Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

BORDA
JORDAN

Training Course in

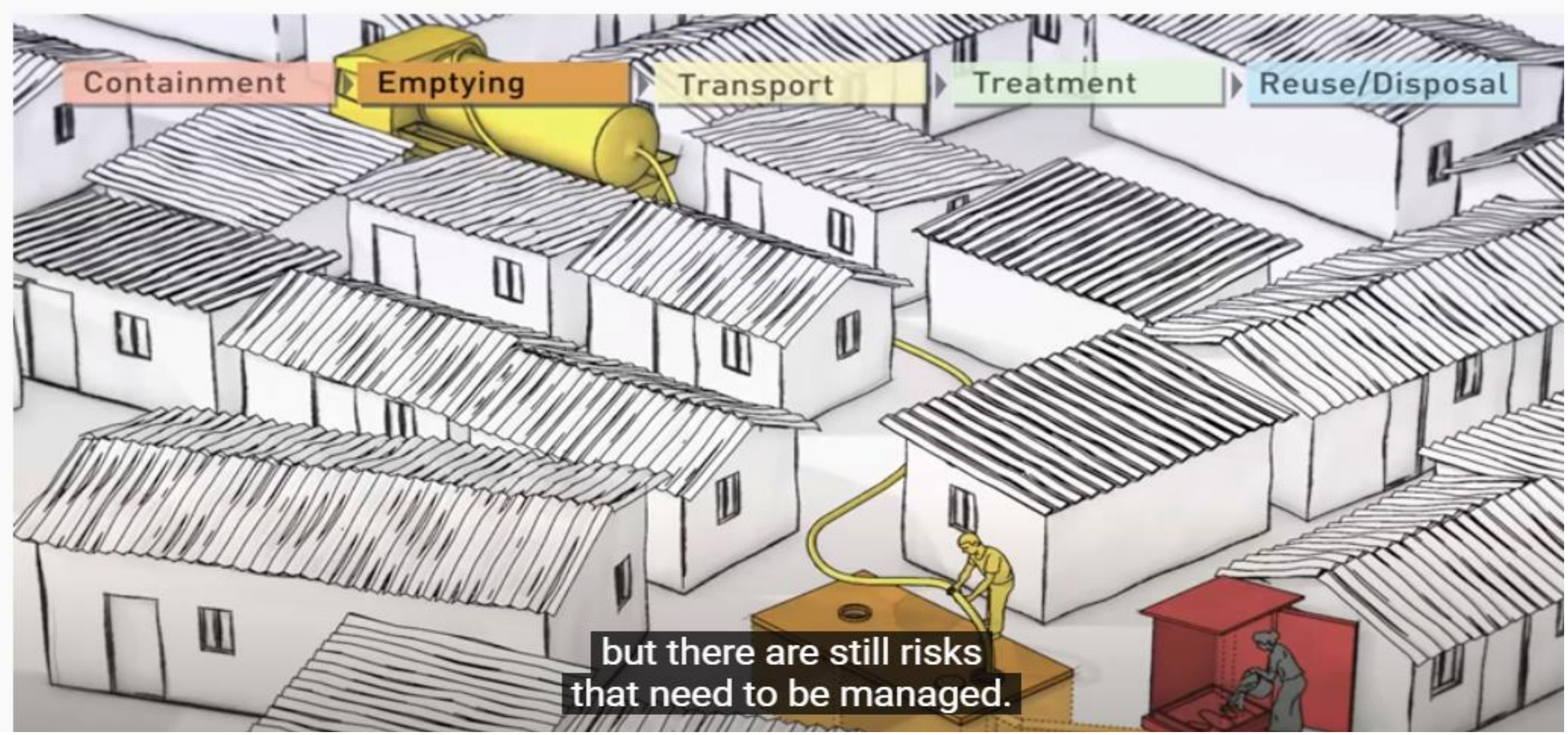
Sanitation safety planning (SSP) manual for safe use and disposal of wastewater greywater and excreta

Muayyad Elbado

First Day

An Introduction

(prevention is better than cure)

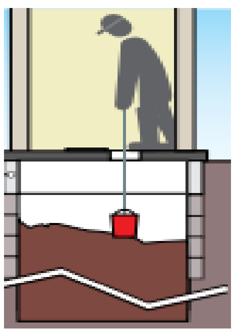


Sanitations:

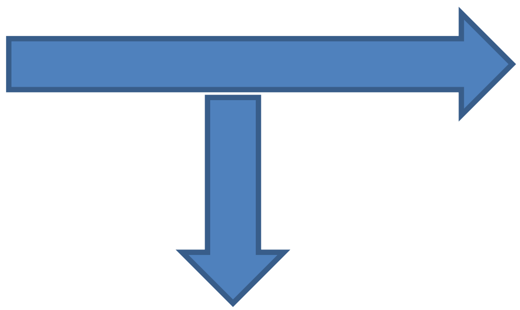
defined as access to and use of facilities and services for the safe disposal of human urine and faeces

Sanitation safety

Ensure universal access to safe systems along the entire sanitation service chain



safe systems



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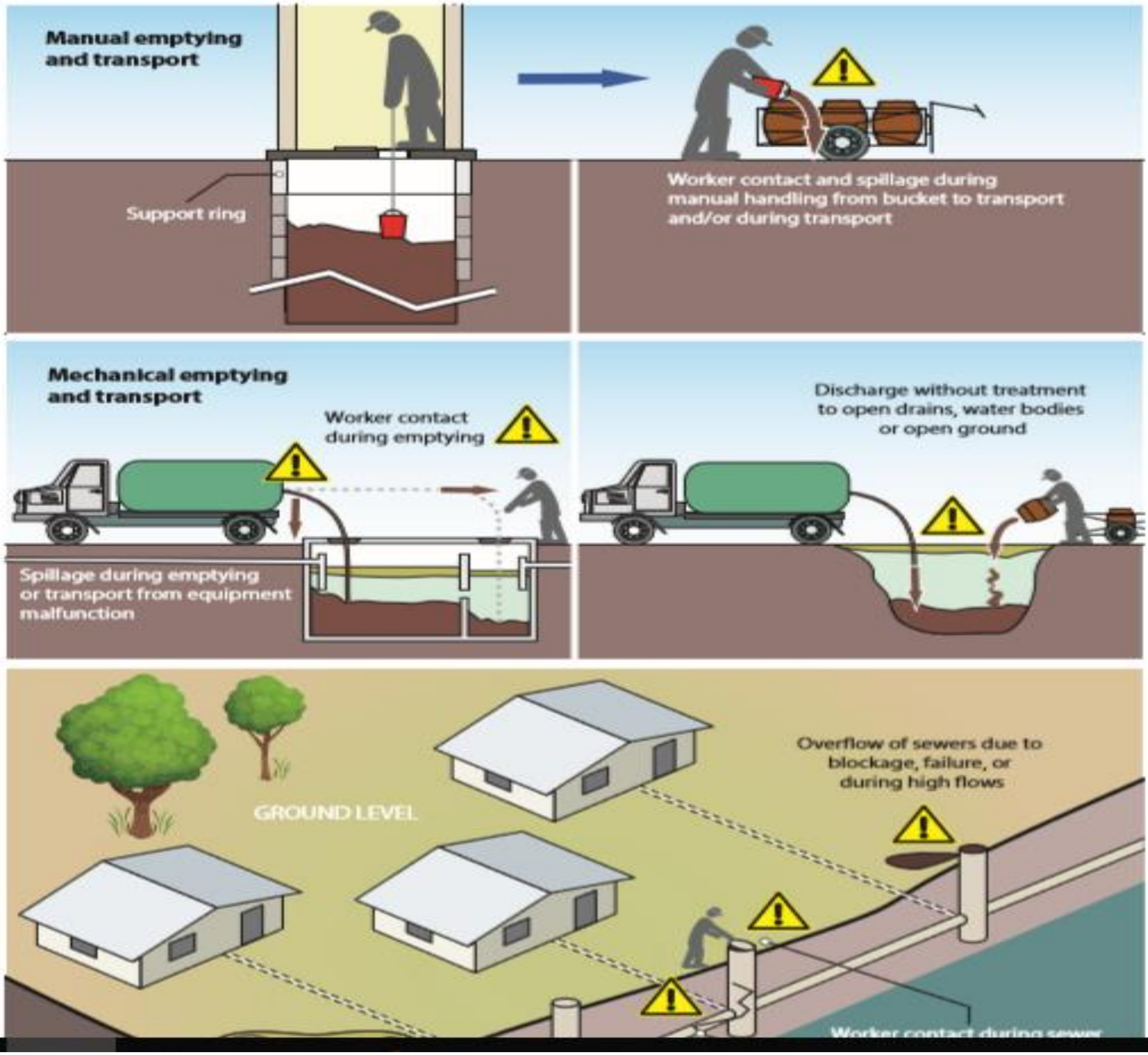
Sanitation safety



