

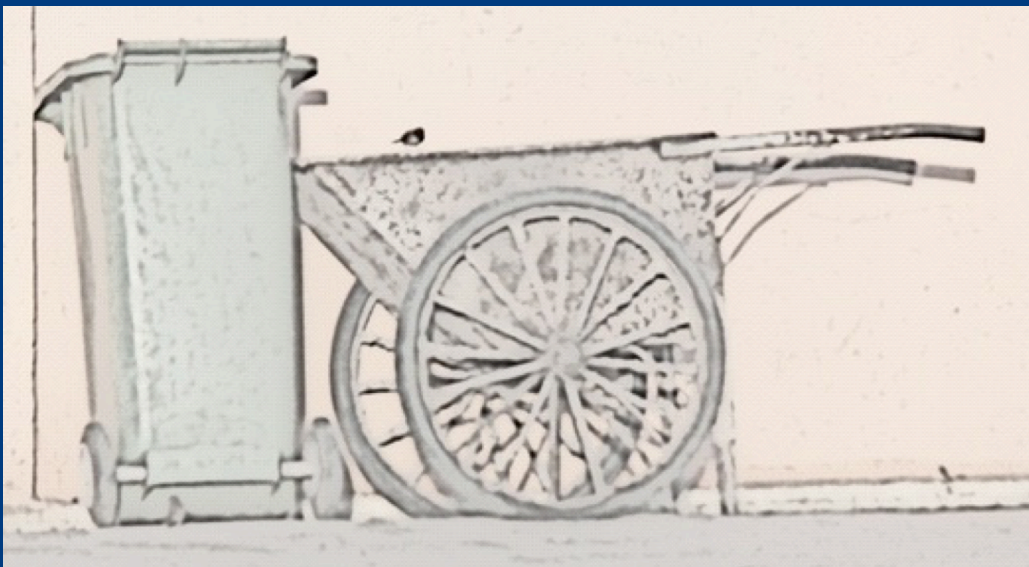
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Landfill Operations Manual

(Landfills with equipment permanently onsite)

March 2017



PREFACE

The Manual is written in simple English and is to be used on site as a day to day guidance for the operators of larger landfills, that is, sites where equipment is permanently established on site. For smaller landfills where equipment is only brought onto site from time to time, a simplified cut-down version of the manual should be used.

This is not a theoretical document with an explanation on why these items are the right operational approaches, but is merely instructive and directive.

Finalization of the document is not possible until after the specific landfill has been designed in detail and all the government and agency approvals are received. These various approvals may contain other requirements in relation to permitted operations that override the general best practice approaches presented in this document.

The Operations Manual should also be used as the primary training document when the landfill has been constructed and is about to commence operation.

It is common for the summary document presented in Appendix B to be translated into the local languages and dialects to provide day-to-day guidance to the general site staff. The entire document is generally only read and digested by the professional staff and foremen on site. Selected sections of the document can be copied and given to specific operators such as the bulldozer compactor operators.

Depending upon the landfill size, some aspects in the Manual can be overlooked at present, such as the more detailed Reporting Procedures.

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1. Introduction

1.1. Background

The correct operation of the overall Solid Waste Management facility is essential to the sustained success of the investment. There are many failed controlled dumps and landfills, as well as mechanised recycling and composting schemes, throughout Asia. **Most facilities fail to meet licence conditions due to operational shortcomings and not design inadequacies.** Therefore, it is critical to provide the operators with guidance on the most fundamental issues associated with managing a Landfill.

This Operations Manual sets out the basic operational guidance for successfully operating the facility. To be successful, Site operators will need a training program, engaged with the actual Site, using live waste deliveries. This will be supplemented with classroom based training to provide the theoretical basis and reasons behind the prescribed operational approach.

To ensure sustainable operations, it is recommended that follow-up audits and additional training or revisions be undertaken by external specialists experienced in actual Landfill operational requirements. This could be completed quarterly over a few years, post - commissioning.

The fundamentals of correctly operating a Landfill are very basic and actually, little more than common sense. **The amount of effort required to operate a Landfill correctly is not greatly different to the effort required to mismanage the Landfill completely.** Therefore, it is important that the Operations Manual is not viewed as a tome requiring educated people to understand and implement, as the issues are simple and easy to achieve.

1.2. Structure of the Operations Manual

The Manual is designed as a field book to guide Landfill staff and not a theoretical report for office-based consumption.

The Manual is written in note form and dot points used, without excessive detail or justification. It is a “How To” manual, not a theory lesson.

2. Policy Statement and Licence Agreement

2.1. Customer Advice

Regular customers are to be advised as to;

- the purpose of the new Solid Waste Management Facility Site
- what wastes types will be generally accepted or excluded
- the costs/charging policy of the new facility, and
- any other operational changes, as compared to the pre-existing open-dumping operation

2.2. City Environmental Commitment

INSERT A COPY OF THE CITY ENVIRONMENTAL COMMITMENT AND POLICY DOCUMENT HERE ONCE THE FINAL DESIGN IS COMPLETED

2.3. Permits and Approvals

INSERT A COPY OF ALL THE FACILITY LICENCES/PERMITS/APPROVALS HERE ONCE THE FINAL DESIGN IS COMPLETED AND ALL APPROVALS ARE OBTAINED

3. Safety

Working at a Solid Waste Management Facility can be dangerous, particularly when precautions are not taken. A Landfill safety plan should be prepared by the operators before commencement of any operations, and updated as required.

The most frequently reported hazards are:

- Direct exposure/contact with hazardous substances, i.e. leachate, acids, alkalis, dusts, infectious wastes, asbestos etc.
- Accident injury through collisions with heavy vehicles or pedestrian impacts.
- Inadequate maintenance of technical equipment.
- Vibration from heavy machinery.
- Accidental contact with sharp or pointed objects.
- Physical body stresses imposed by dust, rain, heat, cold, odours and insects.
- Over exposure to the sun - skin cancer.
- Working too close to loud noises without precautions.
- Fires and explosions of gas.
- Toxic fumes from burning waste - including simple incinerators



Constant supervision of the Landfill is required, even though the general public should not be allowed access to the majority of the Landfill site areas. This is to ensure that vehicles are in the correct place, are able to tip safely and reverse safely. It is also vital to know if people are at safe locations when on the Landfill.

Inhalation of dust is an important health consideration. A few simple measures can reduce the dust in the area - see Dust Control.

Adequate protection against noise for staff and operators working near or on loud machinery should be ensured-such as greenwaste chippers in the future.

It is essential that all staff and operators undertake training programs thereby ensuring the safe transfer of responsibility when assigned people are unavailable, such as on leave.



First Aid kits must be provided on Site and be properly maintained. Several staff members must be trained in First Aid, to ensure at least one is available at all

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times and a safety officer appointed. In addition, appropriate access for emergency vehicles and directional signage to main facilities should be maintained at all times.

4. Staffing and Facilities

4.1. General Staffing and Responsibilities

The **general staffing and responsibilities will be divided into two; management positions and the remaining operational staff;**

- **General Manager - Waste Management;** senior officer to whom the Site supervisor reports. Usually the Head of the Environmental Management Division based in the City offices, t the Cleaning and Greening Department, and responsible for the overview of all operations, including the Environmental Monitoring and Management Plan (EMMP) implementation.
- **Site Foreman,** based on-Site, and responsible for all Site operations on a daily basis and to implement the Operation Manual approach.

The key operational staff will include the following;

- **Site Landfill Compactor operator**
- **Excavator/Payloader and bulldozer operators**
- **Truck drivers**



Other staff will include the following;

- **Water cart operator/leading hand** and backup driver for the heavy equipment
- **Gatekeepers** will be in charge of checking loads and be assisted by the clerks. Much closer inspection of waste streams is an expected requirement in the future to avoid hazardous and dangerous loads entering the landfill. (An elevated platform at the gate house will assist in inspections of truck loads)
- **Clerks** to maintain load receipts and records. Possibly will be the same person as the Gatekeeper at smaller facilities and may work shifts to allow the Landfill to operate for extended hours.
- **General labourers** for daily litter patrols around the Landfill and buffers, plus traffic direction and tipping control, managing any scavengers on site, picking up litter, clearing drains, moving irrigation pipes, operating the generator, EMMP monitoring, Site safety issues, fire monitoring and control, fence repair and litter fence relocation etc. Will usually need to work shifts to allow the Site to operate for extended hours.



4.2. Training

Aspects of the training program will extend to all Site staff to ensure their understanding of the operational methods that would now apply, particularly when compared with the open dumping operations common in the past. Training must also address the Environmental Monitoring and Management Plan (as applies), and how the EMMP affects their day-to-day operations.

In addition to the training required for the key management positions of Manager and Foreman, training should be provided for their temporary replacements for when they are absent.

All key staff should be trained in the relevant issues associated with each other's roles.

Nominees will also be trained to undertake the Site Foreman's role in his/her absence. This training will include all aspects of the day-to-day operational issues, Environmental Monitoring and Management Plan implementation and associated reporting/recording responsibilities. Generally, this would include the Gatekeeper, leading hand and head clerk.

4.3. On-Site Facilities

Facilities on Site will vary but may include;

- Gatehouse, including the clerks' offices and record keeping
- Storage compound for equipment, vehicles and fuel
- Amenities building
- Workshop
- Generator building, fuel bund
- Weighbridge
- Wheel wash (future possibly)
- Bins or dedicated areas for recyclables
- Bin wash/ sterilisation
- Container triple wash evaporation pan
- Composting facility



A weather station may also be located near the gatehouse in the future. Its purpose is to keep records of rainfall, temperature, wind direction and speed and evaporation. The weather station can be used to verify odour, dust and even noise complaints to some extent, by interpreting the wind direction recorded at the time of complaint.

5. Signage

Adequate signage needs to be in place to inform who has access to the Site (the public is usually prohibited), where key aspects are located, and fundamental rules for the operation of the Site, etc. By ensuring adequate signage, misunderstandings and misuse of the Landfill are avoided and emergency vehicle access assisted in a timely fashion.

A sign at the entrance should include;

- name of City
- name of waste management authority and facility
- who does/who does not have access
- hours of operation
- emergency contact phone number.



A sign near the weighbridge should include;

- name of City
- name of waste management authority and facility
- wastes that are accepted
- materials that are not accepted
- speed limit (usually 10kph)
- details on access i.e. public only allowed into recycling area and public tipping face.

A sign near both the public and any commercial tipping face should include;

- **Directions to deposit various recyclables or green waste**
- **directions on where to tip**
- **instructions to follow the operator's directions.**



On the Landfill and access roads, temporary signs must clearly mark the roads, direct vehicles to the tipping face and indicate tipping locations.

All signs should be removed at the ultimate completion of operations at the Site, except for monitoring locations.

6. Reporting Procedures

6.1. Daily Diary and Miscellaneous Report Sheets

The **Daily Diary must be completed each day** before the Site Foreman leaves the Site. A typical diary form is provided in **Appendix A**.

