MODULE 3

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

SANITATION
SAFETY
PLANNING

SSP Manual
Pages
37 to 61

SSP Modules

Page 37 of your SSP manual

MODULE 3

Identify hazardous events, and assess existing control measures and exposure risks

Module 3 answers the question:

“How significant are the risks?”

Module 3

Ensures that the following efforts and investments in improvements respond to highest health risks first.

Module 3 helps us understand how well the hazardous events are already controlled in the system.

MODULE 3

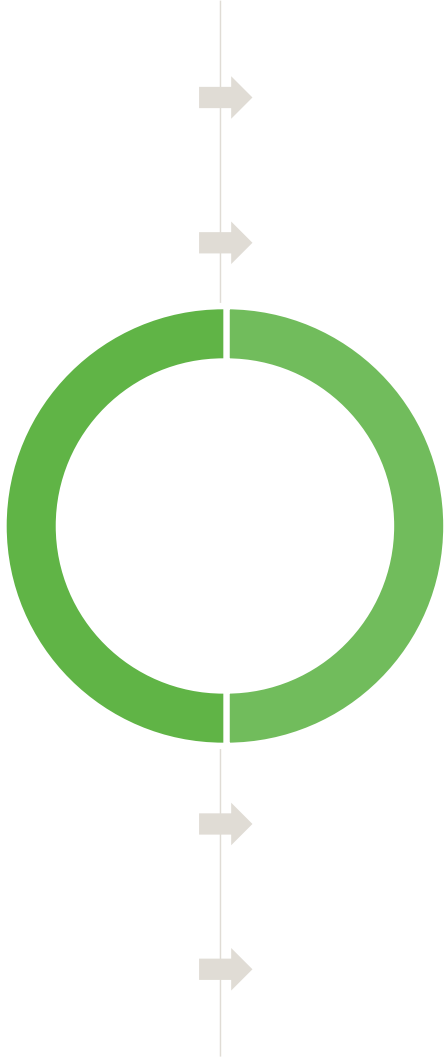
Overview

STEPS

3.1 Identify hazards and hazardous events.

3.2 Identify and assess existing control measures.

3.3 Assess and prioritize the exposure risk.



OUTPUTS

- A risk assessment table
- A prioritized list of hazardous events.

MODULE 3

Identify hazardous events, and assess existing control measures and exposure risks

Output 1: Risk assessment table

COMPONENT	HAZARD IDENTIFICATION				EXISTING CONTROLS		RISK ASSESSMENT						COMMENTS JUSTIFYING RISK ASSESSMENT (Under current conditions, climate change scenarios, or effectiveness of the control)
							Under current conditions (L = likelihood; S = severity; R = risk (H = high; M = medium; VH = very high)				Under the most likely climate change scenarios (+ means increased risk, – means decreased risk, = means the same risk)		
Sanitation step	Hazardous event	Hazard	Exposure group	Number of people at risk	Description	Validation	L	S	Score (LxS)	R	Drought	More intense precipitation	
P1 Toilet and containment–storage/ treatment with soak pits and septic tanks	Ingestion after contact with excreta in nonfunctional toilets	All microbial pathogens	**U1**	30 000	Flush toilets and water supply	Visual and survey	4	2	8	M	+	-	Currently, households do not have a continuous water supply. This worsens in dry conditions, and there also is not enough water to flush toilets.
P2 Disposal of liquid fraction by infiltration	Ingestion of contaminated groundwater due to infiltration from soak pits and septic tanks into shallow groundwater	Faecal pathogens	**L1**	20 000	In some cases, safe distance from wells has been considered.	Field visits	5	4	20	H	+	+	High prevalence of diarrhoea is reported among among young children, especially during the dry season. Likelihood of groundwater use is expected to increase during drought periods. Severity will increase with more and prolonged flooding due to climate change. Consideration should be given to vulnerable communities that may have a reduced ability to find alternative water sources.
		Nitrates and nitrates	**L1** (children less than 5 years old)	8000	Awareness-raising campaigns among mothers	Interviews with mothers	5	8	40	VH	+	+	

A summary of:

- hazards
- hazardous events
- exposure groups
- exposure routes
- existing control measures
- and their effectiveness

STEP 3.1

Identify hazards and hazardous events

OBJECTIVE

This step lists circumstances of how the risk occurs during use, operation and maintenance of the sanitation system for the exposure groups.

Hazard ≠ **Hazardous Event**

STEP 3.1

Identify hazards and hazardous events

What is a hazard?

A biological, chemical or physical constituent that can cause harm to human health.

Biological

Microbiological pathogens:

- Bacteria
- Viruses
- Protozoa
- Helminths

Chemical

- Heavy metals
- Compounds found in industrial effluents

Physical

- Sharps (e.g. needles)
- Physical injury from equipment

STEP 3.1

Identify hazards and hazardous events

Environmental transmitted pathogens

- We are continuously exposed to microorganisms
- Only a small proportion cause infection and disease.

Pathogens: microorganisms that cause disease

Enteric pathogens: Microorganisms transmitted by the fecal-oral route and infect the gastrointestinal tract.

To cause illness, the pathogen must usually first grow within or on the host.

STEP 3.1

Identify hazards and hazardous events

Organism	Per Gram of Feces
Protozoan parasites	10^6–10^7
Helminths	
Ascaris	10^4–10^5
Enteric viruses	
Enteroviruses	10^3–10^7
Rotavirus	10^{10}
Adenovirus/Norovirus	10^{11}
Enteric bacteria	
Salmonella spp.	10^4–10^{10}
Shigella	10^5–10^9
Indicator bacteria	
Coliforms	10^7–10^9
Fecal coliforms	10^6–10^9

At any time during infection the pathogen may be released into the environment by the host in faeces, urine or respiratory secretions.

