BAND TECHNICAL PUBLICATIONS

LANDFILL CONSTRUCTION - O&M GUIDE

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1.0 INTRODUCTION

This publication is intended to provide information to band personnel engaged in activities related to the construction, operation and maintenance of sanitary landfill areas for the disposal of domestic solid waste material in Indian reserves and northern communities.

Sanitary landfill is the disposal of solid waste under controlled conditions on land. This includes compacting the waste into a cell, in order to confine it to the smallest possible area, and covering it with earth at regular intervals.

This publication describes acceptable methods of waste disposal by landfill which avoid creating nuisances or hazards to public health or safety. The minimum levels of performance required at any landfill site are given and commonly used methods for achieving them are discussed.

2.0 DEFINITIONS

Cell: compacted solid wastes that are enclosed by natural soil or cover material in a waste disposal site.

Compaction: the process of achieving a denser state in a material by repeated loading; this can be achieved by passing heavy equipment over it, or by a series of heavy impacts.

Cover material: soil or other suitable material that is used to cover compacted solid waste in a land disposal site.

Disposal: the final treatment, discharge or placement of solid wastes in a manner which results in minimal or no impact on the environment.

Garbage: rejected food wastes including waste accumulation of animal, fruit or vegetable matter used or intended for food or that attend the preparation, use, cooking, dealing in or storing of meat, fish, fowl, fruit or vegetable; moisture content of 30 to 70% and a gross heat value of 1055-1465 kJ (1000-3000 BTU/lb.).

Gas: garbage dumps can generate up to 55% methane gas -- the average is around 20%.

Hazardous and toxic waste: a product or substance that is or contains a poisonous, toxic, inflammable, explosive or corrosive product or substance of similar nature, which upon release or escape to the environment may cause or may contribute to a harmful effect on the environment, and on human health and safety. It covers chemical, toxic, hazardous, pathological and similar gaseous, liquid and solid wastes, but excludes gaseous, liquid and solid municipal wastes, radioactive materials, non-toxic and non-hazardous commercial and industrial solid wastes, construction debris, and similar wastes.

Hydrogeology: deals with the ground water and subsurface geology of an area.

Leachate: liquid (water) that filters through the garbage material.

Sanitary landfill: 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 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.

Solid waste handling: the purposeful systematic control of the collection, processing, storage and transport of solid wastes.

Waste management: refers to all aspects of the establishment and operation of a system for safe and efficient control of wastes.

3.0 SANITARY LANDFILL SITE SELECTION

3.1 Physical Characteristics of the Site

To reduce delivery costs, select a site that is close to where the solid waste is produced, or to a road system.

The following are important in selecting a site:

a. subsoil, topsoil, groundwater and ground surface conditions;

b. whether the site is upland, valley, or in a depression;

c. surface drainage conditions; and

d. the site should be 100 m (325 ft.) from the nearest dwelling and 30 m (100 ft.) from public roads.

3.2 Community Growth

When selecting a site, consider all aspects of any anticipated population growth and consequent changes in refuse character and density.

3.3 Environmental Assessment

An environmental assessment is strongly advised and bands should consult with Health and Welfare Canada and the local provincial environment agency.

The environmental assessment process for solid waste disposal by landfill includes a study of both present and future waste quantities together with associated disposal needs and systems. For a major site, the study would be extensive; for a smaller site a less costly one may suffice. The site should be selected only after careful consideration has indicated that it

represents the best environmental compromise. Only rarely will the site be regarded by all as the best proposal since most individuals will prefer the location to be as far away as possible from their neighbourhood. Compromises are necessary on technical as well as overall environmental grounds.

4.0 SITE HYDROLOGY

4.1 General Remarks

Knowledge of the site hydrology should be sufficiently detailed to permit an environmental evaluation of the proposed landfill and development operation. Well records, and any relevant maps and reports should be reviewed to establish the characteristics and volume of the wastes, and local ground and surface water quality and uses. Exploratory soil borings may be necessary to describe the type and composition of the earth materials as well as their vertical and horizontal distribution. Groundwater studies may also be carried out to determine both the groundwater quality and quantity as well as any movement patterns.

4.2 Surface Water Hydrology

To prevent pollution, surface waters should be diverted from the actual disposal area. Other measures that should be taken include ditches and swales around the site and adjacent to on-site roads. Disposal areas should be graded to permit drainage.

In spite of these precautions, it should be noted that the final cover will not entirely prevent surface water infiltration.

4.3 Groundwater Hydrology

The extent to which groundwater may be contaminated by a landfilling operation is influenced by the type, composition, and sequence of underlying and adjacent soils or geologic materials. Of particular importance are the type of openings (fractures or intergranular

pores) through which the groundwater moves. A minimum of 1 m (3 ft.) should separate the water table from the bottom of the garbage layer.

5.0 SANITARY LANDFILL CONSTRUCTION

5.1 General Remarks

Sanitary landfill construction is a long-term project, requiring many conventional construction activities, including clearing, earthwork, road construction, drainage control, and installation of utilities.

5.2 Site Preparation

5.2.1 Access Road

An all-weather access road should join the public road to the site. Its design should accommodate the anticipated volume and weight of delivery vehicles and allow it to remain open at all times (minimum 1000 kg load per wheel).

5.2.2 On-site Roads

A temporary road may be built by compacting natural soil. Drainage is controlled by topping the soil with a layer of such wearing surface material as gravel, crushed stone or cinders. If fewer than 25 round trips each day are anticipated during operation, and if the soil is suitable, graded and compacted soil will suffice.

