1st Edition

LEARNER'S GUIDE

TECHNICAL COMPETENCY UNIT

ADM.TEC 028.1

Provide Technical Guidance on Core Public Health Engineering Concepts

ASCEND

AHA CENTRE
ONE ASEAN ONE RESPONSE

ASEAN Standards and Certification for Experts in Disaster Management

ASEAN Standards and Certification for Experts in Disaster Management

PROVIDE TECHNICAL GUIDANCE ON CORE PUBLIC HEALTH ENGINEERING CONCEPTS

ADM.TEC.028.1

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ONE ASEAN
ONE RESPONSE

Project Sponsors:

The Association of Southeast Asian Nations (ASEAN) was established on 8 August 1967. The Member States are Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam. The ASEAN Secretariat is based in Jakarta, Indonesia.

The "ASEAN Standards and Certification for Experts in Disaster Management (ASCEND)" is under Priority Programme 5: Global Leadership of the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) Work Programme 2021-2025 that envisions ASEAN as a global leader in disaster management.

The ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre) implements the ASCEND project in collaboration with the Korean National Fire Agency (KNFA) and support from the ASEAN Secretariat and the Republic of Korea.

The publication of this document is part of the "ASEAN Standards and Certification for Experts in Disaster Management (ASCEND) Toolboxes Development for Five (5) Professions" project.

General information on ASEAN appears online at the ASEAN Website: www.asean.org

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1.1 The ASCEND Programme

Southeast Asian governments, through the ASEAN Committee on Disaster Management (ACDM), continue to invest in strengthening disaster management systems for a more secure and resilient region. However, the compounding risks and increasing uncertainty of disasters in our new climate reality threaten to set back the socioeconomic development gains of ASEAN societies. Widespread and recurring disaster damages and losses can overwhelm national capacities and worsen regional transboundary effects.

The Declaration on One ASEAN One Response (OAOR) at the 2016 ASEAN Summit in Vientiane, Lao PDR, reaffirms ASEAN's vision to move towards faster and more integrated collective responses to disasters inside and outside the region. However, ASEAN's past experiences responding to large-scale disasters showed that realising the OAOR can be challenging. Various responders from different countries, institutions, organisations, and companies seek to contribute to the overall response. Their goodwill is appreciated, and several provide much-needed assistance. But ASEAN and affected Member States sometimes found it challenging to determine what knowledge and skills responders have and how they can effectively contribute to national and regional efforts.

Learnings from past experiences and shared commitment to realising the OAOR vision increased the need to develop regionally recognised Competency Standards and a certification process for disaster management professionals. The increased support led to initiatives that eventually created the ASEAN Standards and Certification for Experts in Disaster Management (ASCEND) Programme. ASCEND is now part of Priority 5: Global Leadership of the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) Work Programme 2021-2025, a programme that envisions ASEAN as a global leader in disaster management.

1.2 The objectives of ASCEND

- To enhance the capacity of the ASEAN countries in the implementation of ASCEND.
- To establish regionally recognised Competency Standards and assessment processes covering five professions in disaster management.
- To improve the capacity of the AHA Centre to serve as the ASCEND Secretariat.
- To promote understanding of the ASCEND Framework among the ASEAN Member States (AMS) and other ASEAN sectors in preparation for the inclusion of ASCEND into the ASEAN Mutual Recognition Arrangement (MRA).

1.3 Advantages and benefits of an ASCEND certification

For ASEAN
The ASCEND certification can assist Member States in ensuring that competent disaster management professionals handle emergency assistance and disaster relief across the region. It also supports mutual recognition of disaster management competencies to facilitate acceptance of external aid and faster response.

For AHA Centre
ASEAN, a rapidly developing and hazard-prone region, will need more competent disaster management professionals. The ASCEND certification can narrow current knowledge and skills gaps. It can also enable stronger cooperation and interoperability between disaster managers in their home countries and across regions.

For disaster management professionals
Disaster management professionals can use their ASCEND certification to promote themselves professionally and serve as evidence of their experience and qualifications. It can also make it easier for organisations to determine the ability of certificate holders to perform critical work functions of specific occupations in the disaster management sector.

These ASCEND toolbox documents support the ASEAN Member States in identifying, building the capacity of, and mobilising competent disaster

managers across Southeast Asia that are highly capable of contributing to reducing disaster risks and disaster losses in the region through timely and effective response.

1.4 The ASCEND Toolbox

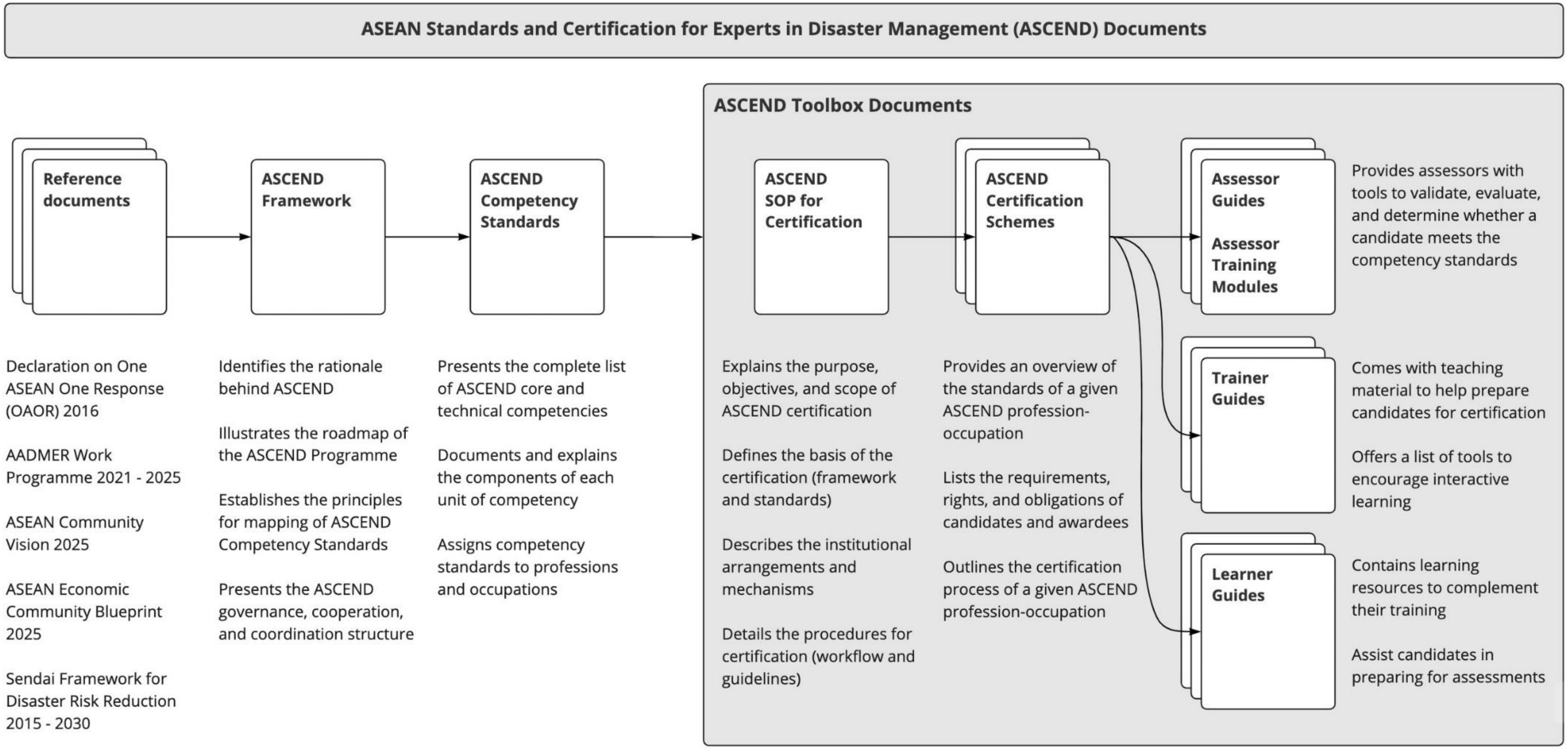
A set of technical requirements must exist before it is possible to implement the ASCEND programme in participating ASEAN Member States. The first requirement is the ASCEND Competency Standards, containing forty-three (43) regionally recognised core and technical competencies in selected disaster management professions. The Competency Standards outline the work elements and performance criteria that guide for certification of disaster management professionals across the region.

Another requirement is the development of an ASCEND Toolbox for five professions. These professions are Rapid Assessment, Humanitarian Logistics, Information Management, Water, Sanitation and Hygiene (WASH), and Shelter Management. The ASCEND Toolbox consists of an SOP, Certification Schemes, Assessor Guides, Trainer Guides, and Learner Guides. The ASCEND Competency Standards, approved by the ASEAN Committee on Disaster Management, are the primary basis of the Toolbox documents.

The SOP defines the basis of ASCEND, describes the institutional arrangements and mechanisms, and details the certification procedures. Certification Schemes present an overview of the standards of each profession-occupation and certification requirements, the rights and obligations of candidates and certificate holders, and general guidelines on the certification process. Assessor Guides provide assessors with tools to validate, evaluate, and determine whether a candidate meets the Competency Standards. Trainer Guides come with PowerPoint slides and presenter notes to help trainers prepare candidates for certification. It also offers a list of tools trainers may use to encourage interactive learning. Learner Guides assist candidates preparing for ASCEND certification in their chosen disaster management profession and occupation. It contains learning resources and complementary readings to help prepare them to undergo the required assessment.

The ASCEND Toolbox documents can assist the ASEAN Member States to identify, build the capacity of, and mobilise competent disaster managers across Southeast Asia to help reduce disaster risks and disaster losses in the region through timely and effective response.

Figure 1: Overview of ASCEND Toolbox Documents



Learner's Guide

Introduction for Candidates

ASCEND

Welcome and thank you for your interest in pursuing an ASCEND certification. This Learner Guide is for you to read. It contains learning resources and helps you prepare for the required assessments: oral interviews, written tests, and observation checklists.

Competency-based learning and assessment

Competency is the attitude and ability to use or apply one's experience, knowledge, and skills-sets to perform critical job functions in a defined work setting.

Table 1: Competency areas and descriptions

Competency area	Description
Experience	Refers to the qualifications of the candidate that make them eligible to pursue certification. It includes the candidate's formal education, work experience, professional training, and job-relevant life experiences.
Knowledge	Refers to what the candidate needs to know to make informed decisions on how to perform the work effectively.
Skills	Refers to the ability of the candidate to apply knowledge to complete occupational tasks and produce work outcomes or results at the standard required.
Attitudes	Refers to associated beliefs, feelings, motivations, and values that influence a candidate to make decisions and act according to occupational standards and the professional work setting.

There is one Learner Guide for each unit of competency. The Competency Standards and Unit Descriptor section of this document outlines the content you will be studying – broken down into elements and performance criteria that will be covered during training and assessed using competency-based methods. This guide contains a glossary of terms, a list of abbreviations,

readings and activities, a self-assessment checklist, and information about the oral interviews and written tests.

Competency-based methods help ensure that the ASCEND certification process is relevant, valid, acceptable, flexible, and traceable – in alignment with the ASEAN Guiding Principles.

The relevance principle confirms that the ASCEND certification reflects the current professional needs in the disaster management sector. The validity principle relates to the consistency and equitability of the assessment process. The acceptability principle is about aligning the ASCEND certification to other disaster management professional standards and good practices. The flexibility principle refers to the responsiveness of the ASCEND certification to changes or differences in disaster management work settings and job requirements. The traceability principle ensures that evidence is sufficient to grant the ASCEND certification.

Competency-based assessment (CBA) is the process for evaluating whether a professional is qualified and competent to perform in a particular occupation. CBA is used to determine if the candidate's experience, knowledge, skills, and attitudes meet the standards and performance criteria defined in a unit of competency.

ASCEND Competency Standards and Unit Descriptor

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3.1 Competency standards

Competency standards are a set of industry-accepted benchmarks that defines the experience, knowledge, skills, and attitudes professionals need to perform well in an occupation. It also reflects the requirements of work settings and considers the developments in the disaster management profession.

3.2 ASCEND Competency Standards

The ASCEND Competency Standards identify the key features of work in selected disaster management professions, and performance standards professionals need to meet to be deemed competent. It also provides the list of the forty-three (43) core and technical competencies that serve as the basis for defining the regionally recognised disaster management qualifications across the ASEAN Member States. The five (5) professions covered by the ASCEND Competency Standards include Rapid Assessment, Humanitarian Logistics, Information Management, WASH, and Shelter Management. Under these professions are five (5) categories of occupations: Manager, Coordinator, Officer, Promoter, and Engineer. Overall, there are fifteen (15) profession-occupation combinations (e.g., humanitarian logistics manager, information management coordinator, WASH promoter).

Each ASCEND Competency Standard has its dedicated Toolbox documents: an SOP, Certification Scheme, Assessor Guide, Trainer Guide, and Learner Guide. One SOP applies to all profession-occupation combinations covered by the ASCEND certification. The Certification Schemes, one for each of the profession-occupation combinations. Both these documents align with the AQRF Level Descriptors, Section 4: Guiding Principles and Protocols for Quality Assurance of the AGP, and ASEAN Disaster Management Occupations Map. The Certification Schemes also outline the ASCEND competencies under selected professions and occupations, eligibility criteria, basic requirements and rights of candidates, and obligations of certification holders. Assessor Guides describe the components of particular competency standards and offer tools to determine the candidate’s qualifications. Trainer and Learner Guides expound on a given competency standard's elements and performance criteria for learning and assessment preparation purposes.

The Toolbox documents may also serve as a reference for ASEAN Member States' seeking to develop and implement national-level competency-based certification processes based on their respective capacities and needs. The ASCEND Competency Standards and its derivative Toolbox documents will be reviewed and updated every five (5) years to ensure it reflects changes in the disaster management profession and remains relevant. Table 2 describes its main components.

Table 2: Components of the ASCEND Competency Standards

Component	Description
Unit title	Describes the critical work function to be performed in an occupation
Unit number	A coding system to organise the units of competency. It also indicates the types of competency standards. ▪ ADM.**COR**.000.0 are core competencies. These are general professional knowledge and skills related to international humanitarian principles and disaster management standards, including ASEAN mechanisms and procedures. ▪ ADM.**TEC**.000.0 are technical competencies. These are specific knowledge and skills needed to perform effectively in work areas under their chosen disaster management profession and occupation.
Unit description	Provides information about the critical work function covered by the unit.
Elements	Presents the occupational tasks required to perform the critical work function in the unit.
Performance criteria	Lists the expected outcomes or results from the occupational tasks to perform and the standard required.

3.3 Unit descriptor

Unit title : **Provide Technical Guidance on Core Public Health Engineering Concepts**

Unit number : ADM.TEC.028.1

Unit description : This unit deals with the skills and knowledge required to implement a project in issues related to public health engineering during emergencies, including building, operating and maintaining water and sanitation system and services.

Element 1.
Provide technical guidance on water supply

Performance Criteria

1.1 Identify and analyse standards related to water supply in emergency
1.2 Conduct water supply needs assessment and prioritization in an emergency situation
1.3 Identify and analyse different elements and relevance of measures for water supply in emergencies
1.4 Identify critical aspects of operation and maintenance of water supply system and facilities for continued health benefits
1.5 Identify learning and good practices on water supply measures in different types of emergencies

Element 2.
Provide technical guidance on excreta disposal

Performance Criteria

2.1 Identify and analyse standards related to safe sanitation on health risks in an emergency
2.2 Conduct sanitation needs assessment and prioritization in an emergency situation
2.3 Identify and analyse different elements and relevance of measures for excreta disposal in emergencies
2.4 Identify critical aspects of operation and maintenance of sanitation system and facilities for continued health benefits
2.5 Identify learning and good practices on sanitation measures in different types of emergencies

Element 3.
Provide technical guidance on solid waste management and drainage

Performance Criteria

3.1 Identify and analyse standards related to proper solid waste management and drainage facilities on health risks in an emergency
3.2 Conduct solid waste management, and drainage needs assessment and prioritisation in an emergency situation
3.3 Identify and analyse different elements and relevance of measures for solid waste management and drainage in emergencies
3.4 Identify key aspects of operation and maintenance of solid waste management and drainage system and facilities for continued health benefits
3.5 Identify learning and good practices in solid waste management and drainage facilities in different types of emergencies

3.4 Glossary of Terms and List of Abbreviations

Terms and abbreviations	Descriptions
AADMER	ASEAN Agreement on Disaster Management and Emergency Response
ACDM	ASEAN Committee on Disaster Management
AGP	ASEAN Guiding Principles
AHA Centre	ASEAN Coordinating Centre for Humanitarian Assistance on disaster management
AMS	ASEAN Member States
AQRF	ASEAN Qualifications Reference Framework
ASCEND	ASEAN Standards and Certification for Experts in disaster management
ASEAN	Association of Southeast Asian Nations
CBA	Competency-Based Assessment
CWC	Community WASH Committees
GWC	Global WASH Cluster
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
KNFA	Korean National Fire Agency
MRA	Mutual Recognition Arrangement
NGOs	Non-Governmental Organisations

NPHMOS	National Public Health and Medical Officer Service
NTU	turbidity units
OAOR	One ASEAN One Response
ORPs	Oral Rehydration Points
OXFAM	Oxford Committee for Famine Relief
PDNA	Post-Disaster Needs Assessment
PE	Polyethylene
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
SI	Solidarities International
SOP	Standards Operating Procedures
TCI	Turks and Caicos Island
UAE	United Arab Emirates
UNDP	United Nations Development Programme
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations International Children's Emergency Fund
UN OCHA	United Nation's Office for the Coordination of Humanitarian Affairs.
UXO	Unexploded Ordnance
VIP	Ventilated Improved Pit
WASH	Water, Sanitation and Hygiene

WHO	World Health Organisation
WTW	Water Treatment Works

Unit Readings and Activities

ASCEND

ADM.TEC.028.1

Learner's Guide

4.1

Element 1. Provide technical guidance on water supply

1.1 Identify and analyse standards related to water supply in emergency

A. Introduction

Water-supply issues arise at every phase of a disaster. Water is necessary for survival, health, and human dignity. In extreme situations, there may not be enough water to meet basic needs, and in these cases, providing safe drinking water is critical. Most health problems in disaster contexts result from poor hygiene due to a lack of water and the consumption of contaminated water.

B. Water supply

Water Quantity and Access
Water should be readily available. It must be located close enough to people's homes to collect it easily, and there must be enough water points to allow everyone access.

Key Indicators:

- In any household, the average amount of water used for drinking, cooking, and personal hygiene is at least 15 litres per person per day.
- The maximum distance between two households and the nearest water source is 500 meters.
- The average wait time at a water source is 15 minutes.
- Filling a 20-litre container takes no more than three minutes.
- Water sources and systems are kept in good working order so that adequate amounts of water are available consistently or regularly.

- **Needs**
  The amount of water required for domestic use varies depending on the climate, available sanitation facilities, people's everyday habits, religious and cultural practices, the food they cook, the clothes they wear, and so on. The closer the water source is to the dwelling, the more water is consumed. Table 1, adopted from The Sphere Handbook (2018), shows a simplified table of basic survival water needs.

Table 3: Basic Survival Water Needs

Simplified table of basic survival water needs		
Survival needs water intake (drinking and food).	2.5-3 litres per day	Depending on the climate and individual physiology
Basic hygiene practices.	2-6 litres per day	Depends on social and cultural norms
Basic cooking needs.	3-6 litres per day	Depends on food type, social as well as cultural norms
Total basic water needs.	7.5-15 litres per day	

Source: The Sphere Handbook, 2018.

- **Water source selection**
  The availability and sustainability of a sufficient quantity of water; whether water treatment is required and, if so, the feasibility of this; the availability of the time, technology, or funding required to develop a source; the proximity of the source to the affected population; and the presence of any social, political, or legal matters related to the source must be considered. Groundwater sources, in general, are preferable because they require less treatment, particularly gravity-flow supplies from springs, which do not require pumping. A combination of approaches and sources is frequently required in the early stages of a disaster. To avoid over-exploitation, all sources must be monitored regularly.

- **Measurement**
  Measuring only the volume of water pumped into the reticulation system or the length of time a hand pump is in use will not accurately indicate individual consumption. Household surveys, observation, and community discussion groups are more efficient in gathering data on water use and consumption.

- **Quality and quantity**
  Until both minimum quantity and quality standards are met, the priority should be to provide equitable access to an adequate quantity of water, even if it is of intermediate quality, rather than an inadequate quantity

of water that meets the minimum quality standard. It should be remembered that people living with HIV/AIDS require more water for drinking and personal hygiene. Care should be taken to ensure that the water needs of livestock and crops are met, especially in drought-stricken areas where lives and livelihoods are at stake.

- **Coverage**
  The priority in the initial phase of a response is to meet the immediate survival needs of the entire affected population. People affected by an emergency are more vulnerable to disease, so the indicators should be met even if they are higher than the norms of the affected or host population. In such cases, it is recommended that agencies plan programmes to improve the host population's water and sanitation facilities as well, in order to avoid provoking animosity.

- **Maximum numbers of people per water source**
  The yield and availability of water determine the number of people per source at that location. Taps, for example, frequently function only at certain times of day, and handpumps and wells may not provide constant water if the recharge rate is low. The rough guidelines (for when water is always available) are as follows:
  - 250 people per tap (based on a flow of 7.5 litres/minute).
  - 500 people per handpump (based on a flow of 16.6 litres/minute).
  - 400 people per single user open well (based on a flow of 12.5 litres/minute).

  These guidelines assume that the water point is only accessible for about eight hours per day; if access is more significant, people can collect more than the minimum requirement of 15 litres per day. These targets should be used with caution, as meeting them does not guarantee a minimum amount of water or equitable access.

- **Queueing time**
  Excessive queuing times are indicators of insufficient water availability (either due to a lack of water points or insufficient water point yields). Excessive queuing times may have the following negative consequences: 1) decreased per capita water consumption; 2) increased consumption from unprotected surface sources; and 3) reduced time for water collectors to attend to other essential survival tasks.

- **Access and equity**
  Even if enough water is available to meet basic needs, additional measures may be required to ensure equitable access for all groups.

Water points should be placed in areas where everyone can access them regardless of gender or ethnicity. Some handpumps and water carrying containers may need to be designed or adapted for HIV/AIDS patients, the elderly, PWDs and children. It may be necessary to supply water to individual buildings in urban areas to keep toilets operational. Water rationing or pumping should be planned in consultation with users when water is rationed or pumped at specific times. Timetables that are convenient and safe for women and others responsible for collecting water should be established. All users should be fully informed of when and where water is available.

Table 2, adopted from OXFAM (1999), shows an overview of water quantity standards for WASH needs

Table 4: *Water quantities and minimum requirements for drinking, cooking and personal hygiene*

Public toilets	1-2 litres/user/day for handwashing 2-8 litres/user/day for cleaning toilet
All flushing toilets	20-40 litres/user/day for conventional flushing toilets 3-5 litres/user/day for pour-flush toilets
Anal washing	1-2 litres/person/day
Health centres and hospitals	5 litres/outpatient 40-60 litres/in-patient/Day *Additional quantities may be needed for some laundry equipment, flushing toilets, etc*
Cholera centres	60 litres/patient/day 15 litres/carer/day if appropriate
Therapeutic feeding centres	15-30 litres/patient/day 15 litres/carer/day if appropriate
Livestock	20-30 litres/large or medium animal/day 5 litres/small animal/day

Source: OXFAM, 1999

Water Quality

The World Health Organisation (WHO) drinking-water quality guidelines recommend that water for human consumption be utterly free of faecal contamination and meet chemical contaminant limits. Faecal contamination poses the most significant short-term risk to public health in most emergencies

rather than chemical contamination. Water quality becomes more critical in areas with a high population density and/or a risk of water-related and excreta-related epidemic disease. Chemical water quality may be of primary concern in disasters such as those caused by industrial accidents. The chemical composition of water may have long-term effects on health, which should be considered.

Key Indicators:

- A sanitary survey reveals that there is a low risk of faecal contamination.
- At the point of delivery, there are no faecal coliforms per 100ml.
- People prefer to drink water from a protected or treated source over other readily available water sources.
- Precautions are taken to reduce post-delivery contamination.
- Water is treated with a disinfectant for piped water supplies or all water supplies when there is a risk or presence of a diarrhoea epidemic. There is free chlorine residual at the tap of 0.5mg per litre turbidity is less than 5 NTU.
- Short-term use of water contaminated by chemicals (including carry-over of treatment chemicals) or radiological sources has no adverse health effects, and assessment shows no significant probability of such an effect.

- **A sanitary survey** evaluates conditions and practices that may endanger public health. The assessment should include potential sources of water contamination at the source, transport, and home, as well as defecation practices, drainage, and solid waste management. Community mapping is an incredibly effective method of identifying public health risks and involving the community in finding ways to reduce these risks. While animal excreta are not as harmful as human excreta, they can contain cryptosporidium, giardia, salmonella, campylobacter, caliciviruses, and other common causes of human diarrhoea, posing a significant health risk.

- **Microbiological water quality**: faecal coliform bacteria (>99 per cent of which are E. coli) are an indicator of the level of human/animal waste contamination in water and the presence of potentially harmful pathogens. If there are any faecal coliforms present, the water should be treated. However, in the early stages of a disaster, quantity trumps quality.

- **Promotion of protected sources**: Providing protected sources or treated water will have little impact unless people understand and use the health benefits of this water. People may prefer to drink from unprotected sources, such as rivers, lakes, and unprotected wells, for various reasons, including taste, proximity, and social convenience. In

such cases, technicians, hygiene promoters, and community mobilizers must understand the rationale for these preferences to incorporate them into promotional messages and discussions.

- **Contamination after delivery**: Water safe at the point of delivery can still pose a significant health risk due to re-contamination during collection, storage, and drawing. Improved collection and storage practices, distribution of clean and appropriate collection and storage containers, treatment with a residual disinfectant, or treatment at the point of use are all steps that can be taken to reduce such risk. Water should be regularly sampled at the point of use to assess the extent of any post-delivery contamination.

- **Water disinfection**: If there is a significant risk of water source or post-delivery contamination, water should be treated with a residual disinfectant such as chlorine. Conditions in the community, such as population density, excreta disposal arrangements, hygiene practices, and the prevalence of diarrheal disease, will determine this risk. The risk assessment should also include qualitative community data on factors such as taste and palatability perceptions. A residual disinfectant should treat any large or concentrated population's piped water supply. In a diarrhoea epidemic, all drinking water supplies should be treated before distribution or in the home. Turbidity must be less than 5 NTU for water to be properly disinfected.

- **Chemical and radiological contamination**: where hydrogeological records or knowledge of industrial or military activity indicate that water supplies may contain chemical or radiological health risks, those risks should be assessed quickly through chemical analysis. The decision should then be made by balancing the short-term public health risks and benefits. A decision on whether to use potentially contaminated water for long-term supplies should be based on a more thorough professional assessment and analysis of the health implications.

- **Palatability**: Although taste is not a direct health problem in and of itself (e.g., slightly saline water), if the safe water supply does not taste good, users may drink from unsafe sources, putting their health at risk. This could also be a risk if chlorinated water is used, in which promotional activities are required to ensure that only safe supplies are used.

