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THE COLLECTION AND DISPOSAL OF CITY REFUSE

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THE COLLECTION AND DISPOSAL OF CITY REFUSE

By M. I. EVINGER and D. C. FABER

Public health, comfort and convenience are the fundamental considerations in the disposal of city refuse. If these conditions did not exist, the municipality might regard with comparative indifference the accumulation of ashes, garbage and other refuse. Such accumulations, however, not only produce disagreeable odors, block the public highways and otherwise interfere with public comfort and convenience, but are also liable to be or become centers of infection, from which disease may be disseminated throughout the community by individuals, by winds, by insects, and possibly in other ways. The disposal of city refuse is a problem of such serious importance to a municipality that its solution should command the deep thought and careful consideration of citizens as well as officials. In the smaller communities, this matter receives very little attention and without serious results, but as the municipality grows, it becomes necessary to adopt and carry out some definite plan by means of which the waste materials can be disposed of in a satisfactory manner. Improvements which have been made in recent years in those branches of municipal service having to do with the public health and comfort have been very marked, but the methods which have been followed for the disposal of refuse in our cities and towns are still for the most part inefficient and unsatisfactory. The disadvantages and objections to the methods used in many cases have long been recognized, but the difficulty and expense involved in improving them have caused delays in the making of changes and the introduction of necessary improvements.

CLASSIFICATION OF CITY WASTE MATERIALS

The materials ordinarily included in the term "City Waste" may be divided into three general divisions: (1) Sewage, (2) City Refuse, (3) Trade Refuse.

A general classification of city waste materials prepared by H. de B. Parsons, Consulting Engineer, is shown on the following page.

Garbage consists of organic waste or residue of animal, fruit or vegetable matter or any other substance used in the preparation, cooking or dealing in meats, fruits and vegetables. As it is made up largely of water and putrescible organic matter, it is subject to rapid decomposition and capable of becoming very offensive.

Ashes constitute the waste or residue due to the combustion of coal or other combustible materials from dwellings, business places or factories. Ashes consist of fine ash, cinders and clinkers, and unconsumed fuel.

Rubbish is discarded material produced in the household and places of business and which cannot be classified as ashes or garbage. It includes such things as waste paper, boxes, packing materials, old shoes and clothing, bottles, crockery, tin cans and metal scrap, and other like waste material.

Street sweepings constitute the waste materials which are collected from the streets, roads and sidewalks. From well paved streets they consist largely of manure, waste paper, leaves, etc., while from unpaved streets they contain large quantities of inorganic matter. Street sweepings often include materials which should be classified as rubbish.

Trade refuse consists of waste materials from building operations, commercial industries, business houses, factories, etc., as distinguished from household refuse.

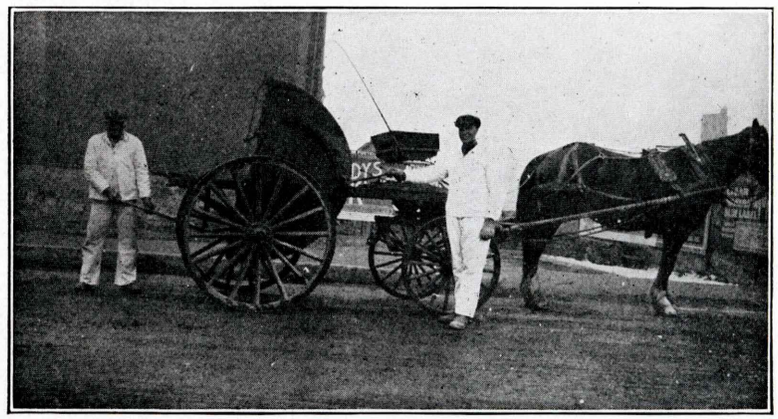
Earth excavations and other wastes from building operations form a considerable part of city waste and, although their removal might be regulated, their disposal is not commonly undertaken by cities and towns. Stable manure is often included in the waste to be dealt with by the municipality, but is usually disposed of to farmers and gardeners under proper regulations and without charge to the munici-

- City Waste Materials
  - Sewage
    - Liquid and Semi-liquid Refuse
      - House Sewage
      - Street, Roof and Area Drainage
      - Night Soil
  - City Refuse
    - Household Wastes
      - Garbage
        - Animal Matter
        - Vegetable Matter
        - Meat and Bones
        - Fruit
      - Ashes
        - Steam Ashes
        - Household Ashes
      - Rubbish
        - Paper
        - Wood
        - Rags and Bedding
        - Leather and Rubber
        - Metals
        - Bottles, Glass and Crockery
        - Sweepings from Buildings
    - Street Refuse
      - Street Sweepings
        - Animal Manure
        - Pavement Dirt
        - Droppings from Carts
        - Materials from Bldg. Constr.
        - Some Rubbish and Leaves
      - Dead Animals
      - Snow
        - Cellar Excavations
        - Materials from Bldg. Constr.
        - Stable Manure
        - Market Offal
        - Slaughter House Offal
        - Dead Animals
  - Trade Refuse

pality. The disposal of snow is an important problem in our larger cities and towns and is sometimes carried on in connection with the collection of the city refuse, but it does not ordinarily affect seriously the problem of city waste disposal. The disposal of dead animals and slaughter house refuse is usually undertaken by rendering or fertilizer establishments operated by private parties, generally under regulations by the municipality.

Night soil material removed from privy vaults is a class of city refuse which must be taken care of under existing circumstances in all cities to a greater or less extent. A city with complete municipal water and sewer connections is in a position to eliminate this class of city refuse. Where deposits of night soil accumulate, they must be taken care of until such time as they are eliminated by the extension of the sewer system. Night soil cannot be used directly for fertilizer, but may be buried if not put too deep nor in too large quantities in one place.

The subject matter of this bulletin deals chiefly with three principal classes of city waste; garbage, ashes and rubbish. The other classes mentioned are not considered except as they may affect the methods for the disposal and collection of garbage, ashes and rubbish.



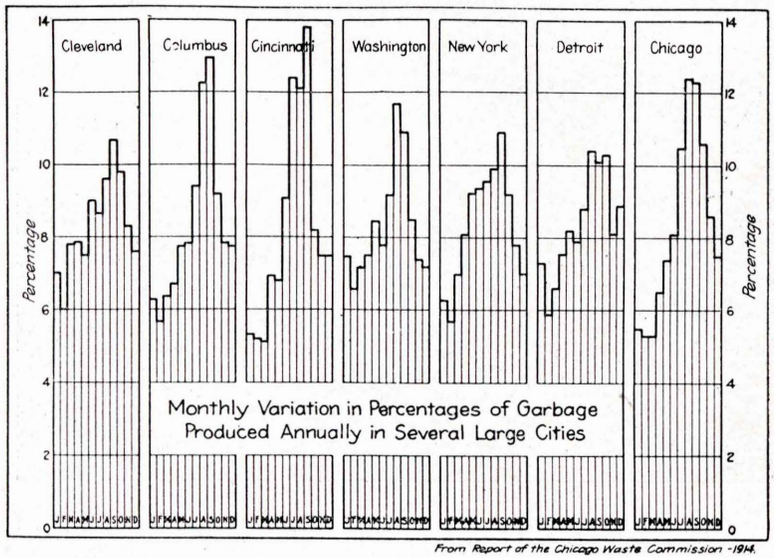
STEEL GARBAGE WAGON IN DUMPING POSITION. THIS IS THE SAME WAGON SHOWN ON FRONT COVER.

QUANTITY OF CITY REFUSE PRODUCED

The average American community of usual mixed population will have a garbage output of from 175 to 250 pounds per capita per annum, varying with local surroundings. About 200 pounds per capita per annum, with due allowance for exceptional conditions, may be used as an approximate figure. An accurate report from four Ohio cities gives 190 pounds as the yearly average per capita.

The proportions of garbage vary greatly, and are governed by the character of the community, the effect of private collections, and the form of the prevailing fuel for houses. In the northern cities, where coal is used extensively, the percentage of garbage is fairly constant, and averages from 10 to 15 per cent of the total collection.

