MODULE 2

DESCRIBE THE SANITATION SYSTEM

-PART 1-

SANITATION
SAFETY
PLANNING

SSP Manual
Pages
21 to 27

World Health Organization

SSP Modules

What is the system; who is at risk?

Page 19 of your SSP manual

MODULE 2

Overview

STEPS

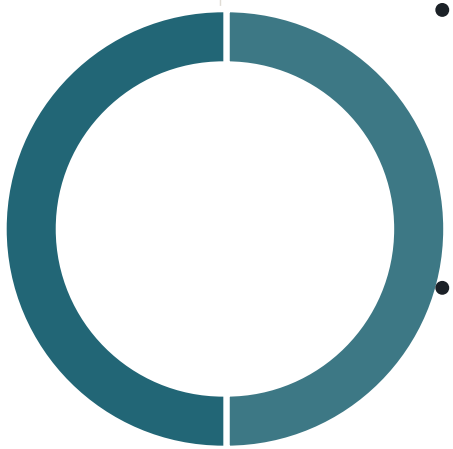
2.1 Map the system

2.2 Characterize the system flows

2.3 Identify exposure groups

2.4 Gather supporting information

2.5 Confirm the system description



OUTPUTS

- A map and description of the sanitation system.
- An understanding of the constituents (excreta and mixed waste) in flows at all steps of the sanitation system.
- Identification and characterization of exposure groups.
- An understanding of the factors affecting the performance and vulnerability of the system
- A compilation of all other relevant information.

STEP 2.1

Map the system

OBJECTIVE

To understand the source and path of flows through the system. This is critical in the later assessment of exposure groups at risk.

WHO Guidelines
Chapter 2
Pages 11-16

WHO Recommendations

Recommendation 2: Ensure universal access to safe systems along the entire sanitation service chain.

Consider full sanitation chain from waste generation to reuse or disposal: toilet, containment, transport, treatment and end use/disposal.

STEP 2.1

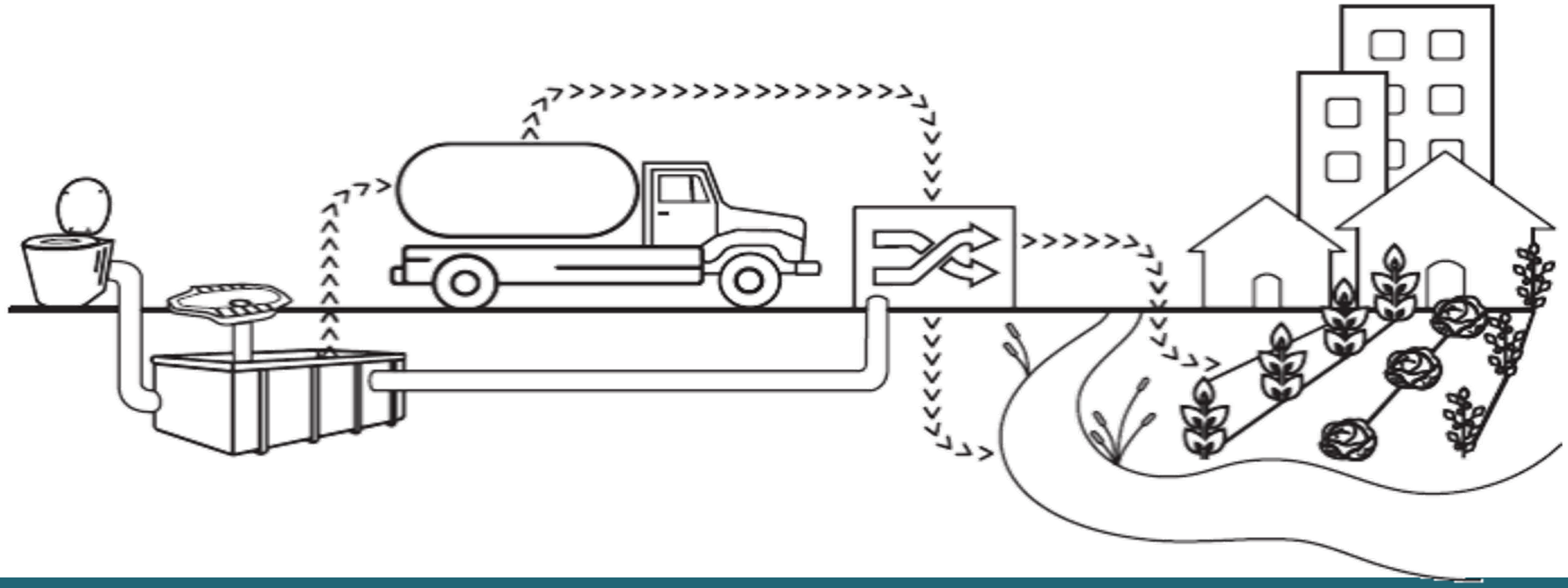
Map the system

WHO Guidelines
Chapter 3
Pages 29-58

WHO Recommendations – Chapter 3

Safe sanitation systems

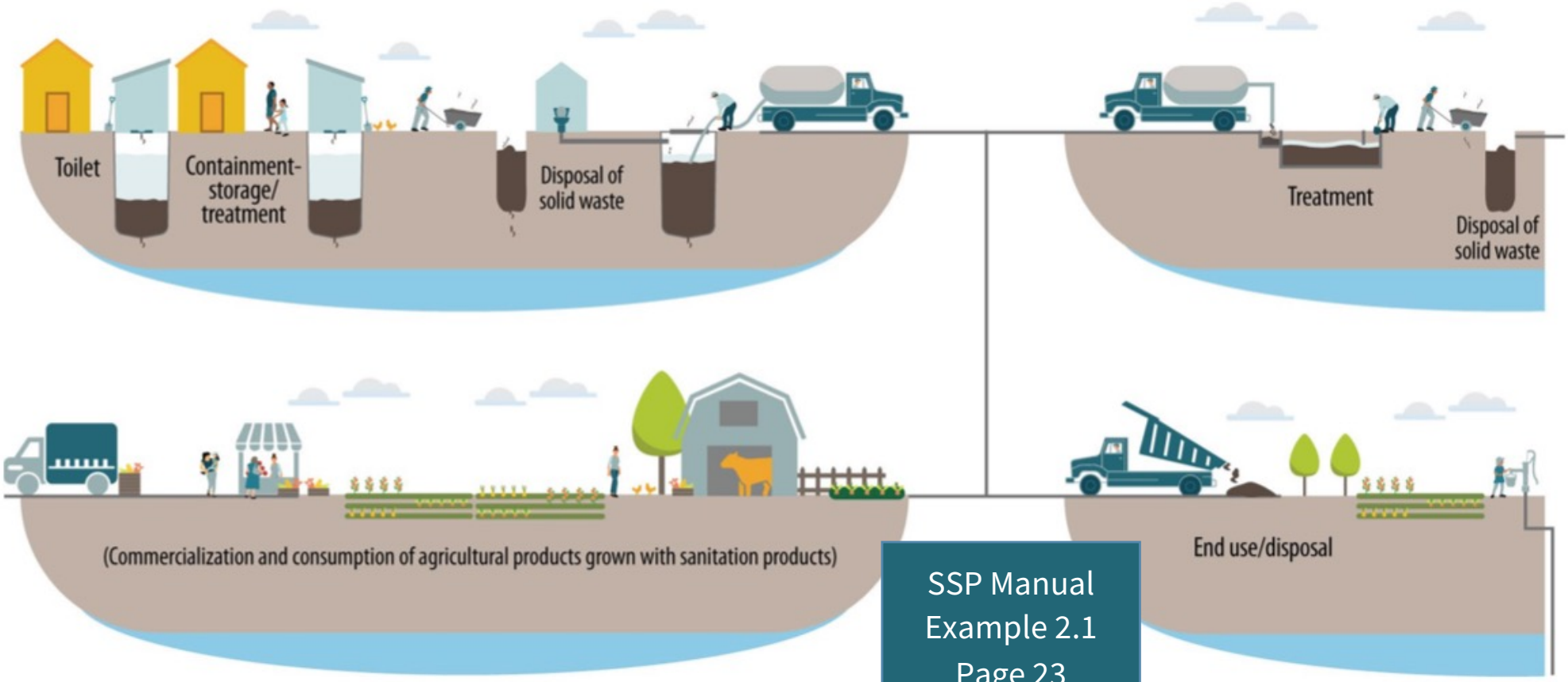
Sanitation systems are a combination of technologies and services that, when linked and properly managed, can form a safe chain.



