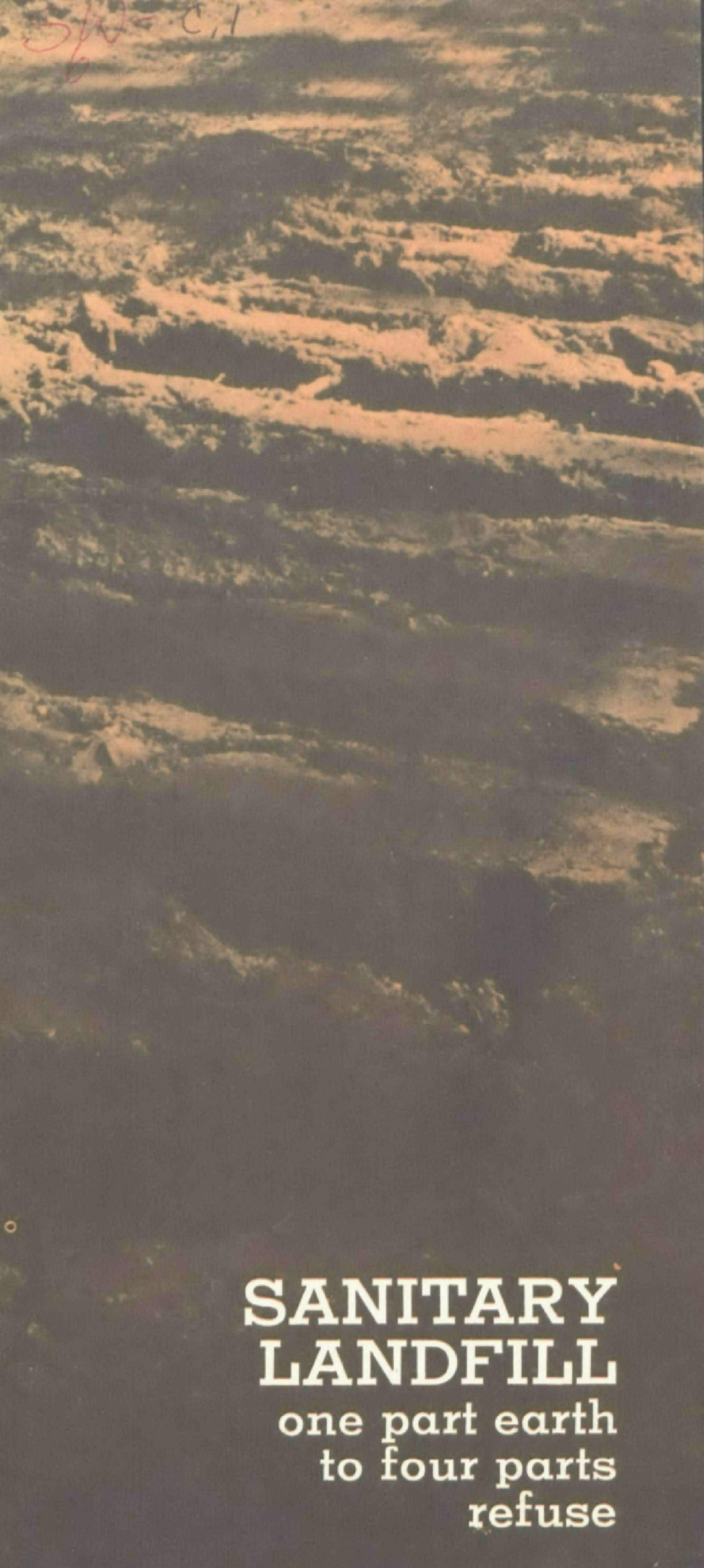

SANITARY LANDFILL

one part earth to four parts refuse

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This narrative (SW-6) has been prepared
by Lester A. Haug and Ralph J. Black
to describe the film made by
the Los Angeles County Sanitation Districts
for the Federal solid waste management program
under contract No. PH-OS-DQ-66.

U.S. ENVIRONMENTAL PROTECTION AGENCY

1972

Many viewers of the film by this title have asked for a copy of the film narrative, since there is so much content to be remembered. The narrative has been prepared with line diagrams and minor revisions to improve its value in the written format.

