CHAPTER 2

Environmental Health

Background

From the beginnings of human civilization, it was well known that unsanitary conditions spread communicable diseases, and Environmental Health has been the principal function of Public Health Inspectors (first designated as sanitary Inspectors) since the inception of the public health services in Sri Lanka. In fact when the extended general health programme, based on the Health Unit system, was inaugurated in 1936, a five-point rural sanitation scheme was introduced, and formed the basis of the departmental rural sanitation programme for many decades.

FIVE POINT RURAL SANITATION SCHEME

- **Well ventilated house**
- **Boiled, cooled water for drinking**
- **Sanitary latrine**
- **Manure pit**
- **Kitchen garden**

It is evident that from early times the emphasis of environmental health has been on the prevention of disease by ensuring good housing, safe water, excreta disposal, refuse disposal and provision of nutritious and safe food. These aspects of environmental health continue to remain priority activities even today**.**

However, new environmental health problems have emerged, mainly due to rapid population growth, urbanization and technological development. There is concomitant expansion of industry and agriculture, and the demand for energy, and material goods of civilization, has increased. Problems of waste disposal have become more complex and new environmental hazards are continuously being recognized. Likewise natural and man made disasters such as floods, droughts, and conflict-situations take place. The PHI, as an important member of the health team in a MOH area, have a fundamental role to perform in maintaining environmental sanitation in these varied circumstances, and therefore it is essential that the PHI is familiar with the various functions he has to perform in these situations.

2.1 Environmental health programme of the ministry of health

Objectives

1. To ensure the quality and safety of drinking water
2. To ensure the proper disposal of human excreta
3. To ensure the proper disposal of solid, liquid and hazardous waste
4. To ensure the use of healthy habitable dwellings
5. To maintain high standards of food safety and hygiene
6. To ensure a safe and healthy environment in work places
7. To ensure a safe and healthy environment at school
8. To ensure the provision of public health measures required during natural disasters
9. To ensure proper sanitation in burial grounds, slaughter houses and dumping sites
10. To ensure proper sanitation of public places, special institutions and special events
11. To promote community participation to protect the environment
12. To assist and ensure the implementation of environmental regulations imposed by the relevant authorities

Strategic Interventions

In order to achieve the above objectives there are strategic interventions, the PHI has to regularly carry out, comprising;

1. Safe water

i. Regular monitoring of quality of drinking water in all public water supply schemes in the area
ii. Measuring the free residual chlorine content of water at source and at points of consumption
iii. Chlorination of all wells when pollution is suspected, i.e. after floods, during epidemics of diarrhoeal disease
iv. Periodic sampling of water for quality
v. Reporting
vi. Create awareness on household water treatment systems or methods

2. Sanitary excreta disposal

i. Promote and assist householders to construct sanitary latrines
ii. Create awareness on proper usage of sanitary latrines and health impacts of improper disposal of human excreta

3. Waste management

i. Create awareness on waste management methods
ii. Promote and guide in establishing waste management systems

4. Healthy habitable dwellings

i. Create awareness on five perceptions on healthy dwellings
ii. Advice on construction of buildings and dwellings on recommended standards

5. Food safety and hygiene

i. Registration and inspection of all food handling establishments
ii. Regular inspection of food items to test for quality and evidence of contamination
iii. Educate food manufacturers, traders, food handlers and public on food safety and hygiene

6. **Safe working environment**
   i. Regular inspection of work places to identify occupational hazards
   ii. Advice on prevention of hazards and promote healthy work settings places

7. **Safe and healthy environment at school**
   i. Inspection of school environment
   ii. Follow up and coordinate with school authorities to rectify the identified defects
   iii. Promote activities to maintain healthier school environment

8. **Public health measures required during natural disasters**
   i. Coordinate activities on provision of safe drinking water, food and sanitation of temporary shelters during natural disasters
   ii. Educate public on prevention of communicable diseases and safe hygienic practices
   iii. Take measures in preventing spread of communicable diseases

9. **Sanitation of burial grounds, slaughter houses and dumping sites**
   i. Regular inspection
   ii. Advice and coordinate with local authorities to maintaining in proper sanitary condition

10. **Sanitation of public places, special institutions and special events**
    i. Regular inspections of markets, fairs and festival sites

11. **Promote community participation to protect the environment**
    i. Organize and Implement community based environment protection programmes with the public of the area

12. **Implementation of environmental regulations**
    Liaise with other stakeholders and assist in implementation of environmental regulations

THE STAKEHOLDERS IN ENVIRONMENTAL HEALTH SERVICES

- **Water supply** -The National Water Supply and Drainage Board, Community Water Supply and Sanitation Projects and Community Based Water Supply Schemes
- **Food safety and hygiene, refuse collection and disposal, housing -** Provincial and local authorities
- **Prevention and control of environmental pollution -** Ministry of Environment and Natural Resources and The Central Environmental Authority
- **Urban development and planning** - Urban Development Authority, National Housing Development Authority
- **Prevention of environmental pollution in disaster situations** - Ministry of Disaster Management
- **Protection of costal environment** - Costal Conservation Authority

The responsibility for the provision of many of the services related to environmental health also lies with certain other sectoral agencies.

Responsibility of the PHI to the Stakeholders

The local level PHI assists these agencies to perform their functions more effectively, by advising, guiding and participating in some of these activities.

2.2 Water Supply and Sanitation

Introduction

For the existence of human beings and animals, air, water, and shelter are the essential universal requirements. Importance of water as an essential element is rated as highest. With the fast growing population the consumption of water is increasing rapidly. Therefore action is essential to supply pure water to satisfy consumer needs.

Water Sources

Water Sources can be divided mainly into the following two types;

i. **Surface water sources**
ii. **Ground water sources**

i. Surface water sources

Surface water sources are the rivers/streams, lakes, ponds, impounded reservoirs, and rain water. These sources are often contaminated with feacal and other organic and inorganic matters. Natural purification of surface water occurs from sunlight, aeration, and the action of aquatic animals and plants. However, this degree of purification is inadequate for purposes of human consumption, and surface water needs special treatment before use.

Rivers **-** Lower reaches of rivers are used for major water supply schemes. Water is normally polluted and a complete water treatment system is necessary to purify water before supplying to the consumers.

Lakes **-**These sources are used for smaller water supply schemes, due to non availability of adequate quantity of water.

Ponds **-** Ponds are normally used as bathing places. But source area should be protected.

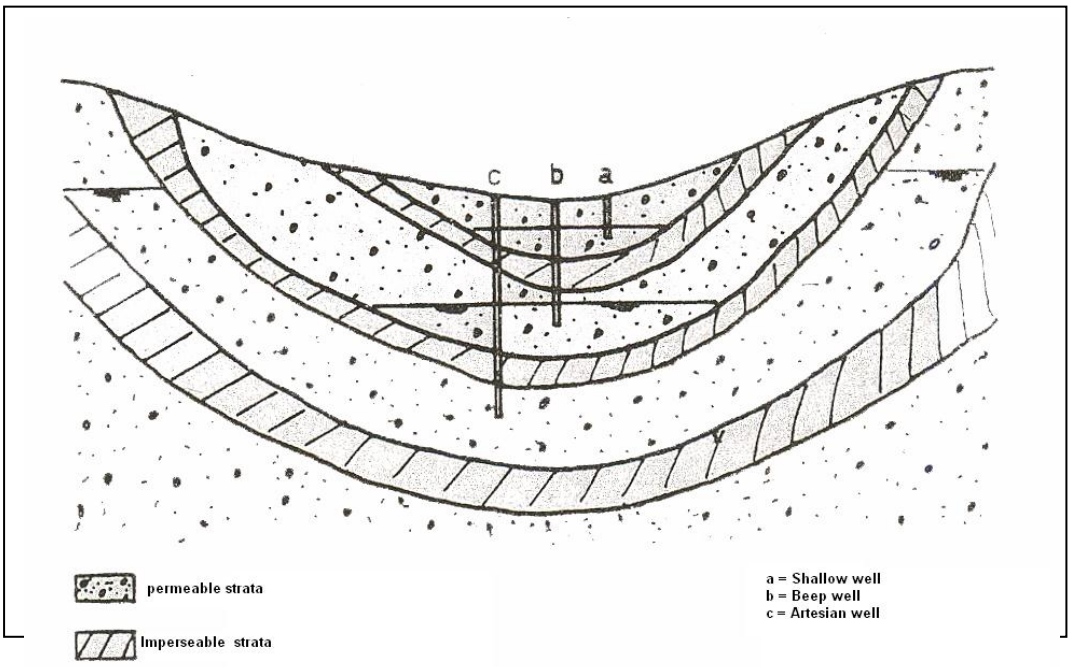
Impounding reservoirs **-** Major parts of this source are impounding reservoir, dams and catchment areas. These sources are usually located in hilly areas. Normally water is clear and it needs less treatment.

Rain Water **-** Rain water is the original source of water, a part of which evaporates; a part runs on the surface giving surface water, and a part percolates through the soil, into varying depths to form underground water sources. Rain water is originally uncontaminated; however it may be contaminated during passage through the atmosphere. Rain water collection can provide safe low cost water at household level, if collected and stored properly.

ii. Ground Water Sources

The Ground Water is obtained by means of wells and tube wells. These include shallow wells, deep wells, artesian wells, bore holes and tube wells.

Types of wells



Sh ween surface and soil. The storage capacity in these upper permeable strata is very limited and consequently the water-bearing capacity of such a well is unreliable and probably intermittent. The well is supplied by surface water which is liable to pollution (no natural filtration). A shallow well should be lined with impervious material up to a few meters from the bottom.

Deep wells - The supply is derived from strata unaffected by surface impurities. There is at least one impervious stratum between the water-bearing stratum and the surface water. Compared to a shallow well, water yield of a deep well will be much more dependable. The yield will be greatest when the well has just been dug.

Artesian wells - These have similar characteristics to deep wells, the essential difference being that the underground water is tapped under pressure and may rise to the surface of the ground under its own head.

Bore holes (Bored Tube Wells) - These are basically tube wells drilled using manual tools. After drilling it would be necessary to install casings down the hole, at least in the water bearing areas. In sandy type of soil it may be necessary to line the whole depth of the drilled hole using casing pipes. Usually PVC pipes are suitable as casing pipes. Tube wells of diameter up to 150mm can be bored up to a depth 20m, and wells with diameters up to 200mm can be bored up to a 15m depth.

Tube Wells (mechanically drilled tube wells) - The drilling equipment used for mechanical drilling are very expensive and complex. It requires highly skilled operators and drillers.

Protection of water sources and remedial measures

Both the sources and the catchment areas need to be protected to provide safe water supply. They may be contaminated with both domestic and industrial discharges. The minimum safe distance (MSD) for all potentially polluting activities should be fixed for both surface and groundwater.

Catchment area protection

- A survey of the catchment area should not reveal any potential sources of contamination.
- Wherever possible, protection zones should be clearly demarcated.
- Activities that may affect water quality (the dumping of toxic waste, the discharge of undesirable effluents, farming, drilling, mining, quarrying, and the use of agricultural fertilizers and pesticides, etc.) should be restricted or prohibited within the protection zone

Source protection

- Any source of microbiological contamination should be located sufficiently far, at least at the minimum safe distance (MSD), from the drinking water source, in order to eliminate or minimize health risks.

Ground water protection
Characteristics of protected water sources are described below. It is the responsibility of the PHI to ensure that all the technical interventions designed to enable consumer to obtain good-quality water, are implemented and that community involvement necessary for the maintenance of water supplies and prevention of contamination, is mobilized.

Drinking water sources

1. Pipe-borne water supplies
Pipe-borne water supplies function mainly in urban areas provided with large water supply schemes. They often obtain water from surface water sources. Therefore protection of both the catchments area and the source should be considered as essential. However the installation of a water treatment plant is necessary since the water obtained from surface water sources may be contaminated with all kinds of pollutants.

2. Wells

a. Shallow dug wells
Dug wells are commonly used for drinking purposes, especially in rural areas. Most are unprotected or semi protected wells, causing public health problems. Therefore it is an important duty of the PHI to ensure that semi protected wells in his area are upgraded into protected wells, and the unprotected wells to at least semi protected wells.

Features of an adequately protected well

- Well should be located at higher level than, and as far as possible from potential sources of contamination such as latrines, animal excreta, household waste water etc.
- There should be no latrine constructed within a distance at least 16 meters (50 feet) of the well.
- The top of the well should be protected with an impervious lining, running down for at least 1 metre (approx. 3 feet) below ground level, and continued upwards for a height of 30 cm (one foot) above the ground level.
- A cemented platform having at least one meter width, adequately sloping out, should constructed around the well at ground level.
- A lead away drain 3 meters long should be provided and be properly maintained.
- The well should be covered with a concrete cover to which is attached a pipe/inlet pipe of a pump, to withdraw water. The opening in the cover, for the pipe, should be kept well sealed to prevent entry of water from outside.
- A manhole should be provided for inspection of the interior of well, with rim of manhole opening raised at least 8 cm above the surrounding surface of cover. The manhole cover should overlap the opening in surrounding surface.

Features of a semi protected well

- The well should be fenced.
- A parapet wall – 0.75 m (2.5 feet) in height, with a steep outward sloping top to prevent pollutants being washed into the well, and to prevent people sitting / standing on it.
- An apron around the parapet wall – 1.5 meters (5 feet) wide, sloping outwards.
- A lead away drain - 3 meters (5 feet) long.
- An impervious lining to the well – at least for 3 meters (10 feet) below ground level.
- A pulley arrangement for raising water with a bucket attached to a rope or chain.
- A common bucket – users should not be allowed to use their own buckets. The common bucket should be kept on a raised cement pedestal when not in use, and should not be exposed to pollutants.
- Washings should be done away from the well.

It should be the effort of the PHI to get the owners of unprotected wells to convert them to protected wells, or at least to semi-protected wells. He should try to get the semi-protected wells converted to protected ones.

Disinfection of unprotected / semi-protected wells

It is the PHI's responsibility to have disinfected the unprotected / semi -protected wells in his area regularly.

b. Deep tube wells

Tube wells with hand pumps, are used mainly in dry zone areas.

Features of well maintained (sanitary) tube wells

- There should be no latrine within a distance of a 16 meters (50 feet) radius around the well.

- The hand pump should be securely fixed and fenced.
- A cemented apron, at least one meter in width, should be there around the pump, and properly maintained to prevent the collection of polluted water.
- The lead away drain should be properly maintained to prevent accumulation of water.
- No collections of standing water or house waste water should be there at least within a radius of 16 meters from the well.
- Tube wells should be disinfected thoroughly with chlorine solutions regularly.
- The cement apron should be thoroughly cleaned with chlorine solutions regularly.

