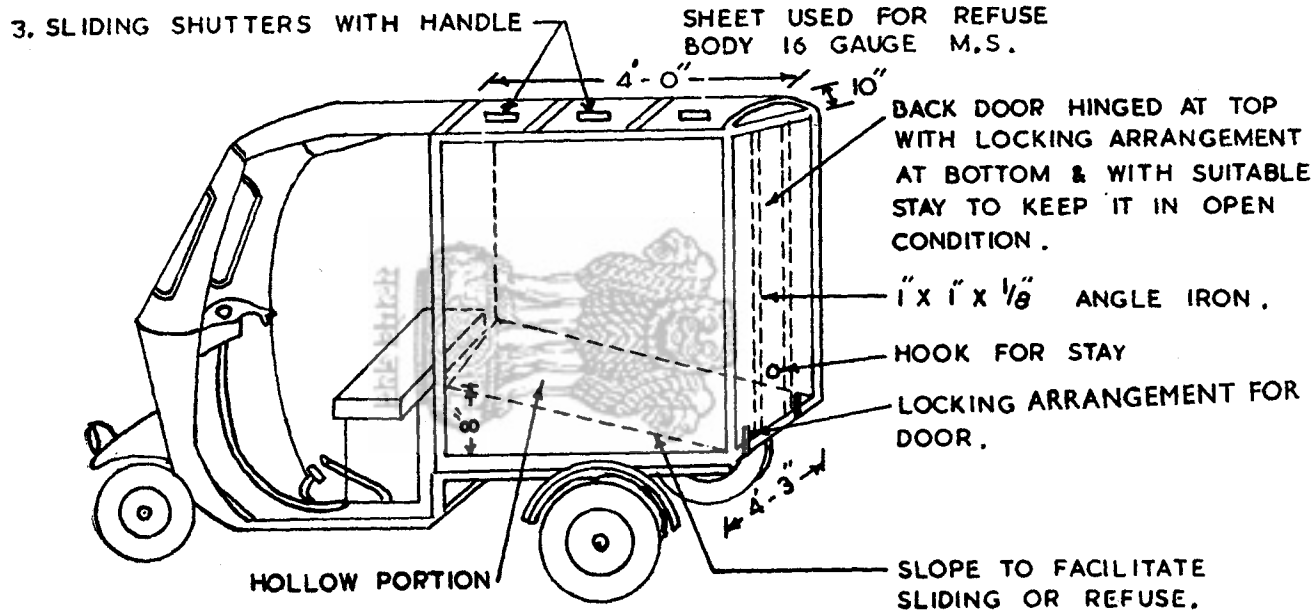
16—1082 W&H/75



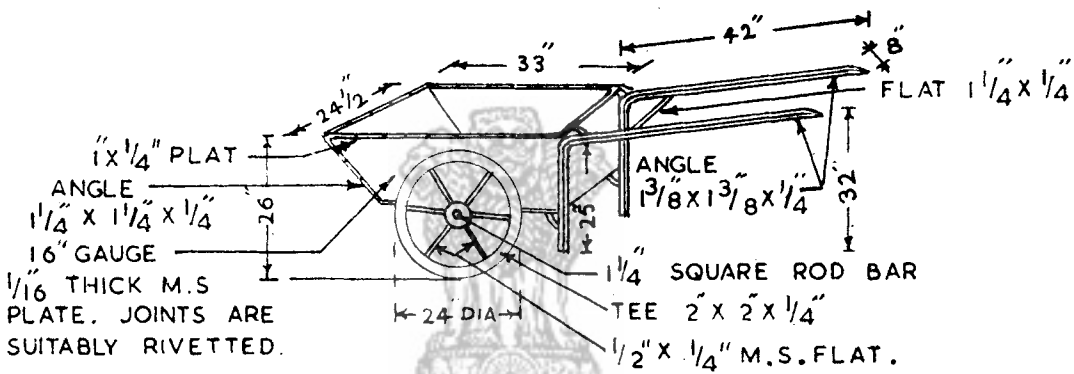
CONVENTIONAL CONTROL



FULL FORWARD CONTROL



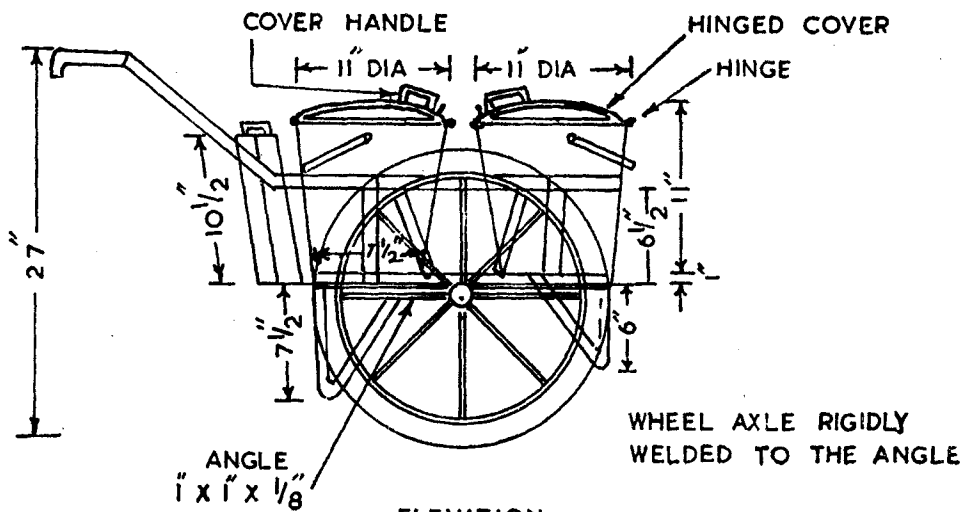
AUTO RICKSHAW



NOTES:— DESIGN BASED ON WHEEL BARROW USED IN AHMEDABAD MUNICIPAL CORPORATION.

HAND WHEEL BARROW

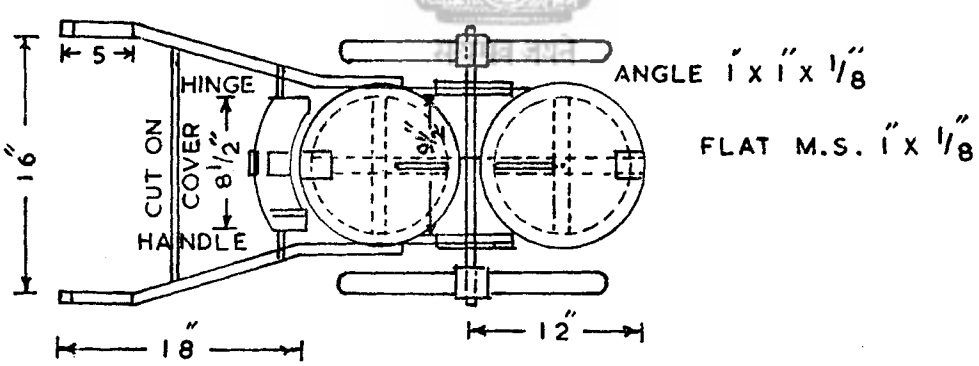
ANNEXURE 19



ELEVATION

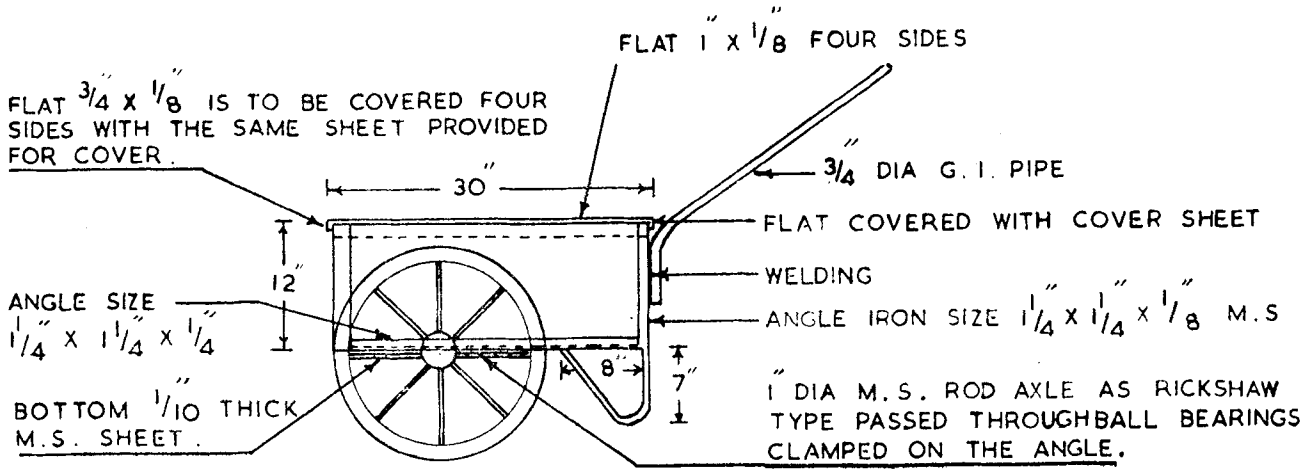
3/4" DIA 16 GAUGE SEAMLESS CONDUIT PIPE

20 DIA WHEEL INCLUDING SOLID TYRES.

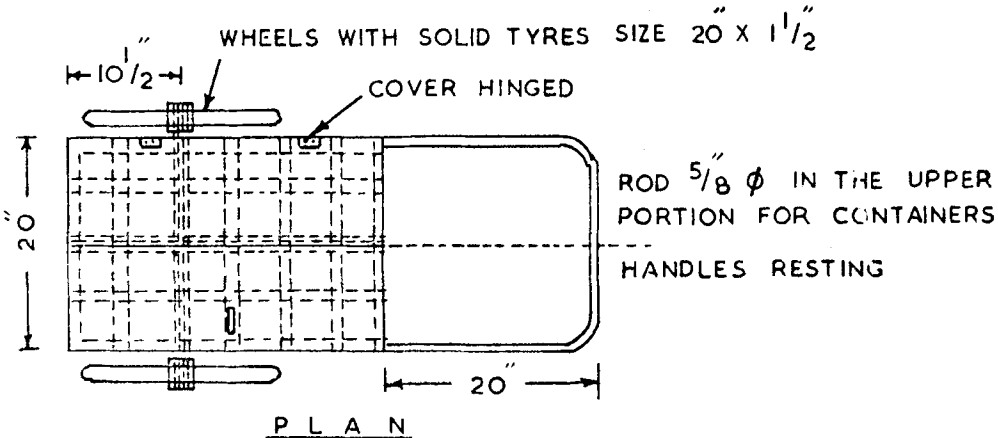


PLAN

WHEEL BARROW CAPACITY 5 GALLONS



FRONT VIEW



P L A N

WHEEL BARROW CLOSED TYPE
CAPACITY 17 GALLONS

CALCULATIONS FOR MULTIPLE UNITS FOR POPULATION UPTO 9 LAKHS

In case of population of more than 3 lakhs and multiples of this viz., 6 lakhs, 9 lakhs etc. the following are the recommendations :

(*i*) Mechanical/Public Health Engineer's post may be suitably upgraded.