A limited number of prints of the film are available on loan from the National Medical Audiovisual Center (Annex), Section K, Atlanta, Ga. 30324. Prints of the film are available for purchase from Capital Film Laboratories, Inc., 470 E Street SW., Washington, D.C. 20024, at a cost of $97.04 FOB Washington.

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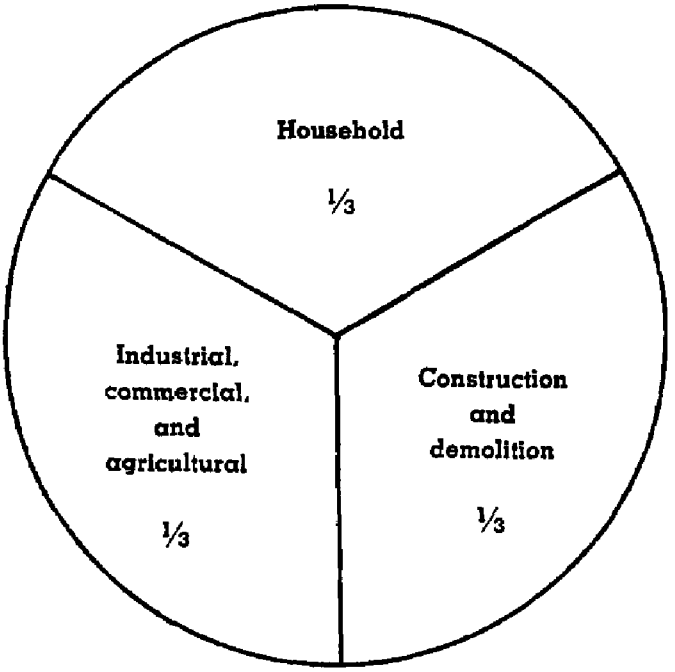
SANITARY LANDFILL
one part earth to four parts refuse

SOLID WASTE DISPOSAL is primarily an urban problem, increasing in magnitude as the population grows in size and affluence. Virtually everything used by man will, in time, be discarded. A large part of it finds its way into storage receptacles, which receive worn-out clothes, broken household appliances, forgotten toys, yesterday's newspapers .... The collection truck then carries these discarded materials to the sanitary landfill for burial. Eventually, even our homes and stores are discarded!

Almost everything man uses, he eventually discards. In the past, when land was plentiful, solid waste disposal posed fewer problems. But urbanization is reducing the land available for disposal; at the same time, a population growing in both size and affluence is generating increasing quantities of solid wastes. The result: communities across the country, large and small alike, are hard pressed to dispose of their solid wastes economically, and without blighting the environment or endangering public health.



The Los Angeles area's production of solid wastes—7½ pounds per person per day—is about equally divided among the three major classifications of solid wastes. The production of nonhousehold wastes can vary widely from community to community.

Industry produces mountains of merchandise, all to be used and eventually disposed of once it has served its purpose. No two communities have exactly the same per capita solid waste generation. Recent studies indicated that the Los Angeles area was producing about 7½ lb solid wastes per person per day. Household refuse accounted for about 2½ lb of this. An additional 2½ lb was contributed by industrial–commercial–agricultural activities, and a like amount, mostly inert material, came from construction and demolition work. In small or rural communities, the quantity of industrial, agricultural, construction, and demolition wastes may vary greatly according to the type of activities in the community.

Some communities use incinerators as a means of partial disposal and volume reduction. Some have tried, or are trying, composting. These methods, however, do

not reduce inert wastes and must be accompanied by landfilling for disposal of their own plant residue. Land disposal of solid waste is practiced by every urban community for part, if not all, of its waste.

Site Selection

Successful landfill operations don't "just happen." They result from the application of sound engineering and economic principles governing the disposal of refuse on land without nuisance or hazard to public health. Planning begins with the selection of a site. Land in the heart of a city is usually too costly to be used for disposal so that selection of more remote sites generally must be made.

The expense of hauling refuse from the collection area to the landfill is an important cost factor in determining the relative merit of one prospective site over another. Travel time on surface streets, open roads, or freeways, and turnpikes is affected

The first step in planning a sanitary landfill is to select a suitable site. The site will generally be in a remote area, to keep land acquisition cost low. But a landfill can still be a good neighbor, if it is properly engineered and operated. Expensive houses were intentionally built overlooking the Mission Canyon landfill west of downtown Los Angeles (above), in anticipation of the park and golf course that will be built when the fill is completed.

by road grades, traffic, and weather conditions. Time–travel studies are made by actually driving the loaded refuse vehicle from the collection area to each proposed site.