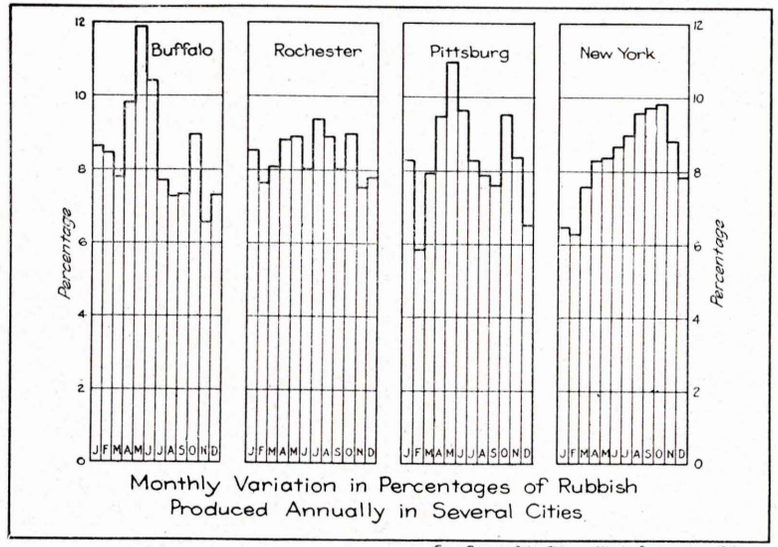
The first of the two following diagrams shows the variation in the amounts of garbage collected in several large cities. This diagram indicates that the minimum quantity is reached during the winter months, and the maximum quantity during the summer months. As a result of this variation, it is necessary that the organization maintained for collection and disposal be one that is flexible and easily adapted to the ever changing conditions. An analysis of the



From Report of the Chicago Waste Commission - 1914.

garbage collection in a city for even a short period of years usually indicates that the quantity collected from its several districts for different years is not a constant figure.

The quantity of ashes produced yearly in any community is controlled by the local conditions, such as the character of the population and the use of solid or gaseous fuels. In the northern cities the quantity of ashes usually collected amounts to from 70 to 80 per cent of the total collection. These quantities vary during the different months of the year; thus, the quantity of garbage is larger in the summer than in the winter and the ashes larger in amount in winter than in summer. Rubbish will vary in amount in much the same way as garbage, being greater in the summer than in the winter. The second diagram shows this variation in four large cities.



From Report of the Chicago Waste Commission - 1914.

As a general rule, the total quantity of refuse to be disposed of during the summer is greater than in winter. The following tables show the amounts of garbage and other refuse collected in a number of Ohio cities, as reported by the Ohio State Board of Health.

TOTAL AND UNIT QUANTITIES OF GARBAGE COLLECTED ANNUALLY.—1907-1908 and 1909.

		Cincinnati	Cleveland	Dayton
1907	Population	352,000	507,000	.....
	Tons	a 32,500	a 37,600	.....
	Lbs. Per Capita	185	148	.....
1908	Population	356,000	525,000	110,300
	Cubic Yards	b 52,200	c 65,997	b 13,480
	Tons	a 32,240	a 41,334	d 9,941
	Cubic Yards per Capita	.1466	.1257	.1220
	Lbs. Per Capita	181	157.4	180
1909	Population	360,000	543,000	113,500
	Cubic Yards	b 54,000	c 65,885	b 16,270
	Tons	a 34,760	a 44,600	d 12,000
	Cubic Yards Per Capita	.1500	.1215	.1430
	Lbs. Per Capita	193.4	164.5	211

NOTES

a Actual weight. Department records.
b Volume calculated from number of wagon loads.
c Volume calculated from number of car loads.
d Weight calculated from data on unit weight secured during studies.

From Ohio State Board of Health.

TOTAL AND UNIT QUANTITIES OF RUBBISH AND ASHES COLLECTED ANNUALLY—1907-1909.

	Cincinnati	Cleveland	Dayton
1907			
Population	352,000	507,000	
Cubic yards	235,370	167,084	
Tons*	92,618	69,674	No records.
Cubic yards per capita	.6687	.3295	
Pounds per capita	526	265	
1908			
Population	356,000	525,000	
Cubic yards	229,818	200,656	
Tons*	90,830	83,650	No records.
Cubic yards per capita	.6455	.3821	
Pounds per capita	510	319	
1909			
Population	360,000	543,000	113,500
Cubic yards	222,634	202,752	55,414
Tons	87,611	84,550	30,200
Cubic yards per capita	.6183	.3734	.4881
Pounds per capita	486	311.6	532.4

*Weight in tons estimated from data secured during studies as follows:
Cincinnati, 787 lbs. per cubic yard; April to November, 682 pounds; January, March and December, 935 pounds.
Cleveland, 834 lbs. per cubic yard.
Dayton, 1,090 lbs. per cubic yard.

From Ohio State Board of Health.

COLLECTION OF CITY REFUSE

The municipal cleaning department should be organized and operated in such a manner that it will obtain a regular collection, prompt removal, and a rapid final disposition of household refuse.

* "In any method adopted for the collection of refuse, there are four requisites for success:

1. A sufficient appropriation.
2. An efficient organization.
3. Sanitary and economical methods of work.
4. Co-operation on the part of the public.

"The first essential is self-evident, for in order to render a satisfactory service, sufficient funds must be provided to carry out the work. The appropriation will be regulated to a large extent by the degree of success obtained in the development of the other three requisites.

"An efficient organization cannot be maintained without a sufficient appropriation, neither can the work be conducted satisfactorily nor economically without an efficient organizations and sufficient appropriation. Co-operation on the part of the public cannot be expected without rendering satisfactory service. All four requisites are dependent on each other to obtain the maximum degree of success. To render satisfactory service, suitable equipment must be provided. Employees must be taught to take pride in their work, and a standard of attainment should be set for each man.

"The sanitary and economical requirements of work will depend, to a great extent, on the money available, and the organization existing. There is no standard of sanitation nor a standard of economy existing at the present time in municipal collection.

Efficient service in the collection of municipal refuse can be obtained by two methods, as follows:

2. By contract where the work is specified and the requirements are such as to obligate the contractor to furnish the desired service.

The contractor must maintain an effective organization, sufficiently equipped and managed to be able to render proper service. A rigid inspection is necessary on the part of the city, and the full compliance on the part of the contractor in carrying out his agreement.

2. By municipal collection, where the city conducts the work with its own teams and equipment, and the men employed on the work are directly responsible to their supervisors, who in turn are responsible to the public for the service rendered.

In the majority of cities throughout the United States, the collection of waste is performed by the municipality. The city owns the equipment and conducts the work under the supervision of the municipal officials. It has been the experience of most cities that the results of municipal operation have, in most cases, proven satisfactory, due to the following reasons:

1. Service is rendered as desired. It is not necessary to specify how and what work is to be done, but the work can be conducted so as to meet conditions as they may arise.

2. The work comes directly under the control of the officials, whose chief object is to render satisfactory service at a reasonable cost.

3. Better equipment can be provided, and the work planned on a

* Quotations so marked are from Chicago City Waste Report by I. S. Osborn and J. T. Fetherston.

more systematic basis, when investments are permanent. By making permanent investments, the first cost can be increased, which results in the use of more modern equipment.

4. Municipal operation eliminates the tendency on the part of the contractor (when work is done by contract) to obtain the largest remuneration possible, at the least cost.

The work of disposing of a city's refuse, including the street refuse, as well as the household wastes, involves so much detail for which there are no definite units to specify and bid for, and, furthermore, as it is of such a character that the overhead charges for proper inspection are disproportionate to the cost of the work, that unquestionably this particular kind of work should be much more effectively and economically carried on directly by the municipal forces instead of by contract. Of the twenty-five largest cities in this country, Philadelphia is the only one which performs this work under the contract system, and there the officials in charge claim that if legislation could be obtained permitting the work to be done by municipal forces, much better results could be obtained.

To secure sanitary and economical methods of refuse collection, suitable equipment must be provided. To obtain the most satisfactory service in municipal collections, the city should own the equipment, as well as employ the men. It is impossible to develop an efficient organization or render the best service in collection with hired teams, where the driver receives his pay from the employer, who in turn receives pay from the city for furnishing the team and driver. The department in charge of the work cannot develop the organnzation from a systematic standpoint when the teams and driver are hired, as the jurisdiction over the men is limited, and the tendency on the part of many is to have little interest in the service.