(*ii*) Sanitation staff viz. Chief Sanitary Inspector, Sanitary Inspector, Transport Inspector, Assistant Sanitary Inspector, Sweepers, Scavengers, Drain cleaners, Dump site Mazdoors, Transport Mazdoors, Bhistis, Drivers etc. are to be proportionally increased viz. for 6 lakhs population increase number by 2 times and for 9 lakhs population increase by 3 times.

(*iii*) Similarly the trucks, tractors, trailers, scooter vans, wheel barrows etc. are to be increased in the direct proportion of the population.

(*iv*) As regards workshop staff, the staff-vehicle ratio comes to 4·3 in case of 3 lakhs population. This includes all helpers, ancillary tradesmen, skilled/semi-skilled workers and supervisory staff. For multiples viz. 6 lakhs, 9 lakhs etc. the increase can be made at the ratio of 2·2 (Staff-vehicle ratio) in which increase of skilled/semi-skilled worker can be given more importance. Substantial increase in all the ancillary tradesmen and other cadres of helpers are not needed. Only a slight increase in this will be sufficient.

(*v*) For 3 lakhs population the total requirement of tools and machineries was worked out to be Rs. 1,27,350·00 (approx.). These equipments will be sufficient up to 9 lakhs population with only increase of 10 per cent for each multiple of 3 lakhs population, for the hand tools and some special maintenance tools.

APPENDIX X
(*Para* 4.10)

RECYCLING OF URBAN WASTES*

(*Reference* : World Science News, Vol. X, No. 1, January 1973, pp. 40—44, by O. P. Vimal, IARI, New Delhi)

The disposal and utilization of urban wastes is an important national problem. Today, the whole environment is being polluted by the accumulation of liquid and solid wastes due to increasing population, urbanisation and industrialisation. An effective solution to the problems of storage, collection, treatment, conversion, re-use and disposal of city wastes involves not only complex and challenging technical questions but also difficulties of a political, financial and legal nature, and problems of public administration and coordination. Failure to deal effectively with the never-ending flow of these wastes constitutes an alarming threat to public health and contributes to air, water and soil pollution as well as to the propagation of flies, rodents and other vectors of diseases. But there is an important relationship between sanitation and agriculture in all parts of the world. This fact emphasises the need for recycling of urban wastes so as to provide an inexhaustible store for the maintenance of soil fertility.

Health Aspects

Insanitary disposal and utilization of wastes results in high incidence of illness and death from faecal borne diseases. The faecal-borne bacterial diseases are bacillary dysentery, typhoid fever, enteritis and cholera. The faecal-borne protozoan diseases are amoebic dysentery, balantidial and flagellate diarrhoea. The faecal-borne helminth diseases are bilearziasis, fasciolíasis, oxyuriasis, trichuriasis and paragonomiasis. From experiments it is evident that adequate composting of faecal and other wastes can control these diseases which are so wide-spread in faeces used as manure without the practice of sanitary measures.

Agricultural Aspects

Humus from night soil, garbage, sewage sludge and slaughter-house wastes contains nitrogen, phosphorus, potash and trace-elements which are vital to the continuing fertility of the soil and optimum plant growth. Moreover the organic colloids formed during the metabolic breakdown of organic materials increase the availability of nutrients due to 'chelation' effect. A good supply of humus maintains the physical and biological conditions in the soils. Humus is especially important in heavy clay soils, in loose sandy soils, in saline and alkaline soils and in poorly aggregated soils.

A. Utilization of Solid Wastes

Solid wastes include domestic refuse and other discarded materials such as those from commercial, industrial and agricultural operations. Domestic refuse includes paper, cardboard, metal, glass, food matter, ashes, plastics, wood and other discarded materials. Commercial refuse includes the waste discarded by markets, shops, restaurants, offices and similar businesses. Industrial refuse comprises a wide variety of wastes ranging from completely inert materials such as calcium carbonate to highly toxic and explosive compounds. The natural growth and diversity of industry have resulted in substantial increases not only in the volume of industrial wastes but also in their complexity. Agricultural wastes arise from the production and processing of food and other crops and slaughtering of livestock. General community wastes include demolition and construction debris, street refuse and discarded motor vehicles. Special care is required for potentially dangerous wastes such as those from hospitals, international ports and airports and firms using radioactive materials.

I. Disposal Systems

There are three generally accepted methods of treatment and disposal of solid wastes : composting, incineration and sanitary land-filling.

(i) *Composting.*—Composting is the aerobic thermophilic decomposition of organic solid wastes to produce a relatively stable humus like material. The principal by-products are carbon dioxide, water and heat, none of which is objectionable. The end product, compost, is a good soil builder or conditioner containing small amounts of the major plant nutrients (1.5—2.0% N, 0.5—1.0% P_2O_5 and 0.5—1.0% K_2O on dry weight basis). The temperature produce during aerobic composting and curing— 140°F (60°C) or higher, over a period of several days destroy eggs and larvae of flies, weed seeds and pathogenic agents.

Modern composting, first suggested by Sir Albert Howard and his associates from studies in India and carried forward there by Acharya and Subrahmanyan has been investigated extensively by Scott and Van Vuren, by Cottas and his associates McGauhey, Golueke and Card at the University of California and by many others in different parts of the world.

*Appendix IV to Sectoral Status Report of Planning Group on Community Wastes of the National Committee on Science and Technology, Department of Science and Technology.

These days disposal of urban wastes in big cities by conventional composting methods is posing a serious problem due to increasing costs, unavailability of land for compost making, labour requirement for composting operations which involve human contact with filthy and obnoxious materials, marketing of compost, etc. These problems result in the utilisation of this valuable waste in an uneconomic and unhygienic manner. Under these conditions mechanised composting is the only alternative in big cities because it can be located at a central location and in small compact areas, thus avoiding long haulage and constant search for new lands. Moreover, the other advantages accruing from mechanised composting are : sanitary control with odourproof devices, working in both dry and wet seasons, recovery of discarded materials like metal, glass etc. and high grade compost quality in a very short time.

The principal operating processes of the modern, mechanised and automated plants are as follows:

1. Presorting to remove bulky materials unsuitable for composting or salvaging; 2. shredding the coarser components; 3. removing glass and metal fragments; 4. composting the organic material at accelerated rates in fully enclosed chambers for 1—3 days (including partial recirculation for seeding purposes) under controlled aerobic, moisture and temperature conditions; 5. completing the maturation in windrows for a further period of 3—10 weeks to produce a stable, odour-free end-product; and 6 the addition of chemical fertilisers as required, either during or at the end of the process, to obtain the required fertilizer characteristics.

(ii) *Incineration.*—In USA and European countries, the city refuse is burnt under controlled, nuisance free conditions at relatively high temperatures in order to reduce it to an inert, organic free residue which can be readily disposed of in a land-fill. But as environmental standards rise, this equipment is becoming more complex and expensive to purchase and operate.

(iii) *Sanitary land-fill.*—This is an acceptable method in suitable locations if the possibility of pollution of surface and ground water is eliminated. Under certain circumstances, land can be reclaimed for valuable urban uses by means of land-fill.

II. Economic utilization of Solid Wastes

There can be many possibilities of utilizing solid wastes for the production of economically useful products, some of which are mentioned below. Intensive and integrated research programmes on these aspects can make the utilization of wastes as a highly paying proposition.

(i) *Production of ethyl alcohol.*—Under the direction of Dr. A. Porteous, a research project has been started at the University of Glasgow, Scotland, with the object of producing ethyl alcohol from refuse with a high paper content.

(ii) *Animal feeding.*—It is reported that experimental work is being done on the conversion of waste paper into cattle food by subjecting cellulose waste to the action of aerobic bacterial and certain enzymes obtained from food-destroying fungi. If these experiments are successful it is hoped that the cellulose will be converted to protein.

(iii) *Converting organic wastes to fuel oil.*—This process consists of treating all types of cellulosic wastes with water gas at a temperature of 35—400°C and pressure, 4000 pisg in the presence of various solvents and catalysts. Oil yields of over 30% have been obtained with a continuous reactor.

B. Utilization of Waste Water

Increasingly rapid urbanisation and industrialization is causing an alarming rise in the pollution of water, resulting in major public health hazards. Drinking water sources are often threatened by increasing concentration of pathogenic organisms as well as by many of the new toxic chemicals disposed of by industry and agriculture. Other industrial wastes may cause aesthetic nuisance, as is the case with dyes, malodorous substances and detergents.

Health factors in the reuse of waste for agricultural, industrial and municipal purposes

1. *Microbiological Problems.*—The effluent from treatment processes must meet the normal bacteriological standards. Several studies have indicated that the number of coliform organisms is often an adequate index for evaluating the viral content of drinking water. However, recent studies at the Hebrew University, Jerusalem, have shown that poliovirus, under special circumstances, is resistant to the heavy doses of chlorine that effectively reduce the number of coliform organisms.

2. *Chemical Problems.*—The waste water flowing in municipal sewers contains high amounts of various organic and inorganic chemicals derived from domestic and industrial uses. Increased quantities of nitrates and dissolved solids can present health problems. Insecticides and herbicides are appearing in waste water as a result of their wide-spread use in agriculture. Moreover, advanced reclamation plants in which absorption on carbon is included, can achieve almost complete removal of most organic pollutants as well as 97% removal of total phosphates and 75% of total nitrogen. However, removal of dissolved nutrients and trace chemicals, still presents a problem.

3. *Aesthetic Problems.*—In addition to the microbiological and chemical problems involved in reusing waste water, aesthetic factors such as taste, colour and appearance of the reclaimed water must be satisfactory.

There are many possibilities of using waste water under special circumstances. There is no clearcut epidermiological evidence to indicate that the carefully regulated use of waste water to irrigated crops, not used for human consumption or crops consumed after cooking and processing, has ever led to any outbreak of diseases. Irrigation practices play an important role

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in the utilisation of waste water in agriculture. Surface, irrigation techniques applied to fruit trees can produce uncontaminated fruit presenting no public health risk. However, if spray irrigation is used, there is a definite possibility of contaminating the fruit. Similarly, certain vegetable crops might be successfully irrigated by the ridge and furrow technique, in such a way as to avoid any direct contact between the sewage and the crop. Little work has been done on the evaluation of health risks to agricultural workers exposed to the spray from irrigation but it is a problem that deserves consideration.

Reuse of treated water in industrial food processing plants must satisfy a bacteriological quality approaching that of drinking water. One of the most effective and economical way of using waste water in industry is the intra-plant re-use of treated and recycled industrial affluents. Public health problems in recycling these wastes are far less severe than those resulting from the use of municipal sewage; nevertheless care must be taken to prevent possible cross-connections and the contamination of potable water used in the same plants.

Treated waste water may be used for restricted municipal purposes such as fire-fighting, irrigation of parks and homes and for the purpose of flushing toilet. The Advanced Waste Treatment Programme of the Taft Sanitary Engineering Centre in the USA has developed plants which include conventional, primary and secondary treatment, coagulation, sedimentation and rapid sand filtration, carbon absorption, electro dialysis and chlorination. A project for treatment and underground recharge of the waste water of the Tel-Aviv region in Israel for ultimate unrestricted utilization is also being developed.