The concentration of organisms released into the environment varies with the type of organism and the route of transmission.

Excreta related pathogens

WHO Guidelines
Chapter 6
Pages 100-124

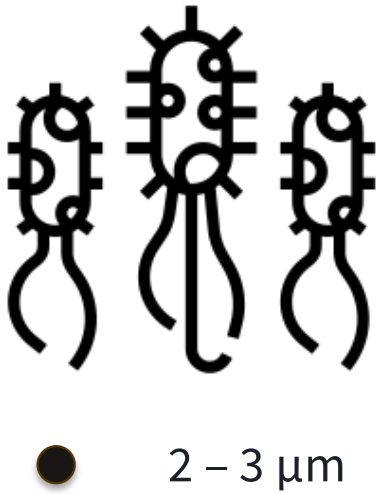
20 – 100 nm

Viruses

- Smallest enteric pathogen.
- Infectious microbe consisting of a segment of nucleic acid (DNA or RNA) surrounded by a protein coat.
- They cannot replicate alone.
- They cannot metabolize in the environment.
- They can be excreted in very high numbers and are transported long distance in water.
- Predominantly cause gastroenteritis (rotovirus and norovirus diarrhoea), hepatitis A&E, viral meningitis.

Excreta related pathogens

WHO Guidelines
Chapter 6
Pages 100-124



2 – 3 µm

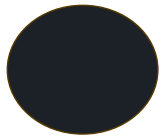
Bacteria

- They are very small single celled organisms.
- Many are capable of multiplication outside a host under favourable conditions
- Cause gastroenteritis, salmonellosis, typhoid, E. coli diarrhoea
- Cause severe health outcomes and long-term effects.

Excreta related pathogens

WHO Guidelines
Chapter 6
Pages 100-124

3 – 20 µm



hair

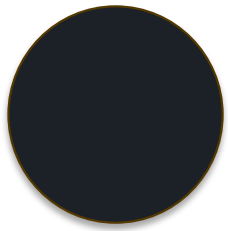
Protozoa

- Complex and large single celled organisms.
- They cannot replicate outside the host, but are very persistent in the environment in cyst stage.
- Enteric, cause gastroenteritis, Amoebic dysentery, giardiasis.

Excreta related pathogens

WHO Guidelines
Chapter 6
Pages 100-124

1 – 300 µm



Visible

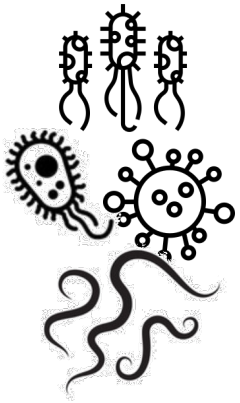
Helminths

- Also known as parasitic worms, include tapeworms, flukes and roundworms.
- They are multi-cellular, complex organisms.
- Soil-based and water based-worms.
- Ingestion of eggs or skin penetration.
- Cause ascariasis, hookworms infections.
- Mild to serious effects: chronic abdominal pain and diarrhoea, anaemia, intestine obstruction, malnutrition.
- Ascaris eggs can survive in the environment for years.

Excreta related pathogens

Environmental transmission of pathogens in faecal waste

WHO Guidelines
Chapter 6
Pages 114-119



Occurrence

Pathogens must be excreted into the environment in sufficient quantities by infected people

Persistence

Pathogens must survive on surface, water, sewage and soil, and remain infectious

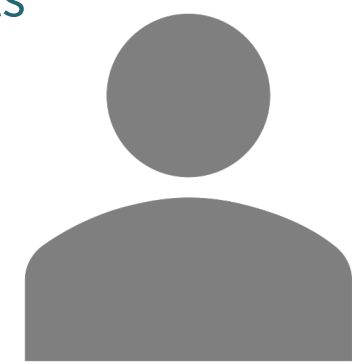
Infectivity

Specific strain and virulence

How do we detect pathogens in the environment?

Vector or hosts

Presence and abundance of any required vectors or intermediary hosts



Individual's susceptibility to infections

Immune status, nutritional status, age, pre-conditions

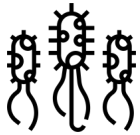
World Health Organization

Excreta related pathogens

Environmental transmission of pathogens in faecal waste

WHO Guidelines
Chapter 6
Pages 114-119

How do we detect pathogens in the environment? (Chapter 6.3.1 WHO Guidelines)



- bacteria

- viruses

- protozoa

Indicator of faecal contamination

E. coli as combined indicator

Also enterococci and bacteroides phage

Not perfect indicators!

But

- Useful
- Feasible
- Economical

In some circumstances, it might be important to identify the source and movement of a specific pathogen.

Excreta related pathogens

Table 6.1

WHO Guidelines
Chapter 6
Pages 105-113

Table 6.1 Excreta-related pathogens (main source: Mandell, Bennett & Dolin, 2000)

Pathogen	Health significance	Transmission pathways	Important animal source	Likely importance of sanitation for control†	Concentration excreted in faeces	Duration of excretion	Additional references
BACTERIA							
Campylobacter spp.	Most common	Predominantly	Poultry	Low	106 – 109 / g	Up to 3 weeks	
VIRUSES							
Adenoviruses	A large group of distinct viruses	Person-to-person, through both	None – strict human	Low	10^{11}/g (lower with	Months after	
PROTOZOA							
Cryptosporidium spp.	One of the most common causes	Person-to-person, and	Of the two main species, C. parvum	High	—	—	Hunter & Thompson, 2005
HELMINTHS							
Ascaris lumbricoides (roundworm)	One of the most common human helminth infections globally. Largely asymptomatic. Can lead to bowel/ intestine obstruction,	Via consumption of contaminated soil and food, and hand contamination.	No (animal roundworm species not thought to be pathogenic to human).	High	10^5 eggs/g	While infection persists	Bethony et al., 2006

Excreta related pathogens

Environmental transmission of pathogens in faecal waste

Helminths

It is important to understand which helminth are endemic in the locality of the SSP.