The teams and wagons should be owned and operated by the city up to the maximum number that can be economically worked. The equipment should be suitable for the work intended and maintained in proper condition. The number that can be economically owned will depend on the average number that can be used. Supplementary equipment should be provided for periods of maximum demand."

It must be fully recognized at the very outset that efficient work in the disposal of city waste materials cannot be accomplished without the active co-operation of the general public. Every effort should be made by the proper city officials in an endeavor to obtain the co-operation of the people at large through the different civic and business men's associations, women's clubs, schools and any other organizations which would be instrumental in exerting any influence in creating an active interest at all times in the work. Circulars should be sent to each householder throughout the city containing important information and instructions designed to improve conditions with regard to suitable and uniform receptacles, the separation of ashes from rubbish and other matters in which the co-operation of the householder is required.

(See instructions of Wheeling, W. Va., Health Dept.)

HEALTH DEPARTMENT

WHEELING, WEST VIRGINIA

The Garbage of Wheeling is Collected Under the Direction of the Board of Control and the Health Department.

1. The owner or occupant of each house is required to provide metallic cans with close fitting covers, and with handles upon the sides.

2. GARBAGE CANS SHOULD BE OF SUFFICIENT SIZE TO HOLD 20 GALLONS. Cans must be placed in a position on the GROUND FLOOR of the premises, easily accessible to the collector, and when filthy, leaking or defective in any way, must be removed.

3. Provide a sufficient number of cans to hold at least SIX DAYS' ACCUMULATION. Garbage will be collected more frequently, but this will prevent an overflow and provide for any emergency.

4. Put into the garbage can only animal and vegetable refuse from the kitchen. Garbage cans containing WATER, SLOPS, TIN CANS, GLASSWARE, CROCKERY, EXCESS PAPER or CUSPIDOR EMPTYINGS WILL NOT BE EMPTIED BY THE COLLECTOR.

5. Garbage drained of all moisture and wrapped in paper before being placed in the can will neither smell badly in hot weather, nor freeze and stick to the can in cold weather. This is the ideal way to keep garbage. Do this and have a clean can all the time. CLEAN GARBAGE IS NOT OFFENSIVE, BUT A FILTHY CAN OR ANY WOODEN GARBAGE RECEPTACLE IS.

6. Report all dead animals to the Health Department, giving the exact location of the same.

7. Report all complaints to the Health Department, City Building.

Both Phones 366. Hours 8 A. M. to 5 P. M.

Hang this card in your Kitchen.

One of the most effective methods of reaching the householder is through the women's organizations. Through their co-operation the housekeeper may be shown how vital is her part in an efficient system of collection of all wastes.

To maintain successfully and efficiently the work of collecting municipal refuse, the regulations as to house treatment of refuse should be enforced. The householder should maintain proper receptacles and comply with the requirements of the city, according to the methods adopted or found most suitable.

To obtain the desired public support, the work must be systematized so that regular collections are made at stated intervals, and, so far as possible, the collections should be made at the same time each day, according to regular schedules. When the householders become accustomed to a systematic refuse collection service, they will depend upon the collector and more readily comply with the laws and ordinances.

An endeavor should be made in every way possible to reach the public in a campaign of education, for it is impossible for any municipality to maintain proper sanitary conditions unless the people of the city do their share, and no matter how well organized and how well the work is performed by the city, it can never be perfected unless the general public appreciates its importance as affecting the health of the community and the appearance of the city.

COLLECTION METHODS

The method or system adopted for the collection of refuse will depend on the conditions to be met, and its adaptability to the work to be performed from a sanitary and economical standpoint.

* "The general practice in cities of the United States may be summarized as follows:

1. Where the collection of garbage alone is made, the municipality is relieved of work that would be necessary if all classes of waste were collected, and the burden is placed on the individual householder. Where this plan is adopted, it usually results in a large amount of ashes and rubbish being thrown on vacant lots or in alleys and streets. Where the householder hires a private scavenger to remove ashes and rubbish, it usually results in a greater cost than where the work is systematically done by the municipality at public expense. This method is only practiced in smaller cities, which have not realized the necessity of a regular and complete collection service, or cannot afford the cost thereof.

2. A separate collection of garbage, ashes and rubbish is the method practiced in many cities. Where this method is used, garbage is disposed of in the majority of cases by the reduction method, or burned in incinerators without being mixed with other waste. Incinerators for burning garbage are usually operated by supplying additional fuel to aid in combustion. Ashes, under these conditions, are usually disposed of as fill, and the rubbish sorted on dumps or in utilization plants, the residue being dumped or destroyed by incineration. In many cases, both ashes and rubbish are disposed of by dumping. Where both are disposed of by dumping, the separation is made to allow the disposal of ashes in places which are not suitable for mixed material.

3. The separate collection of garbage and the combined collection of ashes and rubbish is used with nearly all methods of disposal, but is applicable in most cases to cities where the garbage is disposed of separately, and the ashes and rubbish disposed of by dumping.

4. The separate collection of ashes and the combined collection of rubbish and garbage is adapted to cities where disposal of garbage and rubbish is made by incineration, and the ashes by fill or dumping. In some cases a percentage of the ashes is added to the garbage to aid in burning the mixture.

5. The separate collection of the furnace ashes and the combined collection of rubbish, garbage and stove ashes is used where disposal is made by incineration, the small amount of stove ashes being collected with other material to aid the combustion, the furnace ashes being collected separately and disposed of by dumping in fills.

6. The combined collection of ashes, garbage and rubbish is used where the disposal of all waste is made by dumping or by total incineration.

As stated, the adoption of any method will depend on the conditions, and considerable difference of opinion is expressed as to which plan is desirable.

Irrespective of what plan is adopted for disposal, it is conceded that, from a sanitary standpoint, all waste should be collected and the results show that the best results are obtained when it is done at public expense.

The combined collection of all waste has the advantage that it requires only one receptacle and one type of collection equipment. The housewife will prefer the combined collection for convenience.

The separate collection of garbage requires separate receptacles and additional equipment of different type than where combined collection is made.

When combined collections are made, it will require a more frequent collection of ashes and rubbish and if a separate collection of garbage is made, a more frequent collection of garbage can be made. and a less frequent collection of ashes and rubbish. The ability of men and teams to collect refuse does not depend on the amount collected, but upon the number of stops, distance of travel and the number of receptacles to be handled. A daily collection necessarily costs more than a collection every other day, and a collection twice a week more than once a week. From a sanitary standpoint, due to the nature of the material, garbage will require more frequent collection than other classes of waste.

If all wastes are collected combined, as a rule the unit cost for collection will be less than if collected separately.

Where separate collections are made, there is a tendency to throw garbage into the ash receptacle or rubbish and ashes into the garbage

receptacle. To obtain the desired separation will require the strict enforcement of ordinances as well as the regulations or rules of the collection department. The enforcement of regulations in regard to th collection of waste in American cities does not receive the attention that is given to it by European officials. Rules relating to sanitation in connection with plumbing and other health measures are rigidly enforced in the majority of American cities and with the same amount of energy and education in connection with household treatment of refuse, similar results should be obtained."

The garbage can and the household treatment of the garbage constitute one of the most important and at the same time most neglected phase of the garbage disposal problem. A municipal regulation of household treatment is limited to the garbage can, its condition and its location. Ordinances regulating the disposal of garbage usually require the use of a galvanized or other metallic can, provided with a cover, and of such form that it may easily be kept clean and easily handled by the collector.

The householder is at liberty to choose his own can, except in a few cases where municipalities have adopted an official can, where both the can and garbage are collected. The can should be of metal, water tight, have a closely fitting cover and be of a size convenient to handle. The garbage can should be so located that it is convenient for the collector, for it is the location of the can that determines to a large degree the speed with which garbage collections can be made. A great amount of time may be lost if the collector has to go to inconvenient places in making his rounds.