Plant service schedules and records of service and safety start-ups each day will be collected.

If blank forms are running out, the Foreman will arrange for more to be sent to the Site office.

The **Incoming Waste Designation Sheets, Load Analysis Sheets** and **Incident Record Sheets** will be **collected at the end of each week**. Samples are provided in the Appendix. **In the initial stages of operation, only the Daily Diary and Incident Reports may be used until waste volumes increase**, and greater control and reporting is necessary.

DAILY LANDFILL DIARY

Date: _____ Day: _____ Shift: _____

WEATHER Temperature: _____ Wind: _____ Hum: _____ Rain: _____ Cloud: _____ Visibility: _____ Time: _____		RECEIVALS: Cubic Meters/Tons: _____ No. of Trucks: _____ No. of Cars: _____ No. of TRAILERS: _____		SAFETY INFRINGEMENTS: Morning Afternoon No. of: _____ No. of: _____ No. of: _____		DEFECTS REPORTED: _____ _____ _____ _____	
PLANT AND EQUIPMENT: List all equipment and equipment number including sub-infractions							
Operator	Shift No.	Hours Worked	Hours Idle	Breakdown	Comments		
SUB-CONTRACTORS: List all sub-contractors, crew size and work area							
Name	Hours Worked	Comments/Work performed					
VISITORS: List any visitors							
Name and Organization	Purpose of Visit	Date					
TRAINING: List all products undergoing training							
INDUSTRIAL SAFETY & ENVIRONMENTAL: List any inquiries, concerns, accidents, improvement actions, issued or safety, or other concerns, grounds, and other instructions given to workers							
OTHER COMMENTS: List any other monitoring, activities, or other issues received, other issues, etc.							

Name Signature Date

Form 100-1 for Aggravate Hope and Redwood (TMA-100-1) Page 4 - 21

A summary report covering the number of loads, total volume/mass of waste or fill received and the number (if any) of incidents at the Site should be prepared. The individual sheets and the weekly summaries should be filed and copy sent to the Manager.



The **Site Foreman will provide a monthly report to the Manager** on all aspects of the Environmental Monitoring and Management Plan, including complaints and monitoring results. A summary of the operation of the Site should be included.

6.2. Complaints Register

The **complaints register serves two purposes**;

- It identifies problems unseen or neglected by the Site staff and will ensure that this problem is recognised and action is taken, if appropriate.
- It enables the public to maintain an ongoing relationship with the operation and enable them to have their concerns formally documented and recorded.



The complaints register applies to many aspects of the operation including noise, odour, dust, mud, visual impacts, wind-blown or water borne litter, water quality and so on.

Staff will keep a record of all complaints made about the Site. Generally, it will be the gatekeeper who receives the initial complaint, if it is given by phone or in person direct to the Site, or to the Site Foreman if a written complaint. **Telephone complaints made directly to the City offices must be recorded and passed on to the Site Foreman immediately.**

The **Site Foreman will deal with all complaints and organise the appropriate action** to be taken, assess the level of urgency and check if the complaint is valid. The Site Foreman is also responsible for informing the party who complains by letter of the outcome of their complaint, with a copy in his monthly report to the Manager.

6.3. Operating Licence Reporting Requirements

The **external reporting requirements will be taken from the Site Licence where one has been issued.** They must be strictly followed or the operator can be fined.

In general, the City will typically be required to report on at least the following issues:

- annual quantity of different waste types accepted
- annual quantity of different waste types rejected
- annual quantity of different waste types recycled
- annual evaluation of the overall Landfill performance, including air space consumed, monitoring results, complaints handling, etc. The review would involve all Site staff, and include a group section on possible environmental improvements. An external component would include neighbour feedback and discussions with local environmental agencies and departments.
- possible quarterly audits by external auditor
- possible yearly comprehensive external audit results
- environmental improvement plan update, including training requirements, amendments to the policy statement, etc. if considered necessary.



7. Waste Categories

7.1. Summary of Categories

The waste entering the Landfill may be categorised as follows, with some examples given;

- **Acceptable Wastes (General)** – general household and commercial waste
- **Acceptable Wastes (but Difficult)** – tyres, mattresses
- **Special Wastes (Sometimes Acceptable)** – asbestos, liquid waste
- **Prohibited Wastes** – radioactive waste

Summerhill Waste Management Centre Small Vehicle Receiving Centre		
Acceptable Waste		
Greenwaste	Inert Waste	Solid Waste
<ul style="list-style-type: none"> • Garden Waste • Trees • Stumps • Lawn Clippings 	<ul style="list-style-type: none"> • As Determined by Site Controller 	<ul style="list-style-type: none"> • As Determined by Site Controller
DO NOT COMBUSTIBLE GREENWASTE ONLY		
Prohibited items will apply if prohibited waste is deposited in bins		
Prohibited Waste		
<ul style="list-style-type: none"> • Stumps • Trunks over 300mm dia • Plastics • Metals • >10% Soil • Treated Timber / Pallets • Painted Timber / Pallets • Asbestos • or as Determined by Site Controller 	<ul style="list-style-type: none"> • Greenwaste • Asbestos • Batteries • Liquid Waste • Flammable Liquids • Tyres • or as Determined by Site Controller 	<ul style="list-style-type: none"> • Asbestos • Batteries • Liquid Waste • Flammable Liquids • Tyres • or as Determined by Site Controller

The first two categories are always accepted, but the second category requires some special management.

The third category may be acceptable based on quantities involved, actual waste characteristics and so on, and is decided on a case-by-case basis.

Prohibited wastes are never allowed into the Landfill.

It is critical that all loads are inspected when they arrive at the Site gate - or any future transfer station in the collection system. An elevated floor at the reception gate allows for better inspections of truck loads, with a lower floor at vehicle window level.

7.2. Acceptable Wastes (General)

The **following general wastes will be accepted** at the Landfill;

- domestic solid waste, as collected by city or private vehicles on a regular basis
- acceptable commercial and industrial waste regularly collected by contractors
- garden refuse (i.e. green waste or yard waste) that may or may not be collected separately to municipal waste
- inert waste, i.e. construction and demolition debris including concrete, timber, masonry, bricks, etc.



7.3. Difficult Wastes (but always Acceptable)

Difficult wastes are those **wastes that are allowed to be tipped at the Landfill but require special treatment to ensure that the best compaction/disposal is achieved**. This class does not include hazardous or dangerous wastes.

- Tyres
- Mattresses
- Whitegoods (fridges, freezers or stoves)
- Car bodies
- Drums



See the following chapter for more details.

7.4. Special Wastes (sometimes Acceptable)

These are other **wastes that may be accepted on Site but these will have to be decided on a case-by-case basis**, and would include some hazardous and dangerous waste. Later sections provide more guidance on how to manage these materials, such as;

- asbestos
- medical waste, including "sharps"
- dead animals
- pathogenic wastes
- dry sludges, such as treatment plant sludges
- low level radioactive waste
- liquid waste, including paints and thinners
- toxic substances, such as acids and biocides (pesticides and herbicides)
- contaminated soil



See the following chapter for more details.

7.5. Prohibited Wastes

Items always unacceptable in the Landfill will include;

- hot loads, greater than 50°C in temperature
- pressure cylinders e.g. Condemned gas cylinders, fire extinguishers



SAMPLE Landfill Operations Manual

- recyclables, except to the recycling area, such as green waste, bulk metals or re-usable demolition waste
- large volumes of liquid waste, particularly if not mixed with an absorbent to a “spadeable” consistency
- radioactive waste
- large containers which cannot be crushed, and
- dangerous goods, such as reactive chemicals, explosives including unexploded bombs and so on. Dangerous goods are those wastes that can affect a person’s health or the environment. Some wastes appear to be safe when delivered to the Site, but when tipped can react with the air, water or other wastes to form a dangerous material. Typical dangerous goods include;

- Chemical wastes which can react to form dangerous gasses, liquids or solids, particularly powerful oxidants like chlorine. Chemical wastes can be either liquid or solid.



- Radioactive wastes. These can come from hospitals, universities, research institutes and private companies

- Liquid wastes can be dangerous. These include oils, pesticides, solvents, paints, etc.

- Asbestos (can be safe if correctly packaged, but dangerous if dry and powdery)

- Medical waste (may be safe if autoclaved or pre-treated in some other manner, but very dangerous if containing infectious material, untreated used sharps and syringes)



There are many dangerous goods that can be delivered to a Landfill, and Landfill staff must exercise extreme caution when dealing with these wastes.

8. Difficult Waste

Difficult wastes are those wastes that are always allowed to be tipped at the Landfill but require special treatment to ensure that the best compaction/disposal is achieved. This class does not include hazardous or dangerous wastes, or Special Wastes.

8.1. Tyres

Tyres are a major problem at Landfills, as they **are impossible to compact** and provide homes for rats and micro-breeding for mosquitoes. After several weeks or months, tyres "float" to the top of the Landfill and pierce through the cover. Tyres should be collected in a special area and shredded before they are tipped.



Alternatively, the tyres may be useful as scour protection around the external bund of the waste mound, or used to make home composting stacks. A tyre wall cutter blade can leave just the tread section which is far less trouble to re-use.

Another option is they can be sold to cement manufacturers as fuel for burning in the cement kiln as RDF (Refuse Derived Fuel).

8.2. Mattresses

Mattresses are also **hard to compact and are difficult to break up**. When found in loads, they should be pushed to the toe of the face and covered.

8.3. Whitegoods

When a fridge, freezer or stove is tipped on the working face, it should degassed, the doors removed and **be carefully crushed** to ensure that it is as small as possible. Preferably, these larger items should be stored in the recycling compound and sold to a metal recycler after degassing.



8.4. Vehicle Bodies

Car and truck bodies should be collected for sale to metal recyclers. If car parts or bodies are to be tipped, they must be carefully crushed. Operators must take extra care, as there may be petrol left in the tank which could catch fire. If car bodies are collected and stored on Site for later recycling, they must not be stacked more than three high. Mobile car crushers are available in some countries.

8.5. Drums

Drums of any size must not be accepted if they are sealed or if they contain any liquid. Paint containers with dried paint are acceptable. If a sealed drum is found on the tipping face it must be removed and the Site Foreman notified. He will arrange for the contents to be tested and disposed safely. The illegal disposer should be fined if identified.

Opened drums or large containers of any sort must be crushed before being covered, but should always be recycled if at all possible.

Whitegoods, cars bodies and drums can trap Landfill gas and become an explosion danger unless well compacted. In any case, they ***should preferentially always be recycled.***



9. Special Wastes

These wastes include **materials that may be accepted into the Landfill, but require special consideration on a case-by-case basis.**

The management of these of wastes may be covered by local legislation and ordinances, or the national standards and codes as appropriate. These wastes are allowed into the Landfill on a case-by-case basis:

9.1. Asbestos

The area where asbestos is deposited is to be identified with date of deposition, quantity, fibrous or bonded, origin, name of contractor and accurate location (GPS co-ordinates and levels at bottom and top). It is **safe - provided that the material is double plastic bagged and not allowed to escape from the bags in a dry state.** It is always safer to keep the asbestos material wet as an added safety precaution.