Other sources

a) Springs

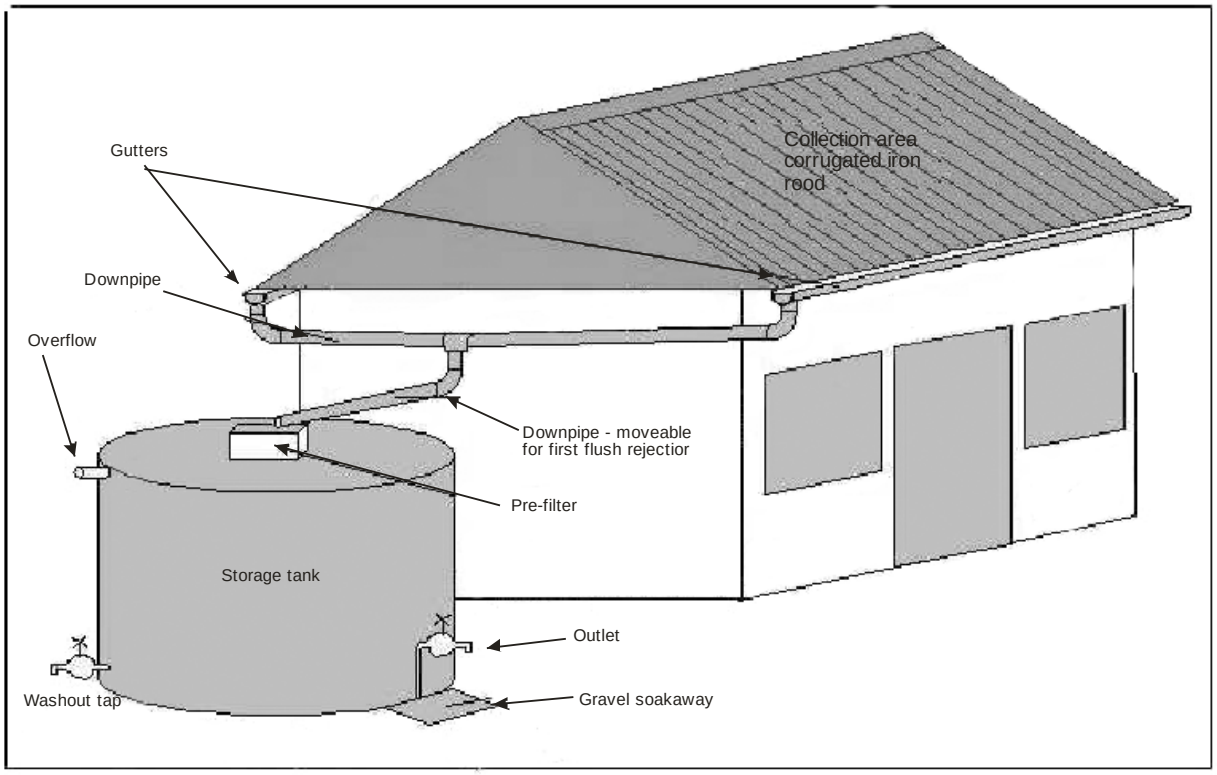
Water on the surface of the ground will filter down through the soil and rocks until it meets the impervious layer or water table (ground where soil or rock saturated with water is lying). Springs are places from where this filtered water reappears from underground, due to some kind of force. As water from the springs undergo filtration and is free of microbes, it is safe to drink such water unless contaminated. Springs form commonly used water sources for drinking and bathing, and therefore the PHI should ensure that such springs in the area, which supply drinking water, are properly protected and that steps are taken to prevent people or animals from contaminating such spring water.

b) Rain water

Rain water can be collected by individual households for domestic purposes (rain water harvesting). Rain water collection can be readily used in emergency situations when water supply in the area has been disrupted, and in areas where water is scarce and public water supply is not available. Quality of water can be maintained by using proper storage measures and household water treatment methods. It is relatively safe when collected on a clean, smooth, impervious surface and stored in containers free of contamination.

Requirements for rain water harvesting

- A hard impervious surface onto which rain water falls (e.gs; roof made out of suitable material, concrete slab)
- A storage container
- A means of collecting water from the collecting surface to the storage container (e.gs. gutters and down pipes system)
- Washout line (to washout collecting surface)



c) Surface water

As cost of treatment and delivery of water is high, this system is used only in large urban water supply systems.

Water Treatment (Water Purification)

Having located a source for water supply, either surface or ground water, water treatment is necessary to bring to the standards required of drinking water, by removing, all types of impurities from it.

Stages in water treatment process

a) Aeration
b) Sedimentation
c) Filtration
d) Disinfection (Chlorination)

1. Aeration – Aeration is done;

- to add oxygen (O_2) to water
- to remove gases like Hydrogen Sulphide (H_2S), Methane (CH_4), Ammonia (NH_3) and Carbon Dioxide (CO_2) from water
- to remove taste, odour and colour
- to remove iron and manganese
- to remove substances that may interfere with the chlorination process
- to remove oil formed by micro organism and algae plants

3. *Sedimentation*

This is the process of causing heavier solid particles in suspension, both organic and inorganic, to settle by retaining water in large tanks. When the process is carried without the addition of coagulants it is called plain sedimentation, and if coagulants are added, it is called sedimentation with coagulation.

3. Filtration

Filtration in its commonest form allows water to pass through a thick layer of sand or other filtering media. By doing so, the suspended and coagulated matter in water is partially removed, the chemical characteristics of water are changed, and the density of bacteria reduced.

4. Disinfection - Disinfection of water using a disinfection method to kill bacteria, virus and small insects contained in the water is termed as disinfection of water.

The microbiological quality of drinking-water can be substantially enhanced by protecting the source, and by treating the raw water. Disinfection should be constantly done, specially in public water distribution systems, as a short-term fault in the disinfection process may lead to distribution of contaminated water.

Disinfection methods

Either physical or chemical methods may be used. Physical methods include boiling, or keeping water for 6 hrs exposed sunlight (ultra violet rays will kill the organisms).
Chemical methods include the addition of ozone, or, most commonly chlorine or its derivatives. The residual disinfectant in water can minimize bacterial re-growth and re-contamination of water.

Selection of disinfectants used, should be based on the availability and the cost of the disinfectant, logistics, and cost of equipment. Based on these factors, chlorine is considered as the disinfectant of choice.

Chlorination

Chlorine is an effective disinfectant in clear water, and inactivates all microorganisms,i.e., protozoa, viruses and bacteria. Chlorine reacts with ammonia, organic substances, sulphides, and ferrous salts, etc., in water. These reactions can reduce effectiveness of chlorine, and therefore the dose of the chlorine required to achieve disinfection of water may vary.

Chlorine can be used in a form of gas dissolved in water, liquid (sodium hypochlorite solution for water disinfection), and solid forms (calcium hypochlorite, commonly available as bleaching powder or Tropical chlorinated lime-TCL, containing about 30% available chlorine).

However, solutions and solid forms are unstable at warm temperatures, and should be stored carefully. Choice of the form of chlorine to be used for disinfection is determined by the availability, and cost of equipment required for the process.

Residual chlorine

It is the amount of chlorine which remains in water after a specified period of time following the addition. Three forms of residual chlorine may exist after dosing:

a) Hypochlorous acid or "residual free chlorine" – It is the most effective form and an important indication of adequacy of chlorination.
b) Chlorine combined with ammonia as chloramines.
c) Chlorinated organic matter.

There should be a chlorine residue of 0.2 to 0.5mg / litre at points of supply. This means that a level of 1 mg / litre is required when water leaves the treatment plant. It is recommended that levels exceeding 0.8 mg / litre are avoided at the point of consumption (Chlorine residue is tested in water at 0.8 mg/l). In drinking water, there should be free residual chlorine level of at least 0.2 mg / litre or 0.2 ppm), after a contact period of 30 minutes.

GUIDE FOR THE CALCULATION OF INITIAL DOSAGE OF BLEACHING POWDER TO BE USED

For clear well water – 0.5 to1ppm

For clear surface water sources – 1- 5 ppm

For highly contaminated sources – 2 - 5 ppm

Formula to be used to determine the amount of bleaching powder required for a particular water supply

$$P = \frac{C \times L}{B \times 10}$$

where
P = weight of bleaching powder in grams
C = PPM to be applied
L = volume of water to be chlorinated
B = % of chlorine in bleaching powder

Chlorination of wells –

There are many ways of disinfecting the wells. But commonest method is chlorination. Conducting chlorination of wells is an important duty of a range PHI. Bleaching powder is usually recommended for this purpose. ½ oz to 1 oz of fresh bleaching powder is used.

Physical Methods

- **Boiling**

At household level boiling is used to disinfect water. This is the most suitable method of disinfection of water for household use, in Sri Lanka. Water should be boiled and maintained at100^0c for about 15 minutes.

- **Ultraviolet radiation**

Disinfection with ultra violet radiation does not leave any taste or odour in water. However this method is expensive, and also it does not leave any residual activity capable of disinfecting the water.

Water supply in epidemic and disaster situations
In these situations there is a possibility of water-borne diseases occurring, and it is vital to ensure adequate supplies of safe drinking water in such situations. The supplies must be;

- of good quality
- continuously available
- accessible to all the population
- available in adequate quantities to maintain human health

WATER SUPPLIES IN EPIDEMIC / DISASTER SITUATIONS

Focus attention on:

- ***Protecting the source of water***
- ***Ensuring optimal use of treatment facilities***
- ***Emergency disinfection***
- ***Ensuring adequate household treatment and storage***

Drinking Water Quality Surveillance

This is the process of gathering systematic information on hazards in water supplies which could pose a risk to health. Quality control and sanitary surveys are integral parts of surveillance. Water supply systems should be tested regularly to make sure that the water supplied is free from any chemical, biological or physical contamination. Testing should be done at least for residual chlorine, turbidity/ suspended particles, and coliform pathogens. Surveillance enables appropriate preventive measures to be taken before a failure of supply due to contamination of water, or any other related cause occurs.

Action to be taken by the PHI – Drinking water quality surveillance

Following actions should be taken by PHI with a view to improve and maintain water quality in drinking water sources;

a) Maintain the sanitation register up-to-date

b) Maintain a register and a map that include all common drinking water sources in his area, with their distribution perimeter identified

A map that depicts the distribution areas of respective water supplies must be maintained at the MOH office.

The Register should be in the following format:

Serial No	PHI area	Name of the water supply	Responsible authority/ person	Address	Covering population (number)	Contact telephone number

c) Inspect drinking water supplies regularly and obtain water samples from the main outlets and from selected peripheral outlets, for microbiological, chemical and residual chlorine analysis.

d) Based on the findings of sanitary inspections, water sample analysis, and disease surveillance data, implement appropriate disease prevention actions whenever required.

Steps to be taken in water quality monitoring

1. Sanitary inspection

It is an on-site inspection of the physical structure, and the purification mechanism of the water supply, and any environmental factors which may pollute the water source (latrines, factories etc.,) using a questionnaire. PHII should carry out sanitary inspection of all new sources at the time of construction and all existing sources on a regular basis.

2. Places of sampling for testing

- From the main outlet of the water supply facility
- From selected outlets (point of use) at periphery

2.1 Testing for chemical parameters

Testing for residual free chlorine

Testing for residual chlorine should be carried out at the drinking-water supply premises by the respective PHI using the Comparators and reagents provided to them. The MOH is responsible for maintaining adequate quantities of reagent, in order to carry out uninterrupted testing.

Testing for basic chemical parameters

A panel of chemical tests should be done

1. At the time of commissioning
2. In situations where health authorities have not verified a water supply before
3. Thereafter annually.

1500 ml of water should be collected in to a clean bottle. Refrigeration or cold transportation is not necessary.

2.2 Testing for bacteriological parameters

Testing for bacterial parameters is usually carried out in a laboratory having

relevant facilities. The procedure to be followed is to collect a sample adopting proper procedure from the water source and transport it to a designated laboratories under the Ministry of Health outlined in table 1 and Regional Laboratories of the National water Supply & Drainage Board.

In case of interruptions in testing samples at peripheral laboratories, samples can be sent to the MRI with prior agreement.

Table 1: Laboratories to which the samples from districts for bacteriological testing should be sent

Laboratory	**District**
Medical Research Institute (MRI)	Colombo, Gampaha, Kegalle, Nuwara Eliya, Badulla, Moneragala, Ampara,Kalmunai, Trincomalee, Batticaloa
Food laboratory- Kalutara	Kalutara, Galle, Matara, Hambanthota
Food laboratory -Kurunegala	Puttalam, Kurunegala, Kandy, Matale
Food laboratory -Anuradhapura	Anuradhapura, Polonnaruwa,
Food & Water Laboratory - Ratnapura	Ratnapura
Water Laboratory Vavuniya	Vavuniya, Mannar, Kilinochchi, Mullaitivu, Jaffna

2.2.1 Procedure for sample collection

A sterile bottle should be used for this purpose. Keep the bottle unopened until sampling procedure begins. Minimum volume needed is 300ml.

Sampling from a tap in a distribution system

(preferably from the outlet of the water supply facility (source) and selected points of use the area of distribution)

1. Use a bottle containing 4-5 drops of Sodium Thiosulphate
2. Remove from the tap any attachments that may cause splashing and wipe the outlet with a piece of cloth to remove any dirt.
3. Wash your hands with soap and water.
4. Open the tap and allow the water to run for 30 seconds.
5. Flame the mouth of the tap for 30 seconds with a lighter or an ignited cotton wool swab soaked in alcohol. If the tap is plastic swab with surgical alcohol and leave it for 2 min.
6. Open the tap and allow the water to run for 30 seconds.
7. Open the lid of the bottle and fill the bottle while leaving a small air space in the bottle. *(The bottle should not be rinsed before collecting water)*
8. Replace the lidFill up the request form and paste it on to the bottle.

Sampling water from a dug well

1. Prepare a sterile bottle with an attached string for emersion.
2. Immerse the bottle into the well and collect the sample.
3. Use "Lovibond apparatus" for water sample collection where there is a legal implication.

2.2.2 Frequency of sampling

A minimum of six samples from different water sources in an MOH area each month. If the number of samples exceed the number routinely sent to the Medical Research Institute (MRI) or the designated laboratory, informing them in advance (Food & Water Division of MRI, telephone. 011 2693532 Ext. 342).

2.2.3 Transportation of water samples

The samples should be immediately placed in a lightproof insulated box such as rigiform box containing ice cubes or ice-packs with water to ensure rapid cooling. If ice is not available, the transportation time must not exceed 2 hours .It is imperative that samples are kept in the dark and that cooling is rapid. If these conditions are not met, the samples should be discarded.

When water containing even traces of chlorine is sampled, the chlorine must be inactivated. If it is not, microbes may be killed during transit and an erroneous result will be obtained. The bottles in which the samples are placed should therefore contain sodium thiosulfate to neutralize any residual chlorine.

The form sent with the water samples for bacteriological investigation should follow the following format. A copy of this form should be kept at the MOH office.

Water Quality Surveillance

Water sample for bacteriological investigation

RDHS Division: ..... MOH area: ..... PHI area: .....

Name of the water supply / location : .....

Date of sampling: ..... Time of sampling: .....

Whether the water is subjected to chlorination: Yes / No

Residual chlorine level: .....

