WATER SAFETY AND SECURITY: EMERGENCY RESPONSE PLANS

Guidance on Developing and Implementing Emergency Response Plans for Community Water Systems

Unathi Jack and Philip de Souza

WATER RESEARCH COMMISSION

TT 656/16

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Water Research Commission

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FOREWORD

All water services systems irrespective of size, location, etc. should have Emergency Response Plans (ERP) to guide officials, stakeholders and consumers through emergencies as one way of managing risks in the water supply system. Emergencies in the water supply system may result from natural disasters, equipment failure, human error, intentional acts (e.g. vandalism), etc. Simply put, an ERP prepares the organisation for emergencies and specifies instructions about what to do if there is an emergency situation that may affect the water system.

This guideline document with associated templates was developed through a Water Research Commission (WRC) project K5/2213 “Water Safety and Security: Emergency Response Plans”. The guideline document provides guidance on how to develop a water safety plan (WSP) and an ERP. The corresponding templates are also provided respectively that can be modified to fit the specific needs of each system depending on the type, size and complexity of the system.

The guideline has been developed in such a way that it should help communities that do not have formal water provision systems, to understand:

- How to protect their resources and/or water supply system infrastructure against contamination.
- How to manage certain water related challenges that may lead to emergencies.

In particular, the guideline document provides guidance on how to:

- Develop a water safety plan for community water supply systems.
- Develop an emergency response plan, including
    - guidance on who should be on the ERP team, and associated roles and responsibilities;
    - guidance on the communication procedures, i.e. who to contact, when and how;
    - guidance on appropriate plans of action for responding to possible threats, hazards and emergencies;
    - guidance on household water treatment methods to protect public health.

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ACRONYMS & ABBREVIATIONS

CWS	Community Water System
DWS	Department of Water and Sanitation
EHP	Environmental Health Practitioner
ERP	Emergency Response Plan
SANAS	South African National Accreditation System
SANS	South African National Standards
SOPs	Standard Operating Procedures
WRC	Water Research Commission
WSA	Water Service Authority
WSI	Water Service Institutions
WSP	Water Safety Plan

GLOSSARY

Community	a social group of any size whose members reside in a specific area, share resources and government, have common cultural and historical heritage.
Contaminants	a substance that renders water unsuitable for its intended use.
Distribution	equipment and facilities interconnected to provide water from the treatment facility to the point of use.
Drinking water	means water which is used, or intended to be available for use, by humans for drinking, cooking, food preparation, personal hygiene or similar purposes.
Emergencies	is an indication that water is contaminated, unavailable or is in excess (in the case of floods).
Indicator/ trigger	an event that causes water contamination, excess or unavailability.
Water source	point where water collects and is drawn for use.
Water supply system	area within which water intended for human consumption may come from and distributed to the community.
Water treatment	process or combination of processes undertaken to treat water to an acceptable drinking water quality.

1 BACKGROUND

It is everyone's responsibility to protect, use and save water

CHAPTER 1: BACKGROUND

1.1 INTRODUCTION

Emergencies can drastically affect the water supply system and the community that depends on it. Each emergency has unique effects on different parts of a water supply system, requiring evaluation based on the actual event. All water services systems irrespective of size, location, etc. should have Emergency Response Plans (ERP) to guide through emergencies as one way of managing threats, vulnerabilities and risks in the water supply system.

1.1.1 PURPOSE OF THE GUIDELINE

This document is developed to provide guidance to communities and water services institutions on how to prepare, plan and respond to possible emergencies and drinking water system risks, threat and vulnerabilities. In particular, this guideline document provides guidance on how to:

- develop a water safety plan for community water supply systems.
- develop an emergency response plan, including;
    - guidance on who should be on the ERP team, and associated roles and responsibilities.
    - guidance on the communication procedures, i.e. who to contact, when and how.
    - guidance on appropriate plans of action for responding to possible threats, hazards and emergencies.
    - guidance on household water treatment methods to protect public health.

It is recommended that the information in both is kept as basic as possible and can be easily accessed by authorized staff and the relevant people.

1.1.2 WHO SHOULD USE THE GUIDELINE?

The guideline document is intended for use by any community water supply system and /or water service institution. The guideline document provides guidance on how to develop a water safety plan (WSP) and an emergency response plan (ERP). The corresponding templates are provided, in Appendices A and B respectively, that can be modified to fit the specific needs of each system depending on the type, size and complexity of the system. The guide has been developed in such a way that it should help communities that do not have formal water provision systems, to understand:

- How to protect their resources and/or water supply system infrastructure against contamination.
- How to manage certain water related challenges that may lead to emergencies.

This guideline should be used in conjunction with the following Water Research Commission (WRC)/Department of Water and Sanitation (DWS) documents:

1. Guidelines on using the refined and translated web-enabled Water Safety Plan tool (2013). WRC Report No TT58/13
2. Guidelines on Protecting Groundwater from Contamination (2004). Toolkit for Water Services: Number 3.4.

3. Quality of Domestic Water Supplies Volume 4 (2002). Treatment Guide TT181/02
4. Quality of domestic water supplies Volume 1 (1998): Assessment Guide TT101/98
5. Selection and use of home water treatment system and devices (2013). WRC Report No 1884/1/13
6. The Development of a generic Water Safety Plan for small community water supply (2009). WRC Report No. TT 415/09

1.2 WATER SAFETY AND SECURITY: EMERGENCY RESPONSE PLANNING

The main aim of this project is to assist Water Service Institutions (WSIs) to develop emergency response plans (ERPs) for community water systems. Emergency response planning is an essential part of managing a drinking water system. ERP is a key component of a WSP.

NOTE: Emergency Response Planning is a component of Water Safety Planning.

Water Safety Planning (WSP) is a risk management tool which encompasses the water management chain from catchment to consumer. The primary objectives of a WSP in ensuring good drinking water supply practice are:

- the minimization of contamination of source waters,
- the reduction or removal of contamination through treatment processes and
- the prevention of contamination during storage, distribution and handling of drinking water; seeking to identify hazards that the water resource and supply system are exposed to and the level of risk associated with each.

In South Africa, most municipalities became aware of WSPs as part of the introduction of the Department of Water and Sanitation's (DWS) Blue Drop Certification programme in 2008. Furthermore, the DWS supports international best practices and consequently indicated that it expects municipalities to manage their water supply systems against WSPs (DWA, 2009). WSPs have therefore been adopted as a tool to fulfil the objective of ensuring safe drinking water supply through the use of a comprehensive risk assessment and risk management approach. This objective is equally applicable to large piped drinking-water supplies and small community systems.

The approach adopted when developing a WSP typically comprises the following sequential steps (WHO, 2009):

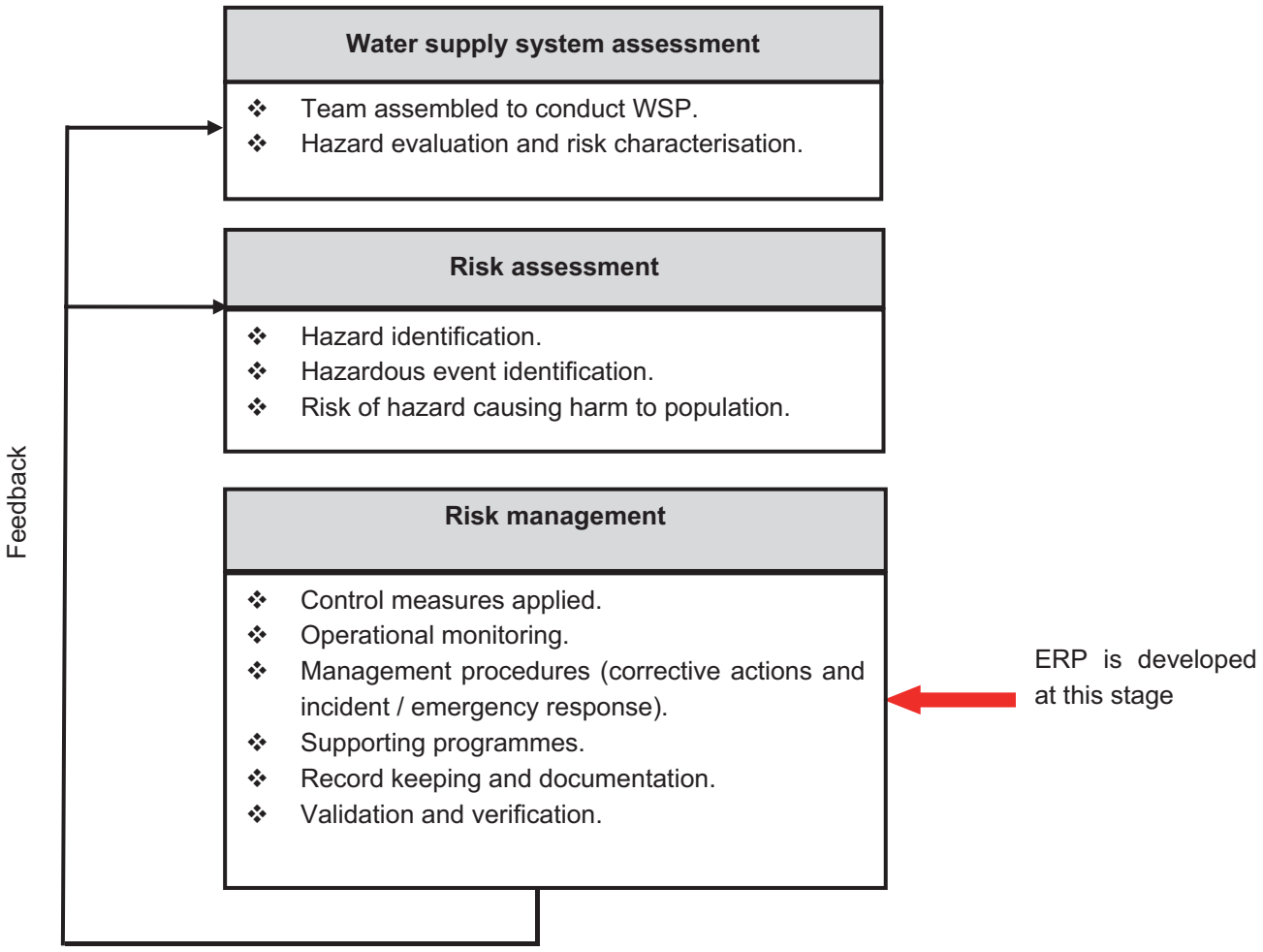


Figure 1.1: Water safety planning steps (Thompson et al., 2009; WHO, 2009)

1.3 DEFINITIONS

Emergency

For the purpose of this guide:

- An emergency may be considered as an indication that water:
  - is contaminated; or
  - is unavailable for consumption; or
  - is in excess (in the case of floods).

A threat is an indication or warning of probable trouble (e.g. drought).

A hazard is a situation that poses a level of threat to life, health or environment (e.g. poor water quality).

A vulnerability is an exploitable security weakness or deficiency at a facility (e.g. non controlled access to a drinking water reservoir).

1.4 DEVELOPING A WATER SAFETY PLAN

For comprehensive guidance on the development of a water safety plan, the following documents can be consulted:

- Water safety plan manual: step-by-step risk management for drinking-water suppliers (2009). World Health Organization
- The Development of a generic Water Safety Plan for small community water supply (2009). WRC Report No. TT 415/09
- Guidelines on using the refined and translated web-enabled Water Safety Plan tool (2013). WRC Report No TT58/13

Below are examples of simplified steps for developing a WSP for a community water system (CWS). Templates for developing your own WSP can be found in Appendix A.

Step 1: Assemble the WSP team

A Water Safety Planning team is responsible for developing and facilitating implementation of WSPs within their institution. It is recommended that, if possible, the team consists of the following persons: (1) water services managers, engineers and technicians, (2) operational staff of treatment plants, (3) water quality managers/specialists, (4) catchment managers, (5) water service providers (6) environmental, public health or hygienist professionals and (7) consumer representatives. When an emergency occurs, there can be confusion, lack of co-ordination and poor communication, if there is no designated person to co-ordinate emergency response effort. Therefore a person who is the first contact (who is likely to co-ordinate) during an emergency should be identified. Examples of a WSP co-ordinator and the WSP team are presented in the Tables 1.1 and 1.2 below.

Table 1.1: Example: WSP co-ordinator details

In case of water related emergencies, please contact:	
Name	Lizo Bhanga (Cirha)
Telephone number	082 5434563
Other contact	079 9990000
E-mail	N/A

Table 1.2: Example of the WSP team / stakeholders

Department	Member name	Location	Work Telephone	Home/cell number
Engineer	Mr Fihla	Batho municipality		0711190087
Technical manager	Mr Nqevu	Batho municipality		0811876776
Water quality technician	Mr Sun	Batho municipality		0788890098
Operations and maintenance manager	Mr Koyana	Batho municipality		0766540000
EHP	Khanyisa Khanyile	Siyaya district municipality		0744446567
Health professional	Head nurse	Ndwendwe clinic	0800571876	0724356781
Community	Chief Azwhindini	Khanya village		0842351678
Community	Headman Rhabula	Khanya village		0735654345
Community	Mr Phika	Veza High School	08608360527	0761234890

Step 2: Document and describe the water supply system

Each water supply system has different components and designs. The components of the CWS should be identified, described and recorded in order to ensure that when preparing for emergencies, all components are included. Examples of what can be considered in order to understand the system are presented in Table 1.3 and Figure 1.2-1.4 below.

Table 1.3: Example: Documenting the system

Water Supply System	Source	Treatment	Storage	Network
Name	Mpefeni river	Gqobonco treatment		
Owner	Department of Water and Sanitation	Batho municipality	Batho municipality	Batho municipality
Treatment methods	River	Disinfection only	Jojo tank	PVC pipes/brass taps
Size		2000 L/day	2500 L	40 mm pipes
Population/villages served	Gqobonco, Mpefeni and Ncokazi villages	Gqobonco village only (~100 households)	Gqobonco village only	Gqobonco village only
Location	Gqobonco village: (GPS co-ordinates)	Gqobonco: (GPS co-ordinates)	Gqobonco: (GPS co-ordinates)	3 taps: 1 – clinic; 2 – near Veza SSS; 3 – near the Jojo tank
Condition	Quality – Fair Quantity – good	Good	Good	Good
System protection measures	None	Fenced, far from community	Fenced, tanks closed	Pipes underground
Comments	Raw water is always sufficient	The treatment system is new and well protected.	The tanks are new and still in good condition.	

NOTE 1: Identify all the components of the system, their capacities, type/make and how they function and their condition.

NOTE 2: In cases where there is more than one source, names and/or number of sources should be indicated with the total capacity.

If your CWS is not documented, map up your area and draw your water supply system below using the examples that follow. You should have something like this.