This is because:

- Helminth infections are context specific.
- Species and concentrations of Helminth eggs in waste influence the control measures.

Examples of helminth infections

Schistosomiasis

Eggs infect snail that lives in standing waters.

Cercarie will swim and penetrate the skin of humans in the water.

Ascariasis

Transmitted by the faecal-oral route.

Contamination of produce grown with contaminated water and faecal sludge.

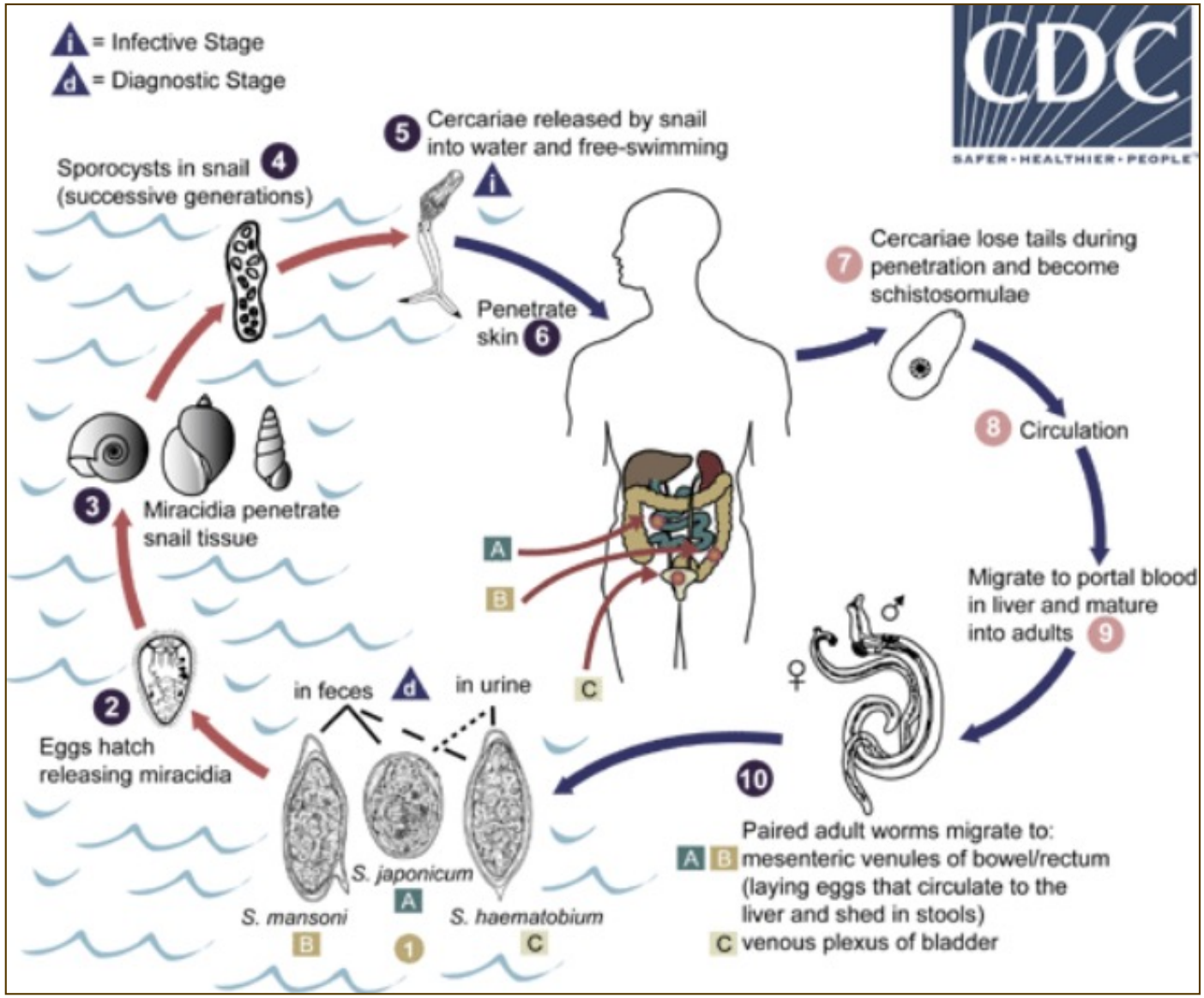
Hookworm infection

Eggs shed via faeces and the larvae penetrates the skin, usually at the feet.