Administration and Management Problems in the Utilization of Urban Wastes

The management of wastes and control of pollution is a complex problem which requires a new field of 'Operation Research of System Analysis'. The key elements of this approach include : 1. Systematic evaluation of the importance and inter-relationship of all relevant aspects of the problem such as social, political, cultural, technical economic and ecological factors; 2. The comprehensive assessment of the possibilities of conversion, recycling and reuse of waste substances including interchanges affecting the economic feasibility of various alternatives and reduction of the amounts of waste to be finally disposed into land, air and water; 3. The analysis of wholly new approaches involving major innovations, such as on-site processing of wastes and the provision of facilities for 'model cities'; and 4. Analysis of benefits and costs, on the basis of which policies can be determined and decisions made.

The system analysis indicates that a sound solution to the problem must take into account the realities of current political life and processes of modern urban and economic planning. Amalgamation of small administrative units into adequately sized operational units requires political and economic sagacity of high order.

Another important aspect in the management of urban wastes is lack of professionally trained personnel. Throughout the world only a few schools offer courses for the training of engineers and managers in this field. This situation has resulted in the lack of scientific interest in carrying out necessary research work.

Collection and dissemination of information between countries is highly essential to avoid unnecessary duplication of research as well as to assess the well founded criteria suitable for local conditions of geography, climate, administration, economic etc. Of equal importance has been a lack of communication between disciplines *e.g.*, waste water management can profit from developments in the chemical and biological industries. Information retrieval systems must be established, both nationally and internationally if full use is to be made of research accomplishments with any unconsciously long lag.

Research Needs

Research into the physical, chemical and biological problems involved in collection, treatment and disposal of wastes as well as studies on the administrative and socio-economic problems have been indeed minuscule in relation to the public and private investment in waste water management. Among the many sided aspects requiring investigation particularly collection of basic data, technology, installations, administrative and management problems, the following are of greatest importance :

1. Comparative research on construction, operation and costs of waste management plants;
2. Better indicators for the presence of pathogenic bacteria and viruses in water;
3. Advanced processes for waste water treatment so as to improve the quality of affluents;
4. The use of wastes and residues and of waste heat, for agricultural, horticultural and other purposes;
5. Studies on the optimum size of plants and of their component units;
6. Methods for making the disposal of wastes amenable to systems analysis, such research should cover the costs and benefits of so-called intangibles such as health, recreation, aesthetics, nuisance and convenience;
7. The kinds of administrative and political institutions necessary to promote the efficient management of wastes particularly on a regional basis;
8. Economic methods of improving the management of wastes including affluent, charges, taxes and financial incentives;
9. Administrative, legal and educational aspects of management including the control of public and private despiling of the environment by littering.

Scope and Limitations in the Utilization of Urban Wastes in India

For centuries, Indian farmers have been using domestic wastes as a source of manure on their lands; Pioneering efforts in this field were carried out by Dr. Howard (Indore Method) and Dr. Fowler (Bangalore Method or Hot Fermentation Process). The latter method was suitably adopted by Dr. E. N. Acharya for utilizing the town refuse and night soil in all the big cities. Keeping in view the importance of composting in providing sanitary surroundings as well as useful manure for the soil, the Ministry of Food and Agriculture in 1945 made it obligatory for all the Municipal Committees to subject their refuse to composting within their jurisdiction. At present the total number of working centres doing compost preparation work under the Urban Compost Scheme is over 3100 and the quantity of compost prepared is anticipated to be 4.5 million tons by 1971-72 which is targetted to be raised to 6.5 million tons by the end of the Fourth Five Year Plan.

The Urban population of the country (as per 1971 census) is 10.8 crores. The compost that could be produced from the wastes of this population is 10.8 million tons per year. The gap between present compost production and potential indicates that there is an enormous scope for increasing production in the country. But the principal difficulties in the intensification of compost work in India are : inadequate arrangements for removal of city wastes; apathy or lack of interest on the part of Municipalities due to inertia or inability to meet the non-recurring and recurring expenditure on account of their poor financial position, and delay in the acquisition of land for composting purposes. These problems can be solved only by making specific provision for loans under Urban Compost Development Scheme in the pattern of Central Assistance to States, earmarking specific areas in the schemes of town planning, provision of transport facilities to farmers on no profit-no-loss basis and enforcing strict legislation for composting all town refuse.

An improvement in the quality of compost is an important aspect both for increasing its market value and ameliorating the fertility of the soil. This can be ensured only by laying down standards of good quality compost and periodically analysing samples from different compost centres as an effective check. In order to serve as an incentive for preparing the maximum quantity of compost of good quality Government of India launched a scheme for the award of an All India Prize to a local body doing the best compost work in 1964-65. During the last four years, the Municipalities of Madurai (Tamil Nadu) Nellore (Andhra Pradesh), Dhulia (Maharashtra) and Burhanpur (Madhya Pradesh) won the All-India prizes. It is highly desirable that all State Governments should foster a spirit of healthy competition amongst bodies.

Utilization of Sewage Sullage and Sludge

In India, nearly 100 cities and towns have complete or partial sewage system. There are nearly 700 towns which have open drains. The total quantity of sewage sullage available in the above cities and towns is estimated at about 800 gallons per day which can irrigate an area of 15,000 hectares.

The benefits derived by crops from sewage irrigation are due to the additional supplies of water as well as plant nutrients and organic matter. Taking an average of 25 ppm N, 9 ppm P_2O_5 and 15 ppm K_2O, the total manurial constituents of 800 gallons of sewage per day would be about 90 tons N, 18 tons P_2O_5, 55 tons K_2O and 1380 tons organic matter. The total manurial value of these wastes works out to be Rs. 6.10 crores annually. Unfortunately in India sewage water is disposed of either by broad irrigation on the land with or without treatment or discharge into the nearest stream or river. This practice not only causes pollution of water with subsequent danger to the health of the people and animals downstream, but also deprives the soil of valuable manure.

Sewage irrigation has a great potential for increasing agricultural production especially of short duration crops, vegetables and fodders in the vicinity of urban areas. It may also be used for industrial crops like sugarcane, tobacco and cotton which undergo drastic treatment before use. Crops such as papaya and plaintain which grow well above the ground level may also be grown through sewage. Root vegetables like potatoes and leaf vegetable like spinach and cabbage which grow near the ground level should not be grown under sewage irrigation. It is a good practice to dilute sewage with well or stream water. The beneficial effect of dilution is due largely to the dissolved oxygen in the diluent which influences development of aerobic organisms and the attendant oxidation changes.

Sludge.—Treatment of sewage results in the production of sludge which is a valuable manure. It is estimated that more than 2 lakh tons of sludge could be available per year by treatment of all the available sewage. Taking the composition of sludge as 3.0% N, 2.0% P_2O_5 and 0.5% K_2O, the above quantity would contain more than 6,000 tons of N, 4,000 tons of P_2O_5 and 1000 tons of K_2O. In sewered cities where little nightsoil is available for composting with refuse, sludge should be used for this purpose. A common site for sewage utilisation plant and for disposal of refuse would be advantageous.

The main difficulties in sewage utilization schemes are : delay in the acquisition of land for sewage farms and lack of funds under drainage schemes. Another major problem faced in sewage farming is that the crops require water and manure at stated intervals only while the stream of sewage flows continuously. Therefore, if the area of land under sewage farms is not adequate, the sewage is allowed to go waste with consequent economic loss, nuisance and danger to health of the people.

Utilization of sewage water is an important national problem which calls for thorough investigation from

technical, economic and administrative aspects. Specific allocation of funds and farm land should be earmarked for this purpose. The management of sewage farms should be directed by an officer of the Department of Agriculture because such items as proper irrigation, rotation of crops, systematic resting and limining of lands are important agricultural problems which require expert knowledge.

From this brief account of the importance and problems in the utilization of urban wastes, it is evident that only proper recycling methods can ensure healthy living environments as well as an inexhaustible wealth for the impoverished soil. Realizing the gravity and significance of this problem, the Government of India has set up a Committee on Urban Wastes under the Chairmanship of Shri B. Sivaraman, Vice-Chairman, National Commission on Agriculture, to study the present and future planning for the disposal and utilization of such wastes. It is hoped that with the active leadership of World Health Organisation a co-ordinated approach may emerge so as to encompass all the multi-sided facets of this problem.

APPENDIX XI
(*Para* 5.16)

ANNUAL PRODUCTION ETC. OF COMPOST

CLASS I—LOCAL BODIES

Name of the Local Body	Total Production per annum (Tonnes)	Production cost per tonne (Rs.)	Sale price per tonne (Rs.)	Method of sale
1	2	3	4	5
1. Rajahmundry	2,000	10·00	3·00	By weight
2. Kurnool	3,500	11·00	11·00	By auction
3. Nellore	7,500	13·00	13·65	By auction
4. Nizamabad	1,410	11·50	4·16	By auction
5. Machilipatnam	4,000	0·50	0·50	By weight
6. Tenali	2,500	4·39	7·37	By auction
7. Bhagalpur	900	3·50	10·00	By weight
8. Srinagar	600	40·00	35·00	By weight
9. Jammu	4,800	5·00	2·50	By weight
10. Cochin	1,250	40·00	6·00	By weight
11. Trivandrum	5,000	30·00	10·00	By weight
12. Calicut	3,000	13·39	5·00	By weight
13. Alleppey	134	37·00	3·00	By weight
14. Jabalpur	4,000	15·00	8·33	By weight
15. Sagar	4,966	4·45	13·20	By auction
16. Ratlam	4,460	7·25	7·00	By weight
17. Burhampur	5,600	15·00	26·35	By auction
18. Sholapur	34,000	11·00	8·33	By weight
19. Amravati	5,106	4·00	4·00	By auction
20. Malegaon	10,000	20·00	25·00	By auction
21. Nasik	9,000	4·84	11·77	By auction
22. Dhulia	12,000	9·00	5·50	By auction
23. Sangli	5,500	12·72	20·00	By weight
24. Bangalore	1,260	16·00	9·00	By auction
25. Mangalore	1,000	10·00	5·00	By weight
26. Belgaum	11,283	13·30	15·38	By auction
27. Bijapur	10,000	2·50	10·00	By auction & By weight
28. Cuttack	6,000	30·50	4·00	By weight
29. Berhampur	3,352	3·00	4·00	By weight
30. Patiala	900	3·50	4·00	By auction
31. Ajmer	3,750	6·00	4·50	By weight
32. Udaipur	4,000	30·00	7·00	By weight
33. Madurai	50,000	4·67	3·00	By auction
34. Salem	14,402·20	4·34	4·34	By weight

1	2	3	4	5
35. Tiruchirapalli	27,000	9·46	3·60	By weight
36. Tuticorin	7,000	6·00	6·00	By weight
37. Kumbakonam	4,950	10.50	3·00	By weight
38. Cuddalore	9,000	2·90	2·90	By weight
39. Aligarh	164	9·00	9·00	By weight
40. Saharanpur	4,000	2. 75	5·00	By weight
41. Shahjahanpur	368	5·00	5·00	By weight & By auction
	CLASS II—LOCAL BODIES			
1. Cuddapah	3,000	18·00	16·00	By weight
2. Guntakal	650	25·00	12·50	By auction
3. Trichur	1,000	4·00	5·00	By auction
4. Gondia	1,100	20·00	11·50	By weight
5. Chandrapur	1,500	7·00	5·00	By weight
6. Raichur	2,000	20·00	3·96	By auction
7. Ganganagar	2,445·5	27·00	34·00	By auction
8. Pollachi	8,480	9·74	3·00	By weight
9. Karur	2,500	3·69	4·00	By weight
10. Ootacamund	5,500	5·00	5·25	By weight
11. Virudhunagar	2,500	5·00	3·56	By weight
12. Srirangam	5,500	7·70	4·00	By weight
13. Bulandshahr	4,513	1·54	5·40	By weight & By auction
14. Pondicherry	708	4·00	5·00	By weight

APPENDIX XII
(*Para* 6.03)

EXTRACTS FROM THE REPORT OF THE NIDC ON MECHANICAL COMPOSTING

Description and General Discussion on Mechanical Composting

In mechanical composting process the aim is to provide congenial conditions of aeration, moisture and temperature for the bacteria, moulds, fungi and other forms of life to flourish and perform their task in the stabilization and decomposition of the wastes at a rapid pace.