- **Water quality in health care facilities**: All water used in hospitals, health care facilities, and feeding centres should be treated with chlorine or another residual disinfectant. When water is likely to be rationed due to a supply interruption, sufficient water storage should be available at the centre to ensure an uninterrupted supply at normal utilisation levels.

Decisions about Quantity and Quality

In many emergencies, the most important routes for water transmission and excreta-related disease are linked to hygiene issues caused by a lack of water rather than contaminated water supplies. When time and resources are limited, and the choice between increasing water quantity or improving water quality must be made, priority should always be given to increasing the quantity of water available, even if the water provided is contaminated. In an emergency, water containing up to 100 faecal coliforms per 100 ml may be provided concisely until treatment systems are in place. It should be emphasized, however, that at this stage, every effort should be made to protect water supplies from contamination and to provide facilities for safe defecation, particularly during times of water-related and excreta-related epidemics, to reduce the risk of water-borne disease transmission.

Preparedness and Protection

Establishing and protecting small-scale decentralized supplies

- *Kinds of damage to small-scale water supplies*

  Wind damage to roof catchment systems is common during tropical storms. People who rely on canals are vulnerable to chronic and acute pesticide poisoning and poisoning from the release of toxic chemicals where the canal drains an industrial zone. During floods, unlined canals can be washed away or broken, cutting off water supplies. Shallow wells in high-water-table areas are more susceptible to flooding contamination than deep boreholes. In a drought, they may also dry up sooner. A landslide could destroy hillside springs. During unusual flash flooding, wells near rivers can become contaminated and filled with sand. All piped systems are prone to failure and disruption during earthquakes, landslides, or civil strife. Dug wells are especially vulnerable during wars because bodies or toxic materials can be dumped in wells.

- *Routine forms of protection*

  Those responsible for providing or improving water supplies during "normal" times must be aware of the specific hazards to which water

sources may be exposed. This hazard mapping should be as crucial as other water supply system planning factors, such as water quality and taste, distance to users, and capital and recurring costs. Simple design changes can sometimes help protect the water source from a catastrophic natural event or industrial accident. For example, flexible plastic pipe is more resistant to earth tremors than rigid pipe.

Some simple improvements, such as raising the headwall of a dug well and providing a cover and outward-sloping concrete apron around it, provide additional protection from contamination caused by floods and run-off into the open hole, as well as short-circuiting seepage from nearby puddles. They also prevent contamination caused by debris and animals falling into the well.

If toxic hazards are present in the surface or groundwater, it is probably best to avoid the water source. The provision of an alternate water source should then be a top priority.

- *Need for consultation with water users*

  Wherever there is a hazard or the possibility of a water supply disruption, primary healthcare workers or other development personnel should discuss alternative drinking-water sources with the people affected. These discussions should take place before the occurrence of an emergency. A delegation from the local health or safety committee should regularly check in on the alternative sources to see how they are doing. Where recent improvements in the water supply have resulted in the abandonment of former sources, the committee may wish to consider the feasibility of providing some minimal maintenance at the old site to preserve it for use in an emergency.

  There should also be local contingency plans to ensure the safety of such drinking-water reserves quickly. These usually entail stockpiling a limited amount of chemicals to disinfect the source (while keeping in mind the shelf-life of these chemicals) and fencing to keep animals out. Depending on the community or neighbourhood's economic base in question, the discussion may progress to consider alternative or reserve water for livestock, small-scale industry, or irrigation. However, the priority should always be water for drinking, cooking, and personal hygiene.

Establishing and protecting large-scale, centralized supplies

- *Types of hazards*

In emergency and disaster preparedness, the location of sources and the design of water-supply systems are critical. Hazards to catchments (forest fires or chemical contamination, for example), reservoirs (drought, earthquake, contamination, landslides), pumping and treatment plants (flood, earthquake, fire, explosion, chlorine gas leaks), and the distribution system (earthquakes, flooding) must all be considered in designing a contingency planning to protect water-supply systems.

- *Strengthening existing systems*

  Weak points in distribution systems, such as river crossings, open canals, landslide scars, and so on, should be reinforced, as should locations where pipes cross earthquake faults. Flood-prone facilities can be raised or protected with levees or bunds. If necessary, back up generators can be provided, and a stock of pre-positioned replacement pumps and pipes for emergency repairs. Standardization of pumps, pipes, and fittings, among other things, is critical so that spares and equipment can be sent as temporary replacements from a nearby town.

  Rapid sand filtration systems can be made less vulnerable to disasters by providing appropriate staff training and including emergency provisions in the planning stage to deal with prolonged high turbidity, power outages, and chemical shortages. Extra chemical stocks, stand-by power generators, and emergency prefiltration storage/sedimentation capacity are emergency provisions to consider.

- *Long-term investment decisions*

  Long-term design and investment decisions must account for the possibility of disaster. Slow sand filters, for example, which can be adequate even for large cities, are less vulnerable to hazards such as interruptions in chemical supplies and power supplies than other treatment systems. Water-transmission mains and distribution networks should be routed with the possibility of damage from natural causes such as earthquakes and landslides.

Preparation for displacement emergencies

When the vulnerability assessment identifies a risk of population displacement, steps should be taken to prepare for such an event by considering the likelihood of displacement, the likely number of displaced people, displacement routes, and likely destinations. Identifying water sources along displacement routes and potential temporary settlements; stockpiling lightweight water equipment (pumps, flexible reservoirs, pipes, and taps) and

supplies (fuel and water treatment chemicals); identifying and training staff; and holding discussions with local communities along displacement routes about access to water sources are examples of preparedness measures. It may be difficult to move staff and equipment along congested roads during a mass population movement. Therefore, it is critical to establish a local response capacity early on.

Water Supply Strategy in an Emergency Response

- *Priorities*
  The priority is to provide enough water, even if it is of poor quality, and protect water sources from contamination. A minimum of 15 litres/person/day should be provided as soon as possible in the immediate post-impact period. Treated water may need to be limited to 7 litres/day/person. Water quality can be improved over several days or weeks.

- *Gradual improvement of water supplies*
  Successful emergency response in the water-supply sector depends on improvisation and gradual improvement of water supplies in all situations, progressing from essential services during the emergency and recovery phases to more sustainable services in the long term when installations should be more robust and less vulnerable to disasters. These enhancements are usually incremental. Emergency measures are designed and implemented to allow them to be expanded later. However, sometimes this may not be possible. Temporary measures, such as using lightweight petrol pumps and flexible tanks that require complete replacement after weeks or months, may be required.

- *Assessment, monitoring, and review*
  Assessment is required to identify needs, damage, and resources to respond appropriately and effectively. Monitoring activities are also required to ensure that water supply activities are carried out as planned. The focus is on looking at indications of problems and unmet needs. Periodic reviews of the situation and response are required to ensure that the intervention remains relevant to the needs and resources of the disaster-affected communities.

- *Hygiene promotion and participation*
  The emergency water-supply response should be carried out in conjunction with, or as part of, a hygiene promotion programme that works with the affected population. The overall aim is to reduce risk, increase resilience, and lessen the impact of disasters on health. Interventions should ensure that water systems are designed and

maintained to meet the needs of all parties involved, including women, children, the elderly, PWDs. Opportunities for participation in assessment, monitoring, review, and programme design and implementation should be sought.

C. Standards Related to Water Supply in Emergency

Here are the standards related to water supply in an emergency based on the Sphere Handbook:

Table 5: *Standards related to water supply in emergency*

Standards	Key Actions
Water Supply Standard 1: ***Water Access and Quantity***	• Identify the most appropriate groundwater or surface water sources, taking account of potential environmental impacts. • Determine how much water is required and the systems needed to deliver it. • Ensure appropriate waterpoint drainage at household and communal washing, bathing and cooking, and handwashing facilities.
Water Supply Standard 2: ***Water Quality***	• Identify public health risks associated with the water available and the most appropriate way to reduce them. • Determine the most appropriate method for ensuring safe drinking water at the point of consumption or use. • Minimise post-delivery water contamination at the point of consumption or use.

Table 6: *Minimum water quantities: survival figures and quantifying water needs*

Minimum water quantities: survival figures and quantifying water needs	
Surviving needs: water intake (drinking and food)	2.5–3 litres per person per day (depends on the climate and individual physiology)
Basic hygiene practices	2–6 litres per person per day (depends on social and cultural norms)
Basic cooking needs	3–6 litres per person per day (depends on food type, social and cultural norms)

Health centres and hospitals	5 litres per outpatient 40–60 litres per in-patient per day 100 litres per surgical intervention and delivery Additional quantities may be needed for laundry equipment, flushing toilets and so on
Cholera centres	60 litres per patient per day 15 litres per carer per day
Viral haemorrhagic fever centre	300–400 litres per patient per day
Therapeutic feeding centres	30 litres per in-patient per day 15 litres per carer per day
Mobile clinic with infrequent visits	1 litre per patient per day
Mobile clinic with frequent visits	5 litres per patient per day
Oral rehydration points (ORPs)	10 litres per patient per day
Reception/transit centres	15 litres per person per day if the stay is more than one day 3 litres per person per day if the stay is limited to daytime
Schools	3 litres per pupil per day for drinking and hand washing (Use for toilets not included: see *public toilets* below)
Mosques	2–5 litres per person per day for washing and drinking
Public toilets	20–40 litres per user per day for conventional flushing toilets connected to a sewer 3–5 litres per user per day for pour-flush toilets
Anal washing	1–2 litres per person per day
Livestock	20–30 litres per large or medium animal per day 5 litres per small animal per day

D. Summary

- Addressing water supply in an emergency involves water quantity and access, water quality, water supply preparedness and protection.

- Developing an emergency water supply strategy can help. This involves determining the priorities, working on gradual improvement of water supplies, conducting assessment, monitoring and review, and promoting hygiene and participation.
- The Sphere Handbook outlines two standards related to water supply: Water Quantity and Access and Water Quality. They are supported with "M*inimum water quantities: survival figures and quantifying water needs*."

1.2 Conduct water supply needs assessment and prioritization in an emergency situation

A. Introduction

Water supply needs assessment involves identifying the quantity, quality, and access of the available water. Having these identified, one can be aware of the gaps and understand what improvements are needed to fill in the gaps. All aspects are essential and must be improved as soon as possible. But some water supply needs should be prioritized depending on the situation. The section focuses on water supply needs assessment and prioritization in an emergency.

B. Water Supply Needs Assessment

Water supply needs assessment looks into the population affected by insufficient or contaminated water supplies; the quantity of water required for various purposes (e.g., drinking, other household uses, agriculture, livestock, industrial uses); the frequency with which it will be needed; and any additional treatment, storage, and distribution facilities needed.

Figures 1 and 2 from WHO's Environmental Health in Emergencies and Disasters (2002) depicts a needs and resources assessment that addresses all of the general issues involved in planning an emergency water-supply system. The assessment depicted in Figure 2 was designed for emergencies. Still, something similar can be adapted for use in any country or region and can serve as a valuable guide for environmental health field teams.

Figure 2: Needs and resources assessment: general considerations for planning an emergency water-supply system (WHO, 2002).

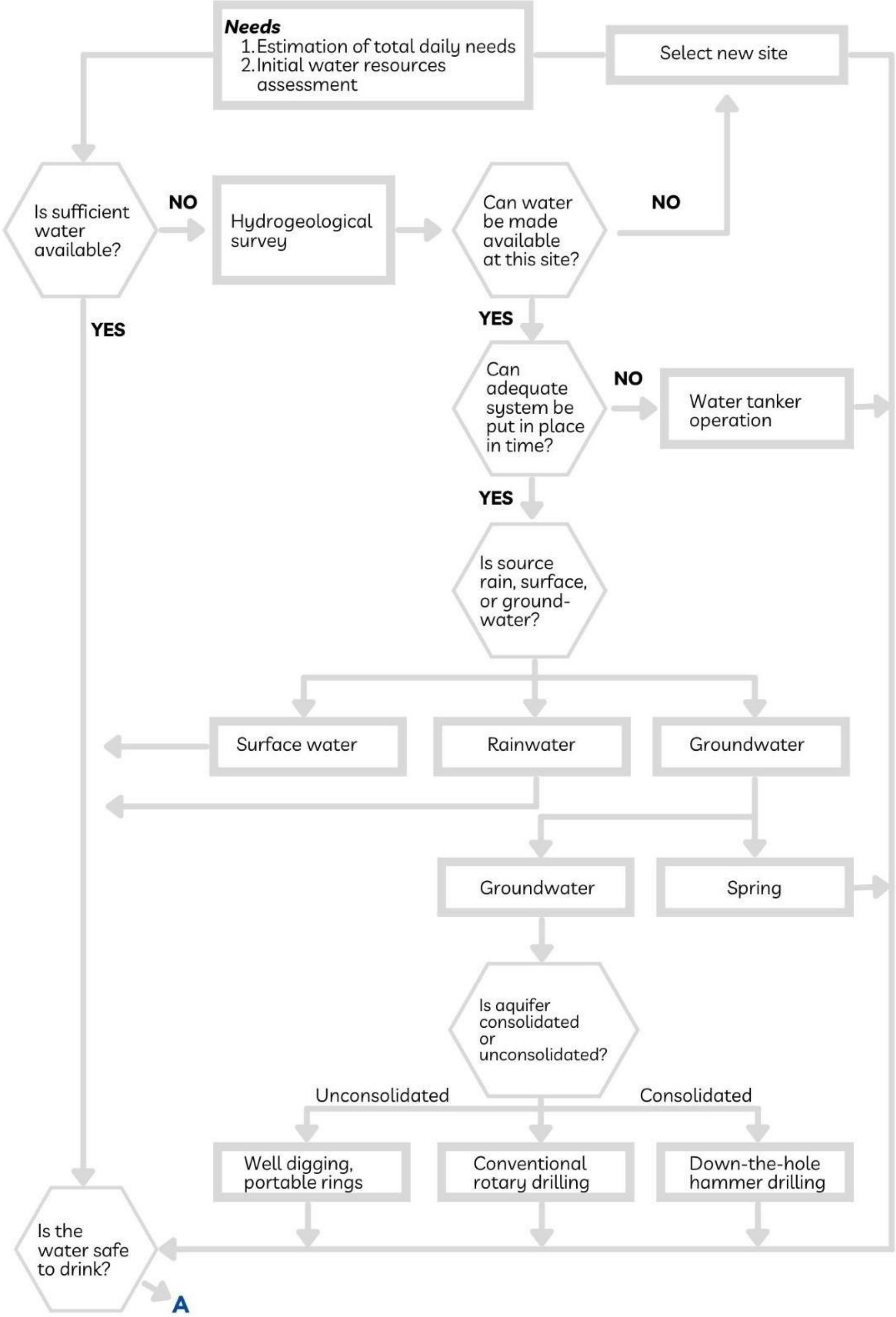
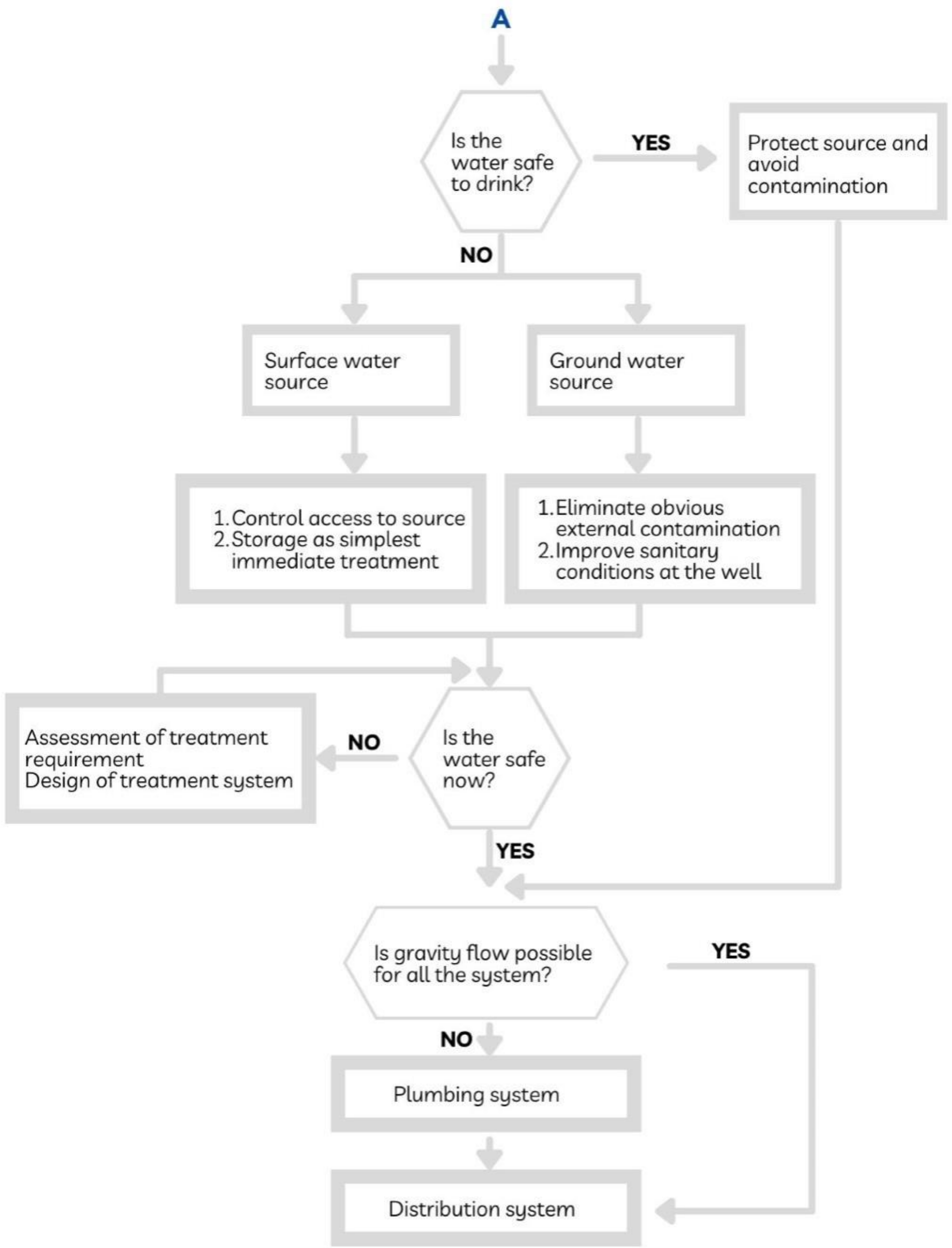


Figure 3: *Needs and resources assessment: general considerations for planning an emergency water-supply system (Continued) (WHO, 2002).*



Adopted from WHO (2002). *Environmental health in emergencies and disaster: Practical Guide.*

Needs and Standards

When planning an emergency response, it is critical to establish objectives based on general and specific needs. For many years, a number of agencies have used standards as general guidance in setting targets for emergency water supply interventions. For example, the [United Nations High Commissioner for Refugees (1992a)] establishes a minimum personal

allowance of water for drinking, cooking, and hygiene of 7 litres per day per person over a short emergency period. However, in most cases, water requirements are much higher, as shown below:

- for the general population: 15–20 litres per day per person
- for operating water-borne sewerage systems: 20–40 litres per day per person
- in mass feeding centres: 20–30 litres per day per person
- in field hospitals and first-aid stations: 40–60 litres per day per person
- in mosques: 5 litres per visitor
- for livestock accompanying displaced persons: 30 litres per day per cow or camel, and 15 litres per day per goat or another small animal.

The Sphere Project has identified widely accepted standards for emergency water supply. In addition to the 3–5 litres per person per day required for drinking and cooking, an adequate water supply is required to control the spread of water-washed diseases, even if the water supply fails to meet WHO drinking-water quality guidelines or national standards. The amount of water required by a community changes over time following a disaster. Following a typical urban disaster, there is a massive increase in water demand for firefighting. A gap between demand and supply capacity may occur when water stored in the treatment and supply system is depleted.

List of Questions Primarily Used to Assess Needs (regarding Water Supply) as adopted from The Sphere Handbook, 2018

- What is the current water supply source, and who are the present users?
- How much water is available per person per day?
- What is the daily and weekly frequency of the water supply availability?
- Is the water available at the source sufficient for short-term and longer-term needs for all groups?
- Are water collection points close enough to where people live? Are they safe?
- Is the current water supply reliable? How long will it last?
- Do people have enough water containers of the appropriate size and type (collection and storage)?
- Is the water source contaminated or at risk of contamination (microbiological, chemical or radiological)?
- Is there a water treatment system in place? Is treatment necessary? Is treatment possible? What treatment is necessary?
- Is disinfection necessary? Does the community have water palatability and acceptance associated with chlorine taste and smell?
- Are there alternative sources of water nearby?

- What are the traditional beliefs and practices relating to the collection, storage and use of water?
- Are there any obstacles to using the available water supply sources?
- Is it possible to move the population if water sources are inadequate?
- What are the alternatives if water sources are inadequate?
- Are there any traditional beliefs and practices related to hygiene (for example, the disease was associated with voodoo culture)? Are any of these beliefs or practices either useful or harmful?
- What are the key hygiene issues related to the water supply?
- Do people buy water? If so, where, at what cost and for what purposes? Has this access (the cost, quality, regularity of delivery) changed?
- Do people have the means to use water hygienically?
- Are waterpoints and laundry and bathing areas well drained?
- Are soil conditions suitable for on-site or off-site management of problem water from water points and laundry and bathing areas? Has a soil percolation test been carried out?
- In the event of rural displacement, what is the usual source of water for livestock?
- Will there be any environmental effects due to possible water supply intervention, abstraction and use of water sources?
- What other users are currently using the water sources? Is there a risk of conflict if the sources are utilised for new populations?
- What opportunities are there to collaborate with the private and/or public sector in water provision? What bottlenecks and opportunities exist that could inform the response analysis and recommendations?
- What are operation and maintenance duties necessary? Who shall be accountable for them? What capacity is there to fulfil them in the short and long term?
- Is there an existing or potential finance mechanism or system that can recover the operation and maintenance costs?
- How does the host population access to water and ensure that its water is safe at the point of use?

List of Questions Primarily Used to Assess Needs (regarding Water Supply) as adopted from UNHCR, 2015

Water availability

- Where are water supplies currently being collected (also note the origin, i.e., groundwater, surface water, rainwater)?
- How far are these water sources?
- Who owns these water sources?
- How many people are using them?

- Who takes care of these sources?
- What is the physical condition of these water sources?
- Are the water supplies protected from contamination?
- Is there sufficient yield/quantity?
- Is water available all day?
- Are the water supplies reliable?
- What do you feel needs to be done to improve these water sources?
- Are there any alternative water sources nearby?

Water quality

- Is there any water treatment infrastructure in place? Is it functioning?
- Are water supplies chlorinated?
- What do you think about the quality of the water (taste, smell, colour, contamination)?
- Does the yield or quality of the water change much during the year?
- What do you think can be done to improve the quality of the water?

Practices concerning water collection

- How much water is typically collected per household per day?
- Who is typically collecting the water?
- What containers are typically used for collection?

Household water treatment

- Do people practice any form of household water treatment (boiling, filtering, chlorination, disinfection)?
- What resources do people have for practising household water treatment?
- What do you think can improve water treatment at the household level?

Local water supply service providers

- Are there any water-related people (water technicians, handpump repair technicians, water quality officers)?
- Who is responsible for water supply within the displaced or host population?
- Can the organisations responsible for water supply cope?
- What resources (infrastructure/water tankers/staff) do they have?
- Do you have any suggestions for improving the water supply services supplied by local service providers?

General perceptions of water-related public health risks

- What are the most significant public health risks related to water supply?

- What do you feel are the solutions?

C. Water Supply Needs Prioritisation

It is critical to confirm that an effective consultation process took place. There was true collaboration and partnership with vital institutional players during the stakeholder engagement process in identifying the components that contribute to the development of the WASH Recovery Plan. The Recovery Plan must be consistent with any national recovery plans that are being developed in the aftermath of the disaster and any national development plans that are in place. The Recovery Plan must also align with the efforts of the local WASH sector's authorities and organisations. The local actors will ultimately be responsible for implementing the recovery strategy.

Similar to the PDNA recovery framework, the WASH sector recovery strategy should be formulated using the results-based model and thus include 1) **priority needs**; 2) interventions required; 3) expected outputs; 4) recovery costs; and 5) intended outcomes. The table below shows an example of how this can be accomplished.

Example of a Results-based Recovery Plan in WASH as adopted from UNDP Post-Disaster Needs Assessment (PDNA) Guidelines Volume B - Water & Sanitation (2014)

Table 7: Example of a WASH Results-based Recovery Plan

Priority Recovery Needs	Interventions	Expected Outputs	Recovery Costs	Intended Outcomes
To assist those affected by the disaster in X province with the rehabilitation of sanitation facilities	Supply construction materials and sanitation inputs Sanitation technical assistance Capacity building training support	468 latrines built 4 training centres were established, and 50 government staff trained 10 sewage facilities repaired	US$7,650,000	65,000 affected people have restored access to basic sanitation service delivery

Source: UNDP, 2014.

Sequencing Priority Needs

WASH recovery needs must be prioritised and sequenced (short-term, medium-term, and long-term, as appropriate). Priority should be given to

critical needs expressed by the affected population and government, vulnerable population groups, geographical areas most affected by conflict, and conflict prevention or peace-building objectives, where applicable. Criteria for prioritization may be developed by the sector WASH Team (or previously by the PDNA Team).

Time Frame: Short-, Medium-, and Long-Term Recovery
While there should be a smooth transition from emergency to recovery and development, a PDNA assessment must maintain a longer view of disaster recovery than a shorter response to an emergency. Data and information gathered must be allocated and used in accordance with either short-term or long-term objectives – or both. Initial goals are simple restoration of services for survival and health, which are typically addressed by humanitarian actions at the PDNA stage. Long-term goals will include improved healthcare services, nutritional security, and improved livelihoods, all of which will feed into a recovery strategy.

D. Summary

- Water supply needs assessment is important because it can help identify the population affected by insufficient or contaminated water supplies; the quantity of water required for various purposes (e.g., drinking, other household uses, agriculture, livestock, industrial uses); the frequency with which it will be needed; and any additional treatment, storage, and distribution facilities needed.
- The list of questions from the Sphere Handbook or UNHCR can assess water supply needs.
- Similar to the PDNA recovery framework, the WASH sector recovery strategy should be formulated using the results-based model and thus include 1) **priority needs**; 2) interventions required; 3) expected outputs; 4) recovery costs; and 5) intended outcomes. The table below shows an example of how this can be accomplished.
- WASH recovery needs must be prioritized and sequenced (short-term, medium-term, and long-term, as appropriate). Criteria for prioritization may be developed by the sector WASH Team (or previously by the PDNA Team).

1.3 Identify and analyse different elements and relevance of measures for water supply in emergencies

A. Introduction

Water supply measures can be tailored to the assigned area and available resources. Various options should be identified and thoroughly understood during an emergency. The elements of water supply measures in emergencies will be explained in this section.

B. Linkages Elements and Relevance of Measures for Water Supply

Water Sources

For large populations affected by disasters, what is usually required is a source of surface water that can be treated using tried, tested and available techniques and equipment to produce sufficient water of adequate quality. When choosing a water source, consider the following points:

- Water quantity and reliability
- Water quality
    - Four most essential measurements of raw water quality:
        - Turbidity
        - pH
        - Faecal contamination
        - Saltiness

The following are examples of water sources:

- **Surface water**

  Surface water in lakes, rivers, and streams is easily visible, measurable, and sampled for testing. Usually, you can learn a lot about its history, behaviour, who it belongs to, where it comes from, and where it goes. Surface water is immediately available for use. However, surface water is of questionable and variable quality — it should always be assumed to be contaminated — and the quantity available can also vary greatly.