STEP 2.1

Map the system

Simplified drawings or free-flowing sketches



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Example 2.1
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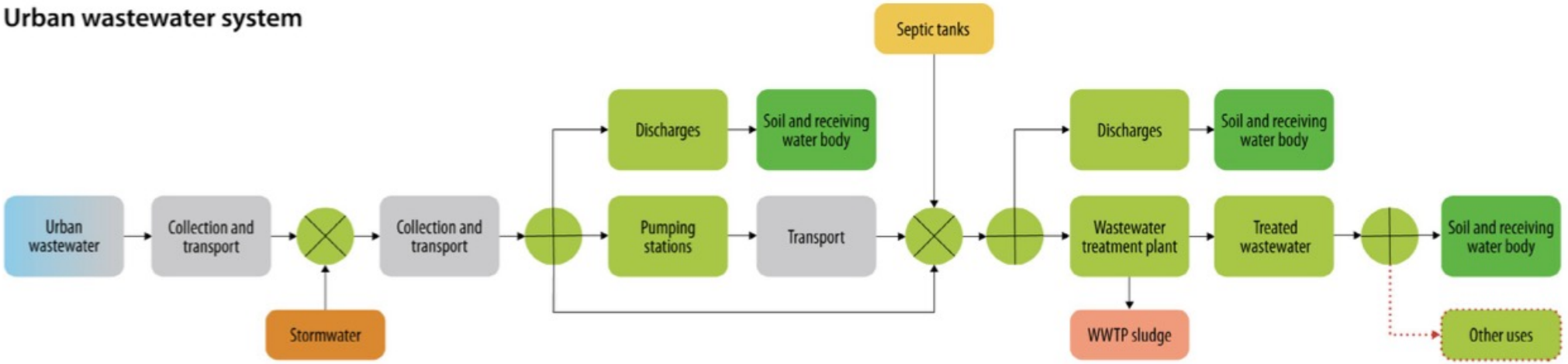
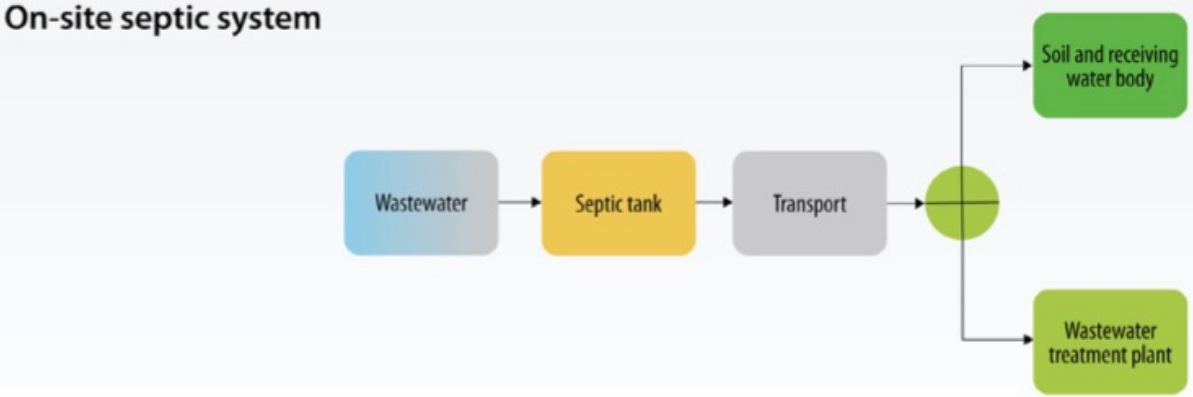
STEP 2.1

Map the system

System process diagram

EXAMPLE: Map of system consisting of a dry or flush toilet with pit, liquid effluent infiltration and off-site treatment of faecal sludge for reuse





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Example 2.2
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World Health Organization

STEP 2.1

Map the system

TIP

Checklist of issues to consider when developing a system map

- Identify **all the steps** of the sanitation service.
- Include **all sources** of system flows.
- Identify **areas in which faecal sludge is being dumped l**egally and illegally.
- Identify **areas where open defecation** is known to occur.
- Identify **public and shared toilets** that serve a considerable proportion of the community.
- Include **drinking-water sources** where this is relevant to the system or could be affected by the sanitation system.

SSP Manual
Guidance Note
2.2
Page 26

STEP 2.1

Map the system

Establish the path of different of system flows through the sanitation system

S_{FS1} = Faecal sludge collected in pit latrines

S_{LF1} = Liquid fraction that percolates from the pits

S_{SWF1} = Solid waste fraction obtained during emptying of pits

S_{FS2} = Faecal sludge emptied in vacuum trucks and transported to the treatment plant

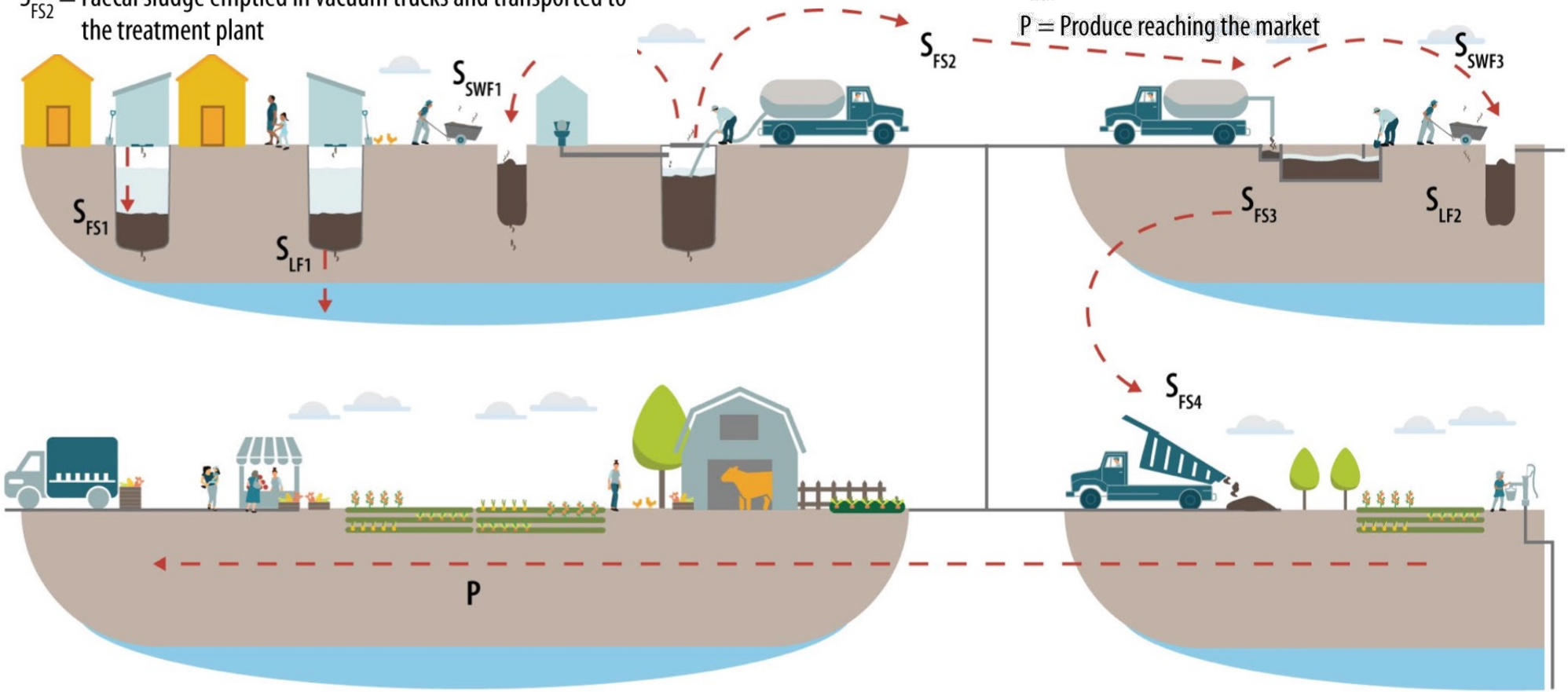
S_{SWF3} = Solid waste fraction screened out before treatment

S_{FS3} = Faecal sludge treated

S_{LF2} = Liquid fraction infiltrated from the treatment plant

S_{FS4} = Dried faecal sludge trasported to agricultural land

P = Produce reaching the market



STEP 2.2

Characterize system flows

OBJECTIVE

This step involves collecting key quantitative information, and examining the microbiological, physical and chemical constituents of flows along the sanitation system.