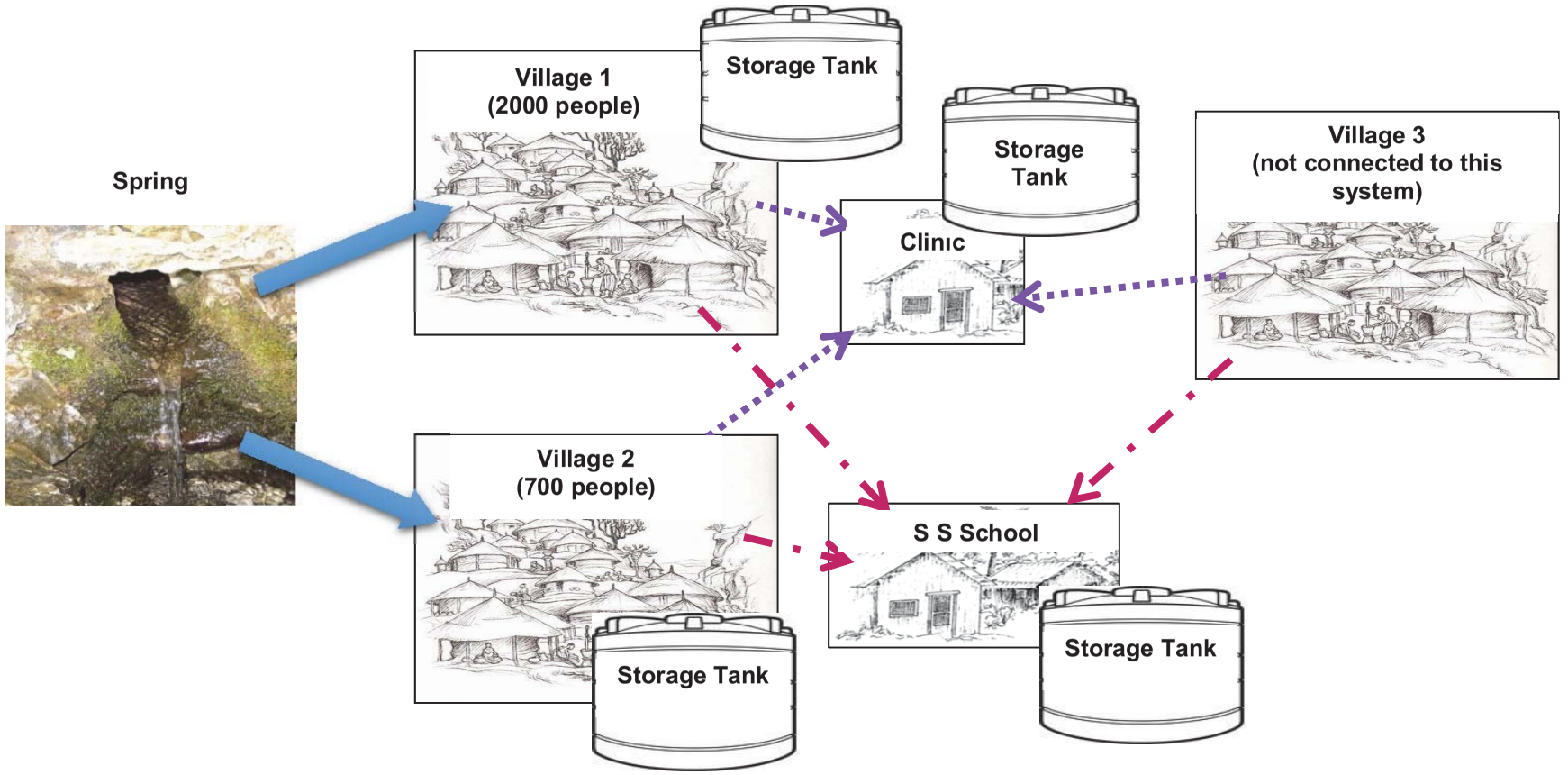


Figure 1.2: Mapping the area example

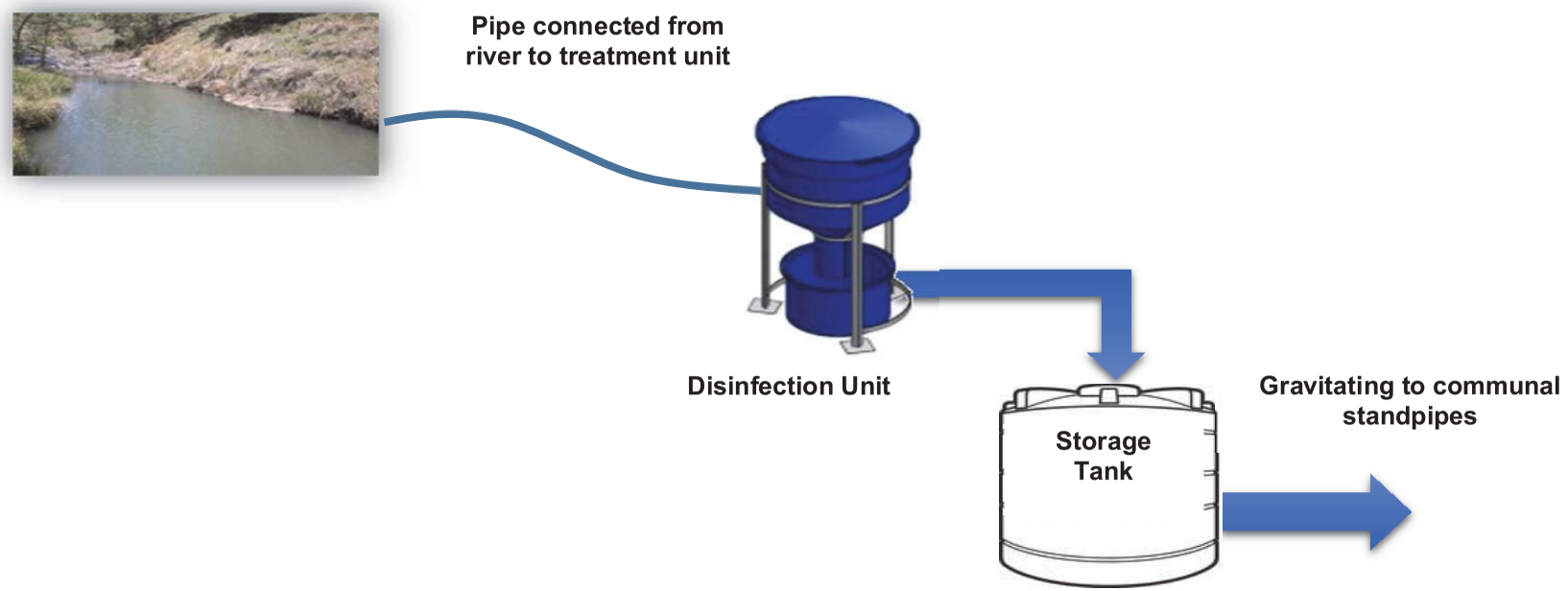


Figure 1.3: Documenting the supply system

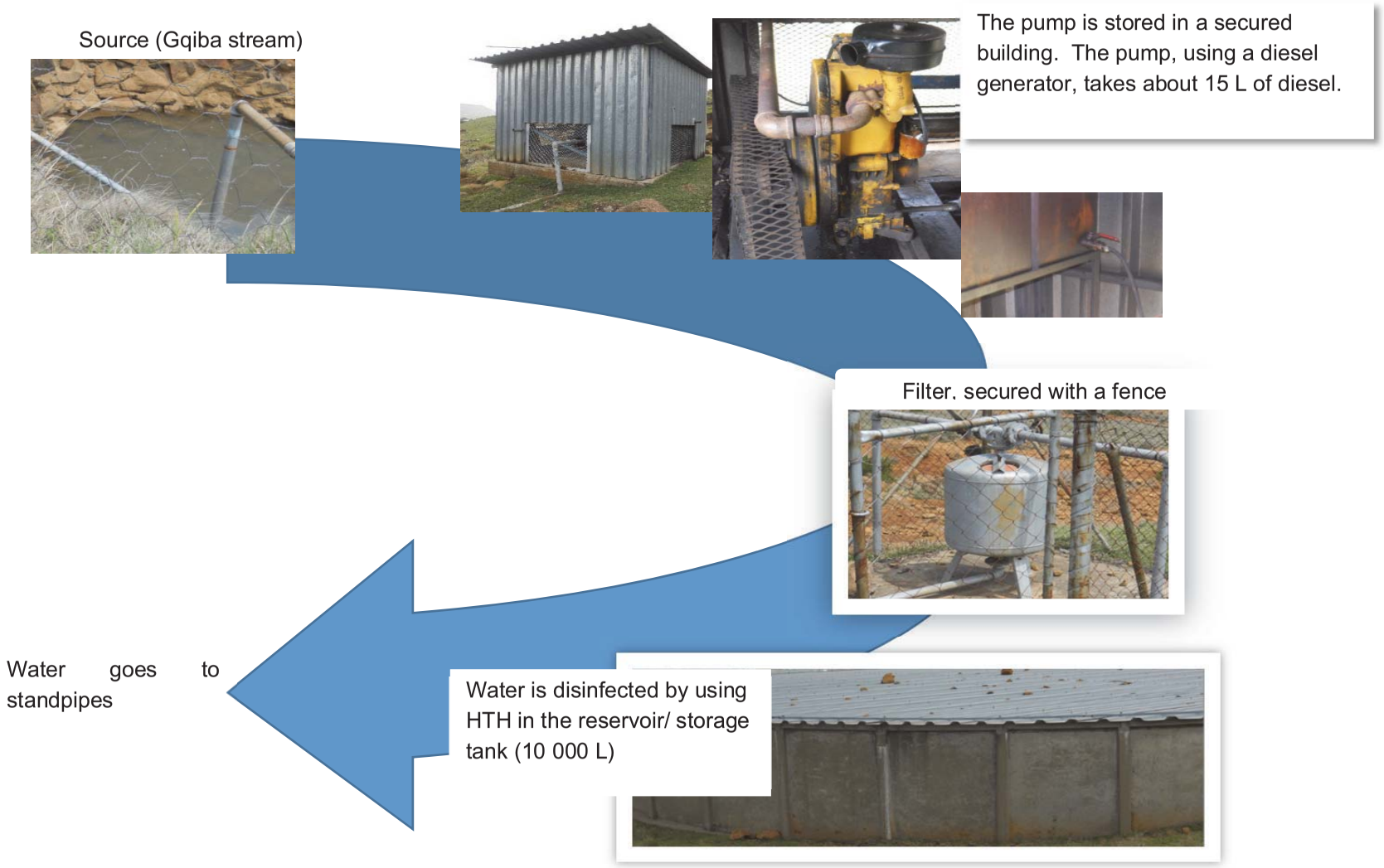


Figure 1.4: Documenting the supply system example

Step 3: Assess the water supply system

An assessment of the community water system is conducted to obtain an idea of the typical hazards/hazardous events faced at each component. This exercise includes:

- Identification of potential pollution sources at each component (e.g. livestock, human activities at water source).
- Identification of hazards associated with the water contamination/unavailability/excess should be considered and listed. Table 1.4 is an example of an assessment of a water supply system.

Table 1.4: Examples of water supply system related threats, vulnerabilities and risks

Emergency category	Possible threats / vulnerabilities /challenges (emergency triggers)	Possible threat impacts
Source		
Water quality	• Children swimming at the source	• People may get sick due to faecal contamination. • Children may drown and die.
Water quality	• Agricultural farms in close proximity.	• Agricultural practices may increase nutrient levels in water due to entry of fertilizers or pesticides.
Water quality	• Evidence of illegal dumping near or at the source.	• Illegal dumping, littering and other debris can lead to solid waste directly entering source water.
Water quality	• The well or spring situated on the flood plain/low lying area.	• Wells or springs get sediments after heavy rain. • Gullies and dongas around the source may be formed.
Water quality	• Source located far from the road e.g. mountains where it is not easy to access.	• Poor access may lead to system neglect resulting in poor system maintenance and/or monitoring.
Treatment		
Water quality	• No fencing, gates, locks, safety/warning signs, inadequate security.	• Treatment facility could be sabotaged or vandalised leading to deteriorated water quality or failure to provide water.
Water quality	• Unavailability of operation and maintenance manual and schedule.	• Unavailability of operation and maintenance manual may lead to: ➢ Poor operation and maintenance of the treatment system. ➢ Poor water quality production at the treatment system. ➢ Poor budgeting for the system.
Water quality	• No alternative power supply in case of power failure.	• No alternative power supply may lead to system shutdown when there is power failure. This may lead to no water supply.
Water quality	• Operational monitoring that is not conducted daily or weekly.	• Poor operational monitoring can lead to delayed reaction to urgent issues of concern.
Water quality and quantity	• Treatment system infrastructure is old and more prone to breakdown or need repair.	• Infrastructure that breaks more often may lead to excessive water losses at the facility.

Table 1.4 (continued): Examples of water supply system related threats, vulnerabilities and risks

Emergency category	Possible threats /vulnerabilities /challenges (emergency triggers)	Possible threat impacts
Distribution		
Water quality	• Storage tanks are overdesigned.	• Water standing in the tank for longer periods (e.g. >5 days) may be re-contaminated.
Water quantity	• Storage tanks are easily accessible to the public.	• Storage tanks that are easily accessible to the public are more prone to vandalism and contamination.
Water quality	• Poor maintenance of the reservoirs/storage tanks.	• Poor maintenance of the storage tanks may cause recontamination of water in the tank.
Water quantity	• Pipes that are above the ground.	• Lifespan of the pipes may be reduced due to exposure to changing weather conditions. This may lead to water losses.
Water quality/quantity	• Vandalism or sabotage.	• Vandalised pipes may result in disturbed water supply.
Point of use: Rainwater harvesting		
Water quality	• Rusty gutters and roofs.	• Rusty gutters and roofs may lead to water with unusual taste and/or cloudy or reddish looking water.
Water quality	• Water collected in the tank after long periods without rain.	• Rainwater, after a long dry period, contains dust from the air.
Point of use: Household		
Water quality	• Water stored in open containers.	• Water in open containers may be contaminated.
Water quality	• Unhygienic practices when handling/drawing water from the storage container.	• Water may be re-contaminated due to unhygienic practices when handling/drawing water from the storage container.

Step 4: Undertake a hazard assessment and risk characterization

Determining the risk associated with the hazards identified is about considering the likelihood (probability) (e.g. is it likely to happen, has it happened in the past?) and consequence (impact should it happen) of a potential hazardous event. The reason for analysing the possible events / challenges is to understand the level of protection required to avoid or minimise the chances of an emergency.

When determining the risk, the following should be considered:

- Is it possible that the hazardous event (emergency trigger) may cause contamination or unavailability of water in the system?
- How frequently does an emergency trigger happen or is it likely to happen?
- What would be the emergency trigger effect?

For a community water system, a simple risk matrix to identify likelihood and effect, can be used as shown Table 1.5 below.

Table 1.5: Example: Risk matrix

Likelihood	Effect
• Daily • Weekly • Monthly • Seasonal • Yearly • Rarely (once in 3 years) • Never	***Quality***
	Mild irritation (e.g. skin)
	People may get sick
	People may die
	Quantity
	All houses have water (time and flow limited)
	Most houses (>50%) have water (time and flow adequate/time and flow limited)
Likelihood rating Daily / weekly = high Monthly /seasonal = medium Yearly / rarely / never = low	Some houses (<50%) have water (time and flow adequate/time and flow limited)
	All houses do not have water
	Aesthetic
	Slight unusual taste/smell/odour and appearance
	Staining of clothing/deposits on household appliances (e.g. kettle)
	Unpleasant taste/smell/odour and appearance
	Offensive taste/smell/odour and appearance (cannot drink)

An emergency rating can be determined once the likelihood and effect have been identified. If the user is uncertain about determining the emergency rating, table 6 can be used as a guide. This process assists in determining the emergency triggers that require more urgent attention (e.g. high and medium), so that appropriate actions are taken.

Table 1.6: Risk rating

Likelihood × Effect	Emergency rating
High × High	High
High × Medium	High
Medium × Medium	Medium
High × Low	Medium
Medium × Low	Medium
Low × Low	Low

Using the likelihood and effect and risk rating tables (Tables 1.5 and 1.6) as a guide, a risk related to each hazardous event/emergency trigger can be determined as shown in Table 1.7.

Table 1.7: Example: Undertaking hazard and risk assessment

Possible hazardous events that may lead to emergencies	Likelihood/ Possibility	Effect	Risk rating
Source			
• Children swimming at the river.	• Seasonal	• People may get sick. • Children may drown and die.	• Medium • High
• Significant drop in the water level.	• Seasonal	• Some houses (<50%) may have water. • Slight unusual taste/smell/odour.	• Medium
Treatment Unit			
• Unavailability of operation and maintenance manual.	• Daily	• Unpleasant taste, odour and appearance. • People may get sick.	• High
• Treatment system is not easily accessible due to poor access roads.	• Daily	• People may get sick.	• High
Distribution			
• Old, broken distribution pipes.	• Once in 3 months	• Unusual colour, smell and taste. • Some houses (<50%) have water (time and flow adequate).	• Medium
• Distribution pipes are not cleaned frequently.	• Yearly	• Unusual colour, smell and taste.	• Low
• Vandalised standpipes.	• Once in 3 years	• All houses do not have water.	• Medium

Step 5: Identify control measures

Control measures include consideration of what needs to be done to rectify the situation. Control measures should be developed for each and every hazard/hazardous event (e.g. alternatives, backups, etc.). An example of identification of control measures and/or corrective actions is provided in Table 1.8.

Table 1.8: Example: Identification of control measures/corrective actions

Possible hazardous events that may lead to emergencies	Risk rating	Suggested control measure/corrective actions
Source		
• Children swimming in the river.	• High	• Raw water should be appropriately treated. • Develop community awareness programmes to educate the children about the effects of swimming at the source. • Develop community awareness programme to educate the community about home based water treatment methods. • Conduct community awareness.
• Significant drop in the water level.	• Medium	• Develop a drought emergency plan. • Conduct community awareness on water saving methods.
Treatment Unit		
• Unavailability of operation and maintenance manual.	• High	• Develop an operation and maintenance manual. • Implement the operation and maintenance manual. • Develop and implement an operational monitoring programme.
• Treatment system is not easily accessible due to poor access roads.	• High	• Communicate with the roads department about the issue. • Identify a community member who stays close to the facility. • Train the community member to operate the treatment system.
Distribution		
• Old, broken distribution pipes.	• Medium	• Develop and implement a pipe replacement programme.
• Distribution pipes are not cleaned frequently.	• Low	• Develop a pipe maintenance programme. • Set aside budget for the implementation of the programme.
• Vandalised standpipes.	• Medium	• Develop community awareness programmes to educate the community about the effects of vandalism.

Sampling and monitoring should be considered as one of the control measures. Water quality testing of raw water assists in identifying the appropriate treatment method required. Water quality testing of treated water provides an indication of whether water is fit for consumption or not. SANS 241 provides guidance on sampling and monitoring requirements and water quality standards.

An example of a simple sampling programme for a CWS is shown in Table 1.9 below.

Table 1.9: Example of a sampling programme

Sampling point	Minimum per point		
	Number of samples per year	Sampling frequency	Parameters tested
Source	1	Yearly	*E.coli*, Turbidity, Fluoride, pH
Treatment	4	Every 3 months	*E.coli*, Turbidity, pH, FCR
Storage	4	Every 3 months	*E.coli*, Turbidity, pH, FCR
Point of use	4	Every 3 months	*E.coli*, Turbidity, pH, FCR

NOTE: Be aware of the quality of water you are using. Is it fit for its purpose?

Step 6: Verify that the WSP is operational

Validation is the process of obtaining evidence on the performance of control measures. The efficiency of each control measure should be determined and verified to ensure that it does make a difference and has a purpose. In the process of verification, the following should be considered and understood:

- What should I be checking on a regular basis to make sure my control measures are effective?
- Development of a risk based monitoring programme.

An example of verification of control measures is shown in Table 1.10.

Table 1.10: Example: Verification of WSP

Risk rating	Hazardous event/Emergency trigger	Action Plan	Effective (Yes/No)	Residual risk rating	Suggested actions if existing actions are not effective
High	• Children swimming at the source.	• Water should be appropriately treated. • Develop a community awareness programme to educate the children about the dangers of swimming at the source. • Develop a community awareness programme to educate the community about home based water treatment methods. • Conduct community awareness.	• Yes, drinking water quality meets SANS standards after treatment. • Incidents of children swimming at the source have reduced after community awareness programmes.	• Low	• Continue with community awareness.
High	• Unavailability of operation and maintenance manual.	• Develop an operation and maintenance manual. • Implement the operation and maintenance manual. • Develop and implement an operational monitoring programme.	• Yes, drinking water quality of treated water meets SANS standards.	• Low	• N/A

Risk rating	Hazardous event/Emergency trigger	Action Plan	Effective (Yes/No)	Residual risk rating	Suggested actions if existing actions are not effective
Medium	• Significant drop in the water level.	• Develop a drought emergency plan. • Conduct community awareness on water saving methods.	• No, there is no alternative source identified.	• Medium	• Identify an alternative source in case the primary source water level drops significantly.
Medium	• Old, broken distribution pipes.	• Develop and implement a pipe replacement programme. • Set aside budget for the implementation of the programme.	• No, no budget for implementing the programme.	• Medium	• Include the plan into the IDP and budget for the programme.

Step 7: Develop supporting programmes

Supporting programmes are actions that do not directly affect drinking water quality, however, they are important in ensuring drinking water safety. These are activities that ensure the operating environment, equipment used and the people themselves do not become an additional source of potential hazards to the drinking water supply. Examples of supporting programmes are provided below.

Staff training requirements

It is essential that the WSP teams be trained in order to be able to respond appropriately to the types of threats, vulnerabilities and risks that may occur. Training could include briefing sessions, classroom sessions, or mock exercises (see example in Table 1.11). Refresher training should be done on a regular basis. Trainees should understand:

- The components of the emergency response plan and
- The various roles and responsibilities during an emergency

Table 1.11: Example of personnel training requirements

No	Name of the person to be trained	Type of training required	Training provider (Internal/External)	Budgeted for (Y/N)	Date completed
1	Menziwa (WSP co-ordinator assistant)	Cleaning a reservoir	Internal	N/A	To be completed June 2015
2	Lizo (WSP co-ordinator)	New disinfection system operation	Internal	N/A	To be completed June 2015
3	Khaya	Plumbing	External (XYZ plumbing academy)	Yes, R5000	Target: April 2016

Personnel safety preparedness

During an emergency, personnel may be at risk of harm, injury or even death. Therefore directions on how to safely implement a variety of response actions for specific situations should be clearly provided. An example of a personnel safety preparedness plan is shown in Table 1.12.

Table 1.12: Example: Personnel safety preparedness

Location/work environment	• Inside a reservoir
Nature of the job	• Cleaning a reservoir
Safety Procedures when working in the environment/ doing that specific job	• Always wear safety clothing before entering the reservoir (e.g. boots, gloves, glasses). • The availability of gas masks and ventilators is recommended. • A person should never work alone. • Ensure that the ladder inside the tank is secure and suitable.
Estimated kind of incident/accident	• Suffocation. • Slipping/falling into the tank
Should an incident/accident happen: Immediate Actions	• Follow procedures developed for responding to this incident (e.g. seek medical help). • Report the issue to the municipal representative.
Notifications (who)	• Person involved to report to the municipality. • ERP co-ordinator (Lizo) to notify the health representative (Miss Khanyile).
Notification Methods	• Telephone • SMS
Is it possible that the injured person cannot reach other people?	• No, never working alone.
Follow-up actions	• The cause of the accident should be investigated and reported. • Investigate whether the safety procedures need to be amended.

NOTE: Ensure that all procedures, communication methods and safety aspects are addressed.

Chemical replacement

Based on the knowledge of the system and its operational and maintenance requirements, an understanding of where and how to find (1) equipment, (2) spare parts and (3) chemicals should be established. The ERP should therefore identify equipment that can significantly lower the impact of an emergency on public health and protect the safety and supply of drinking water. A procedure to manage resources should be developed. An example of chemical supply handling is shown in Table 1.13.