The asbestos will be managed under any local legislation or suitable international standards such as the Australian Code of Practice for Asbestos Removal and Management NOHSC.

9.2. Dead Animals and Obnoxious Waste

Animals and obnoxious wastes will be **tipped in front** of the Landfill face and **covered immediately.** Obnoxious waste would include rotting food produce or other condemned foodstuffs.



The animal and obnoxious wastes should not be placed directly on the base/liner of the Landfill.

9.3. Non-toxic Liquid Waste

Disposal of large quantities of any liquid wastes and soluble chemical wastes will not be permitted. This may encourage the generation of excessive and contaminated leachate.

It is common to **allow up to five percent (5%) of the total Landfill waste stream to be liquid.** This is because refuse usually has a moisture content of 15% to 30%, and is not saturated until the moisture content reaches more than 70%. Leachate will not flow until the refuse reaches saturation.



Whilst this may be currently practiced, liquid wastes should be adsorbed using sawdust or sand to a spadeable consistency to limit their mobility and disposed in discrete sealed areas as a last resort. They can compromise future leachate

recirculation, combine to form dangerous substances (chlorine plus any oil based products or ammonia) and are an OHS danger to staff.

However, even with the moderately low rainfall conditions experienced in some regions, liquid waste should not be accepted in large quantities until the Landfill mound is well established and experience is derived on leachate generation rates and waste moisture content. Limiting the liquid waste to a maximum of 5% of the refuse volume would be appropriate for low toxicity waste, such as grease trap pump-outs. This is a last resort as, preferably, grease trap wastes should be tankered to a wastewater treatment plant along with septic tank pump-outs.

9.4. Toxic Liquid Waste

These wastes must be recorded for type, source and quantity at the front end of the Landfill operation. If there is any doubt about the actual content of the load, it should be emptied into a septic tank, or sealed bund in a separate trench, for subsequent inspection, and if deemed necessary, chemical testing.



The **general approach is to pre-treat toxic waste prior to placing in trenches cut into a clay mass within the operating cell.** The waste will then be covered and entombed in the dedicated trench. Strong acids or alkalis should be neutralized before disposal.

The **trench should be constructed within the Landfill cell,** and should be located at head of the Landfill mound to maximise the distance to the leachate interception system. Secondary lining of the trench with 2mm HDPE may be required if waste is highly toxic.



The trench would be cut into a purpose-installed clay cell that would then be sealed prior to the entry of any stormwater. **At least 600 millimetres of low permeability clay or clay/lime mix should be underneath and around the trench.** Cementitious material may need to be added to further immobilize the waste and lock in any metal compounds.

The size of the trenches cannot be determined until there is reliable data on liquid waste generation volumes. They should be sized to accept up to 6 months' production of the component waste streams. This will allow the liquid to isolate from surface scum and bottom sludges, and allow evaporation to occur. A HDPE trench liner (if HDPE not attacked by the liquid) with a further cover sheet over when full would be a wise precaution.

An alternative is to store the waste for eventual export to countries which can provide higher technology solutions. The disadvantages to accessing this higher treatment standard is cost and violation of the international convention where the general aim is that people who produce the waste should manage it themselves and not export their potential problems. Another consideration is that the style of treatment proposed for the Landfill, although less than ideal, is essentially what happens to some cities' waste in many developed countries.

The possible waste streams and treatment methods are as follows:

9.4.1. Oily Waste Water

The best option is to **recycle the oil from the emulsions and suspension**. Triple interceptor pits will assist as would a centrifugal oil/water separator. Nations with ports generally possess separators and ballast oil bilge incinerators which would be far better for disposal. A recovery plant should be made available where this is a recurrent problem.

These waste waters generally have a high Biochemical Oxygen Demand, high salinity, a waste oil or oil emulsion fraction and potential contaminants such as radiator anti-rust fluids and heavy metals. These wastes usually come from petrol stations. Because of the potential toxicity, the volume should be limited to 1% of the refuse volume. (This is compared with the general non-toxic liquid waste such as grease trap wastes that can be up to 5% of the waste stream). This does not work with a newly opened landfill until a mass of waste is generated.



For quantities exceeding the 1% limit, the waste should be lagooned for separation purposes. The oil film and bottom sludges should be **tested for toxins**. If **below acceptable limits, the solids can be directed into the Landfill**. If the **toxin content is considered excessive, solids should be blended with kiln dust, cement or fly ash to fix the toxins in a cement matrix, and encapsulate any mobile fractions. The resulting solid blocks should be land filled, preferably with a secondary HDPE liner and cap.**

9.4.2. Phenolic and Emulsified/Concentrated Oil Waste

This includes wastewaters contaminated with **degreasers and decarbonisers, emulsified oils such as machine and cutting oils** and other products from the metal fabrication industry and tanker washouts.

Where possible, the **phenolics should be oxidised using potassium permanganate**. The treatment and disposal method is then the same as for oily wastes. The waste generator should preferably carry this out at its site before delivery to landfill as a licence condition.

9.4.3. Acid/Alkali/Metal Wastes

These **wastes are derived from metal plating works, metal finishers and the paint manufacturing industry.**

Wastes should be **neutralised where possible** by blending acidic and alkaline wastes. This may require the construction of holding lagoons for the various waste stream components. Strong oxidants such as chlorine will explode if mixed with oil derived liquid or ammonia.

The **blended product is then treated as for the oily waste** by chemical fixation using cement products. The disposal method is also the same, involving landfilling the solidified waste capsules and evaporating where possible the remaining liquid waste fraction.

If evaporation is unsuccessful, the liquid might be added as a last resort, to the Landfill mound provided that the 1% rule is observed.



9.4.4. PPS (Paint/Pesticide/Solvent) Wastes

This includes all **pesticide, fungicide and herbicide wastes, plus solvents such as Methyl Ethyl Ketone derivatives.** Sources would include manufacturing processes for the nominated waste types, laboratories and other heavy industry.

This is **generally regarded as the most toxic waste stream and generally requires fixation with cement material** as the first precaution. Because organics do not fix strongly into the cement matrix (unlike metals, which are strongly fixed and become effectively immobile), the **resulting cement capsules should be placed in a dedicated disposal trench as monofill, with a HDPE liner and cap (or compatible plastic).** The trench into clay would then be sealed prior to the entry of any stormwater. **At least 600 millimetres of low permeability clay or clay/lime mix should be underneath and around the trench or an artificial liner as part of the main cell.**



The **trench should be constructed within the Landfill cell,** and should be located at head of the Landfill mound to maximise the distance to groundwater. The location and levels should be recorded by GPS.

The size of the trenches cannot be determined until there is reliable data on waste generation volumes. They should be sized to accept up to 6 months' production of

the component waste streams. This will allow the liquid to isolate from surface scum and bottom sludges, and allow evaporation to occur.

The one exception is the Paint/Pesticide/Solvent (PPS) waste, which should be stored for only one month prior to solidifying.

9.5. Pathogenic and Medical Waste

These wastes typically do not make up a large fraction of the overall waste volume from medical facilities but are dangerous.

Various local medical facilities, such as hospitals and medical clinics, often have inadequate or unserviceable facilities to correctly handle all their special waste. This has been confirmed by medical wastes appearing in some waste dumps in the region.



The **best solution is to require medical waste incinerators** at the various institutions. It would be remote from the public, and ash residual could be safely co-disposed with the refuse. The general requirements for an incinerator are that the temperature should be over 1 200° Celsius and a residence time of 2 seconds.

However, sometimes because of local cost constraints, a **dedicated disposal area at the Site for medical and other special wastes may** have to suffice at this stage. This is **preferred over requiring individual medical facilities to bury their own waste within their compounds** as these burial pits will not have the leachate control systems provided at the Site.

An alternative is autoclaving the hospital waste either at source or centrally at the SWM site.



The only residual concern is that the **collection and handling of the medical waste must be dedicated and safe**, and mediwaste is not co-mingled with other domestic or commercial waste.

The **main issue of concern is unsterilized infectious waste, sharps (needles, scalpels)**. These should only be managed by either:

- placing in a puncture proof container, disinfected and co-disposed with refuse in a dedicated cell at the Landfill, or
- destroying by burning in dedicated cardboard boxes fuelled by petrol or in special desk-top electric incinerators, for example. This is usually done at the site of waste generation.

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A key issue is that all medical facilities must segregate their waste at source prior to collection, as follows. That will ensure that only small quantities of the dangerous wastes are generated for special handling.

- green - biodegradable
- black - non-bio, non-infectious
- yellow - infectious
- orange - nuclear
- red - sharps

A dedicated disposal area backfilled with lime and with a secondary HDPE liner may be provided (open ended to prevent flooding or preferably roofed with plastic or relocatable roof) and is capped with HDPE when filled and a new repository built. GPS location and levels should be recorded as for asbestos.

9.6. Contaminated Soil

This soil can be **from contaminated Sites**. The soil should be **tested to ascertain the health and environmental risk** profiles, such as using the ASTM Standard Methods for Toxicity Characteristic Leaching Procedure.



There are three options for managing contaminated soil coming to the Site, namely;

- Non-acceptance based on laboratory testing, because it is too contaminated for the environmental standard of the Landfill.
- Acceptable into the Landfill, but still too contaminated (or unsuitable for some other reason such as too wet) for use as cover material but suitable for incorporation into the waste mound as waste
- Acceptable into the Landfill for use as daily, but not final, cover material

If the soil is determined as being too hazardous for the environmental capabilities of the particular Landfill, it must not be allowed onto the Site and should be directed to a hazardous waste facility. This would apply to highly contaminated soil from an old pesticide factory for example.

However, if the soil is not an occupational or health risk, it may be used as daily cover. It must not be used as final cover.

If unsafe to use as cover for whatever reason - such as being too wet, it should be incorporated into the Landfill as normal refuse.

9.7. Biological Sludge

This **material is recyclable**, provided that it has been stockpiled or otherwise treated to control pathogens. It should only be incorporated into the Landfill if the material is not recyclable, due to excessive heavy metals or biocides, or lack of market demand.

The sludge would not require any special treatment prior to landfilling with other refuse.

9.8. Batteries

Lead-acid batteries are recyclable and should not be allowed into the Landfill.

If the local recycling market fails, then batteries should be drained of the acid prior to placing in the mound. However, this is a waste of the lead contained in the plates and should only be used as a last resort. At the time of preparing this Manual, South Korea pays an attractive price for undrained shrink-wrapped vehicle batteries on pallets and recyclers from many nations send shipments to the recyclers. Unskilled recycling of these batterie is dangerous and could result in severe poisoning.