5.2.3 Clearing and Grubbing

Land should be cleared and grubbed from the existing road along the proposed access road to the landfill site. Land should include a fire break and an area big enough for at least five years of operation. It may, however, be more cost efficient to clear and grub the entire site. Topsoil stripped from the site and stockpiled in berms provides the maximum visual shielding of the landfill site and may be used for restoration of the completed landfill.

5.2.4 Fencing

Fencing should be installed at the site property limits as should a gate at the site entrance which can be locked when the site is unattended.

It may be beneficial to provide a garbage receptacle at the gate for use by individuals when the site is closed.

5.2.5 Drainage Facilities

Drainage must be constructed to control surface runoff at the site.

5.2.6 Signs

Signs should be provided which identify site regulations, for example, hours of operation and dumping locations.

5.2.7 Equipment

See Table 1 for the performance characteristics of landfill equipment and Table 2 for the suitability of general soil types for cover material.

5.3 Methods of Sanitary Landfill

5.3.1 Trench Method

Use the trench method when the groundwater is low and the soil is more than 2 m deep. This is the most suitable operation for smaller sanitary landfill sites since the trench provides cover material and limits the working area.

Excavate the trench to a maximum depth of 3 m.

Stockpile excavated material next to the trench for easy application as cover material. Compact the cover material into a layer at least 150 mm thick.

Slope the excavated trench away from the working face. Build up the trench lip to divert surface water away from the trench and grade it to prevent water ponding.

Table 1

PERFORMANCE CHARACTERISTICS OF LANDFILL EQUIPMENT*

	SOLID WASTE		COVER MATERIAL				
EQUIPMENT	SPREADING	COMPACTING	EXCAVATING	SPREADING	COMPACTING	HAULING	SITE PREPARING AND MAINTAINING
Crawler dozer	E	G	E	E	G	N/A	G
Crawler loader	G	G	E	G	G	F	G
Rubber-tired dozer	E	G	F	G	G	N/A	F
Rubber-tired loader	G	G	F	G	G	G	F
Farm tractor	G	P	F	G	P	F	F
Dragline	N/A	N/A	E	F	N/A	N/A	F

* Rating Key: E - excellent
G - good
F - fair
P - poor
NA - not applicable

Table 2

SUITABILITY OF GENERAL SOIL TYPES FOR COVER MATERIAL

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 of gas+	E	F	G	P	P	P

E - excellent
G - good
P - poor
* Except when cracks extend through the entire cover.
+ Only if well drained.

As a guideline for trench excavation, a community of 500 persons requires a trench of 540 m^3 (or 3 m deep by 5 m wide by 36 m long) to accommodate domestic waste disposal for a 60-day period.

Since excavation of earth materials is difficult during winter, dig a trench or trenches beforehand which are large enough to handle the solid waste generated over the winter.

In some areas a bulldozer may be used to excavate a trench. However, for larger excavations or in areas with stiff clay soil, it may be necessary to use more sophisticated equipment such as a Gradal, dragline, or backhoe. Depending on the size of the community to be served, this equipment may be contracted as required to open trenches. The trench method is illustrated in Figure 1.

5.3.2 Area Method

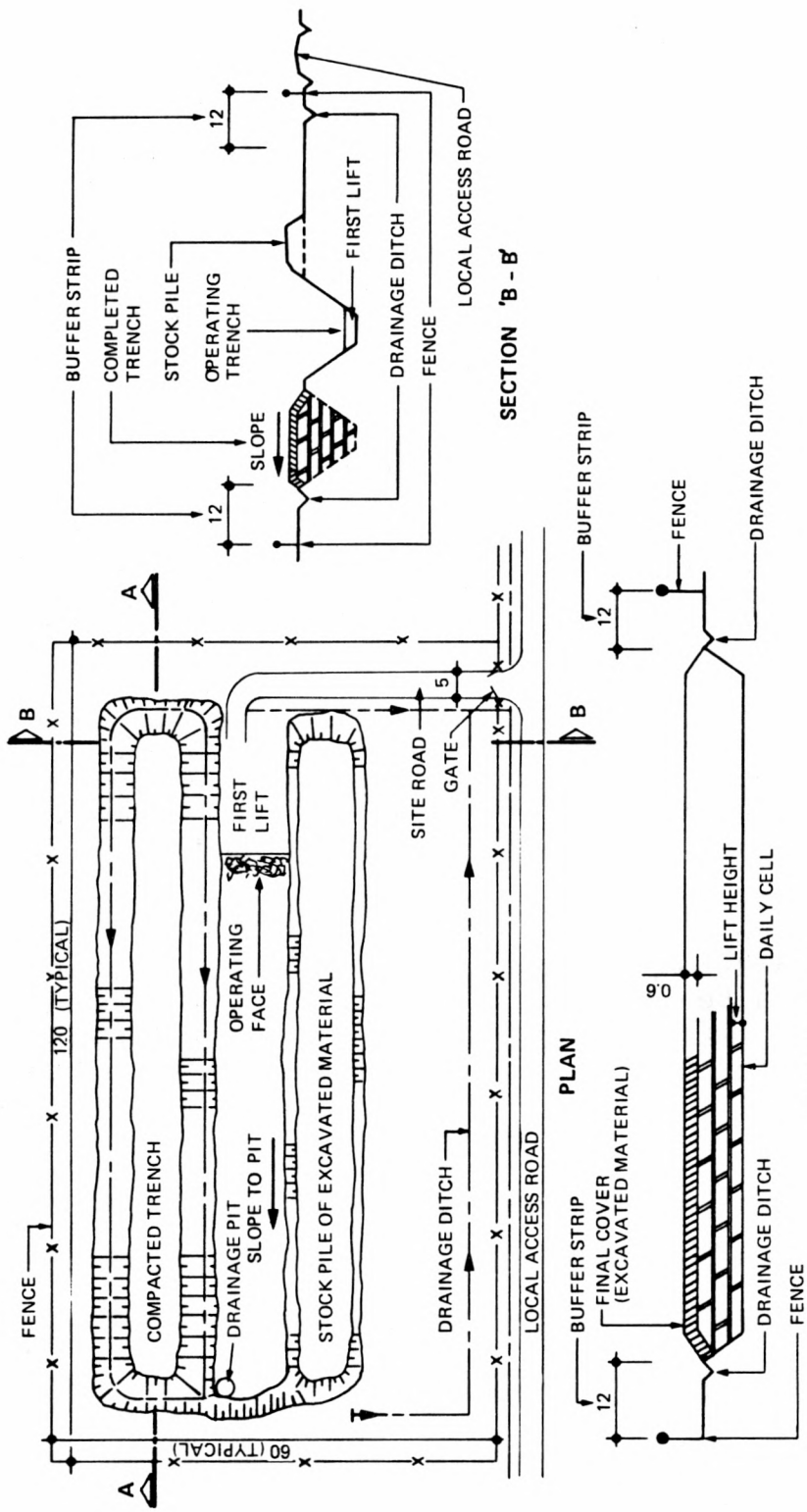
The area method is applicable to most landfill sites and is often used to dispose of large quantities of solid waste. It is also used where a high water table may be a problem. The loose refuse is compacted against an earth berm, and cover material is brought from adjacent areas or from the base of the working face.