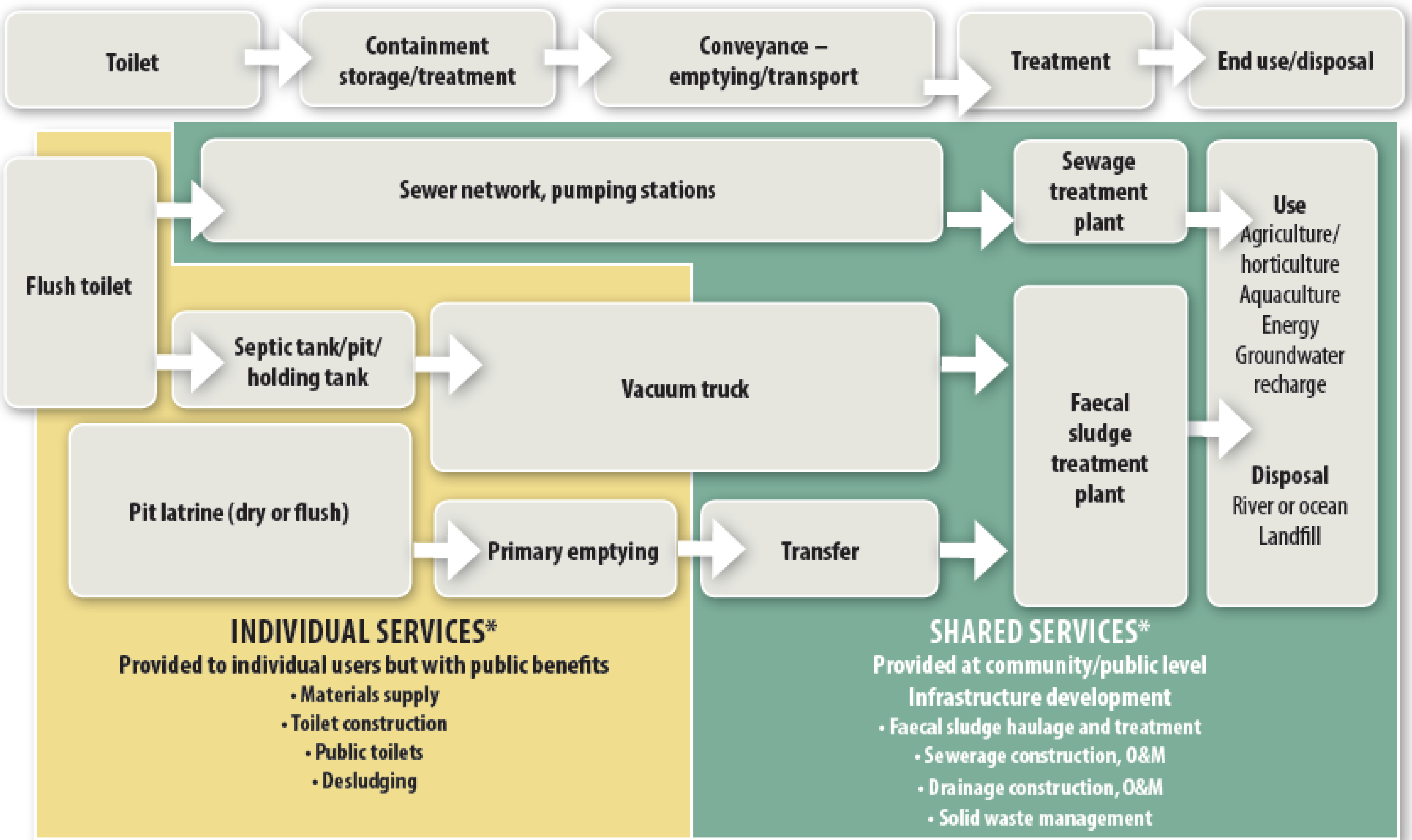
EX: Sanitation safety

Figure 4.5 The components of the SDG sanitation ladder (based on WHO and UNICEF, 2017)

SERVICE LEVEL	DEFINITION
SAFELY MANAGED	Use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated off-site.
BASIC	Use of improved facilities that are notshared with other households.
LIMITED	Use of improved facilities shared between two or more households.
UNIMPROVED	Use of pit latrines without a slab or platform , hanging latrines or bucket latrines.
OPEN DEFECATION	Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other spaces, or with solid waste.

sanitation service chain

Figure 4.1 Categorization of sanitation services



Box 1.2 Human right to sanitation (UN, 2015a)

The human right to sanitation entitles everyone to sanitation services that provide privacy and ensure dignity, and that are physically accessible and affordable, safe, hygienic, secure, socially and culturally acceptable. Human rights principles must be applied in the context of realising all human rights, including the human right to sanitation:

1. **Non-discrimination and equality:** All people must be able to access adequate sanitation services, without discrimination, prioritizing the most vulnerable and disadvantaged individuals and groups.
2. **Participation:** Everyone must be able to participate in decisions relating to their access to sanitation without discrimination.
3. **The right to information:** Information relating to access to sanitation, including planned programmes and projects must be freely available to those who will be affected, in relevant languages and through appropriate media.
4. **Accountability (monitoring and access to justice):** States must be able to be held to account for any failure to ensure access to sanitation, and access (and lack of access) must be monitored.
5. **Sustainability:** Access to sanitation must be financially and physically sustainable, including in the long-term.

The normative content of the human right to sanitation is defined by:

1. **Availability:** A sufficient number of sanitation facilities must be available for all individuals.
2. **Accessibility:** Sanitation services must be accessible to everyone within, or in the immediate vicinity, of household, health and educational institution, public institutions and places and workplace. Physical security must not be threatened when accessing facilities.
3. **Quality:** Sanitation facilities must be hygienically and technically safe to use. To ensure good hygiene, access to water for cleansing and handwashing at critical times is essential.
4. **Affordability:** The price of sanitation and services must be affordable for all without compromising the ability to pay for other essential necessities guaranteed by human rights such as water, food, housing and health care.
5. **Acceptability:** Services, in particular sanitation facilities, have to be culturally acceptable. This will often require gender-specific facilities, constructed to ensure privacy and dignity.

All human rights are interlinked and mutually reinforcing, and no human right takes precedence over another.

The Sustainable Development Goals (SDGs) and sanitation

Box 1.3 The Sustainable Development Goals (SDGs) and sanitation (UN, 2015b)

The SDGs provide a global framework for ending poverty, protecting the environment and ensuring shared prosperity. Goal 6 on clean water and sanitation (specifically targets 6.2 and 6.3 on sanitation and water quality respectively), and Goal 3 on good health and well-being, are particularly relevant to sanitation. Several other goals for which sanitation contributes or is necessary for achievement, including those on poverty (particularly 1.4 on access to basic services), nutrition, education, gender equality, economic growth, reduction in inequalities and sustainable cities. The SDGs also set out the principles of implementation for States to follow, including increasing financing, strengthening capacity of health workers, introduction of risk-reduction strategies, building on international cooperation and participation of local communities. Goal 1 states the need to improve the flow of information and increase monitoring capacities and disaggregation so that it is possible to identify which groups are being left behind.