With urban land so valuable for other uses, shallow refuse fills spreading over large areas are not economical. Some sites in the Los Angeles area that are being filled to depths in excess of 400 ft justify use of relatively high-cost land.

The availability of utilities is included in any site value determination. Water for fire protection and dust control is particularly important. The cost of bringing in electrical power and telephone service must be considered. Restrooms should be provided for employees and customers.

Public acceptance of the access road is another important consideration in choosing a site. In Glendale, California, the residents did not want large refuse trucks traveling their streets to the landfill each day. It was necessary to construct a road to bypass the residential area and to provide access from a major commercial boulevard. In this case, the landfill is very large, so that the cost of the access road can be amortized over many tons of refuse.

As has been demonstrated in the Los Angeles area, refuse landfills can be operated near homes, provided a very careful housekeeping job is accomplished. At the request of owners of surrounding homes, Rockbluff Canyon was sanitary landfilled to create suitable land for horse stables, riding and other recreational purposes.

Homes at Mission Canyon were intentionally built overlooking a large sanitary landfill because the owners knew that a park and golf course would be constructed

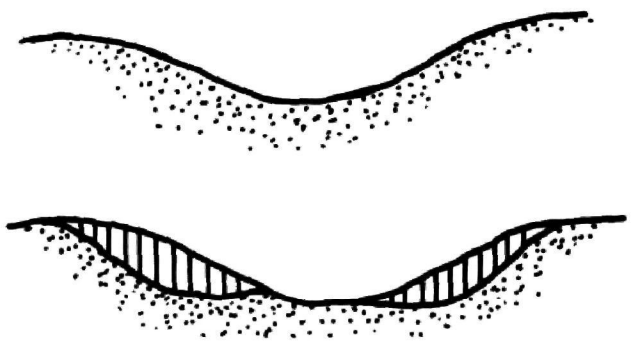
on the completed fill. This is evidence that the public will accept a landfill in their backyard, if the operation is attractive and free of nuisances.

Landfilling Method

Sanitary landfills can be located on various types of terrain—for example, in a valley, canyon, and pits, on level or sloping ground.

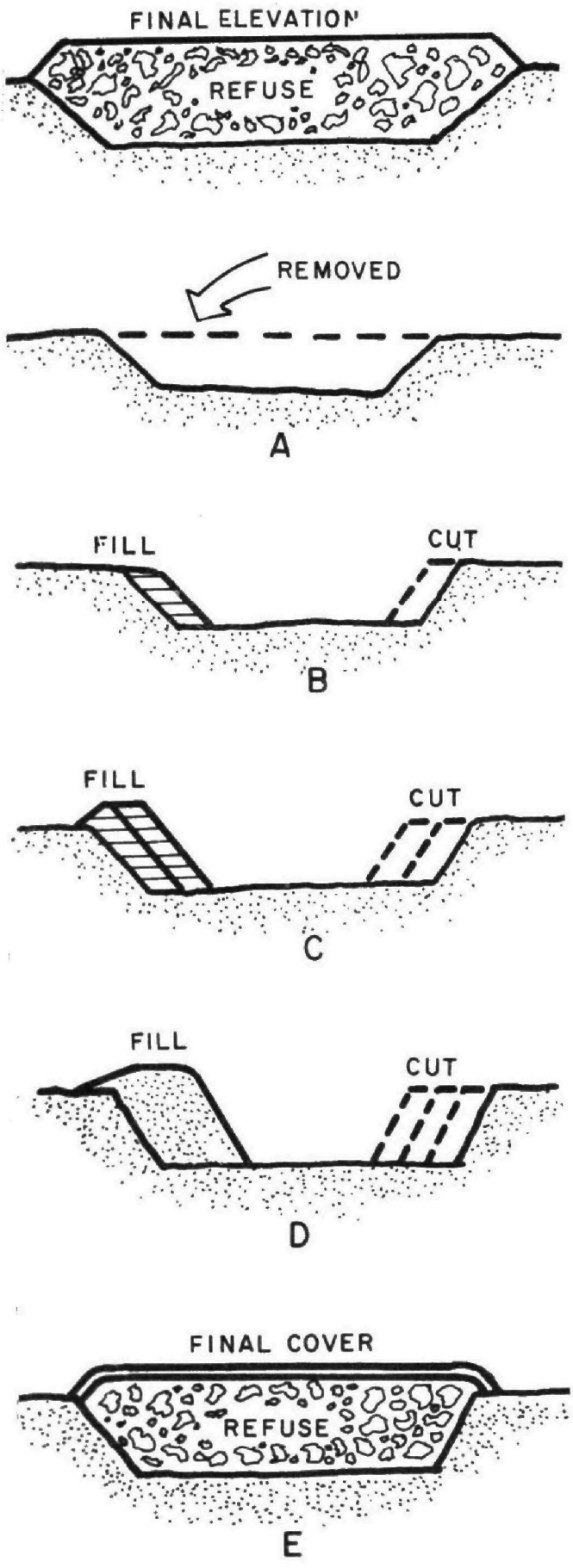
A sanitary landfill requires about **one part earth** for daily cover **to four parts refuse.** Additional soil is needed for final cover. When all of the earth cover is to be acquired from within the site, the amount of earth available determines the amount of refuse that can be placed within the site.