In this method, solid wastes are deposited in a confined area such as a natural depression. Waste is compacted with mechanical equipment and covered with a layer of earth at least once a week and, depending on the dump's location, every day during the fly breeding season.

A bulldozer or front end loader should be used to spread and compact the dumped refuse in 300 mm layers. The compacted refuse is built up to the level of the adjacent lift. Do not exceed a maximum lift height of 2.4 m. The area method is illustrated in Figure 2.

Figure 1

TRENCH METHOD

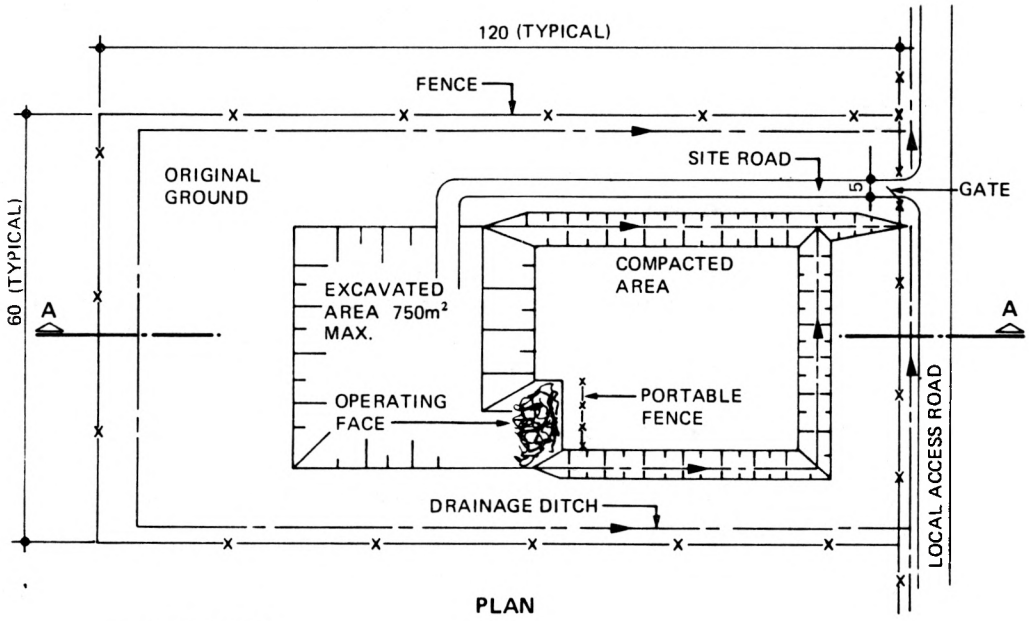


NOTE:
ALL DIMENSIONS IN METRES AND ARE MINIMUM UNLESS OTHERWISE NOTED.

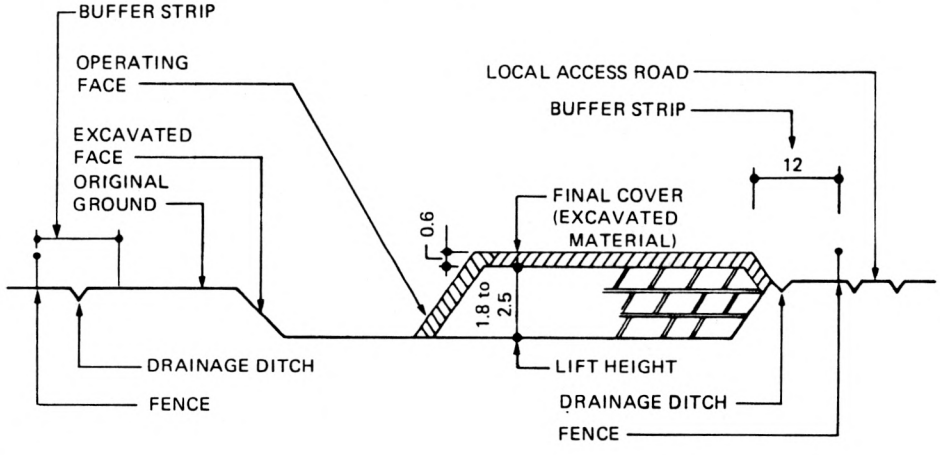
*Data provided & drawn by J.L. Richards & Assoc.