....

Sender's name Designation Date

2.2.4 Interpretation of results

Relevant SLS standards that can be used in interpretation of test results on water quality are given in the following table.

Table 2: Interpretation of results of bacteriological testing

Source	APC	PCC	ECC
Pipe borne public water supplies (>2000)	No Standard	Throughout any year 95% of the samples shall not contain any coliforms /100ml None of the samples examined shall contain more than 3 coliforms per 100ml Coliforms shall not be detected in 100ml of any 2 consecutive samples.	Should not be detected/100 ml
Individual and small community supplies	No Standard	Should be < 10/100ml	Should not be detected / 100ml

APC- Aerobic Plate Count, **PCC**- Probable Coliform Count, **ECC**-Escherichia Coli Count

Household water treatment

Drinking water can be purified at home using following methods;

i. Boiling

Boiling drinking water is a simple way of killing microorganisms. It should be encouraged in all circumstances where it is possible. Small bubbles appearing in the water and steam appearing over water does not mean that water has been sufficiently treated for subsequent cooling and drinking. Water must be brought to boiling and kept so for at least for one minute. For turbid water it should be kept boiling for at least five minutes. Water should be boiled, cooled and stored in the same container to avoid re-contamination. The container should be regularly cleaned and disinfected

ii. Filtration

Several types of filters are available, and include candle filters, stone filters and household sand filters.

iii. Disinfection

The commonest method of disinfection is to add 1% chlorine solution to the water and leave for 30 minutes to allow sufficient contact time for chlorine to act. Three drops of liquid chlorine solution should be added to each 1 litre of water. After 30 minutes taste water to detect a slight chlorine taste. If there is no slight taste of chlorine, add one more drop of chlorine solution to every litre of water already treated.

Solar Water Disinfection

Solar water disinfection is a water treatment method which uses solar energy to destroy the microorganisms in water. It may used at household level to treat small quantities of drinking water. This is an old, but hardly applied water purification method.

The treatment process involves simple technology, and uses solar radiation to inactivate and destroy pathogenic microorganisms present in the water. The treatment basically consists in filling transplant containers with water and exposing them to direct strong sunlight for about 5 hours.

Solar water disinfection does not change the chemical quality of water, the odor, nor the taste of the water. Microorganisms are heat sensitive. 99.9% of microorganisms present in water do not require that water be boiled, for their destruction, but heating up water to 50-60 ^{0}C for one hour is sufficient. However there are few limitations to this method,

- It is not possible to treat large volumes of water
- requires relatively clear water (turbidity less than 30 NTU)
- needs solar radiation (exposure time: 5 hours under bright sun / sun with 50% cloudy sky, or for 2 consecutive days under 100% cloudy sky)

Rural Water Supply and Sanitation

Effective and sustainable programmes for water supplies require the active support of local communities, which should be involved at all stages of such programmes. These stages include initial surveys, monitoring and surveillance of water supplies, reporting faults, carrying out maintenance, and taking remedial action / supportive actions including sanitation and hygiene practices.

The appropriate sources and technology options for rural water supply

Water sources

a. Surface water sources
b. Ground water sources
c. Rain water

Technology options for household water supply
The most appropriate technology options include,

i. Household Wells

- Fully lined wells (Annexure- 1)
- Wells lined with concrete rings (Annexure- 2)
- Partly lined well brick masonry (Annexure- 3)

ii. Communal water supplies

The most appropriate technology options include

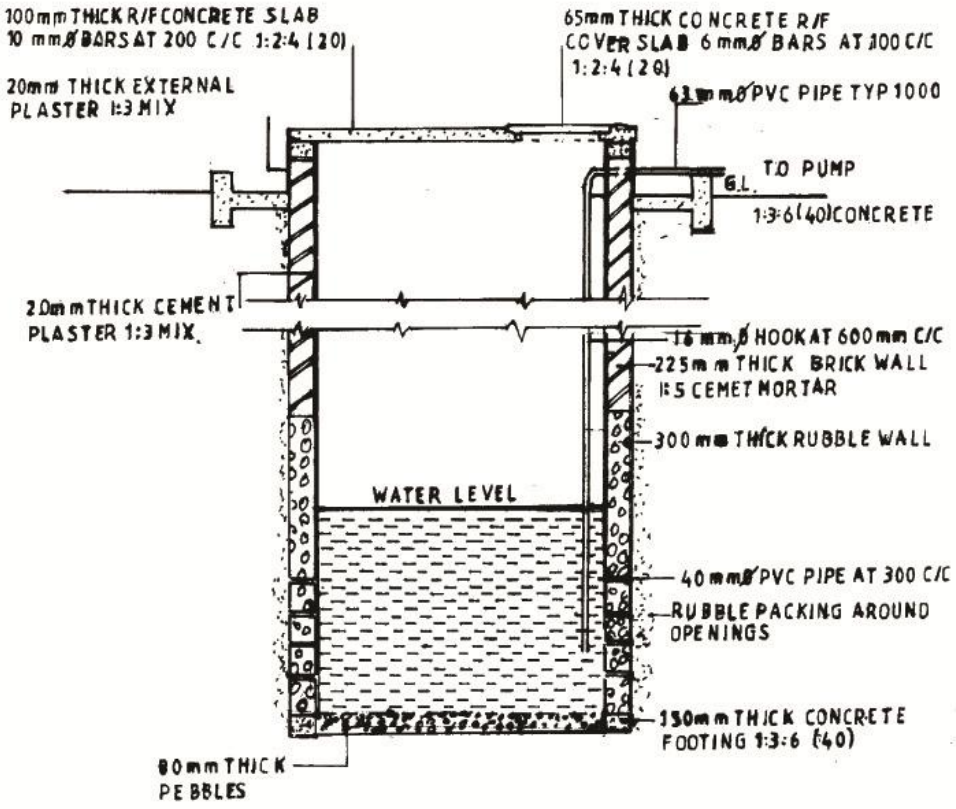
iii. Common wells

- Fully lined wells
- Half lined wells
- Wells lined with concrete rings

Major difference between household wells and common wells is that common wells are larger in size compared to household wells.

Gravity System (Annexure- 4)

In gravity and pumping systems, surface water as well as ground water is used depending on the situation.



SECTION A-A

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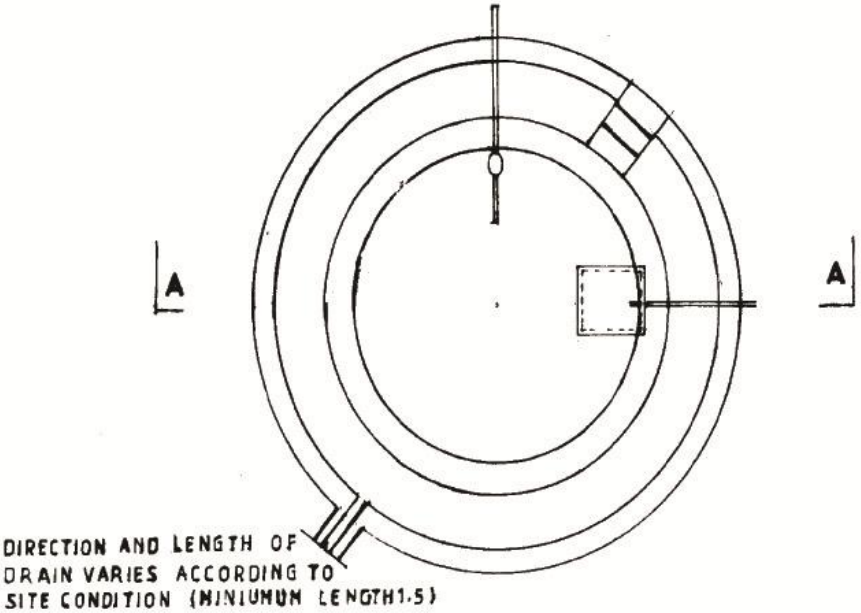
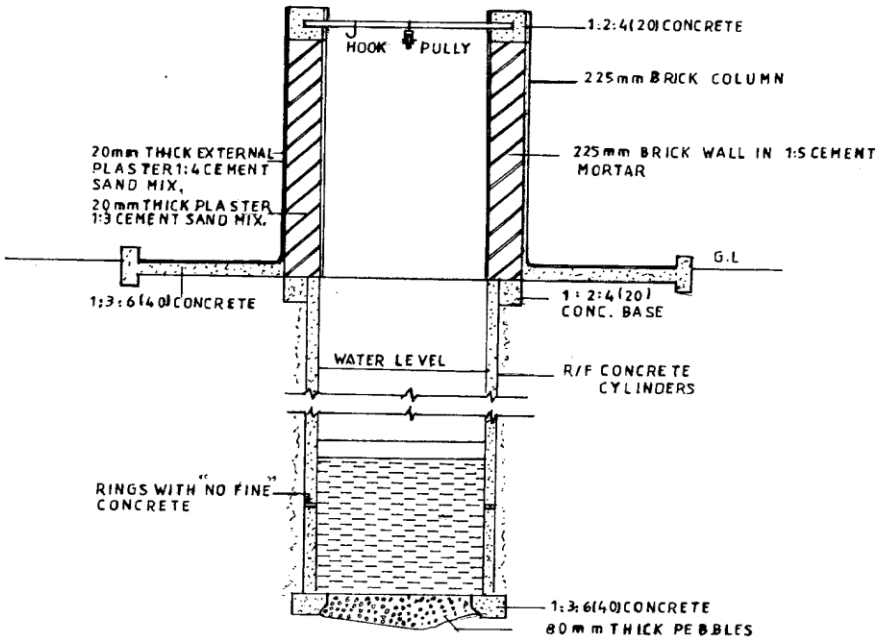