  Information on surface water availability can be obtained from hydrological data, reports, and local information before going to the site. Locals may also be able to provide accurate information about seasonal

water availability. However, direct measurement is often the only way to know how much water is available. Large lakes, rivers, and streams may not need to be measured if they are present all year and do not dry up during the dry season. Small streams and springs should be measured with a bucket or a measuring weir to ensure enough water to meet demand. It is necessary to investigate the typical seasonal variations in flow. It may be necessary to rely on local knowledge of stream and spring flows in an emergency. Pump testing open wells can be used to determine yield.

A lot can be done to improve raw-water quality and make any treatment more effective and simpler by improving surface-water source protection. Options include pumping water from the source to a more distant point to avoid contamination by users; using physical protection, such as a jetty on a lake, to allow people to collect water without stepping in it; and organizing activities that take place in the water, such as laundry and bathing, in such a way that contamination upstream of the intake or point of collection is avoided; and locating and constructing intakes in such a way that the raw water is taken is of the highest possible quality.

- **Groundwater**
  Groundwater cannot be directly seen or measured. There is no direct way to judge how much water, if any, is available, for how long, and of what quality it is unless there are already developed and in use groundwater supplies at or near the site. It usually takes too long to assess, reach, and develop for use in the early stages of most emergencies. On the other hand, it is usually of very high biological quality and requires no treatment other than chlorination. Emergency water supplies are based on groundwater, the wells left behind when a disaster-affected community departs may provide long-term benefits to local people. Wells are an excellent water source for small groups of people.

Information on groundwater may be found from the following sources:

- ***Existing Information***: Previous records or nearby existing boreholes. These may provide information on expected yield and an indication of water quality.
- ***Groundwater Surveys***: A ground-water specialist may conduct an on-site survey, often using electrical resistivity equipment, to build up a picture of underground conditions and interpret this information to indicate the presence and likely quantities of water. A desk study could back up this information.

- ***Test or Production Drilling***: Very little can be said definitively about groundwater until it has been physically reached and extracted via drilling or digging. Test drilling with small-diameter boreholes, or even full-size production boreholes, may be the only way to determine whether enough water is available, whether it can be reached and extracted, and whether it is of suitable quality.
- Yield, pH, conductivity, and dissolved iron are critical measurements. If groundwater is to be used for an extended period, trace elements such as arsenic and fluoride should be tested.
- Options for reaching groundwater:
    - Drilling
    - Hand-drilled and jetted wells
    - Well digging

Water Quality and Testing

- **Important water quality criteria**

  In most emergencies, the transmission of faecal pathogens is the most significant water-borne risk to health due to inadequate sanitation, hygiene, and water source protection. Diarrhoea, typhoid, cholera, dysentery, and infectious hepatitis are waterborne diseases. However, some disasters, such as those involving damage to chemical and nuclear industrial installations or volcanic activity, may result in acute chemical or radiological water pollution problems.

  Whatever the source and type of contamination, determining acceptable water quality in an emergency requires balancing short- and long-term health risks and benefits. At the same time, ensuring adequate access to water is critical for health protection.

- **Bacteriological testing**

  The basic idea behind bacteriological testing is to find a “faecal indicator” organism that is continuously excreted by warm-blooded animals, both healthy and unhealthy, and use the degree of its presence to determine the level of faecal contamination. Bacteria from the thermotolerant (faecal) coliform group are almost always present in faeces, so their presence in water indicates faecal contamination. Most thermotolerant coliforms are typical of *Escherichia coli*, which is always derived from faeces.

  The membrane-filtration technique is typically used in field kits for bacteriological testing. A measured volume of water is filtered through

a membrane, which retains the bacteria on its surface. The membrane is then incubated for 18 hours on a suitable medium in a battery-powered incubator. This test is generally simple to carry out. High turbidity caused by clay, algae, and other particles (which may be suspended in large quantities after storms and floods) can interfere with the test. But because small volumes are frequently analysed in these conditions.

Membrane-filtration is an alternative to the multiple-tube method. Amounts of water to be tested are placed in tubes containing a suitable liquid culture medium and incubated for at least 24 hours. The bacteria in the water reproduce. The most likely number of bacteria present is calculated statistically based on the number of tubes that exhibit a positive reaction (colour change and/or gas production). This test can handle turbid samples containing sewage, sewage sludge, mud and soil particles, and so on.

- **Residual chlorine**
  Chlorine content should be tested in the field using a colour comparator in the 0.2–1mg/l range. The sense of taste does not provide a reliable indication of chlorine concentration.

- **pH**
  The pH of the water must be known because more alkaline water necessitates a longer contact time for adequate disinfection (0.4–0.5mg/l at pH 6–8, rising to 0.6mg/litre at pH 8–9, and may be ineffective above pH 9).

- **Turbidity**
  Turbidity has a negative impact on disinfection efficiency. It is simple to perform with a turbidity tube that allows direct reading in turbidity units (NTUs). Turbidity, also known as cloudiness, is measured to determine the type and level of treatment required.

- **Sanitary surveys and catchment mapping**
  A sanitary survey can be used to assess the likelihood of faecal contamination of water sources. This is frequently more valuable than bacteriological testing alone because a sanitary survey shows what needs to be done to protect the water source and because faecal contamination varies. A water sample only represents the quality of the water at the time it was collected. When combined with bacteriological, physical, and chemical testing, this process allows field teams to

assess contamination. It also provides a foundation for monitoring water supplies in the post-disaster period.

Even when bacteriological quality testing is possible, the results are not immediately available. Thus, the immediate assessment of contamination risk should be based on gross indicators such as proximity to faecal contamination sources (human or animal); colour and smell; the presence of dead fish or animals; the presence of foreign matter, such as ash or debris; and the presence of a chemical or radiation hazard or a wastewater discharge point upstream. Catchment mapping, which involves identifying pollution sources and pathways, can be a useful tool for determining the likelihood of a water source being contaminated.

It is critical to use a consistent reporting format for sanitary surveys and catchment mapping to ensure that information gathered by other staff is reliable. That data from different water sources can be compared.

- **Chemical and radiological guidelines**
  Water from sources thought to pose a significant risk of chemical or radiological contamination should be avoided, even if only temporarily.

- **Testing kits and laboratories**
  Water pH (acidity/alkalinity), free residual chlorine, faecal coliform bacteria count, turbidity, and filterability can all be determined using portable testing kits.

  When a large number of water samples need to be tested, or a wide range of parameters is of interest, laboratory analysis is usually the best option. If laboratories at water treatment plants, environmental health offices, and universities cannot function as a result of the disaster, a temporary laboratory may need to be established. Handling is critical when transporting samples to laboratories. Inadequate handling can result in meaningless or misleading results.

Water Treatment
Water treatment's primary goal is to remove and/or destroy disease-causing organisms (pathogens) in the water. Chlorine disinfection is frequently used in emergencies to kill microorganisms and add an extra layer of protection by leaving some disinfecting power in the water. Many pathogens in turbid water are closely associated with suspended solids, which must be removed by settling or filtration before the water can be effectively disinfected. This is true for most surface waters, which are the most used water source in large-scale

emergencies. The water should also have an acceptable taste, odour, and appearance to not drink from unsafe sources instead.

Treatment techniques used in emergencies should be dependable and tolerant of variable operating standards, capable of dealing with a wide range of raw-water qualities, simple to measure and monitor, rely on readily available resources and skills, and be inexpensive and effective. Examples of treatment techniques are as follow:

- **Water intakes:**
  The intake or point at which water is taken from a lake or river can be designed, located, and built to ensure the best quality water is abstracted for treatment.
- **Pre-treatment:**
  Before proceeding to the subsequent treatment processes described below, the raw water may be passed through a pre-treatment or roughing filter to remove some suspended solids. This makes the subsequent treatments faster, more effective, and less expensive.
- **Coagulation and flocculation:**
  Alum is the most used chemical for coagulation in an emergency (chemical dosing to encourage small particles in turbid water to agglomerate). It works best in the pH range of 6.0 to 7.5, and it may be necessary to adjust the pH with an acid or an alkali in waters outside of this range. Some agencies also use ferric salts, which are more effective over a more comprehensive pH range but are less widely available. Jar tests are performed on a treated water sample to determine how much alum should be added. The goal is to reduce turbidity to less than 5 NTU so that chlorination can occur.
- **Disinfection:**
  There are various disinfection methods available, including boiling, ultraviolet light treatment, and a variety of chemical methods. Chlorination is the most commonly used method for emergency work because it has the following advantages:
  - It kills pathogens in the water in a reasonable amount of time (Some helminth cysts and protozoa are chlorine resistant. The best way to deal with them is to improve water source protection).
  - It can function in a variety of temperatures and physical conditions.
  - It disinfects without causing any harm to humans.
  - It allows for the quick and straightforward measurement of water strength and concentration.
  - It maintains an adequate active residual concentration as a safeguard against post-treatment contamination.

- It is widely available at a reasonable cost.
- It can be safely transported, stored, and handled with only a few precautions.

- **Slow sand filtration:**
  To remove nearly all pathogens, slow sand filtration relies on the biological activity produced at the surface of a sand layer underwater. Slow sand filters can work in a variety of temperatures. They are effortless to operate and maintain once they are set up. It is a suitable method for more stable phases. They do not require any chemical inputs. The primary disadvantage of slow sand filters is their slow filtration rate (o.2m3/m2/hour). A filter area of 150m2 would be required for a population of 10,000 people consuming 15 leds, assuming operation 12 hours per day plus provision for cleaning filters. Building filters of this type takes time and space. Both of which are often in short supply during an emergency.

Packaged water-treatment systems are available for purchase: self-contained mobile units that take in raw water and produce high-quality drinking water. These are commonly used for military field supplies and hospital emergency supplies. Most systems are incapable of dealing with high-turbidity raw water. They are less adaptable to changing conditions than a collection of independent components combined in various ways. They are generally unable to produce the quantities of water required to supply populations of more than a few thousand people. They are not suitable as the primary water supply in large emergencies. But they can be used very successfully to supply water to field hospitals, feeding centres, or way stations.

Water Storage and Distribution

- **Storage capacity**
  Water storage is required for the treatment processes, controlling water distribution, providing water stock in the camps, and routine maintenance such as cleaning tanks. Plan for 12-24 hours of storage in a centralized water-supply system as a rough guideline, depending on the reliability of the supply. Allow 375 to 750m3 of storage for a settlement of 50,000 people, assuming 15 leds. If stored water is not distributed within a few hours of being chlorinated, the chlorine residual may become too low to continue disinfection. Allow enough space when installing storage and treatment tanks to allow for future tank additions if necessary. The storage capacity should be increased if the supply is unreliable.

- **Storage tanks**

There are numerous types of storage tanks available. Flexible bladder or pillow tanks and onion tanks made of reinforced PVC are the quickest to install. Onion tanks have the advantage of providing a relatively deep body of water for coagulation and sedimentation. Both types of tanks come in different sizes ranging from 2 to 30m3. These tanks are easily dismantled and moved during unstable situations. But they only last a few months unless they are well protected from the elements and wear and tear. Large tanks used in the water industry can be built with bolted steel or reinforced glass-fibre panels, but they require specialized and experienced personnel to construct correctly.

On-site tanks can be built with masonry, block or brickwork, reinforced concrete or Ferro-cement. This takes longer than assembling tank kits. Tanks with capacities greater than 5m3 require careful design and construction to ensure that they hold water and are not potentially dangerous.

Earth dams can be built to store large amounts of raw water as part of the treatment process. Temporary dams for water abstraction can be quickly constructed using stone, wood, and plastic sheeting. This will take months to complete and will necessitate specialized engineering skills and many workers or access to earth-moving equipment. Temporary tanks may be built-in desperate circumstances using holes in the ground, earth bunds, or timber and plastic sheeting. It is challenging to build in outlets and make such tanks watertight.

- **System design and installation**
  After the water has been treated, it must be placed within easy reach of users, or they will not be able to collect enough of it. A water source should be located within 500 meters of each shelter. The location of water points will be determined primarily by topographical and engineering constraints but should also consider users' advice. The opinions of users should be sought during planning and implementation. The distribution system should be designed to allow camp expansion and increased water consumption to avoid replacing or doubling up pipes later on. Aim for a system layout that provides 0.125 litres per second (7.5 litres per minute) at each tap.

  Use the ground slope where possible to achieve gravity flow at each tap-stand. Place pipes as close to a continuous slope as possible. In extremely hilly areas, air vents may be required to prevent air locks at high points, or tap-stands may be installed to act as venting points. A pressure-relief valve or a break-pressure tank may be required if the height difference between the tank outlet and the lowest taps is greater

than 40m. A platform for a storage tank or installing a pump in the distribution system may be required where the ground is very flat. The tank's minimum water level should be 2 meters above the tap. A simple branched distribution main is frequently used because it provides the best access to the water points for the length of pipe used. 32mm branch pipes should not be longer than 10m in length unless there is a lot of head available to keep friction losses to a minimum. A ring main allows flow in both directions - allowing all taps to be served even if part of the main is closed or blocked. Complex systems are developed in large camps or urban settings, significantly when the systems must grow to accommodate an expanding population.

Make sure that all agencies are aware of the water system plans. Please do not rely on other agencies to tell you where they intend to build health centres and other locations that will need to be linked to the distribution system ahead of time. It is usually necessary to pay them a visit, learn about their plans, and suggest alternatives if their preferred locations are difficult to reach with the distribution system.

The entire water system cannot be built overnight. Engineers should design to meet immediate needs but provide allowances for the final system layout.

- **Distribution equipment**
  - Standard equipment:
    - Emergency distribution equipment must be quick and straightforward to use and fitted with standard water fittings. It should also be robust and compatible with equipment from other agencies.
      - Pipe:
        - A flexible hose, either reinforced plastic or textile-based fire hose (lay-flat hose), may be used in an emergency. It is not usually buried because it is only temporary. This can be easily transported and set up in a matter of minutes. But it will only last a few months at most.
        - Pipe made of uPVC or polyethene (PE) is used in more permanent systems. uPVC pipe is less expensive to buy and much less expensive to airfreight than coils of PE pipe. It can usually be purchased locally and assembled quickly using the pipe's integral couplings. But uPVC pipe must be buried for protection and stability. PE pipe is more expensive because it comes in coils or straight lengths and must be joined with special compression couplings,

electrofusion couplings, or butt welding. During the early stages of an emergency, coils of PE pipe can be used to quickly install distribution mains, with compression couplings every 100 meters, without the need to bury the pipe right away.

- Where the ground conditions do not permit pipe burying, PE pipe can be laid on the surface because it is less brittle than uPVC pipe and is less prone to degradation due to ultraviolet light exposure.

- Taps:
  - In large-scale emergency water systems, tap-stands with multiple taps are typically used for distribution. Self-tapping ferrule straps and 32mm PE pipe connect the tap-stands to the distribution mains.
- Other fittings:
  - Bulk water meters on tank outlets help measure water supply when the system is used for an extended period. Pressure-reducing valves, check valves, and float valves may all be required to help the system operate.

Factors influencing the selection of drinking water during an emergency usually differ from those influencing the selection of “normal” water supply. The following are the most important determining factors for drinking water supplies during floods:

- the security situation regarding access to the area for national/international organisations and people's freedom of movement.
- Access to the area in terms of roads and topography.
- Socio-political, legal, and cultural constraints.
- Availability of water sources and their characteristics.
- Time is required to develop the water sources.
- Time is required to mobilize the necessary resources.
- Characteristics of the affected population (e.g., number of people displaced or not, the extent to which coping mechanisms are still in place).

The intervention's initial goal will be to quickly provide a survival supply of drinking water to keep drinking water-related morbidity and mortality rates among the affected population within acceptable limits. Work can begin establishing a longer-term supply to provide people with more sustainable (less expensive) and better drinking water facilities once the survival supply is established. If this is not possible, the affected population must be relocated to a more suitable location.

C. Summary

- Water sources, water quality and testing, water treatment, and water storage and distribution are among the main elements of water supply.
- Factors influencing the selection of drinking water during an emergency usually differ from those influencing the selection of "normal" water supply. The intervention's initial goal will be to quickly provide a survival supply of drinking water to keep drinking water-related morbidity and mortality rates among the affected population within acceptable limits.

1.4 Identify key aspects on operation and maintenance of water supply system and facilities for continued health benefits

A. Introduction

The term "operation" refers to the routine activities and procedures carried out to ensure that the water supply system functions appropriately. The activities that contribute to the operation of a water utility are carried out by technicians and engineers who control the system's functions. Maintenance refers to planned technical activities or activities performed in response to a breakdown to ensure that assets function correctly. There are two kinds of maintenance: *corrective or breakdown maintenance* and *preventive maintenance*. This section lists down the key aspects of the operation and maintenance of the water supply system and facilities.

B. Critical aspects on operation and maintenance of the water supply system

The nature and scope of the required operation and maintenance will vary depending on the design and elements of water-supply systems. Depending on the circumstances, field work may include:

- well, spring, or drainage basin inspection and maintenance
- dam and reservoir maintenance
- pump and engine operation and maintenance
- treatment operation

- distribution system maintenance
- service connections to the system
- meter repairs and maintenance
- operation in emergencies
- detection and elimination of cross-connections.

Most water system failures are caused by two significant factors: (1) equipment and materials used in conditions for which they were not designed; and (2) operators who, due to either ignorance or disinterest, fail to recognize the signs that precede or portend breakdowns and failures.

Equipment

The following recommendations are made for small water systems:

- Recommendations for operation and maintenance procedures should be strictly followed. They should be written in a way that the operators can easily understand. This is especially important when it comes to pumping equipment.
- Maintenance should be organised according to strict timetables. This includes greasing, oiling, inspections, adjustments, and minor repairs.
- A supervision system should be established to follow procedures and schedules.
- The manufacturer's lubrication recommendations for a specific piece of equipment must be followed.
- Ample space must be made available for equipment operators or maintenance personnel to work and store tools, spare parts, oil, grease, and other supplies.
- It is necessary to make plans for establishing adequately equipped workshops.

The following major field equipment will be helpful depending on the scope of the water system:

- Dump truck(s) for transporting pipes no larger than 25 cm (10 in.)
- A pavement breaker, an air compressor as well as air hammers
- Ditch pumps (at least two of them) with 3.6-m (12-ft) hoses to keep trenches dry while working
- Electric generators with two floodlights and extension cords for night-time emergency work
- A small crane capable of turning 180 degrees and handling up to 2.5 metric tons (3 tons), with pneumatic tires and a ball-bearing swivel safety hook. A crane is not required for handling pipes with diameters less than 15 cm (6 in.). But it is helpful for handling, turning, and lowering pipes with larger diameters.

Distribution System

The operation and maintenance of a distribution system necessitate the creation of system maps and records. The system map should be drawn on a large scale, preferably 1:10,000. The map will ideally include information about the streets, their names, mains, sizes and locations. It should also identify valves and hydrants, reservoirs, elevated tanks, and supply sources. The same map can be divided into sections and bound for handling in the field.

Valve records are required in addition to the system map (except in minimal water supplies) to show their exact location, numbering, and any specific reference regarding their operation. These records are helpful when valve boxes and cones have been hidden or "lost" because of street repairs or construction. These systems can take the form of separate large-scale drawings, each for a single valve, then stored in a loose-leaf binder for easy reference.

Cross-Connections

There are numerous opportunities for direct cross-connections between public water supplies and private cisterns and wells in small community water systems. When domestic plumbing systems are not properly built, there is always the risk of contaminated water back-siphoning into public distribution pipes from lavatory washbasins, water closets, and so on. It is not uncommon for the positive pressure in the main pipe to suddenly drop to zero or even become negative when there is an accident, fire demand, leaking valves, or some human error in operation.

Sanitary engineers are well-versed in the various types of cross-connections and the public health risks associated with them. There have been numerous reports in the literature of water-borne epidemics caused by unintentional cross-connections. Small water-system field personnel should be aware of the danger. While they are not usually responsible for inspecting house plumbing, the field service should be prepared to advise and assist customers in eliminating such plumbing defects.

Cross-connections should be avoided. Special requests from industries or neighbouring public water systems, for example, for connections of their water pipes with the town's distribution system, should be carefully reviewed by competent public health or water engineers acting on behalf of or attached to the controlling health administration.

C. Summary

- The term "operation" refers to the routine activities and procedures carried out to ensure that the water supply system functions appropriately.
- Maintenance refers to planned technical activities or activities performed in response to a breakdown to ensure that assets function correctly. There are two kinds of maintenance: *corrective or breakdown maintenance* and *preventive maintenance*.
- Most water system failures are caused by two significant factors: (1) equipment and materials used in conditions for which they were not designed; and (2) operators who, due to either ignorance or disinterest, fail to recognize the signs that precede or portend breakdowns and failures.
- The operation and maintenance of a distribution system necessitate the creation of system maps and records.
- Cross-connections should be avoided. If not possible, engineers should assess the public health risks.

1.5 Identify key aspects on operation and maintenance of water supply system and facilities for continued health benefits

A. Introduction

Although even the same type of emergency has different impacts and situations, it may be worthwhile to learn from other interventions and make attempts to apply recommended good practices. This section aims to offer several examples of lessons learned and good practices. In some cases, these examples may be suitable. In other cases, they may not. Remember to analyse them carefully and thoroughly before deciding if it is appropriate to adopt them.

B. Learning and Good Practices on Water Supply Measures in Different Types of Emergencies

Provisions should be made to ensure that people who have lost possessions and possibly livelihoods can continue to have access to water, even if they cannot afford to buy it. Water distribution networks should be repaired as soon as possible after the emergency, and normal water supplies should be

restored. Normal municipal water supplies should be made available as soon as possible. More expensive temporary water supplies should not be used for any longer than is necessary.

Accurate maps of water supply system facilities should be kept on hand to familiarise local and international staff with water distribution systems and other WASH facilities. This is especially important in a city setting.

A list of people with relevant specialist skills should be kept on hand to be called on in the event of a disaster. Repairing or reinstalling pumping equipment, for example, is a top priority. This necessitates the use of skilled electro-mechanical engineers.

After an emergency, wells and boreholes should be rehabilitated and returned to service as soon as possible. Temporary facilities should be safe and meet the same standards as permanent facilities. Two examples to demonstrate the importance of adopting safe practices are:

- Heavy bladder tanks used as water reservoirs should be supported on structures capable of bearing the considerable weight of the tanks when filled with water.
- Temporary water distribution pipes should not be placed in or near drainage channels because they will likely be damaged or allow contamination to enter the pipe.

Flood

Good Practice: Water Supply Tanks Disinfection.
Alternative water supply tanks should be disinfected for 24 hours with a chlorine solution (for example, 14 per cent sodium hypochlorite solution), rinsed (with safe, potable water), and refilled with a safe water supply. After about 30 minutes, a sample of the tank contents should be taken to ensure a safe supply to consumers. The water must meet all local drinking-water quality requirements applicable to the supply method (and advice given to consumers).

Good Practice: Regaining Drinking-Water Supply Systems
When restoring drinking-water supplies following a flood, water suppliers must collaborate closely with community leaders and local health professionals/health departments, particularly regarding any precautionary measures taken before consumption of supplied water (e.g., boiling it before use).

As a general rule, water suppliers should prioritize the use of groundwater/well water where it is well protected (i.e., where it comes from a confined or well-protected aquifer) over water taken from rivers or lakes (surface water). This is due to the fact that the contamination impact on surface water will most likely be much more significant. This will, however, vary depending on local circumstances, and a risk assessment based on local knowledge of source waters should be used to prioritize their use for treatment and supply as drinking water.

Before restarting, flooded treatment plants and distribution network disinfection necessitate a number of planned actions that must be implemented and tailored for centralized, decentralized, and community-based production utilities.

Lesson Learned:
Environmental Health Aspects of Flooded Karstic Drinking-Water Resources, Hungary

A Hungarian city's (Miskolc) water supply is primarily on sensitive karst water springs. A massive amount of rain fell on the water source's catchment area, resulting in unusually strong water flow and flooding. Microbiological contamination from several potential sources in the water's protecting zone washed into wells and water mains, causing an outbreak. Out of the 60 000 people living in the water supply zone, 3673 became ill, and 161 were hospitalized. Public health intervention and hygienic measures were implemented, with a focus on:

- safeguarding the health of people by providing safe drinking water
- identifying the contamination; and
- implementing risk-reduction and preventive measures

Lesson Learned:
Recovering Water Supply System After Floods, England, 2007.

In June and July 2007, extreme rainfall following a prolonged wet period caused unprecedented flooding in England and Wales. This caused significant disruption to essential services such as transportation, electricity, and the provision of water and sanitation. Floodwater levels were significantly higher than previously experienced and exceeded the levels planned for in many cases.

Over 300 sewage treatment works were flooded, and six water treatment works (WTWs) were forced to close due to the flooding, including Mythe WTW, the only source of piped drinking water for 340.000 Gloucestershire residents. Mobile tankers, temporary tanks (bowsers) in the streets and bottled water were used to provide alternative water supplies. It took 16 days to restore the piped water supply fully.

Although no direct health effects were reported due to the water supply interruption, it demonstrated the importance of a holistic (water safety plan) approach to risk management throughout the water supply system.
Existing plans to shut down the WTW during flood events aided in restoring WTW operations. Existing regulations to prevent significant contamination of depressurized water mains effectively lowered consumer risks when water supplies were restored.

The recovery of the piped water supply was hampered by other agencies responding with a lack of understanding of the role and responsibilities of water suppliers. Consumers were also initially given incorrect water consumption advice due to a lack of understanding of risk management in water supply operations.

Even though a flood plan was in place at the site, the events of summer 2007 were more severe than the water supplier had anticipated. There is a need to rethink vulnerability assessments to account for more extreme events. As a result, understanding and knowledge of the roles and responsibilities of responding organisations are highlighted as a critical learning point from this incident.

Drought

Good Practice:
Demand Management

Demand management is one method for addressing the issue of water scarcity. Technological solutions have their limitations, and technical advancements are frequently insufficient on their own. It is also necessary to change people's perspectives, behaviour patterns, and municipal policies for water resources to be used and managed more efficiently. This can happen over time, for example, through proactive consumer education. But it is often part of emergency response during a major event.

Water suppliers' roles should be central in reducing water consumption at the local level. This can be accomplished through either voluntary measures or supply restrictions.

During times of scarcity, demand may rise as consumers with consistent consumption patterns (e.g., some industrial users) continue to use water, while others (e.g., farmers using irrigation or households) increase their consumption in an attempt to maintain their way of life in non-drought conditions. Given the associated weather conditions, consumers may increase their outdoor activities and associated water uses (swimming pools or irrigating crops).

See Recommended Readings for “Options for demand management” (pg. 71).

Good Practice:
Regaining Drinking-Water Supply Systems

Reservoir managers should ensure that raw water storage reservoirs are replenished in a controlled manner so that the quality of water being abstracted for treatment is not harmed. For example, allow the reservoir to replenish only at a specific rate to avoid the disturbance of excessive sediment or ensure the adequate dilution of a poor-quality source.