A number of cities are adopting the method developed in Minneapolis a few years ago of requiring the householders to drain garbage of all moisture and wrap it in paper before placing in the garbage can. This keeps the can clean at all times and prevents the garbage freezing to it in cold weather and from sticking to it in hot weather.

In order that collections may be made efficiently and in a sanitary manner, the type of wagon used must be carefully selected. Wagons which fulfill all the requirements are made of steel, are water tight, have close fitting lids and may be of the dump wagon type. A number of wagons conforming with the above general description are shown in the accompanying cuts. Such wagons may be purchased from the makers at prices ranging from $150 to $275, depending upon

the type and size. The wagons are usually drawn by one or two horses, the number depending upon the size of wagon adopted, the rate which the garbage is collected and the topography of the district served.

Wagons for the disposal of rubbish need not necessarily be covered, as the material is usually dry and the omission of the cover permits of carrying a larger quantity of refuse without overloading in weight.

COST OF COLLECTION

* "In the collection of municipal refuse there are a number of items that must be considered in estimating the cost. The two principal items are:

1. Cost of loading.
2. Cost of haul.

The cost of loading will depend on the following:

1. Method adopted, i. e., whether the material is removed from the premises or placed on the curb by the householder, as well as the manner in which the refuse is picked up, using collector and helper, or by adopting the gang method.
2. Whether the waste is collected separately or combined.
3. Frequency of collection.
4. Character of population.
5. Congestion of population.
6. Type of population.

The cost of haul will depend on:

1. Capacity of wagon.
2. Rate of travel.
3. Grades, pavement, traffic obstruction and day or night work.

It is impossible to establish a standard method to meet all conditions, and the system to be finally adopted should be determined by trials and cost records. The most effective capacity of the wagon should be determined by trials. The larger the load that can be easily handled, the less the ton mile cost for hauling."

The cost of collection in many cases is paid by the city out of its general funds, while in other cases the householder is charged a certain amount for this service. For example, Madison, Wisconsin, charges the householder $3.30 per year for collection of garbage. Council Bluffs, Iowa, furnishes twenty coupons for $1.00, each of which entitles the holder to have one five-gallon can of garbage removed.

METHODS OF DISPOSAL

The various methods that may be adopted for the disposal of city refuse may be divided into seven general divisions and enumerated as follows:

1. Feeding to Swine.
2. Dumping on Land.
3. Dumping into Large Volumes of Water.
4. Disposal by Sanitary Fill.
5. Burial.
6. Incineration.
7. Reduction.

1. FEEDING TO SWINE

This method applies particularly to the feeding to swine of fresh garbage, unmixed with any other form of refuse. It is a primitive method and one which is very commonly followed in the smaller cities and towns.

It is necessary that the garbage be placed in receptacles reserved especially for it and collected at regular intervals while it is fresh. This is a condition which is difficult to obtain when the city attempts to make its own collection, as it is difficult to obtain the necessary co-operation in order that the garbage may be disposed of while in a fresh condition, and still suitable for feeding to swine. The only advantage which may be stated in favor of this method is that it probably costs less, under the existing conditions about most of our cities, than any other available method. The following quotation taken from the annual report of the Massachusetts State Board of Health for 1909 is of interest in showing the attitude of that board on this method of disposal.

"It is objectionable and unsanitary in the extreme, as health authorities are constantly pointing out, but without sufficient support from municipal government or public opinion to secure a satisfactory change. Prominent among the objections to this method of garbage disposal are the great nuisance it usually creates and the uncertainty of its operation. Where garbage is disposed of by feeding to swine, it not infrequently happens that an epidemic among the pigs destroys great numbers of them in a short time, and the garbage accumulates and must be disposed of by some temporary means hastily devised—usually by dumping it into some adjacent water or on the most readily available land, with more or less objectionable results. Difficulties of this sort also not infrequently interfere with the regularity of the collection of these wastes, with the result that they are left to decompose in the neighborhood of dwelling houses. Of the great nuisances caused by piggeries where large quantities of municipal garbage are used, no description is necessary, and in many cities and towns such places are not tolerated, one of the conditions commonly imposed on the collector of garbage being that it shall be removed beyond the limits of the municipality.

Aside from the nuisance which piggeries create, one of the most serious objections to them is the fact that they are breeding places of myriads of flies and other insects, and they are very often the home of great numbers of rats, which at times infest the neighboring buildings and dwellings. The danger from flies, as carriers of disease, is well known, and it has been determined that rats and their attendant parasites are probable agencies in the spread of the plague."

2. DUMPING ON LAND

All the classes of refuse as previously outlined may be hauled and dumped on waste land. The land used for this purpose should be located at a remote distance where the decomposition of any part of the refuse would not be offensive to neighboring property owners. The dumping of garbage on land is objectionable, and especially so where there are large quantities to be disposed of. When the garbage is deposited in sufficient quantity, fermentation and decomposition will give rise to offensive odors and may create a nuisance. When a sufficient quantity of ashes and rubbish is mixed with, or used to cover the garbage, disposal may be had by dumping in remotely located places, and, if properly attended to, should not create a nuisance. If special attention is given to the treatment of the dumps, ashes and rubbish may be disposed of by dumping if they are thoroughly mixed. Unless a thorough mixing may be had, the dumps are liable to fire and create odors and cause a nuisance from smoke and unconsumed gases.

Dumps where ashes and rubbish and other refuse are deposited are not only unattractive in appearance, but are detrimental to the health of those living in the immediate vicinity, and as a city grows, it usually becomes increasingly difficult to find locations where these dumps can be maintained without incurring the objections of those living in the neighborhood.

3. DUMPING INTO LARGE VOLUMES OF WATER

Practically all forms of refuse may be dumped into a large body of water, such as a large stream, lake or the ocean. This method is based on the principle that the water

will dilute and make harmless any material which will float and that heavier particles will sink without interfering with navigation or otherwise becoming a nuisance. This method has been prohibited in many cases on account of the material being washed onto the neighboring shores. A number of cities have followed the practice of using scows for the removal of refuse to safe distances from the shores, but as a rule this method is prohibitive from the standpoint of expense. In practically all cases it is the cleanest form of refuse which sinks and the foulest which floats. It is principally because of this reason that this method cannot be recommended. This method of disposal by cities on the Mississippi river has recently been stopped by the United States government.

4. DISPOSAL BY SANITARY FILL

This is a method which heretofore has been practiced in only a few cities, but it is now being given more serious consideration than heretofore, even by some of the largest cities in the country.

VIEW OF SANITARY FILL AT DAVENPORT, SHOWING WAGON WHICH HAS JUST BEEN DUMPED STANDING ON PREVIOUSLY COVERED GARBAGE.

A LOAD OF GARBAGE AND OTHER REFUSE AFTER DUMPING ON RIVER FRONT, SANITARY FILL AT DAVENPORT, IOWA.

Disposal by sanitary fill should be distinguished from disposal by dumping. It is usually carried on by the filling in of excavations, natural ravines and other low places where the creation of "made ground" may be made an asset to the municipality. This method consists of dumping the garbage onto low ground, spreading it and then covering it in layers with a sufficient quantity of ashes, street sweepings, building excavations and other similar materials. It is desirable that a sufficient quantity of earth should be mixed with the refuse to insure oxidation and thorough digestion of the garbage or other decomposable wastes. This method of disposal when properly performed is effective, cheap and successful in practice. The principle upon which the method rests lies in the activity of the bacteria of the soil. This activity results in a mineralization of the organic matter, and when conducted in the presence of sufficient air or oxy-

gen, no putrefactive or other odors are produced. In order that the method may be followed out with success, the following conditions must be observed:

The garbage must not be buried so deep that bacterial activity is reduced, nor must the garbage be spread in a thick layer on the surface of the ground.

The ground used should be sufficiently open and drained so that the air can penetrate.

The garbage must not overload the soil, but must be sufficiently diluted with earth, ashes or rubbish so that purification may take place, due to the presence of an ample supply of air in the pores of the soil.

The method of "sanitary fill" is used with success in a number of cities, among them Davenport, Iowa; New Orleans, La., and Seattle, Wash. At New Orleans, the dumping grounds are seeded as soon as a sufficiently filled area is available and later trimmed and planted for use as small parks and playgrounds. By adopting this method, the city of Davenport has also made a good start toward creating a river front that will be of immeasurable value to the city.