Fully Lined Well

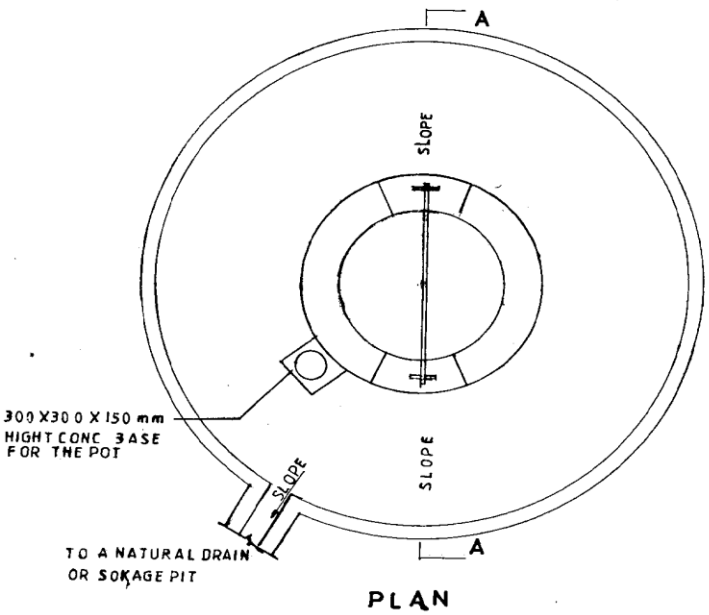
PLAN

SCALE - 1:50

Annexure -1



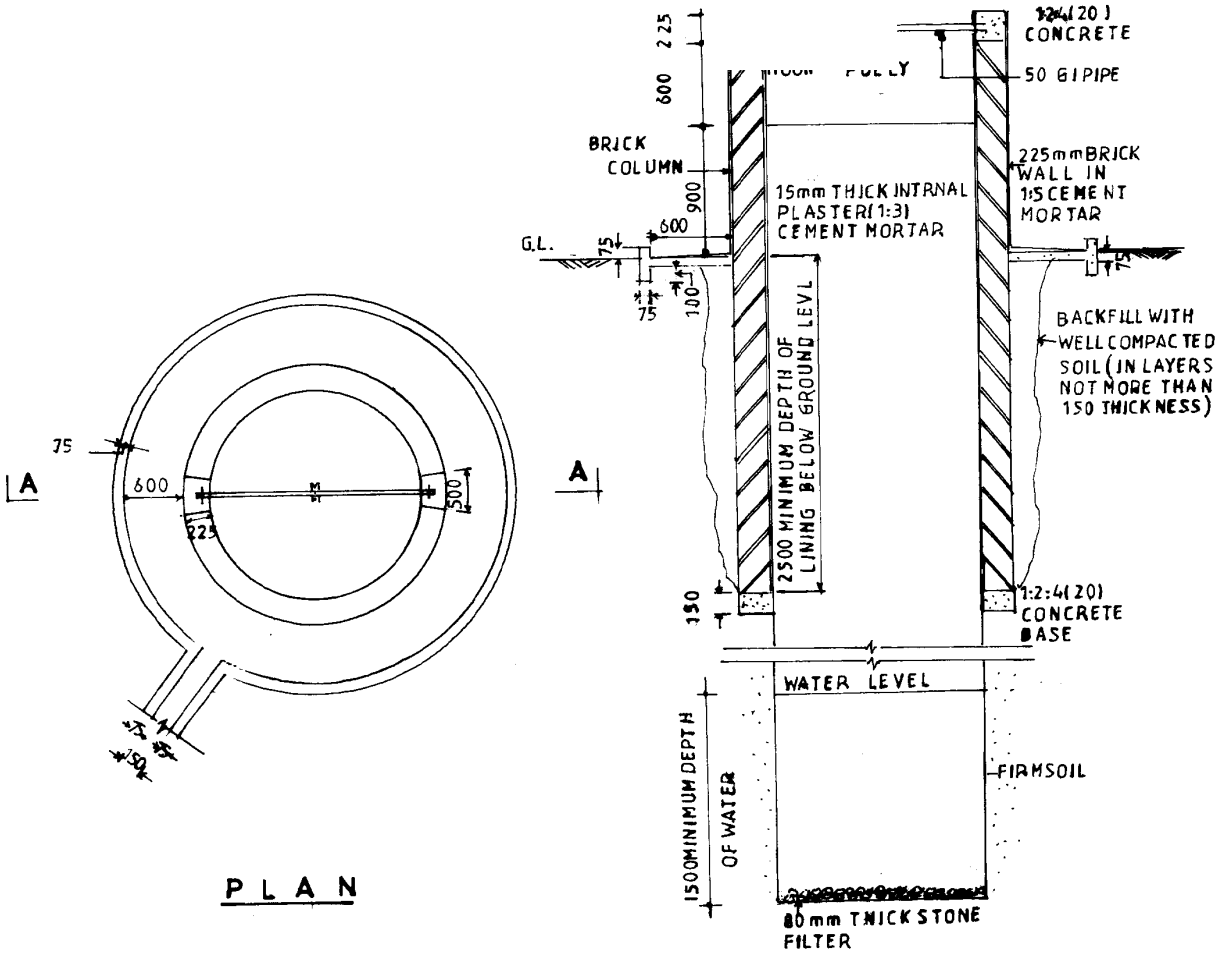
SECTION A-A



PLAN

WELLS LINED WITH CONCRETE RINGS

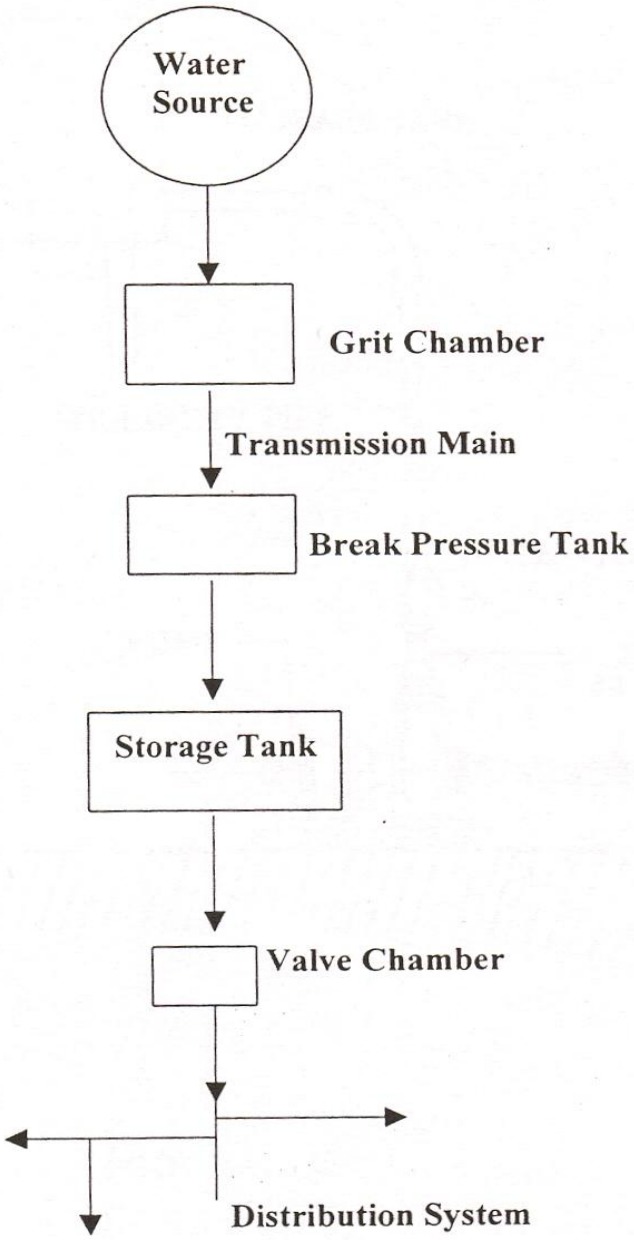
Annexure - 2



(SCALE 1:50)

PARTLY LINED WELL
BRICK MASONRY
(1200 mm AND 1500 mm DIA METER)

ANNEXURE- 3



GRAVITY WATER SUPPLY SYSTEM

ANNEXURE- 4

2.3 Disposal of Human Excreta

Many infectious diseases are caused by pathogenic organisms found in the excreta of infected persons, finding their way to other human beings, by water, food and soil. Human excreta, both faeces and urine, should therefore be disposed of in such a manner that they do not reach water sources or food. They should also be prevented from reaching the soil, and be out of reach of insects and other animal vectors that can help keep pathogenic organisms in circulation. The provision of sanitary toilet facilities is essential for this purpose, and therefore every household should be provided with a sanitary latrine. Several systems have been developed for the purpose of excreta disposal in this country. The commonly adopted systems are described briefly.

Excreta Disposal Systems
In urban areas the method of choice is the water carriage system, which removes excreta and liquid waste, through a system of pipes (sewers) to a common disposal point, where disposal is carried out after treatment. However in Sri Lanka such systems are in operation only in the municipal area of Colombo and its suburbs.

Households in the majority of urban areas and in all rural areas require individual disposal systems. The most common types of excreta disposal systems in use are as follows:-

COMMONEST TYPES OF EXCRETA DISPOSAL SYSTEMS IN USE

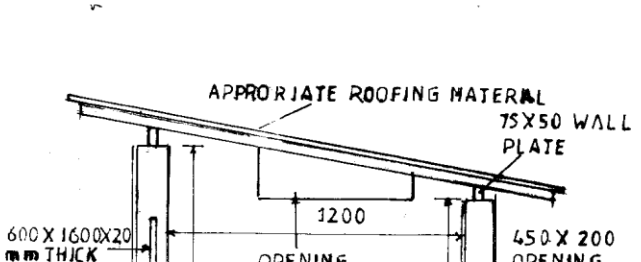
- **The pit toilet method**
- **The direct-pit water-seal toilet method**
- **The water-seal toilet method**
  - **Cesspool toilet method**
  - **Septic Tank toilet method**

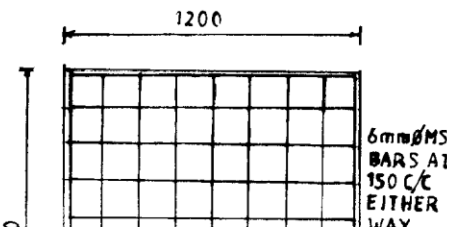
Many households, particularly those in rural areas, do not have any form of excreta disposal system. It is the PHI's responsibility to persuade householders to build sanitary latrines and use them, and to advise householders in the selection and construction of the most suitable type of latrine.

Selection of suitable type of latrine

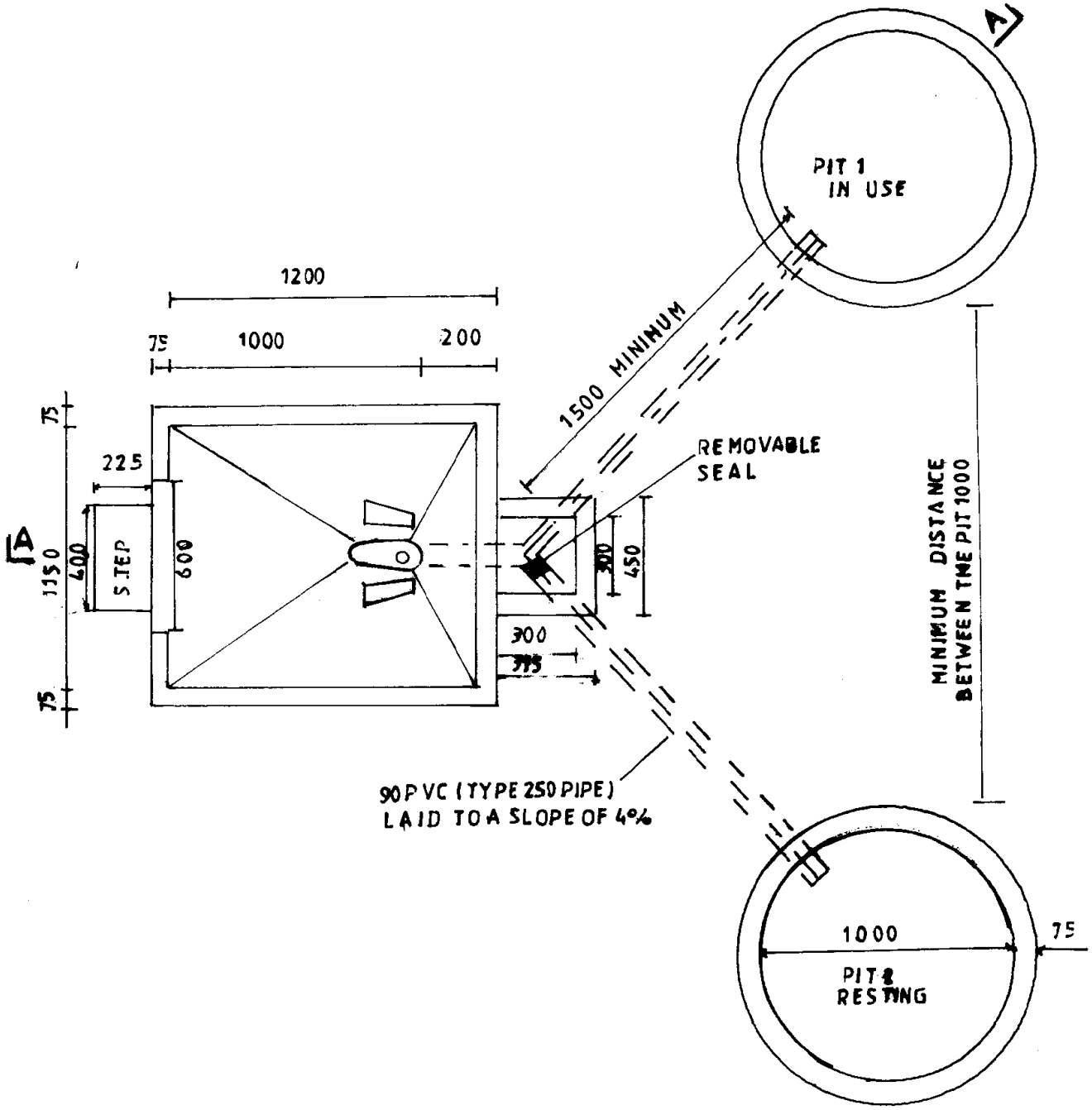
In recommending a latrine to suit individual requirements, PHI should consider the following factors:

1. Cost of construction
2. Operation and maintenance cost
3. Water requirements
4. Health benefits
5. Maintenance requirements





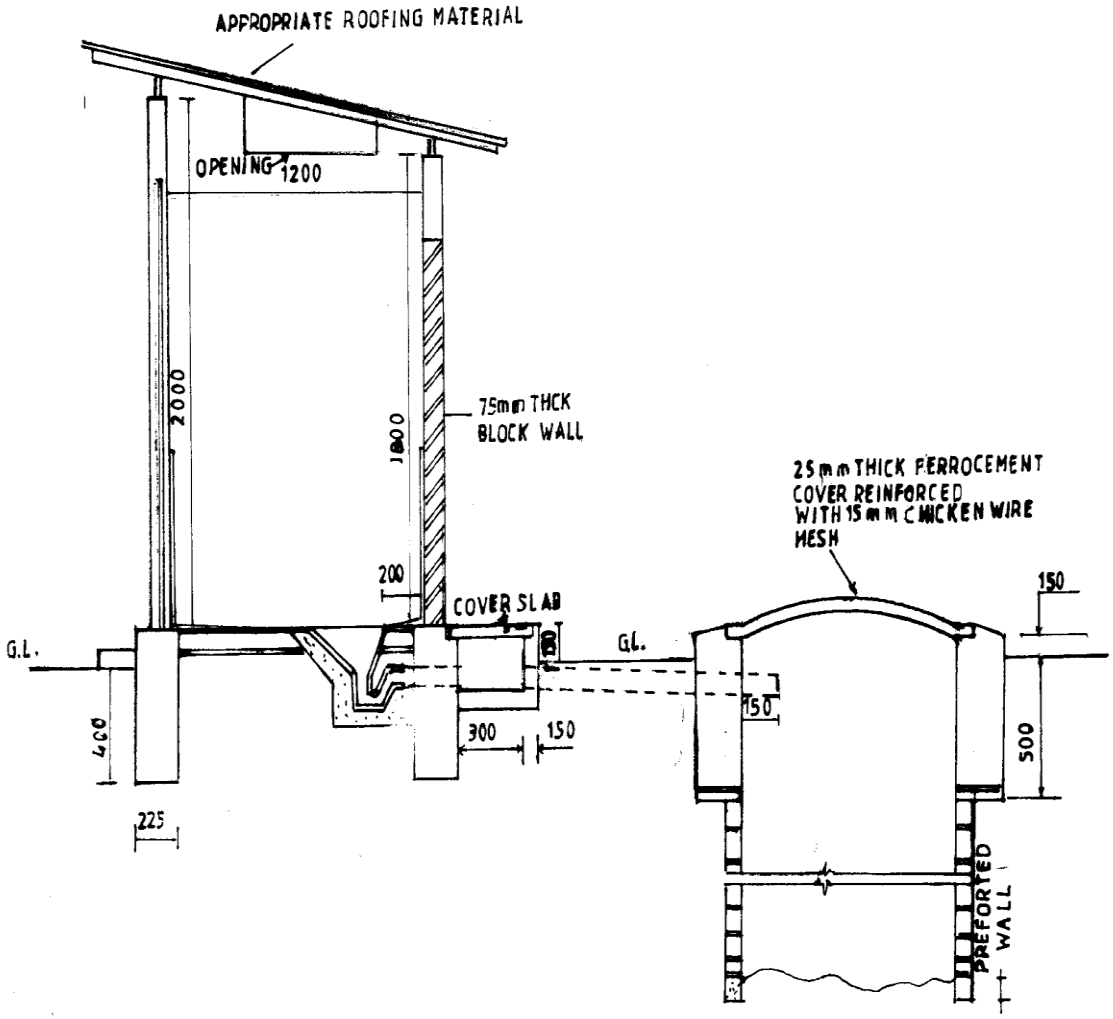
Annexure - 5



PLAN

WATER SEAL POUR FLUSH LATRINE
TWIN TYPE

Annexure - 6



Section A-A

Annexure - 7

These factors are evaluated in the table below:

Type of latrine	Construction cost	Operation & maintenance cost	Health benefits	Water requirement	Maintenance requirements
Pit	Low	Low	Satisfactory	None	Dig new pit & move super structure
Direct pit water-seal	Low	Low	Good	Water close to toilet	- do -
Water-seal with soakage pit	Medium	Low	Good	- do -	Dig new pit
Water-seal with septic tank	High	Medium	Very good	- do -	Dislodging

1. Pit toilet

The pit toilet method is the commonest method of on-site excreta system used in rural areas.

Type of pit toilets

- Single pit; sealed lid
- Single pit; ventilated
- Twin pit; ventilated

In all types of pit toilets, excreta fall directly or indirectly into a hole in the ground, or into a built pit. In the pit excreta decompose, and the resulting decomposition gases like Carbon dioxide and Methane, escape to the atmosphere or are absorbed by the soil.

2. Cess pool toilets

- Pour flush single pit off set
- Pour flush twin pit

These types of toilets are used in village areas and semi urban areas. When the tank is full with excreta it can be disconnected and the toilet pan joined to a new cesspool. But if the land space is not sufficient this pit can be emptied and reused.

3. Septic tank toilet

This is a more advanced on-site excreta disposal system in which a rectangular septic chamber constructed below ground level, or a cylindrical pre-constructed tank placed underground, receives both excreta and other waste water from the household.

The septic tank is usually divided into two compartments, the volume of the first compartment being twice the volume of the second compartment.