Sanitation Safety Plane(SSP)

Sanitation Safety Planning (SSP) is a risk based management tool for sanitation systems

Why Sanitation Safety Planning:

- systematically identify and manage health risk along the sanitation chain
- guide investment based on actual risks, to promote health benefits and minimize adverse health impacts
- provide assurance to authorities and the public on the safety of sanitation-related products and services

FIGURE 1. SSP MODULES

MODULE 1: PREPARE FOR SSP

MODULES

1.1 Establish priority areas or activities
1.2 Set objectives
1.3 Define the system boundary and lead organization
1.4 Assemble the team

MODULE 2: DESCRIBE THE SANITATION SYSTEM

MODULES

2.1 Map the system
2.2 Characterize the waste fractions
2.3 Identify potential exposure groups
2.4 Gather compliance and contextual
2.5 Validate the system description

MODULE 3: IDENTIFY HAZARDOUS EVENTS, ASSESS EXISTING CONTROL MEASURES AND EXPOSURE RISKS

MODULES

3.1 Identify hazards and hazardous events
3.2 Refine exposure groups and exposure routes
3.3 Identify and assess existing control measures
3.4 Assess and prioritize the exposure risk

MODULE 4: DEVELOP AND IMPLEMENT AN INCREMENTAL IMPROVEMENT PLAN

MODULES

4.1 Consider options to control identified risks
4.2 Use selected options to develop an incremental improvement plan
4.3 Implement the improvement plan

MODULE 5: MONITOR CONTROL MEASURES AND VERIFY PERFORMANCE

MODULES

5.1 Define and implement operational monitoring
5.2 Verify system performance
5.3 Audit the system

MODULE 6: DEVELOP SUPPORTING PROGRAMMES AND REVIEW PLANS

MODULES

6.1 Identify and implement supporting programmes and management procedures.
6.2 Periodically review and update the SSP outputs

Module 1: PREPARE FOR SSP

Preparing for the SSP process requires clarity on the priority area, the specific public health objectives of the SSP and the components in the sanitation chain that need to be included to meet the objectives. Additionally a lead organization and team need to be identified. These should represent the various steps of the sanitation system.

Module 1.1 establishes the priority sanitation challenges for in-depth SSP, to ensure the SSP addresses the areas or activities that pose the greatest health risks

Module 1.2 focuses the SSP outputs by ensuring they respond to the agreed public health objectives for the system

Module 1.3 helps to drive and sustain the SSP process and to ensure that the scope is understood by all stakeholders and is manageable

Module 1.4 ensures broad stakeholder commitment to design and implement the entire SSP process. In sanitation systems this is particularly important, as responsibility along the sanitation chain is seldom the purview of one organization

Module 1.1

Considerations for selecting priority areas or activities include:

a) Coverage and performance of sanitation systems:

- all waste discharge, treatment, collection, processing, disposal and reuse points with particular emphasis on waste streams that receive inadequate or unknown treatment and high risk wastes (e.g. hospitals and industrial discharges);
- type and condition of toilets including location and frequency of open defecation;
- faecal sludge management, location and discharge, dumping or sludge use sites;
- untreated or partially treated wastewater discharges to stormwater drains and open channels, and their downstream impacts;
- activities in which human waste is mixed, processed or disposed with animal or solid wastes

Module 1.2

Typical SSP objectives

- To improve public health outcomes from the collection, treatment, reuse and/or disposal of human wastes in both formal and informal settings.
- To increase amenity of public parks by safe use of treated or partially treated wastewater or sludge.
- To ensure products produced using human waste are safe and consistently meet quality requirements.
- To protect the health of consumers of vegetables grown within the SSP boundary, the farmers who use the water for irrigation and the users of parks in contact with grass irrigated with treated wastewater or contaminated river water.
- To safeguard human health, promote the safety of workers and users, and enhance environmental protection.
- To promote national discussion and policy and regulatory changes for risk assessment and management approaches such as SSP.

1.3 Define the system boundary and lead organization

The SSP boundary should reflect the specific SSP objectives defined in Module 1.2. Clear boundaries need to be defined and a lead institution identified

The SSP boundaries may need to be defined to suit:

- the scope of operations of a sanitation business;
- administrative boundaries;
- sanitation catchment area;
- areas where waste products are used
- a specific product;
- protection of specific exposure group.

In practice, it is common that the boundaries do not fit neatly into any one of these classifications. Sub-systems within the overall system boundary can be defined. The lead organization does not need to be responsible for all sanitation steps within the boundary. Unlike WSPs, where institutional ownership rests with the water utility, the lead institution for SSP will depend on the boundary and purpose of the SSP.

1.4 Assemble the team

Conduct a stakeholder analysis and select expertise for the team.

Often the SSP process is initiated by one or several interested individuals or an organization. They, however, are unlikely to have the necessary skills to identify all the problems, represent the whole system, and drive improvements in all areas of the sanitation system.

In order to make the SSP successful, the initiator will need the support of:

- managers within the relevant organizations to allocate staff time and resources to the SSP effort;

- a team representing a range of technical skills along the sanitation chain and also stakeholders

TOOL 1.1

Stakeholder analysis

SANITATION STEP	STAKEHOLDER	ROLE OF STAKEHOLDER	MOTIVATING FACTORS	CONSTRAINING FACTORS
See Note 1	See Note 2	See note 2: Direct control, influence, affected by, or interest in	List factors which may motivate the stakeholder in adoption of a safe system	List factors which may demotivate the stakeholder in adoption of a safe system

Note 1: Examples of sanitation steps: waste generation, transport or conveyance of waste, treatment, use of product, application of the waste product for use, disposal, consumers or users of the waste produce.

Note 2: Stakeholders:

- have direct control over some aspects related to wastewater system and use (e.g. regulatory authority);
- have some influence over practices that affect wastewater use safety (e.g. farmer cooperatives);
- are affected by actions taken in the system to protect water quality (e.g. local community); or
- are interested in water quality (e.g. an NGO working with people affected by the system).

Volume 4, Section 10.2.2 of the 2006 WHO Guidelines on the Safe Use of Wastewater, Excreta and Greywater (WHO 2006) provides guidance and examples of stakeholders and stakeholder analysis.

TOOL 1.2

Suggested SSP team membership recording form

NAME/JOB TITLE	REPRESENTING	ROLE IN SSP TEAM	CONTACT INFORMATION

GUIDANCE NOTE 1.1

Checklist of issues to consider when identifying the SSP team and allocating responsibilities

- Are organizations (or stakeholders) for all steps of the sanitation chain represented?
- Are day-to-day technical operational skills included?
- Does one or more member have an understanding of management systems and emergency procedures?
- Do members have the authority to implement recommendations stemming from the SSP?
- How will the work be organized? Will the activities be regular or periodic?
- Can the team activities be done as part of regular activities?
- How will specific stakeholders not represented on the team be engaged?
- How will documentation be organized?
- What external technical support can be brought in to support the team?