Figure 2

AREA METHOD



PLAN



SECTION 'A – A'

NOTE:

ALL DIMENSIONS IN METRES AND ARE MINIMUM UNLESS OTHERWISE NOTED.

*Data Provided & Drawn by J.L. Richards & Assoc.

5.3.3 Slope/Ramp Method

The slope/ramp method is a combination of the area and trench methods. The solid wastes are dumped and compacted on a slope. Cover material is obtained by excavating or scraping directly in front of the working face. This small excavation allows a portion of the waste to be deposited below the original surface and cover material does not need to be imported. Subsequent lifts at the site will have to follow the area method. The slope/ramp method is illustrated in Figure 3.

5.3.4 Pit Method

This method requires special consideration of leachate and surface water control.

If such a site is the only alternative, or an economic solution to local waste problems, proceed in a similar fashion to the area method. The pit method is illustrated in Figure 4.

5.4 Working Face Practices

All landfilling requires the following working face practices:

a. Place the solid waste close to the working face.

b. Do not back vehicles over uncovered refuse.

c. The working face should be only wide enough for efficient vehicle movement.

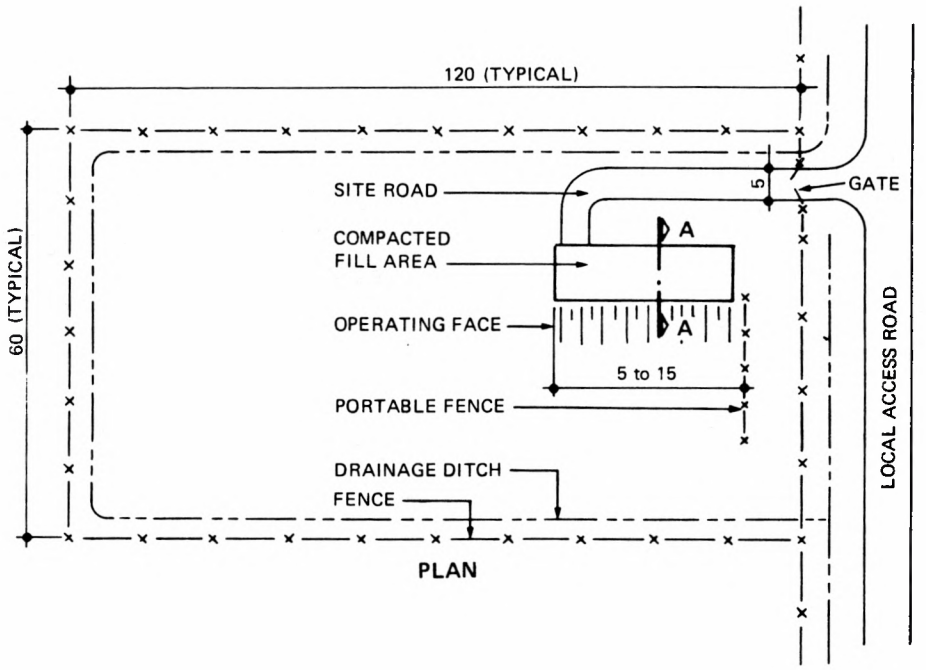
d. Spread loose refuse in layers of 600 mm (2 ft.) thickness or less and compact with two to five passes of the equipment.

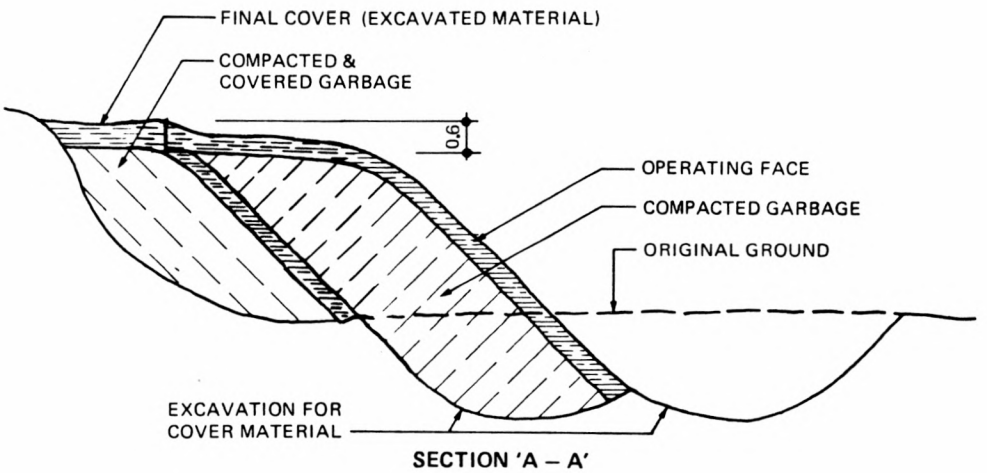
e. Move the equipment slowly in the waste to prevent damage.

f. Maintain proper cell height, slope and width.