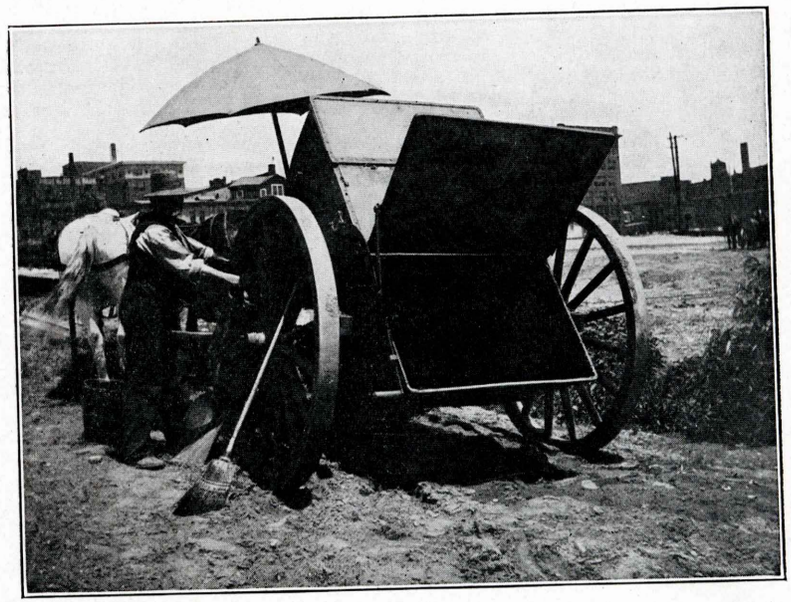
The following data on garbage collection at Davenport, Iowa, furnished by A. M. Compton, Consulting Engineer, are of interest in showing the quantity and methods of collecting garbage in a typical Iowa city.

DATA ON GARBAGE COLLECTION AT DAVENPORT, IOWA.

1914	Cubic Yards of Garbage Hauled by City Teams Only
January	537
February	462
March	558
April	702
May	681
June	895
July	975
August	990
September	982
October	904
November	707
December	691

The above figures do not include garbage hauled by private teams from hotels, restaurants, wholesale fruit and commission merchants, etc., which amounts to about 50% of the above and fluctuates in about the same manner; nor the night soil, which is very regular the year around at about three 3-yard loads for the working day. The garbage collected by the city wagons is hauled by nine 1½-yard wagons six days per week during the heavy season, and by seven wagons five days per week during the winter. The garbage is received and buried by one foreman and three men in summer and by one foreman and one man during the winter months.

The following copy of a letter from the health commissioner of Seattle, Washington, shows the results obtained in that city by the adoption of the "sanitary fill" method of refuse disposal. One incinerator is now used instead of four, which formerly were required to dispose of the city wastes.



A DAVENPORT GARBAGE WAGON WHICH HAS JUST BEEN WASHED AND IS READY TO BE RETURNED TO COLLECTION ROUTE.

The Editor of Municipal Engineering.
Sir:

Your communication addressed to Mr. A. H. Dimock, city engineer, regarding disposal of waste has been referred to this department for reply.

We are at present disposing of our garbage and waste by making sanitary fills, or at least of all but sixty-five tons per day, which is incinerated. This is light material and such as would be difficult to dispose of at the present fills on account of their location.

This method of filling works very satisfactorily in this climate, but I believe it necessary to include all waste materials, as ashes, boxes, tin cans, etc. These all assist oxygenation and nitrification. I do not believe pure garbage can be handled in this way.

We also find that it is best to keep as little of the face of the fill exposed as possible. It is always best to keep a man constantly on the job, whose duty is to rake down to the bottom of the fill all boxes, rough materials, etc., thus leaving the ashes to form a covering on top. When this is not sufficient, we cover wtih a layer of earth about five inches thick.

The success lies in the proper mixtures of waste materials, and next the fill must be properly covered to protect from flies. Chemicals can also be used to protect same. This covering also prevents the slight sour odor of fresh garbage, and, by keeping out the sunlight, at the same time encouraging bacterial growth by increasing the warmth inside of the fill. People residing within one hundred feet of these fills make no complaint, but the public has to be educated when you first adopt this method. We aim to fill city property, as ravines, swampy land or docks on the lake or salt water front.

Enclosed find copy of our laboratory findings, which will show that the process is simply one of slow incineration by nature instead of the expensive method of burning by incinerators, and at the same time will help prove that there is nothing detrimental to public health in these fills.

We have eleven fills distributed over our city, thus making short hauls, and these are taken care of by eleven laborers, disposing of approximately three hundred and fifty tons per day by this method alone, while one incinerator with about an equal pay roll will only dispose of sixty to seventy-five tons per day, running twenty-four hours. A fill increases the value of property, while the refuse from our incinerator has to be hauled away at an added cost.

(Signed) J. S. McBride,
Seattle, Washington.

Following is the chemist's report referred to:

Results of chemical examination of samples of "garbage borings" submitted to this laboratory for examination:

Sample Number	Moisture Per cent.	Organic Matter (Unburned Coal) Per cent.
Three months old:		
1	26.17	16.26
2	24.29	18.79
7	29.86	10.02
Six to eight months old:		
3	29.40	8.79
4	24.90	7.80
5	32.46	9.10
6	33.03	10.02
One year old:		
8	15.00	12.41
Eighteen months old:		
9	8.33	7.32

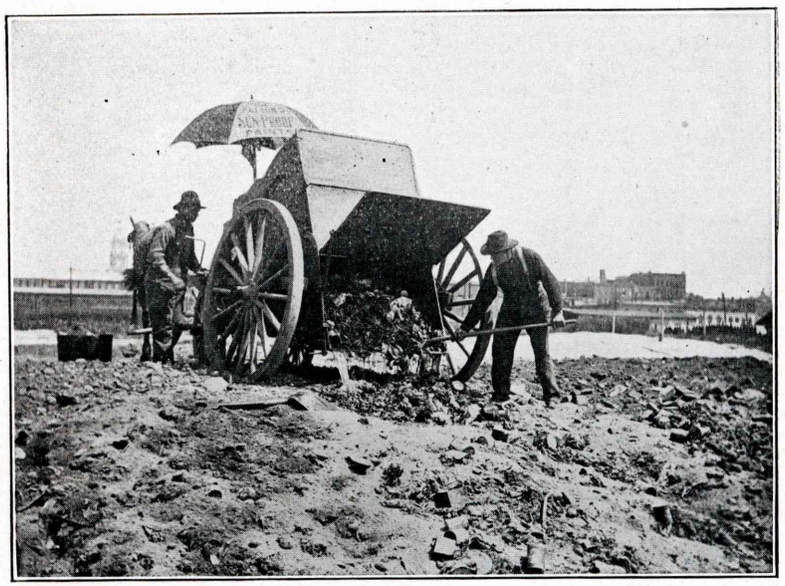
The organic matter in the above samples consists almost entirely of carbon or unburned coal. The samples contain very little of a fermentable or decomposing nature. The decomposing matter in the above samples would in all probability not amount to over 0.1 per cent.

(Signed) A. Jacobson,
City Cheimst.

From "Municipal Engineering," Feb., 1915.