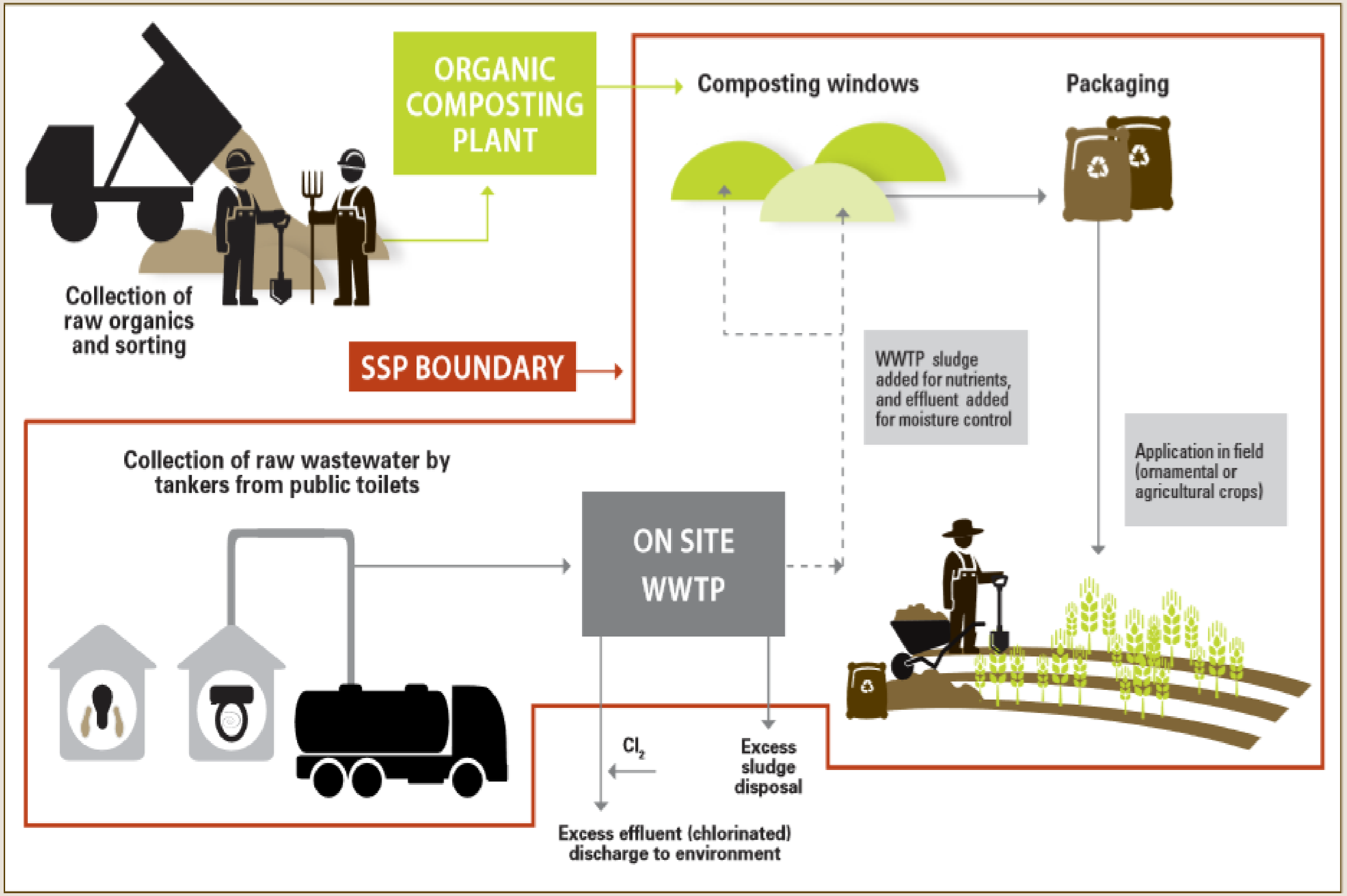
MODULE 2 DESCRIBE THE SANITATION SYSTEM

2.1 Map the system

Each SSP system is unique and its description and maps should, therefore, be specific.

The method chosen for mapping will depend on the scale and complexity of the system. For some projects it may be useful to map using a system flow diagram which tracks the path of all fractions of the waste. Where the SSP boundary covers a community or catchment, a geographic map may be more helpful.

Co-composting of municipal solid waste and faecal sludge



2.2 Characterize the waste fractions

The mapping exercise in Module 2.1 establishes the path of different waste fractions through the sanitation system.

In Module 2.2, the composition of the waste fractions is characterized. This is an important preparatory step for the hazard identification in Module 3.1 and one that helps to identify factors that will affect system performance, especially the performance of treatment steps. Once the likely components of the raw waste or treated waste are understood, the SSP team can be more focused (in Module 2.4) in collating and collecting data about the health hazards that are likely to be associated with the use of the waste or wastewater

The waste characterization aims to identify all the different fractions of the waste streams in the sanitation system

2.3 Identify potential exposure groups

The identification of potential exposure groups aims at categorizing people that may be exposed to a particular hazard. This enables a further prioritization both for control strategies as well as for potential exposure groups in the risk assessment under Module 3. Their initial identification and characterization is an integral part of Module 2.

Tool 2.1 shows the usual broad classifications of exposure groups used in SSP. The broad classifications of exposure groups may be added to the system map developed in Module 2.1. In Module 3.2, these broad exposure groups will be refined and defined into subgroups to aid the detailed hazard risk assessment

GUIDANCE NOTE 2.4 Waste fractions and associated potential health hazards

Waste fractions and associated potential health hazards

	WASTE COMPONENTS									
	POTENTIAL BIOLOGICAL HAZARDS					POTENTIAL CHEMICAL HAZARDS		POTENTIAL PHYSICAL HAZARDS		
	Viruses	Bacteria	Protozoa	Helminths	Vector-related diseases	Toxic chemicals	Heavy metals	Sharp objects	Inorganic material	Malodours
Liquid waste fractions										
Diluted excreta (human or animal)	□	□	□	□						□
Urine (human or animal)	□	□	□	□						□
Domestic waste water	□	□	□	□	□			□	□	□
Stormwater	□	□	□	□	□	□	□	□		
River water	□	□	□	□	□	□	□			
Industrial wastewater (Note 1)						□	□			
Solid waste fractions										
Faecal sludge	□	□	□	□	□			□	□	□
WWTP sludge	□	□	□	□	□	□	□	□	□	□
Organic domestic waste	□	□			□					
Inorganic domestic waste						□	□	□	□	
Agricultural waste (crop residuals)	□	□	□	□	□			□	□	
Gardening waste					□				□	
Animal manure/slurry	□	□	□	□	□				□	□
Medical waste	□	□	□	□		□	□	□	□	□
Industrial waste						□	□	□	□	□
Slaughter house waste	□	□	□	□	□		□			□
Construction and demolition waste								□	□	

2.5 Validate the system description

Module 2.5 validates the system description through field or other investigations. This should be carried out while completing Modules 2.1 to 2.4 to ensure that the information is complete and accurate. System validation should also provide evidence of the stated system characteristics and system performance (e.g. claimed treatment efficiency).

GUIDANCE NOTE 2.5

Compiling biological hazard information

- The control measures defined by the WHO 2006 Guidelines address **bacterial, viral and protozoan** contamination combined without distinguishing between different types and species. An important indicator, however, for assessing pathogen loads in faecally contaminated waste, as well as treatment efficiency of control measures, is the concentration of *Escherichia coli* as a reference organism.
- The presence and frequency of different **helminth** infections is context specific. As the species and concentration of helminth eggs in waste influence the design of control measures, it is important to determine which helminth species are endemic in the study area.
- When waste-fed aquaculture is of concern in the given sanitation system, special attention needs to be paid to food-borne trematodes and schistosomiasis, since transmission of those disease agents involves fish, aquatic plants or exposure to contaminated water (see WHO 2006 Guidelines Vol. 3).
- **Vector-related diseases**
  These are linked to sanitation systems in two ways. Firstly, stagnant parts of drainage systems, treatment ponds or stored waste may serve as breeding sites for insect vectors. This not only results in nuisance to workers and nearby communities but also increases the risk for transmission of vector-related diseases. Secondly, flies can, in addition to breeding in waste, feed on it (e.g. faecal sludge) and subsequently mechanically transfer pathogens to a person or food items.
- Against this background, it is recommended that the SSP team determines which insect vectors are of public health concern in the study area and which vector-related diseases they may transmit.
- **Potential data sources**
  To obtain information on the presence or absence of a specific disease or pathogen, a desktop literature review may give additional information. Information can also be obtained from public health authorities (e.g. Ministry of Health), which have access to the routine health information system, but this information often underestimates disease prevalence and is dependent on the existing medical surveillance system. Consultation of personnel working in health facilities within, or in proximity to, the study area is also a useful way to obtain the information required. Ideally, different data sources are consulted for obtaining reliable information.

