Administrative Report



# Sanitary Landfill as a Land Use

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Land, water and the air are the only three repositories available to accept solid wastes. The improper disposal of such wastes can cause pollution to all three. Solid wastes, on the other hand, can become a community asset if they are properly handled and disposed.

The total solid wastes produced from all sources in the United States reached about 4.3 billion tons in 1969. A little more than 8 percent, or 360 million tons, was classified as residential, commercial, and institutional solid wastes. Another 2.3 billion tons were agricultural wastes, and 1.7 billion tons were mineral wastes. Included in this annual discard were 8 million television sets, 7 million cars and trucks, 30 million tons of paper, 48 billion cans, 26 billion bottles and jars, and 4 million tons of plastic.1/ Much of this material will neither decay nor burn.

Sources differ on the amount of solid wastes generated on a per capita basis. Most fail to separate residential, commercial, institutional, and industrial wastes. According to a study released in 1972,2/ each person in the United States is currently generating an estimated 8.6 pounds of solid wastes per day. Of this, 3.9 pounds are residential, 2.5 pounds are commercial, and 2.2 pounds are industrial.

Although the cited study is one of the first to consider commercial and residential solid wastes separately, it is only applicable to those wastes that are collected. If wastes that are abandoned, dumped, disposed of at the point of origin, or hauled away by the producer to a disposal site were considered, the per capita solid wastes generated per day would probably reach 10 pounds. At a 4 percent annual rate of increase, each person will be producing approximately 11.8 pounds of solid wastes on a daily basis by 1980.

The storage, collection, and disposal of solid wastes is expensive. An estimated 190 million tons of solid wastes are collected annually by collection agencies and hauled to disposal sites at a cost of $4.5 billion, or more, per year.3/ Approximately 80 percent of this cost is for collecting the waste and transporting it to the disposal sites. Litter collection averages $88 per ton--4 times more per ton than the collection of residential refuse. Upgrading the nation's present waste disposal facilities would cost about $4.2

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1/ "Toward a New Environmental Ethic," Environmental Protection Agency, U. S. Government Printing Office, Washington, D.C. 1971.

2/ The Private Sector in Solid Wastes Management--A Profile of its Resources and Contribution to Collection and Disposal, Vols. I & II, November 10, 1972, from data collected, 1970-71. Republished July 1973.

3/ "Toward a New Environmental Ethic," Environmental Protection Agency, U. S. Government Printing Office, Washington, D.C. 1971.

billion, making expenses for disposing solid wastes third to expenditures for education and highways.

The two most common disposal methods are incineration and landfill. Over 90 percent of all solid wastes eventually go to some type of land disposal site, such as open dumps or sanitary landfills. The final disposal site for an estimated 77 percent of all collected solid wastes is the open dump. Thirteen percent is deposited in "sanitary" landfills, which in many cases do not conform to the definition of a sanitary landfill. Nearly all the remaining 10 percent is burned in incinerators. A small quantity is turned into conditioners by the composting process; some is flushed down drains through garbage disposals; a small though troublesome quantity of waste is dumped at sea; and some small amounts are recycled.

There are approximately 300 municipal incinerators in the United States, handling about half of the tonnage burned. The rest of the waste is handled by the thousands of small, privately owned trash burners. Incinerators are used in large cities because of the tremendous volume of refuse, and the high cost of transportation and the land make landfill operations difficult. Seventy percent of these 300 incinerators lack adequate air pollution control devices. Incineration is only about 70 to 80 percent efficient so there is always a residue requiring some form of land disposal. This can lead to land pollution when improperly burned residue is later deposited in landfills. The overall reduction efficiency of the burners is closer to 50 percent, as many items, such as appliances and scrap metals, are not incinerated and must be disposed of on land.

Of the estimated 16,000 landfills in our nation, 94 percent are open dumps (with open burning, no daily cover, and no cover when completed). Less than 6 percent of the landfills meet the definition for a sanitary landfill.[4/] A landfill is actually an engineering project, as defined by the American Society of Civil Engineers:

> A method of disposing of refuse on land without creating nuisances or hazards to public health or safety, by utilizing the principles of engineering to confine the refuse to the smallest practical area, to reduce it to the smallest practical volume, and to cover it with a layer of earth at the conclusion of each day's operation, or at such more frequent intervals as may be necessary.