Transmission route affects risk and required control measures

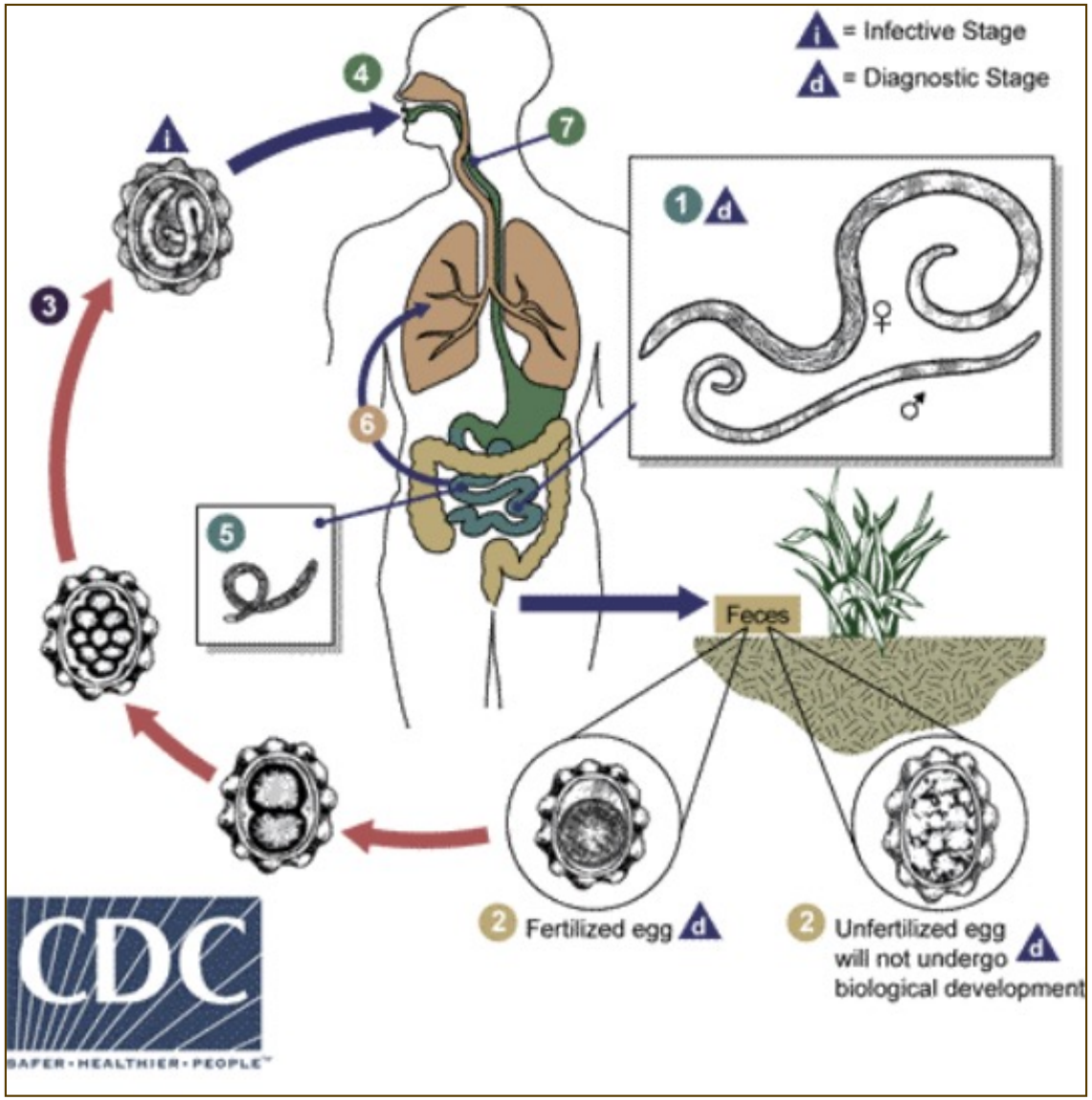
Excreta related pathogens

Helminths: transmission of Schistosomiasis (Bilharzia or Snail Fever)