Compiling chemical hazard information

- **Chemical contaminants** in waste are a critical issue since they often pose considerable health risks and are difficult to control/eliminate. Toxic chemicals (e.g. insecticides, pesticides, pharmaceuticals) and heavy metals persist and may accumulate in water bodies, soils and animals. Where toxic chemicals or heavy metals have been identified as a potential health hazard under the waste characterization (Module 2.2), information on the type of chemical pollutants and, if possible, concentrations need to be determined.

  For assessing the suitability of use of a given waste (e.g. treated wastewater), the soil concentration of potential receiving soils needs to be taken into account. See Annex 3 for maximum tolerable soil concentrations of various toxic chemicals based on human health protection.

  Additional comments on chemicals are given in Module 5 – see Guidance Note 5.5.

- **Potential data sources:**
  In the first instance, environmental authorities should be contacted for information on potential data sources (e.g. existing environmental monitoring programmes) on chemical concentrations in different media (e.g. wastewater, river water).

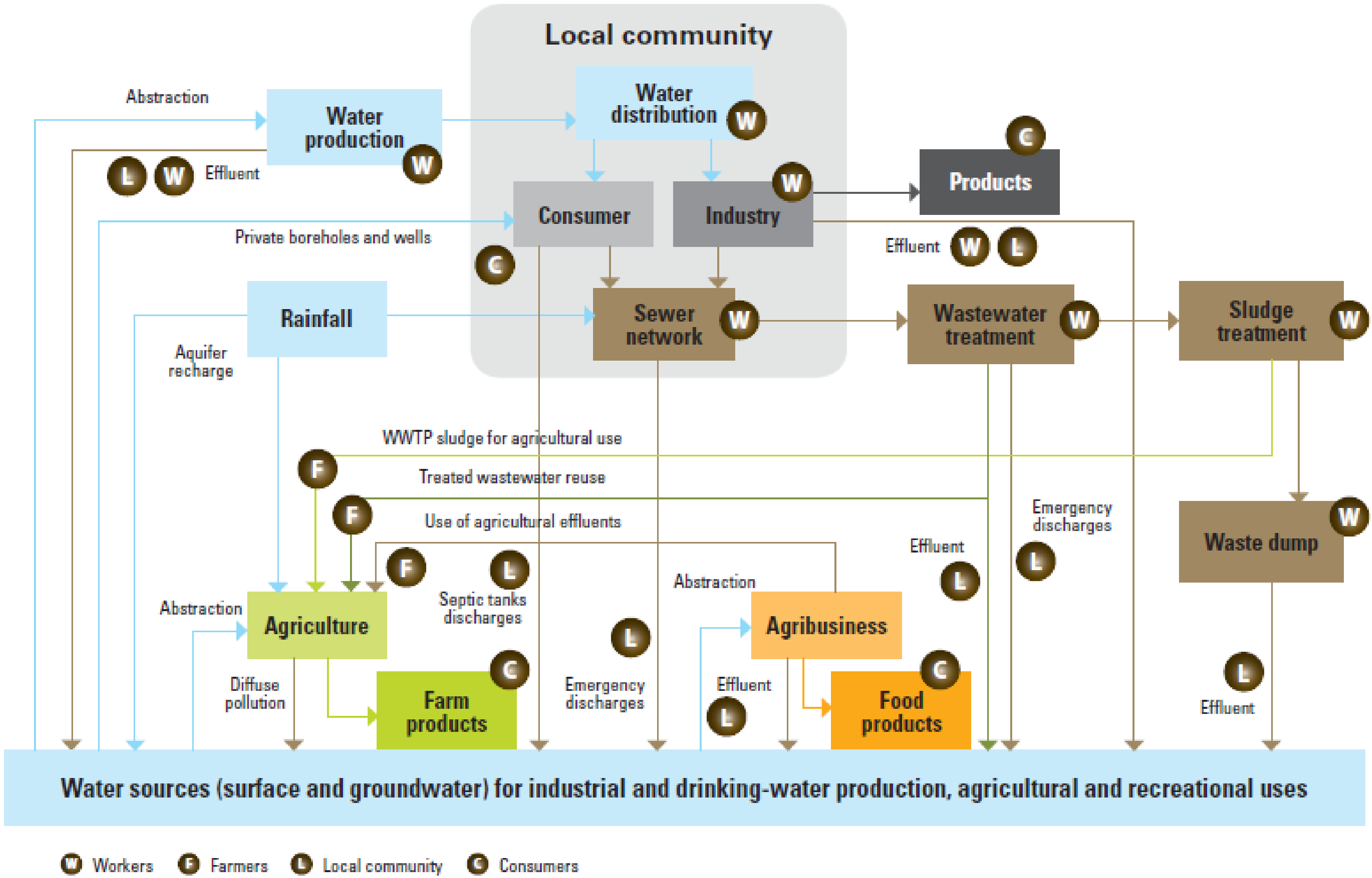
  In addition, existing WWTP may have ongoing monitoring activities that can provide valuable data on chemical hazards. Industrial entities or published references (e.g. Thompson et al., 2007) may also be consulted where industrial waste is of concern.

  In case of poor data availability, the collection and analysis of environmental samples that are obtained from specific waste fractions or environmental media may be warranted.

Compiling physical hazard information

Physical hazards such as **sharp objects** (e.g. broken glass, razor blades, syringes), contamination with **inorganic material** and **malodours** are often general characteristics of the given waste or linked to a mixture of different waste streams (e.g. razor blades and plastic bags being mixed in faecal sludge). Since the presence or absence of physical hazards has important implications for health risk mitigation, it is important to build up a thorough understanding of the composition and characteristics of the waste as part of the waste characterization.

Additional data sources only need to be consulted based on specific needs detected.


Local community
Abstraction
Water production
Water distribution
Effluent
Consumer
Industry
Products
Private boreholes and wells
Effluent
Rainfall
Sewer network
Wastewater treatment
Sludge treatment
Aquifer recharge
WWTP sludge for agricultural use
Treated wastewater reuse
Use of agricultural effluents
Emergency discharges
Waste dump
Effluent
Abstraction
Septic tanks discharges
Abstraction
Agriculture
Agribusiness
Diffuse pollution
Farm products
Emergency discharges
Effluent
Food products
Effluent
Water sources (surface and groundwater) for industrial and drinking-water production, agricultural and recreational uses
Workers
Farmers
Local community
Consumers

TOOL 2.1

Exposure group categories

SYMBOL	SHORT NAME	SHORT DESCRIPTION
W	Workers	A person who is responsible for maintaining, cleaning, operating or emptying the sanitation technology.
F	Farmers	A person who is using the products (e.g. untreated, partially or fully treated wastewater, biosolids, faecal sludge).
L	Local community	Anyone who is living near to, or downstream from, the sanitation technology or farm on which the material is used, and may be passively affected.
C	Consumers	Anyone who consumes or uses products (e.g. crops, fish or compost) that are produced using sanitation products.

Second Day
Module 3

MODULE 3 IDENTIFY HAZARDOUS EVENTS, ASSESS EXISTING CONTROL MEASURES AND EXPOSURE RISKS

MODULES 3:

3.1 Identify hazards and hazardous events
3.2 Refine exposure groups and exposure routes
3.3 Identify and assess existing control measures
3.4 Assess and prioritize the exposure risk

3.1 Identify hazards and hazardous events

Hazard and hazardous event identification helps to focus efforts in the subsequent risk assessment. Example 3.1 shows typical health hazards in sanitation systems. Before commencing on this step it is important to understand the subtle difference between hazards and hazardous events (see Guidance Note 3.2

3.1.1 Hazard and exposure reduction

Box 3.2 Definitions (WHO, 2016)

Risk: The likelihood and consequences that something with a negative impact will occur.
Hazard: A biological, chemical or physical constituent that can cause harm to human health.
Hazardous event: any incident or situation that introduces or releases the hazard (i.e. faecal pathogens) to the environment in which people are living or working, or amplifies the concentration of the hazard in the environment in which people are living or working, or fails to remove the hazard from the human environment.