At the present time, about 150 acres of land are required per year for sanitary landfill operation per million population. Another way of stating annual land use requirements is in acre-feet. Waste can be disposed on land to an average depth of 10 feet. About 1,500 acre-feet per year per million population are needed for current sanitary landfill operations. These estimates may change if the ratio of land disposal to waste volume reduction

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4/ American Society of Civil Engineers, Manual No. 39, Sanitary Landfill 1 (1959).

methods used on solid wastes changes substantially. The residue from volume reduction processes, such as incineration, must be added to direct fill requirements. This requires another 500 acre-feet, making a total land volume requirement of 2,000 acre-feet per million population per year.5/

Cover materials differ in their suitability and must be chosen to fit the needs of a particular site (see table). A minimum daily cover of 6 inches and a minimum of 2 feet of compacted earth for the final cover are recommended. The cover must assure that wind and water erosion do not expose the wastes, must keep flies and other insects out, and must provide a base for subsequent land uses.

The site must have favorable geology to avoid ground and surface water pollution. Landfill operations cannot usually be carried out in flood plains or near rivers, streams, and lakes. Climate, particularly the amount of rain and the extent and severity of freezing, has a bearing on landfill design.

Three major techniques are involved in landfilling: area method, trench method, and ramp variations (see accompanying diagrams). In the area method, after the solid wastes are deposited on the land, a bulldozer or some such equipment spreads and compacts the solid wastes. The area is then covered with a layer of earth and the material is compacted again. This method of disposal is particularly suitable for canyons, ravines, valleys--places where land depressions already exist. Cover materials will probably have to be hauled in from a nearby area (diagram #1).

The trench method of disposal requires a trench in the ground, wherein the wastes are spread, compacted, and daily covered with earth, usually with the material excavated from the trench. This technique is ideal for areas with a low water table and where soil is deep enough for trench excavation (diagram #2).

The third method is the ramp or slope method, a variation of the other two. The solid wastes are deposited on the side of an existing slope, spread in thin layers, compacted, then covered and compacted again. This method is generally suitable for any area; it has an advantage in smaller landfill operations since only one piece of equipment is needed (diagram #3).

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5/ Mr. E. P. Baker, Jr., P. E., Office of Solid Waste Management Programs, Cinn., Ohio, in a letter dated 7/21/72. Acreage estimates are based on the following:

| | | |
|---|---|---|
| 3.9/day = 1,423.5 lbs. per year per capita | | (residential) |
| 2.5/day = 912.5 lbs. per year per capita | | (commercial) |
| 2.2/day = 803.0 lbs. per year per capita | | (industrial) |
| Total = 3,139.0 lbs. per year per capita overall | | |

4,745 tons = 1 acre-foot
1 million people will generate 1.4 million pounds or 711,750 tons, which will require 150 acres @ 10 acre-feet per ton.

COVER MATERIAL SUITABILITY OF GENERAL SOIL TYPES

| Function | General soil type | | | | | |
|---|---|---|---|---|---|---|
| | Clean gravel | Clayey-silty gravel | Clean sand | Clayey-silty sand | Silt | Clay |
| Prevent rodents from burrowing or tunneling | G | F-G | G | P | P | P |
| Keep flies from emerging | P | F | P | G | G | E* |
| Minimize moisture entering fill | P | F-G | P | G-E | G-E | E* |
| Minimize landfill gas venting through cover | P | F-G | P | G-E | G-E | E* |
| Provide pleasing appearance and control blowing paper | E | E | E | E | E | E |
| Support vegetation | P | G | P-F | E | G-E | F-G |
| Be permeable for venting decomposition gas† | E | P | G | P | P | P |

E, excellent; G, good; F, fair; P, poor.
* Except when cracks extend through the entire cover.
\+ Only if well drained.

Source (1).