Moreover, it is necessary to know not only the amount of refuse being produced, but also the density that will be achieved in the fill. Refuse carefully compacted in place with crawler tractors weighs approximately 1,250 lb per cu yd.



The maximum side slope cut possible in a valley or canyon is determined and the total volume of available earth calculated.

After deducting the earth for final cover, the remaining earth volume multiplied by 4 gives the approximate volume of refuse that can be placed within the site without importing additional cover material.


FINAL ELEVATION
REFUSE
REMOVED
A
FILL
CUT
B
FILL
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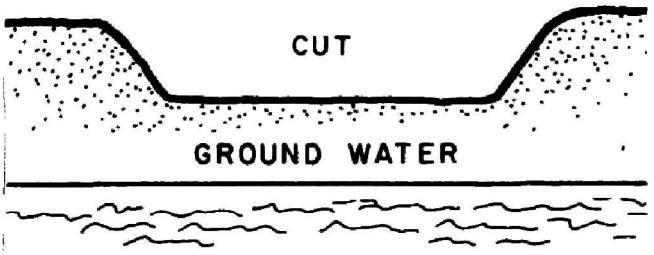


In a typical sanitary landfill, the maximum cut is made on the side slope. As the solid wastes are deposited, they are covered with the earth taken from the cut. This is continued until the site is filled. The entire area is then covered with a clean layer of earth. The final elevation depends on the planned use for the site.

For example, when a site is cut to a depth of 25 ft, 3 ft of this is reserved for final cover, leaving 22 ft of material to be used in the fill. With the use of the ratio of **one** part earth to **four** parts refuse, the surface of the completed fill is 88 ft above the original ground surface.

After the volume and the resulting elevation of the fill have been estimated, it may be decided that the final elevation is not compatible with the planned ultimate use and some compromise will have to be made. Property may be acquired to provide sufficient cover material. Soil from the lowest elevations is used early in the fill, with soil at the higher elevations reserved for later use.

When a site is short on cover material, soil taken from the initial cut is stockpiled away from the refuse disposal area to provide cover during the last phase of the operation.

As the refuse is placed, the initial excavation is enlarged by the amount of earth used for daily cover material.

This is continued until the site is filled.

The steep-wall canyon site has great refuse capacity, but these same steep

canyon walls often indicate hard soil that may be very expensive to use for cover material. If the rock is loose enough to be ripped by tractors, the site can be worked. When it becomes difficult for the scraper to load material, assistance from a tractor may be necessary.

Fine soil can also be troublesome because of dust. The soil at Palos Verdes, California, is diatomaceous earth and care must be exercised to keep dust from becoming a nuisance.