SSP Manual Guidance Note 2.2 Page 26

Factors to consider when characterizing system flows

- Focus on excreta-related inflows and effluents in each step of the system.
- Key information:
  - **flow rates**, where known, including for different seasons, or different levels of rainfall, in the context of potential climate change impacts; and
  - **capacity** or design loading of components, where known (e.g. treatment plant flow or loading limits, transfer system capacities).

STEP 2.2
Characterize system flows

SSP Manual
Tool 2.1
Page 27

Use the template to characterize system flows:

TOOL 2.1. Template to characterize system flows

SANITATION STEP	DESCRIPTION OF THE SYSTEM FLOW (Focus on excreta-related flows, such as wastewater or sludge. Also list other waste streams when relevant to the sanitation system)	KEY INFORMATION OF THE SYSTEM FLOW (Volume, flow, concentration, etc.)	EXPECTED VARIATIONS (Seasonal variations or unusual events, such as accidentally mixed components or climate events)	TYPE OF POTENTIAL HAZARD (Biological, chemical or physical)

STEP 2.2

Characterize system flows

Hazards

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

Biological

Microbiological pathogens:

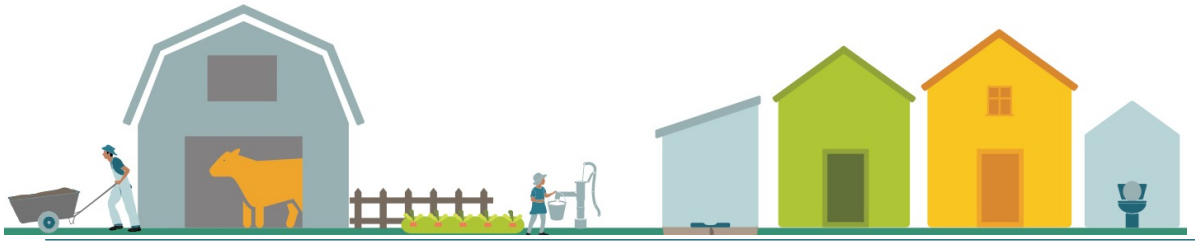
- Bacteria
- Viruses
- Protozoa
- Helminths
- Vector-borne

Chemical

- Heavy metals in sludge or biosolids
- Herbicides and pesticides

Physical

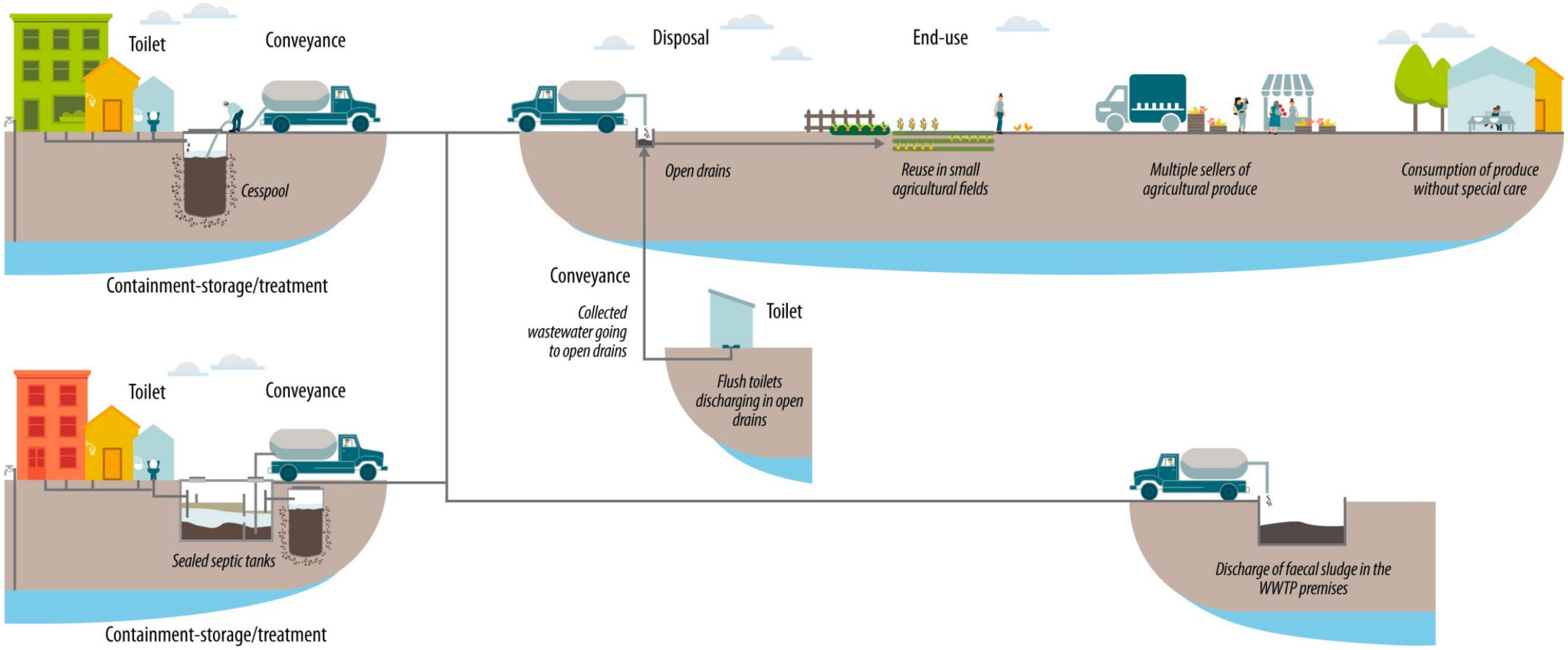
- Sharps (e.g. needles)
- Odours
- Physical injury from equipment