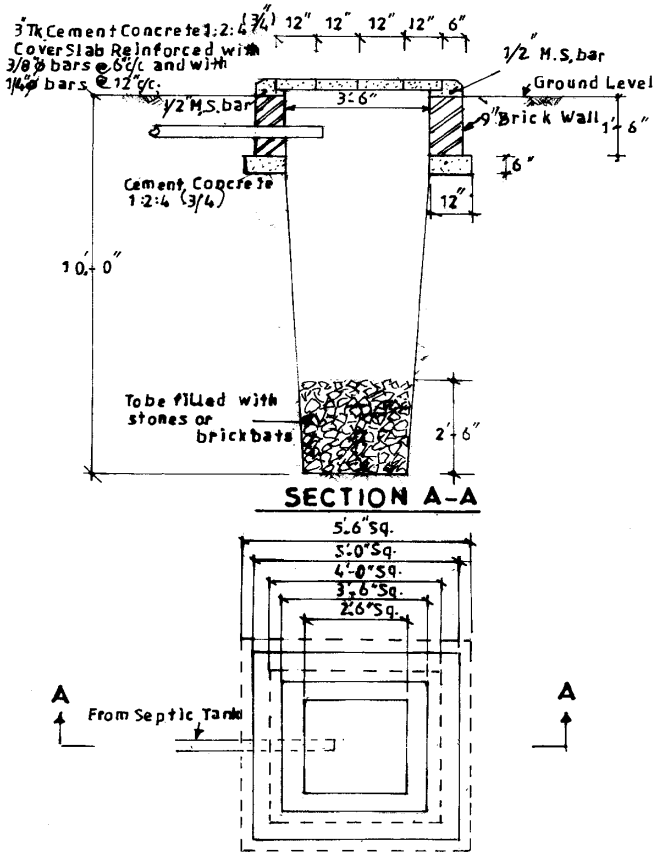
The septic tank is built water-tight and the depth is around 1-2 meters and length to breadth ratio 1:3. The sludge accumulation in a septic tank is around 0.03-0.04 m^3 per person per year. (Annexure -9)

The discharge from the septic tank is either led to a soak away pit which is dug 2-3 meters into the ground, or to a drain field which disperses the effluents through perforated pipes 0.5 -1 meter below the ground level. The latter system is more suited for high ground water level areas, as a low cost option. (Annexure -8)

Periodic emptying of the sludge from the septic tank is necessary, frequency depending on the designed volume. Normally one septic tank can serve up to 300 persons.

De-sledging interval (in years) = $\frac{\text{1/3 tank volume } (m^3)}{\text{sledging accumulation x population}}$

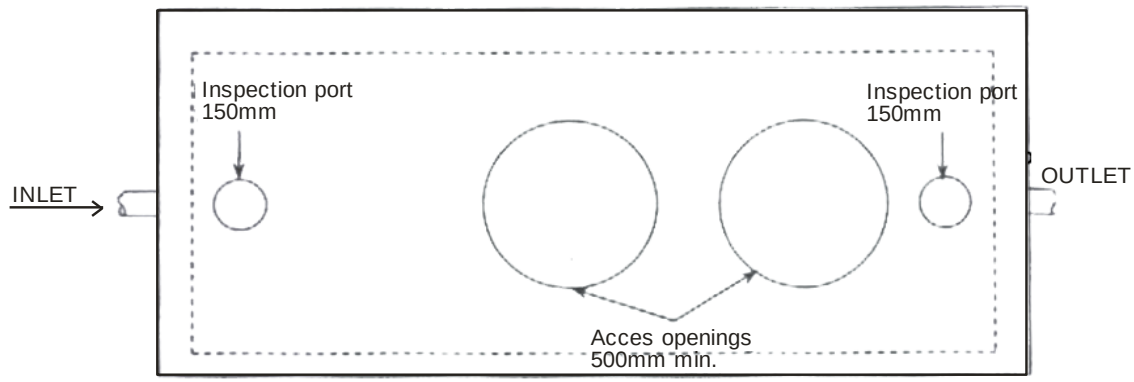
Total tank volume (m^3) = 3 x waste flow x0.1 m^3 per head per day x population



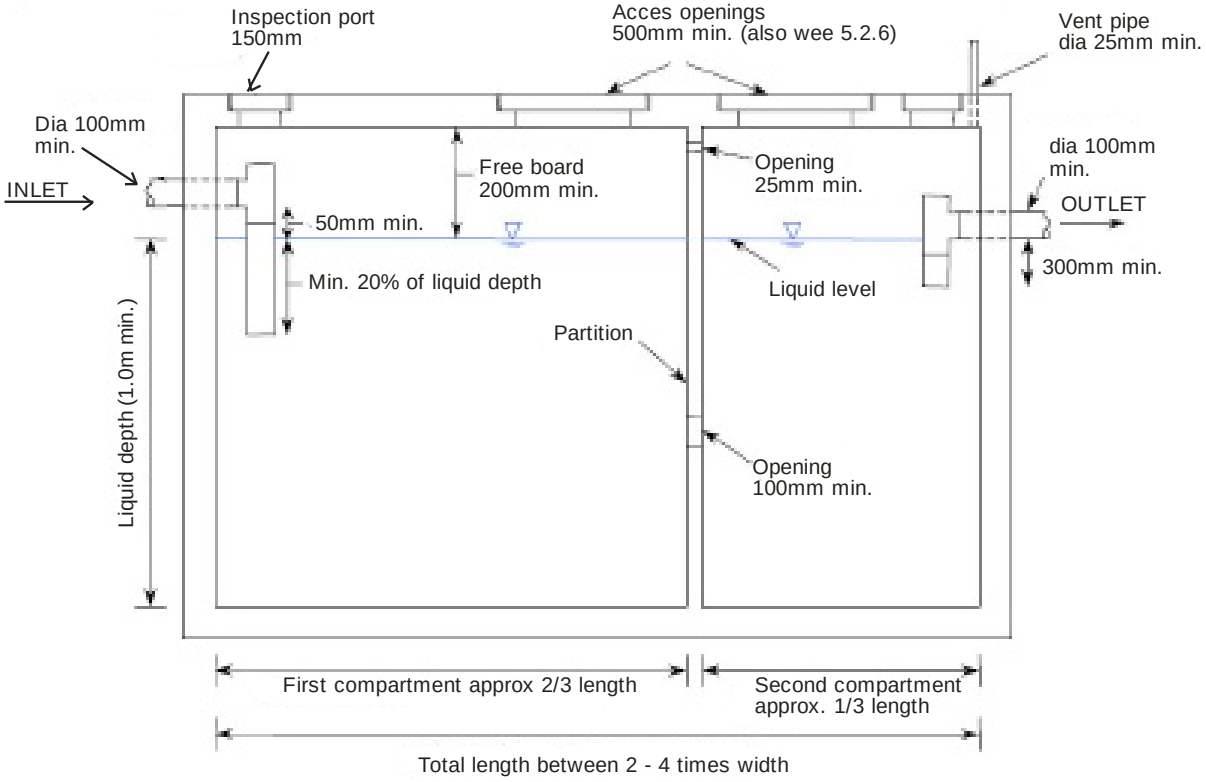
PLAN OF SOAKAGE PIT

ANNEXURE - 8

TYPICAL SEPTIC TANK ARRANGEMENT



PLAN



SECTION

ANNEXURE - 9

Urine Diversion Dry Toilet

Dry sanitation or eco-sanitation is an onsite disposal method that requires the separation of urine and faeces This type of latrines are suitable for dry zones with scarce water supply resources and can be constructed in the compound attached to the house or inside the house. In contrast to conventional latrines, Urine Diverting Dry

Toilets (UDDT) can be constructed in areas with less than 30m distance to need drinking well and water table depth less than 3m.

For urination and anal washing the respective sections are used. For defecation the chamber is used. One chamber shall be used for 1 year or until the chamber is full. A hand full of ash, sand or wood chip shall be added to the chamber after every usage. Care shall be taken not to add water into the faecal chamber. The chamber shall be closed with a lid after each use.

The other chamber shall be used for the next 1 year and the cycle be continued.

Soil or straw shall be spread to about 0.02 m (2 cm) at the bottom of the chamber before the first use. Soil or straw shall be added to the pile after 1 year of usage to cover the pile.

The full chamber shall be let to rest for a period of 10- 12 months before emptying. The emptied material shall be used as soil conditioner (compost) or shall be buried under the soil.

Non-biodegradable materials, including tampons and sanitary pads, shall not be disposed in the faecal chamber in any case. Separate collection bins shall be provided in the toilet for this purpose.

2.4 Waste Water Treatment

In the past the amount of waste water produced in the country was small, and could be safely disposed into surface water and lands. Now the volume of waste water discharged has much increased due to population growth and industrial expansion, which ultimately has caused failure of self purification in many areas in the country. Consequently, waste water treatment methods have gradually been installed.

CATEGORIES OF WASTE WATER TREATMENT

- **Pre Treatment**
- **Primary treatment**
- **Secondary treatment**
- **Tertiary treatment**

Pre treatment - This is done to remove larger objects from raw waste water, and may also include screening or grit removal.

Primary treatment - Usually refers to the removal of suspended solids by sekkling or floating. Primary treatment reduces the BOD up to 35% and suspended solids up to 65%.

I. **Screening** - Bigger particles cannot be digested by bacteria, and have to be removed using screens e.gs. clothes, paper, timber logs etc.
II. **Grit removal** - Sand and stones which come with the influent are settled here using grit chambers. Settled particles lay on drying beds.

III. **Primary settling** - Sekklable particles which come with the influent are settled in primary settling tanks. For industrial waste water, aluminum sulphate, Ferric

chloride, and lime are added for coagulation, in coagulation tanks (detention time up to 2 hrs).

IV. **Digesting** - In these tanks the settled solid matters are kept for 40-50 days, for the digesting process

V. **Drying** - These tanks are prepared with layers of sand and stones, with an under drain system in the bottom. The water in the solid matter goes down through the sand beds and the solid matters dry naturally. Sludge drying period is 3-4 weeks.

Secondary treatment - This is generally done by biological processes and is capable of achieving BOD removal by 35% to 95%.

I. **Activated sludge aeration** - supply O_2 by sending compressed air, or using mechanical stirrer, to encourage the growth of bacteria in waste water. These bacteria will digest solid particles and break them into pieces.

II. **Final settling** - Waste water with broken-up solid particles come to the secondary or final settling tanks, and these particles settle in these tanks.

Tertiary Treatment - Tertiary treatment is intended to polish the effluent from secondary treatment plants in order to effect further removal of BOD and suspended solids, etc.

2.5 Solid Waste Management

Introduction

Any unwanted item in a given place at a given time is defined as waste. Any solid item which is unwanted, with no productive use and requires disposal is considered as solid waste. Solid waste is generally known as non-liquid waste, rubbish or garbage.
Solid waste is generated from domestic, commercial, industrial or agricultural activities. Solid waste may consists of food waste, garden waste, paper, plastics, glass, metal, wood, rubber, leather, discarded clothes or small pieces of cloth, ceramics, construction waste and factory off cuts.
The composition of waste in households depends mainly on the consumption pattern of the inhabitants of the households. In general 60%-75% of bio-degradable or organic waste is found in domestic solid waste, which includes food residue and garden waste.
Solid waste can be categorized in to two groups. They are Municipal Solid waste and Hazardous (scheduled) waste.

Municipal Solid Waste

This is generated from households, commercial and other establishments which are not considered as hazardous but requires sanitary disposal. Municipal waste consists of the following;

1. Bio degradable waste – eg. food waste
2. Inert waste – eg. demolition waste

3. Recyclable waste –eg. paper, plastic
4. Composite waste – made up of two or more different materials eg. toys
5. Domestic hazardous waste – eg. Electronic waste, chemicals, fluorescent tubes, injection needles, bandages

Hazardous Waste (Scheduled Waste)

Hazardous waste is generated from industries, research institutions, laboratories, healthcare institutions and transport sector. They can be by-products of manufacturing processes or simply discarded commercial products, like cleaning fluids or pesticides. Hazardous waste has properties that make it dangerous or potentially harmful to human health and to the environment. Hazardous waste can be liquids, solids, gases or sludges and will have one or more of the following characteristics;

They can be explosive, flammable, oxidizing, toxic, infectious, or corrosive.

Some of the hazardous waste are paints, pesticides, electronic waste (e-waste), florescent tubes, batteries, asbestos, detergents, waste oil and infectious waste.

This waste has to be treated and disposed in a secure manner, in a hazardous waste management facility, to avoid adverse health impacts caused to human beings and the adverse impacts to the environment.

Issues related to waste management

- Haphazard disposal of solid waste.
- Lack of suitable lands in major cities to develop sanitary and secure landfills.
- Public protests on establishing landfills.
- Lack of financial and human resources in certain municipal councils and local authorities.
- Fluctuations in the market of recyclable items.

Health Impacts caused due to haphazard disposal of solid waste

1. **Dengue:** Disposal of tins, cans, tyres or other receptacles of fresh water provide breeding grounds for Aedes egypti and Aedes albopictus the vectors of dengue fever.

2. **Urban Filariasis:** Drains get clogged and pools get polluted due to accumulation of waste. This polluted water bodies provide a breeding ground for Culex fasciatus, vector for urban filariasis.

3. **Fly borne diseases:** Breeding of flies in a solid waste dump is another health impact which can lead to spread of diahoreal diseases.

4. **Rabies:** Accumulation of food residue in solid waste dumps attracts stray dogs and cats which influences the increase in the population of these dogs and cats, increasing the threat of rabies.

5. **Leptospyrosis:** Breeding of rats in solid waste piles can influence the incidence of leptospyrosis. Also the rats and other insects in solid waste piles also attract predators like snakes and other reptiles, which is a risk to people who live nearby.

6. **Social problems:** Haphazard disposal of waste causes social problems and mental stress to some householders, when solid waste is dumped in front of houses and private properties at times.

7. **Cancer:** Toxic materials in the waste can cause cancer. eg heavy metals.

8. **Respiratory diseases:** Inhalation of pollutants from waste causes respiratory problems.

9. **Occupational Health Hazards:** waste handlers are exposed to occupational health hazard.

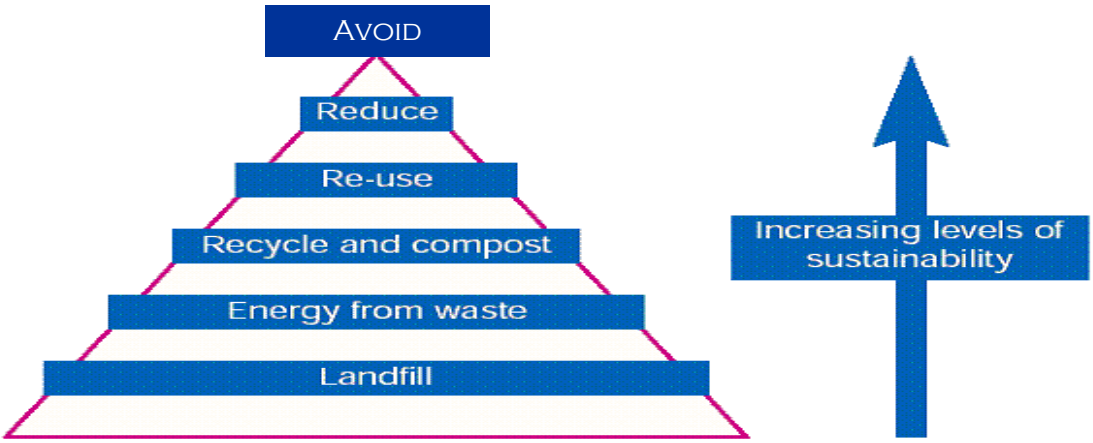
Therefore it is essential that solid waste and hazardous waste are disposed in a sanitary and secure manner. The PHII should create awareness among general public and provide necessary guidance to the community to manage their solid and scheduled waste properly.