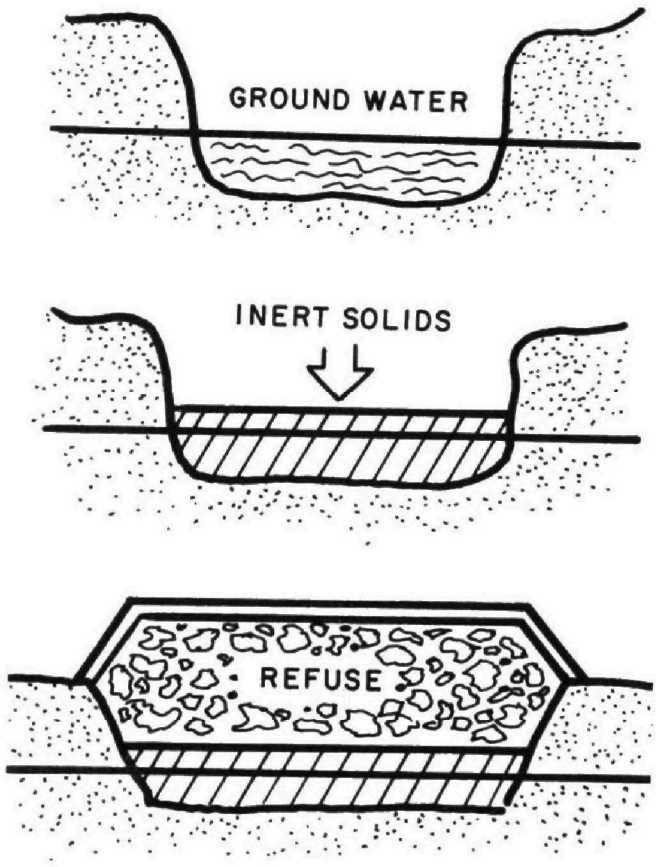
An underlying groundwater table may limit the depth of cut. Organic and soluble wastes are not deposited at locations where groundwater pollution will result.

Rainfall is diverted from the site to prevent percolated water from becoming a contaminant. The advice and consent of those governmental agencies charged with the responsibility of protecting groundwater supplies must be solicited.

The pit site has its special problems. When the site includes only the pit and it has been excavated near or below groundwater, cover material must be imported.

If excavated below groundwater level, the

Rainfall must be diverted from a sanitary landfill site to prevent water from percolating through the refuse and contaminating the groundwater.



A pit site poses special problems if it has been excavated below groundwater level. It must first be filled with inert solids to a safe level above the groundwater before refuse can be deposited.

pit must be filled with inert solids to a safe elevation above the groundwater before refuse can be placed in it.

Scales are used to weigh refuse vehicles in and out of the disposal site. Accurate weights are the basis for charges levied for disposal and also provide a method of production control and density determination. The traffic pattern must allow room for slow-moving or halted vehicles to be off public thoroughfares.

Many of the roads inside the disposal site may be temporary in nature, but they must be well maintained. Nonetheless, some paving is necessary for operating during wet weather. Roads must be kept clear of snow and ice so the heavily laden trucks

All entering vehicles at the sanitary landfill—the municipal collection truck or the householder's vehicle with trash and yard debris—must be weighed as they enter and leave. Disposal charges are based on weights. Weight information is also important in determining in-place densities.

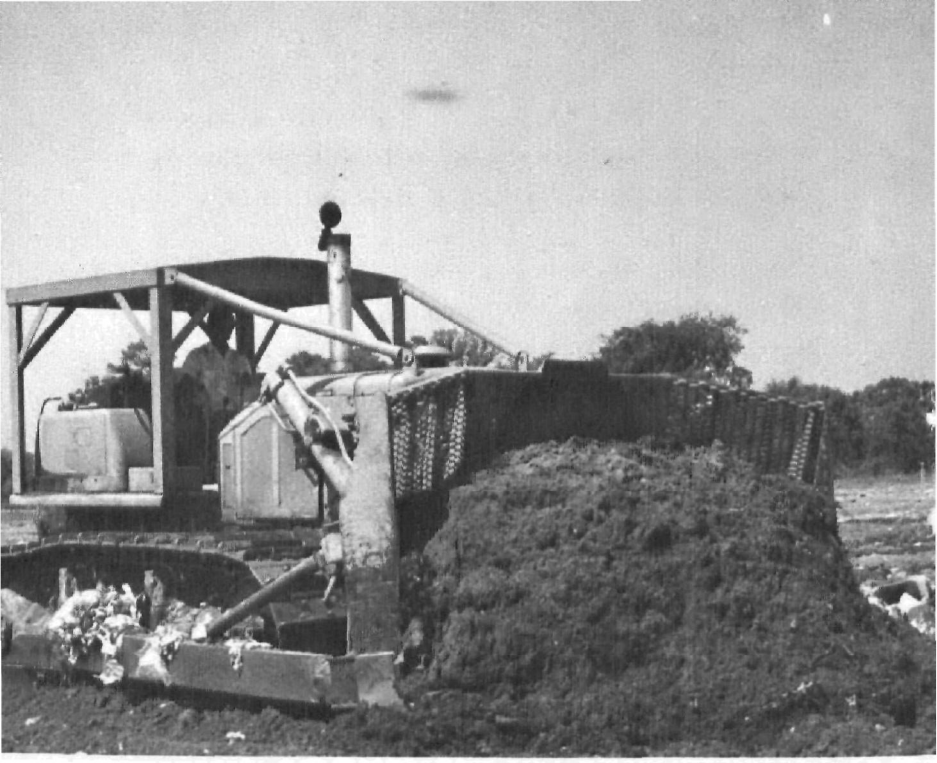
Many roads inside the disposal site have short lives, since they will be abandoned as the areas are filled in. The roads must nevertheless be properly maintained. Snow and ice must be cleared away. To prevent heavily loaded trucks from slowing traffic--or even stalling—on roads in the site, steep grades must be avoided.