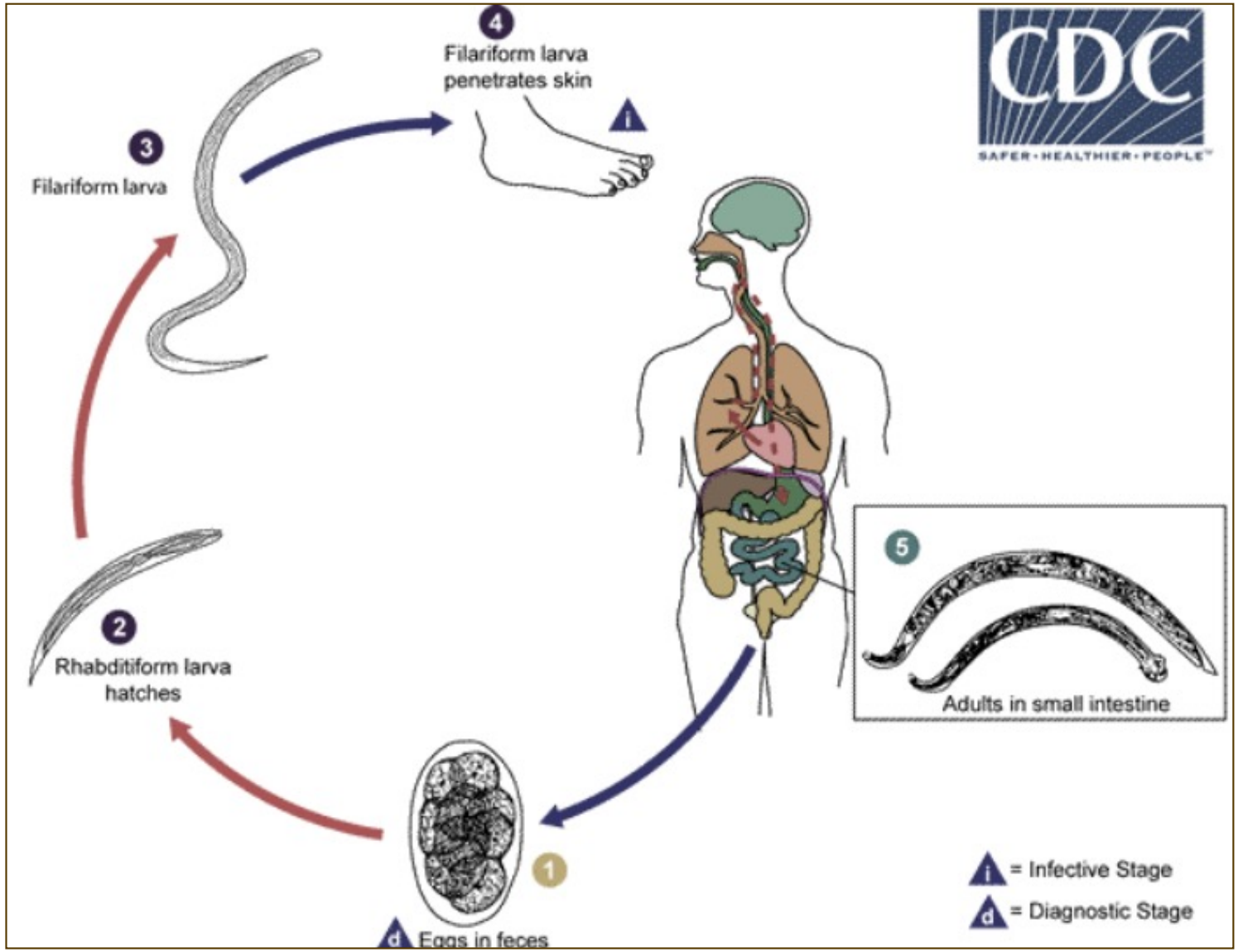
Excreta related pathogens

Helminths: transmission of Ascariasis



Excreta related pathogens

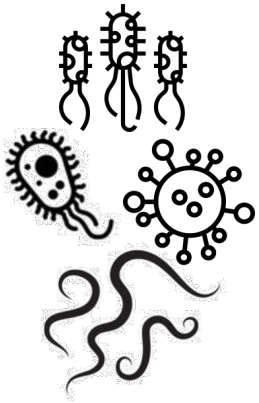
Helminths: transmission of Hookworm infection



Excreta related pathogens

Environmental transmission of pathogens in fecal waste

WHO Guidelines
Chapter 6
Pages 114-119



Occurrence

Pathogens must be excreted into the environment in sufficient quantities by infected people

Infectivity

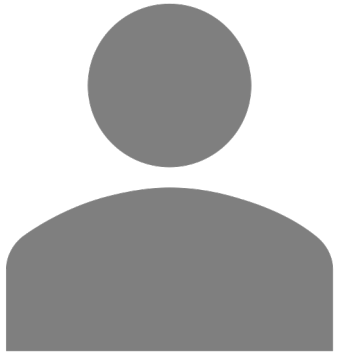
Specific strain and virulence

Persistence

Pathogens must survive on surface, water, sewage and soil, and remain infectious

Vector or hosts

Presence and abundance of any required vectors or intermediary hosts



Individual's susceptibility to infections

Immune status, nutritional status, age, pre-conditions

Why do we need to consider vectors in SSP?

World Health Organization

Excreta related pathogens

Environmental transmission of pathogens in faecal waste

WHO Guidelines
Chapter 6
Page 104

Excreta facilitated vector breading (Chapter 6.3.1 WHO Guidelines)

- Excreta, water and waste may serve as breeding sites.
- Insects can act as vectors of disease by mechanically transporting pathogens in the environment.

Cockroaches:

Breed in excreta, such as pit latrines.

Carry human pathogens
High microbial counts.

Enhance faecal-oral transmission, providing pathways from excreta to food or kitchen utensils.

Flies:

Carry a variety of enteric pathogens, including bacteria and protozoa.

Cause trachoma.

Mosquitos

Improper drainage, stagnant water and ponds contribute to their breading.

Wide range of mosquito-borne diseases: dengue, malaria, West Nile virus, chikungunya, yellow fever…

Vector-habitat and mode of transmission must be considered in SSP

STEP 3.1

Identify hazards and hazardous events

What is a 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.

STEP 3.1

Identify hazards and hazardous events

Hazard, hazardous event, effect, risk, ...!?

Hazard(s) + **Hazardous event** → **Health effects**

Example: wastewater channel

Biological = pathogens (e.g. bacteria, virus and protozoa) + Ingestion of pathogens after contact with wastewater while entering into drains during maintenance → e.g. diarrhoea, fever, vomiting

STEP 3.1

Identify hazards and hazardous events

Hazard ≠ **Hazardous Event (HE)**

A good hazardous event tells a short story.

The **villain** is the **hazard** and the hazardous event (the story) says what happens - how the **villain** causes harm.

For example:

*Workers are **exposed** to **pathogens** in raw sewage in open drains during maintenance activities*

➡ **How exposed?**

STEP 3.1

Identify hazards and hazardous events

SSP Manual Guidance note 3.2, page 42

Hazardous events should describe how groups are exposed to hazards. Common exposure routes to consider in SSP:

- Ingestion after contact with wastewater/ excreta

- Ingestion of contaminated water

- Consumption of contaminated produce

- Dermal (skin) contact with excreta and wastewater

- Vector-borne with flies/mosquitoes/ cockroaches

- Inhalation of aerosols and particles

World Health Organization

STEP 3.1

Identify hazards and hazardous events

Hazards and hazardous events must be identified at each step along the sanitation chain

Existing – normal operation	• e.g. faulty equipment, system overloading, lack of maintenance
Potential – system failure or accident	• e.g. treatment failure (full or partial), power failures, equipment breakdown
Seasonal factors	• e.g. seasonal behaviour changes by farm workers, seasonal farm workers
Indirect	• e.g. hazards that relates to people not directly involved such as effects on downstream communities.
Cumulative	• e.g. chemicals in soils.