Dry cell batteries should be accepted without any special precautions being required, unless the quantities become significant.

10. Incoming Load Inspection Procedure

10.1. Background

The following *inspection procedure is comprehensive and may be introduced in a staged manner* unless required in the operating licence/permit to operate the Landfill.

Unless otherwise required by the Landfill approvals permit, it is recommended that the basic recording system be adopted initially, and the more complete docketing system be introduced over time or as legally required.

SWM LOAD RECEIPT

Date: _____

I, Contractor/Carrier: _____, Vehicle Registration No. _____

Volume/Weight of Waste: _____ Waste Type: _____

Signed: _____ Name/Title: _____

Original + 2 copies:

Original	- to Asset Office for recording
1 st Copy	- to Contractor/Carrier
2 nd Copy	- retained on Site

In any case, the following activities must occur:

1. ***All vehicles must stop at the gate/weighbridge.***
2. ***The gatekeeper carries out an initial inspection*** and any vehicles obviously carrying a load containing obvious amounts of 'prohibited material' are rejected from the Site.



3. If the waste load appears acceptable, the ***following minimal data is recorded by the gatekeeper on Incoming Waste Designation Sheet:***

- Date and time
- name of contractor, carrier or owner of vehicle
- registration number and type of vehicle
- volume or weight of waste
- general summary of waste (major constituents such as builders waste or municipal domestic garbage)

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The Load Receipt number will allow a ready cross-reference to the data on the incoming Waste Designation Sheet and the Load Analysis Sheet.

Notice of all "incidents" should be referred to the Contractor or Carrier so that they, in turn, can track down the source of the Prohibited Substances.

For the sake of completeness and possible future reference, it is preferable for the Office Clerk to also fill out an Incident Record sheet for loads rejected during the initial inspection at the Site office. The Incident Details description of "rejected at gate" will explain why there is not a cross-reference to an Incoming Waste Designation or Load Analysis Sheet.

11. Site Preparation

11.1. Purpose

It is critical that waste is not just dumped anywhere on Site. Every load must be placed, according to the Site development plan and within the sub-cell constructed for that day's waste - or placed in the recycling compounds according to the appropriate locations for the specific recyclable, such as green waste.

Each landfill cell must be set out carefully to optimise the operation of the Landfill. For each cell, several things need to be carefully considered:

- access for the collection trucks and commercial trucks - for the life of the cell
- access for the general public to the tipping face or a separate self-haul area
- access for the tipping of cover material
- storm water drainage, so that water does not enter the waste, so that no ponds are formed, and so that access roads remain open. Also, diversion of stormwater after the cell is full and capped.
- the slope and area for turning and reversing vehicles and plant on the top of the cell
- where the next cell is to be built
- the length of the cell
- haul distances for cover material
- the amount of waste to be put in the cell, and
- leachate collection.



11.2. Size of cells

The ***area required for each cell stage should be at least enough to allow for one month of tipping***. Subcells taking one week's waste can be developed within each cell if required to minimize stormwater inflow mixing with waste.

11.3. Installation of Liner

The most common design incorporates a clay or modified clay and/or geosynthetic liner beneath the refuse mounds, depending on whether local soils are permeable. However, this will have to be confirmed by soil tests prior to detail design stage.

The base should be prepared with a 600 mm thick clay liner or equivalent and well compacted (preferably to 95 per cent of Standard Compaction). To control moisture loss and



cracking of the in-place clay liner, it ***should be covered soon after placement. Visqueen thin HDPE weighed down with tyres, or composted or chipped green waste are two possible approaches.***

Clay used in the liner construction, repairs or extensions should have a minimum liquid limit (LL) of 50 and a minimum plasticity index (PI) of 20. The reworked clay should have a permeability of 10^{-9} m/s. However, if local clay is unsuitable, this will have to be imported from off site, or a liner using sodium bentonite sheets (Geosynthetic Clay Liner) or other geosynthetics applied.

11.4. Stormwater Runoff Management

Stormwater runoff at all Landfills/Sites is one of two types, clean or dirty.

Clean stormwater is water running over undisturbed areas of the Site, such as

- areas of the Site still not cleared or areas which have been cleared, prepared and have re-established vegetation or grass cover.
- previously worked areas that have been covered with soil and are revegetated with grass or other plants
- hardstand areas such as parking areas, and
- building roofs

Dirty stormwater is rainwater runoff from;

- active dumping cells excluding any leachate which should be intercepted separately.
- previously worked areas of the Site that have not been covered and/or revegetated as yet
- cleared areas of the Site
- dirt access roads



The aim is to keep all stormwater separated from the waste mounds at all times, as stormwater should be directed straight off the Site without treatment of any sort.

“Dirty” stormwater is often allowed to also flow off the Site untreated, but future permits may require that it should be directed through a settling pond prior to flowing off the Site.

Neither type of stormwater should ever be mixed with leachate.

Clean storm water diversion drains or bunds must always be constructed immediately upslope of the active cell to stop rainwater runoff entering the active waste cell. This is to minimise the volume of water contacting the exposed waste prior to covering.

The base of the Landfill is sloped to allow stormwater runoff to flow by gravity to a central location from ***where it either drains away or will be pumped outside the cell to the perimeter stormwater drain. Impounded stormwater only needs to be pumped out of the cell if the waste, or runoff from the waste, is likely to come in contact with the impounded water. Otherwise the impounded water may be allowed to evaporate or taken to disposal by portable sludge pumps or syphons over the cell bund walls.***

When a new cell is to be built on top of the older cells, any areas of excess cover clay should be stripped and stockpiled for use. Stripping off old cover layers should only be performed on areas about to receive waste and not left exposed. ***This allows better movement of Landfill gas through the waste mound, better leachate recirculation and also reduces the quantity of cover material required. Daily cover of compost or chipped green waste also permits better bio-reactor landfill operation without removal. Contaminated compost with glass etc. is ideal for this purpose.***

11.5. Leachate Collection

The ***leachate collection system should be inspected by the Foreman or Supervisor before placement of any waste*** in the cell.

The leachate pipes must only be uncovered (remove the temporary plastic cover) when waste is ready to be placed over the leachate pipe to prevent stormwater entering the leachate collection system. Alternatively, coupled unslotted pipes can be used to divert leachate through “clean future cell areas” and swapped for slotted pipes before activation.



11.6. Access Roads

Construct the access road to the start of the cell. The road should approach the current tipping area by ***going over previously covered waste or native soil.*** It should ***not require vehicles to drive over uncompacted and uncovered waste*** in normal operation.

The road should be planned so that as the cell grows, the access road can be extended. The access ***road should be about 8 metres wide (6 metres for one way traffic)*** and drainage constructed so that the road does not become boggy. Passing space for a broken down or bogged vehicle should be possible.



Construct the access road to the cover stockpiles. The road should preferably be apart from the cell access road to help reduce traffic problems. The road should be 6 metres wide.

12. Recycling Areas

12.1. Background

A focus of the Solid Waste Management site is trying to maximise recycling and re-use interventions.

This will be achieved through a number of mechanisms as follows:

- Maximising segregation, such as for green waste where processed, to allow it to be chipped and then reused on access roads and daily cover and to protect final cover against erosion.
- Providing set-down areas for other materials that require reprocessing before re-use such as builders' rubble. This will be later crushed and re-used as road aggregate or for other gravel needs on site, such as leachate drain encasement or landfill gas blanket construction.
- Stockpile areas or concrete bunkers accessible to front loader buckets, for other recyclables such as large metal objects, large volumes of paper or cardboard waste and plastics.
- A separate stockpile area will be provided for any uncontaminated or lightly contaminated soil that can be re-used as cover material.
- Additional areas will be provided for processed recyclables such as chipped green waste, open windrow composting slabs and crushed builders' rubble.



12.2. General Operational Requirements

There are few specific operational requirements associated with the recycling facilities.

The main issue will be maintaining litter management throughout the area as well as minimising dust through the application of water or leachate application and erosion control by applying chipped greenwaste or revegetating. Supervision to prevent cross-contamination or incorrect deposition will be required for the public.

13. Cell Construction

13.1. Construction of Operating Cells

The **'area filling' method will be used. Therefore, earth bunds must be constructed on the sides of the cell to keep the waste in place.** The bunds are usually constructed of builder's waste or rubble, clay or old waste as a last resort, with slopes of 1:2.5 and are **constructed well ahead of the tipping face.** If no suitable builders waste or rubble is available, then cover material will have to be used. It can be salvaged when a weekly subcell is extended into the monthly cell and used for a new bund or interim capping.



Builders waste or rubble sent to the Landfill at any time should never just be incorporated into the waste cell, but stockpiled for either road construction, cell bund or leachate drain construction, or use as a possible gas collection blanket under the final cover.

The Site Foreman will arrange for profiles to be built every 50 metres along the cell. The profiles are usually made from timber pegs and show the width and finished height of the lift. Operators should check each day that they are building the cell to the correct levels.

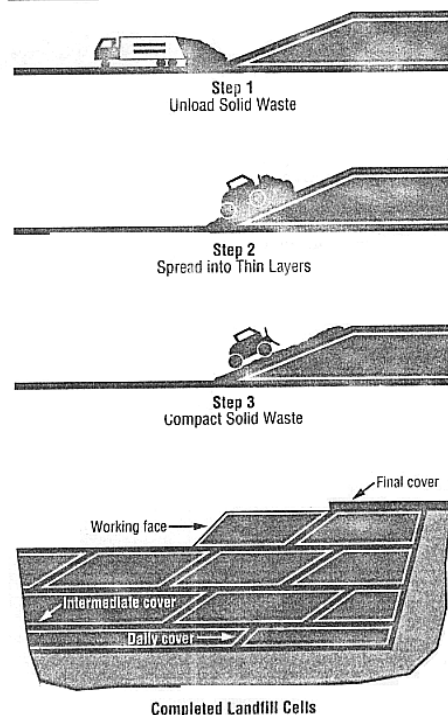
Each lift should be no more than 3 metres high.

The top of **each cell should drain uniformly to one side at a minimum slope of 5% i.e. 5V:100H.** Runoff from the top of the cell is to be drained to the stormwater control system running each side of the cell.

Every year, the Site Foreman may arrange for the Site to be surveyed to calculate the amount of airspace used and to provide plans which show the development of the Site. Aerial imagery is also feasible for large sites.

Before each cell is completed, the next cell must be set out and prepared.

Figure 1
Solid Waste Placement and Compaction



13.2. Impact on Waste Pickers

For Landfills, ***the waste should be spread over a reasonable area to allow efficient recovery of recyclables by waste pickers, prior to pushing, compacting and covering.***

The ***width of the tipping face should be as small as possible, to allow efficient use of plant and to minimise queuing of tipping vehicles.*** Typically, ***the face is wider than 15 metres but should be no more than 25 metres.*** The area of uncovered waste should be minimised to limit leachate formation and odours etc., but still adequate to allow recyclable's recovery by the waste picker associations.