HAZARD	HAZARDOUS EVENT	CAUSE OF THE HAZARDOUS EVENT AFFECTING ITS FREQUENCY OR SEVERITY	APPROACHES TO CONTROL THE HAZARDOUS EVENT	PEOPLE GROUP EXPOSED TO THE HAZARD
Pathogens in raw sewage	Exposure to raw sewage from	• Conveyance system undersized	• Design standards to establish	People living adjacent to the sewer

3.2 Refine exposure groups and exposure routes

The broad classification and the location of exposure groups identified in Module 2.3 should be described in more detail.

While some exposure groups, such as waste handlers, are easy to identify, others will be more difficult (e.g. communities accessing nearby groundwater sources, seasonal labour, informal settlements or immigrant populations). Demographics, such as gender, age and potential social exclusion of the exposure groups, should be noted when it will have an impact on the risk associated with the hazardous events. If unsure, include such groups until such time that they can be ruled out.

Figure 1.1 Transmission of excreta-related pathogens

EXAMPLE 3.3

Examples of control measures, their expected control performance and common performance failures

CONTROL MEASURE	EXPECTED CONTROL LEVEL, see note	COMMON CONTROL FAILURE IDENTIFIED THROUGH VALIDATION
Personal protective equipment (PPE).	Barrier to dermal and aerosol contact for workers.	Waste handlers only use PPE during cool season leading to exposure risk during in 7 of 12 months pe year.
Waste stabilization ponds.	Treating waste to a specified number of coliforms per 100ml	Poor design, overloading or short circuiting leading to reduced retention times and lower quality effluent.
	Reduction of helminth eggs to less than 1 per litre.	
Irrigation application: Use of localized drip irrigation.	High level of worker protection (2 log reduction potentially credited).	Clogging of the pipes means that workers are potentially exposed to wastewater during repairs.
Irrigation application: Pathogen die-off after last irrigation and before harvest.	Actual log reductions are dependent on crop type and temperature and are site specific.	Inconsistent use in the field in dry conditions when alternative fresh water supply is limited. As the reduction rate is highly variable, if helminth eggs remain viable for long periods (e.g. in cooler weather with little direct sunlight) irrigation water with more than targeted maximum number of helminth eggs is vulnerable to failure of control.
Food preparation methods: Vigorous washing of rough-leafed salad crops.	1 log reduction.	Inconsistent use by householders especially the poor and those with limited water supply.

Note: See Module 4 and Annex 1 for more information on how to judge the effectiveness or the expected outcomes from control measures.

3.3 Identify and assess existing control measures
For each hazardous event identified in Module 3.1, identify what control measures are already in place to mitigate the risk of that hazardous event. Then determine how effective the existing control measure is at reducing the risk of that hazardous event; this can be challenging but information on control measures is provided in Guidance Note 3.4 and Annex 1.

GUIDANCE NOTE 3.4

Control measures

Control measures are any action and activity (or barrier) that can be used to reduce, prevent or eliminate a sanitation-related hazard, or reduce it to an acceptable level. A barrier is a part of the conveyance, transport, treatment or handling chain that substantially reduces the number of pathogens along a pathway. A multiple barrier approach (i.e. the use of more than one control measure as a barrier against hazards) is recommended.

TYPE OF CONTROL MEASURE	EXAMPLES
Treatment	• physical settling (e.g. settling tank); • bacterial process (e.g. activated sludge); • adsorption (e.g. in constructed wetlands); • biological inactivation (e.g. composting); • chemical inactivation (e.g. sludge drying (controlled by of pH, temp) and disinfection).
Non-treatment	• crop selection; • irrigation type; • withholding times; • control of intermediate hosts and vectors; • vaccination and preventive chemotherapy.
Non-technical	• use of personal protective equipment; • restricted access to treatment or use sites; • produce disinfection, washing and cooking. Note: Behavioural controls are often in combination with the treatment and non-treatment barriers. Behaviour practices are dependent on individual values and preferences (e.g. fears, phobias, habits), constraints (e.g. cost, time, interest), sense of responsibility, and social-cultural perceptions and practices and can be reinforced with health and hygiene promotion.

Based on Stenström et al. (2011).

Sanitation systems should provide a series of barriers against different types of or hazards. That is, a multi-barrier approach is recommended. Put another way, good sanitation systems provide several controls along the entire pathway to reduce the risks to human health.

In systems in which the waste product is used (e.g. in agriculture or aquaculture), an understanding of the exposure pathways and transmission routes aids

3.4 Assess and prioritize the exposure risk

The hazard identification in Module 3.1 will yield a large number of hazards and hazardous events, some of which will be serious while others will be moderate or insignificant. Module 3.4 establishes the risk associated with each, so that the SSP team can prioritize interventions.
For SSP, different approaches to risk assessment are proposed with varying degrees of complexity and data requirements:

1. Team-based descriptive risk assessment decision.
2. Semi-quantitative risk assessment, using a matrix of likelihood and severity.
3. Quantitative methods

Team-based descriptive risk assessment

The team-based descriptive risk assessment method involves using the SSP team's judgement to assess the risk of each hazardous event by classifying them according to high, medium, low or uncertain/ unknown risk. These definitions can be defined by the SSP team or those given in Tool 3.2 can be used. However, the principle of safeguarding public health should never be compromised in any definitions.
If the team-based descriptive approach is used, the team may choose to conduct a semi-quantitative risk assessment in the next revision of the SSP. In either case, it is important to record the basis of the decision as this acts as a reminder to the team and/or an auditor or reviewer, on why a particular decision was taken at the time.

Semi-quantitative risk assessment

A more rigorous approach is the semi-quantitative risk assessment. This is appropriate for organizations in well-defined regulatory environments, SSP teams that are already familiar with HACCP or WSP methodology, or SSP teams working on the second or later revision of the SSP process

Suggested risk category descriptions for the team-based descriptive risk assessment

RISK DESCRIPTOR	NOTES
High priority	It is possible that the event results in injuries, acute and/or chronic illness or loss of life. Actions need to be taken to minimize the risk.
Medium priority	It is possible that the event results in moderate health effects (e.g. fever, headache, diarrhoea, small injuries) or unease (e.g. noise, malodours). Once the high priority risks are controlled, actions need to be taken to minimize the risk.
Low priority	No health affects anticipated. No action is needed at this time. The risk should be revisited in the future as part of the review process.
Unknown priority	Further data is needed to categorize the risk. Some action should be taken to reduce risk while more data is gathered.

TOOL 3.4

Semi-quantitative risk assessment matrix

			SEVERITY (S)				
			Insignificant	Minor	Moderate	Major	Catastrophic
			1	2	4	8	16
LIKELIHOOD (L)	Very unlikely	1	1	2	4	8	16
	Unlikely	2	2	4	8	16	32
	Possible	3	3	6	12	24	48
	Likely	4	4	8	16	32	64
	Almost Certain	5	5	10	20	40	80
Risk Score R = (L) x (S)			<6	7–12		13–32	>32
Risk level			Low Risk	Medium Risk		High Risk	Very High Risk

EXAMPLE 3.1

Typical hazards types in sanitation systems

HAZARD TYPE	EXAMPLES
Microbial pathogens	Bacteria, parasitic protozoa and viruses in wastewater from faecal sources (e.g. *Vibrio cholera, Giardia intestinalis,* Coxsackievirus, Hepatitis E). Helminths (e.g. *Ascaris lumbricoides*, hookworm). Vector-borne pathogens (e.g. dengue virus, *Schistosoma* spp.).
Chemicals	Heavy metals in sludge or biosolids from industrial sources (e.g. arsenic, cadmium, mercury). Herbicides and pesticides. In specific situations compounds relate to crop productivity (e.g. boron).
Physical	Sharps (e.g. needles). Odours. Physical injury to workers from equipment. Skin irritants (these are a mixture of microbial and chemical hazards).