AND climate related factors

STEP 3.1

Identify hazards and hazardous events

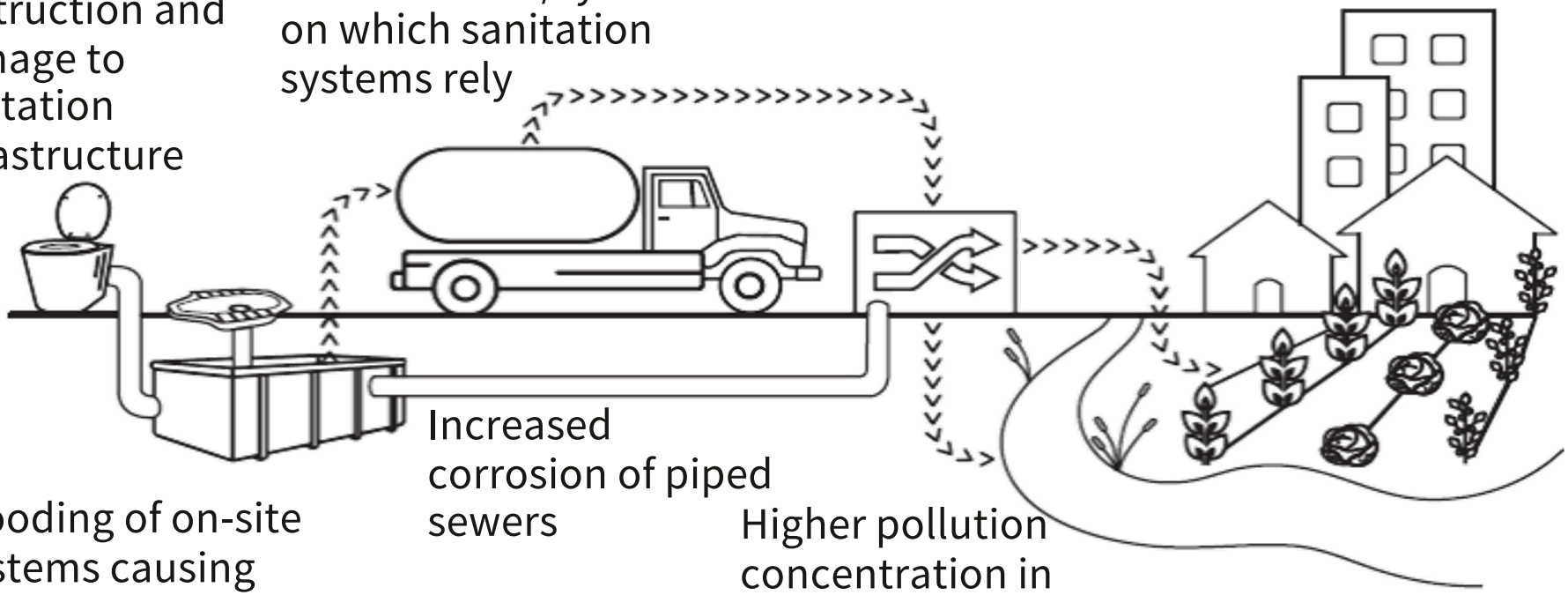
SSP Manual Guidance note 3.4, page 45

Think about climate-related **effects** that affect the sanitation system:

Declining water supply impeding function of water-reliant sanitation systems (e.g., flush toilets, sewerage, treatment)

Damage to other infrastructure/systems on which sanitation systems rely

Destruction and damage to sanitation infrastructure



Increased corrosion of piped sewers

Flooding of on-site systems causing spillage and contamination

Overflow and/or obstruction of sewerage and septic systems

Higher pollution concentration in wastewater and reduced capacity of receiving water bodies to dilute wastewater

Proliferation of algal blooms or microbes carried by vectors in water

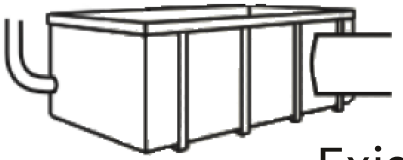
STEP 3.1

Identify hazards and hazardous events

SSP Manual
Example 3.2
Page 42

WHO Guidelines
Chapter 3
Page 34-38

Containment-storage/treatment



Hazardous events:

Existing and potential:

- **Ingestion** of groundwater contaminated with leachate percolating from pits or septic tanks.
- **Ingestion** of groundwater contaminated with leakage from cracked/damaged septic tanks.

TIPS

WHO Guidelines

Table 3.6 – climate change potential impact on septic tanks

Page 55

Climate change related:

- **Ingestion** of pathogens caused by structural damage to tanks during floods.

World Health Organization

STEP 3.1

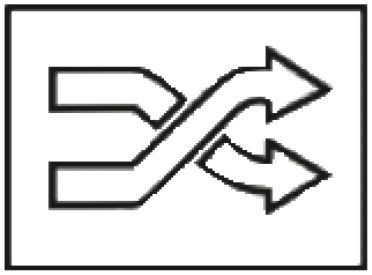
Identify hazards and hazardous events

SSP Manual
Example 3.2
Page 42

WHO Guidelines
Chapter 3
Page 44-49

Hazardous events:

Treatment



WHO Guidelines

Table 3.6 – climate change potential impact on treatment

Page 55

Existing and potential:

- **Inhalation** of aerosols while manual handling of the dried faecal sludge.
- **Ingestion** of pathogens in incompletely treated effluent, resulting from discharge of fresh faecal sludge in wastewater treatment ponds, causing overload and failure.

Climate change related:

- **Ingestion** of pathogens contained in untreated sewage during extreme weather events or floods damaging wastewater treatment systems.

World Health Organization

OBJECTIVE

To determine how well the existing system protects those at risk.

What is a control measure?