At Landfills, it may necessary to operate a number of tipping areas to accommodate the various waste picker groups. Waste would be directed into one tipping area initially (say for an hour) and then second tipping area on the second hour. During the second hour, the waste pickers would access the waste deposited in the first hour. The waste in the area of the first hour's tipping would be pushed, compacted and covered at the end of the second hour ready for receiving waste again in hour three. The waste pickers would move to the second tipping area on the third hour whilst waste is again being deposited in the first area. In the following hour, waste pickers would return to the first tipping area and the second cell would again receive waste, and so on.

This allows one hour for the waste to be exposed for recyclables to be retrieved prior to covering with soil.

Different landfill specifics may require that the wait time is more than an hour which is acceptable provided that the waste residuals are still covered daily.

14. Operation of a Cell

14.1. Overview of Cell Operation

When waste arrives at the Site it is only lightly compacted. If the **waste is dumped in the cell and is not carefully compacted it can take up to two or three times the airspace volume of well compacted waste**. Poorly compacted waste **causes many other problems** including:

- more litter
- more odour
- more vermin problems
- extra leachate
- damage to vehicles because the roads settle and are not as smooth
- drainage problems.

In addition, the Landfill will continue settling for many years making it difficult to keep the final landform. Also, the closed Landfill will be more difficult to develop for other uses.

To achieve the optimum compaction there are a number of things to consider:

1. The **most important point for good compaction is the thickness of each layer** of waste.

EACH LAYER MUST BE LESS THAN 0.6 METRES THICK PRIOR TO COMPACTION.

If the layers are thicker than 0.6 metres, then it does not matter how many times the waste is compacted, the density will not further increase and fuel is wasted.



2. The second most important point for good compaction is the number of passes made over the waste.

Each layer should receive a minimum of 3 passes. For the best compaction, 5 passes are required.

If more than 5 or 6 passes are made, the density will not be increased significantly.

3. The type of plant used for compaction will also affect compaction. **If possible, a landfill compactor should be used. If a bulldozer is used, keep the layers thin and the face steeper than for a compactor.**
4. The **width of the face should be kept as small as possible**. The width required will depend on how many vehicles are at the tipping face. For an

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efficient operation, vehicles should not be kept waiting to tip. The width of each face for each cell will need to be judged when the Landfill starts, however as a guide, a 25 metre face should be more than adequate.



THE TIPPING FACE SHOULD NOT BE WIDER THAN 25 METRES.

EACH LIFT SHOULD BE BETWEEN 2 - 3 METRES HIGH.

- 5. All waste should be tipped at the bottom of the face and pushed up and across.** This pushing up hill helps to compact the waste further. Pushing waste down or over the face does not achieve the compaction essential to the efficient running of the operation.

- 6. If a tracked bulldozer is being used to compact waste the tipping face should be kept at a slope of 1 in 3.** This high slope will help the tracks to break up and cut the waste as the dozer climbs up the face.



- 7. If a landfill compactor is being used, the tipping face should be kept relatively flat at 1 in 8 or 1 in 10.** The compactor does not need the steep slope to break up the waste as the teeth on the wheels are designed to do this. The much heavier weight of the compactor is best at compacting waste if the slope of the face is fairly low. **Compactors should not operate on faces steeper than 1 in 4.**



- 8. The top of each cell should drain away from the tipping face,** either to one side or towards the start of the cell (minimum slope 5:100).

14.2. Effective Use of Equipment

All equipment must be properly inspected each day and serviced when required. All problems with equipment must be reported to the Site Foreman.

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Manufacturers start-up checks and regular maintenance should be recorded in daily sheets and returned to the foremen.

Over-compaction should be avoided as it wastes fuel and people's time.

The most efficient use of equipment will result if the following guidelines are followed:

- **WASTE IS SPREAD IN LAYERS LESS THAN 600 MM THICK**
- **EACH LAYER SHOULD BE GIVEN 3 - 6 PASSES.** The best compaction is 5 passes for MSW
- each lift should be between 2 - 3 metres high
- don't try to push big heaps of waste, eat away at the sides of heaps
- if there is not much waste arriving at the face, park the equipment and do other work, do not keep compacting
- use a bulldozer for spreading cover
- keep the width of the face to the minimum necessary to avoid queuing of tipping vehicles
- two faces may be necessary to allow appropriate access for waste pickers
- to get better compaction have waste tipped at the bottom of the face, and push it up and across the face
- have cover material tipped at the top of the face.

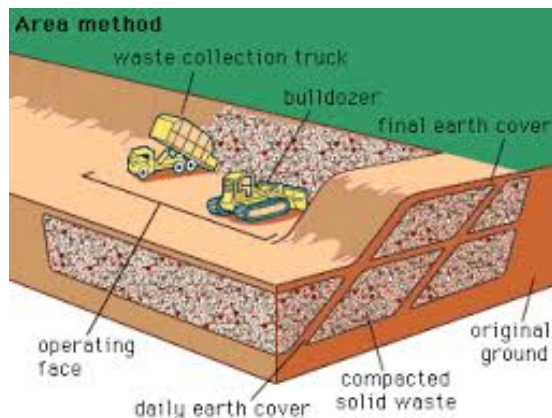


14.3. Spreading Waste

When truckloads of waste are tipped at the Landfill, the **best method of spreading is to "eat" the sides from the pile, not push front on.**

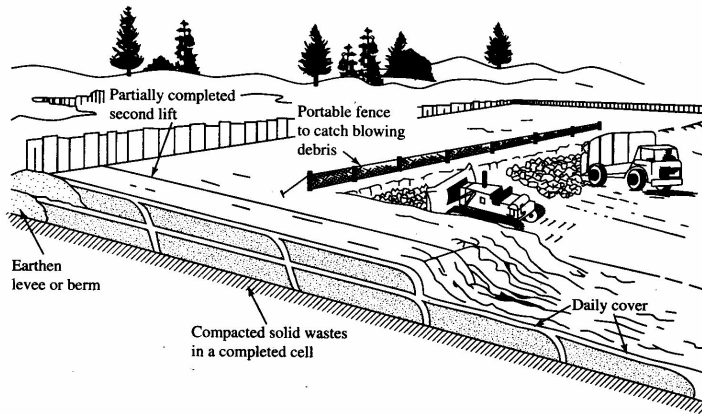
The **dozer blade should have waste about half way across and the waste pushed up and across the face in layers less than 600 mm thick.**

To try and push the whole of the load will not give good compaction and wastes a lot of fuel.



14.4. Soil Cover

At the end of each day, the tipping face must be covered with soil, called "cover". In areas of low rainfall or at relatively small tonnage sites, the frequency can be reduced. However, if excess leachate is observed in the landfill, then daily and intermediate cell cover must be applied more frequently.



To make covering easier, the face must be fully compacted and as smooth as possible. Unevenly compacted waste surfaces use extra soil to provide the minimum thickness of cover.

Cover material which is delivered to the cell

should be tipped near the top of the tipping face and if available a dozer should be used to spread out the material as soon as the face reaches final height.

There are many materials suitable for daily cover, including;

- material dug from Site
- excavation material from building Sites
- crushed and broken concrete from building demolition
- road demolition material.

The cover must always contain suitable fines to limit water intrusion and fly breeding. Micro containers should be crushed to suppress mosquito breeding.

If the material is to be **used for final cover, it must provide a stable, impermeable, permanent barrier to water, odour, pests and vermin and not be easily eroded.** The requirements for daily cover are less strict, particularly if the Site is operating in dry, cool periods.



The best material is a sandy or silty clay, with some gravel to provide reasonable trafficability when wet.

Too much sand increases the permeability of the cover (allowing landfill gas out and water in). Too much clay increases the chance of cracking in dry weather and makes the surface slippery in wet periods.

The **daily cover on the face should be about 150mm thick or as determined by licence approval and must be spread only after the face has been well compacted (3 or 4 passes) and graded to a uniform smooth slope.** If the cover layer is too thin, refuse can protrude. If thicker, valuable airspace and cover is being wasted as it does not provide any additional benefits.

If there is going to be a long timeframe involved before the temporary slopes will be amalgamated, these slopes should also be mulched and/or grassed to control erosion and siltation. Tyres with sidewalls cut can be roped or bolted together for erosion control and filled with green waste.

The cover depth should be increased to 300 millimetres for intermediate slopes. Intermediate slopes are those slopes which will not be covered on a daily basis, for up to 6 months but will eventually be covered with more waste.

The ***final cover layer*** must keep the waste in, water out and allow plants to grow. A typical final cover/capping would be:

- **600mm of well compacted, sandy/silty clayey material** - to make a waterproof layer to keep out the rainwater/snowmelt. The low permeability of clay or sandy/silty clay soils is essential to minimise percolation of rainwater. Sandy clay is better than a pure clay because it does not develop deep cracks if the layer dries out. This is less important if the cover will be mulched.
- **Optional 300mm to 1800mm of top soil or mulch** - to allow grass and larger plants to grow. If trees are required, it will be necessary to provide the thicker layer of top soil in the immediate area of the tree. When plant roots grow through the capping, the plants are often stunted or killed by the Landfill gas collected under the clay layer. Mulch should be added on top to keep the moisture in and help the grass grow. Chipped or mulched green waste is an ideal medium for mulch and can avoid the need for topsoil if applied over a number of years to build up an organic, rich surface on the cover material.

The total thickness of final cover may be determined by licence conditions.

14.5. Sequence of Filling

The sequence of filling chosen must satisfy the following key issues:

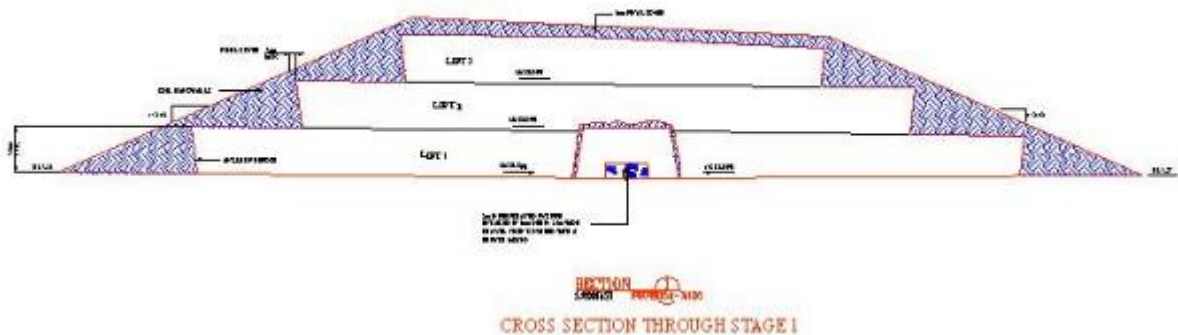
- ***place waste fill progressively from the top or “head” of the cell and move*** towards the eventual final outlet, that is, the lower part of the cell
- ***Ensure that the cell is filled such that the waste mound has the smallest practicable footprint and the smallest fraction of slope areas with only 5% fall.***
- ***DO NOT INITIALLY COMPLETE ONE FULL LIFT ACROSS THE ENTIRE CELL BASE AND THEN PLACE ANOTHER FULL CELL LIFT ON TOP. RATHER DEVELOP A SERIES OF PARTIAL LIFTS ON TOP OF ONE ANOTHER (starting from the highest area of the cell) TO MINIMISE THE PROGRESSIVE FOOTPRINT SIZE AND MAXIMISE THE FRACTION OF THE MOUND THAT HAS THE FINAL SHAPE AND ASSOCIATED 1:2.5 SLOPE. This is critical to minimise the amount of water that will infiltrate the waste mound and form leachate.***
- allow the progressive shedding of surface water outside the cell as the landforms are built and eventually merge.