Figure 3

SLOPE RAMP METHOD





NOTE:

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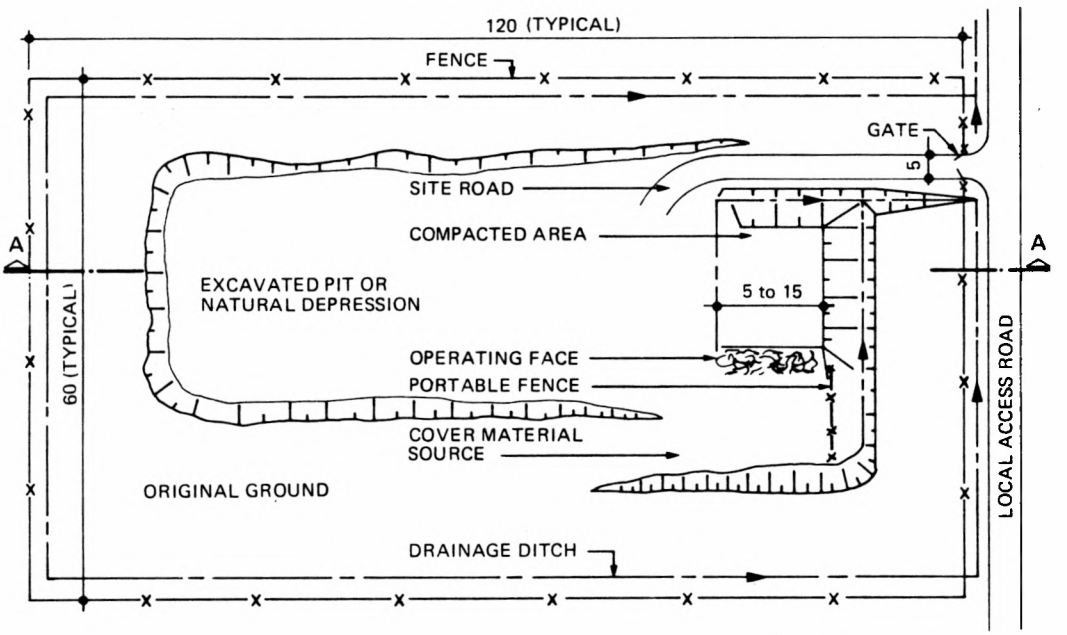
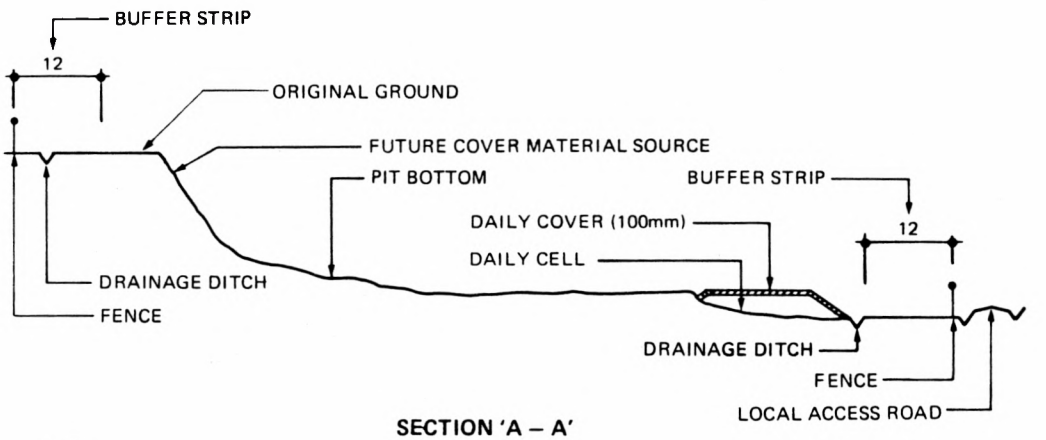
*Data Provided & Drawn by J.L. Richards & Assoc.

Figure 4

PIT METHOD



PLAN



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ALL DIMENSIONS IN METRES AND ARE MINIMUM
UNLESS OTHERWISE NOTED.

*Data Provided & Drawn by J.L.R. Richards & Assoc.

g. Cover all refuse at least once a week with 150 mm of soil, particularly during the fly breeding season. Two passes with the equipment is normally sufficient to compact the soil.

h. Check and correct drainage of working and borrow areas after carrying out covering operations.

i. Place a minimum of 600 mm final cover on and seed any completed areas as soon as possible.

6.0 SPECIAL AND HAZARDOUS WASTES

It is not recommended to add liquids to refuse at a sanitary landfill, other than small quantities of water for dust and litter control.

Do not add digested sewage sludge or compost to refuse but, because of its value as a soil conditioner, spread and disk it into completed areas.

Store bulky metallic wastes such as automobile hulks and machinery in a separate area. Remove these materials periodically, if practical, and transport them to a reprocessing centre.

Prepare a separate landfill area for the handling of special wastes such as dead animals, sewage from holding tanks or honey bags, and slaughterhouse or hospital wastes. Cover wastes with soil immediately upon receipt.

Inspect and empty, before crushing, any drums and containers that might contain liquid. Handling procedures for hazardous materials are outlined in the Code of Good Practice for Management of Hazardous and Toxic Wastes at Federal Establishments.