Waste Management

In managing solid waste life cycle approach (cradle to grave) has to be adopted. That is steps should be taken to mange waste from waste generation to treatment and disposal. The following steps will help to minimize the waste generated in their households and other establishments. Reduction of waste generation will in turn reduce the burden of disposing huge amounts of waste by individuals and local authorities.

Waste hierarchy

Adhering to following steps will bring about sustainability in waste management.



1. **Avoidance of waste**: Waste generation can be avoided.
2. **Reduction of waste**: This is a very important step in waste management. The people should be educated and encouraged to take action to reduce waste generation by behavioural and attitudinal changes. eg. To avoid bringing in unwanted items and excessive amount of packaging material in to households.
3. **Re-use:** Some unwanted items can be reused instead of disposal. eg. Glass bottles and containers.
4. **Re-cycle and Composting**: Some items can be recycled. eg. Paper and plastics can be recycled to make recycled paper and plastic.
   Bio-degradable or organic waste can be converted to compost, which can be used as a soil conditioner.
5. **Energy from waste**: Waste can be converted to energy. The biodegradable or organic waste under anaerobic conditions can be converted in to bio-gas. In addition waste can be converted to electricity using plasma pyrolysis technology.
6. **Landfill**: The waste that remains after following all the above steps has to be disposed in a sanitary land fill.

Sanitary Landfill is an environmental friendly way of waste disposal.

Important steps in Waste Management

i. **Waste Segregation:**
Waste has to be segregated at the source of generation, in to different categories.

ii. **Waste Collection:**
Plastic or metal garbage bins with a lid and polythene garbage bags can be used to store garbage until disposal. Perishable garbage should not get accumulated for more than two days in a collection bin.
The public bins located in urban areas should be managed properly to avoid overflowing of garbage.

iii. **Waste storage:**
Waste should be stored in ventilated rooms, it should be locked to avoid scavenging by people & animals. These rooms should have washing facilities.

iv. **Transportation:**
The waste transportation vehicles should be closed vehicles, to avoid waste falling on to roads while transportation and also to avoid emission of bad odours causing nuisance to the people traveling on roads.
Waste transportation should avoid traffic as much as possible.

v. **Treatment & Disposal:**
Waste should be treated and disposed in a sanitary manner.
The general public should be encouraged to segregate waste as per the National Colour Code on Solid Waste segregation, to bring about a uniform system within the country.
The PHII should work closely with the general public and local authorities to educate them to take necessary action in this regard.

National Colour Code on solid waste segregation

Biodegradable waste	–	Green
Plastics	–	Orange
Paper	–	Blue
Glass	–	Red
Metal	–	Brown

The waste disposal is the responsibility of the municipal councils and the local authorities, where adequate legislation is available under these authorities.

Management of bio degradable waste

Once the bio-degradable waste is separated they can be composed. Composting can be carried out using several methods. Composting is carried out under aerobic conditions, in the presence of oxygen.

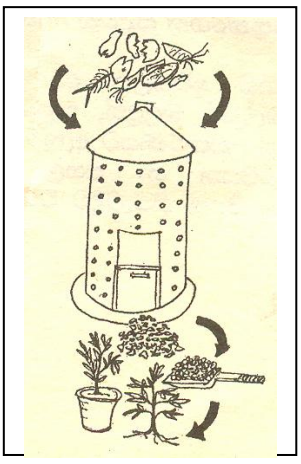
Compost bins can be used to compost bio-degradable material of households. There are plastic, metal and cement barrels available in the market. Plastic barrels could be obtained from the Central Environmental Authority at a subsidized rate.

Compost Bin

Plastic compost bins should be kept on a perforated cement slab which is provided with the bin and waste has to be fed from the top removing the lid.

It is advisable to keep metal bins under a roof to avoid rain water getting in to the bin and to avoid rusting of the barrel.

Cement bins can be kept on open areas.



Degradable waste (kitchen waste and garden waste) should be put to the barrel daily. The moisture content of the compost barrel should be maintained properly to avoid breeding of worms. If the moisture level is high in the compost bin, leaf litter or saw dust could be added to reduce moisture content. If the waste is dry and moisture is not sufficient for composting small amount of water could be added. Mixing of waste using a rod once in a while will improve the aeration process.
After few weeks waste will be converted to compost and could be taken out from the window at the bottom of the bin. Compost can be used as a soil conditioner for home gardening.

The PHII should provide the necessary education and the guidance to manage compost bins, and encourage the community to compost bio-degradable waste.
The local authorities should be encouraged to provide compost barrels to households at a reasonable price or encourage the community to make their own compost barrel at a low cost. Used metal bins could be obtained from chemical industries for this purpose.

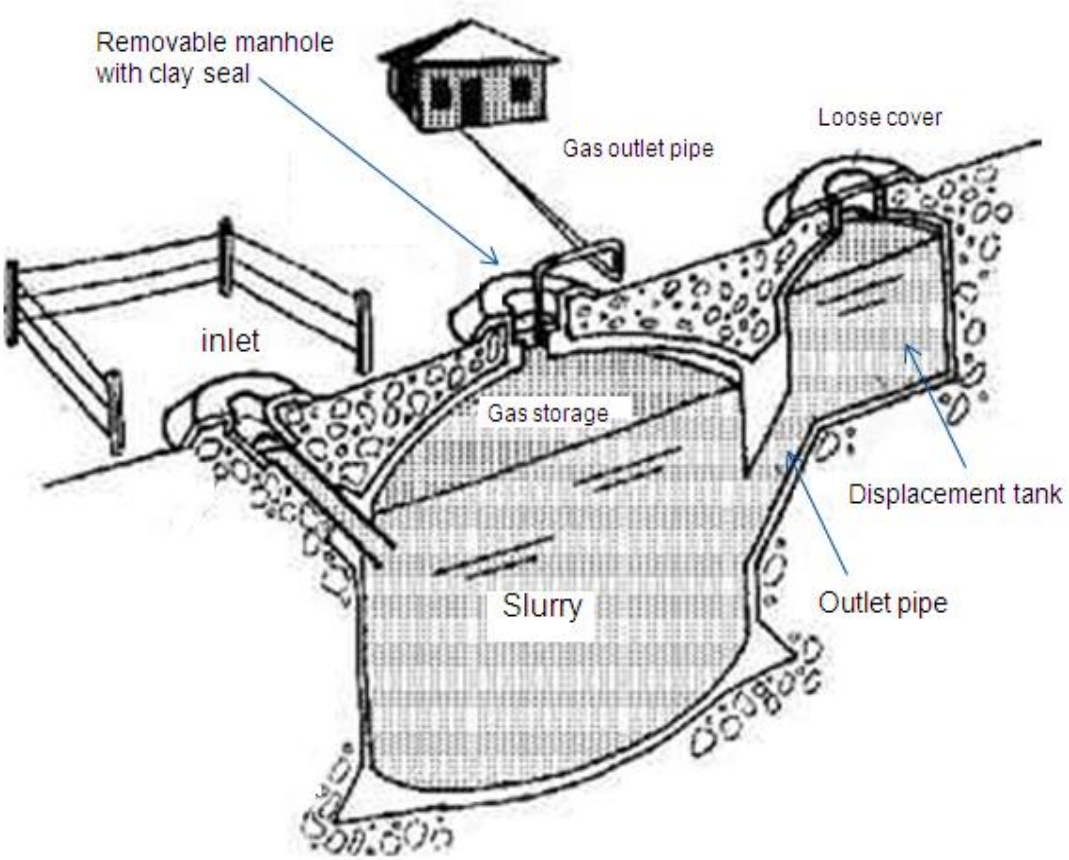
If a considerable amount of bio-degradable waste is generated in households and land area is available, open composting can be carried out using pits or “jeewa kotu”.

Preparation of Bio- Gas

Bio degradable waste can be digested under anaerobic conditions to prepare bio-gas.

Bio-gas could be prepared by;

- Vegetable waste/ Kitchen waste
- Cattle shed waste/ Cow dung, straw
- Night soil/ sewage



Bio-degradable waste can be converted to bio-gas using anaerobic digestion. The above digesters should be made to suit the quantity of waste generation. If required technical assistance could be obtained from NERD Centre of Ministry of Science and Technology or other government agencies/ NGOs implementing such projects island wide.
Bio-gas preparation will reduce the fuel cost of the households providing a good solution to the waste problem.

Management of non bio- degradable waste

Non bio-degradable waste such as paper, plastic, glass and metal can be recycled. Glass bottles can be reused. Used plastic is converted to pellets for making other plastic products and used paper is converted to recycled paper. Similarly metal and glass are recycled. National Paper Company and Glass Company are major buyers of used paper and glass.

Collection centres: Some local authorities have established collection centres- "Sampath Piyasa" for recyclable items. The PHII should encourage the general public to make use of these centers for disposing recyclable items.

Collection of segregated waste: Some of the Municipal Councils and local authorities collect the segregated recyclable items at regular intervals using trucks. If a such system exists, the community should be encouraged to handover all recyclable items to the local authority. Some authorities collect only non bio-degradable waste, allowing all households to compost their bio-degradable waste.
Buyers of recyclable and reusable items: In certain areas buyers of recyclable items visits homes, where the people can sell recyclable items. Most of the recyclers are

registered under the Central Environmental Authority. A list of waste recyclers could be obtained form the Central Environmental Authority (CEA).

Recyclable Waste Transportation
The vehicles which collect recyclable items should have the truck partitioned for categories of waste and painted as per the National Colour Code.
The PHI should encourage the community to adhere to environmental healthy solid waste management systems by improving the existing waste management system in his area.
The benefits of waste recycling are as follows:

- Saves money, raw materials, and land.
- Encourages individual responsibility.
- Reduces pressure on disposal systems.
- Lowers demand for raw resources.
- Reduces energy consumption and air pollution.

The following steps have been considered by industries in the view of minimizing the generation of waste (Shrinking the Waste Stream).

- Action has been taken to produce less waste by reducing excess packaging of food and consumer products.
- Increase use of photo-degradable and bio-degradable plastics.

Unhealthy practices of waste management

1. **Dumping:** Waste collected by local authorities is dumped on a land with out adhering to sanitary guidelines. This is a common practice at present, carried out by local authorities and municipal councils, which should be discouraged at all times as this creates many health and environmental problems including contamination of the ground water and causing visual pollution.

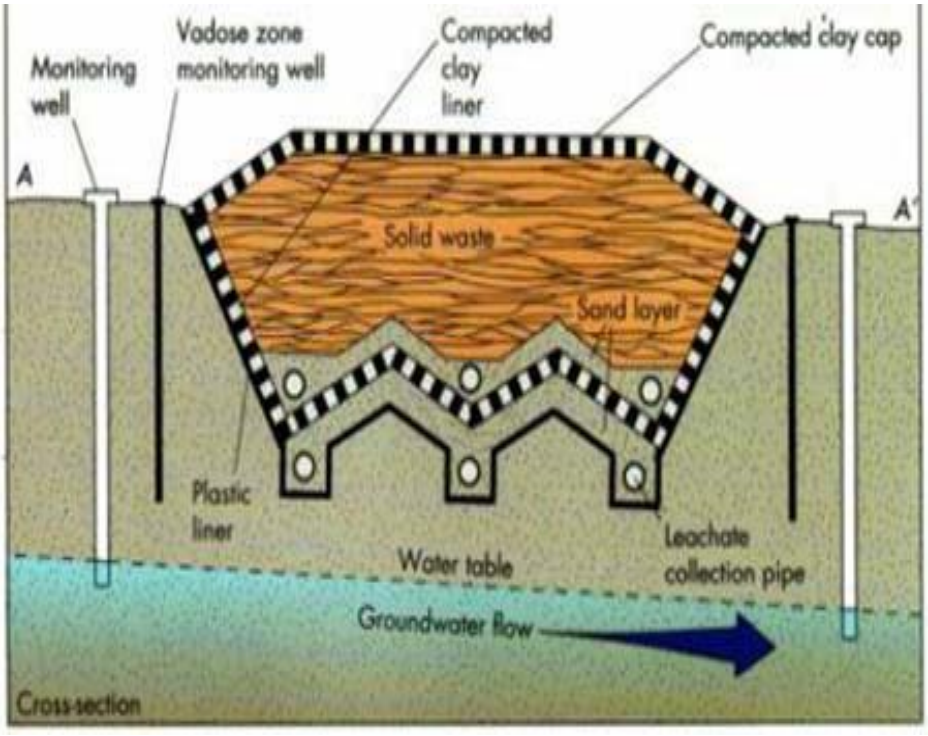
2. **Open Burning:** Open burning of mixed waste has to be avoided, as far as possible. Burning of mixed waste can emit toxic gases. The paints, PVC containing plastics, used batteries and other toxic substances should not be burned. They can be buried in a secure manner or be given to collectors of such items.

Short term solutions for waste management

1. Controlled tipping: under this method waste should be covered with soil just after dumping. This is somewhat a better method compared to open dumping. This too has many risks of contaminating the ground water. This method can be practiced until environmental friendly systems are established. A suitable land should be selected for this purpose to minimize environmental and health impacts (Refer National Guidelines on Solid waste Management – prepared by Central Environmental Authority).

Methods of environmental friendly waste disposal

Sanitary Landfill: Landfills are of many types. The main important features of a land fill are: it should be lined with a suitable lining material to avoid ground water contamination and the leachate that comes out has to be treated to minimize hazardous impacts. The emissions from a land fill also have to be controlled properly.



Schematic Diagram of a sanitary landfill

The following are the legislations available on managing solid waste:

- Local Governmental Laws
- National Environmental Act
- Police Department
- Local Government Laws
- Municipal Council Ordinance Section 129,130,131
- Urban Council Ordinance section 118,119,120
- Pradeshiya Sabha Act No 15 of 1987, section 93,94

Actions taken by the government to improve solid waste management

The following have been developed by the Ministry of Environment and Natural Resources with the assistance of the relevant stakeholders.