Table 1.13: Example: Chemical replacement

Type of chemical	• Chlorine granules
Responsible/Preferred supplier	• Name of supplier (ABC chemicals)
Location where stored	• Municipal storage room / on-site chlorine room
Person responsible for signing	• Municipal representative (Mr Bheja)
Actions in case of emergency	• In the case of a powder spillage, follow clean up procedures for spillage. • Always take the required safety precautions. • Always keep records of what happened and what was done to attend to the situation.
Procedures to use the equipment/chemical	• Refer to SOPs. • Refer to the developed procedure number.
Notifications (who)	• ERP co-ordinator to notify the municipality when a new order is required. • Municipality to notify the chemical provider of chemical requirements.
Notification Methods	• Telephone. • SMS.

Step 8: Prepare management procedures

The purpose of management procedures is to avoid emergencies occurring or minimise the chances of emergencies. You should not wait for an emergency to happen, rather plan ahead so that when/if it happens you are better prepared to deal with it. This means that the plans/programmes/procedures developed should not only focus on an emergency, but should include day to day procedures and protocols that will minimise the likelihood of emergencies.

This is the step where ERPs are developed. Development and implementation of these plans/programmes and procedures are discussed in detail in the section that follows (Section 2).

Step 9: Establish documentation and communication procedures

Documentation of all aspects of drinking water quality management is essential. Documents should describe activities that are undertaken and how procedures are performed. This is also discussed in detail in the section that follows (section 2).

Step 10: Review the WSP

This step is about putting all the material in the WSP steps together so that it becomes a working document and includes:

- Identification of what is needed to ensure that the supply system works well and how it can be improved continuously,
- Review and updating the WSP document whenever there are changes in CWS staff, roles and responsibilities, contacts or changes in infrastructure,
- Verify the WSP document after events to check if protocols and procedures are effective,
- Understand what needs to be changed, what needs to be reviewed, what needs to be added, with the following considerations:
  - Identify whether the team and contact details are still the same.

- Identify what has happened within that year that is not addressed in the existing ERP document. Make amendments to your document to include such.
- Review your high and medium emergency triggers to identify if the suggested actions were effective or not. If actions are found not be effective, suggest new actions.
- Review your identified possible emergency triggers and identify if there are new ones identified.
- Update your ERP document accordingly.

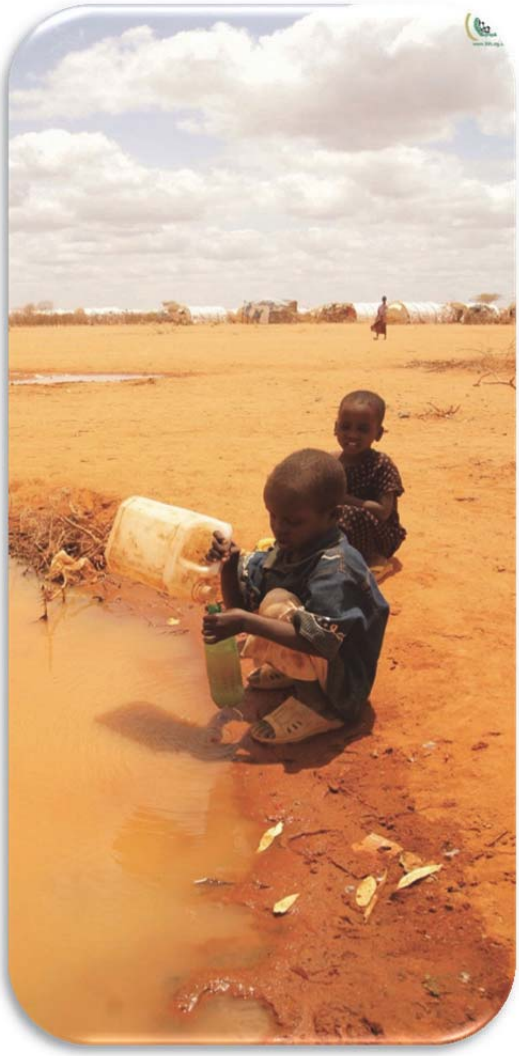
Identify if there is any change of status to the existing emergency triggers. Update the status of your emergency triggers after implementation of some actions (focusing more on high and medium emergency triggers). Identify if the actions taken were effective or not. If not, identify what additional or different actions are required to address the issue. Indicate any new emergency triggers that have been identified during review. An example of considerations when reviewing a WSP is shown in Table 1.14 below.

Table 1.14: Example: WSP review status

ERP review	Yes/No	Updated (Yes/No)	Date updated
Is there any change with the team?	No	N/A	September 2014
Is there any change with the supply system?	No	N/A	September 2014
Are there any new emergency triggers?	Yes	Yes (see table …of the WSP)	September 2014
Are there any emergency triggers to be removed (that have been fully addressed)?	Yes	Yes (see table …of the WSP)	September 2014
Are there any new protocols/procedures to be developed?	Yes	Protocol …. Amended accordingly	September 2014
Is there any change with the sampling and monitoring?	No	N/A	September 2014

NOTE: Check what has changed, what needs to be included in your WSP, what is no longer a challenge?

2 DEVELOPING AN EMERGENCY RESPONSE PLAN



Where did our water go?

CHAPTER 2: DEVELOP AN EMERGENCY RESPONSE PLAN

2.1 INTRODUCTION

This section provides guidance in developing and implementing emergency response plans (ERPs). The proposed structure is based on both international and local practices. In the previous section, the steps of developing a water safety plan (WSP) were covered. Therefore it is expected that a WSP for your water supply system has been developed and the necessary information exists. The purpose of ERPs is to be prepared to manage anticipated incidents and emergencies in a structured and planned way. Emergencies are likely to require the resources of organisations beyond the drinking water supplier, particularly public health authorities. It is also a regulatory requirement (Disaster Management Act, 2002) that all water service systems, including community water systems (CWS), irrespective of size, location, etc., must have ERPs to guide them through emergencies in order to manage risks in the water supply system.

2.2 DEVELOPING AN EMERGENCY RESPONSE PLAN

Developing an ERP is all about planning for anticipated emergencies which includes:

- Identifying a range of possible threats, hazards and emergency causes, as well as appropriate plans of action for responding.
- Preparation and implementation of emergency management plans.

The following should be considered when planning for emergencies:

- Assign roles and responsibilities to the emergency team.
- Develop communication protocols (e.g. between the community and the municipality, between clinics and the municipality, and between the municipality and the community).
- Develop emergency response procedures (step by step what to do or how to react) (e.g. daily inspections – what should be inspected, how?)
- Review the ERP (e.g. are there changes with the emergency team, are there new procedures that should be developed?).

Sections 2.2.1 to 2.2.5 are illustrations of all the considerations mentioned above. In Appendix B, templates are provided for guidance in developing your own emergency response plan.

2.2.1 Assign roles and responsibilities

A multi-disciplinary team (stakeholder team) that is likely to have different roles and responsibilities in case of an emergency should be identified (see Example in Table 2.1). In most cases, this is the same team as a WSP team. Responsibilities should be clearly defined for personnel involved during normal operations and an emergency to speed up the response time. The roles and responsibilities of the emergency team could include:

- Conducting regular/daily checks according to the operations and maintenance plans.
- Communicating emergency reports received.
- Immediately conducting an assessment of the emergency according to the emergency assessment plan procedures.
- Ensuring that emergency programmes are followed accordingly.
- Facilitating public announcements (if or when necessary).

Table 2.1: Example: ERP team roles and responsibilities

Department	Member name	Roles & Responsibilities	Contact numbers
ERP co-ordinator	Lizo Bhanga (Cirha)	• Facilitate communication during an emergency according to the communication protocol developed.	0825434563
Municipality (Engineer)	Mr Fihla	• Support the ERP team.	0842351678
Municipality (Technical manager and water quality technician)	Mr Nqevu and Mr Sun	• Ensure that the process controllers and network personnel are properly trained. • Inform the communications department of public communications that are required. • Assist the customer care department with guidance on water related awareness programmes that are required. • Provide alternative methods of water provision where and when necessary.	0711190087
Municipality (Operations and maintenance manager)	Mr Koyana	• Support the emergency team with assessments in case of an emergency. • Develop a monitoring programme of infrastructure for the operations and maintenance team (e.g. source, pump stations, reservoirs, etc.)	0811876776
Municipality (EHP)	Khanyisa Khanyile	• Monitoring of water quality. • Communication of failures with the municipal management. • Provide advice to the community on home water treatment methods (where necessary).	0766540000
Health professional	Sister Kati (head nurse)	• Report any possible water related health trends observed at the clinic to the municipal representative. • Obtain information from the patients about the source used and the village/area they live in. • Provide advice to the community on home water treatment methods. • Ensure that clinic storage tanks are maintained according to the programme.	0744446567
Community	Chief Azhwindini and headman Rhabula	• Facilitate the means of communication and public announcements (at the village level as per plan).	0800571876
Community (Education)	Mr Phika	• Report any possible water related health trends observed at the school to the clinic. • Provide relevant information to the clinic (e.g. where the children stay, what is happening). • Ensure that school storage tanks are maintained according to the programme.	0724356781

2.2.2 Protocol to respond to failure

One of the methods of developing a protocol to respond to failure is through identification of alert levels. Failure can be categorised according to:

- failure to provide services and
- failure of water quality.

Alert levels should be set for both situations. Identifying alert levels relates to categorising the severity of an emergency. The severity of an emergency could be classified and described according to its intensity or result at different levels. The emergency team could decide if they categorise the severity as "high, medium or low emergency" or according to levels (e.g. "level 1/2/3 emergency"). An example of identifying alert levels is shown in Table 2.2 below.

Table 2.2: Example: Categorising alert levels

Intensity	Emergency trigger	Alert level	Responsible person	Action Plan
Low	• Leaking pipes	• <2hours limited supply.	• Network supervisor	• Maintenance personnel should follow maintenance procedures to solve the issue.
Low	• Power outage	• <24 hours.	• Emergency co-ordinator and Area Manager	• Emergency co-ordinator to inform the area manager. • Emergency co-ordinator to inform the community.
Medium	• Vandalised storage tank	• Tank water with unusual colour/smell and taste. • 24 hours limited water supply.	• EHP • Network supervisor	• EHP to inform the network supervisor. • Maintenance personnel should follow maintenance procedures to solve the issue.
Medium	• No raw water treatment	• Drinking water with unusual colour/smell and taste. • *E.coli* between 1 and 5 count /100 mL	• Top management • Customer care • EHP	• Water treatment options should be investigated. • The community should be made aware of the health impacts and advised on what to do.
High	• Naturally occurring chemicals	• Water quality results (Nitrates) exceeding drinking water standards.	• Top management	• Top management to plan for a suitable treatment system to remove the chemical. • Find an alternative source.
High	• Broken infrastructure	• No water supply for more than 3 days. • People are sick.	• EHP • Network supervisor	• Maintenance personnel should follow maintenance procedures to solve the issue.

2.2.3 Develop a communication protocol

This defines clear lines of authority and responsibilities for the emergency team and/or affected parties who have roles and responsibilities during an emergency. Develop community protocols for different incidents (see Examples in Figures 2.1-4). The community needs to know who to report the emergency to, whilst the ERP team needs to understand who manages the emergency, who makes decisions, and what their own responsibilities are.

Example 1: Generic communication protocol is provided in the figure below.

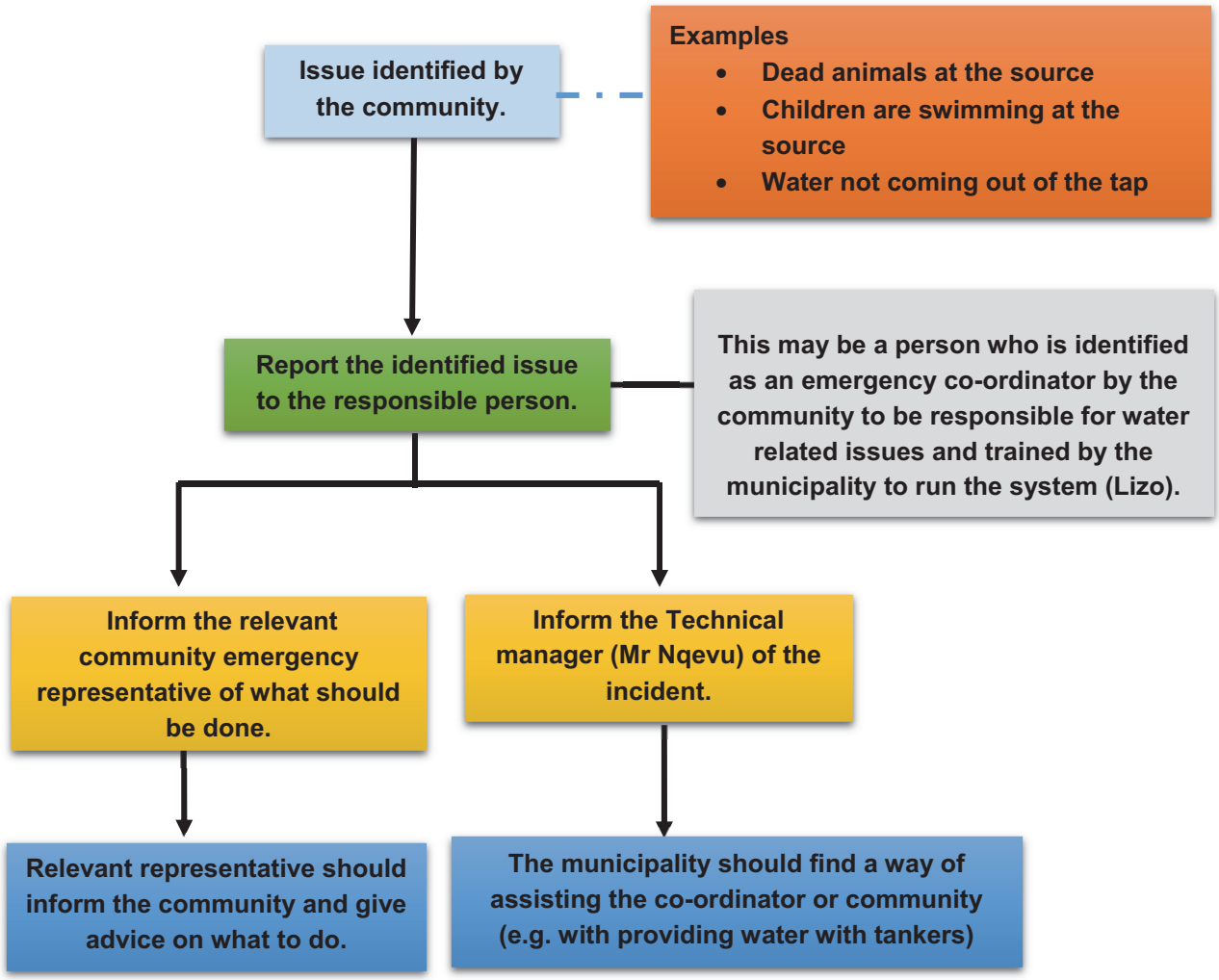


Figure 2.1: Generic communication protocol example

Example 2: An example of a communication protocol for a water contamination emergency is provided in the figure below.

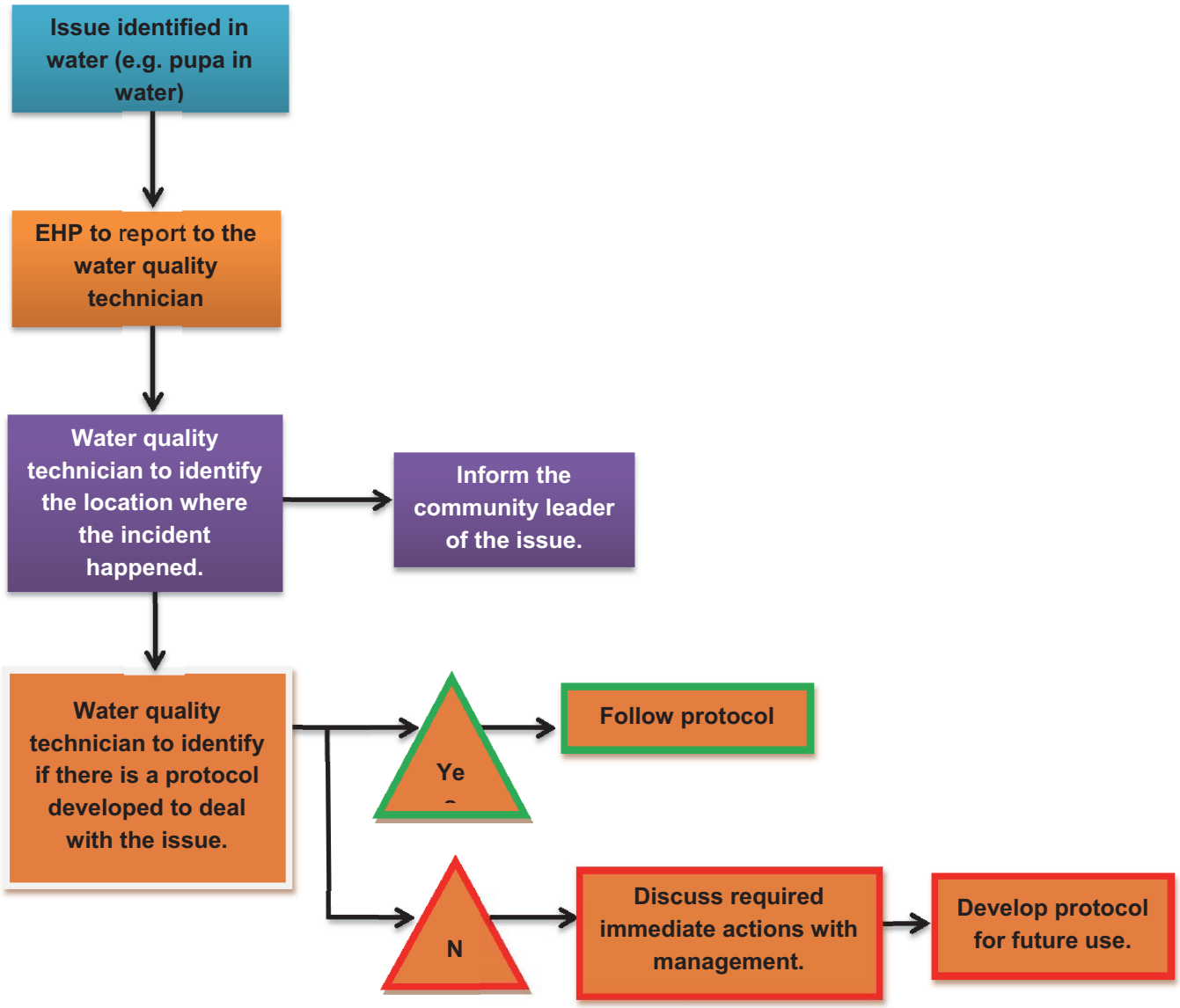


Figure 2.2: Water contamination incident handling procedure example

In the above example, once the water contamination issue has been identified, the EHP reports to the water quality technician, who may be able to attenuate the problem. It is very important to indicate who should be contacted first, who should report to who and who should take what action.

Example 3: An example of a communication protocol in the case of a water system operational failure emergency is provided in the figure below (e.g. chlorine dosage system failure).