7.0 INCLEMENT WEATHER

Maintaining good roads, dry soil, and prepared wet weather areas is preferable to using chains and cables for pulling vehicles during inclement weather. Have a separate area next to a good road available for wet

weather operations. Second and higher lifts can be worked on during dry and frozen periods while lower (unfilled) levels may be reserved for wet weather. Stockpile dry soil near the working face and protect it with plastic sheeting.

8.0 CONTROL PRACTICES

Blowing refuse can be controlled by properly aligning unloading areas and using barriers such as downwind portable wire fabric fencing, earthern berms, and vegetation. Regular policing of the landfill area should be carried out to present a good public image of the operation.

9.0 SAFETY

The following safety precautions must be observed:

a. All employees at the site must wear safety boots and hard hats.

b. Equipment should be fitted with rollover protective cabs and fire extinguishers.

c. Any equipment windows should be of safety glass or unbreakable scratch resistant plastic.

d. A well-stocked first aid kit must be on site and personnel instructed in its use.

e. Scavenging is prohibited.

10.0 MAINTENANCE

10.1 Landfill maintenance procedures include the following:

a. periodic inspection to ensure proper operation procedures are being followed;

b. regular policing of the area for blown paper and debris;

c. regrading and filling of covered areas to ensure proper drainage;

d. regrading and filling of site roads no longer used;

e. cleaning of ditches and culverts to ensure surface water is diverted around the landfill site; and

f. repairing and replacing fencing as necessary.

11.0 DUMP CONVERSION OR CLOSURE

11.1 Conditions at Existing Dumpsite

Operations at existing disposal sites must be properly evaluated to determine if improvements, conversion or closure are required. Check the facility to make sure:

a. open burning is prohibited;

b. access is limited to authorized personnel;

c. solid waste is adequately compacted;

d. exposed solid waste is periodically covered;

e. a final cover is applied within a week to each completed portion of the site;

f. environmental control is strongly advised;

g. blowing litter is controlled;

h. scavenging is prohibited;

i. there is continual operation despite weather and equipment failure; and

j. special wastes are handled in accordance with the Code of Good Practice for Management of Hazardous and Toxic Wastes at Federal Establishments.

11.2 Dump Conversion or Closure Procedure

11.2.1 General Remarks

Any decision to close or convert a dump should be based on the assessment in 10.1. The closure or conversion should be a planned procedure rather than merely an act of abandonment. A clearly thought-out sequence of activities is important. Suitable replacement disposal facilities must be prepared and the closed dump must be visually and environmentally acceptable.

The dump conversion or closing procedure will depend on the intended use of the area, and on the particular problems at the dump such as rodents, fires, water pollution or gas movement to neighbouring structures.

11.2.2 Rodent Control

When converting or closing an open dump, rodents must be exterminated to prevent their migration to surrounding areas.

Only trained persons should exterminate rodents since poisons are used.

11.2.3 Extinguishing Fires

Firefighting experts should be consulted before converting or closing an open dump where burning has been practised.

The procedure for fighting landfill fires is:

a. identifying hot spots;

b. isolating the burning area(s); and

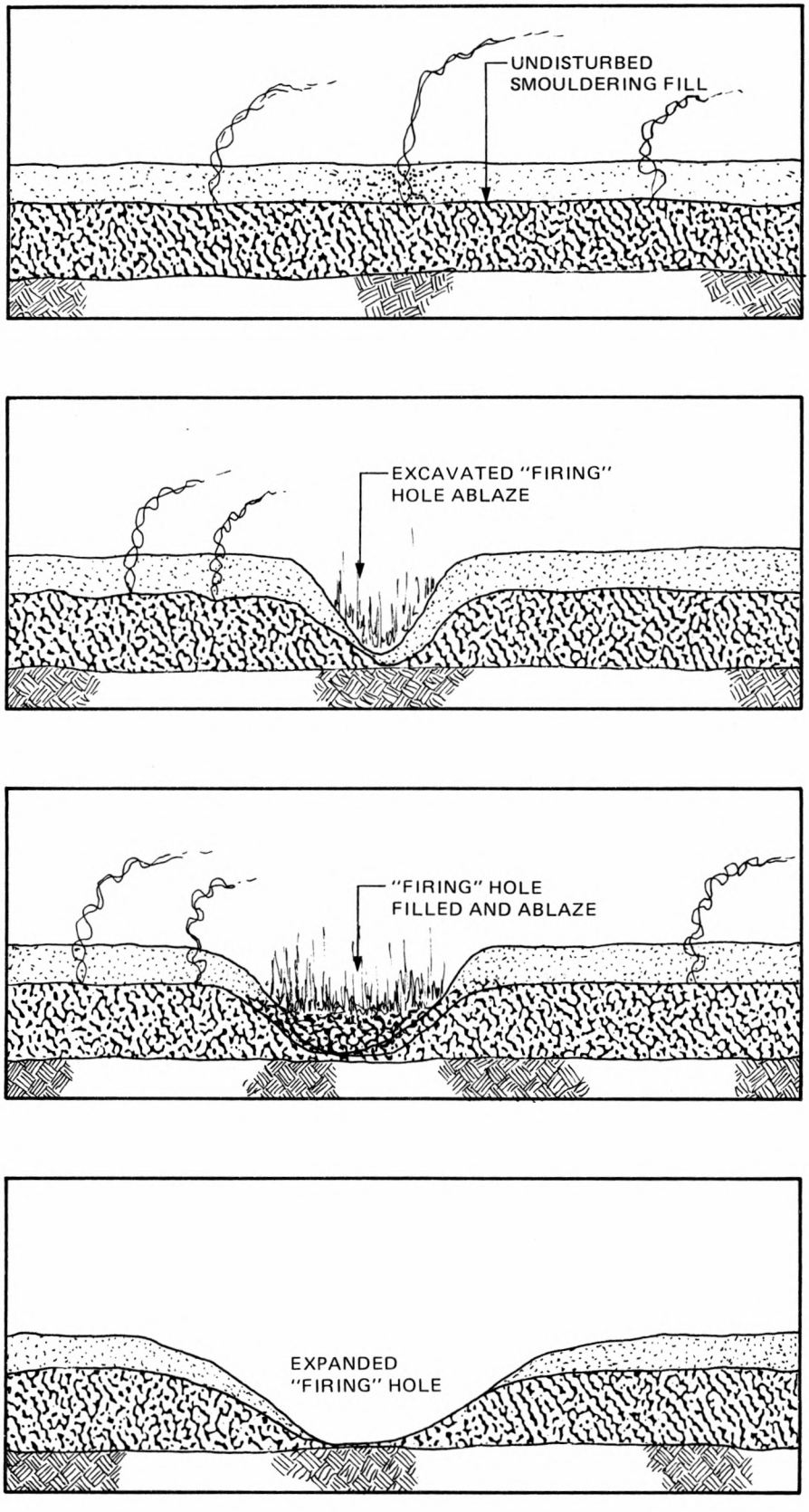
c. extinguishing the fire by dousing or complete combustion.