will have traction. Grades in excess of 7 percent are difficult for loaded trucks.

Roads on refuse fill are satisfactory, but, where possible, permanent roads of compacted earth should be constructed to reduce maintenance cost. Bricks or broken concrete are often used in roadbeds or other places where a firm subgrade is desired. Sometimes these roads can be used both during the fill operation and later as an access road to the recreational area or for whatever other ultimate use is planned for the completed fill.

Once at the disposal area, the large trucks need ample room to maneuver. Graders are used to dress up and level the truck unloading area. Leveling ensures stability for the trucks with high centers of gravity. Trucks utilize many unloading techniques. Some use a yoke and cable placed in the trucks before it is loaded. The refuse is pulled from the truck by a tractor hooked to the pull-off cable. Many trucks, however, must be unloaded by hand. Separating self-unloading vehicles from the slower hand unloaders increases efficiency and safety and eases traffic congestion at a busy working face. Small areas of exposed refuse minimize wind-blown papers, and the more confined quarters also discourage wandering seagulls from loitering.

Keeping the unloading area confined reduces the travel distance of the crawler tractors, thereby increasing efficiency. Generally, loads are discharged at the bottom of a slope and the refuse is pushed and spread in layers with an inclination, approximately 4-ft horizontal to 1-ft vertical, prior to compaction. At the sites operated by the Los Angeles County Sanitation Districts, no special compacting



The crawler tractor equipped with a bulldozer blade is the mainstay of sanitary landfill equipment. Los Angeles uses them for compacting, having found that special compacting equipment does not appreciably increase the in-place density of solid wastes.

equipment is used; the weight of the tractor is sufficient to compact the refuse.

Other types of equipment are available for pushing, spreading, and compacting solid wastes. However, in-place density of refuse, especially in deep fills, is not appreciably increased by the use of wheeled equipment in lieu of crawler equipment.

Water is necessary for dust control, standby fire protection, and, on windy days, to help prevent papers from blowing. Water may not be warranted as an aid to compaction because volume reduction generally does not justify the cost and the additional water also increases the production rate of methane gas, a hazardous byproduct of decomposition.

Many different types of material are disposed of in a typical sanitary landfill.

Waste paper represents a larger portion of today's refuse than in years past. Large numbers of rubber tires are discarded, collected and dumped at the fill, sometimes to roll down the slopes to some obscure corner of the site, adding to housekeeping chores. Items such as telephone poles can be landfilled, but they require special attention. In some areas, building demolition wastes amount to as much as a third of the total tons handled. Loads of clean dirt are used to advantage for cover.

Daily covering of refuse is a major part of the operation of a sanitary landfill. At the Mission Canyon site, to take one example, the gate closes to incoming refuse trucks at 5:00 p.m. Scrapers have been working stockpiling earth and covering refuse. Starting to unload at the top of the ramp, they come down the refuse slope, spreading the cover evenly over the exposed refuse. Cover material is conserved by compacting the refuse to a tight, uniform surface ahead of the covering operation. Within an hour after closing time, the cover is complete and there is a thick layer of clean soil over the refuse.
There is no refuse in sight at the end of the day.

Day's end at a sanitary landfill finds no refuse in sight. A thick topping of clean soil makes a landfill nuisance-free. It means no rats, no odors, no fires, no papers scattering in the wind. It means waste disposal that protects the environment.