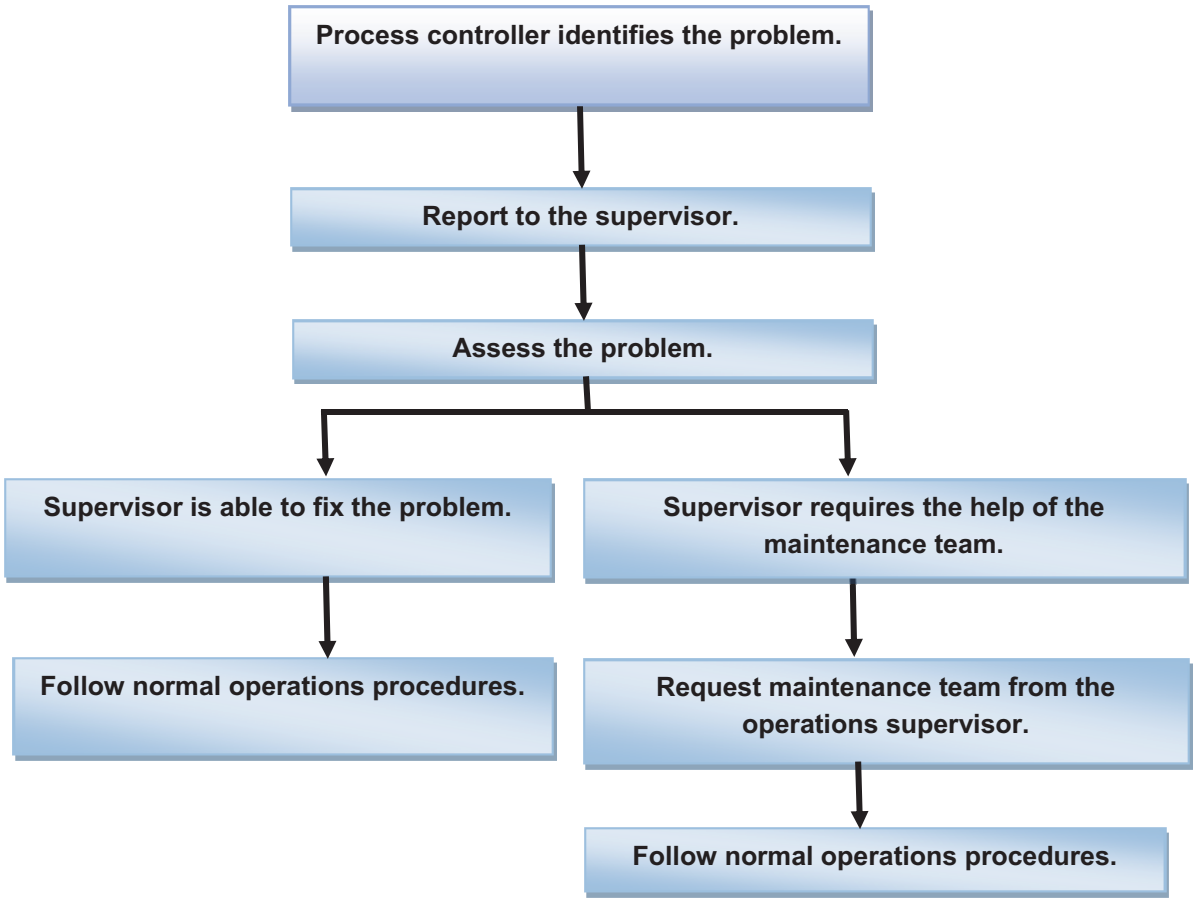


Figure 2.3: Operational failure emergency communication procedure example

Example 4: An example of a communication protocol in the case of a natural disaster (e.g. floods) is provided in the figure below.

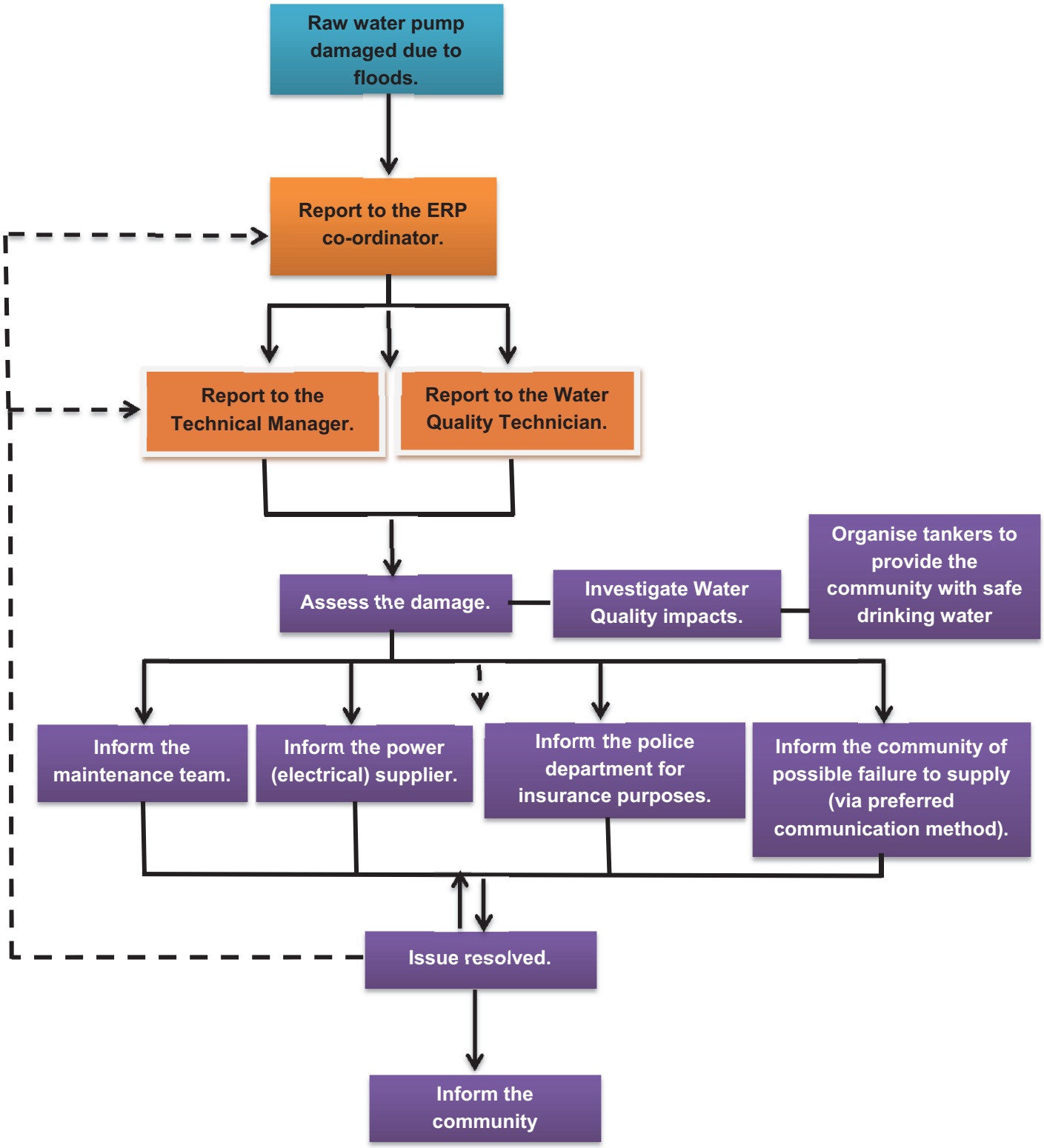


Figure 2.4: Natural disaster (flood) incident communication protocol example

In some instances, the emergency may require that relevant/specialised external institutions are notified. Table 2.3 shows an example of an emergency notification list. In circumstances where an external (contractor) water system operator is required, it is necessary that a contact list for emergency service/repair personnel is developed (see Table 2.4).

Table 2.3: Emergency contact numbers for external departments/institutions

Emergency Notification List		
Organization or Department	***Telephone***	***Night or Cell Phone***
Police	0800657342	
Fire Department	0860127654	
Emergency Medical Services	0800900089	
Department of Water and Sanitation	0800222265	0822765432
Power Utility company (Eskom)	0860987990	0848898765
Laboratory Services	0800111111	0765678390
Local radio station	0860000099	
Local newspaper	0860222345	

Table 2.4: Contact numbers for service/repair personnel

Service/Repair Contact List			
Organization or Department	***Company and Name***	***Telephone***	***Night or Cell Phone***
Plumber	Digit plumbing: Willem Shoe	0256666897	0827788990
Pump Supplier	Pumpup Co.	0370012321	0834454456
Rental Equipment Supplier	Rentall Co.	0256786521	
Chlorine Supplier	Killgerms Co.: Jeff Jeff	0378910888	
Well Drilling Co.	Drillwell Co.	0608987659	
Pipe Supplier	Slide pipe Co.: Ndwe Taba	0374545456	

2.2.4 Develop emergency response procedures/protocols

The recommended method of developing emergency response procedures is to consider all the possible hazardous events, threats, vulnerabilities (emergency triggers) along the various stages of the community water supply system (i.e. at source, through the treatment system, within the distribution network and at point of consumption) that were identified in the WSP. A procedure for dealing with each of the identified possible emergencies should be developed (see Examples 1-4).

Example 1: An emergency response procedure for cleaning a storage tank after contamination or at a scheduled time is provided in the figure below.

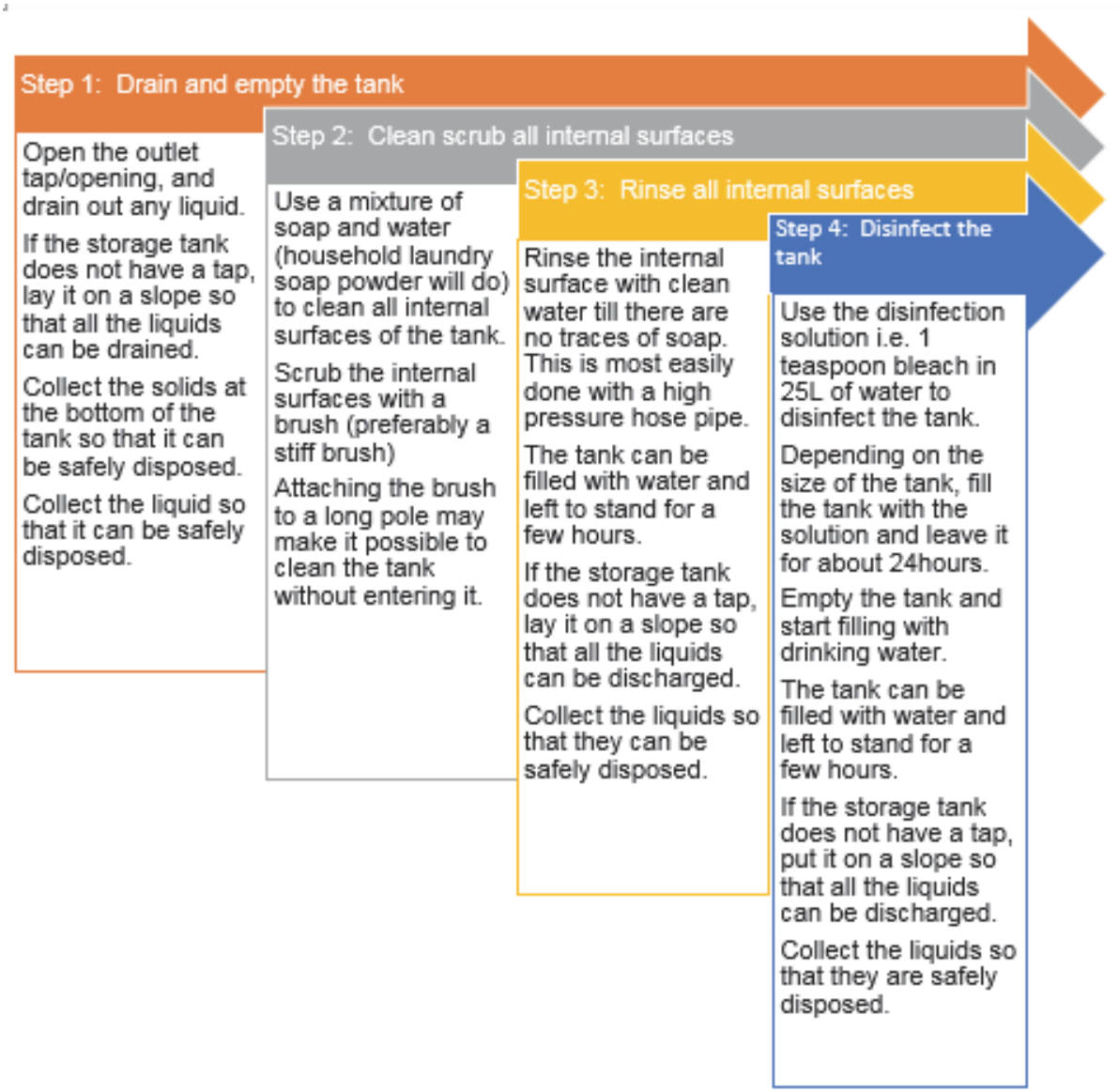


Figure 2.5: Cleaning a storage tank procedure (after contamination or at the scheduled time) (adopted from WHO, 1994)

Example 2: An emergency response procedure for cleaning the distribution pipes at specified times or when the water from the pipe looks dirty is provided in the figure below.

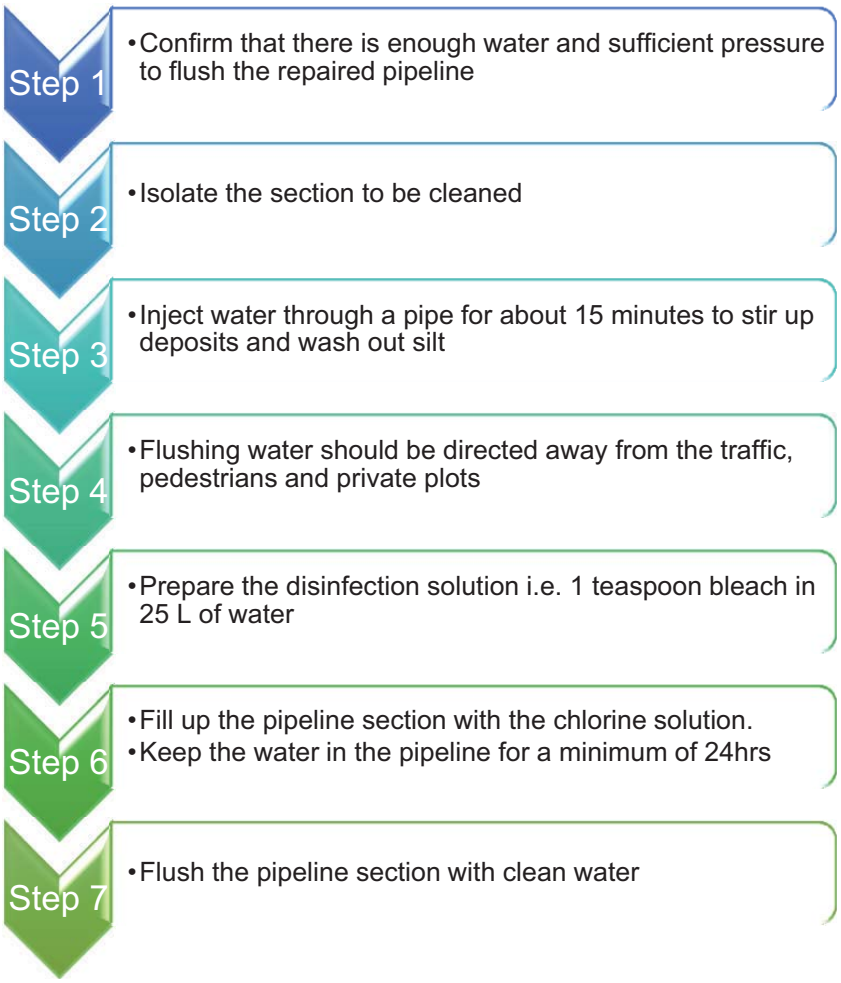


Figure 2.6: Cleaning a dirty pipe procedure example

Example 3: An emergency response procedure for responding to a power outage at a pump station is provided in the table below.

Table 2.5: Example: Power outage emergency response procedure

System Component	Pump station pumping to Neka Treatment system and Vela village
Describe the issue	Power outages that may last for several days are sometimes experienced in the area. This is more frequent in summer when the region experiences thunderstorms. The system does not have a back-up generator but has an arrangement with a service provider/supplier to rent a generator for the system.
Immediate Action	• Process controller to assess whether the outage is likely to last more than a day. If no, be on alert for changing conditions and monitor storage tanks. If yes, complete the following steps. • Process controller to inform the technical manager about the situation. • Technical manager to obtain generator. • Process controller and operations and maintenance team to install the generator and operate the treatment system.
Notification	• Municipality to let Eskom know that a CWS is experiencing an outage and that the generator will be turned on until power is restored. • Water quality technician to inform the community leader about the situation. • The community leader to inform the community to cut back on water usage until the power is restored.
Returning to normal operation	• Operations and maintenance representative to turn off and disconnect back-up generator. • Return system to general power supply. • ERP co-ordinator to inspect storage tanks and pumping facility to ensure proper operation. • ERP co-ordinator to inform the municipality to collect the generator. • Municipality to collect the generator and return to service provider/supplier. • ERP team to update ERP as needed.

It is important to include procedures for returning to normal operation once the issue has been resolved.

Example 4: An emergency response procedure in the event of source water contamination.

Table 2.6: Example: Source water contamination emergency response procedure

Primary source	Khune River
Type (e.g. ground/surface)	Surface
Alternate source in case primary source is contaminated or unavailable (name, type)	None
At what stage (quantity) is an alternative source considered?	• When the water quality results indicate that the water is contaminated and may have health impacts.
How was it verified that water is contaminated?	• Diarrheal reports from the clinic. • Water quality monitoring results.
Immediate Actions	• Disconnect supply to the community. • Take sick people to the health care facility immediately. • Provide water with the tankers.
Notifications	• Laboratory to inform the water quality technician of the failure immediately. • Water quality technician to inform the technical manager (Mr Nqevu). • Technical Manager to inform the communications department to issue a public notice. • Communications department to inform the community not to drink the water from the source.
Notification Methods	• Local radio; loud speaker; posters at the municipal office, clinics and other business areas.
Follow-up Actions	• Investigate the source of contamination. • Follow appropriate procedure to attend to the issue. • Ensure that the water quality complies. • Laboratory to confirm the water quality compliance to the water quality technician. • Update ERP as required.
Returning to normal operations	• Reconnect to Khune river supply. • Water quality technician to inform technical manager. • Technical manage to inform the communications department to issue a public notice. • Communications department to inform the community that it is safe to drink the water.

In the case of water contamination or unavailability, alternative sources should have been identified during the process of risk assessment. Table 2.7 provides an example of alternative source identification.

Table 2.7: Alternate source(s) of water to be used in cases of emergency

Alternative Sources	Name of supplier	Phone	Availability	Is the water safe for drinking?
Tanker trucks in the area available to deliver bulk water for potable use.	ABC tankers	0258768787	During working hours.	Yes, water is collected from Nxuba water treatment works.

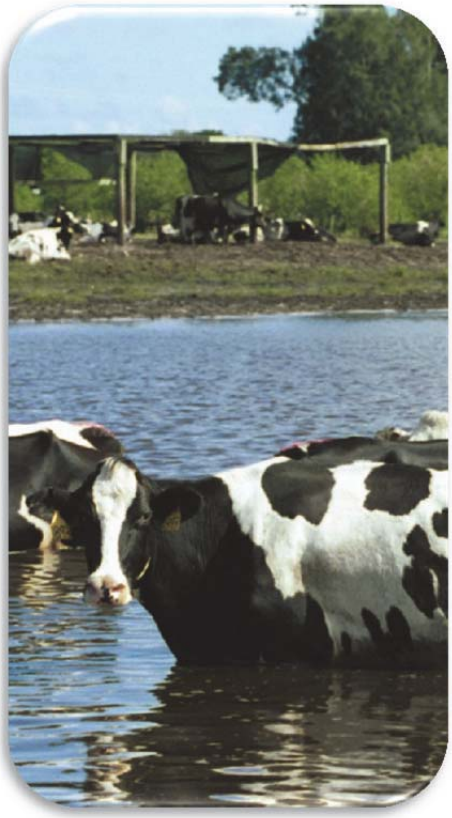
2.2.5 Emergency Response Plan review

Similar to all other plans, once the ERP has been developed, there is a need to verify and validate, and have the plan approved by management. In addition, it is important to review the plan periodically. Table 2.8 provides an example of a list of people that should be involved in this process. It is important to note that the plan will be officially in effect when reviewed, approved, and signed by the relevant people.