Suppliers should also consider the impact on the aquatic system downstream of the reservoir and the needs of other downstream abstractors. However, the safety and security of drinking-water supplies should always take precedence.

Suppliers should also be aware that changes during a drought period may cause some deterioration in raw water quality several months or years later. Water colouration from upland catchments containing peat soils, for example, has been observed to increase

significantly in summers following a previous drought period (due to naturally occurring humid acids). Ongoing risk assessment from catchment areas, informed by local knowledge of catchment hazards, is critical in the post-recovery period.

Extreme Weather

Lesson Learned:
Water Supply Problems in the Case of Power Cuts Caused by Extreme Weather Conditions, Hungary

On 27 January 2009, a Mediterranean cyclone brought significant precipitation in the form of snow to Hungary's west Transdanubia region. A large amount of snow froze on (mostly medium voltage) network cables, causing them to be damaged by their weight and the accompanying strong wind, resulting in widespread power outages. The outage affected 34 settlements and 89.000 customers. Because of the power outage, the electrical pumps and equipment of both the water utilities and the WWTPs ceased to function due to a shortage of emergency power generators with the required capacity. The pressure in the water supply systems dropped and varied dramatically. Not so much the stagnant water in the piped distribution systems as the possibility of groundwater and wastewater feeding back into the water pipes caused the most concern in terms of public health. In accordance with the provisions of Government Decree 201/2001 (X. 25.) on the quality requirements of drinking water and the associated control procedures, the municipality and the water supply company informed the population that, on the recommendation of the National Public Health and Medical Officer Service (NPHMOS), any water intended for drinking or cooking should be boiled until the water pressure was fully stabilised. Water tankers had to be used in several settlements to ensure adequate water supply, which proved difficult in the snowy conditions. The measure remained effective until negative bacteriology resulted in water samples taken after water pressure stabilization confirmed the restoration of the water supply.

The restoration operation took more than 72 hours due to the challenging ground conditions. Both water supply and wastewater treatment are critical for public health, as their absence can pose a significant health risk. An essential factor in the vulnerability assessment is providing an adequate backup power supply based on a sufficient number and capacity of emergency generators to cover for power outages caused by extreme weather conditions.

C. Summary

- Some general examples of good practices on water supply are:
  - Water distribution networks should be repaired as soon as possible after the emergency, and normal water supplies should be restored.
  - Normal municipal water supplies should be made available as soon as possible.
  - Provisions should be made to ensure that people who have lost possessions and possibly livelihoods can continue to have access to water even if they cannot afford to buy it.
  - Accurate maps of water supply system facilities should be kept on hand at all times.

- Temporary facilities should be safe and meet the same standards as permanent facilities. Two examples to demonstrate the importance of adopting safe practices are:
    - Heavy bladder tanks used as water reservoirs should be supported on structures capable of bearing the considerable weight of the tanks when filled with water.
    - Temporary water distribution pipes should not be placed in or near drainage channels because they will likely be damaged or allow contamination to enter the pipe.
- In some cases, adopting good practices are suitable. In other cases, they may not. Remember to analyse them carefully and thoroughly before deciding if it is appropriate to adopt them.

4.2 Element 2. Provide technical guidance on excreta disposal

2.1 Identify and analyse standards related to safe sanitation on health risks in an emergency

A. Introduction

Understanding the health risks of sanitation in an emergency is essential to taking the correct measures, especially in handling excreta disposal. Measures on sanitation in an emergency should also follow the available standard to meet the affected community's demands best.

B. Sanitation health risks in an emergency

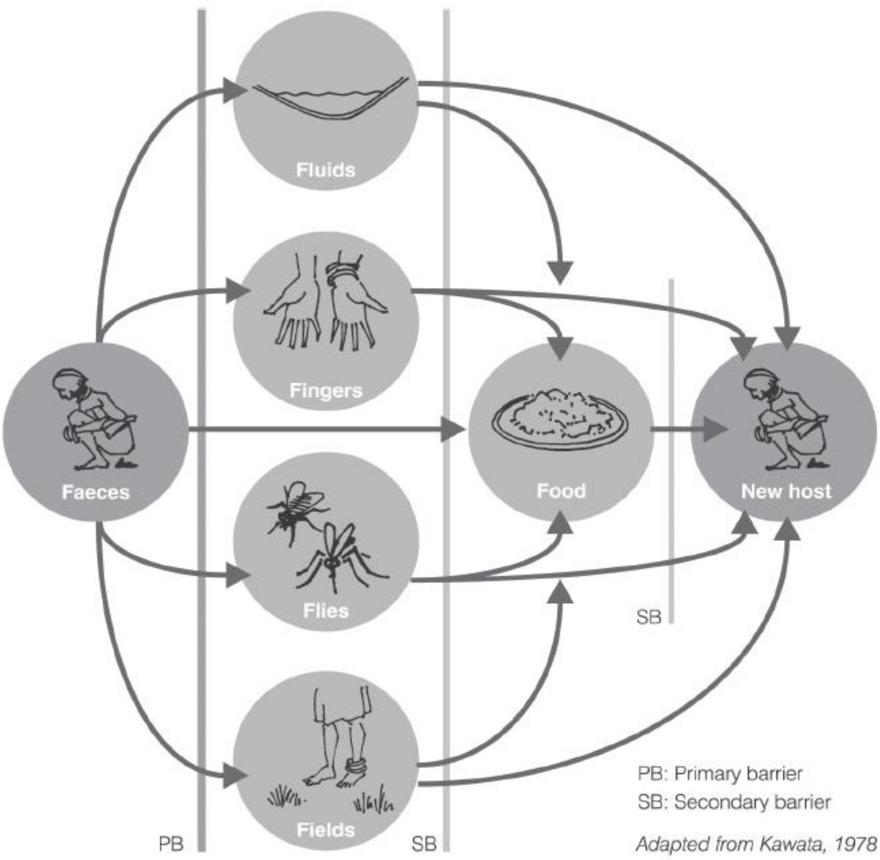
Faeces
Viruses, bacteria, and parasites' eggs or larvae that come from human faeces could cause various diseases. These microorganisms may enter the human body through contaminated food, water, eating and cooking utensils. This is how diseases like diarrhoea, cholera, and typhoid spread and are significant causes of illness and mortality in disasters and emergencies.

While some fly species (and cockroaches) are attracted to or reproduce in faeces, there is little evidence that this significantly contributes to disease transmission. High fly populations increase the risk of trachoma and shigella dysentery transmission.

Faeces-contaminated soil could transmit intestinal worm infections (hookworm, whipworm, and others). The transmission could occur rapidly where open defecation exists and people are barefoot. These infections will increase the risk of anaemia and malnutrition, making people more vulnerable to other illnesses.

The most vulnerable group at risk from infectious diseases are children under five years of age because of the undeveloped immune systems. Malnutrition caused by food insecurity and repeated emergencies would exacerbate the risk. Faeces must remain securely contained because young children are unaware of the risks of contact with faeces. The figure below illustrates the potential transmission routes for pathogens found in faeces.

Figure 4: Faecal-oral transmission routes



(Source: Harvey, 2009)

Urine

Urine is usually harmless unless in areas where the urinary form of schistosomiasis is present. This parasitic infection, caused by Schistosoma haematobium, resides in the veins around the bladder, and its eggs are excreted with urine. Urinating in water bodies should be prevented in some of these places. Otherwise, indiscriminate urination is not a health risk.

Sullage
Sullage is the wastewater from kitchens, bathrooms, and laundries. It could contain pathogens, mainly when it fills poorly drained places and causes pools of organically polluted water. Those places can become the breeding places for *Culex* mosquitoes. This genus of mosquitoes transmits some viruses and the parasitic disease lymphatic filariasis. Mosquitoes that transmit malaria do not breed in polluted water.

Hygiene behaviour
Hygiene behaviour directly impacts the connections between sanitation, water supply, and health. It is important to bear this in mind when considering technical options. Facilities provided in emergencies should be acceptable to the users and can be utilized and maintained hygienically.

C. Standards related to safe sanitation in emergency

Standards related to safe sanitation in an emergency are addressed in the Sphere standard. Sanitation-related standards for excreta management are divided into three elements. Please look up the Sphere Standard for detailed descriptions of the standards.

Table 8: Sphere standards for excreta management

Excreta management	
Standard 3.1 Environment is free from human excreta	All excreta is safely contained on-site to avoid contamination of the natural, living, learning, working and communal environments.
Standard 3.2 Access to and use of toilets	People have adequate, appropriate and acceptable toilets to allow rapid, safe and secure access at all times.
Standard 3.3 Management and maintenance of excreta collection, transport, disposal and treatment	Excreta management facilities, infrastructures and systems are safely managed and maintained to ensure service provision and minimum impact on the surrounding environment.

(Souce: Sphere, 2018)

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D. Summary

- Sanitation aspects related to health risks include faeces, urine, sullage, and hygiene behaviour.
- Sphere standards for excreta management include the safe containment of all excreta, adequate access of safe toilets, and safe management and maintenance of excreta management systems.

2.2 Conduct sanitation needs assessment and prioritization in an emergency situation

A. Introduction

One of the duties of WASH engineers before selecting the best sanitation technology is to recognize the community's needs. This element will guide engineers on what and how to assess and prioritize sanitation needs in an emergency.

B. Sanitation needs assessment

Quantifying the toilet needs of affected people based on public health risks, cultural practices, available water collection, and storage is one of the most essential steps in ensuring sanitation facilities are available to affected communities. The recommended ratio of toilets to people is one per 50 persons in the early stage of an emergency, which should be improved to one per 20 persons for the longer term. Ideally, there's one toilet accessible for every family. The toilet access issue concerns the numbers provided and how the access is organised. The goal is for everyone, regardless of age, sex, or physical abilities, to be able to use a toilet that they'd like to use that's convenient, hygienic, and safe.

Moreover, the existing religion or cultural norms should also be considered. For example, in Indonesia, where the majority population is Muslim, there are regulations to strictly separate the latrines for men and women. There is also water needed for ablation.

Further descriptions about toilet access can be looked up in the Sphere Standards.

Table 9: Minimum number of toilets

Location	Short term	Medium and long term
Community	1 toilet for 50 persons (communal)	1 toilet for 20 persons (shared family) 1 toilet for 5 persons or 1 family
Market areas	1 toilet for 50 stalls	1 toilet for 20 stalls
Hospitals/medical centres	1 toilet for 20 beds or 50 outpatients	1 toilet for 10 beds or 20 outpatients
Feeding centres	1 toilet for 50 adults 1 toilet for 20 children	1 toilet for 20 adults 1 toilet for 10 children
Reception/transit centres	1 toilet for 50 individuals 3:1 female for male	
Schools	1 toilet for 30 girls 1 toilet for 60 boys	1 toilet for 30 girls 1 toilet for 60 boys
Offices		1 toilet for 20 staff

(Source: Sphere, 2018)

Below is how sanitation needs should be assessed in different emergency settings.

Urban situations with existing facilities

The assessment of health risks from damaged sanitation systems requires a sanitary survey. An inspection of the sewage system, in particular, is necessary as soon as possible after emergency relief has been delivered. The gathered information should include the number of obstructions in sewer lines, the lengths and sizes of pipes that need to be replaced, and the needed equipment such as pumps, bulldozers, excavators, trucks, tools, and construction materials etc. Initial estimation is also required to measure equipment, materials, and labour needs to restore sewage-treatment plants and pumping stations to work properly.

In the suburban areas where onsite sanitation is typical, the assessment should identify the number of households without functioning toilets, the current adjustments by the affected families for excreta disposal (including the

use of neighbour's toilets), and requirements for immediate and post-emergency actions.

Displacement emergencies

The assessment process should be different in displacement emergencies because the affected people are likely to find themselves in unfamiliar situations. There is a significant loss of social cohesion. Key information includes the number of affected people and their population movements; existing excreta disposal arrangements; pre-disaster excreta disposal practices; ground conditions; availability of construction materials and tools; the workload and labour availability of the affected population; the water supply and drainage situation; the general health of the displaced population; and the incidence and/or risk of excreta-related diseases.

To help sanitation engineers assess sanitation's existing condition and emergency needs, twenty questions adapted from A Field Manual of Excreta Disposal in Emergencies below can be utilized. These questions are still very general and need to be adapted to the emergency setting.

Table 10: Twenty questions for sanitation assessment

Sanitation Rapid Assessment
1. What is the estimated population, and what is the population density? 2. What are the crude mortality rate (number of deaths per 10,000 people per day) and the main causes of mortality and morbidity? 3. How did people dispose of excreta before the emergency? What are the current beliefs and traditions concerning excreta disposal, especially regarding women and children's excreta? (do men and women or all family members share latrines, can women be seen walking to a latrine, do children use potties, is children's excreta thought to be safe?) 4. Will people who traditionally use water-seal latrines accept direct-drop dry systems in the short term? Is there sufficient water available for water-seal latrines to be provided? 5. What material/water is used for anal cleansing? Is it available? Is soap available? 6. Are there any existing facilities? If so, are they used, are they sufficient, and are they operating successfully? Can they be extended or adapted? Do all groups have equal access to these facilities? 7. Are the current defecation practices a threat to health? If so, how? 8. What is the current level of awareness of public health risks? 9. Are there any public health promotion activities taking place? Who is involved in these activities? 10. What are health promotion media available/accessible to the affected population? 11. Are men, women and children prepared to use defecation fields, communal latrines or family latrines? Consult people with disabilities and those who are elderly. 12. Is there sufficient space for defecation fields, pit latrine etc.?

13. What are the topography and drainage patterns of the area?
14. What is the depth and permeability of the soil, and can it be dug easily?
15. What is the level of the groundwater table?
16. What local materials are available for constructing latrines?
17. Are there any people familiar with the construction of latrines?
18. How do women deal with menstruation? Are there materials or facilities they need for this?
19. When does the seasonal rainfall occur?
20. Whose role is it normally to construct, pay for, maintain and clean a latrine (men, women, or both)?

(Source: Harvey, 2009)

C. Sanitation needs prioritisation

Priority-setting depends on the phase of the emergency. The WASH team may create criteria to guide the prioritizing process. This should contain critical needs voiced by the affected people and government, of vulnerable population groups and geographical areas most affected by conflict. These should also be based on the key public health risks that affect the communities, which eventually determine immediate and chronic needs.

At the beginning of facilities construction, tension might occur to meet urgent needs in high-risk situations. The consultation and stakeholder engagement process is necessary to assess the sanitation priority needs and preferences. Needs and priorities will be context-specific. Some actions may begin simultaneously or may need to extend in the next phase. Below are some examples of actions that are generally done in the early phase:

- The sanitation team should obtain information about which excreta disposal system is the most appropriate and where facilities should be located. As soon as possible, find out the social norms and preferences that should be adapted into the construction plans.
- If appropriate, build shallow trench defecation enclosures immediately in the time of early planning for communal or family toilet construction.
- Discuss with public health promoters whether dedicated facilities for children are needed.
- Dig several trial pits around the camp to determine soil stability and permeability, bedrock depth, and the water table. This would decide the appropriate constructions, whether they’re lined or unlined pits, raised latrines or septic tanks, small sewage systems or small treatment systems.

- It is also important to consider whether it is possible to upgrade any existing sanitation facilities in the location.

D. Summary

- Sanitation needs assessment is used to determine the adequate number of accessible toilets. It is also used to understand whether planned facilities are appropriate and acceptable to the affected communities.
- Sanitation needs prioritization is primarily determined based on the existing health risks in different phases of an emergency.

2.3 Identify and analyse different elements and relevance of measures for excreta disposal in emergencies

A. Introduction

There are many kinds of excreta disposal technology. This section describes what kinds of technology are commonly used and the considerations.

B. Choosing the appropriate excreta disposal management technology

The considerations for choosing excreta disposal management technology include the current situation, technical, environmental, social and governmental issues. Selecting appropriate interventions must also involve the affected communities and stakeholders. Consultations and assessments are essential to ensure the options will be accepted and used by the affected community.

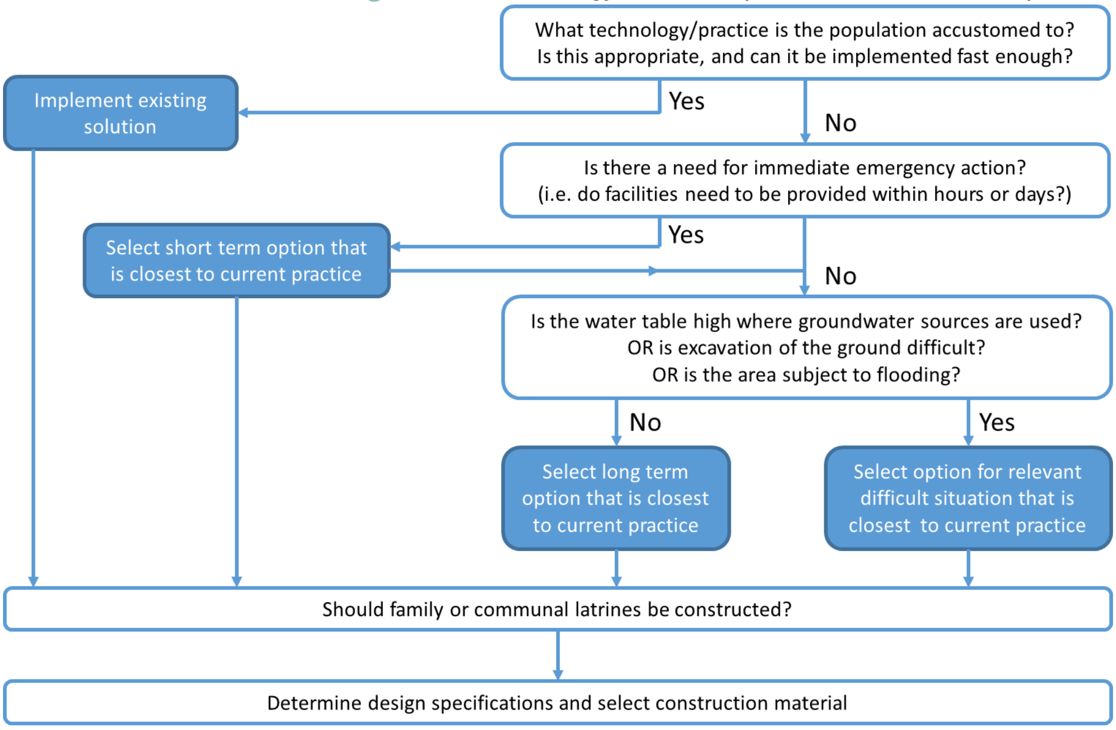
Criteria of considering appropriate technologies:

- Cultural practices/preferences

- Available space
- Ground conditions
- Time constraints
- Availability of resources
- Operation and maintenance
- Financial constraints

The diagram below is a simplified technology-selection process for excreta disposal adapted from A Field Manual of Excreta Disposal in Emergencies.

Figure 5: Technology selection process for excreta disposal



(Source: Harvey, 2009)

C. Excreta disposal technical options

The elements of excreta management follow the movement of the waste: excreta containment, collection, transport, treatment, and reuse or disposal. In an emergency setting, sanitation intervention is almost similar. Technical options vary according to the phases and situation of emergency.

D. Immediate measures and short term technical options

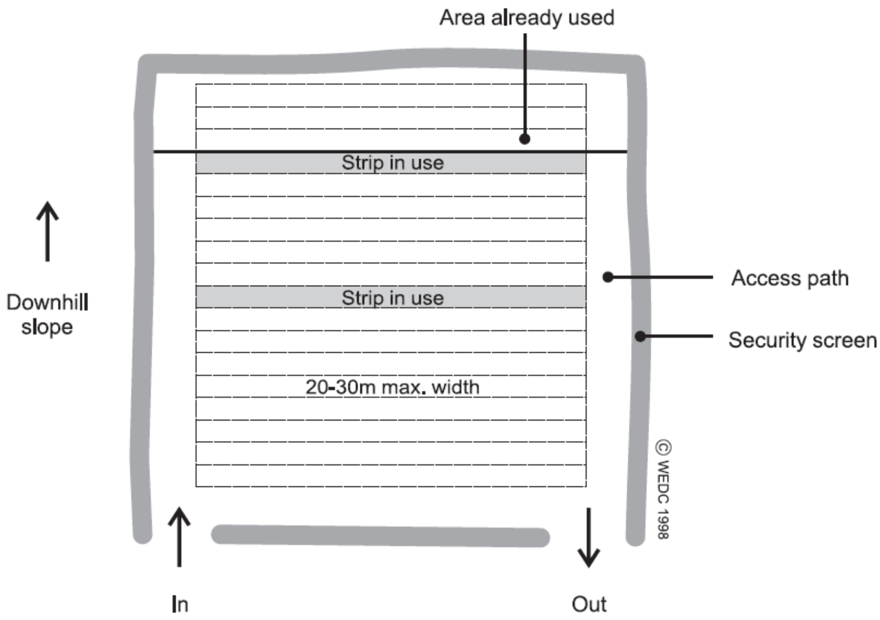
Clearing of scattered excreta

The immediate measures where indiscriminate open defecation is practised is to clear scattered faeces and provide designated defecation sites. This is unpleasant work, and finding willing and appropriate staff in some cultures may be challenging. But it is necessary to prevent the transmission of faecal-oral disease. The scattered excreta can be coated with lime and sent to a safe disposal site such as a pit. The people responsible for doing the job must wear protective wear and use the appropriate tool.

Controlled open field defecation

Controlled open field defecation can be a solution when resources are very limited. The areas should not be near water and food sources to prevent contamination. People should be encouraged to use one strip of land at a time and used areas must be marked. Mesh barriers may be set up with division ties for each sex.

Figure 6: Open defecation field.'



(Source: Harvey, 2002)

Defecation areas must be:

- Far from water storage and treatment facilities
- At least 50 m from water sources
- Downhill of settlements and water sources
- Far from public buildings or roads
- Not in field crops grown for human consumption
- Far from food storage or preparation areas.

Table 11: Advantages and disadvantages of open defecation field

Advantages	Constraints
• Rapid to implement • Minimal resources required • Minimises indiscriminate open defecation	• Lack of privacy • Considerable space is required • Difficult to manage • Potential for cross-contamination of users • Better suited to hot, dry climates

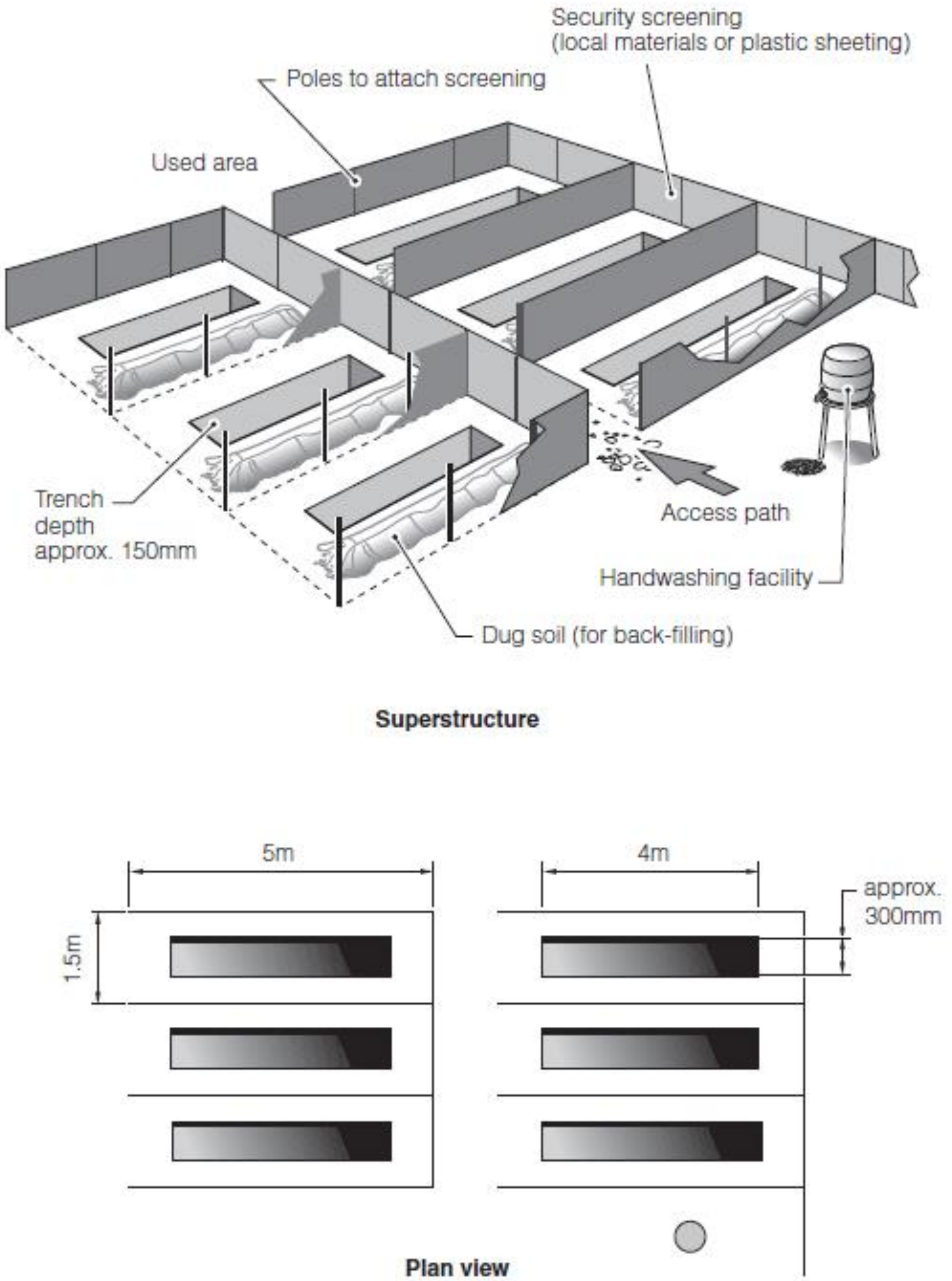
Shallow trench latrines

To reduce faecal-oral contamination risks and increase the hygiene and convenience of open defecation, shallow trenches can be a small upgrade. These shallow trenches would allow people who defecate to cover their faeces. Trenches need only be 200-300 mm wide and 150 mm deep. Shovels may be provided to allow each user to cover their excreta with soil.

Each latrine area can be divided into 1.5 m strips with access paths. The furthest strip from the entrance must be used first. When a section of the trench has its bottom layer fully covered with excreta, the next section can be used. Only short lengths of the trench should be opened for use at any one time to encourage the full utilization of the trench in a short time. It may be appropriate to have a number of trenches open simultaneously. Men's and women's areas should always be separated. A rule of thumb is to allow 0.25 m2 per 10,000 people per day or nearly two hectares per week.

Put plastic sheeting or bamboo-mat barriers as high as a standing human to gain greater privacy.