The organisms work on the surface of the organic wastes. Therefore, the speed, thoroughness, and uniformity of decomposition are improved if the material is first broken into fragments or ground to increase the surface area exposed to the biological activity. The range of sizes up to 2" (5 cms) of the material is such that aeration is maintained throughout the mass of the wastes.

Mechanical composting of municipal solid wastes consists of the following steps :

1. Reception
2. Segregation
3. Compost Preparation
4. Decomposition and stabilization
5. Market preparation.

These are basic steps which are common in almost all processes except that in some they are combined or in other they are slightly modified.

Quantity and Characteristics of Refuse

The quantity and characteristics of solid wastes vary from place to place and it cannot be said that they would consistently remain same. The quantity depends upon method practised by the collection agency, habits of the people, effluence or poverty in the area and such other factors. It is observed from the surveys conducted by CPHERI, Nagpur that per capita refuse produced in larger cities (*e.g.*, Calcutta, Bombay) is approximately 0.5 kg/day and for medium size cities such as Poona, Nagpur etc. it is approximately 0.3 kg/day; out of this, compostable constituents are of the order of 45—50%.

The characteristics of wastes vary in different parts of the country and also vary from season to season. CPHERI has done a lot of work in defining the problem of solid wastes in various cities and about analysis of characteristics of wastes. This information will be very useful while considering the compost plants for individual cities.

Available Process Alternatives

During the past, forty years since "Indore" and "Bangalore" process were developed, many other processes of composting have come into existence. In Western countries, several processes have been developed to speed-up the reaction and to carry out the operations in hygienic manner. There the main problem is disposal of municipal solid wastes rather than production of compost for agricultural needs. Although the processes available are many, they are all based on similar principles. Their primary aim is to reduce the volume of solid wastes to be ultimately disposed. As far as production of compost is concerned, there are two methods which are most common. In one case, the final stabilization or decomposition takes place in open windrows while in the other it takes place in vertical or horizontal cylinder or silo-type digesters in which the refuse is mechanically aerated.

At the present time, there are basically four processes of mechanical composting available in India. All these processes are based on processes developed in European countries and manufacturers have foreign collaboration. Except for one, Nusoil Process, the other three processes are such that the equipment can be manufactured in India and only the process know-how has to be imported.

A brief description of the above four processes and their salient features are given in the following paragraphs :

Buhler Process

Buhler Brothers Company, a factory in Uzwil, Switzerland were associated with the garbage disposal problems since 1922. Recognizing the need for a thorough reduction of the refuse they developed a mechanical composting process based on two stage grinding. In India, this process is marketed by Messrs Larsen & Toubro Limited, Bombay.

Primary and secondary crushing of the refuse for coarse reduction of the heterogeneous mass is provided in specially designed Buhler hammer mills. Non-compostable inorganic materials are separated from the compostable material by strong sifting action on circular swinging sieves. Aerobic fermentation of the pulverised refuse is then provided in open windrows. Complete stabilization of organic matter in windrows may take about two to three months. Fermented refuse is then transferred with the help of dumpers to final fermentation stockyard.

Dano Process

The rotating drum system was developed in Denmark by the Dano Works of Copenhagen. This type of plants were built for the hygienic disposal of city refuse since 1933. Initially, the refuse was treated in a rotating silo, where it was thoroughly mixed and homogenised and then fermented in stock piles for three to six months. In India, the Dano Process is marketed by Buckau Wolf- New India Engineering Works, Poona.

In Dano Process fermentation of refuse is provided in a long rotating drum called a bio-stabilizer unit. It is kept in an inclined position so that the waste flows from one end to other. Special arrangements for cutting rags etc. and addition of air and water are provided inside the drum so that partial fermentation of refuse takes place under optimum conditions in about 2 to 3 days. The refuse coming out of the bio-stabilizer unit is generally free from odour and pathogenic organisms. Complete fermentation of the refuse is provided in windrows, however, turning over of the material is not required. Complete decomposition of the organic matter may take about four weeks. Fermented material in the windrows is pulverised in a hammer mill and then passed through screens to separate and reject material.

Tollemache Process

Tollemache Process was developed in early sixties in the United Kingdom and a number of plants based on this process have been built since 1965. Tollemache plants are marketed in India by Messrs Tractel-Tirfor India Private Limited, Calcutta.

Fine pulverisation of the refuse is provided in a specially designed vertical pulveriser in which the hammers rotate horizontally. The refuse material enters from the top of the machine and is ground throughout its length. The pulveriser has a rejection section where heavy metal objects and other reducible items are rejected ballistically out of the pulveriser via a reject chute. Water is added to the refuse prior to pulverisation. Pulverised refuse is then passed through a screening plant to screen out paper, plastics etc. and to produce particle size suitable for composting. The pulverised-screened refuse is allowed to decompose in the windrows for three weeks with three to four turnings. Then it is transferred to stockyard where maturing of compost takes another four to five weeks. Thus complete stabilization of refuse results in about two months using Tollemache Process.

Nusoil Process

This process is a very recent innovation and was developed in the United Kingdom. It is marketed in India by Wisdom Traders of Bangalore. In Nusoil Process, initially pulverisation of refuse is provided in a hammer mill after segregation of non-compostable items. The pulverised refuse is then fermented in vertical digesters. The digester is a circular unit which is divided into seven sections; each provided with stirring mechanism. Water spray system is provided in the ceiling of each compartment and air is introduced through hollow stirrer areas. A special control system is provided to regulate air flow and water addition so that fermentation may take place under optimum conditions. Pulverised refuse moves downward through each section of the digester and is kept in each section for about one day. The digestion process is completed in seven days and it is claimed by the process developers that the resultant compost will be satisfactory for direct application to the fields. At present, there are no full scale plants utilizing this process.

Comparison of various Processes

In addition to the above four processes, there may be a few more. M/s. Dorr Oliver (India) Limited were representing one of the processes where the refuse is pulverised by rasping action in a machine and the pulverised waste is then allowed to decompose in windrows. Other process is distributed by Schuechtermann and Kremmer-Baum, Calcutta, a subsidiary of a German Group of Companies. This process depends upon coarse and fine reduction machines, conveyors and vibrating screens. Finally pulverised refuse is then incinerated in a furnace because there may not be a good market for compost in Germany. In India, the pulverised wastes can be further stabilised in windrows. This Company does not have all the working arrangement in India so that first few plants may have to be imported from Germany *involving* foreign exchange difficulty.

These two processes are not described in detail because of very limited information being available. M/s. Dorr Oliver India Ltd. had indicated that for some time the Company had stopped promoting composting plants as it could not find a good market for such plants in India. However, these processes are akin to Buhler or Tollemache Process with the added benefit that some of their drawbacks have been removed in these two processes which are studied in depth hereinafter. Therefore further discussion of the processes in particulars is not considered necessary. Thus the various process alternatives deserving consideration resolve into few main processes as follows :

(i) Buhler Process
(ii) Dano Process
(iii) Tollemache Process
(iv) Nusoil Process.

For proper evaluation and appraisal of these four processes with regard to their suitability or otherwise in Indian conditions, fifteen basic parameters exposing the merits and demerits of the processes have been selected and a comparative statement of the above mentioned four processes has been given in the table annexed.

ANNEXURE

MECHANICAL COMPOSTING PROCESSES

COMPARATIVE STATEMENT (Based on data submitted by the plant Supplier for 125—150 tonnes/day capacity plant)

S.No.	Item	Buhler Process	Dano Process	Tollemache Process	Nusoil Process
1.	*CAPITAL COSTS*—Total	Rs. 47,97,000	Rs. 41,80,000	Rs. 36,58,789	Rs. 126,94,903
	Per tonne/year	Rs. 127·50	Rs. 112·00	Rs. 98·00	Rs. 338·00
	(A) Machinery & Equipment	—	Rs. 33,20,000	Rs. 29,27,040 (80%)	Rs. 107,00,000
	(B) Civil Works	—	Rs. 8,60,000	Rs. 7,31,760 (20%)	Rs. 15,00,000*
	(C) Extra C.I.F to A'bad	—	—	—	Rs. 4,94,903
2.	ANNUAL OPERATING COSTS PER TONNE OF REFUSE HANDLED	Rs. 18·50	Rs. 16·50	Rs. 16·00	Rs. 33·00
3.	EASE OF OPERATION	Relatively Simple	Special care in operation required.	Simple to operate & fewer operations are involved. Separation of heavy particles done in the hammer mill & final pulverisation is not required.	Digester operation complicated. Proper supervision of process is required.
4.	Possibility of breakdown	Frequent because of design of the hammer mill and as hammers need periodic welding or replacement.	Less as the number of moving parts in small and breakdown of rotating drum is very rare. However, when there is any trouble with the Bio-stabilizer unit it would take more time to repair.	Minimum as compared to other processes because of rugged construction. Hammers will have to be periodically welded or replaced.	Periodic maintenance of water spray and air piping system and stirrer arm-mechanisms would be required.
5.	Out-put to in-put ratio	0.5 to 0.6	0.45 to 0.54	0.6 to 0.8	0.60
6.	Quality of Final Product (Compost) C/N value attained.	∠20	∠20	∠15 after maturing in final stockyard.	∠20 (It is doubtful if this value could be consistently attained after only 7 days digestion).
7.	Time required for complete stabilization.	2 to 3 months	One month	Two months	Seven days
8.	Moisture Air and Temp. Control	None. Water has to be added to pulverised refuse.	Good. However, if any blockage of water or air piping occurs then rotation of bio-stabilizer unit has to be stopped.	Fair. Reqd. quantity of water is added prior to pulverisation by finely atomized water spray system. (No provision for air or temp. control)	Excellent. Master control system is provided for air flow and water addition.
9.	Open Fermentation area required	Yes. For initial fermentation in windrows and final in stockyard.	Yes. Only for final fermentation in windrows.	Yes. Same as Buhler Process.	No. Digestion takes place in enclosed digester.

*This would be less if a good portion of the plant is fabricated in India.