Cover is important, because more than any other single factor it makes a sanitary landfill nuisance free. It keeps rodents out and odors in. It prevents fires and keeps papers from scattering in the wind. Each day's refuse is sealed in an earthen cell.

An important consideration in operation is control of access to the site. A fence is both a physical and psychological barrier that helps to isolate the operation. Planting large shrubs or trees is beneficial for screening the site.

Equipment Needs

Although many types and sizes of equipment find application in sanitary landfills, the most commonly used piece of equipment is the crawler tractor equipment with a bulldozer blade. The crawler tractor can also be used to haul cover material by coupling it to a towed scraper. At large sites, however, it is more economical to haul cover material in self-propelled, rubber-tired scrapers.

The basic equipment for sanitary landfill operations handling 200 tons or more of refuse daily consists of the crawler tractor, scraper, water wagon, and part-time use of a motor grader. In operations handling less than 200 tons daily, smaller crawler equipment can be used, including all-purpose units with combination bulldozer-clamshell buckets, which push and compact refuse and also carry dirt for cover.

EQUIPMENT REQUIREMENTS

UNIT	TONS PER DAY			
	200	500	1000	4000
CRAWLER TRACTOR	1	2	3	10
EARTH SCRAPER	1	1	1	3
WATER WAGON	1	1	1	2
MOTOR GRADER	1	1	1	1

If the daily business rate is less than 200 tons per day, smaller crawler equipment can be used, including all-purpose units with combination bulldozer–clamshell buckets, which push and compact refuse as well as carry dirt for cover. A front loader cannot do the work of a larger crawler tractor, but, in a small operation, it can be used to maintain cleanliness between visits of a large crawler.

The basic equipment for operations larger than 200 tons of refuse per day is the crawler tractor, scraper, water wagon, and part-time use of the motor grader.

As the daily business rate increases, the equipment requirements will climb approximately as shown in the table. The numbers for the larger operations include standby units. The crawler tractor is a machine weighing close to 50,000 lb and is equipped with an engine of 200 or more horsepower. The scraper is a self-propelled unit of 14-yd capacity. A twin-engine unit will, in many cases, eliminate the necessity of having an additional tractor to push-load the scrapers. The water wagon is built to haul and power spray between 1,500 and 4,000 gal of water per load, depending on the length of unpaved road and type of soil. (All-wheel drive is particularly desirable.) Larger operations use scrapers with capacities in excess of 20 cu yd and off-highway type water wagons with tank capacities of 6,000 gal. or more.

Personnel Needs

Landfill operating personnel requirements also vary with the daily rate of disposal. The listing in the table shown below, from the records of the Los Angeles County Sanitation Districts, applies to a sanitary

PERSONNEL REQUIREMENTS				
CLASSIFICATION	TONS PER DAY			
	200	500	1000	4000
EQUIPMENT OPERATORS	1	2	4	12
LABORERS	0	0	1	3
WEIGH MASTERS	1	1	1	2
FOREMEN	0	0	1	1

The personnel required by a landfill depends not only on its size but also its operating procedures. The Los Angeles requirements (above) apply to a landfill open to the public with charges based on the net weight of the refuse load. On a part-time basis, a landfill might also need managerial, supervisory, engineering, planning, administrative, clerical, and legal personnel.

landfill open to the public with disposal charges levied on the net weight of the refuse load.

Additional staff requirements on a part-time basis include managerial, supervsory, engineering, planning, administrative, clerical, and legal personnel.

Weather Problems

Storm drains and debris settling basins are required to prevent storm water erosion and release of debris-laden water to off-site drainage works. Runoff from the upper surface is controlled by proper surface grading and construction of improved drain channels. Corrugated metal pipe is excellent for interim drainage systems because of its flexibility during the early stages of settlement and its potential for salvage and reuse as the fill level is raised in successive lifts. Refuse fills do settle, and, wherever possible, permanent storm drains are located in

solid ground. An easily maintained slope is provided by limiting the finished rise to 1 ft for every 2 ft of horizontal run. Interrupting the slope every 40 ft of elevation with a 12- to 15-ft-wide bench permits diversion of surface water to a lined channel. A ground cover of vegetation is established on all finished slopes for slope stabilization. Forming open channels by the gunite process is an effective method for some of the smaller drains.