The following methods of extinguishing smouldering fill can all be effective:

a. The firing hole method is described in Figure 5.

Figure 5

OPERATION SEQUENCE-EXCAVATION
OF "FIRING" HOLES



b. Trenching is usually more successful and less time-consuming than digging firing holes. Dig trenches parallel to the bedrock or the bottom of the fill, set fires in them, and allow to burn (see Figure 6).

c) The windrowing method uses crawler tractors equipped with buckets and rakes. Windrows are created by pushing material into long parallel piles as shown in Figure 7.

For more details, see Code of Good Practice on Dump Closings or Conversion to Sanitary Landfill at Federal Establishments, Report EPS 1-EC-77-4.

11.2.4 Water and Gas Movement

Prior to conversion or closure of a dump, evaluate the necessity of leachate (liquid) collection and gas (methane) ventilation and ensure that the dump closure process keeps leachate and gas movement hazards to a minimum.

Keep water runoff diverted from the landfill site. Use leachate collection and treatment systems if necessary to protect ground and surface waters.

12.0 RESTORATION AND/OR CONVERSION OF SITE

When planning the restoration and/or conversion of a site, consider that:

a. a minimum final cover of 600 mm is required;

b. this final cover must be deeper if deep-rooted vegetation such as trees are to be planted on the site;

c. if the final cover is thin, plant only such vegetation as shallow-rooted grass, flowers, or shrubs;

d. finished surfaces must be contoured to divert runoff from the site;