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S.No.	Item	Buhler Process	Dano Process	Tollemache Process	Nusoil Process
10.	Land Requirement	17,000m²	10,000m²	8,000m²	6,500m²
11.	Explosion Hazards	Very serious problem when petrol or aerosol cans explode in the hammer mill.	Less chances of explosion as material size is reduced by abrasion action of the rotating drum. However, if explosion takes place, damage would be great.	Problem is not very serious because of the vertical type design of the hammer mill. Also, if explosion occurs, the damage would be less.	Serious problem same as Buhler Process as pulverising is done in a hammer mill.
12.	Pollution and related problems	Proper storm water drainage for windrowing area has to be provided. Odour and fly nuisance condition may be expected.	Proper drainage of windrowing area has to be provided. No fly nuisance or odour problem.	Same comment as Buhler Process. Odour and fly nuisance may be expected.	None. Stabilization takes place in enclosed digesters.
13.	Plant capacity available	200 Tonnes/day	100—300 T/day	120—520 T/day	100—150 Tonnes/day
14.	No. of operating plants in the world	More than 50	More than 160	More than 50	None.
15.	Foreign Exchange involved	None	None. The plant will be manufactured in India. However, the process know-how will have to be imported on payment of royalty.	Yes. Only pulveriser and screens will have to be imported from U.K.	Yes. Entire plant will have to be imported from U.K.

Conclusions

As a result of a study made of the available mechanical composting processes described in this report, it may be concluded that :

1. Basically all mechanical composting processes are similar in the sense that they are designed to provide size reduction and decomposition of organic matter. Decomposition and stabilization of refuse is either provided in open windrows or under enclosed conditions in vertical or horizontal silo digesters.
2. At the present time, there are major mechanical composting processes available in India. They are as under :

   Buhler, Dano, Tollemache and Nusoil.

3. Dano process utilising a bio-stabilizer unit for pre-fermentation and the Tollemache process appear to be more suitable for Indian conditions.
4. The initial capital cost of erecting a 100-150 tonnes per day capacity mechanical composting plant will be approximately Rs. 40–45 lakhs.
5. The processing cost of producing compost will be approximately 40 rupees per tonne.
6. A 100–150 tonnes per day capacity plant would be a good size for standardisation.

APPENDIX XIII
(*Para* 6.03)

COMPOSTING SYSTEMS

Process Name	General Description
"A" COMPOSTING IN WINDROWS	
(*i*) Indore	Specially constructed pits—2′ to 3′ deep material placed in alternate layers of refuse, night-soil, earth, straw, etc. No grinding—original procedure of turning thrice during a period of 6 months-modified subsequently with more turnings reducing detention period.
(*ii*) Bangalore	Trenches—alternate layers of refuse and night-soil—top layer refuse/earth—digested under anaerobic conditions—detention time 4 to 5 months.
(*iii*) Baden-Baden	Sieving, magnetic removal of metals-hand sorting—refuse mixed with digested sewage sludge and piled for 4 to 6 months without turning—air dust system for aeration—compost sieved and ground.
(*iv*) VAM	Manual and magnetic segregation-shreding in rasp—composting in heaps—turning from time to time.
(*v*) Edaphon	Pre-sorting—aimed with night-soil or sludge and piled in open—turning every 3 to 4 weeks till digestion—inoculation with special cultures.
(*vi*) Van Mannen	Un-ground refuse in open piles turned by grab crane for aeration—detention period 120 to 180 days.
NOTE—Windrow composting system also developed with pre-shreding by hammer mills (Tollemache, Buhler) rasps (Dorr-Oliver), etc.	
'B' COMPOSTING IN SPECIAL CELLS	
I. Static—Batch Operation	
(*i*) Beccari	Pre-sorting—initial anaerobic breakdown in sealed tanks followed by aerobic process by means of airvents—detention time 20 to 30 days.
(*ii*) Verdier	Modification of Beccari-RC Cells, provides for aeration—detention period 35 to 40 days.
(*iii*) Hyganic	Modification of Beccari—anaerobic for 7 days and 7 days aerated-inoculation with bacteria—detention period 2 weeks.
(*iv*) Boggiano Pico	5·5 metre towers—air blown from bottom and sucked from top for 10 hours a day—detention time 25 days.
(*v*) Metro Waste	Horizontal open tanks—refuse ground—air blown through perforated bottom on periodic cycle or continuously—special agitator-unloader to mix and unload at completion of detention time of 4 to 6 days—grinding.
(*vi*) Prat	Cells of heavy gauge wiremesh—refuse unsorted to aid aeration—special attention to aeration and air circulation around cells—injection of air after 2 to 3 days to cool and to provide oxygen—detention time 5 days—dust removed later fed back to cell—add well formented matter to new batch-grinding.
(*vii*) Dumfries	Drained brick cells having false raised floor of planking to permit aeration from base-material heaped and moistened by sludge-compost transferred from cell to cell by overhead crab.
II. Intermittent Disturbances—Continuous Operation	
(*i*) Riker	4-storey bins—ground refuse dropped from floor to floor which opens every 5 days—forced aeration—detention time 20 to 30 days.
(*ii*) Jersey	6-deck cell each equipped to dump refuse on to next floor after one day-aeration effected by dropping from floor to floor—detention time 6 days.
(*iii*) Eweson	4 to 5 deck verticle bins—special arm to force composting material through perforations rotates at intervals-forced aeration—detention time 4 to 5 days.
III. Continuous Disturbances—Batch Operation	
Fermascreen	Hexagonal drum with 3 sides of screens—ground refuse—screens sealed for initial composting—aeration occurs when drum is rotated with screens open-detention time 4 days.
IV. Continuous Disturbance—Continuous Operation	
(*a*) *Static Horizontal digesters*	
(*i*) Crane	Cells consisting of 3 horizontal decks-horizontal ribbons screws extending, length of each deck recirculate ground refuse from deck to deck—air from bottom to cells.
(*ii*) Kobe	Similar to Crane process—central shaft to which a number of agitator blades are fitted—raw material stirred slowly—forced aeration detention time 2 days—curing in bin for 2 days.

Process Name	General Description
(*iii*) Fair field Hardy	Circular tank—vertical screws mounted on rotating radial arms keep the material agitated—forced aeration from bottom and through holes in screws—detention time 5 days.
(*b*) *Rotary horizontal digester :*	
(*i*) Dano	Rotating drum slightly inclined to horizontal—no grinding—forced aeration—detention time 1 to 5 days.
(*c*) *Multi-deck digesters :*	
(*i*) Earp-thomas	Vertical silo with 8 decks—ground refuse moved downward from deck to deck by ploughs—air passed upward—uses patented inoculum—detention period 2 to 3 days.
(*ii*) Multi-bacto	Vertical silo with 8 decks magnetic separation-rasper—4 rotating arms on central axis move refuse from deck to deck—forced aeration in each deck—detention time 24 hours.
(*d*) *Moving belts :*	
(*i*) Naturizer :	Steel conveyor belts arranged to pass material from belt to belt—each belt is an insulated cell—air passes upward through digester—detention time 5 days.
(*e*) *Other systems :*	
(*i*) Varro :	Highly sophisticated—step enclosed box separately shredded and pulped refuse conveyed to top of box in stationary layers of compost about 12″ deep are moved along belts by chain driven racks—automatic control of temperature aeration, PH and moisture content.
(*ii*) Caspari (Briquetting)	Ground material compressed into blocks and stacked for 30-40 days—aeration by natural diffusion and air flows through stacks—curring follows—blocks later ground.

APPENDIX XIV
(*Para* 6.30)

REPORT

ON

GUIDELINES FOR MECHANICAL COMPOST PLANTS

FOR

THE COMMITTEE ON URBAN WASTES

(MINISTRY OF WORKS AND HOUSING)

Prepared By :

THE NATIONAL INDUSTRIAL DEVELOPMENT CORPORATION LTD. NEW DELHI


सत्यमेव जयते

INTRODUCTION

The Committee on Urban Wastes formed a Project Formulation Group on Mechanical Composting Plants in connection with the setting up of such plants in the country. In their fifth meeting on 24th and 25th March 1974 this Group decided that a sub-group consisting of the representatives of National Industrial Development Corporation, National Environmental Engineering Research Institute and the Gujarat Agro-Industries Corporation Ltd. will meet to decide on the preparation of guidelines in respect of Mechanical Compost Plants. The sub-group in their meeting on 17th August 1974 decided that the National Industrial Development Corporation Ltd. prepare the guide lines on the following aspects, in consultation with NEERI and GAIC experts.

1. Advice on the machinery available in the market and its suitability or unsuitability under given conditions.
2. General criteria regarding the use or otherwise of any particular item of machinery in the process.
3. The processes where machinery can be replaced by labour together with analysis of the economics of such switch over and its practicability.

General Criteria

Mechanical Composting of municipal garbage essentially consists of the following unit operations :

1. Reception of garbage
2. Segregation of non-compostable materials
3. Preparation for composting by pulverising, shredding or screening.
4. Decomposition and stabilisation
5. Final preparation.

For each of these individual unit operations certain basic guidelines are provided for consideration while implementing a composting project. Some deviations may be necessary in the individual cases on the merits of the situation.

It has been generally established that the Mechanical Compost Plants will receive garbage rich in organic matter from selected areas in the city and that under Indian conditions the city refuse is not big size and generally consists of smaller and softer material. It will be useful at this stage to describe the characteristics of refuse that can go into the compost plants more clearly.

(1) Household refuse, foodwastes, rags, paper, cartons, glass, porcelain, ashes, cinder etc. and wastes from hotels, restaurants and other such public places.

(2) Wastes from markets, gardens, parks, offices, streets etc.

The following types of refuse should not be treated in the compost plants.

1. Industrial wastes consisting of large objects or toxic materials.

2. Construction or demolition materials like concrete, bricks, sand etc.

Reception

1. A hopper, bunker or depressed area should be provided to receive the refuse from the municipal corporation. This bunker should be designed to store half a day's capacity of the plant and shaped for the easy removal of entire garbage and washing if necessary.

2. The reception area should be designed for easy unloading of trucks. Adequate space must be provided to avoid delay in unloading and congestion.

3. The receiving area need not be covered in many places and where the covering is necessary due to the general weather conditions it may consist of a roof with open sides.

4. The reception area should not be located in low lying areas or near mosquito and fly breeding areas.

5. The refuse arriving at the plant in vehicles is to be weighed at a weigh bridge and the weight recorded. The weigh bridge capacity can be 10,000 to 20,000 kgs. Except in big cities where big trailer trucks will be bringing the refuse, a weigh bridge capacity of 10,000 kgs will be quite sufficient. The weigh bridge will have a room in which the dial indicator and recording mechanism are housed. The dial indicator and recording mechanism can be omitted to reduce the cost of the weigh bridge by going in for a steel yard type weigh bridge.

6. A steel slat conveyor of simple and sturdy construction should be provided to take the incoming garbage to the sorting and segregation conveyor. Garbage will have to be transported to the slat conveyor from the storage bunker by a grab crane or a front-end loader.

Segregation

1. Segregation area should be covered so that the workers can work conveniently during all seasons.

2. A belt conveyor with about 8 to 10 metre long horizontal stretch should be provided for segregation and salvage of metallic and other non-compostable matter by handpicking.

3. A suspended electro-magnet for removing tramp iron is to be installed before or after the handpicking segregation area if the waste characteristics show high ferrous content. Arrangement can be made to allow the magnet to be swung clear off the conveyor belt for cleaning of tramp iron. As an alternative the magnet is hung from a trolley running on the lower flange of a suitable beam.

4. Hoppers, receptacles or wheel barrows should be provided near the sorting belt conveyor for collecting equipment depending on the composition of the refuse and the percentage of non-compostable matter that will have to be removed from the refuse. Adequate working space should be provided around picking area.