Table 2.8: Example of an ERP approval

Name/Title	Signature	Date
Municipal Manager (Mr Khan)		16/03/2014
Municipal Engineer (Mr Fihla)		16/03/2014
Technical Manager (Mr Nqevu)		16/03/2014

3 ADDITIONAL EXAMPLES OF POSSIBLE CWS EMERGENCIES AND HOW TO RESPOND



I treat my water, I protect my health

CHAPTER 3: EXAMPLES OF POSSIBLE CWS EMERGENCIES AND HOW TO RESPOND

3.1 INTRODUCTION

This section presents an approach and structure for communities to be able to identify when and if there are emergencies. Possible causes of emergencies and suggested actions are also presented. An example of the approach followed is presented in Figure 3.1 below.

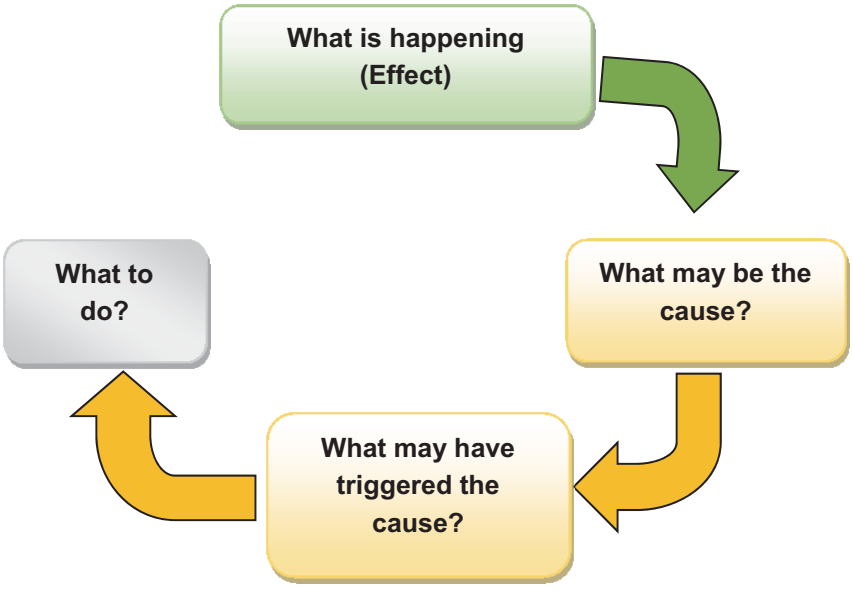


Figure 3.1: Approach to prepare for possible emergencies

This approach allows the community to plan and take action (where possible) before an actual emergency occurs. Therefore, if an emergency trigger has been identified; suitable actions are already taken before the emergency is able to have a serious effect.

3.2 WATER QUALITY AND HEALTH RELATED EMERGENCY CAUSES AND SUGGESTED ACTIONS

3.2.1 Diarrhoea, stomach ache, vomiting

WHAT IS HAPPENING?

Large number of diarrhoeal cases being reported at the local clinic and / or stomach ache, vomiting.

POSSIBLE CAUSE

Consumption of contaminated water.

WHAT TO DO?

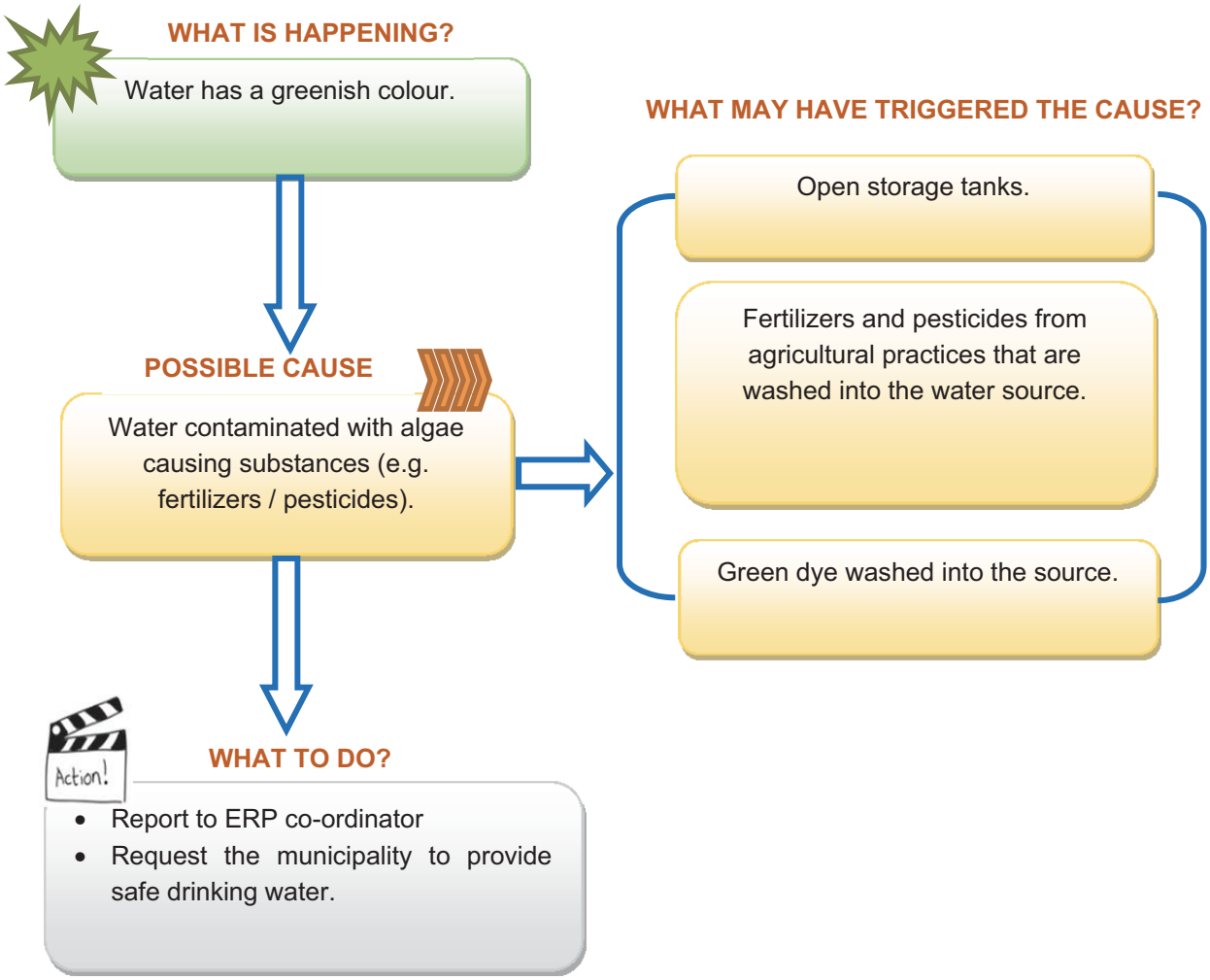
- Report to ERP co-ordinator.
- Take the sick people to the clinic / hospital.
- Identify alternative safe water sources.
- Practise appropriate home based treatment methods presented in Appendix C.
- Once the problem has been solved, follow return to normal procedures.

WHAT MAY HAVE TRIGGERED THE CAUSE?

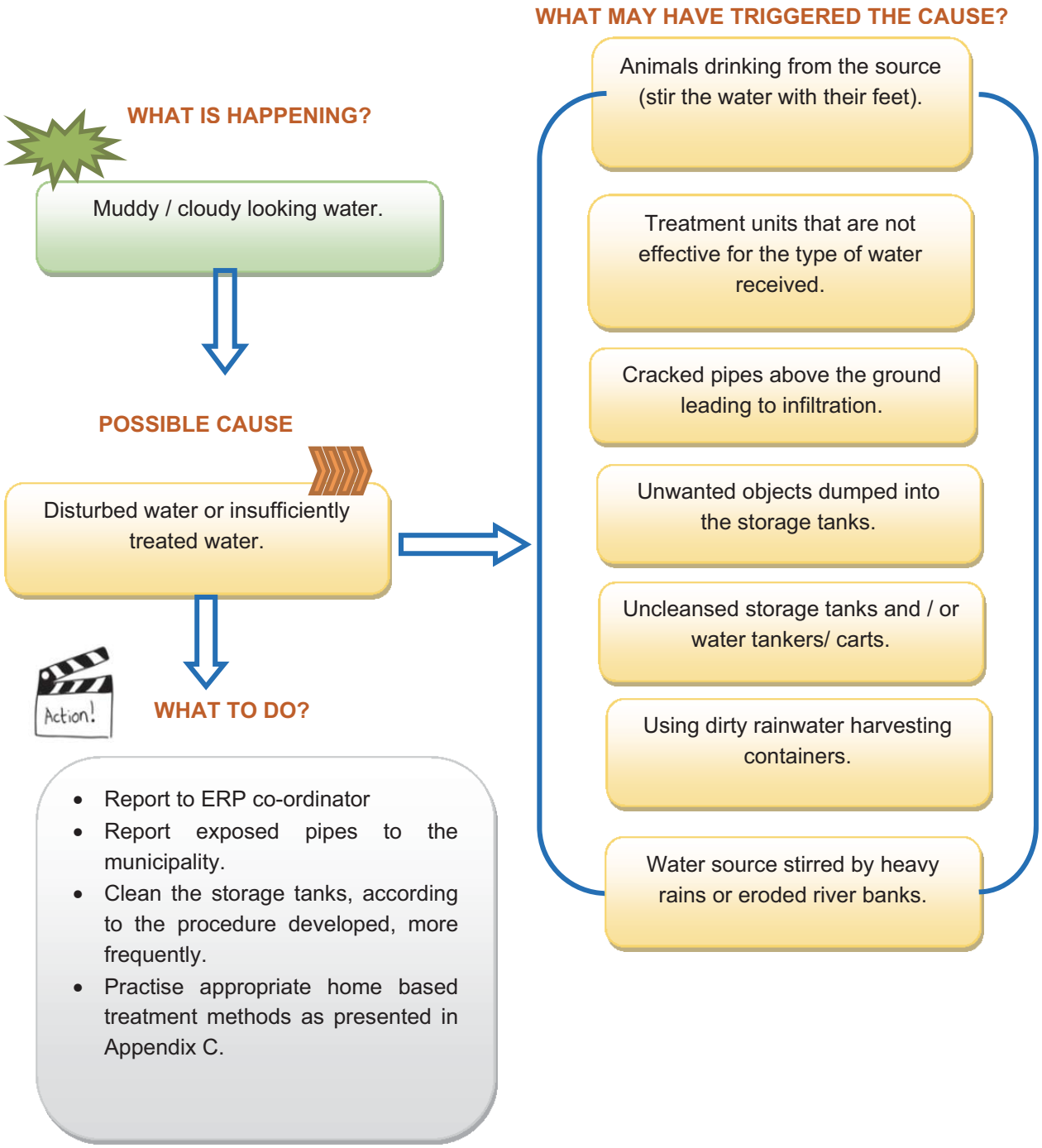
- Children swimming at the source, excreting in the water.
- Animals excreting in the water and/or dying near or at the source.
- Pit latrines and improperly lined septic tanks located close to the ground water sources.
- Ineffective water treatment system.
- Non-treated raw water used.
- Unwanted objects dumped in open storage tanks.
- Contaminants washed into the source by floods or heavy rains.
- Dirty water tankers / carts, storage tanks and / or containers used for rain water harvesting.
- Water contaminated by chemicals.