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- allow diversion of stormwater runoff from previously worked areas around the ongoing stages of filling.

The staged filling sequence will be outlined in detail in the future detail design Landfill plans.

The method of construction recommended for the development of soil berms up the interior slopes of each stage uses excessive soil, but this will be recovered as fill is eventually placed against these batters.



14.6. Vegetation

On completion of the final cover for each lift, ***the surface should be adequately prepared by placing mulch or some other growing medium.***

A mixture of grasses and small shrubs should be planted. If certain varieties of trees/shrubs are seen to be not performing, then new types should be trialled.

It is critical that all exposed batters are revegetated upon completion of earthworks, as the vegetation:

- assists in screening the Landfill from public viewing.
- softens the general appearance of the operation
- stabilises the batters against erosion, especially if Vetiver grass is used.

- hastens the opportunity to convert the Landfill into the selected end use.

14.7. Post Closure

The post closure management plan has been incorporated into appropriate sections of the EMMP as it is a progressive process.

The ***ultimate landform and use of the Landfill will not have been finalised***, however a typical proposed rolling/hilly topography will be compatible with most existing areas.

With simple gas control measures, the following uses are possible;

- walkways, playgrounds, cycle paths, passive recreation
- re-pasture and allow grazing
- grass and tree planting



15. Leachate Management

15.1. Description

As rain water seeps through the waste mound, it becomes polluted by the waste. When the water finally reaches the bottom of the Landfill, it can be very heavily polluted and is often a dark grey or brown colour, and is then called leachate. In areas of high rainfall or where the waste has not been properly covered, large amounts of leachate can be produced. The landfill is initially aerobic and anaerobic decomposition and formation of full strength leachate can take up to 6 years. Early effluent is weaker and can be acidic, with more slimes formation and odours.

If leachate is allowed to collect in the bottom of the Landfill, it could eventually leak into the ground under the Landfill and end up in the ground water or a water supply. After some years, the ground water may permeate a long way from the Landfill and be used by other people.

As leachate can contain pollutants which could make the local water unsafe to use, leachate must be collected and safely disposed.

The direct discharge of leachate offsite is environmentally unacceptable, and would generally breach the Landfill operating conditions.



15.2. Leachate Control

The overall philosophy of the leachate control system is to minimise leachate production and use the dry waste to absorb any collected leachate and promote rapid biodegradation. (Bio-reactor landfill).

The most effective way to control leachate is a combination of design features and operational practices as follows;

- continuous compaction of incoming waste and provision of daily cover.
- grading of working areas and deposition areas to divert rain water away from the waste working face.
- provision of surface interceptor drains to divert surface water around the filling area.
- progressively developing final grades and shapes to shed surface water off the mound as quickly as possible to reduce infiltration



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- prevent leachate escape beneath the Landfill by means of a clay/ synthetic liner or compacted natural clayey subgrade.
- installing leachate drains at the base and the downstream edge of the Landfill to promote leachate drainage to collection points.

Leachate drains are installed in the base of the landfill cell consisting of a slotted pipe inside a gravel drain. This pipe leads to an evaporation pond for very small landfills or a leachate pumping station for larger facilities.



For smaller landfills, just with leachate lagoons, leachate will be allowed to passively evaporate in the leachate lagoon. If the leachate lagoon is filling and is at risk of overflowing, then the portable sump pump usually used for pumping out stormwater from the cells could be used to pump out leachate and dispose of it by the usual means of evaporation or reinjection.



Disposing **of the leachate in the leachate pumping stations can be by three options**, listed in order of preference below:

- recycling the collected leachate by pumping into the waste mounds by means of “dry wells”, located near the top of the filled areas. The Landfill plans may show the design for a reinjection well, or
- irrigation on previously worked areas on stones in prepared future cells, or open pasture to encourage vegetation growth.
- as a last resort, installing and operating a leachate treatment plant and then discharging the treated leachate to irrigate tree farms or coconut plantations or similar non-contact agriculture, or as a last resort discharge into a local canal or watercourse.

The base of the Landfill is graded to a series of low points. Leachate collector pipes are provided which are surrounded with gravel and possibly a woven drainage fabric. **The collector pipes will only be exposed (or connected) just before the slotted leachate pipe (collector pipe) is covered with waste** to stop stormwater entering the leachate system. These main drains are connected to a pumping station, and the leachate is pumped to the dry well injection system on-site, irrigated or treated and discharged.

If the flow of leachate becomes too high for re-injection, it may be irrigated over previously worked areas, over stone on future cells, or treated prior to discharge.

The leachate irrigation system will include a number of flexible hoses such



as light gauge HDPE or flexible hoses. These flexible hoses have a number of holes drilled in them to distribute the leachate flows over a large area at the top of the external batters. The **site operators must ensure that the irrigation pipes are regularly relocated to avoid ponding of leachate or run off of leachate from the landfill.**

The leachate pump stations are equipped with pumps that will allow the leachate to be irrigated or injected into the refuse mounds. The pumps should be operated as often as is required to keep the leachate wet wells at suitable level to prevent overflow. The pumps have a low-level electrode cut-out so they cannot run dry and become damaged. The motors must be explosion-proof against methane build up in the well. The Site Foreman will be trained in the disposal of the treated leachate.

All staff are to tell the Site Foreman of any problems with the leachate system. The Site Foreman will also decide whether leachate is to be reinjected or irrigated at **any time**, based on prevailing and expected weather conditions and the need for plant vitality.

15.3. Leachate Lagoon

In relatively smaller landfills and especially in drier areas, leachate can be directed to a leachate lagoon for evaporation. In wetter areas, the lagoon may need to balance wet season infiltration until the dry evaporating season arrives in which case they must be covered. The only operational involvement would be to check the lagoon integrity, especially the inside face of the encircling bunds and remove any litter.



If the leachate lagoon is filling and is at risk of overtopping, then the portable sump pump usually used for pumping our stormwater from the cells could be used to pump leachate and dispose of it by the usual means of evaporation or reinjection. Another lagoon may have to be constructed in unusually wet periods.

15.4. Leachate Monitoring

Any leachate collected in the de-leaching wells will be tested quarterly to assess its quality, or as stated in the site Licence. Ground water will also be tested as this could be affected by leachate. Nitrogen compounds are a common indicator of pollution, but it is important to test the ambient water quality for a year before operations start to avoid false alarms.

It is proposed that the ground water bores/ leachate wells will generally be monitored **on a quarterly basis** or in accordance with the approvals, regulations or guidelines of the time. The **Environmental Monitoring and Management Plan outlines typical water quality parameters and frequency to be tested but the parameters and testing specified in any approvals for the Site should take precedence.**

15.5. Emergency Action

The correct operation of the leachate system is extremely important.

If the system has broken down or is in danger of leaking, the Site Foreman must be immediately notified. He will then investigate the problem and immediately notify the Manager.

16. Stormwater/Snowmelt Systems

16.1. Background

If external runoff water is not carefully controlled, many operational problems will arise, including the following;

- extra leachate will be formed,
- pollution can be carried off Site,
- the Landfill will be hard to operate due to bogged vehicles, and
- the operator of the Landfill can be fined for breach of the Landfill Licence.

The storm water on a Landfill can be classified as either clean or dirty. The clean storm water falls on undisturbed land and is not polluted. This water usually drains onto the Landfill from the adjacent catchment. To ***stop the clean water from being polluted, diversion drains and bunds will be constructed around the Landfill to divert clean storm water runoff or flood water from entering the working areas*** and disturbed areas of the Landfill. All storm-water channels and the entrances into local canals and natural creeks should be checked regularly for signs of erosion and/or instability such as after each major storm event.

Internal stormwater runoff contaminated by soil cover stockpiles and disturbed areas is classified as dirty. This dirty water volume can be minimised by implementing progressive revegetation of completed areas.

In certain locations there is no requirement to treat dirty stormwater before discharge. If treatment is required, a hay bale/geotextile barrier can be constructed across the runoff points within the Site to minimise escape of silt or a settling pond constructed, if required by the Landfill Licence or Permit. The barrier should be inspected after each major storm event. Trapped sediment will be removed for use as cover, and the silt barrier inspected for any damage.



Where storm water is to cross an access track, a piped crossing must be provided.

Any ***water that ponds against the waste face for a lengthy period, or even against litter, must be treated as leachate,*** and must not be directed to the storm water systems.

16.2. Stormwater Controls

The ***cells will be filled with waste from higher areas to lower areas to avoid stormwater ponding at the base of the working face or previously worked areas.***

The base of the Landfill is sloped to allow stormwater runoff to flow by gravity to a central location from ***where it will be pumped outside the cell to the stormwater drain.***

Any stormwater runoff from higher areas or previously worked areas will be diverted away from the active face through small drains or bunds as necessary during new sub-cell development.

16.3. Surface Water Monitoring

Visual inspection of the water leaving the Site should usually suffice. If obviously turbid or dirty, then treatment will be required, such as silt barriers or settling ponds.

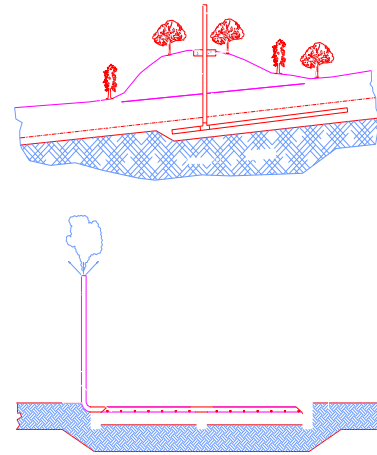
If required by the Landfill Licence in the future, monitoring of surface water as it enters and leaves the Site may be specified on a regular basis, such as during major runoff events to determine the level of any contamination. Parameters analysed could include the following but will be stipulated in the Landfill Licence if required: electrical conductivity, pH, redox potential, temperature, total dissolved solids, suspended solids, turbidity, nitrogen scan, bicarbonate, chemical oxygen demand, standard water analysis, iron total, zinc, chromium, lead and copper. Similar monitoring of the internal storm water above and below the working face should also be carried out.