5. Mechanical devices for segregation may be applied only when justified by the volume or type of the non-compostable matter to be segregated. Glass is practically all pulverised by any of the hammer mills. Plastics, rubber and other tough organic materials that cannot be turned into compost can be separated from the rest of the compostable matter by-means of a strong action on circular swinging sieves. Efficient separation calls for the correct size of mesh and proper amount of vibration so that damp or fibrous material is not allowed to adhere and the openings permit sifting of fine and medium sized particles.

6. If the dust content is very high then the refuse may be first screened to remove the fine inorganic matter. The dust removed by screening may be stored and mixed with the final product from windrows.

Preparation of the Compost

1. Size reduction is helpful in making the next operation of biological stabilisation faster as by this method, the surface area per unit weight of the material is increased. Organic matter composts more rapidly and satisfactorily if the maximum particle size is less than about 5 cms.

2. The size reduction should follow as far as possible the sorting unit so that the hammer mill a pulveriser does not get damaged due to unsorted non-compostable matter.

3. When the refuse characteristics show considerable amount of smaller size particles, the possibility of using screens for separation of refuse of smaller particle size to reduce the input of the hammer mill/Pulveriser and consequently their size. This screening operating can be combined with oversize screening easily.

4. A mechanical conveyors system should be used, to feed solid wastes to hammer mill/pulveriser so that the feeding will be uniform and fluctuations in the load are avoided on these machines.

5. Pulverising equipment type and size should be selected on the basis of solid waste characteristics of the particular city. The design of the selected equipment should be sturdy requiring minimum care of operation and maintenance. Replacement of worn out parts should be easy.

6. Facility to add water prior to or after the pulverising operation should be provided.

7. Where sewage sludge is available for mixing with the refuse for composting sludge mixing facility should be provided after the hammer mill/pulverisers. A double shaft mixer will properly mix the pulverised refuse and the sludge.

8. The pulverising equipment should be located in a covered building (except in the case of Bio-stabiliser) and the pulverised wastes should be taken to a covered area from where it can be conveniently transported to windrows. Conveyor after pulverising can be avoided by arranging discharge direct from pulveriser/hammer mill. Where this is not possible due to the design of the pulverising unit can be made of belt conveyor instead of slat conveyor for pulverised material transport.

Decomposition or Stabilisation

1. Mechanical equipments like loader should be used for transporting pulverised refuse to windrows and turning over of the material in the windrows, except in the case of very small capacity compost plants. Otherwise large labour force will be required for manual operation and the unsatisfactory working conditions can cause discontent and labour troubles.

2. Windrows should be located on level ground and well drained ground.

3. Facility to add water should be provided in the windrowing yard.

Final preparation

1. Except in the case of Bio-stabiliser unit where the initial pulveriser/Hammer mill is avoided final grinding is not necessary unless there is a consumer demand for ground compost. In a Bio-stabiliser if the primary Pulverised/Hammer mill is omitted final grinding may be necessary to take care of large lumps which do not get pulverised during their passage through the stabiliser unit.

2. Where required a secondary hammer mill of smaller capacity (in terms of the largest particle size that can be crushed) may be provided.

3. Final compost product may be screened and bagged in the case of garden grade compost only. Bagging can be done manually.

4. Sufficient space must be provided in the stockyard for final stabilisation, i.e. bacterial decomposition that may take place in the stockyard while it is stored.

General

1. In a climate where there is considerable amount of rain all the operations have to be carried out under cover and the finished product should be stored in a roofed building.

2. The grinding and screening operations may produce some dust, particularly when dry refuse is being processed. Adequate precautions are to be taken to make the complete system an enclosed one or separate dust collecting systems arranged at the main dust producing equipments. The complete plant should be well ventilated.

3. A small maintenance and repairs shop should be provided within the plant to undertake routine maintenance jobs like rebuilding the hammers of a hammer mill etc.

Annexure III gives a complete listing of equipment suppliers who can furnish part or complete turnkey plants.

PART II

The guidelines for the Mechanical Compost Plants are to embrace mainly the equipment aspect for the various processes mentioned below in composting. In order to give complete scope, the first part of the report gives the guidelines for site development, which is equally a vital aspect for integration.

(a) Receipt of Garbage
(b) Segregation
(c) Pulverisation
(d) Final screening
(e) Maturation

The above aspect is divided into four sections under the following divisions :—

1. Study of operations and equipment
2. Study of manufacturers in this field in India
   (i) indigenous manufactures (ii) Problems faced with turnkey suppliers.
3. Study of the equipment essential for each operation.
4. Study of operations for manual operation and economics.

1. Study of operations in brief with equipment

(a) *Reception of Garbage*

The solid wastes are collected from the city generation areas by trucks and trailers and received at the Mechanical Compost Plant. In order to have the data on collection rates a truck weigh bridge is necessary. The specification is indicated in the Annexure I—M.C.P.I.

The garbage is to be transported to the pulveriser through a garbage loader.

The specification is indicated M.C.P. II of Annexure I.

The garbage from the receipt area is to be moved to the place of reception by means of a front end pushers.

The specification is mentioned as per M.C.P. III in the Annexure.

(b) *Segregation*

The segregation of garbage is generally associated with removal of non-compostable and recoverable material. This is listed as below :

(i) Ferrous material
(ii) Non ferrous material
(iii) Paper & Rags
(iv) Plastics

Pieces of bulky nature and easily recognisable can be segregated manually. Small ferrous material may not be segregated at the initial stage. This can be segregated by means of a magnetic separator. The specification for the same is indicated under M.C.P. IV of the Annexure.

(c) *Pulverisation*

The garbage after segregation is discharged into the pulveriser where the solid waste size is reduced to 10 mm to 15 mm for the process of hastening up decomposition. The specification for the pulveriser is indicated in the Annexure under M.C.P. 5.

(d) *Final screening*

The solid wastes are to be screened for ensuring that the pulverised material is receptive for quick microbial action. This specification is indicated under M.C.P. 6 in the Annexure.

2. Study of manufacturers in this field in India

Mechanical Composting is a new concept in India for supplementing the chemical fertilisers and is used for converting city refuse into organic manure. This has not yet had sufficient impact so as to have the industries in India fully or partly geared up for the manufacture of the needed equipment. Most of the equipments required for a composting plant are available in India which are being manufactured for different applications viz., Mining and handling applications.

Recent survey for assessing the potential manufacturers for the supply of equipment for composting plants was undertaken by N.I.D.C. Limited. The equipment suppliers were contacted and discussions were held to induce them to convert some of their equipment designs used for mining and allied industries and make them suitable for compost plant requirements. Few suppliers have shown interest in this regard. Since there is good future for more and more plants of mechanical composting to be installed the manufacturers desired to have information from the study from the plants which are in operation.

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There is wide variance in basic parameters like density, hardness, moisture content, and hetrogenous contents of the garbage. These are necessary data for designing the size reduction equipment, like pulverisers needed for size grading and equipment like screens and feeders.

The conveying and handling equipment required can be procured from the indigenous suppliers. The existing designs for the other equipment *viz.*, Crushers screens and feeders could be modified once the mechanical compost plants go into operation.

(ii) *Equipment suppliers with foreign collaboration*

Since the advent of idea for mechanical compost plants some reputed companies in India diversified their activities in this field by offering turnkey plants with full foreign collaboration. The following listed are the Indian agencies indicating their foreign collaboration. The processes of all these collaborators are not the same for mechanical compost plants.

(1) M/s Tractel Tirfor New Delhi with Collaboration of M/s Tollemache of U.K.

(2) M/s Buckau Wolf—New India Engineering Works Poona with collaboration of M/s Dano Inc. of Switzerland.

(3) M/s Larsen & Toubro, Bombay with collaboration of M/s Buhler & Co. of Switzerland.

(4) M/s Dorr Oliver (India) Ltd. with M/s Dorr Oliver Ltd. of U.S.A.

The above Indian Agencies were approached for the details of the processes for the Mechanical Compost Plants.

The processes employed were studied in detail and the suppliers were contacted and discussions were held for the supply of only few equipments which are essential rather than total plants. For simplified mechanical Compost Plants, all the equipments recommended for the Turnkey plants are not essential. Much of the equipment recommended can be made available from the indigenous sources. This posed a major hurdle for the turnkey plant suppliers with foreign collaboration.

These parties are having collaboration for supply of only turnkey plants. Due to this obligation, the Indian agencies did not show much interest for supplying of part equipment which are found essential. Also some of the collaborators have made binding on the Indian agencies that the first few plants for the mechanical composting have to be imported and the design should not be divulged for undertaking manufacture in India.

From all the above processes we studied we find that the pulveriser offered by M/s Tractel Tirfor is of versatile design for size reduction of the garbage. Since the plants with above design are operating in tropical countries with similar garbage characteristics, the consultant find that the above design is more suitable for Indian conditions. Also this has vertical shaft design with radially revolving hammers in horizontal plane. This particularly offers more advantages than the hammer mill of horizontal type. A comparative study between these two are enclosed in the Annexure II under caption of comparative study of hammer designs.

For the cost of the above the consultant had discussions with M/s Tractel Tirfor Ltd. They have agreed for supply of the pulveriser of M/s Tollemache design completely manufactured in India.

3. **Study of equipment essential for each operation**

It is now seriously felt that sophisticated Mechanical Compost Plants are not needed for Indian cities. Instead a large number of simplified Mechanical Compost Plants are to be set up with essential equipment requirements.

(1) Weigh bridge
(2) Belt weigh scale
(3) Compost loader
(4) Pulveriser
(5) Magnetic separator
(6) Portable conveyors
(7) Single side discharge tripper
(8) Garbage handling trucks and trailers
(9) Front end pushers

4. **Economic analysis of manual operation versus using Mechanical Equipment in a Mechanical Composting Plant**

Basic general operations in mechanical composting plants are already described earlier. Among these operations, those which can be considered for manual operations are as follows :

1. Handling of garbage from storage to the receiving hopper of slat conveyor.
2. Handling of garbage to a pulveriser/hammer mill.
3. Handling of garbage after pulverisation to the windrows.
4. Segregation of garbage for removing non-compostable matter.
5. Turning over of garbage during stabilisation in windrows.
6. Handling of decomposed garbage from the windrows to the stockyard.
7. Bagging of final product *i.e.* compost.

Of the above listed operations, the last two operations can be conveniently done manually and do not require any further discussion.

Following equipments are considered to be essential for the simplified mechanical compost plants.

Sr. No.	Description of Equipment	Estimated Cost in Rs. lakh
1.	Front end Pusher	1·50
2.	Garbage loader	1·50
3.	Portable conveyor	1·00
4.	Tripper conveyor	0·75
	Sub-Total :	4·75

(i) Depreciation Cost assuming 10 years life for the machinery — Rs. 47,500
No. of working days in a year — 300
Depreciation Cost per day — Rs. 158.30

(ii) Maintenance Cost of Equipment at 3% per annum — Rs. 14,250
Maintenance cost per day — Rs. 47.50

(iii) Power consumption per day assuming total load of 8 Kw. and unit rate of Re. 0.15 per unit — Rs. 9.60

Total cost of operation of machinery per day (i)+(ii)+(iii)=Rs. 158.30+47.50+9.60
=Rs. 215.40

Capacity of the Mechanical Compost Plant=150 Tonnes/day.