Figure 7: Shallow trench latrine



(Source: Harvey, 2009)

Table 12: Advantages and disadvantages of a shallow trench latrine

Advantages	Constraints
• Rapid to implement (one worker can dig 50 m of trench per day)	• Limited privacy • Short life-span

• Faeces can be covered easily with soil	• Considerable space required

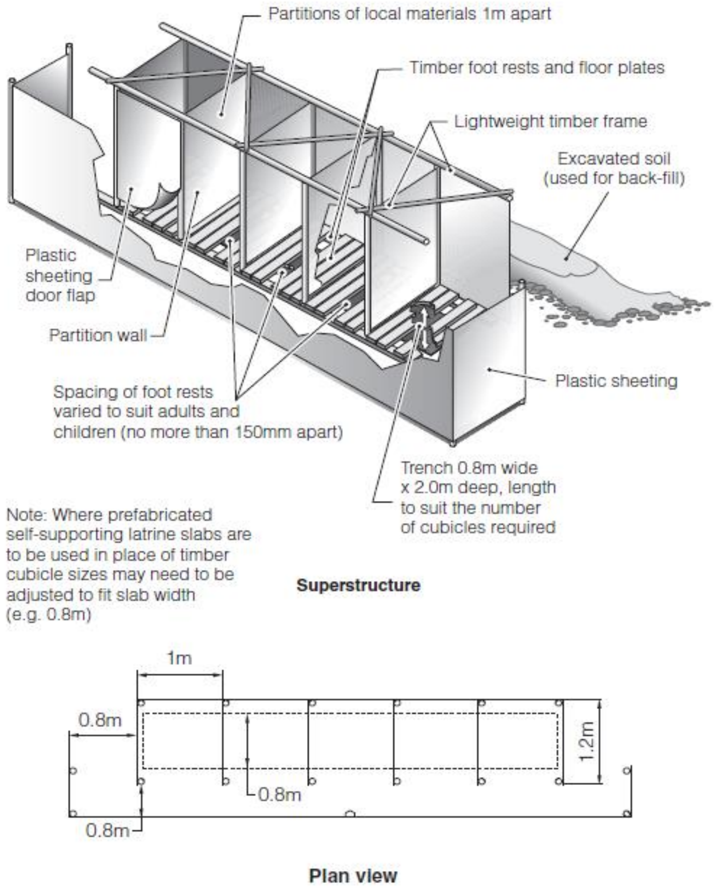
(Source: Harvey, 2009)

Deep trench latrines

Deep trench latrines are frequently built in the early disaster recovery phase and are acceptable if equipment, materials, and human resources are available. These include the placement of several compartments over single excreta collecting trench. Caution should be taken in providing too many latrines side by side. The recommended maximum length of trench is 6 m, providing six cubicles.

Trenches should be 0.8-0.9 m wide at least the top 0.5 m of the pit should be lined to ensure that the trench remains stable. There are a number of different pit-lining materials that can be used, including concrete, bricks, blocks, sandbags, and timber.

Figure 8: Deep trench latrines



(Source: Harvey, 2009)

Table 13: Advantages and disadvantages of a deep trench latrine

Advantages	Constraints
• Cheap • Quick to construct • No water is needed for operation • Easily understood	• Unsuitable where water table is high, the soil is too unstable to dig, or ground is very rocky • Often odour problems • Cleaning and maintenance of communal trench latrines are often poorly carried out by users

(Source: Harvey, 2009)

Bucket/container latrines

Buckets or containers can be used for people to defecate if there is limited space. These should have tight-fitting lids and should be emptied at least daily. The disinfectant may be added to reduce contamination risks and odour. The excreta collected in the containers can be disposed into a sewerage system, a landfill site or waste-stabilisation ponds. A bucket or container is only appropriate if there are no other options and people find this method acceptable.

Table 14: Advantages and disadvantages of container latrines

Advantages	Constraints
• Defecation containers can be procured easily and transported • Once containers are provided, only the final disposal system needs to be constructed • Can be used in flooded areas or where the water table is very high	• Many people find the method unacceptable • Large quantities of containers and disinfectants are required • Extensive education regarding final disposal is required • The disposal site must be fairly close to homes to minimise transportation needs • Containers may be used for alternative purposes

(Source: Harvey, 2009)

Chemical toilets

Chemical toilets are commonly used temporarily in developed countries. These are normally single prefabricated plastic units incorporating a sit-down

toilet, lockable door and effluent tank containing chemicals to aid digestion and reduce odour. But they are an expensive and unsuitable solution in more resource-limited areas.

Table 15: Advantages and disadvantages of chemical toilets

Advantages	Constraints
• Portable • Hygienic • Minimised odour • Can be mobilized rapidly	• High cost • Difficult to transport • Unsustainable • Regular servicing and emptying required

(Source: Harvey, 2009)

Repair or upgrading of existing facilities

This measure can be implemented where the affected community stays or be displaced in areas where sanitation facilities exist. However, these facilities may have been damaged or may have become inappropriate in the changing circumstances. The most effective intervention option might be repairing or upgrading these facilities in such cases. But it will also depend on whether this is an acceptable immediate measure or how soon this can be accomplished.

Table 16: Advantages and disadvantages of repairing or upgrading existing facilities

Advantages	Constraints
• The basic infrastructure is in place to build on • Indigenous technology and materials are used	• There are limited expansion possibilities • Repair and upgrading may take time

(Source: Harvey, 2009)

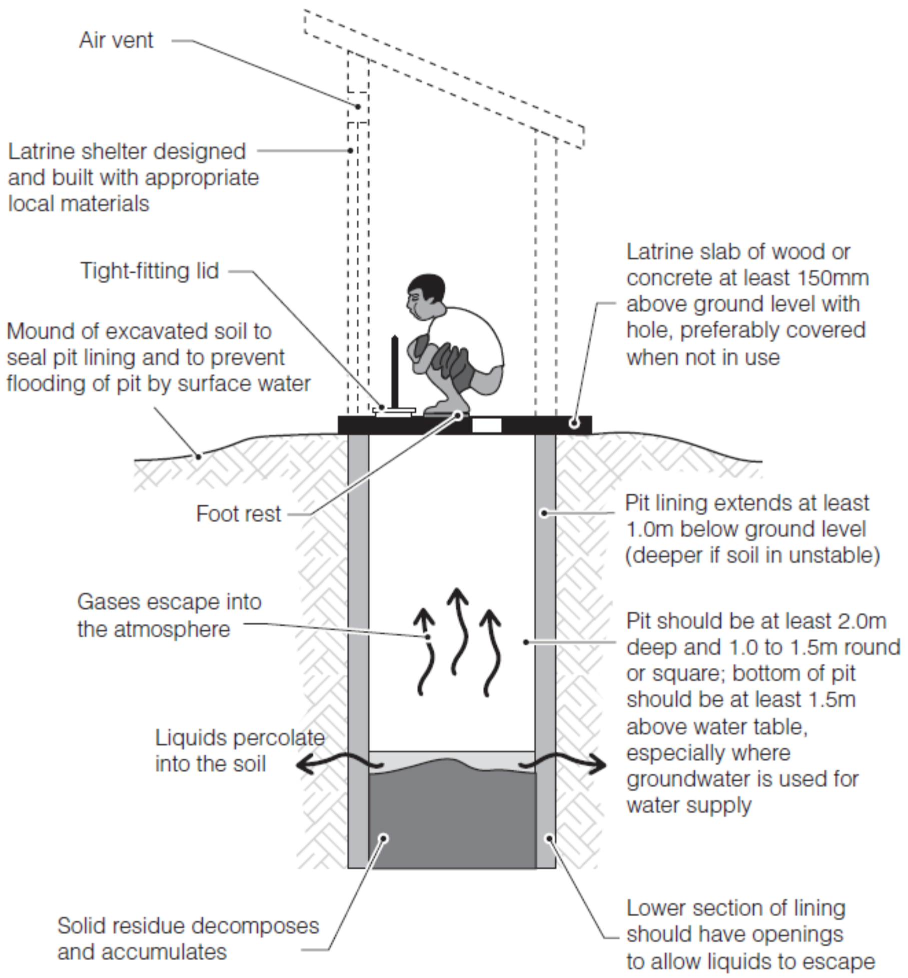
E. Long term technical options

Simple pit latrines

Simple pit latrines are the most common technology choice adopted in emergencies. This is because they are simple, quick to construct and generally inexpensive. The pit should be as deep as possible (at least 2 m in depth) and covered by a latrine slab. The size of the pit can also be determined from the sludge accumulation rate and the soil's infiltration rate. The top 1 m

of the pit and where the soil is suspected to be unstable should be lined to prevent collapse. A squat or drop hole is provided in the slab, allowing excreta to fall directly into the pit. This can be covered with a removable lid to minimise flies and odour. The superstructure can be made from local materials, such as wood, mud and grass. Or it can be made from a more permanent structure of bricks and mortar.

Figure 9: Simple pit latrines



(Source: Harvey, 2009)

Table 17: Advantages and Disadvantages of Simple Pit Latrine

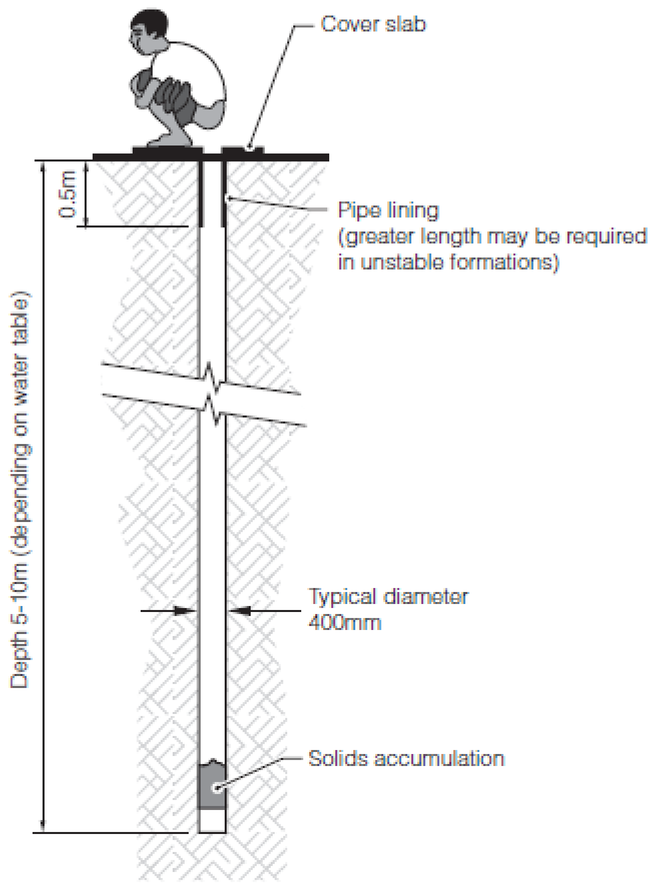
Advantages	Constraints
• Cheap • Quick to construct • No water is needed for operation • Easily understood	• Un-suitable where water table is high, the soil is too unstable to dig or ground is very rocky • Often odour problems

(Source: Harvey, 2009)

Borehole latrines

A borehole A borehole drilled by a machine or hand-powered auger can be used as a latrine. This has a typical diameter of 400 mm and a depth of 4-8 m. At least the top 0.5 m should be lined. But it is rarely necessary or appropriate to line the entire depth. Borehole latrines are most appropriate in situations where boring/drilling equipment is readily available, where a large number of latrines must be constructed rapidly, and where pits are difficult to excavate, either due to ground conditions or lack of a suitable labour force.

Figure 10: *Borehole latrines*



(Source: Harvey, 2009)

Table 18: *Advantages and disadvantages of borehole latrines*

Advantages	**Constraints**

• The borehole can be excavated quickly if the equipment is available • Suitable in hard ground conditions (where there are no large stones or rocks) • Appropriate where only a small workforce is available	• Drilling equipment is required • There is a greater risk of groundwater pollution due to greater depth than pit latrines • Lifespan is short • Sides are liable to be fouled • Causing odour and attracting flies • There is a high likelihood of blockages • **This option should only be considered in extreme conditions when pit excavation is impossible.**

(Source: Harvey, 2009)

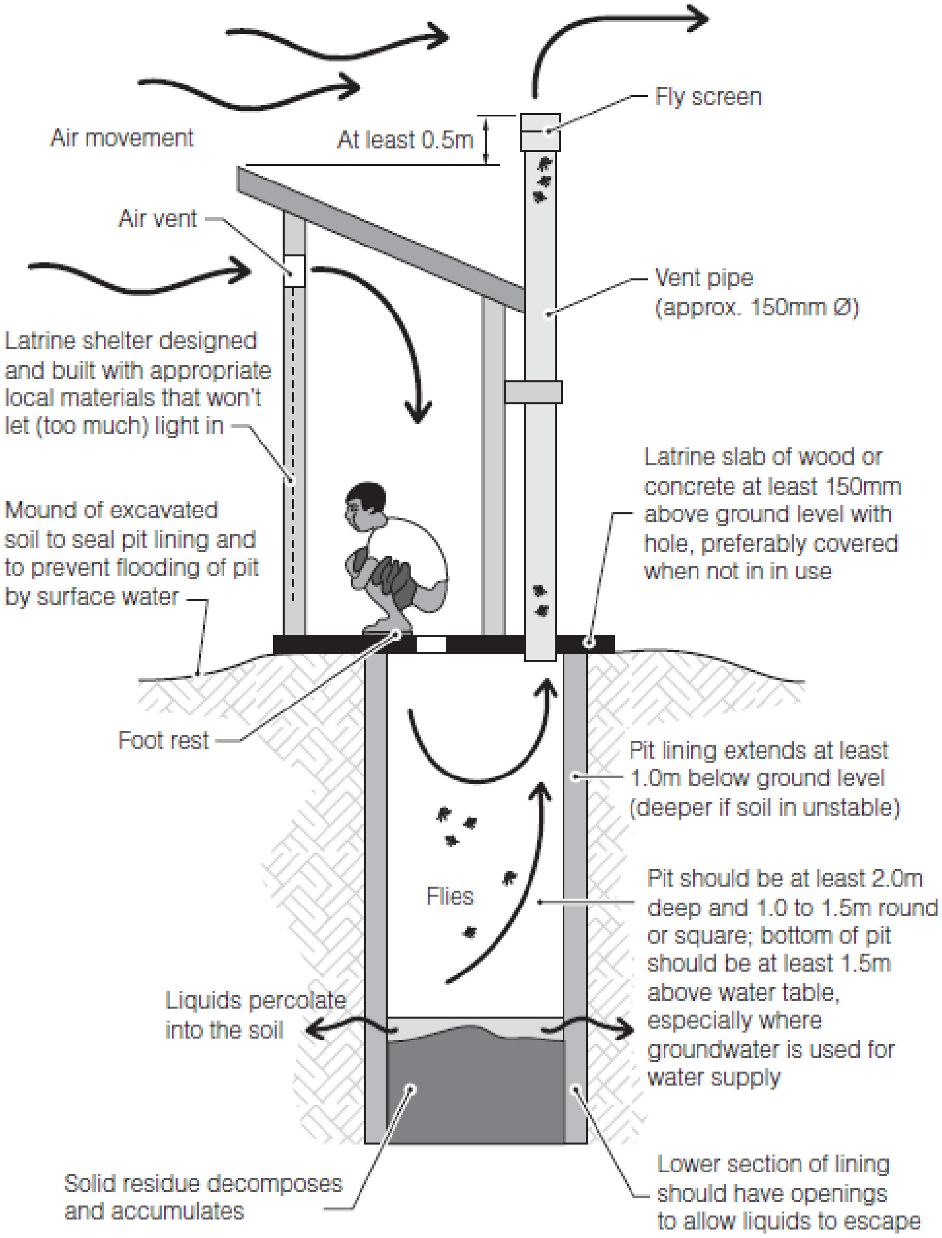
Ventilated-improved pit (VIP) latrines

The Ventilated Improved Pit (VIP) latrine is a simple pit latrine upgraded with an air vent to reduce odour and flies. In emergency settings, this type of latrine is usually built for hospitals or schools because it is more expensive.

A vent pipe will remove odorous gases from the pit. This pipe should extend at least 50 cm above the latrine superstructure and ideally be situated outside the latrine interior which would warm the pipe quicker and encourage airflow. Air should flow freely through the squat hole and vent pipe. No drop hole cover is required.

The superstructure interior should be kept reasonably dark to deter flies. But there should be a gap, usually above the door, to allow air to enter. This gap should be at least three times the cross-sectional area of the vent pipe. Airflow can be increased by facing the door of the superstructure towards the prevailing wind. Each drop hole should have its compartment. There should always be one vent pipe per compartment.

Figure 11: *VIP Latrine*



(Source: Harvey, 2009)

Table 19: *Advantages and disadvantages of VIP latrines*

Advantages	Constraints
• Reduced odour • Reduces flies • Good quality • Long-term solution	• Difficult and expensive to construct properly • Design and operation are often not fully understood • Construction may take time

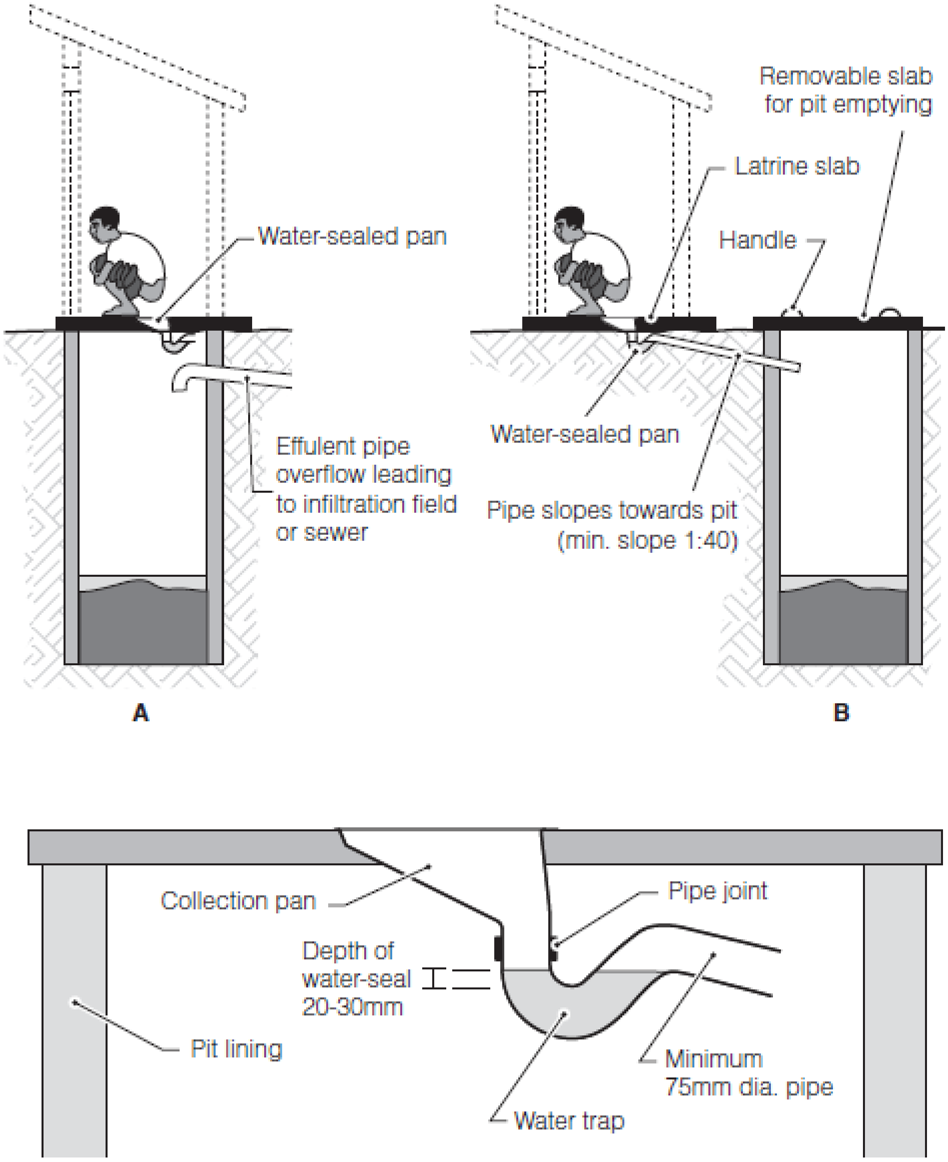
- Dark interior may deter young children from using it
- Does not deter mosquitoes
- Low replicability as PVC pipes are expensive
- Increased odour outside

(Source: Harvey, 2009)

Pour-flush latrines

Pour-flush latrines rely on water to act as a hygienic seal and help remove excreta from a wet or dry disposal system. The simplest pour-flush latrines use a latrine pan incorporating a shallow U-bend which retains the water. After defecation, a few litres of water must be poured or thrown into the bowl to flush the excreta into the pit or sewage system below. Pour flush latrines may be constructed directly above a pit or offset whereby the waste travels through a discharge pipe to a pit or septic tank.

Figure 12: Pour-flush latrines



Dimensions of sealed pan

(Source: Harvey, 2009)

Table 20: Advantages and disadvantages of pour-flush latrine

Advantages	Constraints
• Lack of odour • Ideal where water is used for anal-cleansing • Easy to clean	• Increased quantity of water required • Solid anal-cleansing materials may cause blockages • More expensive than simple pit latrines

- The off-set design does not require a self-supporting latrine slab

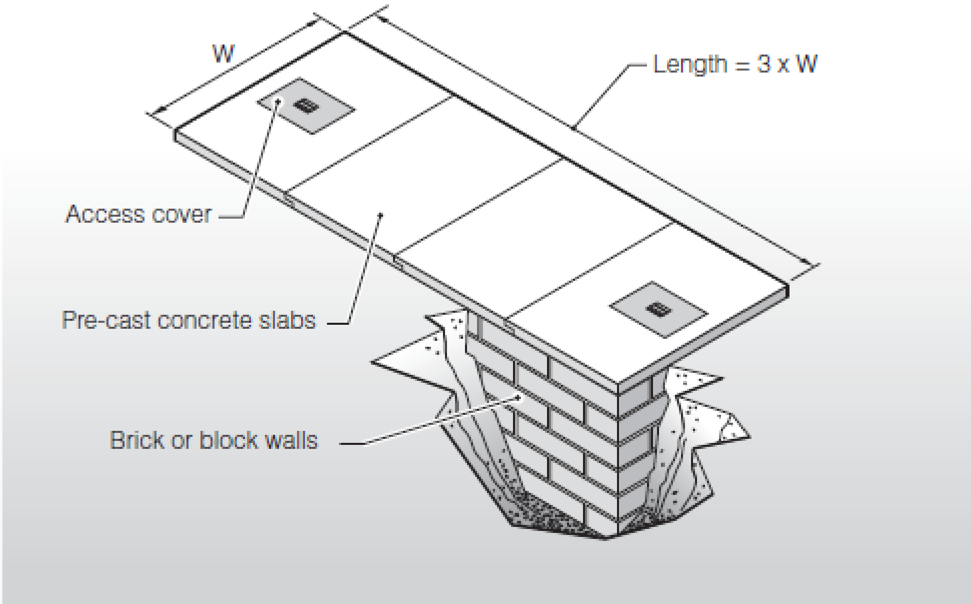
(Source: Harvey, 2009)

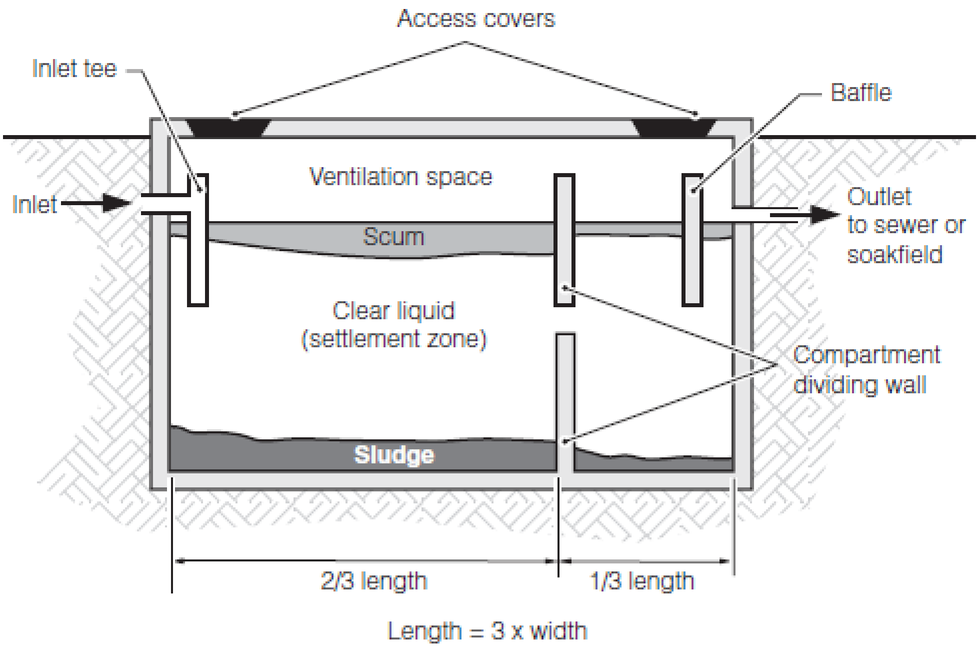
Septic-tanks

Septic tanks are usually used together with pour-flushes latrines. A septic tank is designed to collect and treat toilet wastewater and other greywater. It is appropriate to use in situations where the amount of wastewater produced is too high for pit latrines to handle and water-borne sewerage is uneconomic or expensive. Septic tanks are particularly suited to high water use systems, especially where water is used for flushing and anal cleansing. They are difficult to manage for large populations and are best suited to single households or hospitals or schools.

All septic-tanks require a system for removing the sludge and disposing of it hygienically. The final effluent leaving the septic-tank will still be full of pathogens. It must be disposed of in an appropriate location such as a soakaway pit, infiltration field or sewerage system.

Figure 13: *Septic Tank*





(Source: Harvey, 2009)

Wastewater treatment

In most emergency cases, on-site excreta disposal methods may dispose of human waste without treatment. But wastewater treatment is required before disposal in some situations. This frequently happens in heavily populated regions where standard on-site solutions aren't feasible. These include urban areas, rocky terrains that prevent pits from being excavated, areas where

groundwater pollution is a concern, and areas where there seems to be a cultural reluctance to low-tech solutions.

Collection and transport

Wastewater treatment systems collect and transport waste from toilets, allowing safe excreta disposal. This requires significantly less space than in-situ systems that provide on-site excreta disposal such as pit latrines. Collection and transport can be done essentially in one of three ways:

1. By temporarily storing the excreta in appropriate tanks and frequently emptying these by vacuum trucks (logistics and operating costs may be a problem with this as is the case with chemical toilets)
2. By setting part of the waste in a septic-tank and transporting the liquid portion of the waste to the treatment or disposal site by means of a small-bore sewerage system by gravity or pumping (this considerably reduces the emptying frequency required but requires water for operation)
3. By transporting the whole waste directly to the treatment or disposal site by means of a larger bore system and more water (these have some of the highest installation costs and require large amounts of water)

Treatment and disposal

Once gathered and transferred to a more suitable location, the waste can be disposed of untreated or processed before dumping into a watercourse or pit. Once collected and transported to a more suitable site, the waste may be either disposed of as it is or treated before disposal into a watercourse or pit. Simple disposal is not recommended due to the high pathogen content of the waste and some form of wastewater treatment is usually required with emphasis on pathogen reduction. In the early phases of an emergency, immediate disposal may be the only choice and the risk can be reduced by adding lime to pits.