5. BURIAL

The burial method applies more particularly to garbage than to the other classes of city refuse. By this method garbage is buried in shallow trenches, where it digests and is thoroughly taken up or oxidized by the action of the soil. It has been found where this method has been used that after a period of about three years the garbage will become humus, and shows no resemblance to what it was in its original state, and the land can be used over again. Burial of garbage may also be obtained by plowing it into the soil

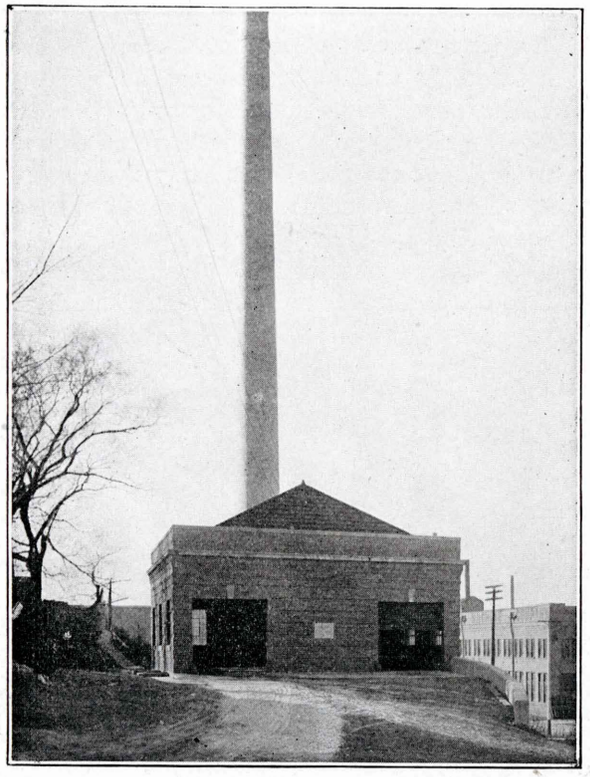


A PARTIAL LOAD OF GARBAGE BEING DUMPED AND SPREAD ON DISPOSAL SITE AT DAVENPORT.

after it has been spread evenly over the surface of the ground. The method may be considered as a sanitary form of garbage disposal, but where large quantities of garbage must be disposed of, such as may be produced in our larger cities, the amount of land required would become excessive.

6. INCINERATION

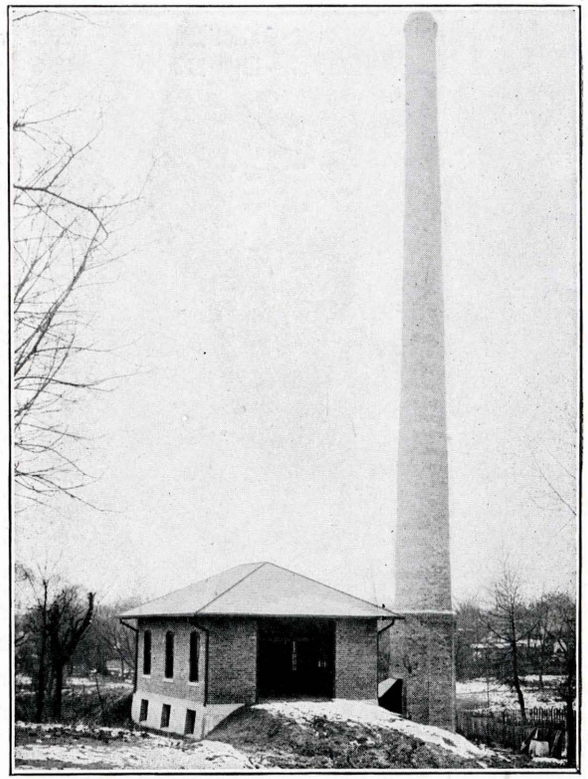
Incineration consists in the disposal by burning by fire of all forms of refuse that may be combustible. This system involves the construction and operation of a specially built



VIEW OF RACINE, WISCONSIN, INCINERATOR PLANT.

plant for the purpose. It is difficult to dispose of garbage alone in such a plant unless the garbage has been well drained of any excess moisture that may be present, and un-

less some form of fuel is consumed with it. It, however, has the advantage over other methods in that almost all forms or classes of refuse may be disposed of by the one process. When rubbish, street sweepings and the more combustible part of ashes are mixed with garbage, the whole mixture becomes self-combustible. A revenue to meet part of the cost is sometimes secured by utilizing the heat derived from in-



25 TON INCINERATOR AT PETERSBURG, VIRGINIA.

cineration for the generation of steam and power and using the clinkers and ashes for filling.

The capacity of incinerator required for any community depends upon the quantity and quality of the refuse collected, and these in turn depend to a large degree on the

TEST OF INCINERATOR PLANT, PETERSBURG, VA.

Rated Capacity, 25 tons in 24 hours.

No. of test	1	2	3	4	5
Date of test	Jan. 5	Jan. 7	Jan. 9	Jan. 14	Jan. 16
Weather	Clear	Clear	Clr.Wdy.	Clear	Clear
Duration of test, hours	10.0	7.0	10.5	6.75	6.0
Mixed refuse consumed, pounds	24,630	20,880	29,510	21,530wet	20,550
Horses and animals consumed, pounds		1,220	700		
Total material destroyed, pounds	24,630	22,100	30,210	21,530	20,550
Per cent of ashes and combustible in refuse receivedat plant (approx.)	50	40	20	20	20
Refuse burned per hour, tons	1.23	1.58	1.44	1.59	1.71
Equivalent incineration in 24 hrs.	29.52	37.92	34.56	38.16	41.04
Equivalent incineration per sq. ft. of grate, per hour, lbs.	43.9	56.4	51.4	56.8	61.1
Labor cost as per terms of contract, dollars	5.50	3.85	5.78	3.71	3.30
Labor cost per ton as per contract, cents	44.7	35.0	38.1	34.6	32.1
Actual labor cost as operated by city, dollars	6.33	4.43	6.65	4.27	3.80
Actual labor cost per ton, cents	51.4	40.2	43.9	39.9	37.0
Cost of fuel required, coal, wood					
Fuel cost per ton, cents					
Total cost of operation per ton as per contract, cents	44.7	35.0	38.1	34.6	32.1
Total actual cost of operation per ton, cents	51.4	40.2	43.9	39.9	37.0
Guaranteed cost of operation (including labor and fuel) per ton, cents	50.	50.	50.	50.	50.
Condition and amount of smoke	light white	light white	light white	practically none	light white

climatic conditions, character of the population and habits of the people. The various incinerator companies usually estimate the capacity of plant needed at about one ton per day per thousand people. The construction of incinerators will be usually found to cost from $700 to $1,200 per ton capacity per day. The costs of operation vary from city to city, and in any particular city, from month to month, according to the season of the year. Including all interest, depreciation and fixed charges, as well as operating expenses, the cost of incinerating garbage will average from $1.50 to $2.75 per ton. The State Board of Health of Ohio, for example, found that in Canton the cost of incineration per ton ran from $1.97 to $2.50; in Marion from $2.00 to $2.66; in Steubenville, $1.00 to $1.84, and in Zanesville, about $2.58 during a period of several years.

There probably have been as many as three hundred different installations of incinerators made for municipalities in this country, varying widely in design. Of this number the greater portion have been permanently discontinued after a short period of operation. This result is due to a large number of experimental incinerators and to a lack of appreciation on the part of their builders of correct principles in the design of the furnaces. In other cases, incinerators have been abandoned because they have been operated by incompetent employees, who, because of their lack of fitness for the work, have destroyed the usefulness of the plant. In many cases, sufficient study has not been made of the conditions that affect the problems, and the result has been the adoption of methods that were not suited to the conditions as they really existed. In order to obtain best results, it is necessary that the conditions must be known in advance and the work planned in accordance with them.

7. REDUCTION

The reduction method is one which is used principally for the disposal of garbage and dead animals. The garbage is broken down by means of heat, and the by-products are recovered and disposed of for commercial purposes and thus reduce the cost of disposal. The garbage is first cooked in closed tanks or digestors for a period of several hours for

the recovery of grease, which may be sold for various purposes at prices ranging from three to five cents per pound. The quantity of grease that may be recovered from the average city garbage may amount to sixty pounds or more per ton of garbage, but usually there is a considerable variation in this item. After cooking and recovery of the bulk of the grease, the residue or tankage is then pressed for the removal of moisture and residual grease and after drying and grinding is sold for fertilizing purposes. In quantity, it may amount to from two to four hundred pounds per ton of garbage treated, and when ground and dried may be worth about $2.00 per ton.

The reduction process is used chiefly in cities having a population of 100,000 or more, and from which there may be received not less than 75 tons of garbage per day. The reduction process involves the use of much patented equipment, and the works are usually operated by private companies under contract with the city. In a few cases, however, such a plant is owned and operated by the municipality; notable cases being the cities of Cleveland and Columbus, Ohio. The cost of a reduction plant for such cities will range from $1,500 to $3,000 per ton of daily capacity.