Therefore, total cost of operation to process one tonne of garbage=Rs. 1.43

Comparative cost of operation using manual labour for different operations works out as follows :

Considering data available in literature and other references for similar operations where manual labour can be employed it has generally been observed that one labourer can handle maximum of 2.5 to 3 tonnes of refuse per day. Assuming an average unskilled labourer's rate of Rs. 6/- per day, the cost of operation per tonne of garbage would be approximately Rs. 2.00. This is much higher compared to using mechanical equipment. In addition, to process 150 tonnes per day of garbage a huge labour force will be required. Keeping in mind various problems associated with utilizing a large labour force at a mechanical composting plant, it seems desirable to employ mechanical equipment for the operation listed above. Manual labour can be utilized for other operations where conditions are hygienic and health hazard problems are not involved.

SPECIFICATIONS

MCP—1

Weigh Bridge

Purpose :

For weighing the trucks, trailer trucks carrying garbage to the Mechanical Compost Plants.

Type :

Platform Type :

Capacity :

15 Tonnes.

Indicator :

Separately mounted dial with pointer for weighing indication.

Accuracy :

Measurable up to 50 kg.

MCP—2

Garbage Loader

Purpose :

To transport the garbage from the reception area by-self loading to conveyor belts and discharging to crusher.

Material :

Garbage.

Density :

0.5 T/M^3

Capacity :

20 Tonnes/Hr.

Length of conveyor :

30 M (approx.)

Type of loading :

Self grabbing from the heap.

The garbage loader shall be complete with loading and conveying equipment with necessary structures for mounting of idlers, drives belt, aprons, pulleys.

MCP—3

Front End Loader

Purpose :

For transporting of material from garbage storage area to garbage loader conveyor.

Engine Power :

50 HP.

Capacity of bucket :

0.60 cubic meters.

Lifting capacity :

600 kg.

Overall length with bucket on ground :

4800 mm.

Overall width :

2000 mm.

Max. height at full raise of bucket :

4500 mm.

Max. height of cutting edge at dumping position :

2750 mm.

Max. dumping angle :

47°

Turning radius :

4800 mm.

Wheel base :

2100 mm.

Tyres :

Front 7.50/16, Rear : 13.6/28

Fuel tank capacity :

40 litres.

The loader shall be provided with all whether steel cab, front wheel hydraulic brakes, parking brake, complete electrical system, horn, head lamps, spot lamp, tail-cum-parking-cum-traficcator lamps, oil pressure gauge, water temp. gauge etc.

MCP—4

Magnetic Separator

(i) For separation of tramp ferrous materials for the protection of crushers from the garbage being conveyed by conveyor for sizing from mechanical compost plants.

(ii) Suitable to be mounted over conveyor and is fitted to facilitate the discharge extracted metal into a chunk at the side.

(iii) The magnetic separator shall be an automatic discharge equipment with static suspension magnet extended poles.

(iv) The maximum weight of metallic pieces to be separated-1.0 kg.

(v) The equipment shall be complete with necessary mounting frames, drives and fasteners. The supply shall be complete with necessary structurals supports.

MCP—5

Pulveriser

Purpose :

For sizing of material of garbage for maturation.

Composition :

Capacity :

20 T/Hr.

Density :

0.5 Tonnes/M^3

Type :

Vertical rotating axis radial arms fixed Hammer type.

Hammers :

Mn-Steel material.

Input size :

Hetrogenous materials of varying sizes.

Size to be Crushed :

½" size.

The supply shall include the necessary drive, motor, and electricals.

MCP—6

Portable Conveyors

Purpose :

Required for mechanical compost plants for handling of garbage after size reduction to tripper conveyors with the following technical specifications.

Material to be Handled :

Garbage.

Density :

0.5 T/M^3

Capacity :

15 Tonnes/Hour.

Length :

30 M (approx.)

Max. Inclination :

15° Inclination angle adjustable type.

Idler Belt :

Trough idlers of 20° and flat return idlers.

MCP—7

Tripper Conveyors

Purpose :

For discharging of the garbage into the windrows for composting by natural aerobic action with following technical specifications :

Material to be handled :

Garbage.

Density :

0.5 T/M^3.

Capacity :

15 T/hr.

Tripper Travel :

50 M.

Type :

Tripper single side discharge.

Motor Drive :

Head drive suitable sized with necessary reduction equipment.

The tripper conveyor shall be complete with structural frames for supporting idlers, pulleys and drive, idlers for carrying and return, belt of suitable length and width and necessary take up provision.

COMPARISON OF HORIZONTAL SHAFT HAMMER MILL AND VERTICAL SHAFT PULVERISER

	Horizontal Shaft Hammer Mill	*Vertical Shaft Pulveriser*
1.	*Design* Usually developed from existing designs of hammer mills used for crushing coal, rock, gravel, etc.	Specially designed for treating refuse.
2.	*Extent of Grinding Zone* By the nature of its design only a proportion of the periphery is used for grinding. Obviously the upward path of the hammers and the feed entrance is hardly effective as a pulverising area.	The grinding zone is effectively the whole 360° with pre-breaking taking place in the conical section with the remainder being pulverised in the vertical section. The path of the single particle travels downwards in a helix giving a very extended, effective pulverising zone.
3.	*Power Consumption* In addition to the power absorbed by the action of pulverising, extra power is required to raise against gravity items not pulverised in the first contact, *i.e.* approximately 10-12 kW hours per ton.	Refuse travels through pulveriser by gravity, its passage being helped by the fan action, thus power is only absorbed for the actual pulverising and is, therefore, minimal, *i.e.* about 7 kW hours per ton.
4.	*Rotation* Since the shaft can only operate in one direction hammers must be removed when one side of the hammer is worn.	Since the shaft rotation is reversible a second corner of the hammer is available for use simply by pressing a button to reverse the rotation.
5.	*Blockages* The screen bars are prone to blockage when the hammers wear. With tropical refuse having a high vegetable content, the screen bars block even with new hammers.	Since there are no screen bars and the flow of material is assisted by an induced air draught, the machine is not prone to blockage.
6.	*Capacity* The capacity is limited by the screen bars and will produce a smaller tonnage with a smaller particle size and, in these conditions, will be very sensitive to blockage.	Capacity is usually very much higher in this type of machine since there are no screen bars and the throw out is aided by an air draught.
7.	*Particle Size* The particle size is controlled by the apertures in the screens. To modify the required particle size is a major operation involving the removal of the complete screen arrangement in the base.	The particle size is easily adjusted merely by altering the hammer arrangement. Hammers can be made longer and more of them fitted to give a smaller particles size.
8.	*Explosions* Explosives materials entering the mill are drawn downwards beneath the shaft and can cause extensive damage to the shaft and bearings.	Explosive items are immediately struck in the conical section and the explosion takes place in a relatively large volume which allows expansion with minimal damage.
9.	*Mounting* Since discharge is vertically beneath, the machine must be supported by a structure above ground.	The side discharge allows the pulveriser to be mounted on concrete at ground level which is ideal for heavy rotating machinery.
10.	*Glass* Due to the short pulverising zone, sharp splinters can be produced.	The side discharge allows the pulveriser to be mounted on concrete at ground level which is ideal for heavy rotating machinery.
11.	*Electric Current Characteristics* Frequent peaks in current amperes occur due to shocks absorbed from heavy iron and steel items etc. in refuse. This puts a strain on the electrical supply system and can result in motor winding burn outs.	Heavy items in refuse take a rotary path through the mill resulting in a very even current curve characteristic giving electric motors longer life and little strain on the electrical supply system.

LIST OF EQUIPMENT SUPPLIERS
MECHANICAL COMPOSTING PLANT

A. **Individual Equipment**

I. *Crushers*

1. M/s Shahabad Heavy Engineering
ACC-Shahabad.
MYSORE STATE.
2. M/s Elecon Engineering Co. Ltd.
Vallabh Vidyanagar,
GUJARAT.
3. M/s Sayaji Iron & Engineering Co. (P) Ltd.,
Chhani Road,
BARODA.
4. M/s Larsen & Toubro Ltd.,
Larsen & Toubro House, Ballard Estate,
BOMBAY-400001.
5. M/s Utkal Machinery Ltd.,
Rourkela,
ORISSA.

II. *Vibratory Feeders*

1. M/s Elecon Engineering Co. Ltd.,
Vallabh Vidyanagar,
GUJARAT.
2. M/s Tata-Robins-Fraser Ltd.,
11, Station Road, Burma Mines,
JAMSHEDPUR.

III. *Conveyors*

1. M/s Elecon Engg. Company Ltd.,
Vallabh Vidyanagar,
GUJARAT.
2. M/s Tata-Robins-Fraser Ltd.,
11, Station Road, Burma Mines,
JAMSHEDPUR.
3. M/s Dynacraft,
Juhu Lane, Andheri,
BOMBAY-58.
4. M/s Machally Bird & Co.,
Chartered Bank Building,
CALCUTTA (W. BENGAL).

IV. *Trucks Pay Loader*

1. M/s Hindustan Motors,
CALCUTTA-700001.
2. M/s Ashok Leyland Pvt. Ltd.,
ENNORE, MADRAS-37.
3. M/s Bharat Earth Movers,
BANGALORE.
4. M/s Hindustan Aircrafts,
BANGALORE-17.
5. M/s Escorts Ltd.,
6 Pratap Building,
Connaught Circus,
NEW DELHI-1.

V. *Screens*

1. M/s Elecon Engineering Company Ltd.,
Vallabh Vidyanagar,
GUJARAT.
2. M/s Bharat Weighing Scales &
Engg. Syndicate,
75/1, Kalachand Nandy, Bantsa,
HOWRAH.
3. M/s India Machinery Co. Ltd.,
Dasnagar,
HOWRAH.
4. M/s Indian Weighing Scales & Engg. Co. Ltd.,
233, Bellilians Road,
HOWRAH.

B. **Complete Mechanical Compost Plants**

1. M/s Larsen & Tourbo Ltd.,
L & T House, Ballard Estate,
BOMBAY-1.
2. M/s BUCKAU-WOLF,
New India Engineering Works Ltd.,
Pimpri, POONA-411018.
3. M/s Dorr-Oliver (India) Ltd.,
Dorr-Oliver House, Link Road,
Chakala, Andheri East,
BOMBAY-400069.
4. M/s Tractel Tirfor India Pvt. Ltd.,
Tractel House, B-56, Greater Kailash,
New Delhi-110048.
5. M/s Wisdon Traders,
Purniah Chatram Road,
BALPET, BANGALORE-24.
6. M/s MUMBOLDT-SKB WEDAG,
Shri Pravin Amin, Resident Representative,
C/o Mitsubishi Corporation,
9-A, Shakespeare Sarani,
CALCUTTA-16.
7. M/s Sepulchro Brothers (India) Ltd.,
20, Rajendranath Mukherjee Road,
P.O. Box No. 2041,
CALCUTTA-I.

APPENDIX XV
(*Para* 7.02)

STATE-WISE DISTRIBUTION OF SEWAGE FARMS IN INDIA

S. No.	State/Union Territory	Number of centres	Area receiving sewage irrigation (hec.)
1	2	3	4
1.	Andhra Pradesh	8	905
2.	Bihar	3	173
3.	Gujarat	14	2083
4.	Haryana	20	619
5.	Himachal Pradesh	3	10
6.	Jammu & Kashmir	1	122
7.	Karnataka	6	396
8.	Kerala	4	84
9.	Madhya Pradesh	16	1340
10.	Maharashtra	19	1030
11.	Orissa	3	162
12.	Punjab	45	7895
13.	Rajasthan	6	423
14.	Tamilnadu	30	593
15.	Uttar Pradesh	40	5084
16.	West Bengal	1	1215
17.	Chandigarh	1	810
18.	Delhi	1	1114
19.	Goa	1	112
20.	Pondicherry	1	61
		223	24231

Ahmedabad City in Gujarat has the oldest sewage farm set up in 1896.