3.3 APPEARANCE, SMELL AND TASTE RELATED EMERGENCY CAUSES AND SUGGESTED ACTIONS

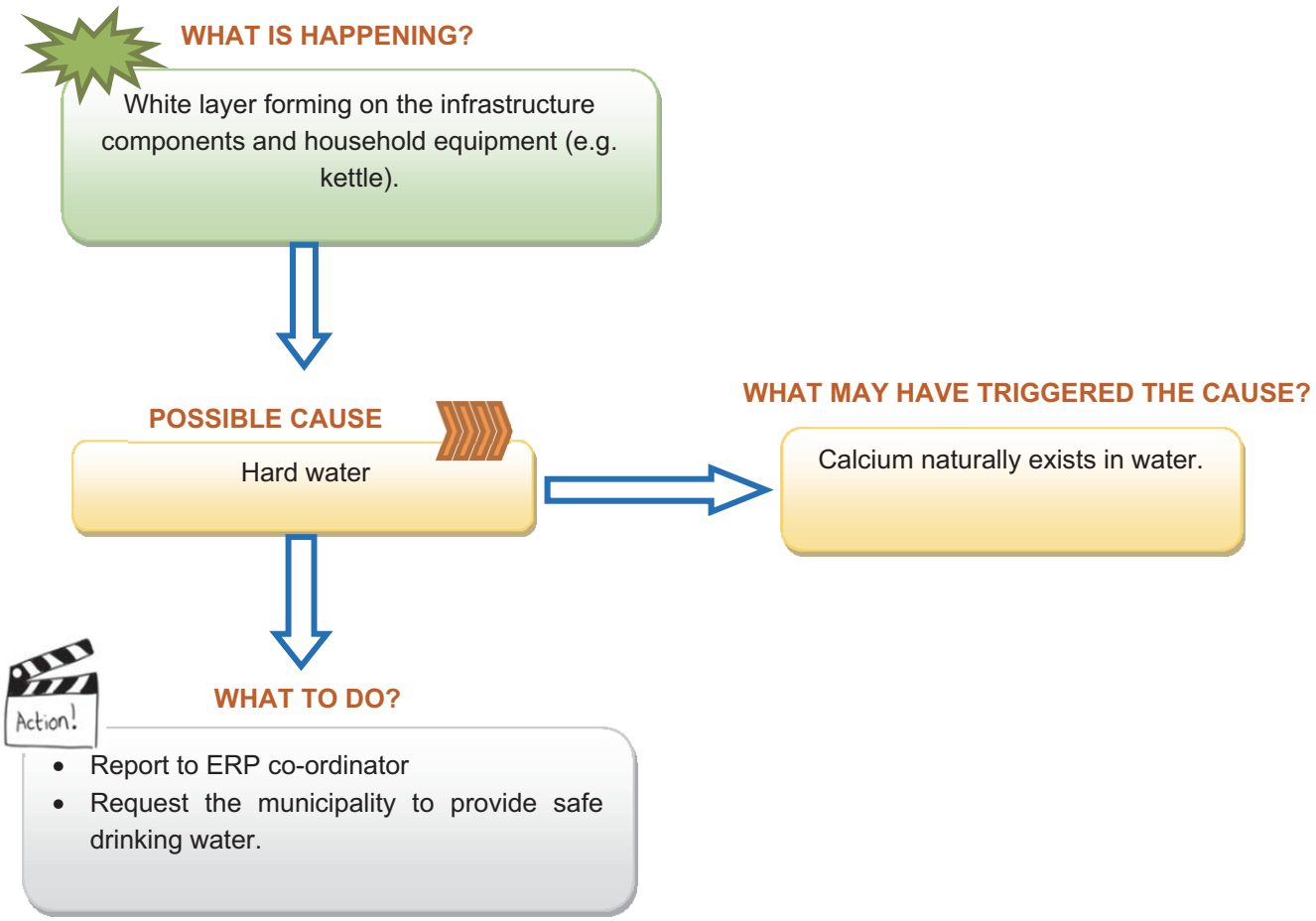
3.3.1 Water with greenish colour



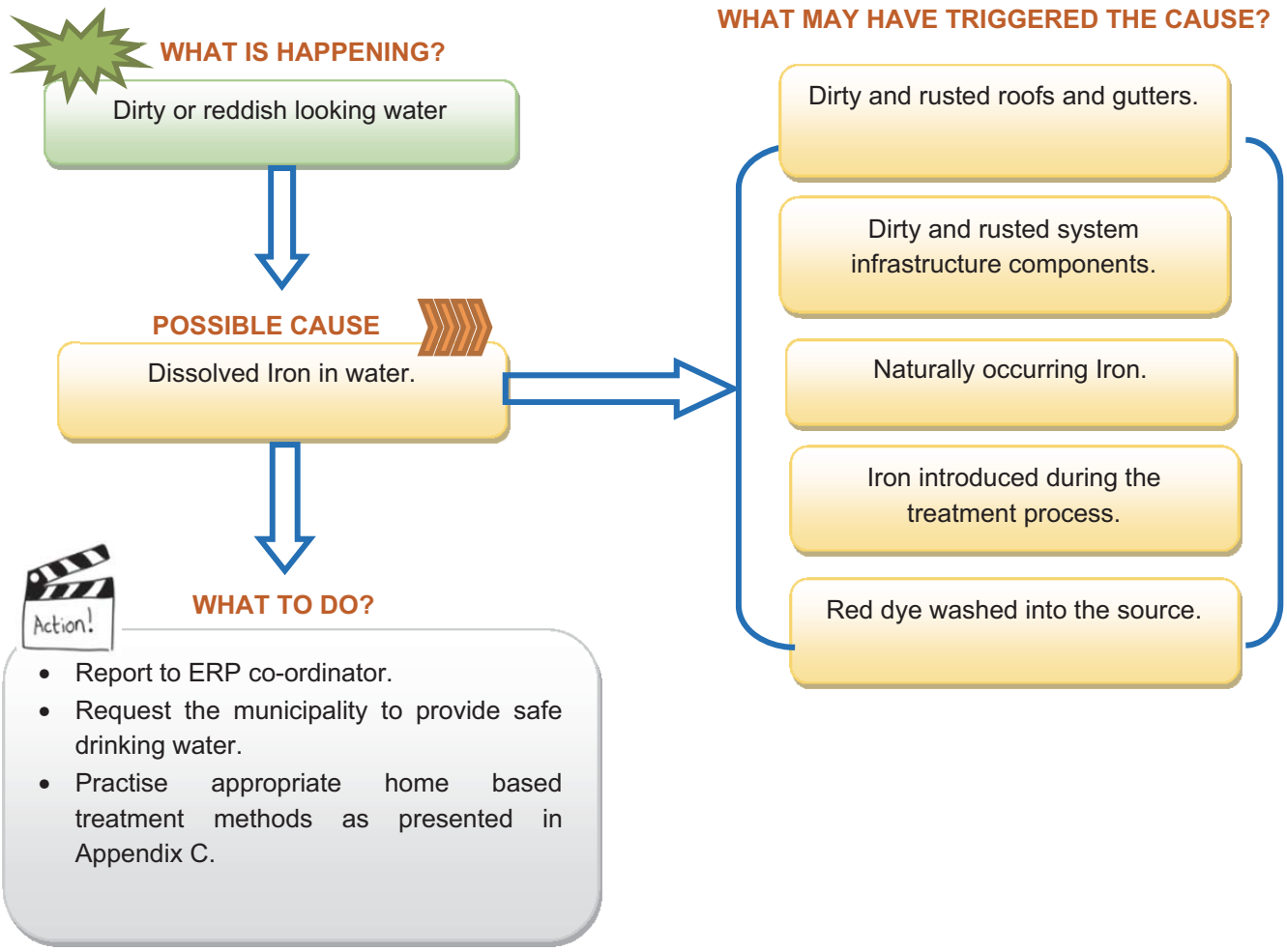
3.3.2 Muddy / cloudy looking water



3.3.3 White deposits on infrastructure and household equipment

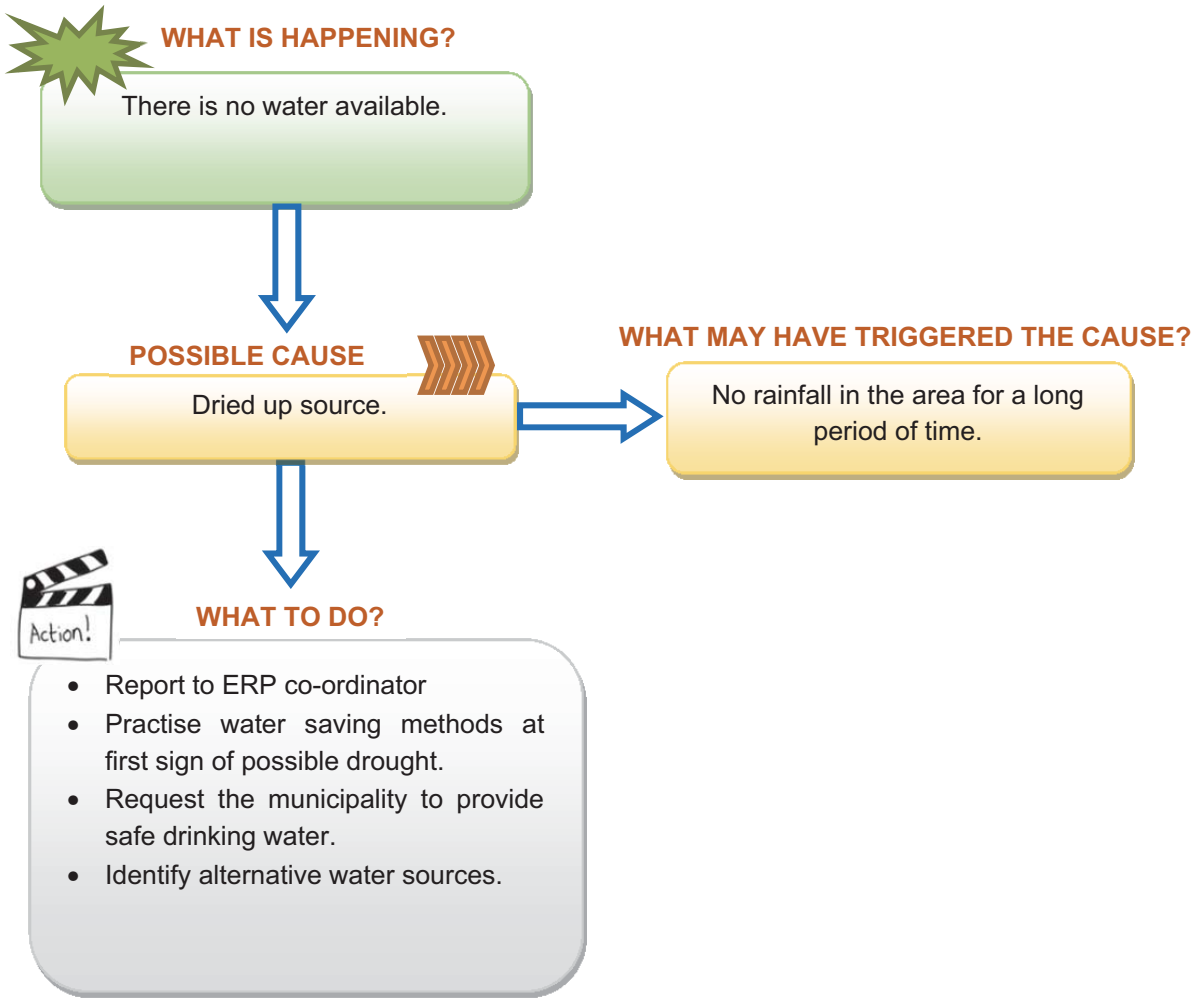


3.3.4 Reddish looking water

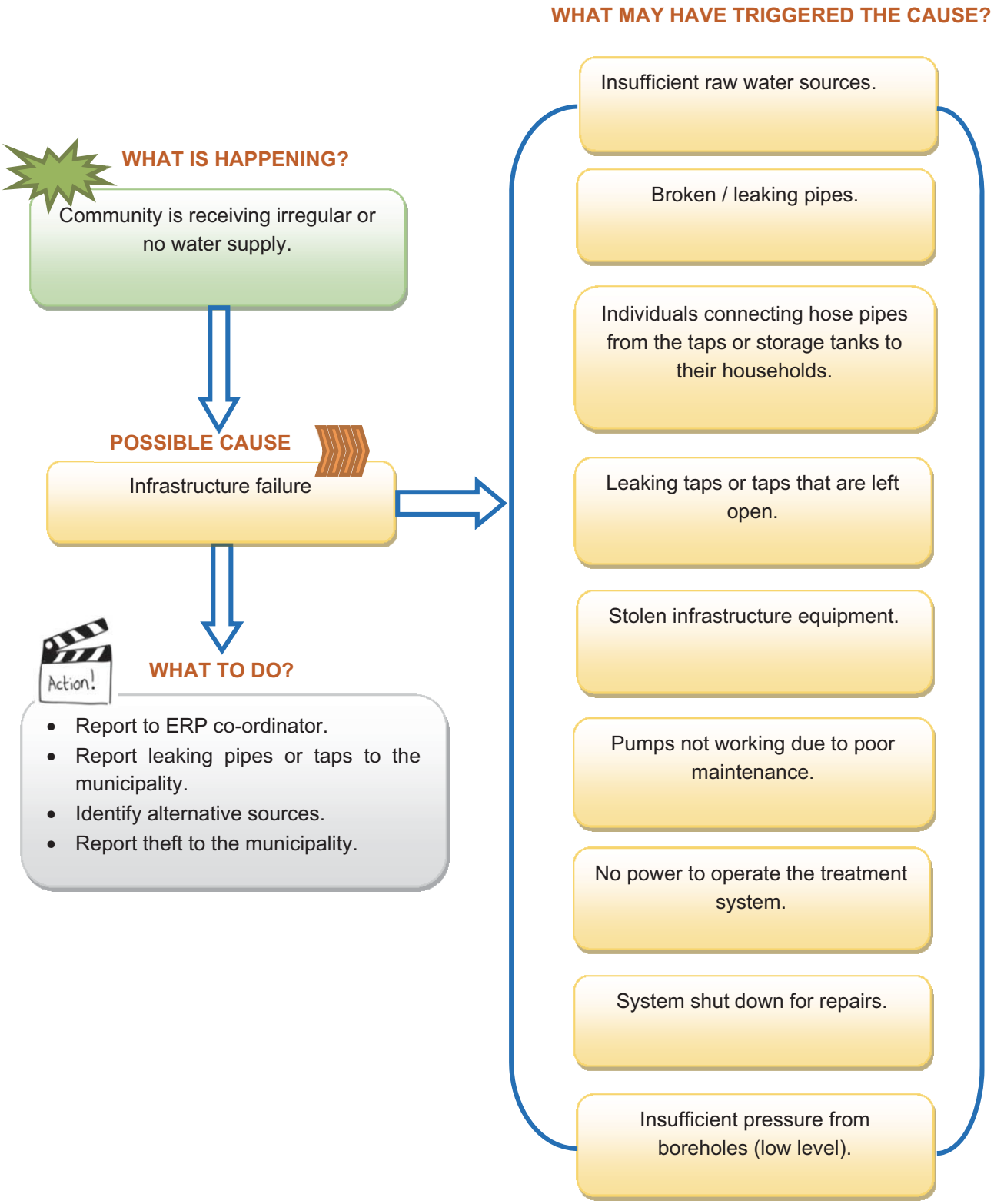


3.4 WATER UNAVAILABILITY/SHORTAGE RELATED EMERGENCY CAUSES AND SUGGESTED ACTIONS

3.4.1 Drought / dried up sources

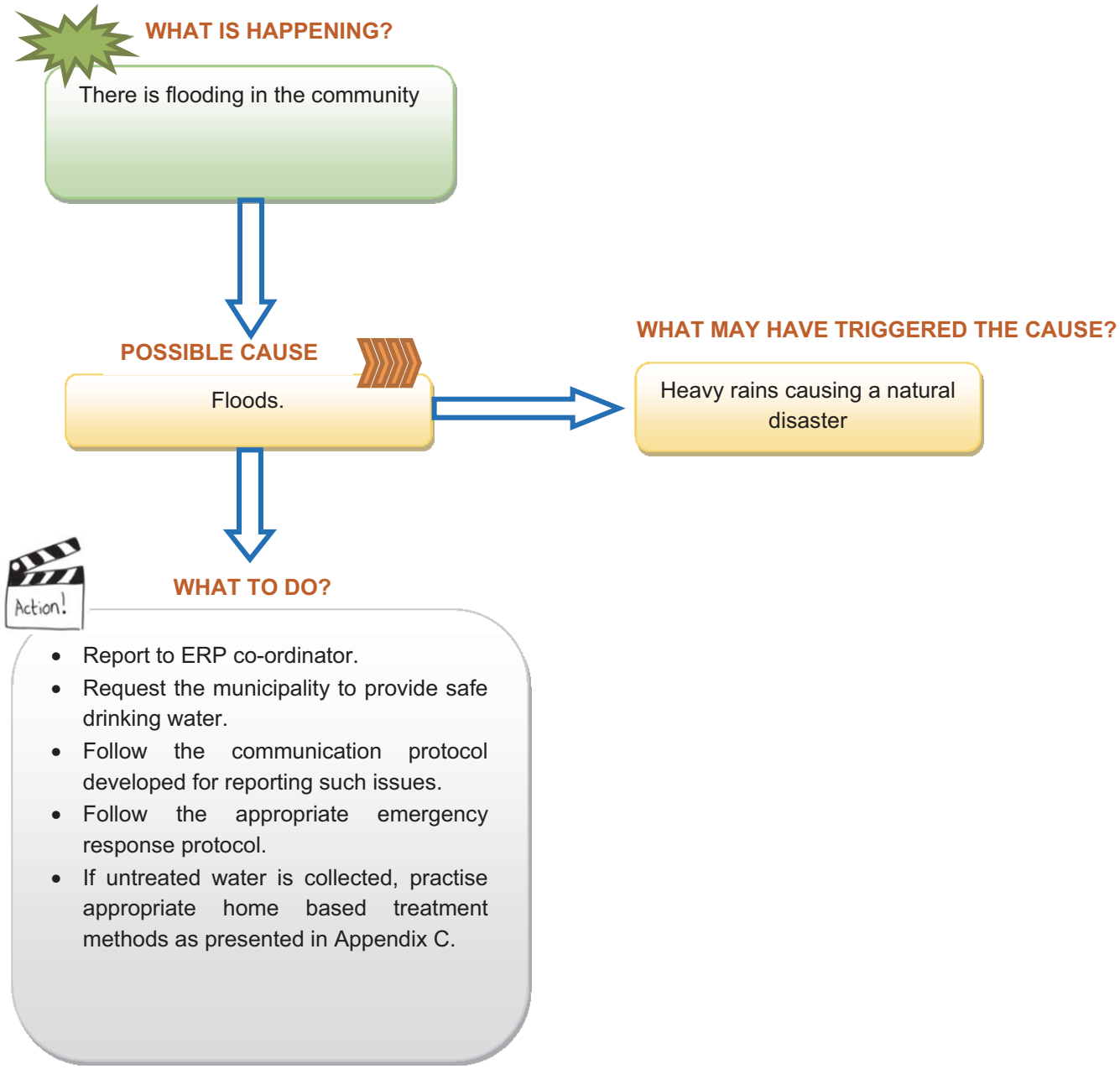


3.4.2 Irregular water supply/inconsistent flow



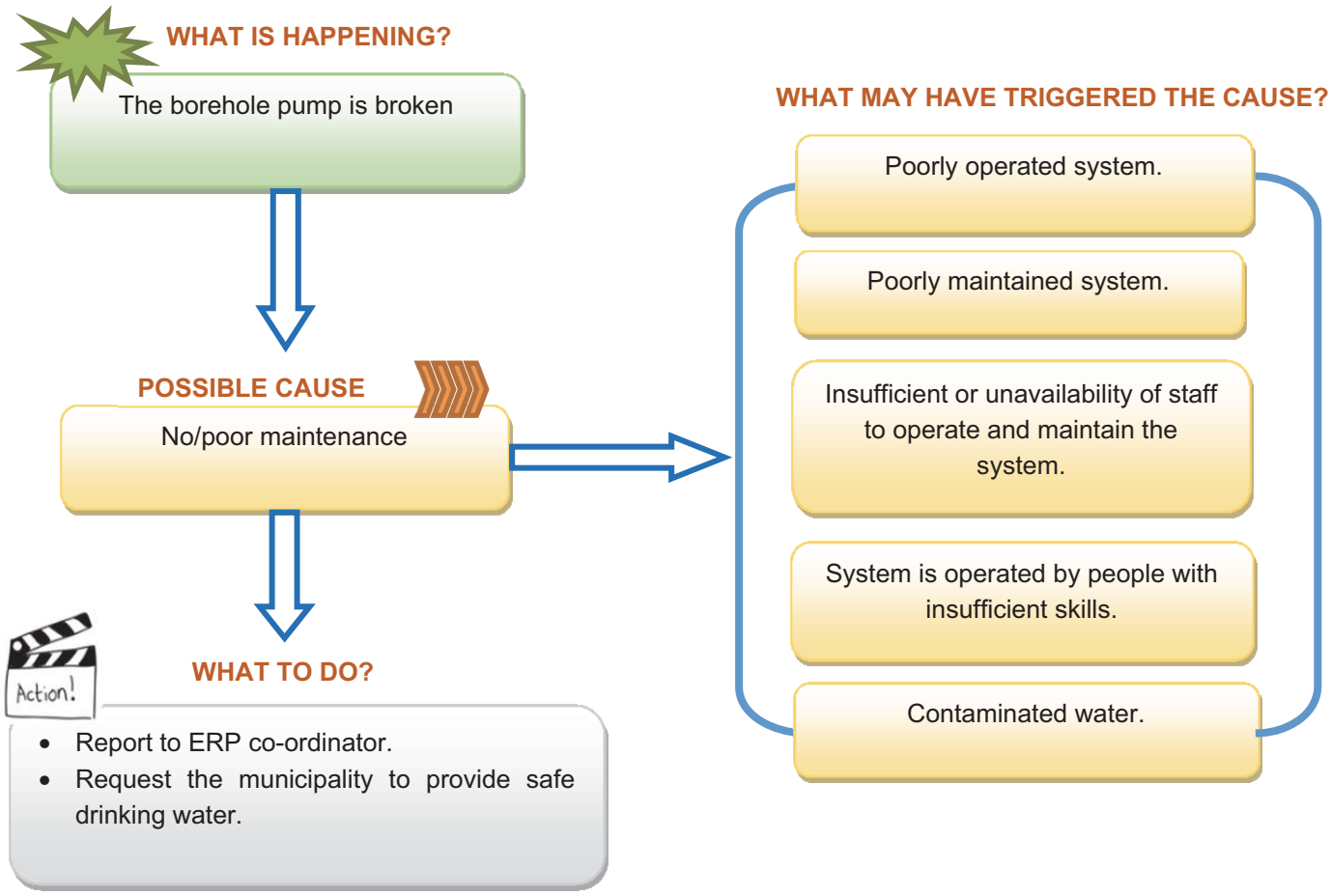
3.5 FLOOD RELATED EMERGENCY CAUSES AND SUGGESTED ACTIONS

3.5.1 Excess water



3.6 RESOURCES AND OPERATIONS RELATED EMERGENCY CAUSES AND SUGGESTED ACTIONS

3.6.1 Poorly operated and maintained system



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APPENDIX A: TEMPLATES FOR DEVELOPING A WATER SAFETY PLAN

The templates in this appendix are provided in the event that the WSP has not been developed for the CWS. These can be used with reference to the examples provided in section 1.4 of this document and can be amended to suit the user's situation / needs. Capture details of your WSP team / stakeholders in the table below.

A1: ASSEMBLE THE TEAM

Table A1: *Assemble WSP team / stakeholders*

Department	Member name	Location	Work Telephone	Home/cell number

A2: DESCRIBE AND DOCUMENT THE WATER SUPPLY SYSTEM

It is suggested that when documenting and describing the supply system; it would be useful to roughly map the supply area and draw the supply system. In addition to the template below, a drawing of the supply system can also be attached.

Table A2: ***Document your water supply system***

Water Supply System	Source	Treatment	Storage	Network
Name				
Owner				
Treatment methods				
Size				
Population / villages served				
Location				
Condition				
System protection measures				
Comments				

A3: ASSESS YOUR WATER SUPPLY SYSTEM

Identify hazards / hazardous events that may result in an emergency and capture them in the table below. When identifying these, consider anything that may result in water contamination / unavailability / excess.

Table A3: *Assess your water supply system*

Emergency category	Possible threats / vulnerabilities / challenges (emergency triggers)	Possible threat impacts
Source		
Treatment		

Emergency category	Possible threats / vulnerabilities / challenges (emergency triggers)	Possible threat impacts
Distribution		
Emergency category	**Possible threats / vulnerabilities / challenges (emergency triggers)**	**Possible threat impacts**
Point of use		

A4: UNDERTAKE HAZARD / RISK CHARACTERISATION

For all the identified threats hazards / hazardous events, identify what is the likelihood of them occurring and the effect, should they happen, using the table below.

Table A 4: ***Undertake a hazard assessment and risk characterization***

Possible hazardous events that may lead to emergencies	Likelihood / Possibility	Effect	Risk rating
Source			
Treatment Unit			

Possible hazardous events that may lead to emergencies	Likelihood / Possibility	Effect	Risk rating
Treatment Unit			
Distribution			
Point of use			

A5: IDENTIFY CONTROL MEASURES

Identify control measures or corrective actions for the identified hazards using the table below.

Table A 5: *Identify control measures*

Possible hazardous events that may lead to emergencies	Risk rating	Suggested control measure / corrective actions
Source		
Treatment Unit		

Possible hazardous events that may lead to emergencies	Risk rating	Suggested control measure / corrective actions
Treatment Unit		
Distribution		

Capture details of your monitoring programme or your suggested monitoring programme as one of the control measures.

Table A 6: *Sampling programme*

Sampling point	**Minimum per point**		
	Number of samples per year	**Sampling frequency**	**Parameters tested**
Source			
Treatment			
Storage			
Point of use			

A6: VERIFY THAT WSP IS OPERATIONAL

Validate the performance of your control measures by verifying whether your control measures are effective using the table below.

Table A 7: *Verify that WSP is operational*

Risk rating	Hazardous event / Emergency trigger	Action Plan	Effective (Yes / No)	Residual risk rating	Suggested actions if existing actions are not effective
High					
High					
High					

Risk rating	Hazardous event / Emergency trigger	Action Plan	Effective (Yes / No)	Residual risk rating	Suggested actions if existing actions are not effective
Medium					
Medium					
Medium					

A7: DEVELOP SUPPORTING PROGRAMMES

Identify what programmes are required to support the WSP requirements. Templates for some of the supporting programmes that can be considered are provided below.