All wastewater treatment systems produce sludge as part of the treatment process either continuously or intermittently. This sludge requires careful handling and can be disposed of in a pit, incinerator, or agricultural land.

F. Strategies for difficult situations

High water-tables

Generally, the pit base must be at least 1.5 m above the wet-season water table to prevent contamination. It is virtually impossible to prevent groundwater

contamination in situations where the groundwater is less than 1 m from the surface. Greater attention should be paid to ensuring that people do not drink water from shallow wells without treating the water somehow.

Where the water table is high and groundwater is used as a water source, there are a number of excreta disposal options that can be applied, including:

- Raised pit latrines – widespread solution, relatively simple to construct, require emptying, may be single or twin-pit
- Sand-enveloped pit latrines – relatively time-consuming to construct, require suitable sand, can be combined with a raised pit
- Sealed pits or tanks – must be water-tight, can be above or below ground, relatively expensive
- Dehydrating or composting latrines – can be raised or shallow twin-pit, work best where people are already accustomed to their use or where there is agricultural activity
- Septic-tanks or aqua-privies – can be above or below ground, relatively expensive, require water and space.

Flooding

While flash floods are responsible for most flood-related deaths, many people die from illnesses contracted from unsanitary conditions and polluted water shortly after a flood. Proper excreta disposal can significantly impact the health of the affected communities in these conditions. Three main areas must be addressed to ensure an environment free from faecal contamination:

1. Promotion of good excreta disposal practices by the affected population through the involvement of the community in the design and siting of the latrines
2. Prevention of overflowing of raw sewage from pits and septic tanks during flooding which would result in a very serious environmental health hazard
3. Provision of adequate excreta disposal facilities for displaced people during flooding

In the case of a flash flood, there is no particular option for excreta disposal. The best option will be determined by local cultural habits, environmental concerns, and the materials accessible in the area. Possible excreta disposal solutions for flood-prone areas for short term emergency response are summarized below.

- Over-hung toilets – In floods where there is still flowing water or a river nearby, one of the quickest ways to eliminate the public health risk is to excrete directly in the river. Before this option is selected, a sanitary survey of downstream water use is essential to ensure that it does not

present major health risks for people downstream. Cubicles should be quickly erected for this as in most cultures privacy is a major concern, especially for women. It is also important that construction is sound and that latrines are accessible and safe for users including young children, the elderly and disabled people.

- Floating latrines – Similar in principle to over-hung latrines, floating latrines are designed so that faeces fall directly into a river or floodwaters. The base of the latrine superstructure is commonly made from timber/bamboo to float like a raft.
- Plastic bags – In the immediate aftermath of some flood events, such as those in Bangladesh in 1998, people can defecate in plastic bags and float them away. This is an emergency short-term measure only and if the bags are not collected and disposed of properly, or a river does not take them out to sea, this would constitute a serious health risk.
- Temporary dismountable latrines – Where flooding has damaged existing sanitation facilities, temporary latrines that can be disassembled after use and reused elsewhere can be constructed locally. These are designed to be assembled above a pit latrine with urine separation to a soakaway. They can also be raised if there is a continued threat of flooding or prevent groundwater contamination in areas with high water tables.

The pits of latrines in areas prone to seasonal floods must be sealed to prevent sewage from mixing with groundwater and contaminating water sources. Cement-plastered bricks or blocks or concrete rings can be used for this. In areas where flooding is an issue, tight-fitting covers should be installed on the squat-hole to prevent sewage from rising out of the hole.

Rocky areas

The solutions suggested for high water-table and flood-affected areas are also applicable to rocky areas. Concentrated defecation areas may be needed in the first phase of emergency response in areas where the ground is extremely rocky – making it virtually impossible to dig trenches or cover faeces with soil. A defecation site is set up in this case and each individual who goes to use it is given a shovel and a cup of burnt lime to take with them. They then sprinkle half of the lime on the sand before defecating on top. The rest of the lime is used to cover the faeces, which are then scooped up on the shovel and taken out to be put in a covered container at the side of the fenced-off area. Staff empty the containers into an off-site pit or load them onto a truck for disposal elsewhere.

Urban environments

It is challenging to ensure proper excreta disposal when operating in a large urban area. The first strategy is usually to use or restore any existing latrines. If certain components of the sewage system are damaged, this may require isolating a component of the sewer system. If the sewerage system was severely damaged, measures should be taken to locate septic tanks and construct temporary latrines that feed into them. Portable toilets may be available for rent in some circumstances. But they require desludging daily in populated areas and should only be considered if regular desludging can be maintained.

In urban areas, it is advisable to focus on common spaces such as markets or transit centres rather than providing household latrines for everyone. Discussions with community groups could help identify risks and potential alternatives, such as several households sharing one toilet or public latrines in strategic places.

A. Summary

- Criteria of considering appropriate technologies for excreta disposal include: Cultural practices/preferences, available space, ground conditions, time constraints, availability of resources, operation and maintenance, financial constraints.
- The elements of excreta management follow the movement of the waste: excreta containment, collection, transport, treatment, and reuse or disposal. In an emergency setting, sanitation intervention is almost similar. Technical options vary according to the phases and situation of emergency.

2.4 Identify key aspects of operation and maintenance of sanitation systems and facilities for continued health benefits

A. Introduction

A successful sanitation intervention would allow the community to reap its benefits sustainably. Maintenance and operation are necessary to achieve the continuous health benefits of the sanitation system.

B. Operation and maintenance of excreta disposal facilities

Cleaning and Maintenance

Cleaning and maintaining excreta disposal facilities, particularly communal latrines, is sometimes the single most difficult problem in promoting their use. People will not use latrines if they are not clean. Latrines should be cleaned regularly to prevent disease transmission due to contact with faeces and flies and avoid insanitary conditions and odours that may discourage people from using them.

Latrine Desludging

Many excreta disposal technologies require building a pit or tank that does not rely on infiltration. But it will need to be emptied over time if used for the long term. Pits should be correctly sized or replaced whenever possible to avoid the need for regular emptying or desludging. This isn't always feasible, and in those cases, facilities for emptying must be in place. Desludging should be considered in situations where:

- Land availability is scarce (i.e., it is not possible to dig another pit nearby when one is full)
- Ground conditions mean that raised latrines have had to be built (e.g., high water-table, impermeable ground or hard rock areas)
- Latrine pits have been lined for stability or to prevent groundwater pollution (if the pit is not lined there is a danger of pit collapse when the solids are removed)

If latrines are to be de-sludged, the hole in the squatting-slab needs to be large enough to allow a hose through for pumping. Or a removable slab or a removable cover, outside the cubicle, needs to be made to allow a hose or a person to enter. The preferable option is a removable cover so that solids that cannot be pumped out can be dug out and any spillage during desludging does not contaminate the inside of the latrine.

Sludge Reduction

Sludge reduction agents can be used to speed up the sludge digestion process. These bio-additives aim to enhance the three essential components of digestion: nutrients, enzymes, and bacteria. Some research has examined the efficacy of various sludge-reduction additives that are useful in speeding the volume reduction and reducing fly infestation. Due to the generally faster sludge accumulation rate in emergencies, it is not yet known how appropriate

such technologies are useful for emergency excreta disposal programmes. Their application also has significant constraints, including cost, procurement, and the need for regular stirring to maximize volume reduction.

C. Key aspects on operation and maintenance of sanitation system

Sphere has developed the standard for management and maintenance of sanitation systems, especially in excreta disposal management:

Table 21: Management and maintenance of excreta collection, transport, disposal and treatment

Key actions:

1. Establish collection, transport, treatment and disposal systems that align with local systems by working with local authorities responsible for excreta management.
    - Apply existing national standards and ensure that any extra load placed on existing systems does not adversely affect the environment or communities.
    - Agree with local authorities and landowners about land use for any off-site treatment and disposal.
2. Define short- and long-term management of toilets, especially sub-structures (pits, vaults, septic tanks, soakage pits).
    - Design and size sub-structures to ensure that all excreta can be safely contained and the pits desludging.
    - Establish clear and accountable roles and responsibilities and define sources of finance for future operation and maintenance.
3. De-sludge the containment facility safely, considering both those doing the collection and those around them.
4. Ensure that people have the information, means, tools and materials to construct, clean, repair, and maintain their toilets.
    - Conduct hygiene promotion campaigns on the use, cleaning and maintenance of toilets.
5. Confirm that any water needed for excreta transport can be met from available water sources without placing undue stress on those sources.

Key indicator: All human excreta is disposed of in a manner safe to public health and the environment

(Source: Sphere, 2018)

It is also important to note that sullage or domestic wastewater is classified as sewage when mixed with human excreta. Unless there is an existing sewerage system in the settlement, domestic wastewater should not mix with human excreta. Sewage is difficult and more expensive to treat than domestic wastewater.

D. Summary

- Sustainable sanitation interventions require regular maintenance including cleaning and desludging.
- A key indicator for measuring the effectiveness of sanitation interventions is to check whether human excreta is disposed of in a manner safe to public health and the environment.

2.5 Identify learning and good practices on sanitation measures in different types of emergencies

A. Introduction

There are several good sanitation practices in emergency response that are documented. This sub-element presents some of the lessons learned about implementing sanitation measures in different emergencies.

B. Good sanitation practices in different types of emergencies

Flooding

The information below is gathered by the Global WASH Cluster from flood emergencies in various locations.

- Emergency preparedness planning should include identifying suitable sites for the safe disposal of sanitary wastes, such as sewage and faecal wastes from latrines. Suitable sites should also be identified in advance to dispose of solid waste and flood debris. The WASH cluster should establish a technical working group to advise debris management in flood situations.
- Latrine should be rehabilitated and returned to service as quickly as possible after an emergency. Desludging of latrine should be an early priority for any flood response.
- The priority in any flood situation is the speed of response. Any first phase technology must be installed quickly and effective in containing excreta.
- Conventional pit latrines – that use traditional infiltration techniques – are never floodproof; other technology options (eg. Those that involve raising latrine pits) should be explored and used in flood-prone areas.

- Adequate lighting should be provided so that people can use latrines safely at night. The provision of torches with hygiene kits is sometimes useful in this regard.
- The choice of option should depend on the situation, particularly whether the flood has displaced communities or whether they have decided to sit the flood out.

Tropical cyclone

UNICEF'S response to Cyclone Nargis that hit Myanmar in 2009 produced some of the good practices of WASH interventions in emergencies. The followings are sanitation-related lessons learned from the event.

- Some aspects of the sanitation system that need to be provided to the affected community are: health education focused on good personnel hygiene, sanitary habits, consumption of safe drinking water, fly proof latrines, and the use of insecticide-treated bet-net. These prevented outbreaks of water and sanitation-related disease in the cyclone-affected areas.
- During and after the cyclone relief and early recovery phase there were no major outbreaks of water and sanitation-related diseases (cholera in particular). Despite the poor living conditions in camps, and contamination of water sources in the villages, there has been no alarming increase in the incidence of diarrhoea. This is an indirect indication of proper drinking water treatment and proper use of disinfectants to clean sewer and open drainage. WASH cluster provided aqua tablets and drums of chlorine to disinfect sewers and ponds.
- One of the constraints that occurred in the cyclone emergency response is inadequate human resource capacity, combined with competing priorities for a limited pool of skilled workers in the affected township have been a major constraint to quickly rebuilding water supply and sanitation infrastructure. All agencies are competing for the same human resources including local labour forces.

Earthquake

The Oxfam response to Haiti 2010 earthquake has provided useful information about how sanitation measures were implemented where challenging poor hygiene practices in urban areas existed. Key lessons that can be learned are as follows.

- Chemical toilets hired from private companies were ineffective due to the limited storage capacity and high maintenance cost for emptying and cleaning.

- PooBags, biodegradable and simple plastic bags were implemented at camps where it was impossible to install latrines quickly. It had improved people's sanitation practices. The elderly, less, less physically able, and women particularly appreciated this practice, as these could be used at night in their tents. The use of an organised bag collection system also prevented them from being discarded indiscriminately into drainage channels. This measure was particularly liked because it can reduce smells, especially in tents.
- Raised latrines worked well due to partner's high motivation and community mobilization work. On daily labour rates, Paid toilet attendants are one factor ensuring high user satisfaction with the units.

C. Summary

- Several good sanitation practices in emergency response are documented, like the interventions in UNICEF'S response to Cyclone Nargis that hit Myanmar in 2009, and The Oxfam response to Haiti 2010 earthquake.
- Phased emergency approach has been a proven effective method. The most important measure is to ensure the sanitation service can be provided quickly in the early phase.

4.3 Element 3. Provide technical guidance on solid waste management and drainage

3.1 Identify and analyse standards related to proper solid waste management and drainage facilities on health risks in an emergency

A. Introduction

WASH actors provide the affected communities with proper solid waste management and drainage facilities. Mismanagement of solid waste and inappropriate facilities could lead to health risks. For example, waste dumped in the water channel could clog the drainage facilities. There are standards to

refer to that help responders determine the effectiveness of solid waste management and drainage facilities.

B. Solid waste management and health risks

Managing and disposing of organic and inorganic solid waste is known as solid waste management. Solid waste management is a system that includes: 1) designing solid waste management systems; 2) managing separating, storing, sorting, and processing waste at the source; 3) transportation to a collection point; and 4) final disposal, reuse, repurposing, or recycling. The term "solid waste" refers to any non-liquid waste created by human activities, as well as a variety of solid waste material arising from the disasters such as:

- Regular residential garbage (i.e., food waste, ash, packaging materials)
- Human faeces disposed of in the garbage
- Emergency waste (i.e., plastic water bottles and packaging from emergency supplies)
- Debris and ruins from the disasters
- Mud and slurry from the disasters, and
- Fallen trees and boulders that block transportation and communication.

Waste can be created at the household, institutional, or societal level. Waste can be either hazardous or non-hazardous. Safe solid waste management is essential for public health. This is especially true in an emergency. Severe health risks may arise if solid waste is not handled immediately in an emergency. This can further demoralise a population already traumatized by the disaster.

Inadequate solid waste management can provide favourable habitats for insects, rats, and other disease vectors—creating a public health concern. Untreated waste can contaminate surface and groundwater. Children also may be injured or sick if they play in improperly managed solid waste. Waste pickers, who make a living by collecting recyclable things from landfills, may be vulnerable to injury or infection. Solid waste may clog drainage systems, resulting in stagnant and contaminated surface water that can serve as a breeding ground for vectors. People may be required to scavenge if food is limited. Some health risks caused by inadequate solid management are shown in the table below.

Table 22: Health risks related to inadequate solid waste management

Solid waste management issue	Health risks and impacts

Collapse of solid waste services, resulting in the loss of experienced waste managers	Uncollected and untreated solid waste
Indiscriminate dumping of waste	Attracts flies, rodents, dogs, snakes, and other scavengers, especially in hot temperatures Contamination of surface and groundwater Block water and cause flooding Stagnant water leads to vector breeding Odour problem
Garbage washed by rain	Contamination of water supply
Pools of rainwater associated with waste collection	Breeding of mosquitoes and transmission of malaria
Burning waste containing plastics and chemicals	Fire risk and smoke, breathing difficulties
Inseparable sharp items (e.g. needle and broken glass)	May cause cuts from sharp materials
Uncollected rubbles from destroyed infrastructures	Hampered access due to the rehabilitation and reconstruction activities Garbage that tends to attract additional rubbish
Exposure to asbestos sheets when it is re-used from reconstruction	Health risks to inhalation

Source: UNOCHA (n.d.)

C. Standard related to solid waste management

The general standard of solid waste management in an emergency is that people should be able to live in an environment free of solid waste, including medical waste, and have the ability to dispose of their household trash easily and effectively. Sphere defines the standards related to solid waste management in an emergency:

Table 23: Standards of solid waste management in an emergency

Standard	Indicators	Key actions

Environment free from solid waste: **Solid waste is safely contained to avoid pollution of the natural, living, learning, working and communal environments**	• There is no solid waste accumulating around the designated neighbourhood or communal public collection points	Design the solid waste disposal programme based on public health risks
		Work with local or municipal authorities and service providers to make sure existing systems and infrastructure are not overloaded, particularly in urban areas
		Organise periodic or targeted solid waste clean-up campaigns with the necessary infrastructure in place to support the campaign
		Provide protective clothing for and immunise people who collect and dispose of solid waste and those involved in reuse or re-purposing
		Ensure that treatment sites are appropriately, adequately and safely managed
		Minimise packing material and reduce the solid waste burden by working with organisations responsible for food and household item distribution
Household and personal actions to safely manage solid waste: **People can safely collect and potentially treat solid waste in their households**	• Percentage of schools and learning centres with appropriate and adequate waste storage • Percentage of public markets with appropriate and adequate waste storage • Percentage of solid waste pits or incinerators at schools,	Ensure that institutions such as schools and learning spaces, child-friendly spaces and administrative offices have appropriate and adequate covered on-site storage for waste generated at that location
		Provide marked and fenced storage for waste generated

	learning centres, public markets and other public institutions that are managed safely	in communal areas, especially in formal and informal marketplaces, transit centres, and registration centres.

Source: Sphere (2018)

Moreover, there are also technical standards and requirements in solid waste management. The table below shows a summary:

Table 24: Other standards and requirements in solid waste management

Solid waste	Standards and requirements
Waste generated	0.5 kilograms of solid waste per person per day (1 – 3 litres per person per day, with the waste density assumption is 200 – 400 kg/m^3)
Container	Provide 100-litre container for every 40 households Provide 1 container for every 10 household
Disposal site	At least 1 km downwind from the settlements

Source: Sphere (2018)

D. Drainage facilities on health risks

Effective drainage is critical when there is a possibility of flooding or poor environmental health conditions emerging from standing water, muddy conditions, or erosion. It is not generally the priority in an emergency. But it should be addressed once the immediate demands for water, sanitation, and hygiene have been fulfilled. Sites with natural slopes and drainage may not require further work except under certain circumstances (e.g., installing cut-off drains to prevent water from running into latrines and shelters). In general, the aims of surface water drainages are:

- To remove water from living spaces safely and effectively, therefore enhancing the living environment;
- To avoid flooding, erosion, and standing water; and

- To ensure that vehicular and pedestrian access is available at all times, especially in a medical emergency.

Household and water-point wastewater, leaking water pipes, latrines, sewers, rainwater, and rising floodwater are all surface water sources in and near emergency settlements. This surface water is collected in drainage facilities, which positively and negatively impact the environment. Surface water could also benefit people to wash themselves, their utensils, and their clothes. The primary health issues connected with this water problem are contamination of water sources and the living environment; damage to latrine and shelters; the development of vector breeding sites; and the risk of drowning.

Effective and proper drainage may extend the life of basic structures, minimise mosquitoes breeding grounds, and prevent the formation of muddy stagnant pools. They can also serve as mosquito breeding sites. Inadequate drainage facilities could harbour harmful bacteria that can cause various faecal-oral diseases that may be harmful to children playing nearby. The impact of drainage facilities on health risks can be divided based on the source of water present: wastewater and stormwater.

E. Standard related to drainage facilities

Drainage design principles

Drainage may be particularly important in camp and urban settings during an emergency. The work required in urban areas may be restricted to unblocking or restoring existing drainage networks. But in impoverished peri-urban locations, existing drainage may be non-existent. To ensure the quality and effectivity of drainage design, this may be useful for an engineer in building low-cost drainage for emergencies:

- The receiving water body or outfall is the starting point for drainage planning. Drain inverts will need to be constructed backwards from this point, following the natural fall of the ground surface as much as possible;
- Secondary drainage is channelled into bigger interceptor drains that connect to the receiving water body or outfall;
- When the water reaches a crossing point, it should not stop flowing. Water must be able to flow properly overall roadways (over or under) and road intersections, while still enabling vehicle and pedestrian access;
- Water should ideally flow quickly enough to prevent particles from being deposited in the drain. Drains with sloping slides and thin bases help to keep the flow consistent;

- Protection against scouring effects will be required when the fall at the bottom of the drain is steeper than 1% (falls larger than 1 unit in 100 units' distance), either by lining or providing protection at especially vulnerable places along the network;
- A steep slope is defined as a slope of more than 5%. Drainage will necessitate design elements such as turn-out-drains, building drainage following contours, or incorporating stairs or check-walls in drain profiles to slow the flow.
- Construction, operation, and maintenance of effective drainage systems benefit from the participation of local communities and/or impacted people.

Calculations in drainage design

There are some commonly used measurements when designing drainage facilities. The table below shows a summary.

Table 25: Measurements used in designing drainage facilities

Terms	Explanation
Rainfall intensity (I) (mm/hour)	The level of water that would cover an area of flat land after one hour of rainfall, assuming there was no infiltration into the earth.
Return period (years)	The probability of a certain rainfall intensity occurs, which act as design criteria in drainage. A balance must be established in the design between the potential damage for shorter return times and the additional cost of building larger drains. Example: In tropical cities: 5-year return period In residential areas: 1 – 3-year return period
Run-off coefficient (C)	The proportion of water that flows over the ground and needs to be collected in drains (the water does not evaporate or infiltrate) Example: Run-off coefficient 1 = all water runs of from the area Run-off coefficient 0 = all water infiltrates

Concentration time (T)	The right rainfall duration to utilise when constructing a drain of the catchment area, or the furthest edge of the catchment area to move across the land and through drains to the design location.

Source: Oxfam (n.d.)

F. Summary

- Mismanagement of solid waste and inappropriate facilities could lead to health risks.
- Solid waste management is a system that includes: 1) designing solid waste management systems; 2) managing separating, storing, sorting, and processing waste at the source; 3) transportation to a collection point; and 4) final disposal, reuse, repurposing, or recycling.
- "solid waste" refers to any non-liquid waste created by human activities.
- Inadequate solid waste management can provide favourable habitats for insects, rats, and other disease vectors—creating a public health concern. Untreated waste can contaminate surface and groundwater. Children also may be injured or sick if they play in improperly managed solid waste. Waste pickers, who make a living by collecting recyclable things from landfills, may be vulnerable to injury or infection. Solid waste may also clog drainage systems.
- The general standard of solid waste management in an emergency is that people should be able to live in an environment free of solid waste, including medical waste, and have the ability to dispose of their household trash easily and effectively.
- Effective drainage is critical when there is a possibility of flooding or poor environmental health conditions emerging from standing water, muddy conditions, or erosion.
- Measurements commonly used when designing drainage facilities are rainfall intensity, return period, run-off coefficient, and concentration time.

3.2 Conduct solid waste management and drainage needs assessment and prioritisation in an emergency situation

A. Introduction

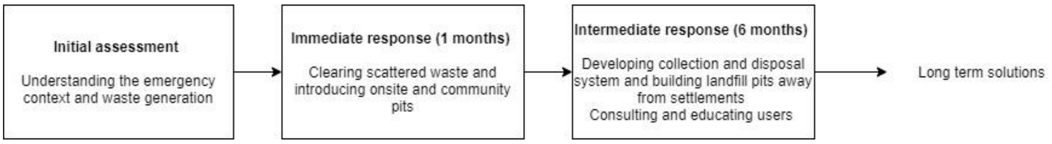
When deciding how to deal with solid waste management and drainage facilities in an emergency, it is important to consider how much of a health risk they pose, how acute the risk is, what other problems they cause, and more. This information can be gathered through a needs assessment. Several problems may occur simultaneously. Prioritisation is a critical step in conducting WASH in emergencies.

B. Solid waste management needs assessment and prioritisation

Needs assessment

WHO (n.d.) outline a planning process for solid waste management in an emergency to help engineers and other WASH actors plan programmes.

Figure 14: Planning solid waste management in an emergency. [(Rouse, n.d.)]



Steps in a needs assessment:

- **Identify waste issues**
  Determine the waste's geographic location using government sources, Geographical Information systems, news, and information from local organisations.

- **Characterize waste**
  Briefly, identify the quantity and quality of waste generated in the assigned area. Do not forget to identify existing waste streams and dumps (e.g. landfill).

- **Map waste**
  Use the information above to create a waste map of the affected area. Throughout the process, the map will be a useful tool and it may be updated as new information becomes available.

- **Assess waste**

Determine the "pathway" and "receptor", if any. Asses the existing waste to allow prioritisation.

- **Prioritise waste**
  Rank the solid waste management programme based on urgency.

The engineer must first understand the emergency context and the nature of waste generated in the assigned area when conducting a needs assessment for solid waste management. Below are some questions that are worthwhile to address during a needs assessment:

Table 26: Questions to ask in the beginning of solid waste management needs assessment

Context	Question
The emergency	• What is the existing solid waste management system in the assigned area before the disaster? • How has it been affected by the disaster? • Is it possible to work with and learn from the existing system? • How many people are affected? • What are they doing with the waste after the disaster? • Are they any cultural habits in the area that may affect solid waste management? • Are there any opportunities or restrictions from the environment? • Where are the water sources located? • Is it possible to dig a pit? • What is the height of the water table? • Is there any land available?
The waste	**Quantity and quality of waste** • What waste is being generated? • Where is waste being generated? • How accessible are waste generators? • What types and volumes of wastes are there (before the disaster)? • How much waste is generated (i.e. per day) (before the disaster)? • What types and volumes of wastes are there (after the disaster)? • How much waste is generated (i.e. per day) (after the disaster)? **Waste streams** • Who (if anyone) is responsible for waste collection and disposal? What resources do they have? **Waste problems**

- Is the current waste management coping with the volume of waste generated?
- Any hazardous waste that requires special attention (e.g., medical waste, electronic waste)?
- Are steps being taken to deal with the waste produced after the disaster? Are these sufficient?

Source:

Needs prioritisation

Prioritisation in solid waste management is critical, for that each identified waste stream may have different importance and urgency. Some may have a higher health risk than others and some can be managed later. The principle in prioritising solid waste management include:

- Appropriate disposal site for various types of waste gathered during the emergency period must be established. If there is an existing disposal site, it should be quickly inspected for environmental compliance before being used. A temporary disposal site may be selected and created if there is no existing disposal site.
- Main roadways have to be cleared to allow for search and rescue activities and relief supplies. Any disaster waste that is relocated should remain in the emergency area. It should not be removed until a suitable disposal place has been identified and located.
- It is recommended that all available equipment and stakeholders be utilised. Where excavators, trucks, and skips do not have access, wheelbarrows and wooden carts carried by animals can be utilised.
- If a disaster strikes, hospitals and clinics should be urged to separate infectious and/or healthcare waste, store it separately, and move it to temporary specific treatment or disposal facilities.
- Whatever resources are available to address the most critical concerns highlighted in the above study should be mobilised.

This matrix shows as a tool that can be utilised in prioritisation a solid waste management programme by identifying the waste stream, the waste age, the distance between waste and the settlement, and the distance between waste and the water source. A detailed example can be seen in the Disaster Waste Management Guidelines of UNOCHA (2011).

Table 27: Template for prioritising in solid waste management

Waste stream	Waste age	Waste to settlement	Waste to water source

Food waste			
Packaging material			
Excreta			
Waste from relief supplies			
....	...	...	...
....	...	...	...

Source: UNOCHA (n.d.)

	Low priority
	Middle priority
	High priority

C. Drainage needs assessment and prioritisation

It is important to assess the capacity of roads, bridges, culverts, fords and drifts to ensure that they can carry the necessary loads needed for building drainage facilities. Rainfall intensity, return period, run-off coefficient, and concentration-time should be assessed.