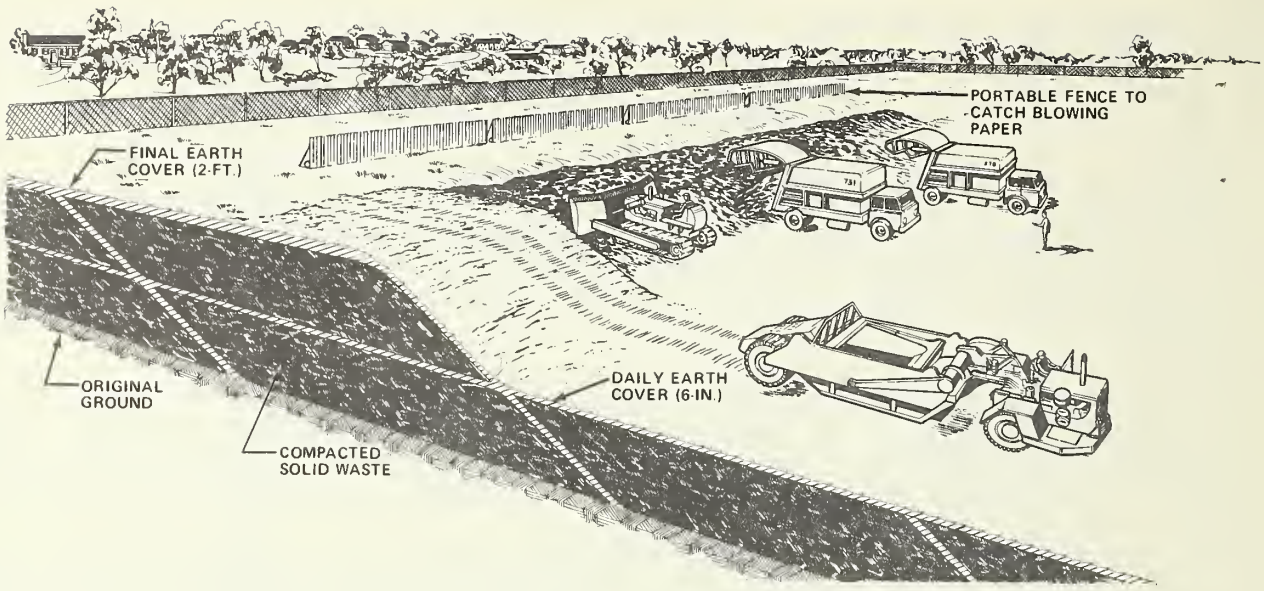


Diagram 1.

AREA METHOD. The bulldozer spreads and compacts solid wastes. The scraper (foreground) is used to haul the cover material at the end of the day's operations. Note the portable fence that catches any blowing debris. This is used with any landfill method. Source (9)