Table A 8: *Personnel training requirements*

No	Name of the person to be trained	Type of training required	Training provider (Internal / External)	Budgeted for (Y / N)	Date completed
1					
2					
3					
4					

Table A 9: *Personnel Safety Preparedness template*

Location / work environment	
Nature of the job	
Safety Procedures when working in the environment / doing that specific job	
Estimated kind of incident / accident	
Should an incident /accident happen: Immediate Actions	
Notifications (who)	
Notification Methods	
Is it possible that the injured person cannot reach other people?	
Follow-up actions	

Table A 10: *Equipment / chemical replacement*

Type of equipment / chemical	
Responsible / Preferred supplier	
Location where stored	
Responsible person for signing	
Actions in case of emergency	
Procedures to use the equipment/chemical	
Notifications (who)	
Notification Methods	

NOTE: Templates for step 8 and 9 are covered in Appendix B.

A8: REVIEW THE WSP

Review your WSP using the table below.

Table A 11: WSP *review status*

ERP review	Yes/No	Updated (Yes / No)	Date updated
Is there any change in the team?			
Is there any change in the supply system?			
Are there any new emergency triggers?			
Are there any emergency triggers to be taken out (that have been fully addressed)?			
Are there any new protocols/procedures to be developed?			
Is there any change with the sampling and monitoring?			

APPENDIX B

TEMPLATES FOR DEVELOPING EMERGENCY RESPONSE PLANS

FOR COMMUNITY WATER SYSTEMS

The templates in this appendix are provided to assist in the development of an ERP. These can be used with reference to the examples provided in section 2 of this document and can be amended to suit the user's situation/needs.

B1: ASSIGN ROLES AND RESPONSIBILITIES

Assign roles and responsibilities for your emergency team using the table below.

Table B 1: *Assigning roles and responsibilities*

Department	Member name	Roles & Responsibility	Contact number

B2: DEVELOP A PROTOCOL TO FAILURE RESPONSE

Identify alert levels using the table below and any other failure response plans required.

Table B 2: *Identify alert levels*

Intensity	Hazard / hazardous event	Alert level	Responsible person	Action Plan
Low				
Low				
Medium				
Medium				

Intensity	Hazard / hazardous event	Alert level	Responsible person	Action Plan
High				
High				

B3: DEVELOP COMMUNICATION PROTOCOLS

Develop community protocols for different incidents. Indicate who should be contacted first, who should report to who, and who should take what action. Guidance to some of the communication protocols that can be developed is suggested in the titles of blank protocols below. Identify and develop any additional protocols that are not listed below.

Table B3: Emergency contact numbers for external departments/institutions

Emergency Notification List		
Organization or Department	***Telephone***	***Night or Cell Phone***
Police		
Fire Department		
Emergency Medical Services		
Department of Water and Sanitation		
Power Utility company		
Laboratory Services		
Local radio station		
Local newspaper		

Table B4: ***Contact numbers for service/repair personnel***

Service / Repair Contact List			
Organization or Department	***Company and Name***	***Telephone***	***Night or Cell Phone***
Plumber			
Pump Supplier			
Rental Equipment Supplier			
Chlorine Supplier			
Well Drilling Co.			
Pipe Supplier			

B4: DEVELOP EMERGENCY RESPONSE PROCEDURES

Look at the list of possible emergency triggers identified and develop a procedure to deal with each. Procedures for normal operations of the system and emergency conditions should be developed. Guidance to some procedures that can be developed are suggested in the procedure titles below.

Table B 5: Emergency response procedures for source water contamination

Primary source	
Type (e.g. ground/surface)	
Alternate source in case primary source is contaminated or unavailable (name, type)	
At what stage (quantity) is an alternative source considered?	
How was it verified that water is contaminated?	
Immediate Actions	
Notifications	
Notification Methods	
Follow-up Actions	
Returning to normal operations procedures	

Table B 6: Emergency response procedures for water quality failure

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	
Returning to normal operations procedure	

Table B 7: Emergency response procedures for chlorine treatment equipment failure

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	
Returning to normal operations procedure	

Table B 8: Emergency response procedures for treatment equipment failure

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	
Returning to normal operations procedure	

Table B 9: Emergency response procedures for source pump failure

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	

Table B 10: Emergency response procedures for bacteriological contamination

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	

Table B 11: Emergency response procedures for vandalism

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	
Returning to normal operations procedure	

Table B 12: Emergency response procedures for source water reduction

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	

Table B 13: Emergency response procedures in case of drought

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	
Returning to normal operations procedure	

Table B 14: Emergency response procedures in case of a flood

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	
Returning to normal operations procedure	

Table B 15: Emergency response procedures in case of fire

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	
Returning to normal operations procedure	

Table B 16: Emergency response procedures in case of an earthquake

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	
Returning to normal operations procedure	

Table B 17: Emergency response procedures in case of electronic equipment failure

System Component	
Describe the issue	
Immediate Action	
Notification	
Returning to normal operations procedure	

Table B 18: Emergency response procedure for cleaning storage tanks/reservoirs

System Component	
Describe the issue	
Immediate Action	
Notification	
Returning to normal operations procedure	

Table B 19: *Emergency response procedure for fixing a broken pipe and flushing*

System Component	
Describe the issue	
Immediate Action	
Notification	
Returning to normal operations procedure	

Table B 20: *Emergency response procedure for checking borehole water level*

System Component	
Describe the issue	
Immediate Action	
Notification	
Follow-up Action	

Table B 21: *Emergency response procedure for handling treatment chemicals*

Type of chemical	
Responsible/Preferred supplier	
Location where stored	
Responsible person for signing	
Actions in case of emergency	
Procedures to use the chemical	
Notifications	
Notification Methods	
Follow-up Actions	

Table B 22: *Emergency response procedure for using an alternative source*

Alternative Sources	
Name of supplier	
Phone	
Availability	
Is the water safe for drinking?	

B5: ERP REVIEW

Once the ERP has been developed, there is a need to verify and validate the ERP, and have it approved by management. In addition, it is important to periodically review the plan.

Table B 23: ***ERP approval***

This plan is officially in effect when reviewed, approved, and signed by the following people:

Name/Title	***Signature***	***Date***

APPENDIX C

HOME BASED AND COMMUNAL TREATMENT METHODS

C1 HOME BASED WATER TREATMENT METHODS

Raw water contains different substances that should be reduced or removed to produce water that is fit for drinking. The main purpose of water treatment is to remove or reduce those germs or unwanted substances that may have health impacts. It is important to understand what treatment method to use under what circumstance. This section presents simple methods to treat water at household level. In addition to these, some of the treatment methods using naturally occurring chemicals and which can be performed at a communal level, are also presented in the Appendix. This section can be read in conjunction with Momba 2013 Guide.

C1.1 Disinfection

Disinfection is a process of killing or deactivating germs that may give rise to infection therefore preventing transmission of diseases. Below are disinfection methods that can be practised in a household. This method is not useful for chemical contamination.

Disinfection by boiling
Boiling or heating with fuel kills germs such as viruses, bacteria and fungi.

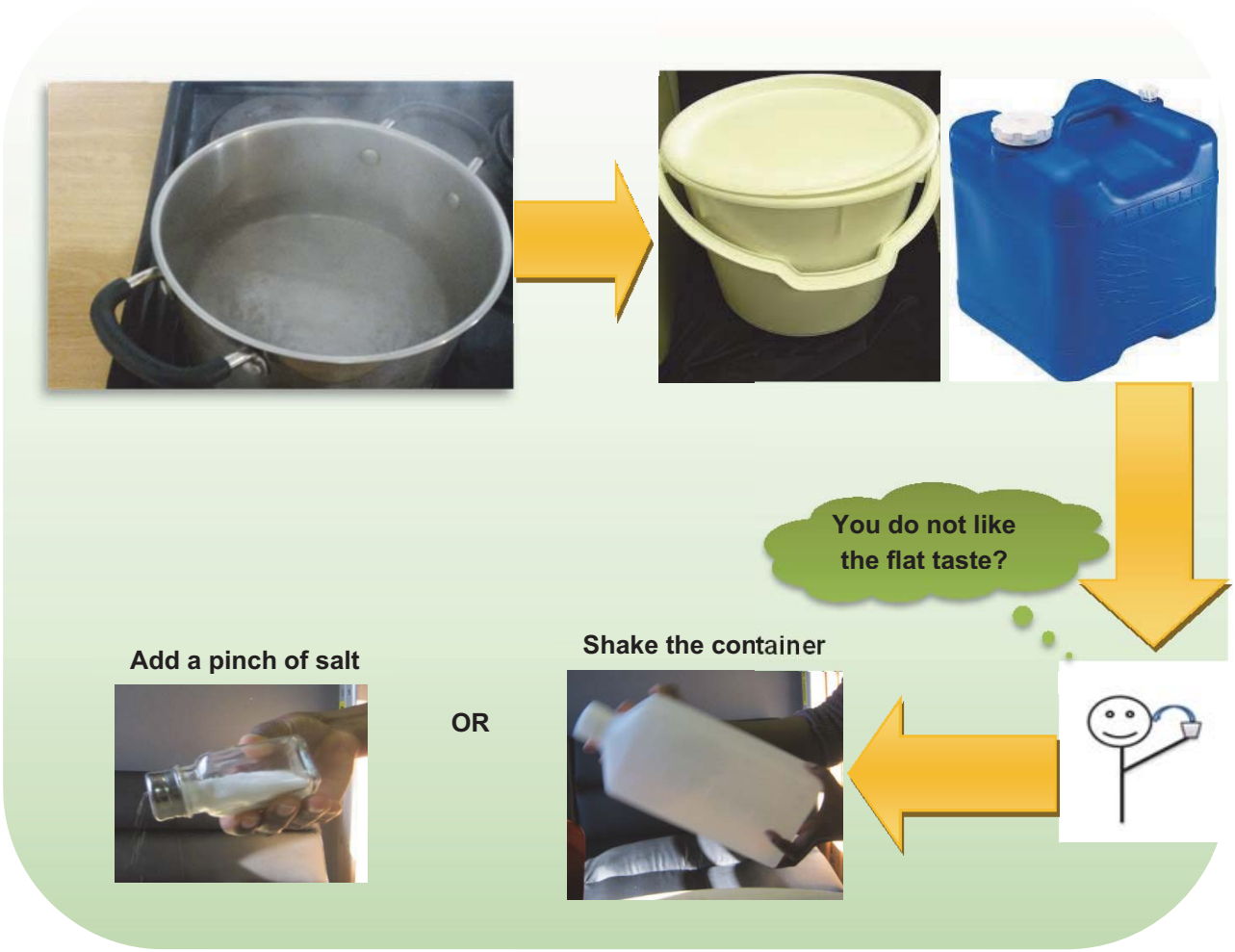


Figure C 1.1*: Demonstration of disinfection by boiling*

Tips when disinfecting using boiling

- Boiling using electricity can be achieved within 2-5 minutes while 5-10 minutes is needed when heating with fuel wood (WHO, 2002).
- Put the lid on top or cover your pot to keep the heat in so that water can boil faster.
- For boiling to work, water must be brought to a rolling, bubbling boil.
- Leave water to cool in the same container that was used to boil it to avoid recontamination.
- After water has cooled you can add a pinch of salt because, after boiling, water tends to taste flat.

Disinfection by adding bleach

Bleach (preferably Jik) kills germs that may be in the water.

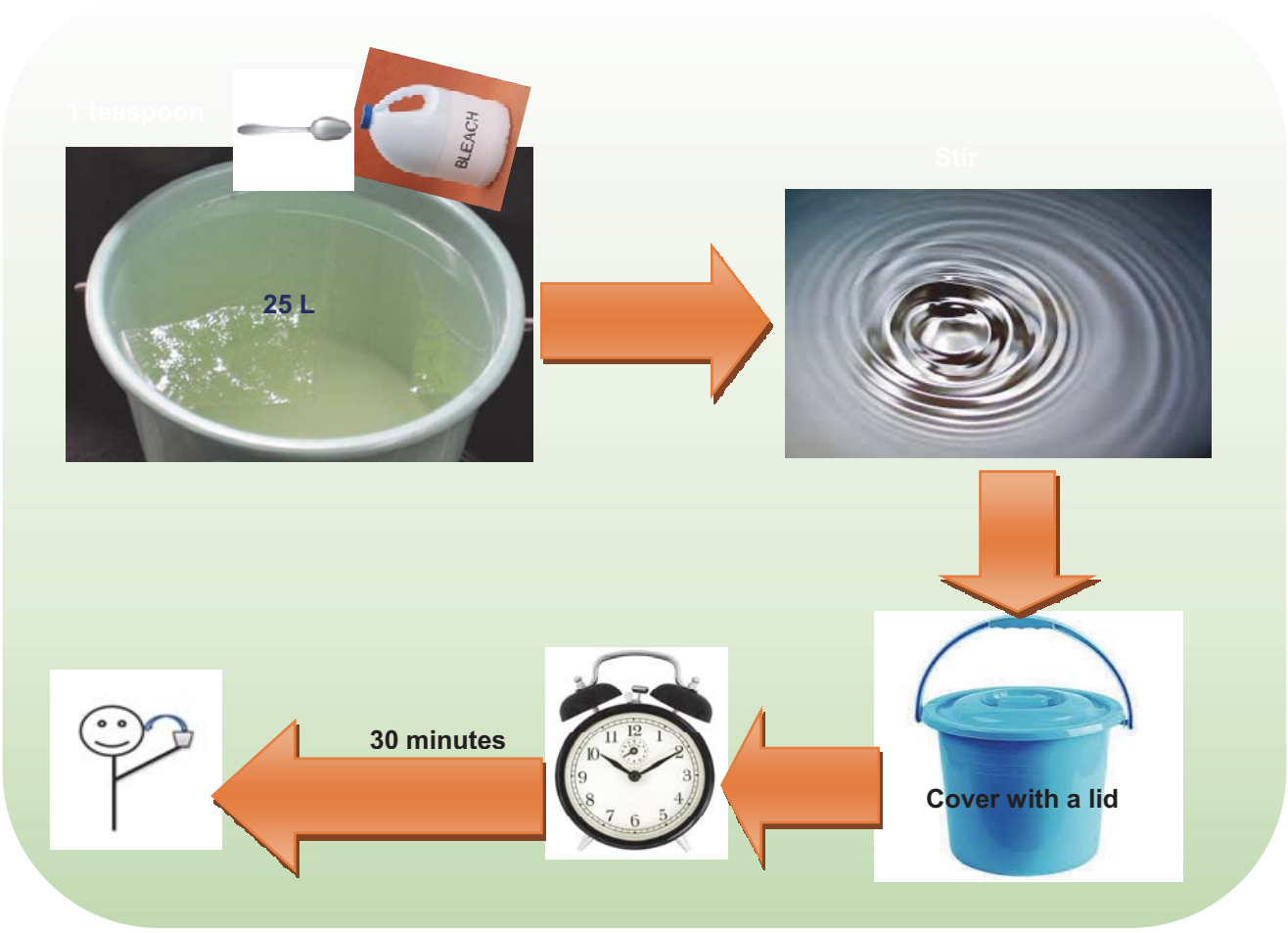


Figure C 1.2: ***Demonstration of disinfection by adding bleach***

Tips when disinfecting using bleach

- Use non-perfumed bleach.
- Do not use non-chlorine bleach.
- The container should be covered to prevent re-contamination.

Solar disinfection

Exposing water to sunlight will destroy most germs that cause diseases. Rinse the bottles with clean water and properly handle the containers. That is, avoid the inside of the container to come into contact with your hands.

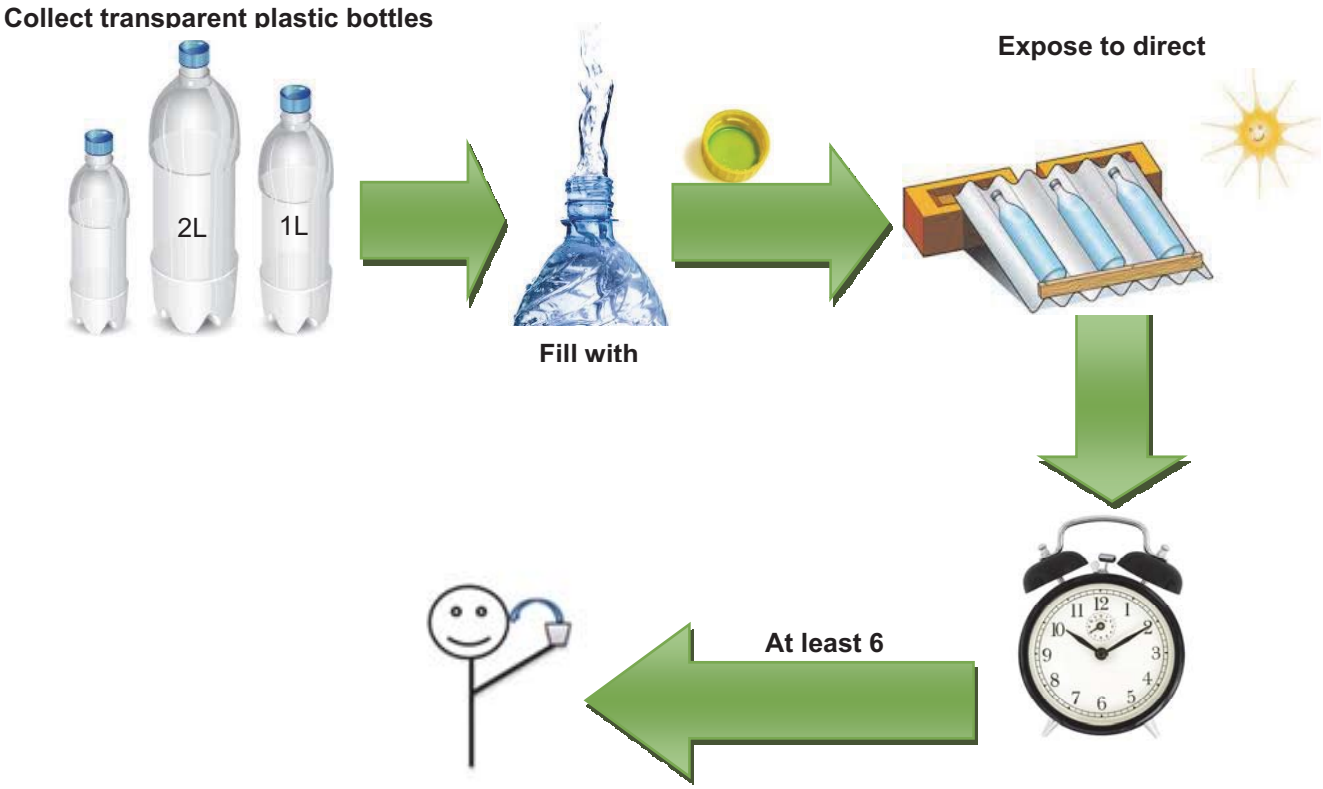


Figure C 1.3: ***Demonstration of solar disinfection (adapted from Swiss Federal Institute for Environmental Science and Technology, 2002)***

Tips when disinfecting using solar energy

- Preferably use 1-2L colourless plastic bottles.
- If more than half of the sky is covered with clouds, extend the exposure time to two consecutive days.
- Tighten the bottle caps before exposing them to sunlight.
- Replace old and scratched bottles

Table C 1.1*: Advantages and disadvantages of most commonly used disinfection methods*

Advantages	Disadvantages
BOILING	
❖ Readily available. ❖ Well suited for emergency and temporary disinfection. ❖ Extremely effective disinfectant that will kill the more resistant germs.	❖ Requires a great deal of energy. ❖ Time to bring to boil and cool before use. ❖ Typically limited capacity. ❖ Water needs to be cooled before consumption.
BLEACH	
❖ Bleach readily available at reasonable cost. ❖ Low/no electrical requirement. ❖ Can treat large volumes of water.	❖ Requires contact time of 30 minutes for simple chlorination. ❖ Turbidity (cloudy water) can reduce the effectiveness of chlorine. ❖ Gives water a chlorine taste if high dosages applied. ❖ Careful storage and handling of bleach is required.
SOLAR	
❖ Very cheap, no capital costs except plastic bottles. ❖ Independent of energy sources other than sunlight. ❖ Treated water is protected from re-contamination in the bottles. ❖ The taste of treated water is fresh, not stale or does not change.	❖ Cannot be used on days with continuous rainfall. ❖ Cannot be used to treat muddy or dirty looking water. ❖ Bottles need to be replaced every 4-6 months. ❖ Has a waiting period of 6-12 hours. ❖ Need to be cooled before consumption. ❖ Typically limited capacity.