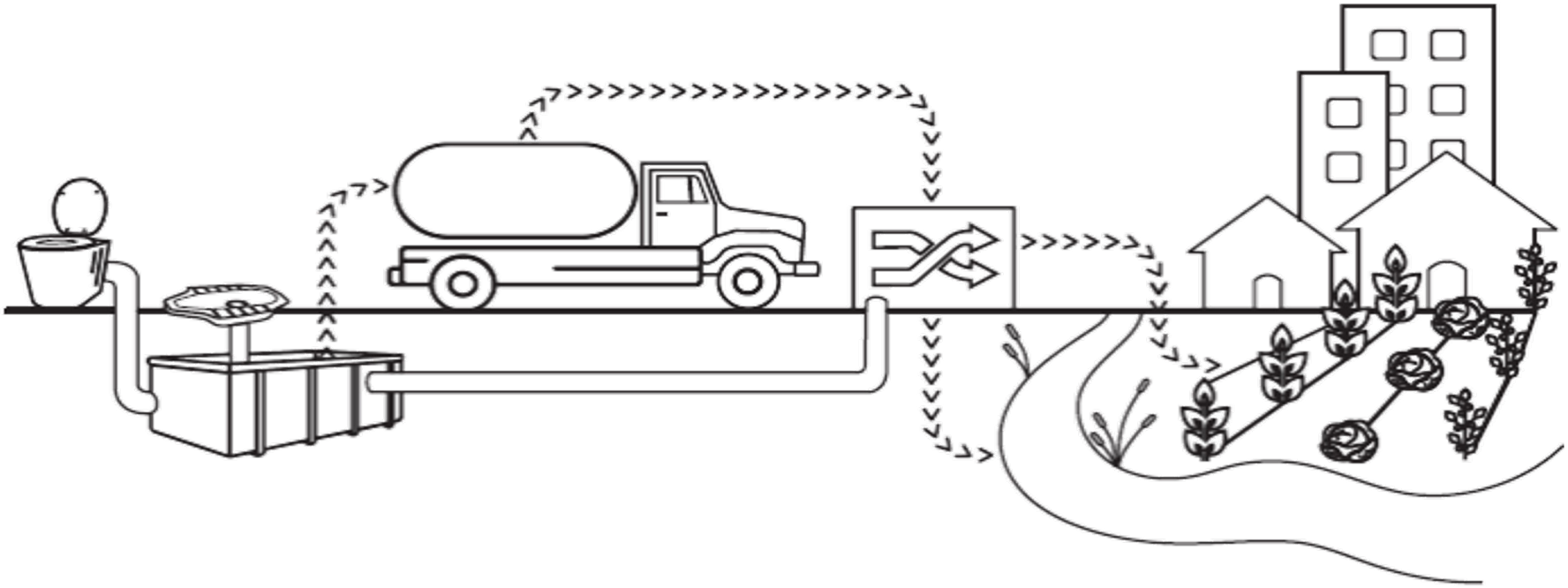
A control measure is any action or activity (or barrier) that can prevent or eliminate a sanitation-related hazard or reduce it to an acceptable level.

STEP 3.2

Identify and assess existing control measures

How do we determine

how effective is a control measure?



STEP 3.2

Identify and assess existing control measures

SSP Manual Guidance note 3.5, page 47

Consider how effective the existing control measure:

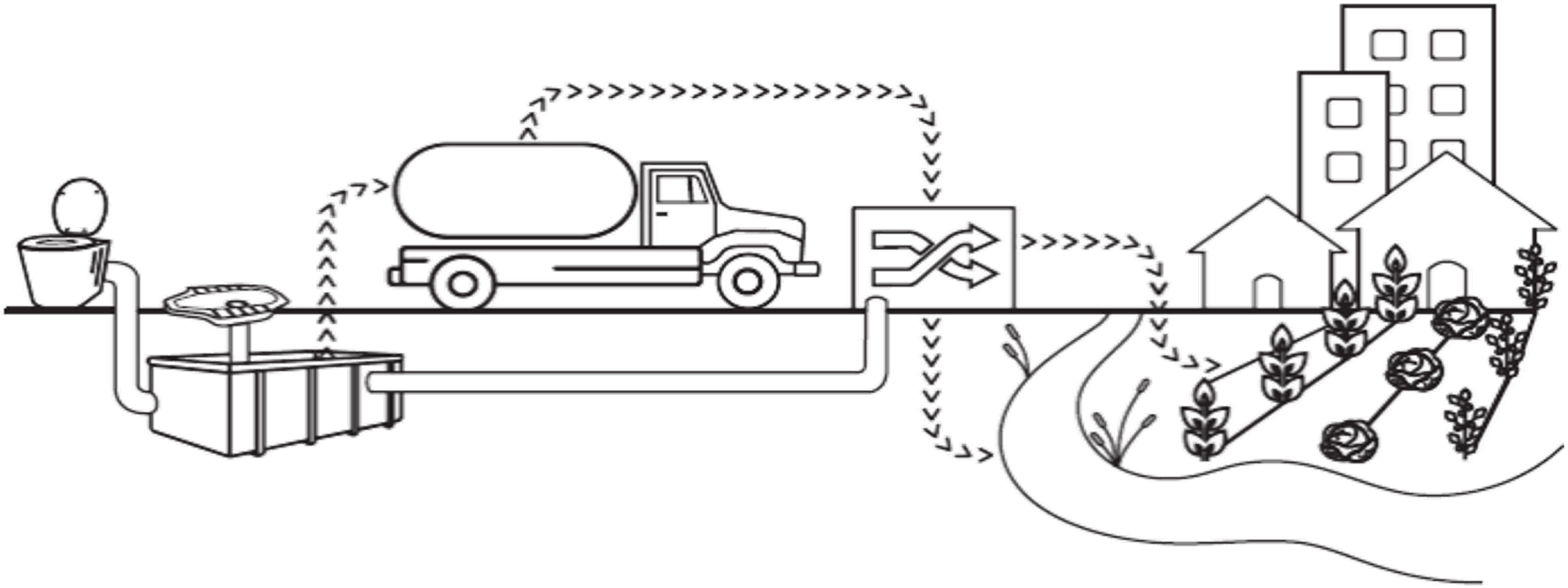
1. **could be**, assuming it was always working well (known as CM validation).

    - checking system loading against its design capacity;
    - checking historical performance under unusual conditions;
    - checking the credited reductions of pathogens for control measures.

2. **is in practice**, considering actual site conditions, enforcement of existing rules and regulations and operating practices.