Needs assessment

The steps in designing a drainage network are:

1. Identify the appropriate return period and concentration-time (based on literature review, local condition and local knowledge);
2. Calculate the maximum rainfall intensity in mm/hour given such circumstances. This is generally available from the hydrogeology or water resources department;
3. Locate or create a map of the region that includes important features and distances;
4. Determine the drainage network's density to handle the surface water. Draw the drain lines on the map as closely as possible to the contours. Cut the ground up around each drain artificially to show which portions of land will feed into each drain, referred to known as the "catchment area (A)".
5. Use the rational method calculation: the method which implies that the storm duration acceptable for a drainage catchment is equal to

the whole time it takes for rain falling on the catchment's furthest point to flow down to the catchment's outfall point.

6. Estimate the run-off coefficient for the catchment.

Table 28: Run-off coefficient and soil permeability

Built-up areas	**Run-off coefficient (C)**			
	Commercial & industrial	**High density residential**		**Low density residential**
	0.75 – 1.0	0.5 – 0.6		0.3 – 0.4
Humid regions	**Soil permeability**			
Average ground slope	**Very low (rock and clay)**	**Low (clay loam)**	**Medium (sandy loam)**	**High (sand and gravel)**
Flat: 0 – 1%	0.55	0.40	0.20	0.05
Gentle: 1 – 4%	0.75	0.55	0.35	0.20
Medium: 4 – 10%	0.85	0.65	0.45	0.30
Steep: >10%	0.95	0.75	0.55	0.40
Semi-arid regions	**Soil permeability**			
Average ground slope	**Very low (rock and clay)**	**Low (clay loam)**	**Medium (sandy loam)**	**High (sand and gravel)**
Flat: 0 – 1%	0.75	0.40	0.05	0
Gentle: 1 – 4%	0.85	0.55	0.20	0
Medium: 4 – 10%	0.95	0.70	0.30	0
Steep: >10%	1.00	0.80	0.50	0

Source: Oxfam (n.d.)

7. Calculate the peak flow or the volume of water to be drained into each drain per second (Q) with this equation:
   Q (l/s) = 2.78 x C x A (ha) x I (mm/hr)
8. Determine the drain size that can transport the needed flow, using Manning Formula and the Manning Roughness Coefficient, shown in the table below.

Table 29: Manning roughness coefficient

Land Use	Run-off coefficient (C)
Earth	0.025
Brick – unrendered	0.018
Brick – smooth rendered	0.015
Concrete – smooth finish	0.015

Source: Oxfam (n.d.)

9. To reduce deposits and restrict scour, check the predicted water velocities and choose the right drain and liner.
10. Modify the drain diameters and iteratively perform the computations until the optimal velocity.

Needs prioritisation

Prioritisation will differ based on the programme's short-, medium- and long-term aspects. While the shift from emergency to recovery and development should be smooth. The programme must consider the longer aspects of disaster recovery rather than just taking the shorter view of emergency response. Improved services to enhance health, nutritional security, and improved livelihoods will be long-term goals that will feed into a recovery strategy.

D. Summary

- The main steps in the solid management needs assessment are to: identify waste issues, characterise waste, map waste, assess waste, and prioritise interventions.
- Prioritisation in solid waste management is critical, for that each identified waste streams may have different importance and urgency. There is matrix that could help engineers in defining the prioritisation.

- In assessing needs for drainage facilities, the engineers should also identify the requirements for building drainage network and assess the existing roads and facilities.
- Prioritisation will differ in the short-, medium-, and long-term.

3.3 Identify and analyse different elements and relevance of measures for solid waste management and drainage in emergencies

A. Introduction

Solid waste management and drainage facilities should be designed as part of a wider preventative health strategy. There are various measures for solid waste management and drainage in emergencies. These should be adjusted based on the assigned area and the resources available.

B. Elements and measures of solid waste management

Solid waste management system consists of six elements: waste generation; on-site handling, storage and processing; waste collection; waste transfer and transport; waste processing and recovery; and disposal. In emergencies, solid waste management is relatively simpler than they are in ideal conditions. But the elements remain the same.

Disposal of waste caused by a disaster

Large amounts of rubble can be produced by floods, earthquakes, and cyclones/typhoons. This can put individuals in danger, restrict access routes, hide trapped people, and clog drainage systems. It will be difficult for other emergency agencies to reach the victim. After survivors are freed from the rubble (they can live for up to seven days), the rubble should be removed and hazardous buildings should be demolished as soon as possible. Waste piles can cause major fires. It is advised to install a security fence to keep the public out and prohibit the use of any bare flames, including cigarettes.

Not all rubbles are waste—some materials can be reused such as zinc roofing sheets, furniture and bricks. This table gives examples of waste generated from specific kinds of disasters.

Table 30: Waste generated from different disasters

Disaster	Waste generated
Earthquakes	Asbestos waste, general building rubble, floor slabs waste
Flooding	Household waste, hazardous materials (e.g. household cleaning products and electronic goods), mud, clay and gravel
Tsunami	Debris waste, soils, trees, bushes, vehicles
Hurricanes, typhoons, cyclones	Brick, concrete walls, roofing materials, dust, asbestos, ships, boats, vessels, electrical and telephone grids
Conflict (short-term and protracted)	Rockets, missiles and bombs, infrastructure waste, furniture, debris, bricks, stones, bridges, roadways, railway structure, unexploded ordnance (UXO)

Source: UNOCHA (n.d.)

Short-term measures in solid waste management

Short-term measures in solid waste management refer to the early recovery phase when the most acute waste issues are required to save lives and reduce health risks immediately. The options in immediate response are relatively simpler and do not require many resources.

On-site household disposal

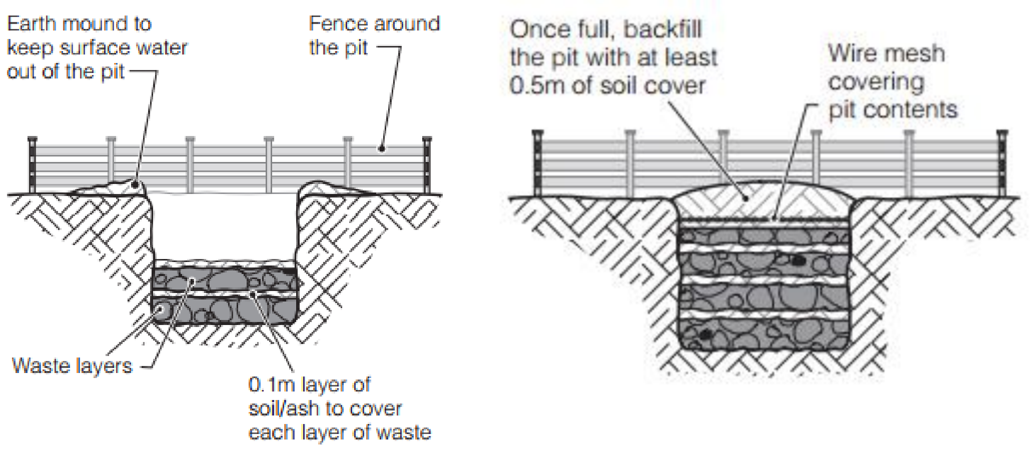
On-site household disposal is the most recommended option whenever available because it involves no collection vehicles, disposal site, or staff. Therefore, an on-site household is one of the immediate responses in solid waste management. This method is applicable in these conditions:

- The waste has a high organic content (it will decompose and reduce in volume);
- The space available is not too limited;
- Rats and other vectors are not a serious problem;
- There are gardens cultivated (the organic decomposition will be helpful);
- There is advanced household cooperation.

Community pits

Community pits are also a method that requires little operation and maintenance, with people may walk 100 meters to the deposited waste. Add fences to the community pits to avoid scavengers or other animals. The estimate is that 50 people will fill 1 m3 of a pit every month (depending on quantity and quality waste generated). possible, there should be layer of soil/ash to cover each layer of waste. Image below was retrieved from Rouse (n.d.).

Figure 15: *Community pits (Rouse, n.d.)*



Long-term measures in solid waste management

Long-term measures in solid waste management refer to response after early recovery. It is better to provide community storage containers, such as community pits in the early phase of a disaster. As the situation has stabilized, the number of bins can progressively be raised to the pre-disaster density. A 100-litre container will serve 200 people after a disaster. There should be one container for 50 people in the long term. This will require a more complex system that will involve storage, collection and transport, and disposal. The solid waste management system should be contextualized based on the condition of the affected community and needs assessment in the early phase of an emergency.

Storage

People should dispose of their trash daily or at least twice a week. When it is a central system, household waste must be kept until it is collected and

disposed of centrally. The period should be limited to a bare minimum, especially in humid tropical climates.

Table 31: Types of storage

Type of storage	Function	Examples
Household containers	Dispose waste in each shelter/household	Sacks, plastic, metal containers
Small collective containers	Roadside containers to collect waste from several people/shelter/household (10 families with the collection every 2 weeks)	A whole or cut of 200-litre oil drums with lids, nylon bags
Waste-collection depots	Collect waste for all people around settlements (note: there should be participation and willingness from the affected community)	Building around settlements from masonry or timber, with high sides to maximise the capacity volume

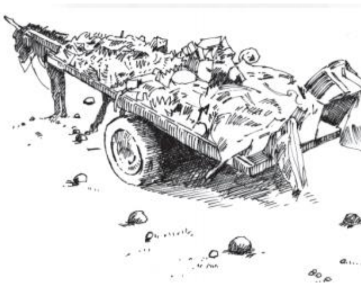
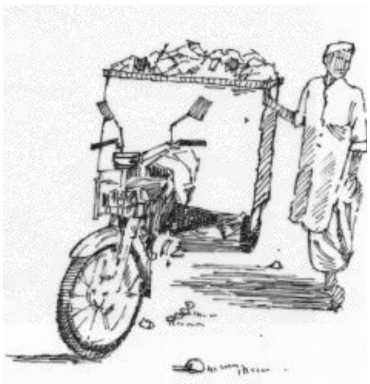
Source: Adams, J (1999)

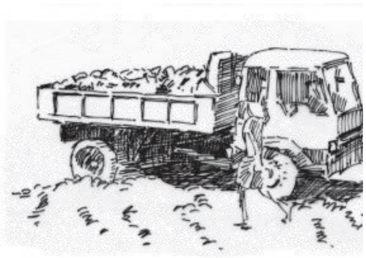
Collection and transport

Empty waste depots every day and small containers like oil barrels every two weeks. There are various methods of transportation: handcarts, animal carts, tiny powered trailers, skip trucks/tractors, and trailers. This table shows some of the options and the engineer may choose the one that is the simplest, cheapest, and the most suitable for the area and the distance between collection and disposal points.

Table 32: Types of waste transportation

Type of transportation	Examples	Standards

Hand-carts		Can be with open high sides or with bins Capacity: 300 – 500 litres Serve 500 families (10,000 – 20,000 people) Radius: 1 km maximum, not suitable for hilly areas Can be managed by the community
Animal-carts		Can use a donkey, horse, or ox Capacity: 2 m^3 Radius: 3 km maximum, can be in hilly areas
Small powered vehicles		Can use local transport (e.g. horticultural cultivators) Radius: 5 km maximum, well operated in quite steep hills (depends on the vehicle) Can be managed by the local community
Skip trucks and tractors with trailers		Allow large container that serve a large camp (> 50,000 people) There should be high sides and cover (avoid the rain which leads to odour)

Ordinary trucks		Can used flatbed trucks Can be used to collect on-household disposal, collection pits, or waste-collection depots in the camp Need between 5 staffs Capacity: 3 – 7 tonnes There should be high sides

Source: Adams, J (1999)
Picture Source: Rouse (n.d.)

Disposal

Intermediate solutions may require large-scale landfill pits constructed in an emergency. The disposal location must be at least 1 km downwind from the settlements. Both WASH actors and the affected community will agree on the location. It will depend on the chosen and the most suitable treatment. It also should be located at least 50 meters from the surface water source. The drainage location should be considered, where the pit is on sloping ground and fences should be erected to avoid animals and scavengers. There are several options of treatment in the disposal site: burying, burning, composting, recycling. The table shows a summary.

Table 33: Types of disposal

Type of disposal	Requirements	Things to consider
Burying	500 metres from living areas and downwind 50 metres away from water supplies Downhill from groundwater The pit's bottom or the ground level of flat tipping is at least 1.5 metres above the water table	Leachate should not pollute surface and groundwater Leachate should be disposed of in a soakaway pit (if possible) Cover the refuse every day to avoid flies, rats, and dogs After six months, refuse can be used as compost
Burning	Suitable for a high organic and low moisture content waste	Consider combining burning and burying when the is limited space in the disposal site

Composing	Leave the waste in pits for several months until it becomes useful for soil fertility	Require careful management to ensure that the waste has the high moisture content and the right ratio of carbon and nitrogen Most effective if conducted centrally to ensure the waste quantity
Recycling	There may be a very few resources to be recycled in camps	There is a great potential for using burnable material for making fuel briquettes
Incineration	At least 1 km downwind of settlements Ashes should be covered by soil daily	Produce air pollution Large capital input and care for operation and maintenance As an alternative from burning of household waste

Source: Adams, J (1999)

Commercial waste

The wastes created may be comparable to home trash depending on the commercial activity. In camps and disaster-stricken cities, markets, stores, and services such as hairdressers pop up fast. Trading is generally organised by a committee or local government which should be urged to take charge of trash management in the market and raise funds from vendors to pay for cleaners. Wastes should be buried on-site wherever possible and covered up each day.

Waste from healthcare facilities and dead bodies

Healthcare facilities waste

Health care facilities, feeding centres, and orphanages generate garbage that poses a health concern and requires specific management. This includes soiled and infectious dressings, discarded needles, and surgical equipment. This sort of trash should be disposed of inside the health centre’s boundaries wherever feasible, and the agency in charge of the centre is responsible for it. Waste should be collected in covered containers and regularly emptied by

workers. Needles, blades, and other sharp objects should be gathered in specific containers.

The ideal disposal method is incineration to eliminate germs and minimise the volume of garbage for future burial. If the incinerator is built above a pit, the ashes will fall. Incineration method is a better alternative than simply burning waste in open fire—where some materials may not be destroyed because open fire is not sufficient. Precautions must be taken to prevent youngsters from using dangerous trash to manufacture toys, fishing hooks, and other items. Contaminated and non-contaminated waste should be separated. Hazardous medical waste should never be combined with garbage for regular collection.

Dead bodies

Dead bodies should be handled and buried or cremated by the deceased's family as much as possible. Unless this is no longer the custom, as it is in parts of the Western world, when professional services may be available. It is critical to understand funeral customs, burial or cremation procedures, grieving, and their implications for the survivors' well-being.

When dead bodies are found in water resources or fishing regions, it is important to retrieve the remains to minimise any potential health risks. The similar case applies for people who have died of cholera, typhus, or plague—safe handling and disposal of corpses need special attention.

C. Elements and measures for drainage

Wastewater and stormwater

Wastewater

Wastewater is water generated from excreta disposal, personal bathing/laundry/cooking/ washing of utensils (sullage), and spillage and leaks from water collection facilities. The source of drainage is divided into two groups based on the source and the characteristics of the water: wastewater and stormwater. This table shows the drainage options related to wastewater.

Table 34: Wastewater and drainage

Water type	Explanation	Treatment

Excreta disposal	Wastewater from latrines leak due to sewage pumps breaking down or sewage spill on the surface	Sprinkle the spillage with sand and quicklime to absorb and disinfect water Control flies frequently Pump the spillage back to the operating sewers Use storm drains to clear the contamination from public areas Ensure no leakage in the water supply distribution system
Sullage	Wastewater generated from personal bathing/laundry/ cooking/washing the utensils *Note: sullage needs careful attention especially when there is a central communal facility to treat this*	Avoid disposing of water to the ground because it may cause blockages, including the soil surface. If there is no option: install a grease trap, expand the soakaway, build a parallel drain with regular maintenance (*note: consider augur impermeable layer to get a more permeable layer*) Flow the water into the open drains for further channelled into natural watercourses (*note: check the flow's final destination)* Utilise the water for irrigation Consider over-design in the early phase of an emergency because the quantity will likely increase throughout time
Spillage	Water leakage from water supply distribution	Direct away from water-collection point to avoid vector-breeding sites Utilise for watering animals (at least 30 metres from water point) Maintain taps regularly along with the tools and spare parts

Source: [Adams, J. (1999).]()

Strom water

In flood-prone areas, determine the magnitude and duration of floods during the first assessment and planning. Stormwater is water generated from rain-water run-off, surface water (e.g., rivers and lakes after rain), and water-logging due to raising the water table. This table shows the treatment options related to stormwater.

Table 35: Stormwater and drainage

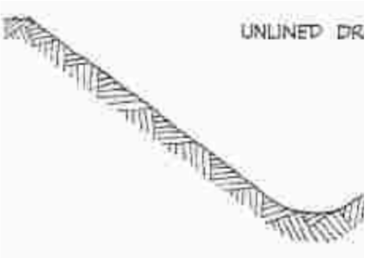
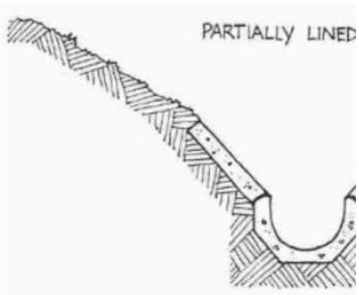
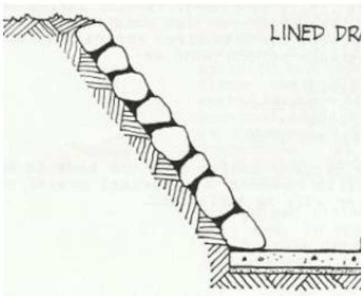
Water type	Explanation	Treatment
Rain-water run-off	Run-off from water that may cause floods in shelters, pollute the water sources and damage latrines	To avoid latrines damages: Raise the latrine slab at least 150 mm above the ground Deflect water away from the pit with a mound of well-compacted dirt surrounding the latrine Build a diversion drain around the toilet to keep water away from the pit borders To enhance water drain: Locate settlements on sloping ground Build diversion channel to direct water away from settlements Build channel with sufficient dimensions to reduce the erosion Strengthen the channel with concrete blocks or wood to avoid scouring and collapse
Flooding of surface water	Water that may occur during heavy rain	In locating the settlements: Avoid flood plains or rivers Avoid areas below high-level points of lakes In dealing with a flood: Coordinate with the local population and use local knowledge in predicting flood
Water-logging due to high water table		Avoid marshy areas with rocky and impermeable soils

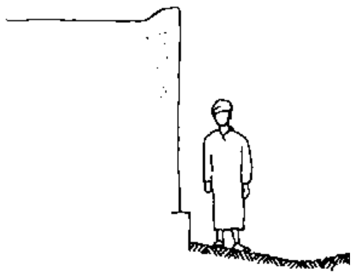
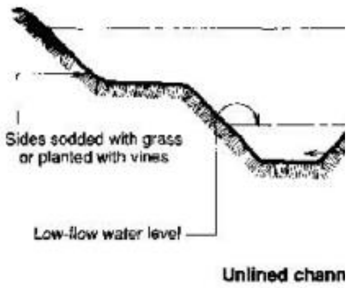
Source: Adams, J. (1999).

Simple drainage channel design

There are various options in low-cost drain cross-sections, and the size, shape, and lining of drainage channels depend on the purpose and the area characteristics.

Table 36: Drainage channel design

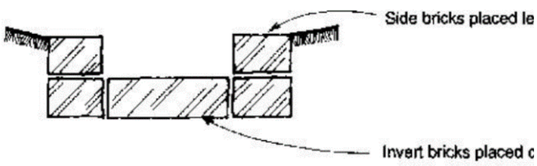
Drainage channel	Example	Explanation
Unlined drain		The cheapest drainage type can be cut along the roadside with a road grader. The slope is not more than 1% - 2% to avoid scouring
Partially lined drain		A cheaper option than the lined drain with a slope of 1% - 5%. Need special protection in vulnerable points (e.g., culverts, drain junctions, sharp bends, and steep sections) by laying turf or sowing grasses
Lined drain		Lined drainage type with permanent or temporary lining. There may be a problem that water may not enter from the ground at either side and can be overcome by providing weep holes about 10 mm in diameter

Roads as a drain		Applicable in very narrow streets where heavy vehicles do not pass, with 5% slope and the road has surfaced (e.g.,. compacted gravel or stone) to avoid erosion
Composite channel		A small drain within a drain is built for places where there is likely to be a large range inflow, particularly when sullage is dumped into the drain. A smaller channel is useful for preventing sullage water deposits.

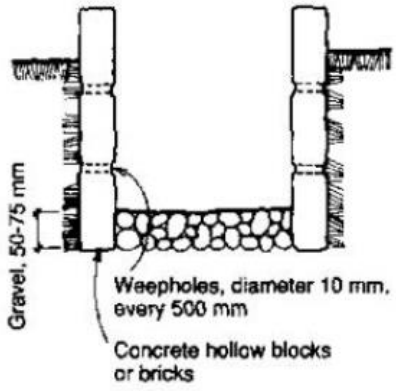
Source: Oxfam (n.d.)

It is advisable not to construct expensive lined drains in temporary camps—instead, simple earth unlined drains may suffice. But simple unlined drains may not be suitable on their own if the ground is steeply sloping and there is a possibility of gulley developing and causing harm to residential spaces. A drain with vertical slides may be the only option when space is limited. The sides should be lined to avoid erosion unless the drainage is only needed for a brief period. The table shows several options available for channel lining.

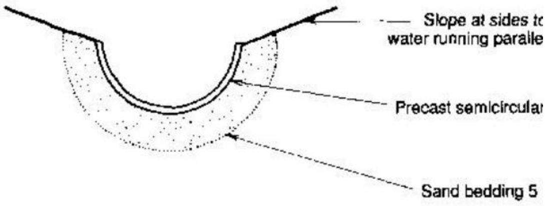
Table 37: Drainage channel lining

Drainage channel lining	Example
Bricks	

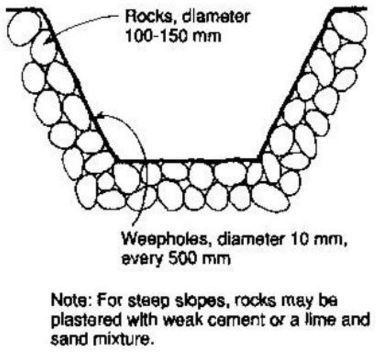
Concrete hollow blocks or bricks and gravel



Precast and sand

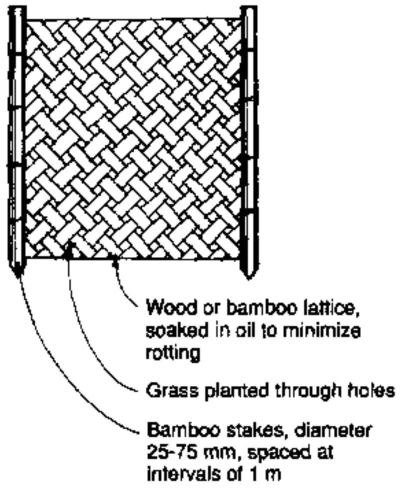


Rocks



Excavated soil, plant with grass or turf

Wood or bamboo lattice



Source: Oxfam (n.d.)

D. Summary

- Different disasters will generate different types of waste. For example, there will be an asbestos waste, general building rubble, and floor slabs waste after an earthquake.
- There are two kinds of responses in solid waste management: immediate and intermediate response. The immediate response includes on-site household disposal and community pits. The intermediate response includes a more complex storage, collection and transport, and disposal system. The engineer should consider commercial waste, waste from healthcare facilities, and dead bodies.
- Drainage includes wastewater and stormwater. Drainage channel designs include unlined drain, partially lined drain, lined drain, roads-as-a-drain, and composite channel. There are also several methods for lining such as brick, concrete hollow, precast and sand, rocks, excavated soil, and wood or bamboo.

3.4 Identify key aspects on operation and maintenance of solid waste management and drainage system and facilities for continued health benefits

A. Introduction

The key aspects in implementing solid waste management programmes and constructing drainage facilities must be understood to ensure continuous improvement. Any solid waste management and drainage plan should be adaptable to local ecology, epidemiology, and knowledge changes. The decision-making process outlined in this part should be repeated to adjust the approach as needed.

B. Key aspects on operation and maintenance of solid waste management

Programme sustainability

The programme's sustainability will depend on:

- Technical capabilities
  Local capacities must be developed to have sufficient technical competence to continue operating and maintaining the waste management systems even after the project ends.
- Financial self-sufficiency
  Ensuring a steady flow of funding (e.g., collecting fees) will help sustain waste management systems and keep them operating after recovery.

.

WASH actors can hand over the solid waste management's programme to the private sector, public sector, community-based organisation (e.g. local NGO), or through a public/private partnership. WASH actors must ensure that the roles and responsibilities for the handover are clear and communicated. Community participation must be regularly monitored and evaluated.

Health and safety disaster waste management

Personnel health and safety is critical to the success of any waste management programme and it must be considered from the start. The following are the minimum requirements:

- Ensure that all the employees in charge of and supervising solid waste management activities have the required experience and that adequate safety mechanisms are in place;
- Ensure that all the solid waste management systems apply personal protective equipment standards (PPE), such as footwear (hard boots to prevent spikes and minimise the harm from heavy and sharp materials), hard hats, gloves, overalls, and masks. All the employees should wear these, from the local communities in debris clearance schemes to casual labour staff;

- Take into account the health and safety in the new waste disposal plant such as one-way traffic systems and restricted cross-over between cars and humans. People who work with waste should have access to adequate and clean change and washing facilities both during and after their working hours;
- An effective dust suppression (e.g., water spraying) is required where debris is crushed or waste is handled. Noise, vibration, and hazardous emission reduction devices and machinery guards should be installed in facilities and equipment to prevent accidents.

Communication and stakeholder management

Effective communication is crucial to the success of a solid waste management programme. The points below serve as a reminder:

- Sending messages to encourage disaster waste cleaning (e.g., use radio spots to tell the upcoming clean-up initiatives or to provide advice on certain types of hazardous waste);
- Assure that national authorities have information outlining who performs what, what data/information has been gathered, and the outcomes of any waste assessment and planning mission. NGOs and implementing agencies are frequently involved in post-disaster relief efforts;
- Assist local governments in providing clear and open information on clean-up efforts future timetables, and other issues. Information on street clearing also will allow residents time to arrange for the recovery of their houses and determine whether or not to rid their houses of damaged furniture and things;
- Ensure the implementing agencies coordinate and communicate to streamline waste assessment project;
- Develop information exchange and coordination mechanisms among stakeholders;
- Implement a comprehensive communication strategy as a wider part of solid waste management.

The following groups in the table below should be considered and included/engaged as needed in planning and implementing solid waste management activities.

Table 38: Stakeholder management in solid waste management

Stakeholders	Roles

Beneficiaries	Involve in every phase of solid waste management programme, such as assessment, planning, programme design and management: **Affected communities,** receive assistance in clearing disaster waste from their property and eliminate the waste generated by families **Scavengers** or **waste pickers,** involve in reuse and recycling **Service companies** provide rehabilitation support **Private sector and non-governmental waste organisation** **Hospital and clinics** treat the affected community **Local authorities**
Local-level administration	Will benefit from disaster waste management programme support
Administrators	To be informed fully in any decisions concerning future waste management in the affected area
Practitioner	Other professionals interested in taking part in solid waste management (e.g.
Regional administration	Informed about disaster waste management reports and evaluation
Donors	Allocate funds and establish minimum standards for disaster waste management project design and implementation

Source: UNOCHA (n.d.)