- National Policy
- National Guidelines
- National Strategy
- National Colour Code for waste segregation
- Regulations

The agencies responsible for waste management

The main responsible agencies are Local Authorities (Municipal Councils, Urban Councils and Pradeshiya sabhas).
The following are the supporting agencies involved in solid waste management;

- Solid Waste Management Authority – Western Province
- National Solid waste Support Centre – Ministry of Provincial and Local Government.
- Ministry of Environment & Natural Resources
- Central Environmental Authority

The following are other uses of solid waste:

1. Treated solid waste can be used to reclaim land
2. Waste is converted to energy -Generation of electricity
3. Wood waste used to make brickets
4. Some of the construction and demolition waste is reused

Relationship with the Local Authorities

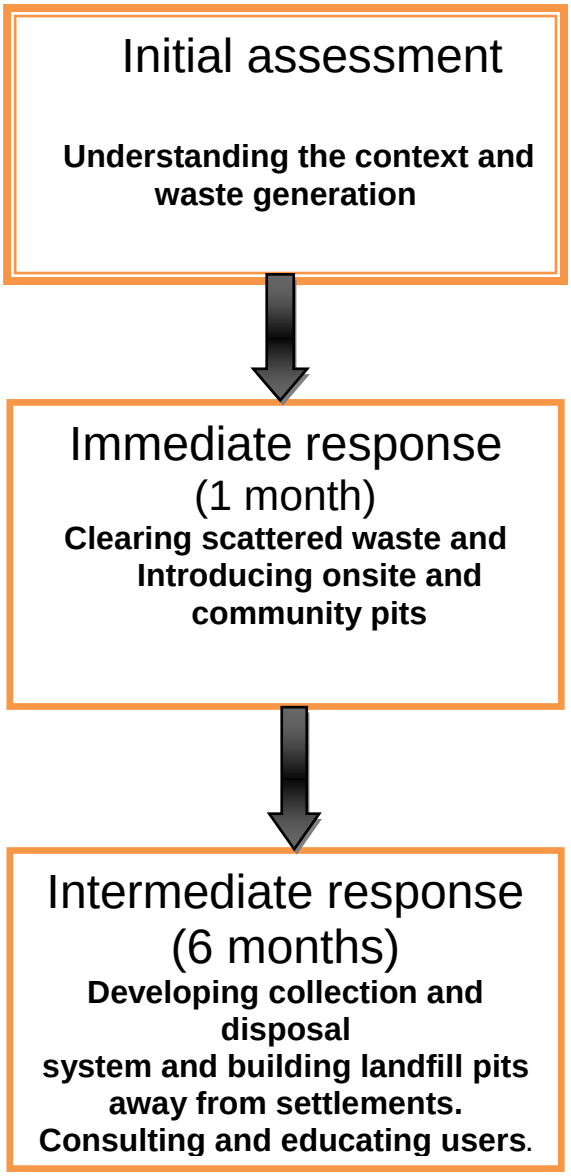
It is the responsibility of the PHII to advise local authorities on solid waste management. They should supervise the work force responsible for the collection and disposal of refuse, and ensure that the activities are carried out satisfactorily. The workers should be encouraged to wear masks, gloves and boots/ shoes in handling waste.

Solid Waste Management at Disaster Situations

In an emergency situation the context should be understood well before establishing systems for waste disposal.

The following factors should be taken into consideration:

- type of waste generated (hazardous or general)
- existing waste management facilities
- the amount of people affected
- present disposal system
- equipment available
- opportunities and restrictions of the environment
- whether pits can be dug
- segregation of waste in to general and hazardous
- land availability
- water table
- cultural factors



Healthcare Waste Management

Waste generated from hospitals, immunization centres, medical laboratories and research institutions is known as healthcare waste.
Only 10% - 25% of the total waste generated from these institutions is hazardous. The rest of the waste (75% - 90%) is general waste which is equal to domestic waste.
The institutions which generate healthcare waste are responsible for its management under the legislation. The local authorities and municipal councils are responsible only for disposing general waste generated from these institutions which is non- hazardous.
The categories of risk healthcare waste are:

1. Infectious waste
2. Sharps
3. Pathological Waste
4. Chemical Waste
5. Radio - active Waste
6. Pharmaceutical waste
7. Waste with heavy metals
8. Geno-toxic waste

9. Pressurized containers

The life cycle approach should be adopted in managing healthcare waste.

Steps should be taken to;

1. **Avoid waste generation:** By prohibiting bringing certain items into the hospital generation of some waste can be avoided. eg. King coconuts, shopping bags
2. **Minimize waste:** By educating the patients and the visitors, haphazard disposal of waste within the hospital premises can be avoided.
3. **Recycle:** eg. saline bottles and paper can be recycled.
4. **Reuse:** eg. glass bottles can be reused.
5. **Composting or bio-gas preparation:** Kitchen and Garden waste can be composted or be used for bio gas preparation.

Management of risk waste

1. **Waste segregation:** The waste generated at healthcare institutions should be segregated as per the National Colour Code at the source of generation. As the quantity of risk waste generated is small, it is essential that the hazardous waste is segregated from the general waste as the treatment is required only for risk waste.

National Colour Code on Healthcare Waste (Circular No: 01-12/2006)

- Infectious waste - Yellow
- General waste - Black
- Sharps - Yellow with a red stripe

- Bio- degradable waste - Green
- Plastics - Orange
- Paper - Blue

2. **Waste collection:** waste should be collected in coloured polythene bags to suit the national colour code. The bags should be of recommended gauge/ thickness made up with HDPE (High Density Poly Ethylene). Mouth of the bag should be tied with a tape, before sending out of the ward, or place of generation.

3. **Waste labeling:** Infectious waste bags should have the bio hazardous symbol displayed on it. In addition the Ward No. and the date should be mentioned on the bag.

4. **Waste transportation:** Waste should be transported in covered carts or secure carts, to avoid spillage of waste and spread of infection.

5. **Waste Storage:** The storage should be painted as per the National Colour Code and have washing facilities; the storage should not have access for scavenging.

6. **Waste treatment:** Hazardous waste should be treated and made non- hazardous before disposal.

7. **Waste disposal:** Treated waste should be disposed in a landfill, and if waste is incinerated, the ashes should be disposed in a concrete pit/ landfill.

Spill management

A spill kit should be available in all wards to clean waste spills. The kit should include gloves, wadding and sodium hyperchlorite solution.
All healthcare institutions are expected to carry out the internal management of healthcare waste as per the National Guidelines.

Refer National Guidelines for Healthcare Waste Management prepared by College of Microbiologists -2007.

Treatment of infectious waste

1. **Steam Sterilization:** This can be carried out by using a direct or indirect steam sterilizers, or autoclave. Waste autoclaves are available for autoclaving waste.

   Sterilized waste can be handed over to the Municipal Councils or Local authorities to be disposed at a sanitary land fill.

2. **Deep Burial:** High risk waste can be buried in deep concrete pits.
3. **Chemical disinfection:** waste should be shredded and immersed in chemicals such as aldehydes, chlorine compounds, ammonium salts.
4. **Microwaving:** The waste can be treated using microwave technology.
5. **Incineration:** Incineration is burning of waste at a very high temperature. A dual chamber should be used for treating healthcare waste. The recommended temperature of the incinerator is 1000^0c – 1200^0c to avoid emission of dioxins and

furans which are known to be carcinogenic. Incinerators can be used to treat many types of waste excluding heavy metals and pressurized containers.

The ashes of the incinerators should be disposed in a sanitary manner in a concrete pit as this is considered to be hazardous. The approval of Central Environmental Authority has to be obtained for installation of an incinerator within the hospital premises.

It is important that PVC contacting plastics or any other chlorinated products are not burned in incinerators where the temperature is lower than 1200^0c.

6. **Disposal at a secure landfill:** Hazardous waste should be disposed in a secure landfill.

7. **Inertization:** The waste should be grounded and mixed with cement, lime and water. Then cement blocks could be made. This method can be used to dispose pharmaceutical waste and incineration of ashes and heavy metals. This method prevents toxic substances getting in to the environment.

8. **Encapsulation:** The waste should be filled (¾) in to plastic (HDPE) or metallic drums, and filled with plastic foam, bituminous sand, cement mortar. This method can be used to dispose sharps, chemical and pharmaceutical waste. Then these boxes can be deposited in a landfill.

9. The radio-active waste has to be disposed as per the guidelines given by Atomic Energy Authority.

10. The amputations can be cremated or buried or given to contractors for disposal.

11. The cytotoxic drugs have to be returned to the supplier, incinerated at a higher temperature (in a cement kiln) or chemically neutralized.

12. **Placenta pits:** Placenta could be put in to pits and allow for natural degradation.

Short term solutions for healthcare waste treatment and disposal

In the absence of environmental friendly technological options at health institution for waste treatment, the following could be adopted until an environmental friendly facility is available.

1. Waste can be buried in deep pits and covered with lime. A suitable place should be identified for this purpose to avoid contamination of ground water and other water sources.
2. A low temperature incinerator could be used, where PVC containing plastics or any chlorinated compounds should not be burned in these incinerators.

Transportation of Healthcare waste out side the institution

If transportation is required, healthcare waste should be transported in a covered vehicle, which should comply with the standards for hazardous waste transportation.

It is essential that infectious waste symbol (bio-hazard symbol) is displayed on the vehicle and approval obtained from the Central Environmental Authority for healthcare waste transportation. The relevant information forms should be maintained within the waste generator, transporter and disposer.

The PHII who are attached to hospitals should make sure that the healthcare waste is properly stored, transported and treated in a treatment facility in a sanitary manner. He should also make sure that waste handlers use protective gear (glouses, boots) and engage in healthy practices in waste management.
Operation and maintenance of the facility also should be monitored by the PHI. He should educate the general public and visitors to dispose the waste properly within the hospital premises.

All hospitals should develop Healthcare Waste Management Plans, waste audits should be carried out and the waste management process should be monitored regularly.

Waste water treatment in hospitals

- Waste water has to be treated before discharged. Small quantities of waste water can be incinerated, autoclaved or chemically disinfected using sodium hyperchlorate solution.
- For large quantities of waste water, a suitable treatment facility has to be designed considering the chemical composition of the waste water.

A list of registered consultants who can design waste water treatment facilities could be obtained form the Central Environmental Authority.

Regulations on Healthcare Waste Management

All hospitals, medical laboratories, and research institutions should obtain Environmental Protection License (EPL) and Scheduled Waste License from the Central Environmental Authority under the National Environmental (Protection and Quality) regulations (gazette extra ordinary 1534/18 dated 01 February 2008).

1. All above mentioned institutions should submit 02 applications to the Central Environmental Authority – Head Office of provincial offices requesting the licenses. (Application could be obtained from the Central Environmental Authority, web site of CEA www.cea.lk or Environmental & Occupational Health Unit (E&OH) / Ministry of Healthcare & Nutrition)
2. If the necessary requirements in relation to healthcare waste and waste water management are fulfilled, the licenses will be issued, otherwise recommendations will be given by the CEA for improvement. Once these recommendations are implemented the licenses will be issued.
3. The licenses have to be renewed annually.

The requirements that has to be fulfilled to obtain licenses

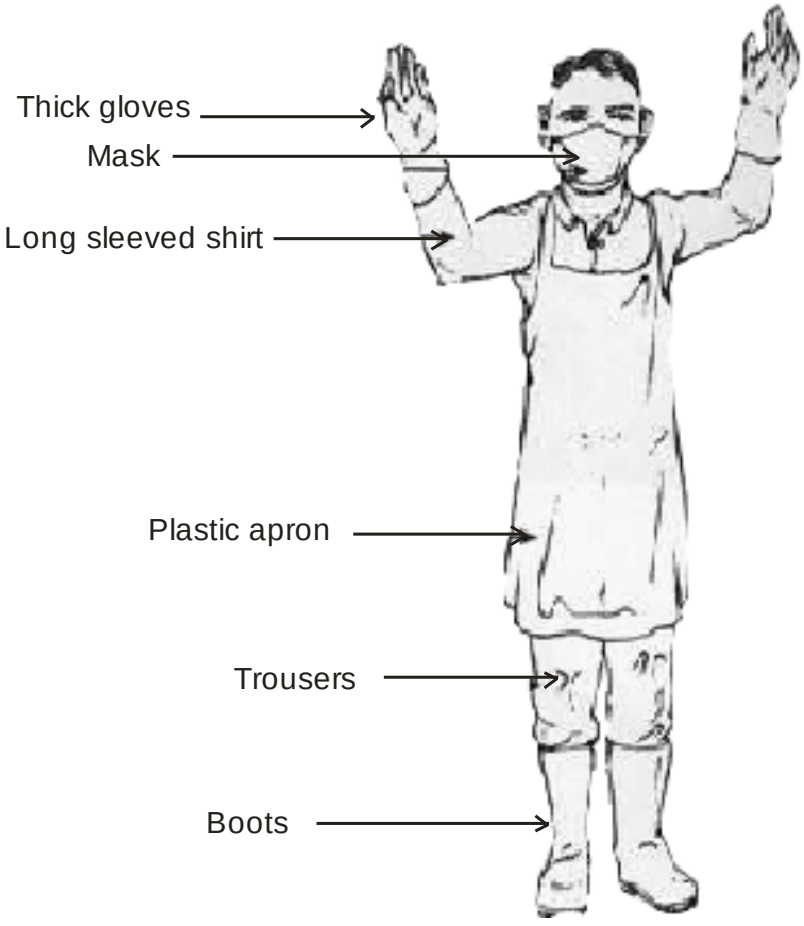
1. All institutions should segregate waste as per the National Colour Code. If it is not possible waste should at least be segregated into 03 categories. (general waste, infectious waste, sharps)
2. If incinerators are used for waste treatment, emissions should be controlled.
3. Waste water should be treated.
4. Sewage should be treated.
5. All waste should be disinfected if transported outside the institutions for disposal.

Follow National Guidelines on Healthcare Waste Management in house management.

Healthcare Waste Management

BIOHAZARD Symbol

Figure 1 Personal Protective gear of a waste handler



2.6 Disposal of the Dead

It is a responsibility of the PHI to constantly supervise proper method of the disposal of the dead. In this connection PHII are legally and professionally authorized. The

practice of the disposal of the dead is based on cultural and religious customs of the people from the beginning. The responsibility of the PHI should be based on social needs which are not a danger to the health of the people and environment. He should give necessary instructions and take action in this regard.

When a dead body is decomposed various gases and microorganisms are formed as a result obnoxious gases forming, smelling and other environmental problems may be created. Therefore most systematic and sanitary disposal methods should be introduced. The results is a formation of a legal background.

The methods of disposal of the dead are as follows:

1. Cremation
2. Burial

Cremation

This methods is mostly used sanitary method. In this process the dead body is brought to very high temperature and finally the result is a mixture of carbon and ash. For this there are crematoriums constructed in most places.

Advantages:
Dead body is completely burnt to ashes.
Very little space is needed when compare to the burial
Time consumed is less
Most hygienical method
No danger to soil and under ground water table

Disadvantages:
Air is polluted due to smoke
Will be expensive

Burial

Although this method is commonly used, it is not a healthy method.

Disadvantages
Need a distinctive land and extensive land is required and therefore land is wasted.
Soil and water courses can be polluted and release of land is not possible.