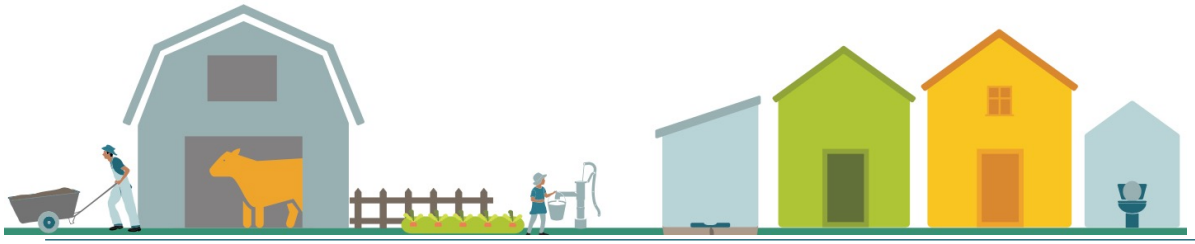


Worked example: SSP IN NEWTOWN

Module 2: Describe the sanitation system

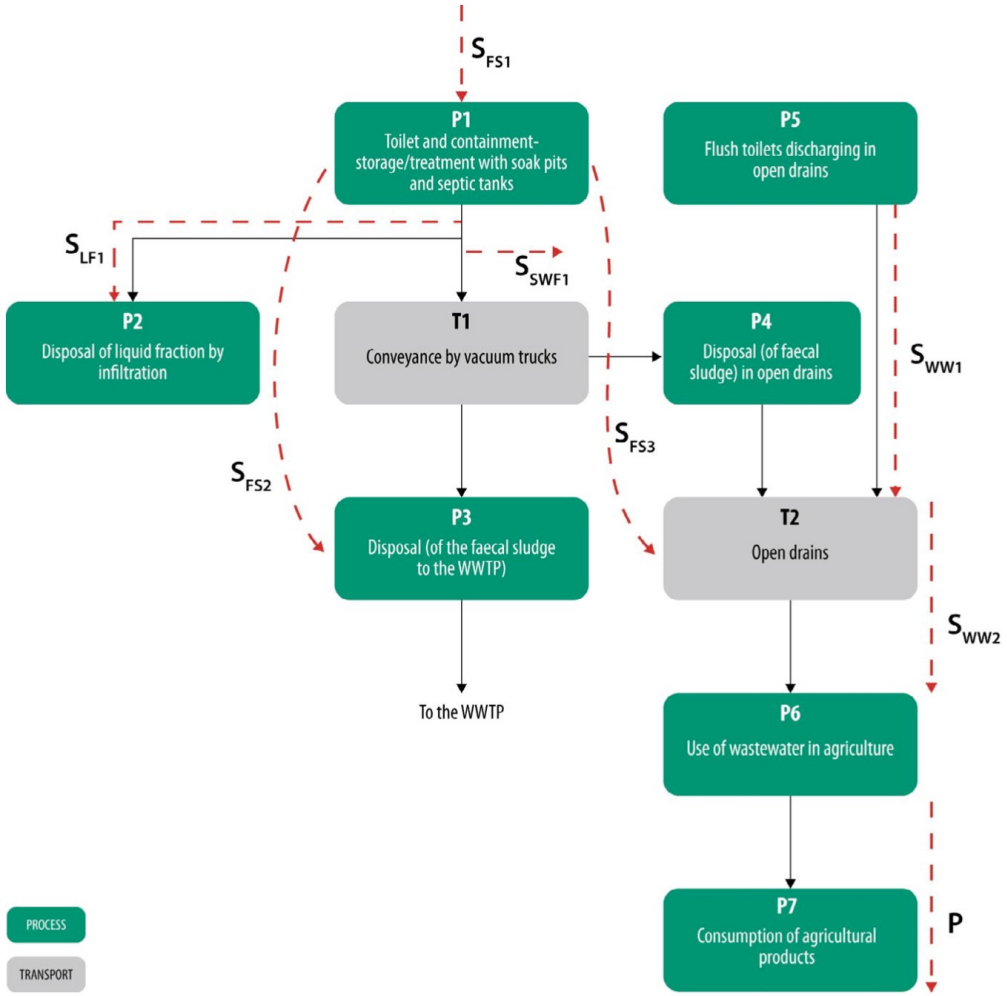
Step 2.1. Map the system





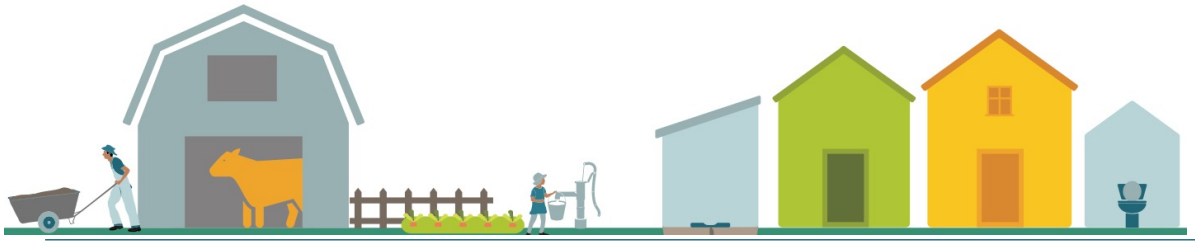
Worked example: SSP IN NEWTOWN

Step 2.1. Map the system



The description of each system flow is as follows:

- S_{FS1} = faecal sludge collected in soak pits and septic tanks
- S_{LF1} = liquid fraction that percolates from soak pits and septic tanks
- S_{SWF1} = solid waste fraction screened out during emptying of soak pits and septic tanks
- S_{FS2} = faecal sludge emptied into vacuum trucks and transported to the WWTP
- S_{FS3} = faecal sludge emptied into vacuum trucks and discharged in open drains
- S_{WW1} = wastewater transported from households directly to open drains
- S_{WW2} = wastewater transported in open drains
- P = produce reaching the market.



Worked example: SSP IN NEWTOWN

Step 2.2. Characterize system flows

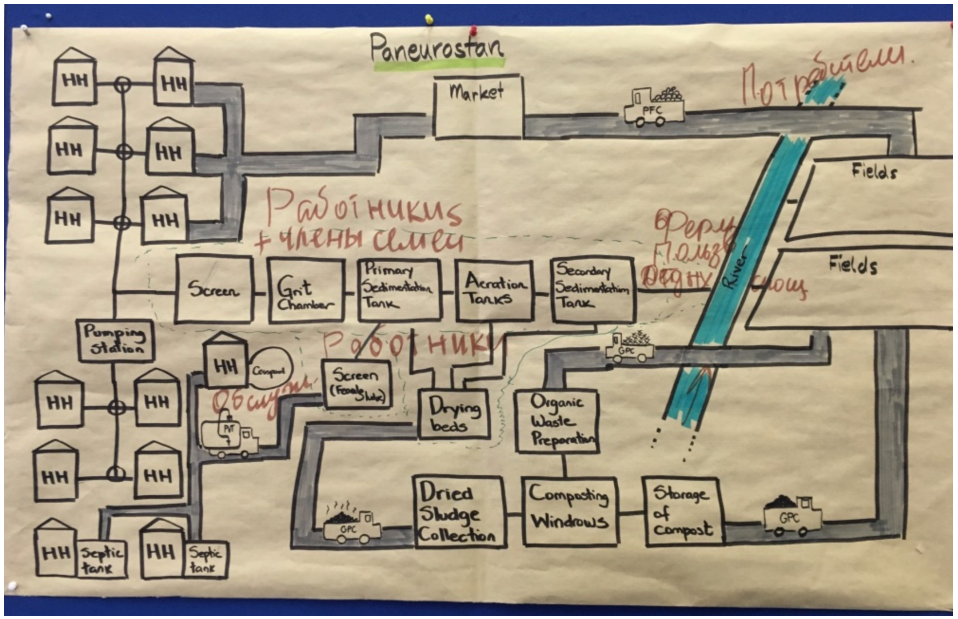
Sanitation step	Description of the system flow	Key information	Expected variations	Type of potential hazard
P1: Toilet and containment–storage/ treatment with soak pits and septic tanks	S_{FS1} = faecal sludge collected in soak pits and septic tanks Faecal sludge – solids and water that are collected in underground tanks	About 7000 m^3 collected. BOD could reach 600 mg/L.	The sludge could contain anal cleansing materials, menstrual hygiene products, sharp objects and other foreign material. It may also contain chemicals present in greywater.	Biological Physical Chemical
P2: Disposal of liquid fraction by infiltration	S_{LF1} = liquid fraction that percolates from soak pits and septic tanks Liquid fraction resulting from infiltration of wastewater from soak pits and unsealed/broken septic tanks	Concentrations of nitrates and nitrites are estimated to be high in groundwater (>50 mg/L for nitrates).	Percolation increases with rainfall. There could be some traces of chemicals in greywater.	Biological Chemical
T1: Conveyance by vacuum trucks	S_{SWF1} = solid waste fraction screened out during emptying of soak pits and septic tanks Solid waste is screened out while pumping out the faecal sludge. Operators throw the solid waste into the nearest waste dump.	About 2 kg of solid waste is screened out each time.	With heavy rainfall, solid waste ends up in the open drains.	Biological Physical
P3: Transfer of the faecal sludge to the WWTP	S_{FS2} = faecal sludge emptied into vacuum trucks and transported to the WWTP	About 20 m^3 of faecal sludge is emptied every day.	No expected variations.	Biological
P4: Disposal of faecal sludge in open drains	S_{FS3} = faecal sludge emptied into vacuum trucks and discharged in open drains	About 40 m^3 of faecal sludge is emptied every day.	Heavy rainfall leads to heavy dilution in open drains.	Biological
P5: Flush toilets discharging in open drains	S_{WW1} = wastewater transported from households directly to open drains	About 1000 m^3 of wastewater. BOD could reach 600 mg/L.	No expected variations.	Biological Chemical
T2: Open drains	S_{WW2} = wastewater transported in open drains Stormwater – surface water including urban runoff mixed with wastewater	There are no data about stormwater. Diluted BOD could reach 300 mg/L.	No expected variations. The wastewater will contain a wide range of dilute constituents, including nutrients, metals, pathogens, organic material (oxygen-demanding substances), hydrocarbons, animal wastes and solid waste.	Biological Chemical Physical
P6: Use of wastewater in agriculture	S_{WW2} = wastewater transported in open drains Stormwater – surface water including urban runoff mixed with wastewater	It is not known how much water is used by farmers.		Biological Chemical Physical
P7: Consumption of agricultural products	P = produce reaching the market	There are no data about quantities.	In dry seasons, more products are expected to be grown using wastewater.	Biological