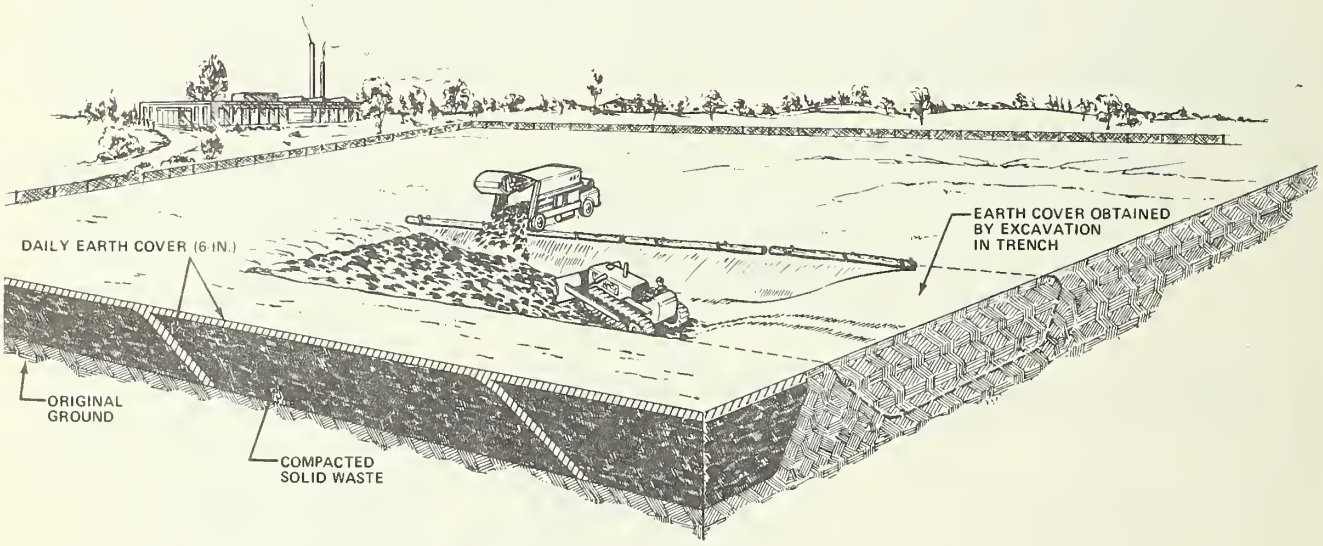


Diagram 2.

TRENCH METHOD. The waste collection truck deposits its load into the trench where the bulldozer spreads and compacts it. At the end of the day the dragline excavates soil from the future trench; this soil is used as the daily cover material. Trenches can also be excavated with a front-end loader, bulldozer, or scraper. Source (9)