SSP Manual
Guidance note
3.6, page 51

Control measure validation at each step of the sanitation system

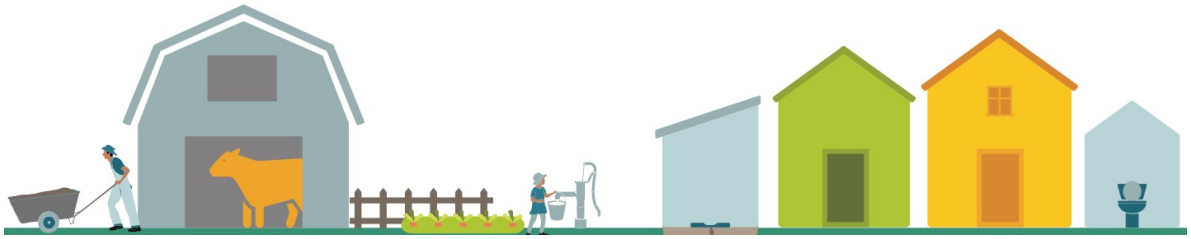


World Health Organization

STEP 3.2

Identify and assess existing control measures

Emptying and transport	Control measure	How effective is it in practice?
	• Preventive emptying • Use of protective personal equipment (PPE)	• Do HHs really call the emptying trucks before the holding tanks are full? • Do the sanitation workers really use the PPE?



Worked example: SSP IN NEWTOWN

COMPONENT	HAZARD IDENTIFICATION				EXISTING CONTROLS		RISK ASSESSMENT						COMMENTS JUSTIFYING RISK ASSESSMENT (Under current conditions, climate change scenarios, or effectiveness of the control)
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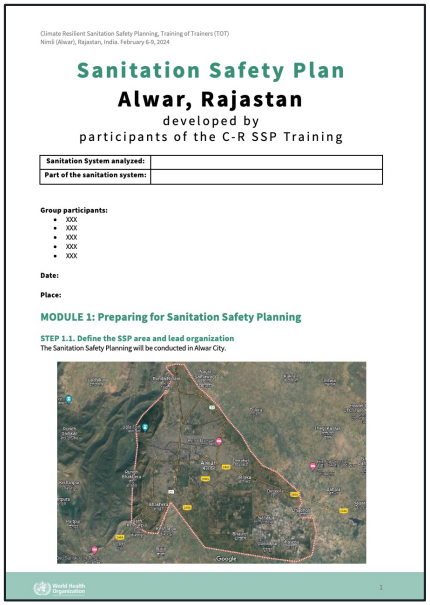
P1 Toilet and containment–storage/ treatment with soak pits and septic tanks	Ingestion after contact with excreta in nonfunctional toilets	All microbial pathogens	**U1**	30 000	Flush toilets and water supply	Visual and survey	4	2	8	M	+	-	Currently, households do not have a continuous water supply. This worsens in dry conditions, and there also is not enough water to flush toilets.
P2 Disposal of liquid fraction by infiltration	Ingestion of contaminated groundwater due to infiltration from soak pits and septic tanks into shallow groundwater	Faecal pathogens	**L1**	20 000	In some cases, safe distance from wells has been considered.	Field visits	5	4	20	H	+	+	High prevalence of diarrhoea is reported among among young children, especially during the dry season. Likelihood of groundwater use is expected to increase during drought periods. Severity will increase with more and prolonged flooding due to climate change. Consideration should be given to vulnerable communities that may have a reduced ability to find alternative water sources.
		Nitrates and nitrates	**L1** (children less than 5 years old)	8000	Awareness-raising campaigns among mothers	Interviews with mothers	5	8	40	VH	+	+	
P1 Toilet and containment–storage/ treatment with soak pits and septic tanks	Ingestion after contact with wastewater from overflowing on-site systems due to damage or blockage	All microbial pathogens	**U1**	30 000	Septic tanks and soak pits present problems.	Interviews and field visits	4	4	16	H	-	+	Likelihood and severity will increase with heavy rainfall and flooding.
			L2	50 000			3	4	12	M	-	+	The localized problem of septic tank damage becomes a community problem with flooding, affecting others in the vicinity.
P5 Flush toilets discharging in open drains	Ingestion after contact with excreta in nonfunctional toilets	All microbial pathogens	**U2**	5000	Flush toilets and water supply	Visual survey	4	2	8	M	+	-	Currently, households do not have a continuous water supply. This worsens in dry conditions, and there is also not enough water to flush toilets.

GROUP WORK

Applying Steps 3.1 and 3.2 to our Alwar case study

In your Alwar SSP Document, for your assigned sanitation system, identify:

- Hazardous events
- Hazards
- Exposure groups and number of persons in risk
- Existing control measures


Climate Resilient Sanitation Safety Planning, Training of Trainers (TOT)
Nimli (Alwar), Rajastan, India. February 6-9, 2024

Sanitation Safety Plan

Alwar, Rajastan

developed by
participants of the C-R SSP Training

Sanitation System analyzed:	
Part of the sanitation system:	

Group participants:
- XXX
- XXX
- XXX
- XXX
- XXX

Date:

Place:

MODULE 1: Preparing for Sanitation Safety Planning

STEP 1.1. Define the SSP area and lead organization
The Sanitation Safety Planning will be conducted in Alwar City.

Component	Hazard Identification				Existing Control(s)		Risk Assessment						Comments justifying risk assessment, under current conditions or climate change scenarios, or effectiveness of the control
							Under current conditions L=Likelihood; S=Severity; R=Risk				Under the most likely climate change scenarios: + means increased risk - means decreased risk = means the same risk		
Sanitation step	Hazardous event	Hazard	Exposure Groups	Number of persons at risk	Description of existing control	Validation of control	L	S	Score	R			