The following legal aspects are available

- Public burial grounds and private burial grounds ordinance No. 231 of no. 26 of 1947.
- Regulation 37 – 89 framed under (No. 30) Quarantine and prevention of diseases ordinance no.26 published in govt. gazette no. 10713 of 17.3.54
- Section to 60 and 61 of the above
- Para no. 25 (10) Gazette No. 520/7 of 23.08.1988
- Letter of DDG(PHS) on burial grounds (approval) vide DU circular No. 749 PK 26/70 of 14.03.71

<u>Ordinance No 26 of 1947</u>

Authorize officer is the Minister of Health. Delegated authority to local authorities by the Minister.

No burial be a done in other places 5 (2), Can be exempted (should be gazette) 5/1, Local authorities can provide land for burial grounds (6), Can not be sold (7), Distance of houses be located above 50 feet (8), Religious places can be built within this limit (9), Prepare a wall of 6 feet built round the land (10), Can be transferred (11)
Private burial grounds can be banned (34), Re-burial cannot be allowed (35)

Section 60: Cremation or burial of a person died of communicable disease should be done under a qualified persons supervision.

Section 61: Should not be done except the authority of authorized officer on communicable diseases. He should be able to decides regarding the disinfection, route of travel, place of burial and the depth of burial pit.

Disposal of Animal dead bodies
Should be done according to sanitary regulations. For burial of animals died on road Labourers can be obtained from the local authority (if the owner is known, he should be instructed to bury)

Requirements of a burial ground

- 6 ft. parapet wall round the burial ground should be built to prevent animals entering.
- Depth of the pit is (maximum) 4ft. and 6ft. (maximum)
- For and adult 6'ft x 3'ft x 6'
- For and child 6'ft x 2 ½' x 4 ½'
- Infant 6'ft x 2'ft x 3'ft
- Burial done with a coffin – The place can be reused after 01 year
- distances between 2 burial pit 6'ft

Conditions that should be considered for a burial ground
- Soil should not be impervious.Sandy soil is ideal
- Ground water level should be more than 6'ft. deep.
- Nearest house should be 50'ft. away
- For cremation, 200yd. away from the nearest house and rood
- Rood access should be available
- No. of dead for last 10 years to be considered
- Distance to nearest burial ground to be considered
- Distance to the nearest water course over 50'ft.

When a PHI is called upon to submit recommendation for a burial ground, he should consider the following information.

- Nearest water courses (distances)
- Nearest houses (distances)
- Distance to the nearest town and road
- A map of the area showing above details to be submitted to the MOH
- MOH should give his recommendations based on PHII observations and report

Following actions should be taken when a case of HIV, infe. Hepatitis, Rabies and Cholera is reported

- All orifices should be plugged with 5% Lysol solutions
- Final disposal of dead body done as early as possible
- Handling and hugging is not allowed
- More attention to be done for cremation

Regulations for burial of such dead bodies
- Lay a layer of lime to the bottom of the pit
- Add 5% Lysol to the body and lay the dead body if no disinfection had been used
- After the dead body is laid, close with a layer of lime. Close the pit
- Ground water level and drinking water supply should be considered
- Ensure the participants to a minimum
- No refreshments can be served

Role of PHI in maintenance of burial grounds
- To inspect and submit a report every 2 months
- To ensure complete burying of dead bodies
- Caretaker of burial ground should register all burials and cremations after supervision and should report to the MOH of the area
- Supervise the work of the labourers
- Informed police if there is open burials
- Disposal of Human remains due to following infectious diseases; Small pox, Plague, Cholera, AIDS, Human rabies, Hepatitis-B, and Avian Flu

Duties and Responsibilities of the Public Health Inspectors have been described on the regulations No.37 – 89 under Quarantine and Prevention Diseases Ordinance. These regulations (published by the gazette No. 10713 of September 17, 1954) made by the Health Minister under section 3(1) of the Quarantine and Prevention Diseases Ordinance, No.3 of 1897.

Some relevant regulations

Regulation 60: Corpse of persons who have died of Disease – Should a person die of disease elsewhere than within the limits of a hospital, or place of observation, no one shall touch the corpse except those who undertake the necessary duties of preparing it for the burial or cremation. Such persons shall disinfect themselves in such manner as may be prescribed by the proper authority. The clothes surrounding the corpse of a person who had died of infectious disease shall be disinfected in such manner as the proper authority may direct, the necessity for so doing having been carefully explained to the relatives. The clothing of persons who carry dead bodies shall be thoroughly disinfected.

Regulation 61; Burial, Disinfection, and removal of corpse - No person shall bury the corpse of any one who has died of disease, except in a place approved by the proper authority, and the proper authority may give orders regarding the disinfection and removal of corpse by specified thoroughfares, and for enforcing burial in certain places or at a certain depth.

Cremation is the best sanitary method. If impossible do so bury under the directions given by the health authority. The private cemeteries should not select for bury or cremate the corpse. Before selecting the cemetery should consider regarding ground water level and away from 50 feet of the residence. Refrain from embalming the corpse. Advices to relatives for bury or cremation as soon as possible within 24 hours after

handed over the death body. Refrain from embrace touch unnecessarily or kissing the corpse. Avoid from food and refreshments at the funeral function.

Preparations of human remains keep in the coffin; every openings of the death body from cotton plugs soaked with 5% Lysol solution. Scatter one inch layer of tropical chloride of lime or calcium hydroxide on the bottom of the coffin and grave. The clothing of persons who carry dead bodies shall be thoroughly disinfected.

Circular No: 749

My No: PK/26/70
Office of the Director of Health Services
Colombo
14.03.71

To all Heads of Decentralized Units.

Approval for burial grounds

There are request for approval of burial grounds make directly to me from local authorities and also to you and sometimes to the MOOH from time to time. In such instances, please furnish following particulars for me to give my approval easily.

A burial ground boundary should be at least 50'ft. away from dwelling houses. f is house is situated within 50'ft. a letter of consent from the owner or occupant should be accompanied. Do not give your decision to the local authority before my approval.

Your recommendations should be submitted within one month and following information should be submitted.

1. Situation of the ground
2. Extent of the land
3. Population of the served
4. Road access to the proposed site
5. Nature of soil
6. Whether the area is inundated
7. Underground water level
8. Distance to the nearest house
9. Whether area can be extended
10. Distance to the nearest water course or well
11. Annexure – letter request in the burial ground by the local authority
12. Recommendation of the MOH
13. Observation and recommendation of the RDHS

Sgd. D.A. Jayasinghe
DDG. (PHS)

2.7 Pest Control

Pest control activities play an important role in the protection of public health. It will be quite helpful for the PHI to have a sound knowledge on pest control procedures in regard to the insects/ other pests responsible for health problems, and also those pests which cause damage to buildings.

When a pest problem arises the PHI should be able to choose the appropriate method of controlling the pest/s involved. Therefore it is necessary for the PHI to identify/ suspect the pest/s causing the problem and thereafter to decide which method of control should be applied. It is also necessary to decide how urgent the problem is, and the extent of the problem. The human population affected by the problem has to be identified. In consultation with the MOH, technical advice may be obtained from the Entomology Division of the MRI, or from the relevant specialized campaign.

Pest control could be by means of chemical or biological method. The available methods target either the larval forms or the adult form. Biological control methods are generally environmental friendly, whereas chemical methods cause some degree of environmental pollution. However, when vector-borne diseases are rapidly spreading, chemical methods have to be used as they cause rapid destruction of the vectors involved. Specialized campaigns function for the control of certain vector-borne diseases, and the district-level officers of these campaigns will initiate action to handle any problems within their districts, with approval of the provincial authorities and technical guidance from the relevant Line Ministry Directorate. In instances where such specialized units do not function, the MOH will take action with the assistance from Line Ministry institutions which can provide technical guidance and sometimes resources necessary for the control measures.

For the planning and implementation of pest control activities it is very necessary to be aware of the life-cycle, feeding habits, and the resting habits of the insects/other pests involved. Chemical insecticides are poisonous for the insects, and the persons involved in handling them and also for the public. Therefore it is essential to educate the persons engaged in handling insecticide and also to supply protective materials when such work is done. (eg. overalls, hand gloves, face masks, boots, and soap and water). It is important to educate them not to chew beetle, smoking, and take any foods while operations without hand washing.

PHI should use insecticide only when there is no other method possible to control insects. The fact remains that the nuisance caused by insects could be stopped only by eliminating them. The destruction or minimizing the density of insects can only be done by controlling their breeding. For this purpose spraying of insecticides or using other chemicals is not suitable and also it is not possible to completely eliminate them.

Mosquito control

Control of communicable disease is one of the main functions of the PHI in our health unit set up. There being five important communicable disease transmitted by mosquitoes, in our country, mosquito control is an important activity.

Vector Borne Diseases prevalent in Sri Lanka

Disease		**Vector**
Dengue / DHF	**:**	Aedes aegypti

Chickungunya	:	Aedes albopictus
Malaria		Anopheles culicifacies (major vector) Anopheles subpictus (secondary vector) Anopheles subpictus (secondary vector
Filariasis	:	Culex quinquefasciatus
Japanese Encephalitis	:	Culex tritaeniorrhyncus Culex gelidus

In the control of mosquitoes adult forms are controlled by using chemical methods. For the control of larval forms, either biological control methods or chemical control methods could be adopted.

Control of adult mosquitoes

- Use of insecticides
  - indoor residual spraying
  - space spraying (thermal fogging or Ultra Low Volume)
  - mosquito-net impregnation

- Control of larval forms
  - chemical (larvicides)
  - biological - larvivorous fish
  - Bacillus thuringiensis israelensis (Bti)

Spraying machines used in spraying

1. Hand-compression type spray tank (for indoor residual spaying / larviciding)
1. Motorized knap-sack type sprayers (for indoor / outdoor spraying)
2. Machines used for thermal fogging / ultra low volume spraying
   - hand carried
   - truck-mounted

What type of spraying is to be carried out, and what insecticide to be used, will depend on the habits of the mosquito to be controlled. Therefore the PHI should obtain advice from the MOH /Specialized Campaign / MRI, regarding these matters. Space spraying has only a temporary effect, and therefore has to be repeated at short intervals. When targeting the vector of dengue, fogging is to be carried out between 7 am to 10 am and between 3 pm to 5 pm. If targeting the vector of Japanese encephalitis or malaria, fogging should be carried out between 6 pm to 10 pm and 4 am to 6 am.

The flight range of vectors differs. Therefore advice should be obtained from the relevant specialized campaign or the Entomology Division / MRI, with regard to the distance around the foci of transmission that should be covered with fogging.

Chemical larviciding

It is the main method of vector control in the Anti Filariasis Campaign. Breeding sites of the filariasis vector are suitable for application of chemical larvicides. Used as a supplementary vector control method by the Anti Malaria Campaign.

Fenthion is used for the control of filariasis vector larvae and Temephos is used when larviciding targeting the malaria vector larvae. When applying chemical larvicides to water bodies used by humans for drinking and other purposes, by animals for drinking, and also from where people catch fish for consumption, the chemical larvicide used should be one which is non-toxic to humans, and other animals including fish.

Biological control methods

Larvivorous fish may be introduced to stagnant water bodies in which vectors are likely to lay eggs. Two species are currently used in Sri Lanka. Guppy fish (*Poecelia reticulata*) can survive in polluted water, and therefore ideal for the purpose of larval control in blocked drains, canals etc. The wild guppy fish is more suitable than the colourful ornamental varieties. *Aplocheilus dayi* ('Nala Handaya') is an indigenous fish commonly found in habitats such as flooded paddy fields and canals. It is not suited for application in polluted waters, and may be used in places such as domestic and agricultural wells, and irrigation channels.

In places where these fish have been introduced, the local authority of the area should exhibit sign boards to indicate that larvivorous fish have been introduced in such places, for the information of the public and health officers engaged in mosquito control activities. The PHI of the area should visit these places at least fortnightly, to ensure that adequate numbers of fish are present. No larviciding chemicals should be introduced to such places, and these water bodies should not be contaminated with pesticide residues as a result of washing spraying machines etc. *B. thurengiensis* (Bti) can also be used in biological control of mosquitoes. Formulations are commercially available both in solid or liquid form.

When applied to breeding sites, the effect lasts for a longer period than after applying chemical larvicides.

Rodent control

Rodents are responsible for causing diseases such as Leptospirosis. They also cause heavy losses by consuming stored food materials like grains. The PHI should be aware of rodent control methods. Coumatetratyl is mixed with food and kept in the areas where rodents gather, specially at night. This could be continued for several days. Coumatetratyl is a poisonous substance and therefore precautions should be taken to avoid contamination of food consumed by humans and other non-target animals.

Cockroach control

Spraying of S.bioallethrin and D. deltamethrin in areas where cockroaches thrive will result in their destruction. The most popular method is to use boric powder in such places. The cockroaches will die after eating the powder. Boric powder is non-toxic to human.

Ticks and Mites and other insects

Spraying of Permethrin 25% EC

Wasps

Fogging with S.bioallethrin and D. deltamethrin mixed with diesel. It is directly sprayed to the nests.

White ants

They destroy buildings and other materials. Deltamethrin 25% solution is used to control white ants. Borehole the ground about 4 ft deep and with a high pressure motorized sprayer spread the insecticide to cover about 1 sq.m. Even concrete floors inside the houses can be bored.

Most of these chemicals cannot be obtained by the general public, and therefore have to be purchased by local authorities.

When using chemicals always follow the instructions of the manufacturer appearing on the label

Trade Name	Chemical Name	Dosage Per Litre	Remarks
Baytex EC 50	Fenthion	1.6 ml per litre of water	A larvicide used for surface spraying
Baygon EC 50	Propoxor	25 ml per litre of water	An adulticide used against flying and crawling insects
Abate	Temephos	2 ml per litre of water (polluted water) 1ml per litre of water (mildly polluted water) 0.5ml per per litre of water (clear water)	A larvicide
Cisilin EC	Deltamethrin	6 ml per litre of water	For flies & cockroaches
Cisilin	Deltamethrin	5 – 10 grams per litre of water	For flies & cockroaches
Deltacide(Fogging)	Deltamethrin	10 ml per ltr. for outdoor fogging 20 ml per ltr for indoor fogging	Against mosquitoes
Coopex wp	Permethrin	5 – 10 grams per litre	Ants & crawling insects
Peripel 10	Permethrin	0.2 - 0.5 gms of active ingredient per sq.mtr	Mosquito net impregnation
Solfac EC 50	Cyfluthrin	5 ml per ltr. of water (outdoor) 8 ml.per ltr of water (indoor)	For flying & crawling insects

Instructions and Precautions to be followed by persons handling insecticides

1. Always use eye guards, hand gloves, over coats, and gum boots when insecticide mixtures are prepared, and when carrying out spraying
2. Refrain from consuming food, smoking, and betel chewing during spraying operations
3. Outdoor spraying should be always done in the direction of the wind
4. Use the correct quantity of chemicals and follow the instructions of the supervisor
5. At the end of operation all equipment should be washed and waste water should not pollute any water resources

Technical advice regarding pest/ mosquito control may be obtained from:-

- Specialized Campaigns handling vector control (Directorate and the Regional Offices)
- Pest Control Division of the Colombo Municipal Council (also gives technical advice to Hotel personnel)