GROUP WORK

Applying Steps 2.1 and 2.2 to our Alwar case study

Within your groups, based on the description provided:

- Using markers and the brown paper provided, prepare a map of **your sanitation system**.
- Establish the path of different waste fractions through the sanitation system.



- In your SSP Document, characterize all system flows.
- With your group discuss: **What do you need to find out tomorrow to map the system and characterize the flows?**

GROUP WORK

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.

- **Which system is your team responsible of analyzing?**

Indicate in the box below what is the system that you and your team are analyzing:

[enter you answer here]
XXXXX

STEP 2.1: Map the system

Based on the description provided, and using the brown paper and markers given to you and your team, prepare a sanitation map of the sanitation system that was assigned to you.

STEP 2.2: Characterize system flows

Use the following table to characterize system flows (for instance, feces, urine, excreta, wastewater, greywater, sludge collected, sludge emptied, dried feces, solid waste dumped in the pit etc.). Read guidance note 2.2 and tool 2.1 for more information. Include all the quantitative information you have and identify if the system flow might have a biological, chemical or/and physical hazards.

System flow code	Sanitation step	Description of the system flow	Key information of the system flow	Expected variations	Type of potential hazard

GROUP WORK

World Health Organization

Sanitation Safety Plan

Alwar, Rajasthan

Description of the locality and sanitation systems

1. Background information

1.1 Description of Alwar City

Alwar City is located on 27° 32' 30"" N latitude and 76° 37" 30"" E longitude in North-eastern Rajasthan. The city covers an area of 48.14 sq.km catering around 4,50,000 population. The population has increased considerably in the past years, particularly because of the steady migration from other parts of the state. This rapid increase in the population size has come with a number of challenges for the Alwar Nagar Nigam, particularly the development of the infrastructure required to support this increase in population.

It is estimated that about 10% of the population is living in poverty.

Alwar has a monsoon-influenced hot semi-arid climate with long, extremely hot summers and short, mild to warm winters. The climate here is a local steppe climate. The city experiences a short monsoon with annual rainfall of about 67 cm which mostly falls in July and August due to monsoon.

City's most of the local population is employed in modern economic activities such as industry (22%), business and commercial domains (22%), services (39%) and transport and communication sectors (9%). Apart from these activities, agriculture is also considered one of the prominent activities in the peri urban areas of Alwar city. They produce crops such as bajra, maize, jowar, karif pulses, arhar, sesamum, cotton, guar, wheat, barley, gram, mustard, and rabi pulses.

1.2. Legal framework

The sanitation sector in Alwar city is governed by the following pieces of legislation:

- Manual on Sewerage and Sewage Treatment Systems, 2013.
- Environmental (Protection) Act, 1986.
- The Environment (Protection) rules, 1986.

Preparation for the field trip

- Questions regarding the description of the system (steps 2.1 and 2.2):

(What do you need to find out tomorrow to map the system and characterize the flows?)

MODULE 2

DESCRIBE THE SANITATION SYSTEM

-PART 2-

SANITATION
SAFETY
PLANNING

SSP Manual
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World Health Organization

STEP 2.3

Identify exposure groups

OBJECTIVE

This step identifies and characterizes exposed groups in terms of who they are, how many there are, where are they in the system and how exposure occurs.

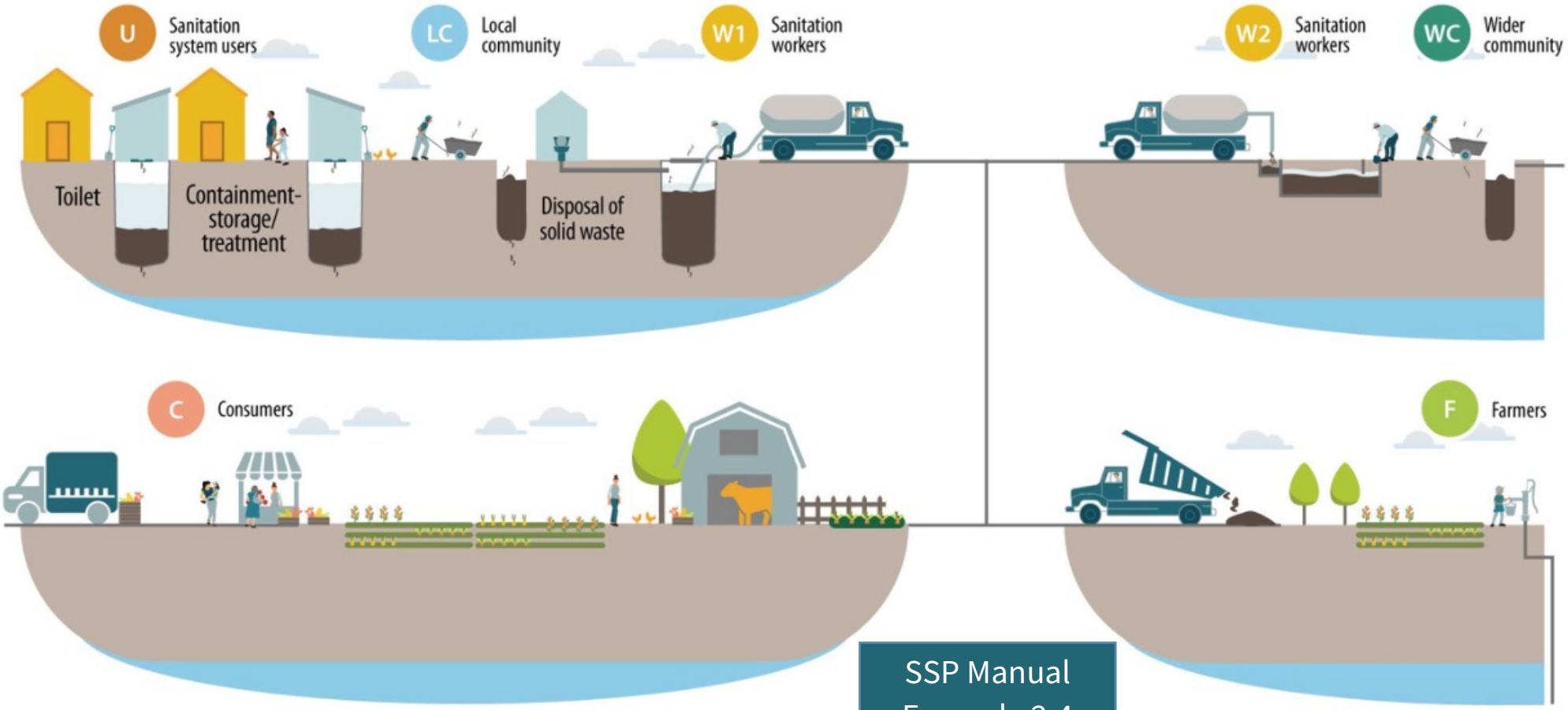
Exposure groups categories: People who might be exposed to sanitation –related health hazards.