All staff are responsible for checking that the storm water systems are operating properly. Any problems are to be reported to the Site Foreman.

17. Landfill Gas

Landfill gas explosions have occurred infrequently throughout the world, but these are always at poorly run Sites with large voids in the Landfill resulting from old water or fuel tanks, vehicle bodies and so on. These items will not be allowed into the Landfill as they are recyclable materials and also may form these large gas pockets. Without these large voids, **there is no risk of explosion at the Landfill even with only passive gas venting systems.** *Where domestic housing is allowed too close to a landfill, natural crevices in the soil formation can allow landfill gas to migrate as at Cranbourne in Victoria, Australia where buffer distances were reduced as cover was applied. This resulted in evacuation of houses and significant fines to the operator and approving authorities. Buffers need to be maintained unless a physical barrier is constructed against gas migration.*



There is no need to have horizontal collection systems and a network of vertical vents and risers for a small Landfill where the gas will not be commercially harvested.

Since the Landfill will provide a relatively low yield of gas, **a simple gas collection blanket could be installed under the final cover with some passive vertical vents.**

The gas collection blanket, consisting of a simple gravel layer, would only be provided under the middle third of the final Landfill footprint.

There are no specific operational requirements. During a temperature inversion, biogas can sink down rather than rise, so attention should be paid to neighbouring terrain if this could be an issue.

In the future if the biodegradable tonnage being landfilled significantly increases, then vertical gas wells can be retrofitted, and a piping network and manifold installed to allow productive reuse or flaring of the gas. The rule of thumb is that landfills receiving less than a few hundred tons a day of waste are unlikely to be commercially successful. The collected gas can still be used for local heating requirements however.



18. Litter Control

Litter control is required on all areas of the Site.

18.1. Litter Fences

Moveable litter fences should be positioned on the downwind side of the tipping face about 50 metres from the edge of the tipping face. They should form a curve in the horizontal plane, slope inwards and have no gaps.

The length of fence depends on the size of the tipping face but should be wide enough to allow for changes in wind direction.

The litter fence should be cleaned every second day, or daily during windy weather.



18.2. Boundary Fence

The boundary fence will help to stop trespassers entering the site and to help keep litter inside the Site.

The boundary fence (or outer litter fence) should be cleaned each week, or more frequently in windy weather.



18.3. General Site

Any material found on the access roads should be cleaned up each day before the Site is closed.

Spilled liquid from engine changes or drum spills should be cleaned up with dry powder, such as sawdust or sand, in the first instance.



18.4. Access Roads

Litter is often dropped from loads on the way to Landfills and is sometimes dumped near the Site by people arriving when the Site is closed.

The approach roads within 200 metres of the Site should be kept free of litter (or other distance as may be subsequently required by the Landfill Licence). This will require ***a hand litter collection to be undertaken each week.***

If a large amount of litter is found on any day, it should be reported to the Site Foreman who will arrange for a special clean up.



All staff should try to "catch" illegal dumpers and get them to pick up their waste and dispose of it legally. If they refuse, obtain as much of the following information as possible and report it to the Site Foreman:

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- name
- address
- vehicle registration number plate
- vehicle type
- vehicle colour
- date and time
- type of material
- amount of material.

If possible, take photographs of the vehicle dumping illegally.

18.5. Responsibility

The Site Foreman will decide how often to have litter clean ups.

All staff should look out for litter problems and report them to the Site Foreman.

19. Pest Control

On a poorly run Site there can be a number of pests including;

- **Birds** such as generic seagulls, ibis and pigeons are common, or local specific species
- **Flies** can be a major problem if the working face is not covered quickly (and mosquitoes in Dengue or malarial areas breeding in micro-containers).
- **Rats** live at nearly all Landfills and can breed into large populations if not controlled
- **Feral cats and dogs, domestic pigs and cattle and goats** are often found on unfenced Landfills and should be controlled, especially as cats and dogs will prey on native animals.



The best method of control of all pests on a Site is to operate the Landfill properly. Fencing keeps out larger animals and it should be kept in good repair. If the waste is properly compacted and quickly covered, the pests find it difficult to feed and will go elsewhere.

Well compacted waste will make it difficult for rats to find homes and tunnels, and access to the waste is difficult if the cover is properly applied.

Many methods are used to control birds, including, poison, guns, shotgun blasts (blanks) wires between high poles, nets, noise, hawks and eagles and even whips. None are completely successful but can be of some use if birds are a problem.

Rats are difficult to control and it is usual to employ a contractor to lay poison to keep the population under control if numbers become excessive. Typically, the contractor would come each day that rubbish is delivered to the Landfill. If the Landfill accepts a lot of solid waste and little kitchen/putrescible waste, baiting may only be required twice each week.

Inform the Site Foreman if pests are increasing. The Site Foreman will arrange for extra pest control.



20. Fire Control

20.1. Notification Procedure

As with any Landfill, purposeful lighting of fires is banned, as is smoking anywhere on the Landfill.

Fires usually occur because of chemical reactions from hazardous chemicals, high piles of composting wastes in the Landfill or someone burns the waste pile to reduce odours or vermin infestations.



When smoke is found coming from the Landfill, the Site Foreman must be immediately notified.

Under no circumstances is the fire to be put out by the bulldozer/excavator operator if no-one else is present.

The Site Foreman/Manager will decide what action is to be taken. If the fire is over a large area, contact the fire brigade.

20.2. Fire Fighting Procedure

Do not just flood the waste mound with water hoping to extinguish the fire. This rarely succeeds and will just form large quantities of leachate.

The best method of putting out a fire is to open up the Landfill and spread out the burning waste. Before the Landfill is opened, the Landfill water tanker is brought to the area and checked that it is in operating condition.



Operators must take extreme care when fighting fires with earthmoving equipment. All major plant equipment must have a fire extinguisher. Before starting to fight the fire, make sure the fire extinguisher is ready for use.

Any plant equipment which is in poor condition must not be used, especially if there are any oil leaks or the plant is unreliable and in need of service.

The waste mound is to be opened near the smoking area and the dozer will move towards the smoking area, by pushing the waste well away from the point of fire.

When the burning area is reached, the waste is spread out on the surrounding cover and either put out with the Landfill water tanker or buried with cover material. When the fire is put out, the material should be reworked to ensure there are no hot spots before it is re-buried.

The Site Foreman will note all fires in the Daily Report including the suspected cause, how long the fire went for and what equipment was used to put it out.

21. Dust Control

Dust is often caused mainly by vehicles as they drive to and from the tipping face, but large stockpiles of cover material can also be a major dust source in dry periods. Dust control is especially needed when dry and windy.

Dust control is achieved by spraying water or leachate on access roads, open dirt areas and stockpiles to reduce the amount of dust emitted.

Where available, magnesium chloride salts added to the tanker water will settle dust for six or more months, with no adverse environmental problems. Magnesium chloride is a waste product from table salt production.

The Site will be provided with a water tank to be used for dust control and firefighting. This is a water tank that can be fitted to the site tipping truck as required. A motorised pump and hose should also be fitted.



When the Landfill is dry, especially on windy days, all access roads should be watered at the start of the day and watering repeated whenever dust starts affecting visibility. Leachate or stormwater is suitable for this purpose.

When spreading cover material, water needs to be sprayed to control the amount of dust generated.

The waste mound batters must be progressively mulched and revegetated which eliminates dust from the previously worked areas of the Site.

Mulching or other techniques may be required to control dust emissions from cover stockpiles, if this becomes an ongoing problem.

All staff should look for dust problems and report them to the Site Foreman who will log the problem and decide the solution.

22. Mud Control

Mud adhering to vehicle wheels could be removed in wheel washes prior to vehicles leaving the Site.

Wheel washes may be classified as static or pressure as described below:

Static

These are shallow drive through basins which remove the dirt from the tyres. The basins are usually made of concrete and can be profiled to enable an excavator or similar to clean out the mud. A sealed road before and after the wheel wash is required. This type of wheel wash does not remove mud from the chassis of the truck.

Pressure

The simplest type of pressure wheel wash consists of a concrete drive through area with spray nozzles on low side walls. As the truck moves slowly through, the wheels and chassis are washed. To help remove the mud before the wheel wash a rough section of sealed/concrete road can be built. This must be cleaned regularly. Access roads should be constructed from sandy/gravel material. If mud is noticed on the public roads near the entrance gate it must be immediately cleaned off by either water trucks and/or shovels. The wheel wash will require regular maintenance.

The City may decide that wheel washes are unnecessary, provided that they are not required in the Landfill permit.

The same facility and treatment can be used for skip bin washing and exchange, with water taken to the landfill or slow sand filter treatment.

23. Emergency Phone Numbers

A list of emergency phone numbers to be inserted here.

The numbers would include the General Manager, Site Foreman, Supervisor, Fire Department, Police, Ambulance, Nearest Hospital, Environment Department, relevant City Officers, etc.

Appendix A - Standard Forms

The ***first three forms are compulsory for all Landfills***, namely

- ***Daily Diary*** – summarises all activities of the day's operations.
- ***Waste Designation Sheet*** – records all vehicles entering the Landfill and their load types
- ***Incident Report Sheet*** – used only if an incident occurs, such as detecting prohibited waste or a fire on the Landfill

The ***Load Receipt*** will only be required if centralised billing of vehicles dumping at the Landfill is adopted.

SWM LOAD RECEIPT

Date: _____

Contractor/Carrier: _____ Vehicle Registration No. _____

Volume/Weight of Waste: _____ Waste Type: _____

Signed: _____ Name/Title: _____

Original + 2 copies:

Original - to Head Office for invoicing
1st Copy - to Contractor/Carrier
2nd Copy - retained on Site

Appendix B - Summary

Reporting Procedures

The **Daily Diary must be completed each day** before the Site Foreman leaves the Landfill.

The **Incoming Waste Designation Sheets and Incident Record Sheets may be required in the future, and would be collected at the end of each week**. Other sheets may also be required.

Waste Categories

The waste entering the Site may be categorised as follows, with some examples given;

- **Acceptable Wastes (General)** – general household and commercial waste
- **Acceptable Wastes (but Difficult)** – tyres, mattresses
- **Special Wastes (Sometimes Acceptable)** – asbestos, liquid waste
- **Prohibited Wastes** – radioactive waste

The first two categories are always accepted, but the second category requires some special management. The third category may be acceptable based on quantities involved, actual waste characteristics and so on, and is decided on a case by case basis. Prohibited wastes are never allowed into the Site.