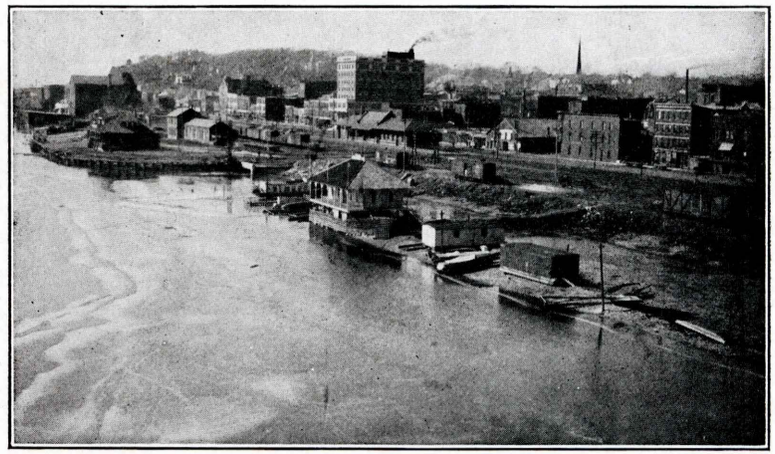
The successful operation of a reduction plant is dependent upon a very efficient technical administration. It is extremely difficult, if not impossible, to prevent the emission of objectionable odors in such a plant, and the fact that these plants are usually located on the extreme outskirts of the city being served is an admission of the nuisance liable to be created.

APPLICATION OF THE VARIOUS METHODS OF WASTE DISPOSAL TO IOWA CONDITIONS

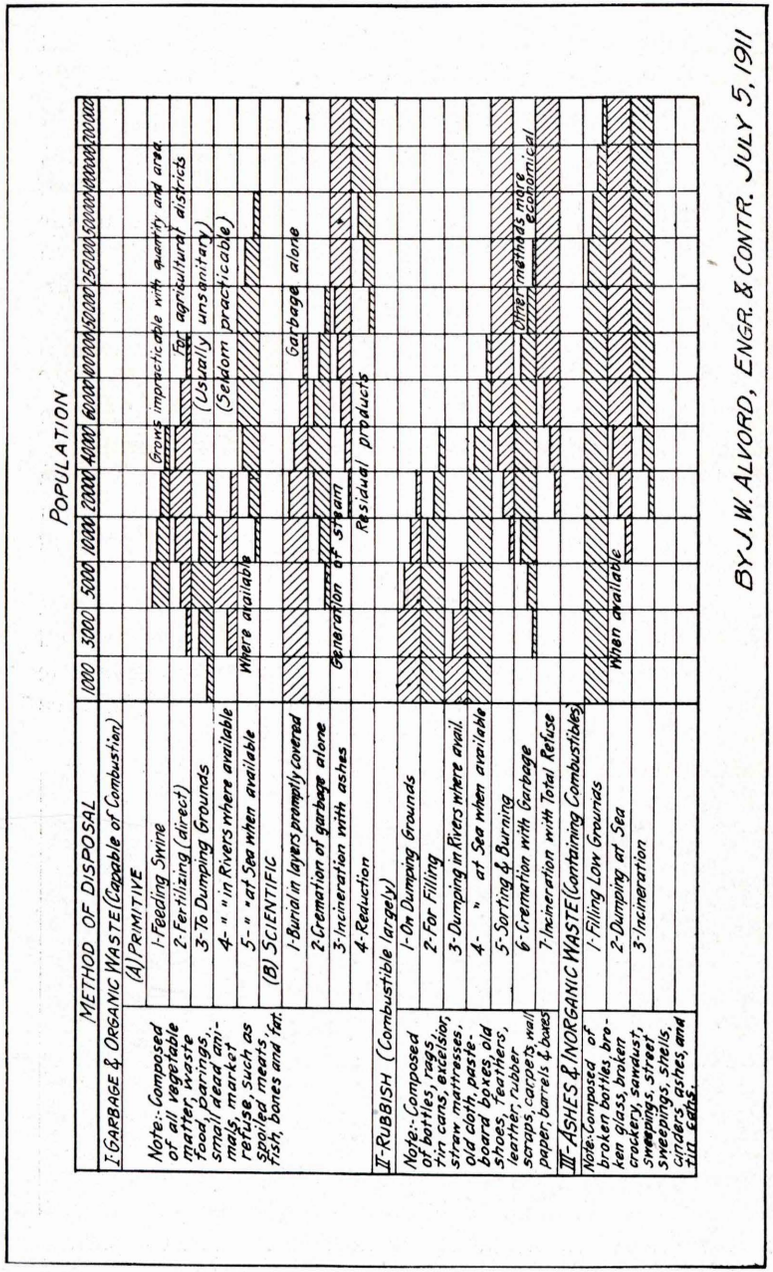
In arriving at a conclusion that will warrant the adoption of any particular method or a combination of different methods for the disposal of municipal wastes, it is found as a general proposition that the population of a city, under average economic conditions, serves as a basis to determine the kind and number of methods to which the general problems may be reduced for detailed study.

In applying the above discussed methods for the disposal of city refuse to the cities and towns of the state of Iowa, using population only as a guide, it is believed that the methods discussed under the heads of disposal by sanitary fill and by incineration are the most applicable. Des Moines is probably the only city in the state where the reduction process may be seriously considered as part of a general refuse disposal system.

The accompanying diagram reproduced from a report by J. W. Alvord, Consulting Engineer, on garbage disposal at Davenport, Iowa, shows in a clear manner the economic methods that may be adopted for the disposal of city wastes according to population.



RIVER FRONT AT MUSCATINE, LOOKING SOUTH FROM THE HIGHWAY BRIDGE, SHOWING GENERAL LOCATION PROPOSED FOR CONSTRUCTION OF RETAINING WALL AND FOR THE DISPOSAL OF THE CITY REFUSE BY THE "SANITARY FILL" METHOD.



BY J. W. ALVORD, ENGR. & CONTR. JULY 5, 1911

DIAGRAM SHOWING ECONOMIC METHODS OF CITY WASTE DISPOSAL, ACCORDING TO POPULATION. THE SIZES OF THE SHADED AREAS SHOW THE RELATIVE PRACTICABILITY OF METHODS FOR ANY SIZE CITY.

RIVER FRONT AT MUSCATINE, LOOKING NORTH FROM THE HIGHWAY BRIDGE, SHOWING SITE NOW BEING USED AS A DUMP. IT IS PROPOSED TO CONVERT THIS DUMP INTO A "SANITARY FILL" THUS DEVELOPING A VALUABLE PIECE OF RIVER FRONT PROPERTY.

In order that a specific application of the methods outlined above might be made to Iowa conditions as an example, conditions were investigated in Muscatine some time ago, in co-operation with the city authorities.

Muscatine is an industrial city located on the Mississippi River, having a population, according to the 1910 census, of 16,178. The present population is probably not far from 17,500.

In selecting an economic method for the disposal of the wastes of Muscatine, a study of the accompanying diagram would indicate that of the scientific methods of handling garbage alone, there are available only two which could properly and economically be considered; that of "sanitary fill" or burial in layers promptly covered, and that of "incineration," wherein the garbage, mixed with some form of fuel, is burned in specially constructed furnaces. Muscatine has a number of suitable and available sites which may be used for the disposal of garbage by the method of sanitary fill. The site considered particularly useful for this purpose at present consists of the low-lying land adjacent to the river and opposite the principal business district of the

city. By the construction of a suitable retaining wall along the river front, and the filling in back of it with a sanitary fill, a very desirable and valuable piece of public property will be gradually obtained. The advantages of such a river-front property to the city are very apparent and need no further discussion here.