Consultation and education can be used to involve the community. Education will help the community understand the benefits and limitations of a solid waste management programme. Consultation can help people understand the other points of view on the programme design. This should be done before and during the implementation.

Resource

The number of people needed to manage a domestic waste collection and disposal operation is determined by the amount of trash, the size of the camp, and other considerations including access. For example, in Kahindo Rwadan refugee camp, for 110,000 refugees with total waste is 350 m3 per week, there are 25 dedicated employees there. Overall, boots, and gloves should be supplied to staff who handle the waste. Protective masks should be used by workers burning trash or handling dusty debris. Water and soap should be

supplied at disposal locations for cleaning hands and faces, as well as vehicles that have been transporting hazardous waste, such as latrine sludge.

C. Operation and maintenance of drainage systems

Self-cleansing and erosion

In some cases, to allow the drainage for self-cleansing, the standards are:

- A channel of 10 – 15 cm wide
- Minimum slope 1%
- A channel twice the size needs roughly half the slope
  Moreover, for slopes ground above 5%, the engineer should consider

getting additional features to avoid erosion and reduce the speed of the water. The feature includes:

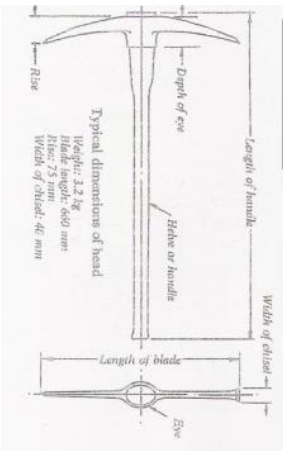
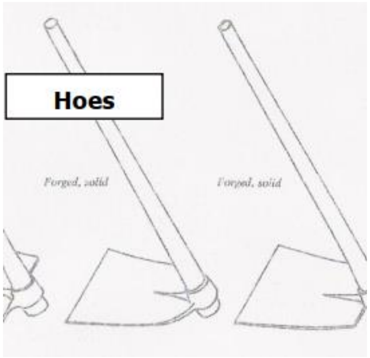
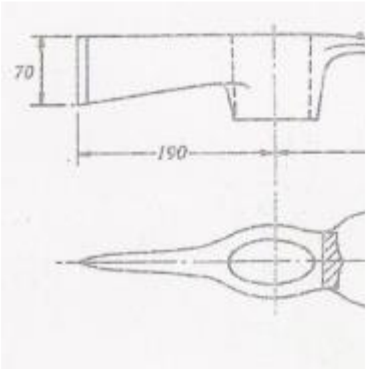
- Build a 'turn-out' drain that diverts water away from the main drainage system and direct it onto fields to soak up. These are typically only available in rural areas or metropolitan areas with enough open space.
- Construct the drainage by following the contours of the land.
- Build 'check-walls' or 'erosion checks' down a slope at regular intervals. These form tiny walls across the drain and can be made of stone, wooden poles, brickwork, or gabions (huge wire baskets with big stones placed within) for large drains. The water stops behind each check-wall on its way down the drain and dumps its solid burden. After a period, the solids pile up to the point when a stepped effect occurs, lowering the drain's effective slope.
- Drains can also be lined with concrete masonry or plants in places with a moderate drain slope (4% - 10%).

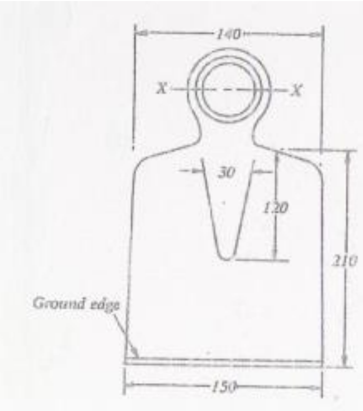
Tools for drainage construction

Selecting hand tools that are acceptable for local users is critical for drainage construction. Communities typically have a preference for the sort of tool they like to use, and local names might differ. The pickaxe, mattock, hoe, and shovel or spade are the tools that will be needed the most. This table shows various tools used in drainage construction.

Table 39: Tools for drainage construction

Tools	Example	Function

Pick		Hoe the land, and can be used for rock quarry, sand quarry and soil excavation
Hoes		Shape soil, remove weeds, clear soil, and harvest root crops
Mattock		Dig, pry, and chop soil

Jembe		Cultivate, digging out roots, harvest of root cingrops
Shovels	 *Source: https://images.app.goo.gl/3YjT133KKj9E2D5k8*	Dig, move loose granular materials (dirt, gravel, grain, snow) from one spot to another
Sledgehammer	 *Source: https://images.app.goo.gl/RVMGsBeFoJbsKLe26*	Breaking rock

Source: [Oxfam (n.d.)]

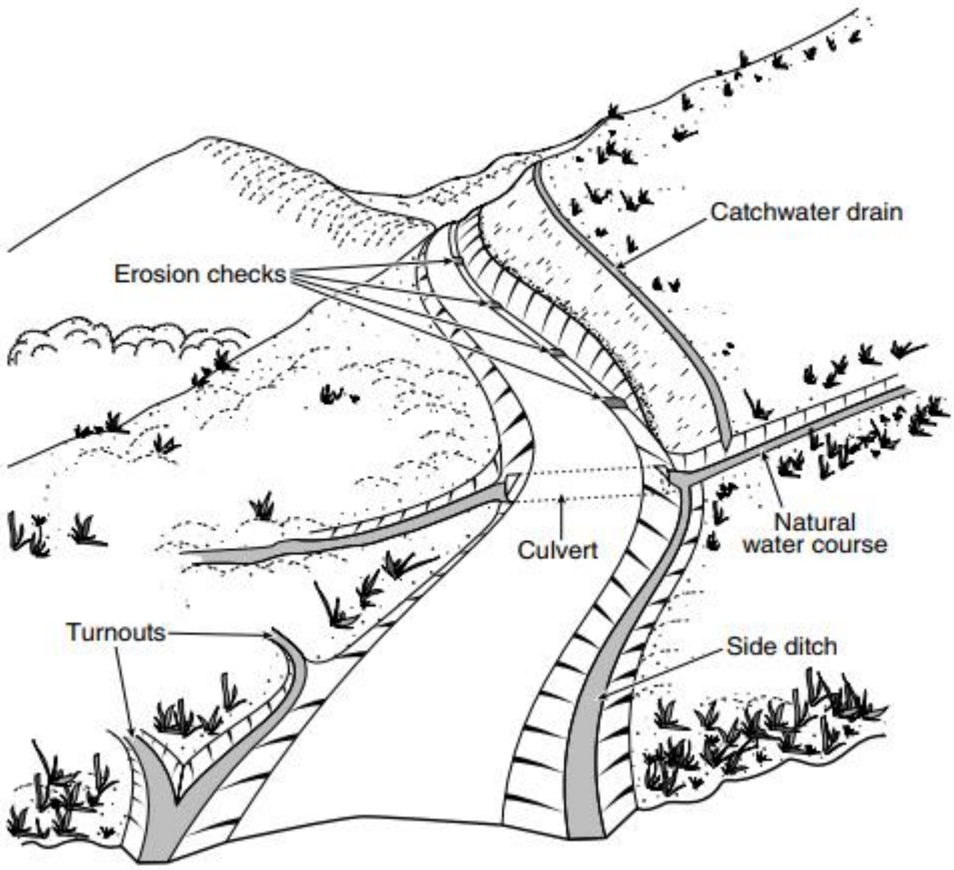
Accidents can be caused by loose heads or blunt instruments. Care must be taken to ensure that the tools are sharpened on a regular basis and that the handles are properly attached into the heads without additional wood being fitted into the gaps - as with any tools used for hard labour work. Men and women may have different preferences when it comes to tools. For example, when it comes to earthmoving, women may choose head-pans wherries while

males prefer wheelbarrows. Consult the users as their chosen tools whenever feasible, especially for large drainage projects.

Roads and drainage

Roads are necessary to maintain access at all times. This is especially crucial in medical situations where a car may be required to transport someone to the hospital. The most essential component of a road is drainage. If the drainage is good and the road surface is adequate, the road will be in a good shape. The figure below shows an example of a road drainage feature.

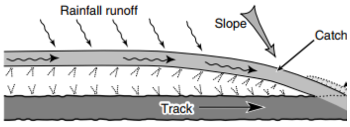
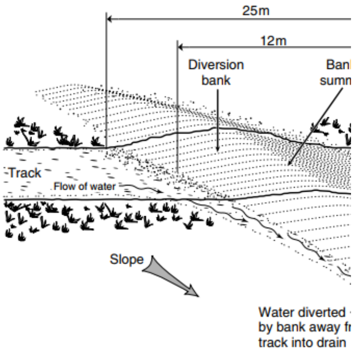
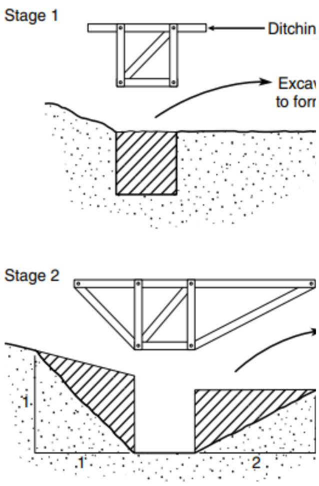
Figure 16: Example of road drainage feature (Davis and Lambert, 2002)

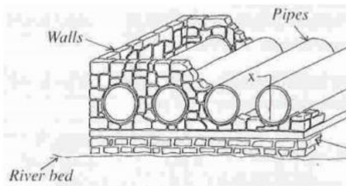


Drainage is divided into several types, with each type having its own function and applicable location. Please see the table below.

Table 40: Drainage based on the location

Type of drainage	Examples	Explanation

Catchwater drains		A diversion to avoid run-off from the higher ground causing substantial floods of the track or road. There may be a 3 – 5 metre digging of catchwater drain from the road edge.
Surface drainage		Small rise across a track which diverts water from the track to a side drain which flows the water away safely 250 m apart on flat ground 30 m apart in steep terrain in a wet climate
Side drainage		Drainage operates by excavating ditches or drains Side gradient: maximum 2 per cent or 3 per cent without erosion protection.
Drifts		Drain crossings with small flows that can be constructed of a range of sizes, with large stones, well-graded road gravel and small chippings, or have a surface of the concrete with weld mesh of reinforcement bars Maximum 5% slope

Culverts	 *Source: https://images.app.goo.gl/UZHfVoosFaJ7nXaf8*	Road crossing with 600mm diameter of pipe with headwalls to provide a visible indication of the edge of the road for vehicles and pedestrians
Vented fords		Cross between a pipe culvert and a drift to allow water to pass through the pipes under a road during normal flows

Source: Davis and Lambert (2002)

Maintenance of drainage systems

The context of the emergency will influence the design of drainage management system. In an emergency, cleaning the drainage system on a cash-on-work basis can occur occasionally. A community-based long-term maintenance programme might be explored in peri-urban areas. In both cases, people will need suitable equipment to clean the drain and remove the deposited debris from the edges of the drains so that it does not wash back in during the next rain.

Long-handled hoes, shovels or scoops, buckets or head-pans, wheelbarrows, gloves, waterproof boots, and overalls will be required if the labour is extremely filthy. Minor repairs may be required after each rainy season to preserve the integrity of stone pitches, built drifts, and culverts.

Local capacity

Local capacity should be included in the needs assessment because it reflects available resources.

- Local government
  Speak with the local authority in charge of highways to learn about current responsibilities and capabilities for road development and maintenance. Local governments may not have the funds to carry out major emergency work, but they may have the personnel, equipment,

and competence. Governments have set up their emergency agencies in certain situations and assigned staff to charge the various sectors.

- Contractors
  Examine the idea of contracting out certain tasks. Examine their abilities by looking at examples of their work and inspecting their tools.
- Local labour
  Inquire about local development concerns and their strategy to collaborative work with local development organisations. Emergencies disrupt ongoing development efforts. Check any minimum or maximum wages and the relevant labour laws.
- Access to materials
  Learn about the rules that govern access to, and ownership of, land and materials. There will be legal and customary procedures, both of which must be followed, even if they take time. River sand and gravel, for example, may be under the care of a person or community.

D. Summary

- The programme's sustainability will depend on: technical capabilities and financial self-sufficiency
- Personnel health and safety is critical to the success of any waste management programme and it must be considered from the start.
- Consultation and education can be used to involve the community.
- The number of people needed to manage a domestic waste collection and disposal operation is determined by the amount of trash, the size of the camp, and other considerations including access.

3.5 Identify learning and good practices on solid waste management and drainage facilities in different types of emergencies

A. Introduction

Learning from past emergencies and good practices is critical so that WASH actors have a more holistic understanding of what to focus on and avoid when implementing the programme.

B. Learning and good practices on solid waste management

Table 41: Good practices from urban flooding response

Good practices from urban flooding response
Background: Flooding is a common occurrence in many regions, and it may be welcomed in rural areas since floodwaters transport sediments that increase soil fertility. Deforestation, development in flood-prone areas, and obstruction of drainage systems are only a few examples of human activities that increase the likelihood of floods. **Good practices and lessons learned:** • There should be containers for storage supplied for the affected community • The container should be emptied on a regularly and the transport and collection should be provided by the stakeholder responsible • The site for disposal should be far from the camp and settlements with proper access for vehicle • The community can be involved and encouraged in clearing the area. The tools needed should be provided. • Effective communication through various media (local radio, newspaper, poster) is important in solid waste management

Table 42: Good practices in rural flooding response

Good practices in rural flooding response
Background: Flooding is a common occurrence in many regions, and it may be welcomed in rural areas since floodwaters transport sediments that increase soil fertility. In any WASH programme, including solid waste management, the main objective is to reduce the transmission of vector-borne diseases and reduce environmental health risks by promoting good hygiene practices and optimising the use of the facilities provided. **Good practices and lessons learned:** • Do not separate solid waste management, drainage facilities, and vector control. They are interconnected with one another • Include community and expertise in designing proper solid waste management • Storage and disposal facilities provision should be one of the first things to provide to the affected community after rural flooding • Provide proper household waste storage disposal containers, especially when the populations are displaced

Table 43: Good practices from Lebanon in 2011

Good practices from the Lebanon in 2011
<u>Background:</u> Since March 2011, Syrian citizens have borne the brunt of the country's growing conflict, causing waves of displacement that have affected an estimated 9 million people. If Palestinian refugees are included, one out of every four people in Lebanon is a refugee. **<u>Solid waste management during disaster:</u>** Lebanon has been suffering from a lack of resources and a faulty infrastructure before the Syrian conflict. According to a widely recognized statistic in the WASH industry, 92% of wastewater is released into the rivers untreated. **<u>Good practices:</u>** Solidarities International (SI), as WASH actors, established community WASH committees (CWC) to take over the WASH intervention, such as small-scale infrastructure, solid waste management, and hygiene promotion. CWC consists of 6 persons, led by a chairperson/supervisor. Each CWC is responsible for 25 households. CWC's role is to emphasize community engagement so that refugees have a greater sense of ownership for WASH activities in their area. For solid waste management, the implementation includes training and the chance to be a volunteer. There are also campaigns that: • Address issue of vectors and stagnant water caused by improper solid waste • Address behaviour change in solid waste management **<u>Results:</u>** • Participation of Syrian citizens in all decision-making • Immediate ownership of solid waste facilities • Absence of solid waste surrounding the household **<u>Lessons learned:</u>** • Community engagement and participation is important in WASH activities • It is a good investment to provide the local community with proper training

Table 44: Good practices from Haiti in 2010

Good practices from Haiti in 2010
<u>Background:</u> A 7.0 magnitude earthquake hit Haiti on January 12, 2010, with the epicentre in the city of Leogane, near the capital Port-au-Prince. The earthquake killed 222,570 people, wounded 300,000 people, and displaced 1,000,000 people. Around 250,000 residents and 300,000 commercial buildings collapsed or were badly damaged. **<u>Solid waste management condition before the disaster:</u>** There was not a reliable solid waste management system. There was a landfill that collected waste from all over the city. But it was mismanaged and not adequately maintained. There were limited institutional facilities for solid waste management. Solid waste was often found in the drains and rivers. **<u>Solid waste management condition after the disaster:</u>** Large-scale destruction of buildings buried everything below. The buildings that were still standing had to be demolished. There was a lot of debris and other construction

materials (concrete, hollow bricks) with municipal wastes piled up the street. The whole solid management system was collapsed.

Good practices:

- Prioritise debris waste clean-up by the local community and governments in the early days of emergency response
- Conduct cash-for-work programmes in the later months for debris management
- Dispose of the debris waste to coastal areas
- Utilise the existing landfill for household waste disposal and healthcare waste with a collection system
- Utilise the functional incinerator in certain hospitals to process the healthcare waste

Results:

- The management of the household, healthcare, and construction waste
- Awareness raising in Haiti regarding environmental sustainability

Lessons learned:

- Waste management planning has to keep up with implementation
- Debris waste has to be sorted as some may be more dangerous than the others (e.g., debris from school laboratories)
- Assess the existing condition of facilities properly and thoroughly

Table 45: Good practices from Turks and Caicos Island (TCI) in 2008

Good practices from Turks and Caicos Island (TCI) in 2008

Background:
On September 7 2008, Hurricane Ike struck Turks and Caicos Island (TCI) and the Great Inagua Bahamas Island with Category 4 storm on Saffir-Simpson Scale. 70% - 80% of houses were damaged, and 35% were severely damaged. There was a total of 348 in the shelters.

Solid waste management condition before the disaster:
There is already a solid waste management problem.

Solid waste management condition after the disaster:
The waste was mostly debris from collapsed infrastructure, followed by healthcare waste (sharps, needles), organic waste, natural debris (vegetation and trees), and human faeces. Waste also started to pollute the water sources. The existing disposal site created health risks because of the hazardous waste near the salt pond connected to the beach.

Good practices:

- Classify the hazardous and non-hazardous waste for collection
- Clean up debris in salt ponds and creeks
- Prioritise and manage the waste
- Collect, analyse and assess the groundwater's quality and other water sources to identify the health risk in the medium- and long-term

Results:

- The government prioritised high-risk waste programmes

- The involvement of experts to plan for long-term approach in solid waste management

Lessons learned:

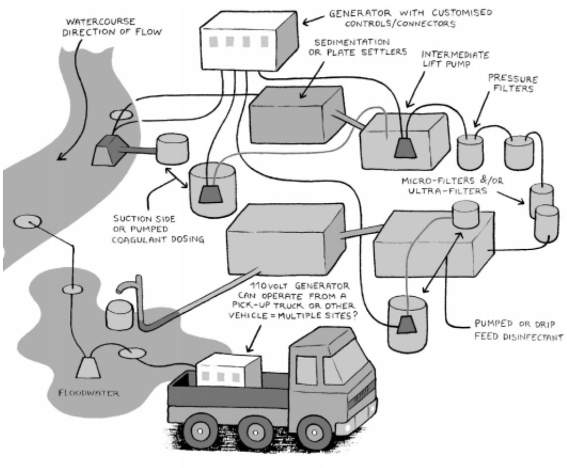
- The support from UN and local government is critically needed in an area such as TCI
- Impacts on fishing livelihoods and fish must be assessed
- Other water and sanitation infrastructure programme should be incorporated in the long-term plan

C. Learning and good practices on drainage

Table 46: Good practices from Sudan crisis in 2013

Good practices from Sudan in 2013
Background: South Sudan's civil war broke out in December 2013, creating a huge number of refugees. The crisis and displacement led to damages and losses of about US $20 million. The refugee camp Bantu in South Sudan has 50,000 inhabitants and is located in a low-lying area. **Drainage condition before disaster:** The low-lying refugee camp is often flooded during the rainy season. Surface water and foul drainage problems have affected the camp and refugees. A Dutch organisation designed surface water drainage systems and a levee to prevent surface water flooding around the camp. **Good practices:** • Build drainage systems that includes canals and pumping stations • Build levee systems (pumps, canals, surface and subsurface drains) • Combine management and engineering skills **Results:**

Scheme of the integrated system of water treatment and supply:



Lessons learned:

- The proper assessment should be conducted to decide where the camp should be located (e.g., local topography and hydrological conditions)
- Design the drainage system as a long-term project, since the camps usually become larger throughout the time
- Design a mechanism to regularly report the situation in the camp and standards for appropriate documentation. This will enable the analysis of programme impacts.

Table 47: Good practices from Jordan in 2013

Good practices from Jordan in 2013
Background: There was severe weather condition across northern Jordan in January 2013, including heavy rain, snow, and sub-zero temperatures. Flooding occurred, swamped tents, and overwhelmed drainage system across the camp. These weathers worsened the condition of 50,000 Syrian refugees in the Zaatari campsite. **Drainage condition before the disaster:** The proper drainage facilities constructions were still in progress with funding from United Arab Emirates (UAE). **Good practices:** • Build a drainage system by first collecting sewage from each household and transporting them to the main tank. Then, transporting surface water drainage and greywater to the wastewater treatment plant. • Build a drainage system that diverts excess surface water to serve agricultural needs.

D. Summary

- Learning from past emergencies and good practices is critical so that WASH actors have a more holistic understanding of what to focus on and avoid when implementing the programme.

Self-assessment Checklist

ONE ASEAN ONE RESPONSE

ASCEND

ADM.TEC.028.1

Learner's Guide

Self-assessment Checklist

Please use the checklist below to help you determine whether you are prepared to be assessed in this unit of competency. The boxes without tick mark indicate that there may be some areas you need to work on to become ready for assessment.

Instructions Please tick (✔) the box if your answer is yes	Questions
☐	Have I read the Learner Guide and understood its contents?
☐	Have I attended, participated in, and completed all training sessions and activities?
☐	Have I reviewed the learning resources to reinforce what I've learned in training?
☐	Am I able to demonstrate my understanding of each element and performance criteria of this unit of competency by writing a summary in my own words?
☐	Am I able to communicate how my experience, knowledge, skills-sets, and attitudes make me qualified and competent enough to perform the job related to this unit of competency?

Oral Interview and Written Test Guide

ADM.TEC.028.1

Learner's Guide

Oral interview and written test guide

This section guides candidates on how to communicate, demonstrate, or present evidence, responses, and their work in a professional manner. There are three primary ways the candidates will be assessed: through observation, oral interview, and written test. The assessor will determine the final assessment methods and tools depending on several factors like the local context, professional needs, and the like.

On observations

Assessors will observe the candidate over a period of time to collect evidence of their capability to meet the required standards and performance criteria. Assessors may attend selected learning sessions, if any, to witness how candidates complete their activities and participate in exercises. In doing so, assessors can get a sense of the candidate's key strengths and areas for improvement concerning the unit of competency. It will benefit candidates to ensure their work is always complete and presentable.

On oral interview

Assessors will conduct oral interviews to confirm and evaluate the candidate's experience, knowledge, skills, and attitudes regarding the unit of competency under assessment.

Please review the Unit Readings and complete the Self-assessment Checklist in this document. It may include verification questions about what you learned from the training content and material. It may also include competency questions about your knowledge and skills. Assessors may ask you what knowledge or skill you will use or apply to address a specific occupational issue or problem. Candidates need to think about how they will carry out their critical job functions in a defined work setting.

Finally, the interview may also include behavioural questions that focus on attitudes. Assessors may ask for examples of what you will do when a particular situation happens or when circumstances change. Candidates will need to support their answers with reflections on their own or others' experiences and the lessons learned from those.

On written tests

Assessors will also present a written test to candidates to confirm whether candidates learned and understood the training content and material concerning the unit of competency under assessment.

Accuracy, brevity, and clarity are the ABCs of good writing. The first thing candidates are suggested to do is answer the questions as accurately as possible. It helps structure your response and sharpen your main points in an outline before writing them down. Candidates are advised to use short and simple sentences and paragraphs. The key messages and transitions between your sentences and paragraphs must be clear. Your answers need to be easy to read and understand. It includes removing and leaving out irrelevant material. Candidates are also expected to write coherently and logically so that readers can follow their thought.

Proofread and correct errors in your work before submitting it. How you format your work also matters. If you are using a computer, please check whether your indentions, margins, spacing, listings (bullets, numerical sequencing), and page numbers are in order.

Recommended Readings

ASCEND

ONE ASEAN ONE RESPONSE

ADM.TEC.028.1

Learner's Guide

Recommended Readings

Gibbs, Michelle. (2007). *Best Practice Environmental Guidelines – Land Drainage* Accessible here.

Harvey, P. (2007). *Excreta Disposal in Emergencies.* Leicestershire: Water, Engineering and Development Centre, Loughborough University. Accessible here.

Harvey, P.A., Baghri, S. and Reed, R.A. (2002). *Emergency Sanitation: Assessment and programme design.* Leicestershire: Water, Engineering and Development Centre, Loughborough University. Accessible here

Humanitarian Innovation Fund. (2016). *Solid Waste Management Problem Exploration Report.* Accessible here.

Humanitarian Innovation Fund. (2016). *Surface Water Drainage Problem Exploration Report*. Accessible here.

IFC. (2007). *Environmental, Health, and Safety General Guideline.* Accessible here.

Options for Supplying Water during Floods: Smith, M. (2009). *Lessons learned in WASH Response during Urban Flood Emergencies*. Pg. 19. Accessible here.

Sphere Association. (2018). *The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response.* Accessible here.

UNOCHA. (n.d.) *Disaster Waste Management Guidelines*. Accessible here.

WHO. (2002). *Environmental health in emergencies and disasters: a practical guide.* Accessible here

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Learning Resources

Centers for Disease Control and Prevention and American Water Works Association. (2012). *Emergency Water Supply Planning Guide for Hospitals and Healthcare Facilities*. Atlanta: U.S. Department of Health and Human Services. Accessible here.

Training Evaluation Sheet

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ADM.TEC.028.1

Learner's Guide

Training evaluation sheet

Name of Training			
Competency unit title and number	**ADM.TEC.028.1** Provide Technical Guidance on Core Public Health Engineering Concepts		
Location of training		**Date of training**	

Instructions Please tick (✔) your level of agreement with the statements below	**Strongly Agree**	**Agree**	**Neither Agree or Disagree**	**Disagree**	**Strongly Disagree**
Training content and facility					
The training objectives were clearly defined and met.	☐	☐	☐	☐	☐
The training content was organised and easy to follow.	☐	☐	☐	☐	☐
The training material was relevant and useful to me.	☐	☐	☐	☐	☐
The training facility is adequate and comfortable.	☐	☐	☐	☐	☐

Training delivery and activities					
The trainers/presenters were knowledgeable and well prepared.	☐	☐	☐	☐	☐
The trainers/presenters were engaging and helpful.	☐	☐	☐	☐	☐
The length of the training was sufficient for learning.	☐	☐	☐	☐	☐
The pace of the training was appropriate to the content and attendees.	☐	☐	☐	☐	☐
The activities and exercises encouraged participation and interaction.	☐	☐	☐	☐	☐

What did you like most about this training?

What parts of the training could be improved?

Other comments and feedback:

Thank you for completing this training evaluation form.
Your response is appreciated.

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ASEAN Standards and Certification for Experts in Disaster Management

THE AHA CENTRE

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