Note: Algal toxins may also occur. Cyanobacteria (also known as blue-green algae) occur widely in lakes, reservoirs, ponds and slow-flowing rivers. Many species are known to produce toxins, a number of which have potential health concerns.

EXAMPLE 3.2

Hazardous events – typical considerations

Hazardous events specifically considered:

- the different sources of wastes identified in the system map;
- seasonal or climatic factors (e.g. flow rate variations, increased toxin chemicals in the dry season, seasonal irrigation demands);
- impacts of upstream urban and industrial development;
- system failures or accidents (e.g. chemical contamination from failure or illegal discharges from industries, damage to irrigation infrastructure results in bypassing of on farm pond treatment step).

See Examples 1.5 and 1.11 for background.

Practical Example:
Gray Water Treatment

Third Day
Module 4+5

MODULE 4 DEVELOP AND IMPLEMENT AN INCREMENTAL IMPROVEMENT PLAN

MODULE 5 MONITOR CONTROL MEASURES AND VERIFY PERFORMANCE

MODULE 4 DEVELOP AND IMPLEMENT AN INCREMENTAL IMPROVEMENT PLAN

Module 4.1 encourages SSP teams to consider a variety of ways to control risks. These may include short and long term plans, treatment, non-treatment and behaviour options, and a range of locations along the sanitation chain.
Module 4.2 consolidates the options into a clear plan of action.
Module 4.3 implements the improvement plan with action taken by the organization responsible for the respective improvements.

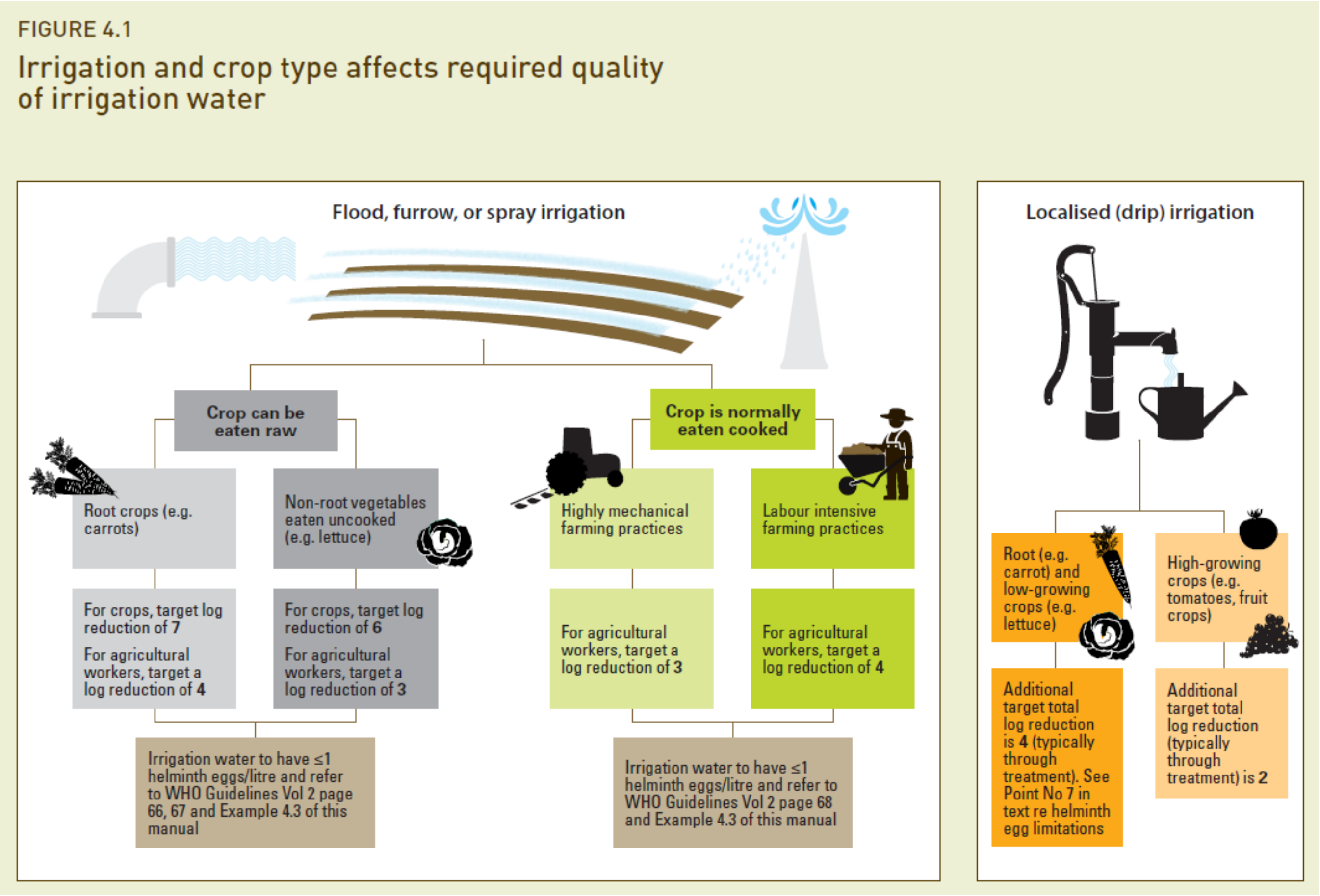
Module 4.1 encourages SSP teams to consider a variety of ways to control

From Module 3 the SSP team will have a comprehensive list of hazards and hazardous events ranked according to risk.
The SSP team should consider a range of options to control the prioritized hazardous events in order to reduce the risk level. Having done that, the SSP team documents the chosen method in an improvement plan

Improvement plans can be:

- capital works (e.g. additional or new treatment plant or process element, fencing of plant for access restriction);
- operational measures (e.g. crop restrictions, longer retention times, vector-control);
- behavioural measures (e.g. improved personal protective equipment, health education, regular medical check-ups, behavioural and protective measures);
- a combination of the above

Example 4.1 shows types of improvement plans and control measures. Annex 1 gives many examples of reuse-related control measures together with comments on their effectiveness in reducing risks



4.2 Use selected options to develop an incremental improvement plan

Once the most appropriate control measures for each risk have been identified the SSP team can record the planned new and improved controls in an improvement plan. The forms used in Worked example: SSP in Newtown can be used as a template for the improvement plan.

Some risks may need actions from more than one organization represented in the SSP team or other stakeholder. In cases where multiple stakeholders are identified for the implementation of the improvement plan, the Steering Committee (Module 1.1) or SSP lead organization (Module 1.3) should take responsibility for agreeing the outcome of the risk assessments and identifying what actions are required.

EXAMPLE 4.3

Improvement plan options for helminth egg control

Hazard: Helminth eggs

Hazardous event: Exposure to partially treated wastewater in the field by farmers or children (under 15 years) causes helminth infections.

Control measure options and considerations:

1. Wearing shoes or boots can reduce the likelihood of exposure to the hazard. However, because this control measure is often not practical or used by the farmers or children in the field, it cannot be relied upon.
2. Providing some simple wastewater treatment upstream of the irrigation area (e.g. properly sized simple detention pond to reduce the concentration of helminth egg to less than 0.1 egg/litre) can reliably reduce the number of helminth eggs to desirable concentrations (see 2006 WHO Guidelines Vol. 2, 84-86).
3. Regularly providing de-worming medicines to waste handlers (e.g. workers exposed to faecal sludge) can reduce the duration and intensity of infection. In settings where helminth infections are very common, de-worming medicines may also be regularly distributed at community level (e.g. in school children) for reducing prevalence rates.