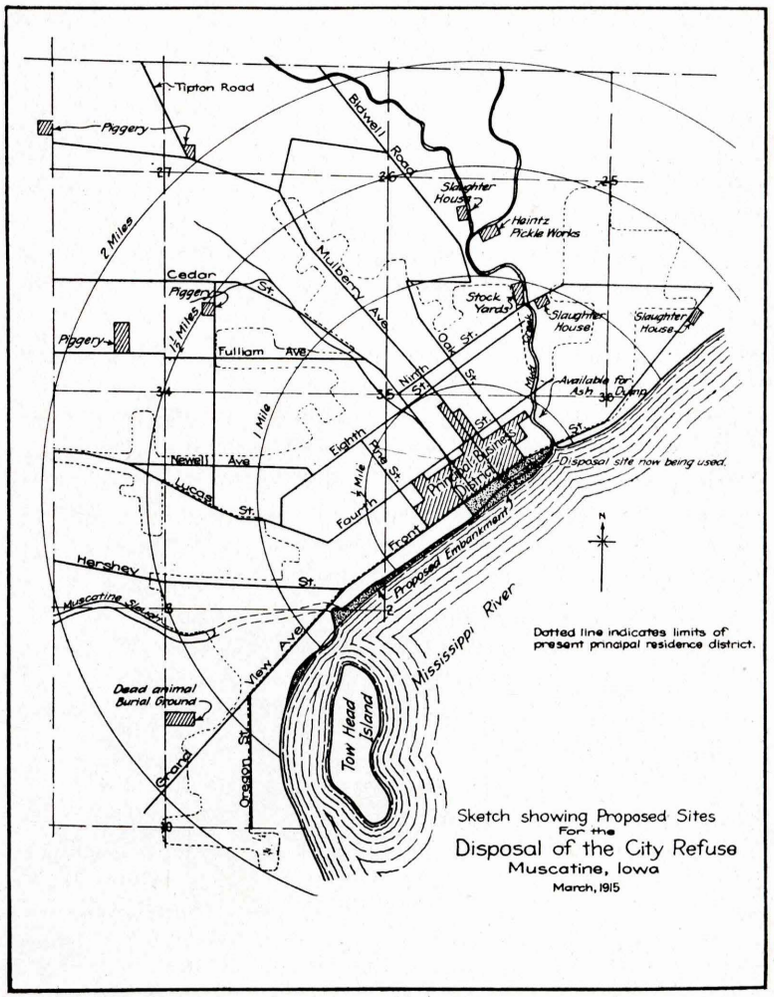
With the river-front site available and highly desirable, if only filled in, it seems that disposal by sanitary fill is the simplest and most economical method that can be adopted. It is a method which requires no expensive skilled operation and no large initial investment, properly chargeable to waste disposal, with resulting fixed charges.

Under such conditions, the sanitary fill method should be given a thorough trial until the method has become exhausted or found inapplicable, due to extensive future growth of the city. The accompanying sketch shows the proposed sites that may be used for the disposal of the city refuse. Rubbish may be disposed of by burning or may be used as a covering for the deposited garbage. Earth from excavations, etc., is preferable for this purpose and should be obtained wherever possible.

The topography of the city of Muscatine is such that practically all of the collection and haul of the wastes will be down hill toward the proposed disposal site. Two steel body garbage wagons with which to begin a collection system should be purchased, and provision should be made for the purchase of another, as it may be found necessary to increase the equipment after the collection system has been in operation a short time, and the citizens begin to take full advantage of the same.

The only strictly sanitary form of wagon for garbage collection is one of steel, with parts carefully riveted together, kept well painted, water-tight, covered and capable of being dumped. The wagons should have a capacity of 2½ cubic yards (not less than 2 cubic yards) and will cost about $275 each.

In order to minimize the cost of collection, the wagon routes should be so selected that they are approximately the



same length, and that a full load is obtained by the time the end of the route is reached.

Rules should be adopted applying particularly to the provision of proper receptacles and their location to facilitate removal.

Records of cost and the quantity of refuse disposed of should be kept. Should it ever seem advisable to change the system of disposal, these records will be of value.

METHODS OF REFUSE COLLECTION AND DISPOSAL USED IN IOWA CITIES.

Very few Iowa cities have organized systems of refuse collection or disposal, it being left in most cases for the individual to find some method for the disposal of the refuse accumulating on his own premises.

Below are given very brief outlines of the methods used in several cities having organized systems of disposal:

DES MOINES—Garbage is collected twice a week by private collectors licensed by the city. Water-tight covered receptacles, with a capacity not exceeding two bushels, are required. Collectors charge 90 cents per month if receptacle is furnished by householder and $1.00 per month if furnished by collector. Garbage wagons are water-tight and are disinfected with chloride of lime each time they are unloaded. Garbage is dumped and covered. Street sweepings are collected and disposed of by the city.

DAVENPORT—Garbage, ashes and other rubbish are collected by city twice each week. No separation of garbage and rubbish is made. Householders use a covered galvanized iron receptacle. Water-tight, covered steel wagons are used in collection, which are disinfected daily. Disposal is by sanitary fill along river front. Six thousand loads were collected last year at a cost of $15,000 to the city. No charge is made to householders.

DUBUQUE—Garbage is kept separate from other refuse and is collected by contractor daily in summer and twice a week during winter. Galvanized covered receptacles are required. Covered water-tight wagons are used, which are scrubbed nightly. Disposal is made at contractor's rendering plant. Collection and disposal cost the city $10,738.09 last year. No charge is made householders. Provision is made for the collection of ashes and other refuse.

CEDAR RAPIDS—Garbage is kept separate from other refuse and is collected by municipality twice a week in summer and once a week in winter. Covered metal cans are required. Seven water-tight steel wagons are used, which are washed after every trip. Disposal is by dumping on city

dump. Cans, bottles and other rubbish (except ashes and manure) are collected by city. Disposal and collection cost the city $5,906.27 last year. No charge is made to householders.

COUNCIL BLUFFS—Garbage is collected by city two and three times a week. Galvanized covered receptacles are required. Separation of garbage and rubbish is not required. Householders are supplied with 20 coupons for $1.00, each of which is good for the collection of a 5 gallon can of garbage. Disposal is by dumping and covering with earth. Collection and disposal cost the city $1,017.75 last year.

TYPE OF WAGONS USED FOR THE COLLECTION OF GARBAGE AND OTHER RUBBISH AT COUNCIL BLUFFS.

WATERLOO—Garbage which is separated from other rubbish, is collected weekly by private collectors, who charge householders 50 cents per month. Water-tight wagons are used for collection. Disposal is by dumping on city dumps and by feeding to swine.

BURLINGTON—Garbage is collected by contractor twice a week. Galvanized covered receptacles are required. Water-tight steel wagons are used for collection, which are washed with hot water nightly. Disposal is by covering with earth. Cost to the city of collection and disposal was $6,000 last year. No charge is made householders. No pro-

vision is made for collection of ashes, manure and rubbish.

KEOKUK—Garbage is collected by private parties every other day in summer, and twice weekly in winter. Householders provide a water-tight receptacle. The usual charge for collection is 60 cents a month. Garbage is disposed of by burial.

MASON CITY—Garbage is separated from other refuse and is collected by contract twice a week in residence district and three times a week in business district. Housholders provide metal cans with covers, placed so as to be accessible to collectors. No provision is made for other refuse collection. Covered water-tight wagons are used for collection, which are cleaned daily. Disposal is by feeding to swine outside city limits. Collection and disposal cost $2,120 last year. This years' contract is for $2,500. No charge is made to householders.

FORT DODGE—Garbage is separated from other refuse and is collected by the city. Covered metal receptacles are used in collection. Disposal is by burial and feeding to swine. Collection and disposal cost $600 last year.

CHARLES CITY—Garbage is separated from other refuse and collected by private parties twice a week. Householders provide galvanized cans with covers. Disposal is by feeding to swine and for fertilizer. Collection cost the city $450 last year.

IOWA CITY—Garbage is separated from other refuse and is collected daily by the municipality. Householders provide metal receptacles with tight fitting covers. A covered steel wagon is used for collection. Garbage is disposed of to farmers and swine feeders. Property owners dispose of their own ashes and other refuse. Garbage collection and disposal cost the city $122.33 per month last year, no charge being made to householders.

FAIRFIELD—Collection of garbage is made by private party under contract with the city, two and three times per week. Householders are asked to furnish covered receptacles. Water-tight wagons are used for collection. Collection and disposal cost $200 last year.