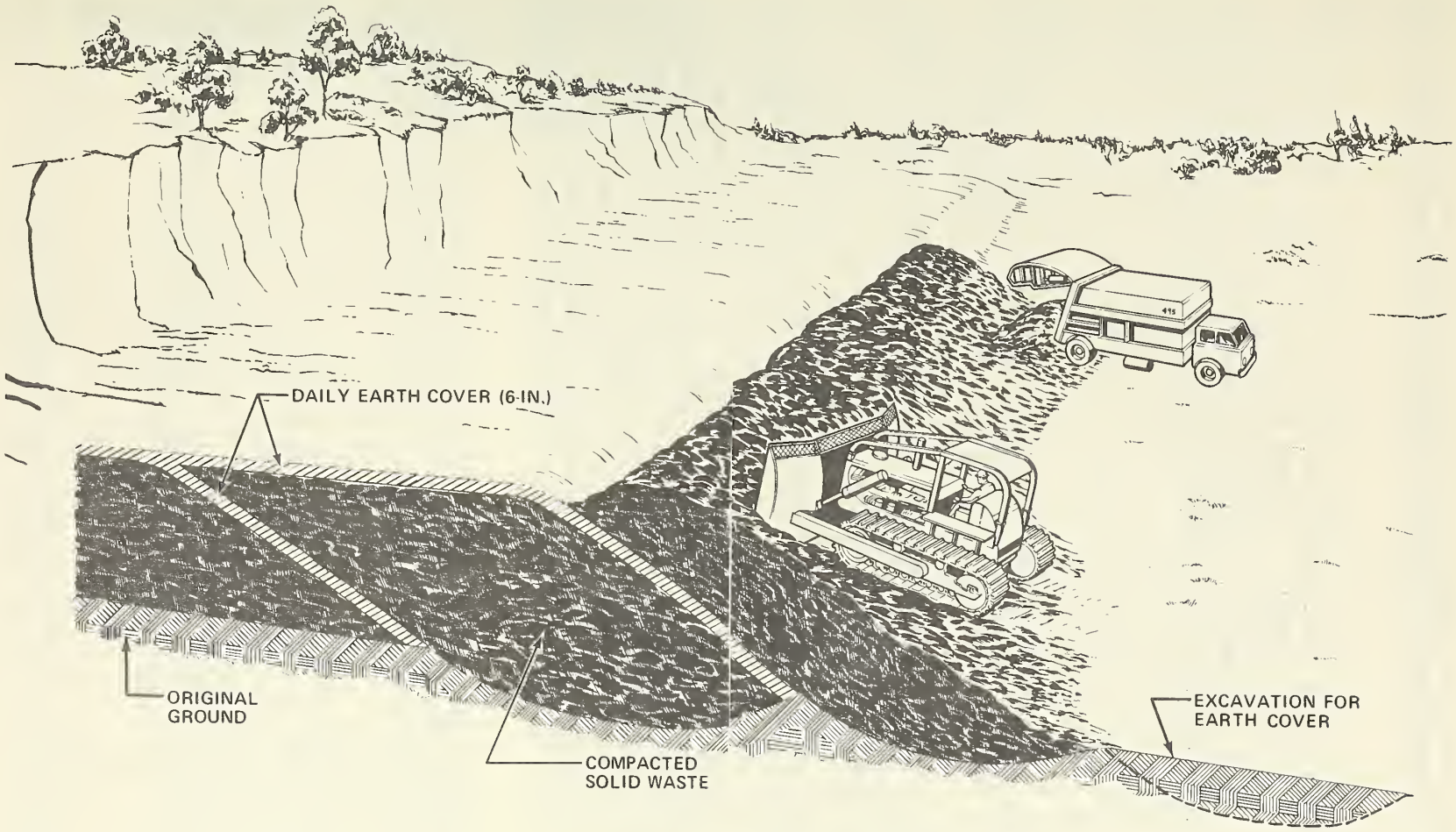


Diagram 3.

RAMP VARIATION. Solid wastes are spread and compacted on a slope. The daily cell may be covered with earth scraped from the base of the ramp. This variation is used with either the area or trench method. Source (9)

In all three landfill methods, a daily completion of compacted waste and cover material is called a cell; these daily cells, all the same height, constitute a lift. A completed landfill is made up of one or more lifts, one on top of the other.

During operations, provision must be made for some of the problems that are common to landfills. Blowing paper, the most frequently reported problem, can be controlled by fences, prompt compaction and coverage, and a daily pick-up of loose paper. Also, precautions must be taken for adequate drainage, to prevent excessive seepage into the landfill and/or possible erosion of the cover material, thus exposing the waste materials. If the landfills (especially trenches) operate in a cold region during the winter months, it may be necessary to excavate and stockpile the cover material and prevent it from freezing.

Some problems could affect public health. A well-operated landfill, properly compacted and suitably covered, should present no serious problem. Dust, in dry weather, may be controlled by sprinkling the cover area (but not the wastes). Odors from the gases produced are best restrained by continuously covering the wastes throughout the day and making sure surface cracks are sealed. The nuisance from wildlife, such as birds and gulls, will be minimal if the landfill is kept clean and covered.

Generally, groundwater pollution and decomposition gases pose the biggest post-landfill problems. Leachate is a result of groundwater or surface seepage mixed with dissolved, finely suspended solid matter as well as microbial waste products. If the solution is in contact with these water sources, the water will become polluted and unfit for use. Leachate is only caused when all or most of the landfill receives water from outside. It can be controlled by locating the site away from lakes, streams, and other water sources; avoiding subsurface materials that will conduct the leachate to water sources; using the correct cover material; and grading and providing trenches to carry away surface water. Any leachate should be collected and treated for water pollution.

The major decomposition gases produced in landfills are methane and carbon dioxide; nitrogen sulfide also occurs. Within the first 2 years following landfill, gas production will probably reach a peak and then gradually decrease. Methane poses a danger if it is allowed to accumulate in close spaces, such as buildings, on or near the landfill. If the methane can be diffused into the atmosphere, such as through gravel vents, trenches, or vent pipes, there should be no problem. Carbon dioxide can cause mineralization of groundwater if it dissolves, forming carbonic acid. In the case of either leachate or gas movement, fine-grained soils, clays, or synthetic liners used in the bottom of the landfill area will help. It is essential that the landfill site be monitored, by drilling peripheral wells in strategic locations around the fill, to insure against any groundwater pollution and/or gas movement.

The rate of waste decomposition varies depending on climate and moisture. It is very slow, in any case, and even slower in dry areas such as Arizona. Approximately 95 percent of the settlement of a landfill takes place within

the first 5 years, and the remaining settlement over a longer period of time. The depth of the fill, composition, compaction, and many other factors determine the rate of settlement.

Underground fires occur, although rarely, in a completed landfill. They must be exposed and extinguished. Cells restrict the spread of fire.

In any case, landfills require perpetual maintenance. They must be continuously watched for signs of bad drainage and depressions from uneven settlement, to guard against future exposure of cells to the elements as well as other problems mentioned above.