EXAMPLE 4.4

Organic composting SSP improvement plans, Viet Nam

Some of the key improvement plans for this system are summarized below:

Short term plans:

- Internal training on the importance of workplace health and safety specifically related to the risks identified.
- Review technical operations and procedures to reduce risks related to vacuum tanker operation and addition of wastes to compost from the on-site treatment plant (e.g. re-instatement of broken pump to transfer treated effluent from the sewage plant to the compost piles rather than using vacuum tanker).

Medium/long term plans:

- Improved and increased vehicle and equipment maintenance to reduce the likelihood of mechanical breakdowns (during which workers are more exposed to hazards).
- Upgrade the toilets to reduce risk to workers and the public using the facilities.

Refer to Examples 1.4 and 2.1 for background.

4.3 Implement the improvement plan

The SSP team should monitor and report on the implementation status of the improvement plan to ensure that action is taken.

MODULE 5 MONITOR CONTROL MEASURES AND VERIFY PERFORMANCE

Module 5.1 regularly monitors control measures to give simple and rapid feedback of how effectively the control is operating so corrections can be made quickly if required.

Module 5.2 periodically verifies whether the system meets the intended performance outcomes such as quality of effluents or products. Verification may be undertaken by the operator or surveillance agency and will be more intensive in situations with greater resource and/or strict regulatory requirements

5.1 Define and implement operational monitoring

In Modules 3 and 4 a range of existing and proposed control measures were identified. The purpose of Module 5.1 is to select monitoring points and parameters to give simple and rapid feedback that key selected control measures are operating as intended and to provide trends over time.

Typically, operational monitoring collects data from:

- simple observations and measures (e.g. flow rate to check on detention times, temperature of composting, observations of onfarm practices);
- sampling and testing (e.g. chemical oxygen demand, biochemical oxygen demand and suspended solids

Guidance Note 5.1 gives some examples of typical operational monitoring.
Monitoring of all control measures may not be practical. The most critical monitoring points, based on the control of the highest risks, should be selected. The following aspects should be identified for each of the monitoring points:

- parameter (may be measured or observational);
- method of monitoring;
- frequency of monitoring;
- who will monitor;
- a critical limit;
- an action to be undertaken when the critical limit is exceeded.

Critical limits are usually numerical limits based on a parameter measurement. In some cases, qualitative limits are appropriate (e.g. “all odours to be acceptable” or “flies not a nuisance”).

SSP teams may use the formats shown in Tools 5.1 and 5.2 to record the operational monitoring plan (see also Example 5.1).

Operational monitoring plans can be implemented by collating the plans into field-friendly monitoring tables or log books

GUIDANCE NOTE 5.1

Some typical operational monitoring in SSP

Operational monitoring is the routine monitoring of parameters that can be measured rapidly (through tests that can be performed quickly or through visual inspection) to inform management decisions to prevent hazardous conditions from arising.

For sanitation system operators operational monitoring may involve:

- flow rates for waste application;
- actual versus planned duration of withholding periods;
- frequency of waste collection;
- the quantity of waste targeted for use (as this will give some information of the general impact of the waste production);
- checking physical barriers are in place;
- turbidity, pH, biochemical oxygen demand, dissolved oxygen, residual chlorine;
- frequency with which waste handlers are correctly wearing personal protective equipment;
- tracking of hazard-related weather and climate data;
- conducting sanitary surveillance;
- visual inspection of integrity of fences, warning signs;
- visual inspection of waters for relevant insect larvae or snail intermediate hosts.

GUIDANCE NOTE 5.2

Monitoring references in 2006 WHO Guidelines

The 2006 WHO Guidelines provide guidance on typical parameters, frequency and limits for operational and verification monitoring. This can be found in:

VOLUME OF GUIDELINES	RELEVANT SECTION FOR MONITORING
Volume 2 (Wastewater use in agriculture)	Section 4.3 Verification monitoring Table 4.6 Minimum verification monitoring frequencies for health protection control measures Section 6.4 Operational monitoring Section 6.5 Verification monitoring
Volume 3 (Wastewater and excreta use in aquaculture)	Section 6.5 Operational monitoring Section 6.6 Verification monitoring
Volume 4 (Excreta and greywater use in agriculture)	Section 6.4 Operational monitoring Section 6.5 Verification monitoring

Guidance Note 5.3 summarizes some of the verification monitoring recommendations from the WHO 2006 Guidelines for quick refere

5.2 Verify system performance

Verification monitoring is done periodically to show whether the system is working as intended and to provide trends over time. Key (critical) points along the sanitation chain should be selected to verify system performance. This type of monitoring usually requires more complicated forms of analysis (e.g. E.coli, helminth eggs) than operational monitoring. Verification monitoring can be done by the SSP team or an external authority as part of the surveillance function described in the introductory chapter.
As with operational monitoring, parameters, method, frequency, responsible agency, a critical limit and remedial actions when the limit is exceeded should all be identified.

Compared with operational monitoring, there will be fewer points at which verification monitoring occurs. Verification monitoring focuses on system end points such as effluent water quality, microbial and
chemical testing of produce and soils and health status of exposed groups.
Guidance Notes 5.2 to 5.5 provide additional information on monitoring, verification and specialized assessments and are supported by Examples 5.2 and 5.3

5.3 Audit the system

A system audit may not be viable in the initial stages of all SSP implementations, especially in the absence of regulatory requirements for risk assessment management approaches. However, audits ensure that SSP continues to contribute to positive health outcomes by checking the quality and effectiveness of SSP implementation. Auditing can be done by internal, regulatory or independent auditors. It should demonstrate that the sanitation safety plan has been properly designed, is being implemented correctly and is effective. Guidance Note 5.7 gives suggestions for key questions to consider in audits. Audits can assist implementation by identifying opportunities for improvement such as the accuracy, completeness and quality of implementation of the SSP outputs, the better use of limited resources and identifying training and motivational support needs.

Auditing frequencies should be commensurate with the level of confidence required by the regulatory authorities. Identifying suitable skilled and experienced personnel for auditing can be challenging.

GUIDANCE NOTE 5.6 Questions to consider in audits

• Have all significant hazards and hazardous events been identified?
• Have appropriate control measures been included?
• Have appropriate operational monitoring procedures been established?
• Have appropriate operational or critical limits been defined?
• Have corrective actions been identified?
• Have appropriate verification monitoring procedures been established?
• Have those hazardous events with the most potential for problems to

human health been identified and appropriate action taken?

Practical Example:
Gray Water Treatment

Fourth Day
Module 6
MODULE 6 DEVELOP SUPPORTING PROGRAMMES AND REVIEW PLANS
+
WORKED Example of SSP

Module 6:MODULE 6 DEVELOP SUPPORTIN PROGRAMMES AND REVIEW PLANS

6.1 Identify and implement supporting programmes and management procedures
Supporting programmes are those activities that indirectly support sanitation safety, but are also necessary for proper operation of the control measures. A key aspect of supporting programmes is communication of health issues with all stakeholders.

Supporting programmes cover a range of activities including training, communication and research, as well as legal aspects such as a programme for understanding the organization's compliance obligations (see Examples 6.1 and 6.2).

Management procedures (see Guidance Note 6.1) are written instructions describing steps or actions to be taken during normal operating conditions and for corrective actions when operational monitoring parameters reach or breach operational limits. These are often called standard operating procedures or SOPs. Additionally, emergency management procedures could also be developed.

In some cases, the lead agency would undertake the supporting programs or allocate specialized aspects to another agency.

6.2 Periodically review and update the SSP outputs.

The SSP should be systematically reviewed and revised on a periodic basis. The review will take into account improvements that have been made, changes in operating conditions and any new evidence on health risks related to the sanitary systems. In addition, to scheduled periodic review the SSP should also be reviewed

in the following situations:

- after an incident, emergency or near miss;
- after major improvements or changes to the system;
- after an audit or evaluation to incorporate findings and recommendations.

Example 6.3 shows some SSP review triggers used in SSP in Peru

WORKED EXAMPLE
SSP IN Gray Water System

End