Sewage farm in Poona (Maharashtra) was set up in 1918.

APPENDIX XVI
(*Para* 7·05)

SEWAGE UTILISATION SCHEME

I. Criteria for Grant of Central Assistance

(1) The cost of the scheme should not exceed Rs. 2500 per hectare benefited.

(2) The items of work will include only laying of connecting sewers, primary treatment and pumping equipment, laying of rising mains, distribution channel and well for diluting the sewage, wherever needed.

(3) Only such schemes are to be considered as are framed by the State Public Health Engineering Department in consultation with the Agriculture Department and can be completed and commissioned within two years.

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APPENDIX XVII

(*Para* 8.04)

CHAPTER-WISE COMPARISON OF THE MUNICIPAL ACTS

(A) Municipal Corporations I

Chapter	Madhya Pradesh Municipal Corporation Act, 1956	Calcutta Municipal Act, 1951	U. P. Nagar Mahapalika Adhiniyam, 1959	Bombay Provincial Municipal Corporation Act, 1949
1	2	3	4	5
I	Preliminary	Preliminary	Preliminary	Preliminary
II	The Municipal Authorities	Municipal Authorities	Constitution and Governance of Mahapalika	Constitution
III	Conduct of Business	Distribution of Powers and Safeguarding Due Exercise of Powers	Proceedings of the Mahapalika Executive Committee, Development Committee & other Committees	Proceedings of the Corporation, Standing Committee, Transport Committees and other Bodies
IV	Municipal Officers and servants	Election of Councillors and Eldermen	Officers and Staff	Municipal Officers and Servants
V	Powers, Duties & Functions of the Municipal Authorities	Municipal Officers and Servants	Duties and Powers of Mahapalika & Mahapalika Authorities	Essential Services
VI	Municipal Property and Liabilities	Conduct of Business	Property and Contracts	Duties and Powers of the Municipal Authorities & Officers
VII	Municipal Fund	Municipal Fund	Mahapalika and other Funds	Contracts
VIII	Budget Estimates	Budget Estimates	Borrowing Powers	Municipal Property
IX	Loans	Loans	Mahapalika Taxation	Municipal Fund & other Funds
X	Audit & Accounts	Accounts	Drains and Drainage	Borrowing Powers
XI	Taxation	Imposition of Consolidated Rate	Water Supply	Municipal Taxation
XII	Property Tax	Tax on Carriages & Animals	Streets	Drains & Drainage
XIII	Public Convenience	Tax on Professions Trades and Callings	Building Regulations	Water Supply
XIV	Conservancy	Scavenging Tax	Improvement Schemes	Streets
XV	Sanitary Provisions	Tax on Carts	Sanitary Provisions	Building Regulations
XVI	Water Supply	Licence Fee for Advertisements	Regulation of Markets, Slaughter Houses, certain Trades and Acts etc.	Improvement Schemes
XVII	General Provisions w.r.t. Drainage, Water Supply & Water & other mains	Recovery of the Consolidated Rate and other Taxes	Vital Statistics	Municipal Fire Brigade
XVIII	Public Health & Safety	Water Supply	Compensation	Sanitary Provisions
XIX	Markets & Slaughter Houses	Drains, Privies & other Receptacles for Filth	Penalties	Markets & Slaughter Houses
XX	Food, Drink, Drug & Dangerous articles	Licenced Plumbers	Proceedings before Judge, District Judge, Magistrates & others	Transport Undertaking
XXI	Restraint of Infection	Streets & Public Places	Recovery of Taxes & other Mahapalika Dues	Vital Statistics
XXII	Disposal of Dead	Buildings	Control	Licenses and Permits
XXIII	Town Planning	Bustees	Rules, Bylaws & Regulations	Power of Entry & Inspection

1	2	3	4	5
XXIV	Building Control	Demolitions, Alteration & Stopping of Unlawful Work	Miscellaneous	Compensation
XXV	Dangerous & Insanitary Buildings	Lighting and Scavenging and Regulation of Public Bathing and Washing	Transitory Provisions, Repeals & Amendments	Penalties
XXVI	Streets	Inspection & Regulation of Premises & of Tactories, Trades & Places of Public Resort		Proceedings before Judge, District Judge & Magistrates
XXVII	General Provisions as to Street & Public Nuisance	Markets and Slaughter Houses		Recovery of Municipal Dues other than Taxes
XXVIII	Cooperation of Police	Food and Drugs		Control
XXIX	Prevention or Extinction of Fires	Milk Supply		Rules, Bylaws, Regulations & Standing Orders
XXX	Dangerous Animals	Restraint of Infection		Miscellaneous
XXXI	Beggars	Registration of Births & Disposal of the Dead		Repeals & Amendments
XXXII	Disorderly Houses	Acquisition, Disposal and General Importance of Land & Buildings		
XXXIII	Weights & Measures	Special Powers of the Corporation		
XXXIV	General Provisions for the carrying of Municipal Administration	Bylaws & Rules		
XXXV	Supplemental Provisions	Penalties		
XXXVI	Control	Procedure		
XXXVII	Bylaws	Supplemental Provisions		
XXXVIII	Punishment of Offences	Transitory Provisions		
XXXIX	Election Petitions			
XL	Transitory Provisions			
	No. of Sections : 445	No. of Sections : 615 Schedules : XXII	No. of Sections : 581 Schedules : 3	No. of Sections : 493 Schedules : XIX Appendices : IV

(A) Municipal Corporations II

Chapter	Kerala Municipal Corporation Act, 1961	Madurai City Municipal Corporation Act, 1971	Bombay Municipal Corporation Act, 1888	Delhi Municipal Corporation Act 1957
1	2	3	4	5
I	Preliminary	Preliminary	Preliminary	Preliminary
II	Municipal Authorities	Constitution of Municipal Authorities	Municipal Constitution	The Corporation
III	Election of Councillors	Election and Appointment of Councillors	Duties and Powers of Municipal Authorities	Functions of the Corporation
IV	General Powers of Municipal Authorities as to Property, Contracts and establishment	General Powers of Municipal Authorities as to Property, Contracts and Establishment	Municipal Officers & Servants	Municipal Authorities under the Corporation
V	Taxation	Taxation	Municipal Property & Liabilities V-A—Powers to Evict Persons from Corporation Premises	Procedure
VI	Finance	Finance	Borrowing Powers	Municipal Officers and other Municipal Employees
VII	Water Supply, Lighting & Drainage	PH, Safety & Convenience, Water Supply, Lighting & Drainage	Revenue and Expenditure	Revenue and Expenditure

1	2	3	4	5
VIII	Scavenging	Sanitation	Municipal Taxation	Taxation
IX	Streets	Public Streets	Drain & Drainage Works	Borrowing
X	Building Regulations	Building Regulations	Water Supply	Property & Contracts
XI	Nuisances	Hunting Grounds	Regulation of Streets	Accounts & Audit
XII	Licenses & Fees	Nuisances	Building Regulations XII-A—City Improvement	Water Supply, Drainage and Sewage Disposa
XIII	Vital Statistics & Prevention of Disease	Licenses & Fees	Licensing of Surveyors and Plumbers	Electricity Supply
XIV	Rules, Bylaws & Regulations	Vital Statistics & Prevention of Diseases	Municipal Fire Brigade	Transport Services
XV	Penalties	Rules, Bylaws & Regulations	Sanitary Provisions	Streets
XVI	Procedure & Miscellaneous	Penalties	Vital Statistics XVI-A— B.E.S.T. Undertaking	Building Regulations
XVII		Procedure & Miscellaneous	Bylaws	Sanitation & Public Health
XVIII			Penalties	Vital Statistics
XIX			Procedure	Public Safety & suppression of Nuisances
XX			Control	Markets, Slaughter Houses, Trades & Occupation
XXI			Supplemental Provisions	Improvement
XXII				Powers, Procedures, Offences & Penalties
XXIII				Rules, Regulations & Bylaws
XXIV				Control Miscellaneous Supplemental & Transitional
	No. of Sections : 445 Schedules : VI	No. of Sections : 512 Schedules : VII	No. of Sections : 638 Schedules : 40	No. of Sections : 516 Schedules : 40

(B) Municipalities

Chapter	Maharashtra Municipalities Act, 1965	Gujarat Municipalities Act, 1963	Madhya Pradesh Municipalities Act, 1961	Rajasthan Municipalities Act, 1959
1	2	3	4	5
I	Preliminary	Preliminary	Preliminary	Preliminary
II	Municipal Councils	Municipal Boroughs & Constitution of Municipalities	Constitution of Municipalities	Constitution and Govt. of Municipalities.
III	Duties and Functions of the Council and the Municipal Executive	President, Vice President, Councillors and Chief Officer	Conduct of Business	Conduct of Business
IV	Director of Municipal Administration and Collector	Conduct of Business	Chief Municipal Officer and staff of Municipality	Rules & Bylaws
V	Provision regarding officers and Servants	Municipal Property and Fund	Property, Contracts and Liabilities	Municipal Property and Fund
VI	Conduct of Business	Functions of Municipalities	Duties of Council	Primary & Secondary Functions of Boards.
VII	Municipal Property, Funds, Contracts & Liabilities	Provisions as to transfer of certain Functions	Municipal Taxation	Imposition of Taxes

1	2	3	4	5
VIII	Budget and Accounts	Municipal Taxation	Recovery of Municipal Claims	Recovery of Municipal Claims
IX	Municipal Taxation	Recovery of Municipal Claims	Municipal Powers and Offences	Municipal Powers and Offences.
X	Recovery of Municipal Claims	Financial assistance to Municipalities	Appeals	Prosecutions, Suits and Powers of Police
XI	Streets and Open Spaces	Municipal Powers & Offences	Prosecutions, Suits & Powers of Police	Municipal Accounts, Administration Reports
XII	Control over Buildings	Power to evict Persons from Premises belonging to Municipality	Control	Control
XIII	Drainage	Cattle Ponds	Notified Areas	Staff of Boards
XIV	Water Supply	Prosecutions, Suits and Powers of Police	Miscellaneous	Notified Areas
XV	Public Safety and Conveniences	Provisions relating to Services		
XVI	Nuisances	Control		
XVII	Prevention and Control of Dangerous Diseases	Special Provisions applicable when limits are altered		
XVIII	Disposal of Dead Bodies and Carcasses of Animals	Miscellaneous Provisions		
XIX	Vital Statistics			
XX	Markets, Slaughter Houses and Trades			
XXI	Cattle Ponds & other Provisions relating to Animals			
XXII	Prosecutions, Suits and Powers of Police			
XXIII	Control			
XXIV	Rules & Bylaws			
XXV	Service of Notices, Execution of Works on Default & Compensation			
XXVI	Miscellaneous			
XXVII	Special Provisions applicable to New Township Hill Station and Health Resort Municipal Areas			
XXVIII	Repeals and Transitory Provisions			

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