C1.2 Settling / sedimentation

If the water is muddy or dirty looking, giving it time to settle can cause the dirt to drop to the bottom of the container and make the water clear. Settling/sedimentation can be performed better by a method called three pots. This method reduces dirt and germs that cause disease by storing water in containers, allowing dirt to settle, and moving cleaner water to different containers over time (WHO, 2002 and WHO and WEDC, 2013).

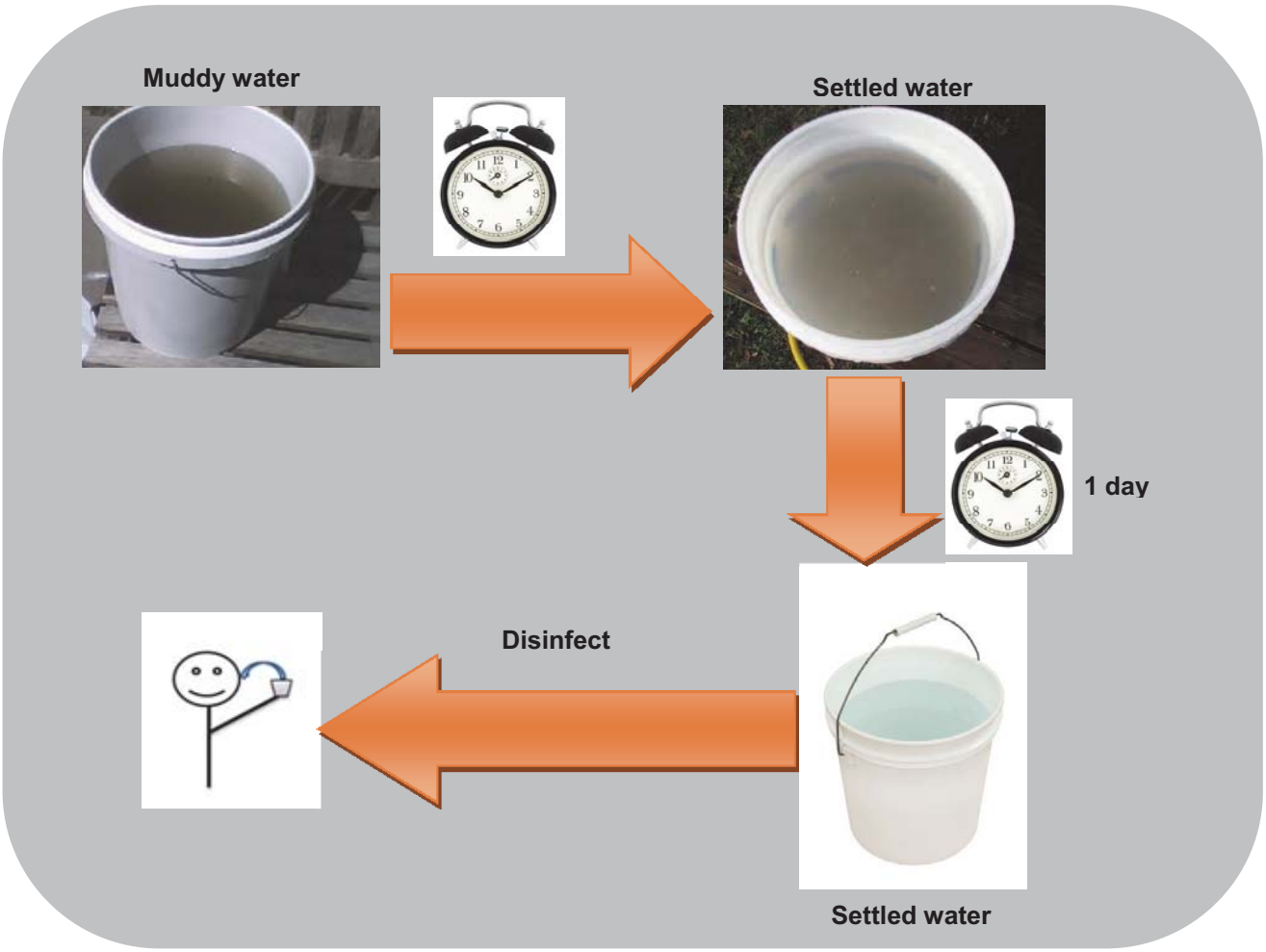


Figure C 1.4: ***Demonstration of settling muddy or dirty looking water***

Tips when settling muddy or dirty looking water

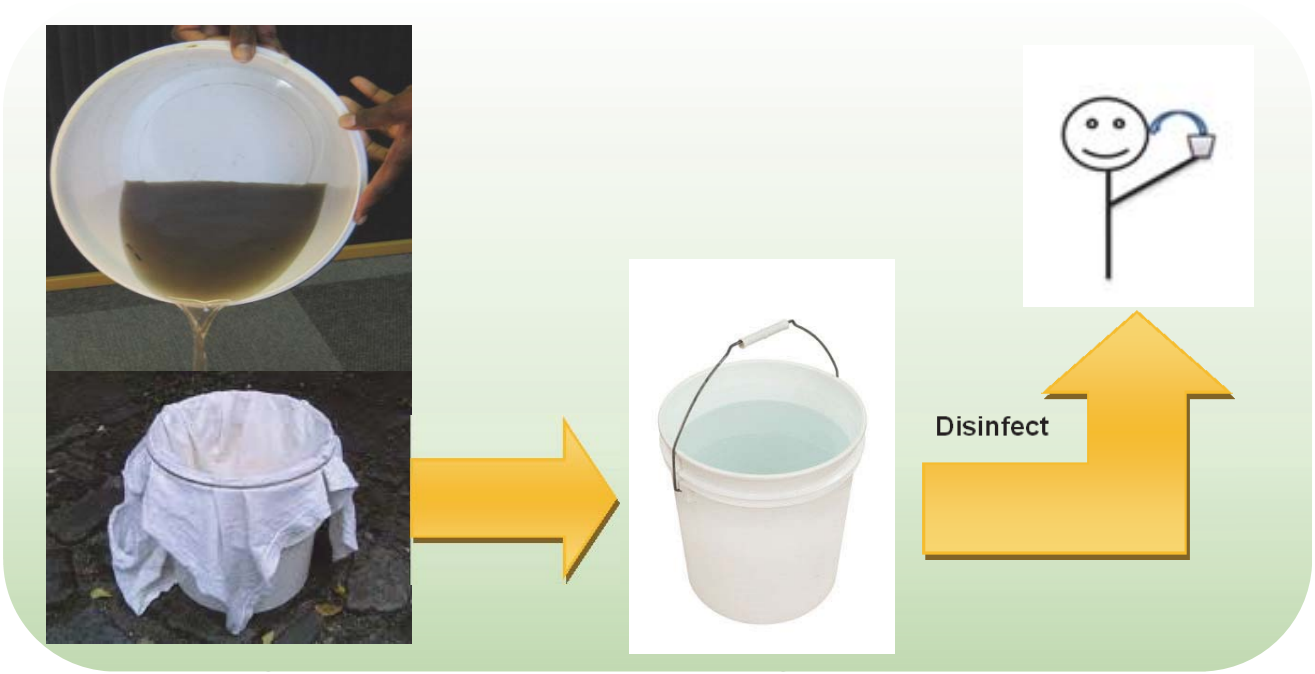
- Longer settling times, such as overnight or for 1-2 days will make plain settling more efficient.
- Typically, at least two containers are needed to settle water: one to act as the settling vessel and another to be the recipient of the water after the settling period. Water can also be settled in larger bulk storage systems.
- Slowly pour water stored in the container being careful not to pour the dirty water at the bottom of the container across.
- Always use water only from the last container (see figure C 1.4).
- Settle the water 2 or 3 days before use to avoid using insufficiently settled water.

Note: Water that has been made clear by settling is not necessarily clean. It still needs disinfection to remove germs that cause disease. First making dirty water clear will make disinfection more effective.

If there is insufficient time to allow water to settle before use, the following method to filter muddy or dirty water could be used. Both these methods (settling and filtration) could be used at the same time in no particular order.

C1.3 Straining/Filtering

Pouring muddy or dirty looking water through a piece of fine, clean cotton cloth will often remove a certain amount of the suspended solids and insect larvae contained in the water. A simple test to determine whether the cloth is adequate is to use it to filter the water. If the dirt does not pass easily through the cloth then it is working correctly (WHO, 2002 and WHO and WEDC, 2013). This method can be used in conjunction with the settling method presented above.



Tips when straining or filtering

- A cotton cloth works best and you should not be able to see through the cloth. On the other hand, the cloth should not be so thick that it takes a very long time to filter the water.
- Washing the cloth between uses will make straining more effective.
- Straining / filtering alone is unlikely to make water from a contaminated source completely safe to drink.

Note: Water that has been strained / filtered is not necessarily clean. It still needs disinfection to remove germs that cause disease. First straining water will make disinfection more effective.

-

C2 COMMUNAL WATER TREATMENT METHODS

C2.1 Communal treatment method to reduce or remove taste and odour by Aeration

Aeration is a treatment process in which water is brought into close contact with air for the primary purpose of increasing the oxygen content of the water. With increased oxygen content:

- Volatile substances such as hydrogen sulphide and methane, which affect taste and odour, are removed.
- The carbon dioxide content of water is reduced; and dissolved minerals such as iron and manganese are oxidised so that they form precipitates, which can be removed by sedimentation and filtration.

Aeration may be achieved by (WHO and WEDC, 2013 and WHO 2002):

1. Rapidly shaking a container part-full of water for about five minutes.
    - Leave it standing for a further 30 minutes to allow any suspended particles to settle.
2. Allowing water to trickle through one or two well-ventilated, perforated trays containing small stones, as shown in the figure below.
    - The water is collected in a container and allowed to stand for about 30 minutes to settle suspended particles.

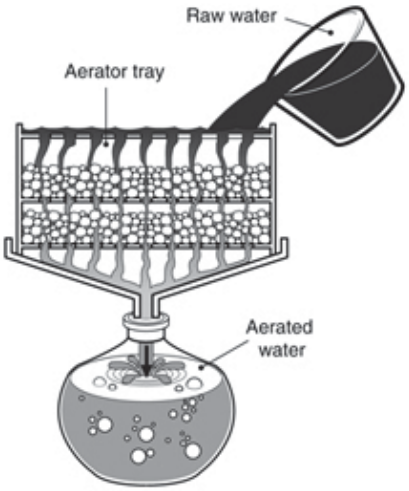


Figure C 2.1: *Treating taste and odour using an aeration method (WHO, 2002)*

C2.2 Communal treatment method to reduce or remove turbidity and some micro-organisms by filtration (WHO, 2013)

Filtration is the passage of polluted water through a porous medium (such as sand). Simple small scale filters may be put together inside clay, metal or plastic containers. The vessels are filled with layers of sand and gravel and pipework arranged to force the water to flow either upwards or downwards through the filter.

This type of filter could be built from a 200 litre drum. It has a filter bed made up coarse sand (of about 0.3 m depth) with a grain size between 3 and 4 mm diameter, and supported by gravel covered by a perforated metal tray. The effective filtration rate of such a filter could be as high as 230 litres per hour.

Such filters must be dismantled regularly to clean the sand and gravel and remove any settled silt. The frequency of cleaning is dependent on the level of turbidity of the raw water. Furthermore, such filters are not

effective at removing pathogens. The water, therefore, still requires disinfection. The figure below shows a simple upward rapid flow filter.

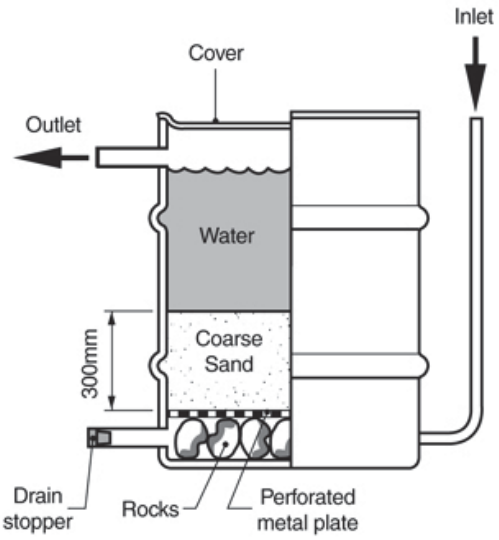


Figure C 2.2: *Turbidity removal using filtration method (WHO, 2013)*

C2.3 Communal treatment method to reduce or remove fluoride using clay (*Padmasiri and Fonseka, 1994; Coetzee et al. (2004)*

Clay is an earthy, sedimentary material composed mainly of fine particles of hydrous aluminium silicates and other minerals and impurities. Clay is fine-textured, plastic when moist, retains its shape when dried and hard when fired. Both clay powder and fired clay are capable of sorption of fluoride as well as other pollutants from water. The technique consist of a column packed with clay chips which can be obtained from manufacturer of bricks, pottery or tiles. Water with fluoride is allowed to flow up the column. De-fluoridated water is collected at the top of the collecting container.

C2.4 Community treatment method to reduce or remove fluoride using a bone char technique (Mavura et al., 2011)

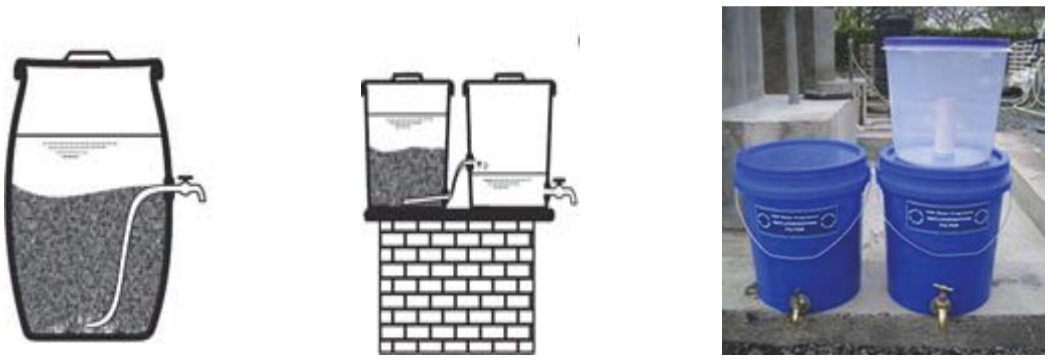
Bones of dead animals can be collected, washed and dried. Bones are then crushed, sieved, washed and dried. Particles between 0.5 mm and 4 mm can be used as media. Bones have to be kept in a ventilated area to keep them dry.

The colour of the bone char determines its quality:

- Grey-brownish: Highest fluoride removal.
- Black: Still contains organic impurities causing odour and colour.
- White: Reduced fluoride removal capacity.

Method:

- Put bone char as a media in a bucket full of water.
- Put a tap on the bottom of the bucket and avoid disturbance.
- The process can be performed in a single or double bucket as indicated in the figure below.



Drum Double bucket Single and combined bone char filter

Figure C 2.3: *Treating Fluoride using the bone char method (Mavura et al., 2011)*

APPENDIX D
WATER SAVING TIPS

D WATER SAVING TIPS

APPENDIX E
SAMPLING AND MONITORING

E SAMPLING AND MONITORING

To ensure a safe and acceptable quality of water supply, effective water quality monitoring and management is required. There are many possible situations, some which may arise very quickly, that could cause potential emergency situations (e.g. microbiological contamination). The implementation of monitoring procedures enables the assessment of water quality against accepted SANS 241 standards.

Sampling

Compliance with water quality standards provides assurance that the water supplied to households is safe. Further to monitoring, both professional evaluation of results, and implementation of corrective action (when required) are vital aspects to the successful operation of a water quality management programme. The recommended sampling programme of drinking water quality is presented below:

- *Sample sites* – Typical sampling sites included in water quality monitoring programmes include raw water sources, treatment system, reservoirs/storage tanks, selected parts of the distribution network, sites where previous sampling revealed problems and random sites, such as multi-occupancy buildings (e.g. hospitals, schools, etc.) **NOTE:** The number of samples collected varies with the size of the community.
- *Water quality determinants* – Based on knowledge of raw water characteristics and water treatment operations, microbiological (e.g. E.coli), physical (e.g. pH, turbidity) and chemical (e.g. aluminium, iron) water quality parameters are determined.
- *Sampling, analysis and data review* – Trained staff should carry out sample collection, handling, transport, storage and processing in accordance with standard sampling procedures. All analyses should be conducted using standard laboratory techniques (preferably at South African National Accreditation System (SANAS) accredited analytical laboratories). The analytical results are then compared to SANS 241 water quality standards.
- *Management of water quality* – Management procedures are followed depending on results from the information review. Where no failures occur, information is used to optimise treatment procedures. Where failures occur, a process of investigation and trouble-shooting takes place with subsequent implementation of temporary, short and medium-term solutions.
- *Summary report*–- A summary report displaying water quality, discussion thereof and recommended actions is produced. This report serves as an important tool for on-going management of the water supply system. The report is structured in such a way to bring attention to problematic areas, such that the responsible parties are immediately aware of potential problems.

Test methods

There are specified tests for all water quality parameters for which SANS 241 has identified a risk from excessive exposure and for which SANS 241 has set a limit.

Analysis must be carefully performed to prevent the sample from being contaminated; conditions should be such that no contamination can take place. In the case of microbiological analyses special care should be taken when sampling. Another important factor is the sampling methodology, the tests are for instance very much temperature dependent. The tap should be briefly flamed or sanitised to ensure that the tap is disinfected. The water should flow for 2-3 minutes before a sample is obtained. The sterile plastic sample bottle can be then filled; taking care that the inner surface of the bottle is not touched by anything (including hands).

Analysis

Analysis can be carried out either in the field (normally done by sampler using appropriate field test equipment and kits) or at a laboratory. The various types of laboratories that are commonly used in South Africa to analyse water quality include:

- *Internal Laboratories* – these laboratories are normally operated and maintained by the Water Service Authority. Large Water Service Authorities (e.g. Metropolitan Municipalities) may have both laboratories at their water / wastewater treatment works and a central laboratory. Smaller Water Service Authorities usually only have basic laboratories at their water / wastewater treatment works (if any).
- *External Laboratories* – these laboratories are those that are operated by external parties/Professional Service Providers. These include those laboratories operated and maintained by Water Boards (e.g. Rand Water), scientific bodies (e.g. CSIR) and other government departments (e.g. National Health Laboratory Service).

The SANAS gives formal recognition that laboratories are competent to carry out specific laboratory tasks. External laboratories that are SANAS accredited have therefore satisfied specified criteria. Further details on sampling and monitoring are presented in the DWAF and WRC guide (2000) Quality of Domestic Supplies Volume 2: Sampling Guide.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