Special operating procedures must be adopted in inclement weather. Asphaltic pavement scraps are sometimes spread in the wet season to form a mat on which the refuse trucks drive to empty their loads, and the landfill is kept open. An operational technique that can be employed in the winter season consists of using leaves, gathered from the city streets, to cover portions of the disposal site to prevent ground freezing in the winter months. Snow presents no real problem within the landfill areas because it is relatively simple for the tractors to clear the onsite roads and the dumping area. Snow is, nevertheless, a factor to

As an area is filled, vegetation is established to stabilize slopes and prevent erosion.

Collection trucks must continue to move during bad weather-- as they did in Duluth, Minn., during a snow storm. Snow on the site itself is no great problem, since the tractors can clear the site roads and dumping area. But snow can be a problem to landfill operation if nearby roads are not kept clear.

consider in choosing a site, for if it is not near streets or highways that are normally kept clear, it may be necessary for the operators of the refuse site to clear roads leading to the site.

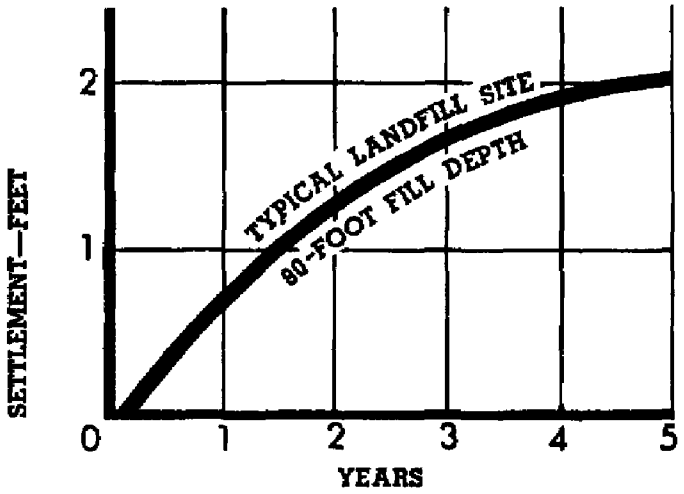
Ultimate Site Use

As an additional benefit, a completed sanitary landfill provides land for other purposes. In planning for the ultimate use of a site, one question always arises, "How much will the fill settle?" The curve shown represents a typical settling rate in the sites operated by the Sanitation Districts of Los Angeles County. An 80-ft fill settled less than 2 ft in 4 years, and the rate of settlement is decreasing.

Although a refuse fill will never be as stable as a compacted earth fill, there are many uses for a completed sanitary landfill. At Palos Verdes, a fill is being developed as a botanical garden. The topography was created by filling to the specifications for planned park usage. The low area will become an artificial stream bed and small lake. Advance planning allowed the lake to be located on original ground. Alternatively, the surface of a refuse fill has provided a parking area for a new shopping center.

Refuse contains much organic material that is subject to bacterial decomposition. The decomposition process entails the production of heat and the generation of carbon dioxide and methane gases and is accompanied by a reduction in volume. Addition of water accelerates the process. If water is allowed to enter the fill in sufficient quantities, it can cause high concentrations of methane that may travel horizontally through surrounding porous soils. One occurrence of this nature was remedied by constructing a rock-filled

A typical 80-ft fill in Los Angeles settles only about 2 ft in 4 years, and the settlement rate at that time is decreasing. A refuse fill, although it will never be as stable as a compacted earth fill, can still be used for many purposes.



trench through the porous soil area to serve as a vent. Also, a reduction in the watering program for the surface vegetation on the completed fill minimized the rate of gas production. Much research is being directed to the solution of this and many other problems in solid waste disposal.

There are many variables affecting cost, operation, public acceptance, and ultimate use of a sanitary landfill. These variables mean that each community must carefully plan its own program. The plan should not only provide for proper location and operation of the refuse disposal site, but must also consider the most beneficial use of the completed site. In this way, solid waste disposal by sanitary landfilling doubly benefits the community.

Most of the available sanitary landfill films serve to promote sanitary landfill as a general concept, and sometimes the merits of a specific piece of equipment. The film **Sanitary Landfill: One Part Earth to Four Parts Refuse,** made by the Los Angeles County Sanitation Districts under contract with the U.S. Government, presents specific design and operation information. While much of the film concerns deep filling and sanitary landfills of 200-ton-per-day capacity or greater, the design and operation information can, with judgment, be applied to smaller facilities.