SSP Manual Guidance Note 2.3 Page 28

- **U= Sanitation systems users**
- **L= Local community**
- **W= Sanitation workers**
- **WC= Wider community**
- **F= Farmers**
- **WC= Consumers**

STEP 2.3

Identify exposure groups



SSP Manual Example 2.4

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World Health Organization

STEP 2.3

Identify exposure groups

Use tool 2.2 to characterize exposure groups

TOOL 2.2. Template to characterize exposure groups

SANITATION STEP	EXPOSURE GROUP	WHO ARE THE EXPOSURE GROUPS? (Description of these people)	HOW MANY ARE THERE? (Actual numbers, if known; otherwise estimate)	WHAT ARE THEY DOING THERE? (Circumstances under which they might be exposed to hazards in the system flow)	WHAT ARE THEY EXPOSED TO? (Which system flows and which types of hazards they have contact with)	HOW OFTEN ARE THEY EXPOSED TO THIS? (Exposure frequency: daily, weekly, once a year, etc.)
Containment–storage/ treatment	U1	Users of flush toilets connected to septic tanks on their properties	400 households (around 2000 people); about half are children	Septic tanks are usually outside the house, in the backyard. Children play and adults perform different activities in the vicinity of the tank.	They could have contact with wastewater during overflows. They are exposed to microorganisms.	It could happen every 3 years, but is more frequent during heavy rainfall.
Disposal	WC1	Visitors to the nearby river	About 5000 people; about 70% are children	These are local tourists who come to the river for recreation. They swim and gather along the river during weekends.	Microbial contamination when the treatment ponds overflow. They could ingest contaminated river water.	Daily contact during summer months.

SSP Manual
Tool 2.2
Page 30

STEP 2.4

Gather supporting information

OBJECTIVE

To identify the relevant health hazards to which our exposure groups are exposed.

For that, we collect and document information about the context (the reality) in which the sanitation system exists.

Potential hazards:

Biological

Microbiological pathogens:

- Bacteria
- Viruses
- Protozoa
- Helminths
- Vector-borne

Chemical

- Heavy metals in sludge or biosolids
- Herbicides and pesticides

Physical

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

Relevant hazards:

- Actual presence of the pathogens in the community
- Actual performance of the treatment system… etc.

STEP 2.4

Gather supporting information

Let's recap:

Waste fractions from Step 2.2 → Potential health hazards → Contextual and health data → Identify relevant health hazards

Use epidemiological and environmental data where available.

For example, if helminths have been identified as a potential health hazard, the characterization aims to determine which species are endemic and to what extent.

STEP 2.4

Gather supporting information

SSP Manual Guidance Note 2.4, Page 33

Examples of data to be collated

Regulatory requirements

- Relevant laws and by-laws
- Effluent discharge quality standards
- Guidelines for climate change preparedness or disaster planning

System management and performance

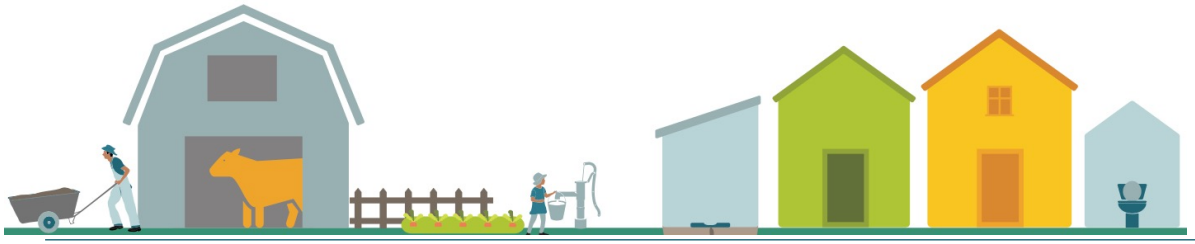
- Monitoring and surveillance records
- Epidemiological data
- Types and amount of products produced

Demographics and land use patterns

- Demographics, land use
- Formal and informal settlements
- Areas predicted for high population growth