Incoming Load Inspection Procedure

The inspection procedure proposed is comprehensive, and may be introduced in a staged manner. It is recommended that the basic recording system be adopted initially, and the more complete docketing system be introduced over time or as legally required, as follows;

- All vehicles must stop at the gate/weighbridge.
- The gatekeeper carries out an initial inspection and any vehicles obviously carrying a load containing a substantial proportion of 'prohibited material' are rejected.
- The tipped load can be broken open and spread by an operator and then checked by the Site Foreman who checks the description of the contents on the Load Receipt form when that form is adopted for use.
- If the Site Foreman is satisfied with the load, it is spread and compacted.

Managing Prohibited Substances

The Site permit/licence may list all material which is acceptable for disposal at the Site. All other material would therefore be considered **prohibited substances**. If the permit does not address this specifically, then the descriptions of acceptable and prohibited waste should be adopted from this Manual:

- When prohibited substances are brought to the gatehouse, the driver of the vehicle is to be told that they are not accepted.
- When prohibited substances are found on the tipping face, if feasible to do so, the prohibited substances are removed by hand and placed in a nearby bin. When full, the bin is to be disposed of in an approved facility.

- If it is not feasible to hand pick the dumped load, it may be necessary to use equipment to load the prohibited substances into the bin, for removal as above.
- If prohibited substances are noticed during tipping, the driver must be told to reload all of the substance and to remove it from the Site. If the driver refuses, write down as much of the drivers and vehicles details as possible
- If a prohibited substance is found on the tipping face, the material should be left alone and the matter immediately reported to the Site Foreman.

All staff are responsible for ensuring that prohibited substances are not accepted or allowed to be buried on the Site.

Landfill Preparation

It is critical that waste is not just dumped anywhere on Site.

Every load must be placed according to the Site development plan and within the cell constructed for that day's waste. ***Each cell must be set out carefully to optimise the operation of the Landfill.***

The ***area required for each sub-cell should be at least enough to allow for one month of tipping.***

Construction

Clean storm water diversion drains or bunds must always be constructed upslope of the active cell to stop rainwater runoff entering the cell. This is to minimise the volume of water contacting the exposed waste prior to covering.

The ***spoil from constructing the cell should be stockpiled nearby for use as daily cover.*** If the new cell is to be built on top of the older cells, any areas of excess cover should be stripped and stockpiled for reuse.

The ***leachate collection system should be installed and inspected by the Supervisor or nominee before placement of any waste*** in the cell.

The road should approach the current tipping area by ***going over previously compacted and soil covered waste, or native soil.*** It should ***not require vehicles to drive over uncompacted and uncovered waste*** in normal operation.

The road should be planned so that as the cell grows, the access road can be extended. The access ***road should be about 8 metres wide (6 metres for one way traffic)*** and drainage constructed so that the road does not become boggy.

Cell Construction

Bunds must be constructed on the sides of the cell to keep the waste in place once the waste is being placed above ground level. The bunds are usually constructed of builder's waste or rubble with slopes of 1:2.5 and are ***constructed well ahead of the tipping face.*** If no suitable builders waste or rubble is available, then cover material will have to be used, or as a last resort during Landfill construction, old garbage.

Each lift should be no more than 3 metres high.

The top of each cell should drain at a minimum slope of 5% i.e. 5V:100H. Runoff from the top of the cell is to be drained to the stormwater control system.

Before each cell is completed, the next cell must be set out and prepared.

The waste should be spread over a reasonable area to allow efficient recovery of recyclables by waste pickers, prior to pushing, compacting and covering. However, the ***width of the tipping face should be as small as possible to allow efficient use of plant and to minimise queuing of tipping vehicles.*** Typically ***the face is wider than 15 metres but should be no more than 25 metres.*** The area of uncovered waste should be minimised to limit leachate formation and odours etc., but still adequate to allow recyclables recovery.

Operation of a Cell

If the ***waste is dumped in the cell and is not carefully compacted, it can take up to two or three times the volume of well compacted waste.*** Poorly compacted waste ***causes many problems.***

The most important point for good compaction is the thickness of each layer of waste when compacting. ***Each layer must be less than 0.6 metres thick.*** If the layers are thicker than 0.6 metres, then it does not matter how many times the waste is compacted, the density will not get any better.

Each layer should receive a minimum of 3 passes. For the best compaction, 5 passes are required.

All waste should be tipped at the bottom of the face and pushed up and across. This pushing up hill helps to compact the waste further. Pushing waste down or over the face does not achieve sufficient compaction.

If a tracked bulldozer is being used to compact waste the tipping face should be kept at a slope of 1 in 3. This high slope will help the tracks to break up and cut the waste as the dozer climbs up the face.

If a compactor is being used to compact the waste the tipping face should be kept relatively flat at 1 in 8 or 1 in 10. The compactor does not need the steep slope to break up the waste as the teeth on the wheels are designed to do this. ***Compactors should not operate on faces steeper than 1 in 4.***

The top of each cell should drain away from the tipping face, either to one side or towards the start of the cell (minimum slope 5%).

Soil Cover

At the end of each day, the tipping face must be covered unless a less frequent frequency is agreed. To make covering easier, the face must be fully compacted and as smooth as possible. Uneven waste surfaces use extra soil to provide the minimum thickness of cover required.

Cover material which is delivered to the cell should be tipped near the top of the tipping face. ***The cover thickness should be 150mm and should be spread and compacted with about 3 - 4 passes.***

The best cover material is sandy clay as it seals the top to stop rainwater getting into the waste but will not dry and crack in hot weather. However any soil is better than none.

The cover depth should be increased to 300 millimetres for intermediate slopes. Intermediate slopes are those slopes which will not covered on a daily basis, for up to 6 months but will eventually be covered with more waste.

The final soil cover will be at least 600mm thick, plus a mulch or loam topsoil cover if possible, and revegetated as soon as possible after placement.

Effective Use of Equipment

The most efficient use of equipment will result if the following guidelines are followed:

- waste is spread in layers less than 600 mm thick
- each layer should be given 3 - 5 passes. The best compaction is 5 passes
- each lift should be between 2 - 3 metres high
- compactors give higher compaction than bulldozers
- don't try to push big piles of waste, eat away at the sides of heaps
- if there is not much waste arriving at the face, park the equipment plant and do other work, do not keep compacting
- landfill compactors are not efficient at spreading or excavating cover
- use a bulldozer for spreading cover, not a compactor
- keep the width of the face to the minimum necessary to avoid queuing of tipping vehicles
- more than one face may be necessary to allow access by the waste pickers
- to get better compaction have waste tipped at the bottom of the face, and push it up and across the face, and
- tip cover material from the top of the face.

Leachate Management

As rain water seeps through the waste mound, it becomes polluted by the waste. ***When the water finally reaches the bottom of the Landfill, it can be very heavily polluted and is often a dark grey or brown colour, and is then called leachate.*** Following heavy rainfall or snowmelt and where the waste has not been properly covered, large amounts of leachate can be produced.

The direct discharge of leachate offsite is environmentally unacceptable, and would breach the Site operating conditions.

The overall philosophy of the leachate control system is to minimise leachate production and use the dry waste to absorb any collected leachate and promote rapid biodegradation.

The most effective way to control leachate is a combination of design features and operational practices as follows;

- continuous compaction of incoming waste and provision of daily cover.
- grading of working areas and deposition areas to divert rainwater away from the waste working face.
- provision of surface interceptor drains to divert surface water around the filling area.
- progressively developing final grades and shapes to shed surface water off the mound as quickly as possible to reduce infiltration
- prevent leachate escape beneath the Landfill by means of a clay/lime liner or compacted natural clay subgrade. where required
- installing leachate drains under the Landfill to promote leachate drainage to collection points.
- recycling the collected leachate pumped from de-leaching wells through the dry waste by means of “dry wells” located near the top of the filled areas, or
- irrigation on previously worked areas to encourage revegetation growth.

The leachate pump stations are equipped with pumps that will allow the leachate to be irrigated or injected into the refuse mounds. The pumps should be operated as often as is required to keep the leachate wet wells at suitable level to prevent overflow. The pumps have a low-level electrode cut-out so they cannot run dry and become damaged.

Leachate Monitoring

It is proposed that the **ground water bores and leachate wells will generally be monitored on a quarterly basis** or in accordance with the approvals, regulations or guidelines of the time. The **Environmental Monitoring and Management Plan would outline the water quality parameters and frequency to be tested.**

The correct operation of the leachate system is extremely important. If the system has broken down or is in danger of leaking, the Site Foreman must be immediately notified.

Stormwater Systems

If storm water is not carefully controlled, many operational problems will arise.

The storm water on a Landfill can be classified as either clean or dirty. The clean storm water falls on undisturbed land and is not polluted. This water usually drains onto the Landfill from the adjacent catchment. To **stop the clean water from being polluted, diversion drains will be constructed around the Landfill to divert clean storm water runoff from entering the working areas and disturbed areas of the Landfill.**

Internal stormwater runoff contaminated by cover stockpiles and disturbed areas is classified as dirty. This dirty water volume can be minimised by implementing progressive revegetation of completed areas.

Litter Control

Litter control is required on all areas of the Site.

Moveable litter fences should be positioned on the downwind side of the tipping face about 50 metres from the edge of the tipping face. They should form a curve and have no gaps.

The length of fence depends on the size of the tipping face but should be wide enough to allow for changes in wind direction. This litter fence should be cleaned every second day, or daily during windy weather.

Any material found on the access roads should be cleaned up each day before the Landfill is closed.

The approach roads within 200 metres of the Site proper should be kept free of litter (or other distance as required by the Landfill Licence). This will require a hand litter collection to be undertaken each week.

Pest Control

On a poorly run Landfill there can be a many types of pests including birds, flies, rats and feral cats and dogs.

The best method of control of all pests on a Landfill is to operate the Landfill properly. If the waste is properly compacted and quickly covered and the tipping face covered each night, the pests find it difficult to feed and will go elsewhere.

Fire Control

As with any proper Landfill, purposeful lighting of fires at the Landfill is banned, as is smoking anywhere on the Landfill. Fires usually occur because of chemical reactions from hazardous chemicals or composting wastes in the Landfill.

Do not just flood the waste mound with water hoping to extinguish the fire. This rarely succeeds and will just form large quantities of leachate. The best method of putting out a fire is to dig up and open up the Landfill, and spread out the burning waste.

Open the waste mound near the smoking area and the dozer will move towards the smoking area, by pushing the waste well away from the point of fire.

When the burning area is reached, the waste is spread out on the surrounding cover and either put out with the Landfill water tanker or buried with cover material. When the fire is put out, the material should be reworked to ensure there are no hot spots before it is re-buried.

Dust Control

Dust control is usually achieved by spraying water or leachate on access roads, open dirt areas and stockpiles to reduce the amount of dust emitted. If leachate become unsuitable for irrigation in dry weather for some reason, it is safe to use as a dust suppressant rather than buying potable water. Magnesium chloride added at a few parts per million causes dust particles to aggregate and suppresses dust for months after watering. It is a waste product of table salt production.

The waste mound batters will be progressively mulched and revegetated which eliminates dust from the external previously worked areas of the Site.