Figure 6

DUMP CONVERSION - TRENCH METHOD

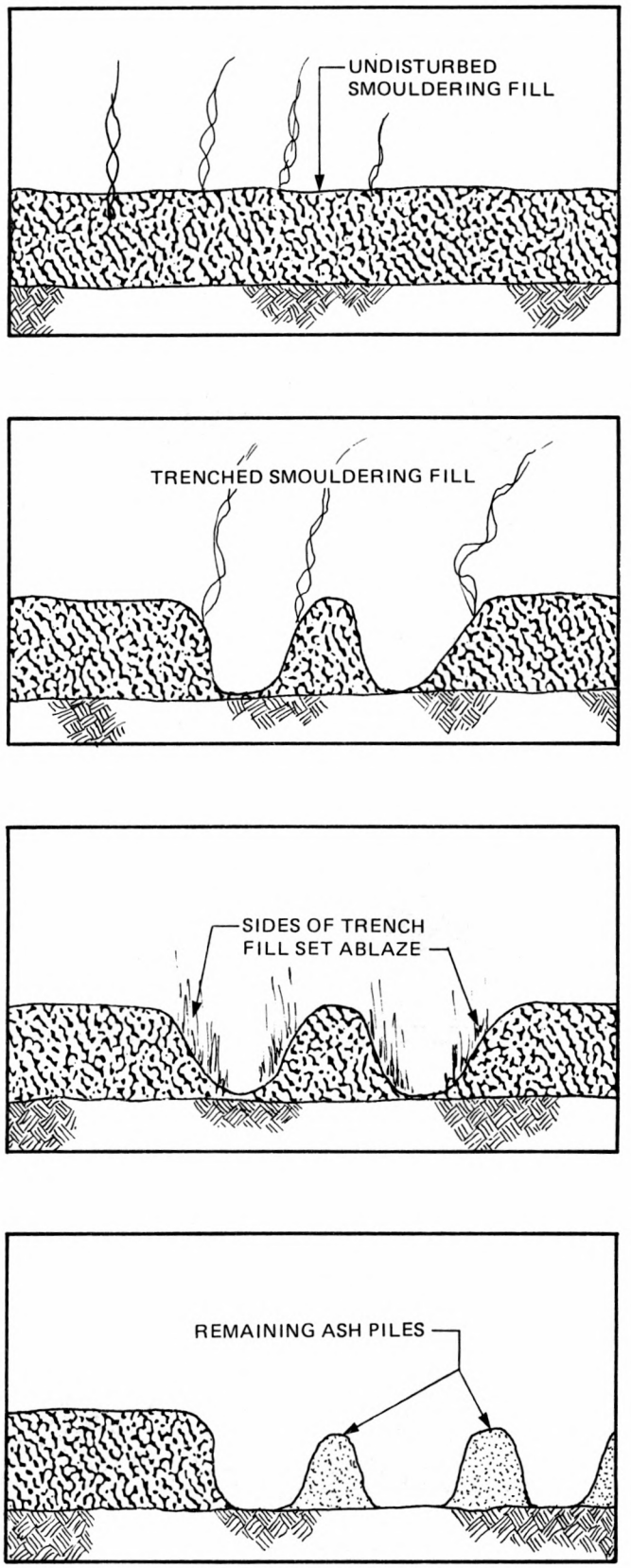
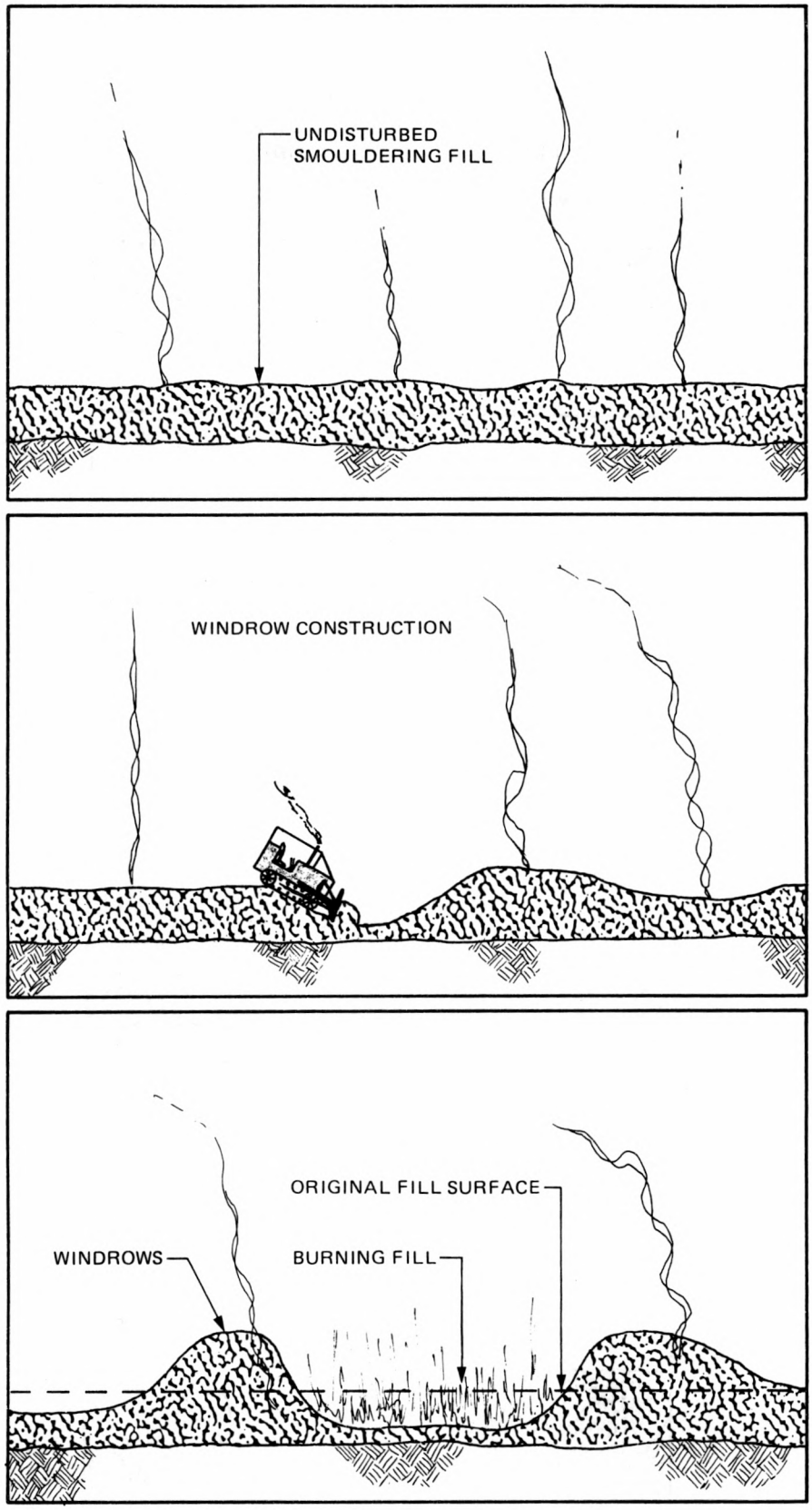


Figure 7

OPERATION SEQUENCE-WINDROWING



e. ponding or standing water requires regrading of the site;

f. periodic maintenance includes regrading, reseeding, and replenishing of cover material;

g. all relevant data must be recorded with the local land recording authority;

h. further building construction on the site should be prohibited due to methane hazards and settlement problems;

i. any utilities traversing the site must be flexible and corrosion resistant, and

j. in the presence of utility lines, special venting is required to prevent the travel of methane gas.

The restricted building capacity of landfill sites makes them particularly attractive for open green spaces, parks, recreation areas and playgrounds.

13.0 REFERENCES

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