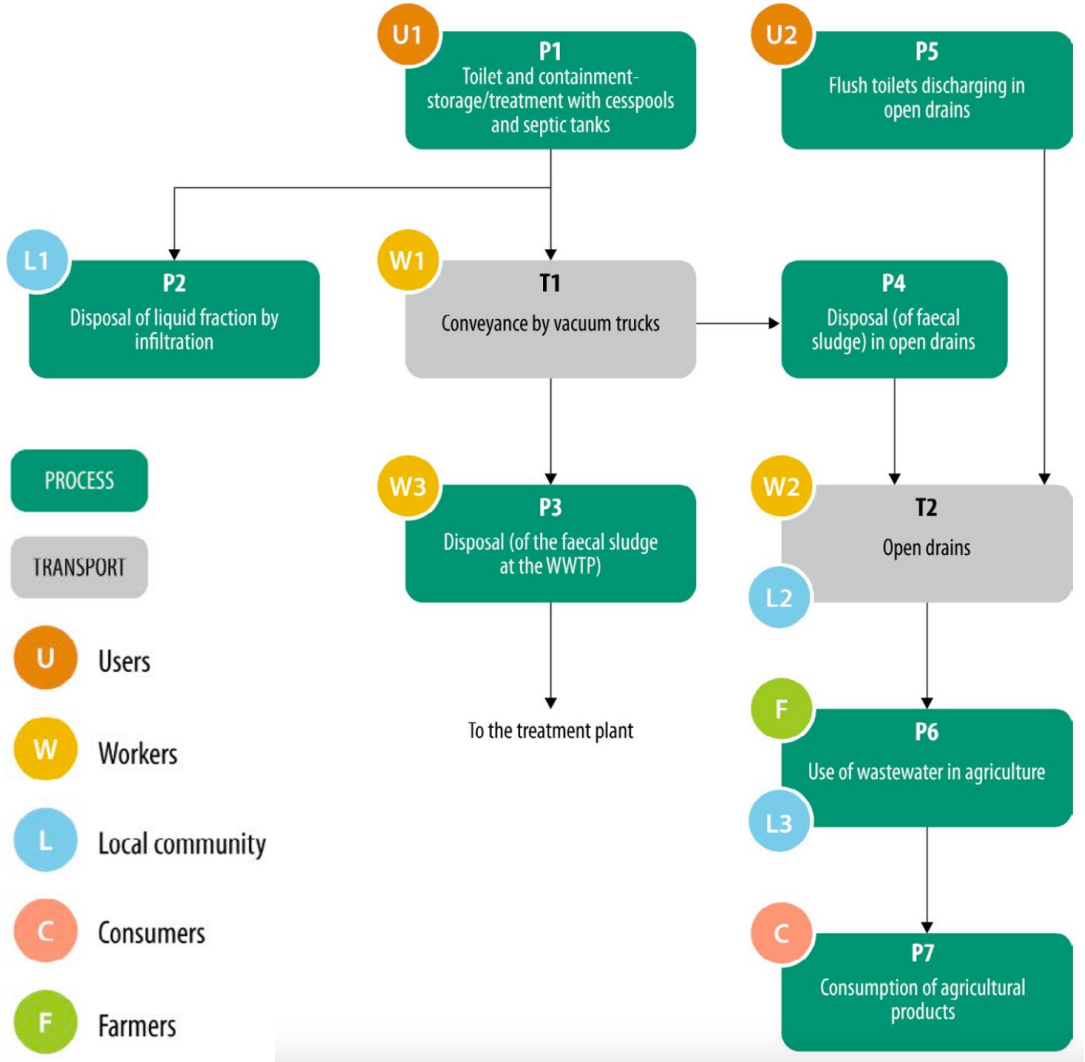
Changes related to climate and weather

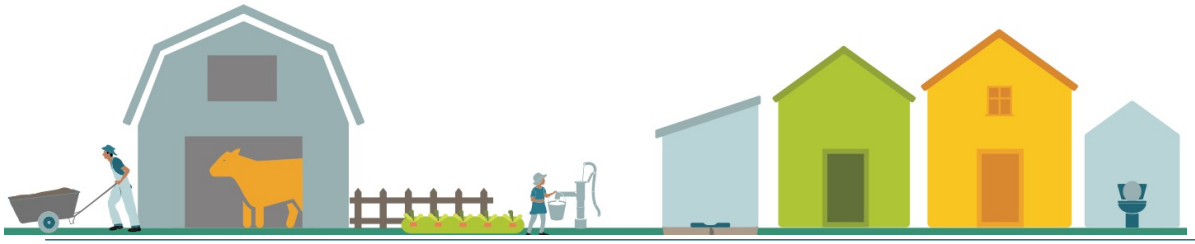
- Seasonal changes and impacts on loadings
- Seasonal crop and harvest data
- Additional inflows during heavy rains
- Changes in water usage due to scarcity



Worked example: SSP IN NEWTOWN

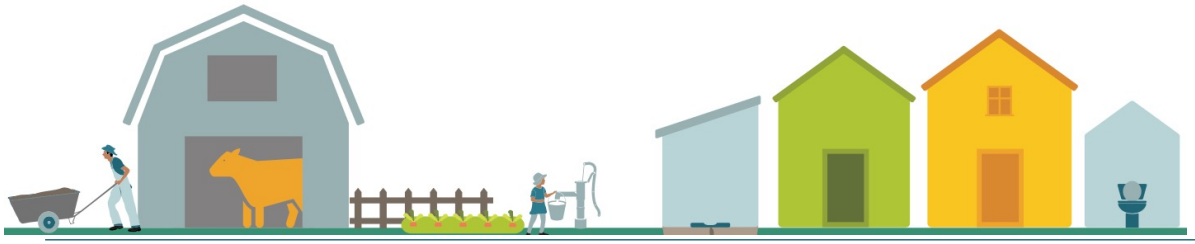
Step 2.3. Identify exposure groups





Worked example: SSP IN NEWTOWN

Sanitation step	Exposure group ID	Who are the exposure groups?	How many are there?	What are they doing there?	What are they exposed to?	How often are they exposed?
P1: Toilet and containment–storage/treatment with soak pits and septic tanks	U1	Users of flush toilets connected to septic tanks and soak pits in their properties	6000 households (around 30 000 people). About 40% are children.	Septic tanks and soak pits are usually outside the house, in the backyard. Children play and adults perform different activities in the vicinity of the tank.	They could have contact with wastewater during overflows. They are exposed to microbial pathogens.	Overflow could happen every 3 years, but is more frequent during heavy rains.
P2: Disposal of liquid fraction by infiltration	L1	Families living in areas where septic tank effluent and soak pits infiltrate to the groundwater	4000 households (about 20 000 people). About 40% are children.	They usually have shallow wells because the water supply is not reliable.	High concentrations of *E. coli* in water samples from shallow wells	It could be daily when the water supply is low. However, this situation is worst during dry periods.
P5: Flush toilets discharging in open drains	U2	Users connecting their wastewater pipes to open drains	1000 households (about 5000 people)	They live in houses not connected to the sewer systems.	There could be a backflow to their houses when the water levels in open drains are too high.	This is very rare.
T1: Conveyance by vacuum trucks	W1	Private vacuum truck operators	About 20 operators (10 trucks, working in groups of 2)	They open the underground tanks, insert the hose and empt the soak pits. They also handle the solid waste extracted.	They are in direct contact with faecal sludge, which contains microbial pathogens.	Every day
P3: Transfer of the faecal sludge to the WWTP	W3	WWTP operators who receive faecal sludge	3 operators (working in shifts of 2 people)	They usually do not come into contact with the sludge (i.e. only administrative work).	They are not in direct contact with faecal sludge.	Not applicable
P4: Disposal of faecal sludge in open drains	L2	All citizens of Newtown	50 000 people	They walk and live beside the open drains, which were designed for stormwater. Children play near the drains.	Mosquitoes breeding, pathogens from the wastewater and sharp objects in the solid waste. They are also exposed to blockages and inundation during heavy rainfall.	Every day; the problem increases during heavy rains.
T2: Open drains	W2	Open drain workers	6 operators (working in shifts of 2 people)	They are in charge of removing the solid waste from the drains and cleaning blockages.	Pathogens in the wastewater. During the dry season, they are exposed to aerosols and sharp objects.	They clean the open drains twice a month.
P6: Use of wastewater in agriculture	F	Farmers using the open drain wastewater to irrigate their land	30 families (about 150 people)	They are in direct contact with the water.	Pathogens, including helminths, and mosquitoes	Every day, but specially during the dry season.
	L3	Community living around the farming plots	150 families (about 750 people)	They live around the farms.	Occasional bad smells and mosquitoes. Children play in the area, and hookworms are very common.	Every day, but specially during the dry season.
P7: Consumption of agricultural products	C	Consumers of farm products	200 families. It is thought that only families living around the farms buy the products.	They eat the products without much care.	Pathogens	Every day, but specially during the dry season.



Worked example: SSP IN NEWTOWN

Step 2.4. Gather supporting information

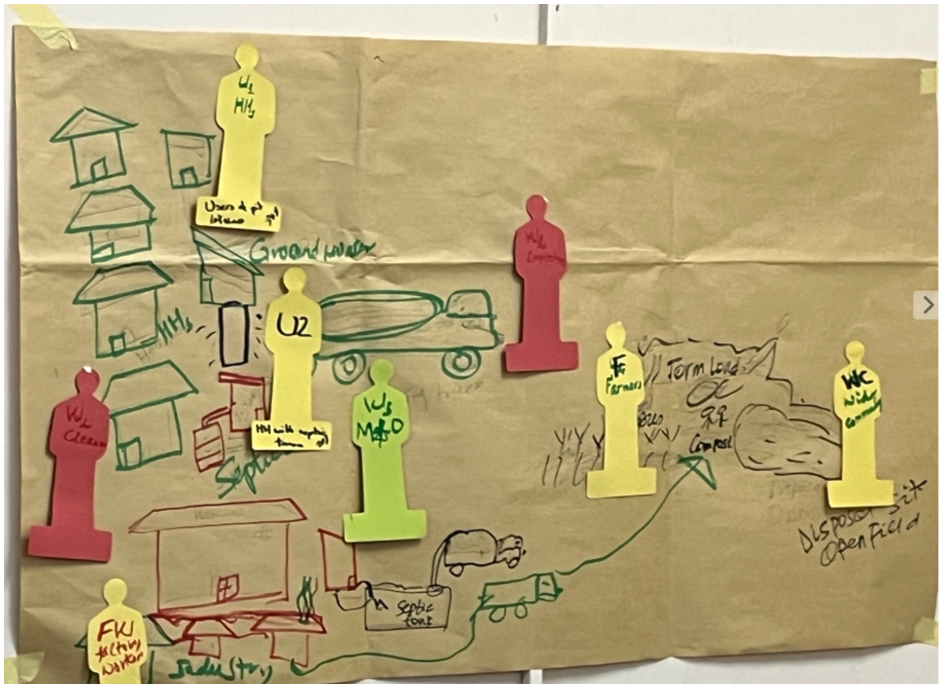
Information sources	Summary of key observations
Standards and regulations	
Sanitola National Effluents Standard 2010	BOD and SS limits. *E. coli* limits of 1000/100 mL are given. Does not include limits for helminth egg concentrations. Enforcement is limited.
Sanitola Biosolid Standards and Regulations 1998	Use of WWTP sludge in agriculture is prohibited in Sanitola because of concerns about heavy metals.
Information related to system management and performance	
2020 Regional Health Department "Epidemiological study on the prevalence of helminthic infections in school-aged children"	A total of 300 school-aged children (9–14 years) were enrolled in a cross-sectional study carried out at the 10 major schools of Newtown in 2019. Hookworm and *Ascaris lumbricoides* were the most common helminth infections, with a prevalence of 21.9% and 18.4%, respectively. *Trichuris trichiura* infection was detected in 1.5% of the children. No *Schistosoma* eggs were found in any of the stool and urine samples. Outbreaks of *Cryptosporidium* have occurred in low-lying areas following flooding.
Demographics and land-use patterns	Limited space is available in Newtown. Populations from rural areas are migrating to the town in search of employment opportunities. Many move to informal settlements at the periphery of the town or in low-lying flood-prone areas where sanitation conditions are poor.
Changes relating to weather or other seasonal conditions	During the cooler months (December–February), use of wastewater by farmers is low. Reduced rainfall during the dry season causes occasional water restrictions, resulting in some households using shallow groundwater wells and an increased demand for wastewater use by farmers. Demand for pit emptying also increases during heavy rainfall events, but flooding makes access to some areas difficult. Sewers overflow during severe rain events as a result of high flow and blockages caused by solid waste.