One of the most favorable aspects of landfills is that once landfill operations are over, the area can be turned into a community asset. Instead of an unsightly and dangerous open dump, a number of uses are possible--from a recreational facility (golf course, tennis courts, etc.) to pasture and crop land (providing the last soil cover is deep enough so that roots and tilling do not interfere with the bottom cover).

Property values, which would suffer severely from the proximity of an open dump, can increase with the promise of a park or other pleasure facility once landfill operations are completed. For example, in the Mission Canyon area of California, because people knew a park and golf course would eventually be established, they accepted homes built overlooking a sanitary landfill.

One of the most ambitious projects is planned for Brookhaven, Long Island, where a 74-acre recreation facility will be built on a landfill receiving 1,000 tons of garbage per day. Two other 200-acre sites are planned along with Brookhaven, all at a cost of about $20 million, with a 20-year completion date. Brookhaven will have 16 tennis courts, 15 handball courts, 5 basketball courts, 2 football fields, 6 baseball diamonds, swimming pools, and a 7,000-seat stadium. One of the other sites will have facilities for winter sports.

In the Washington area, since completion of the Kennilworth landfill, the District of Columbia has joined forces with neighboring Virginia areas in a landfill operation near Lorton Reformatory, where a 20-year landfill will be turned into a recreation facility.

In areas with a high water table, the wastes and landfill cover material can be mounded. A prime example of this is in Virginia Beach, Virginia, where there was nowhere to go with trash but up. Thus, Mt. Trashmore, currently 72 feet high, 800 feet long, and 100 feet wide, consisting of 15 percent dirt and 85 percent garbage and trash, will soon be converted to various uses, including a 10,000 seat amphitheater. In order to prevent erosion, a 6-foot-deep layer of fill over the entire site will be seeded and landscaped. City officials say a $700,000 bill for 5 years' operation was cheaper than incineration.

Mounding can also provide recreational facilities to areas that would not normally have them. Winter sports, such as skiing and tobagganing, are now

possible in the prairie lands, where topography does not lend itself to such activities. A landfill in the Dupage County Forest Preserve, Illinois, offers an amphitheater and camping and picknicking grounds. At a height of 150 feet, total volume of the hill will be approximately 2 million cubic yards of refuse and soil. Most of the cost of $2 million was recovered in garbage fees. Date for completion was December 1972, climaxing 7 years of landfill operation. Another Mt. Trashmore, in Evanston, Illinois, consists of tree stumps, concrete, rubble, and other nonburnables. The hill is oval in shape, 65 feet high, with a base of about 600 by 700 feet. The handling cost for the refuse was about 75¢ per ton. This facility offers four lighted softball fields, 4 grass diamonds, 2 baseball diamonds, an archery range, eight tennis courts, and a soccer field.

A landfill can also be used to reclaim "unusable land"--areas such as depressions, canyons, and ravines, as well as man-made features--strip mines, quarries, and open pit mines. These sites usually hold more wastes than the customary type of disposal area.

Whether or not buildings can be safely constructed over landfill sites remains to be tested. It has been done, in the case of rambling one-story buildings and airport runways. Generally though, because of gas and settlement, buildings have been avoided. If buildings are constructed, the designer must allow for uneven settlement, and provide means for gas to dissipate into the atmosphere rather than collect in the building. With special engineering design and the use of steel and concrete pilings, multi-storied buildings are feasible.

Research on solid waste disposal is still underway and guidelines are being formulated and enforced. The Environmental Protection Agency launched Mission 5000 in July 1970, designed to close 5,000 of the nation's 16,000 open dumps. As of 1972, 1,500 had been closed, and the program continues.

With proper design, landfills can probably overcome the problem of public acceptance, and replace the disgraceful open dumps they are unfortunately confused with. Landfills can accomodate themselves to wide variations in topography and climate, and can be converted to a variety of uses. Landfill costs run one-fourth to one-third cheaper than other solid waste disposal methods. More-over, once post-landfill plans are completed, the facility can be used to recoup costs by charging a fee for such activities as skiing, sledding, and riding.

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