GROUP WORK

Applying Steps 2.3 and 2.4 to our Alwar case study

In your maps:

- Identify the exposure groups.



In your Alwar SSP Document:

- Characterize the exposure groups.
- Identify the supporting information that needs to be collected.

- With your group discuss: **What do you need to find out tomorrow to identify the exposure groups and the actual hazards?**

GROUP WORK

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.

STEP 2.3: Identify exposure groups

In your maps, identify the exposure groups, using the letters U, L, W, WC, F and C are as symbols. You might want to define sub-groups, such as U1: users of latrines, U2: users of flush toilets. Use SSP manual Tool 2.2 to characterize the exposure groups. Remember the exposure groups are:

U: Sanitation system users L: Local community W: Sanitation workers
WC: Wider community F: Farmers C: Consumers:

Sanitation step	Exposure Group ID	Who are the exposure groups?	How many are there?	What are they doing there?	What are they exposed to?	How often are they exposed to this?

STEP 2.4: Gather supporting information

Write down any information you will want to obtain to characterize the system. Indicate the source of the information. Record below:

Regulatory requirements	Demographics and land use patterns
System management and performance	**Changes related to climate and weather**

GROUP WORK

World Health Organization

Sanitation Safety Plan

Alwar, Rajasthan

Description of the locality and sanitation systems

1. Background information

1.1 Description of Alwar City

Alwar City is located on 27° 32' 30"" N latitude and 76° 37" 30"" E longitude in North-eastern Rajasthan. The city covers an area of 48.14 sq.km catering around 4,50,000 population. The population has increased considerably in the past years, particularly because of the steady migration from other parts of the state. This rapid increase in the population size has come with a number of challenges for the Alwar Nagar Nigam, particularly the development of the infrastructure required to support this increase in population.

It is estimated that about 10% of the population is living in poverty.

Alwar has a monsoon-influenced hot semi-arid climate with long, extremely hot summers and short, mild to warm winters. The climate here is a local steppe climate. The city experiences a short monsoon with annual rainfall of about 67 cm which mostly falls in July and August due to monsoon.

City's most of the local population is employed in modern economic activities such as industry (22%), business and commercial domains (22%), services (39%) and transport and communication sectors (9%). Apart from these activities, agriculture is also considered one of the prominent activities in the peri urban areas of Alwar city. They produce crops such as bajra, maize, jowar, karif pulses, arhar, sesamum, cotton, guar, wheat, barley, gram, mustard, and rabi pulses.

1.2. Legal framework

The sanitation sector in Alwar city is governed by the following pieces of legislation:

- Manual on Sewerage and Sewage Treatment Systems, 2013.
- Environmental (Protection) Act, 1986.
- The Environment (Protection) rules, 1986.

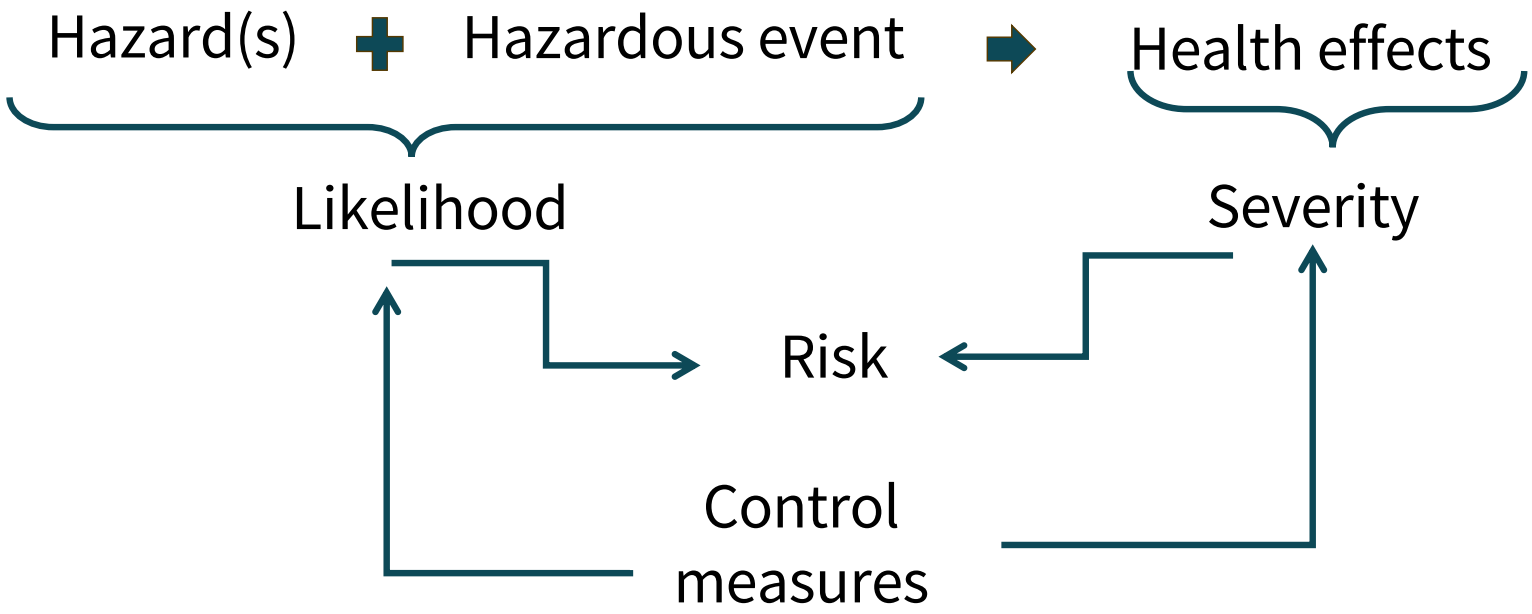
Climate Resilient Sanitation Safety Planning, Training of Trainers (TOT)
Nimli (Alwar), Rajastan, India. February 6-9, 2024

World Health Organization

- Questions regarding the exposure groups and actual hazards (steps 2.3 and 2.4):

(What do you need to find out tomorrow to identify the exposure groups and the actual hazards?)

Tomorrow: Module 3



Hazard

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

Hazardous Event (HE)

Any incident or situation that:

- **introduces or releases the hazard** to the environment in which people are living or working
- **amplifies the concentration of the hazard** in the environment in which people are living or working,
- or **fails to remove the hazard**

GROUP WORK

Preparation for field visit

- Questions regarding possible hazardous events, their probability and severity, as well as the control measures in place (Module 3):

(What could go wrong?)

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			