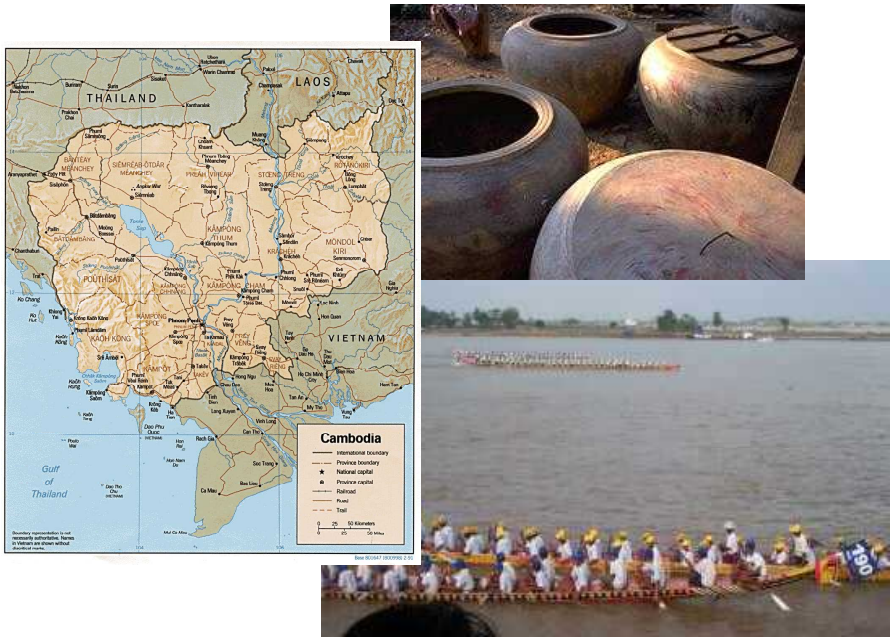
Water Safety Plans



Training for Phnom Penh, October 2006

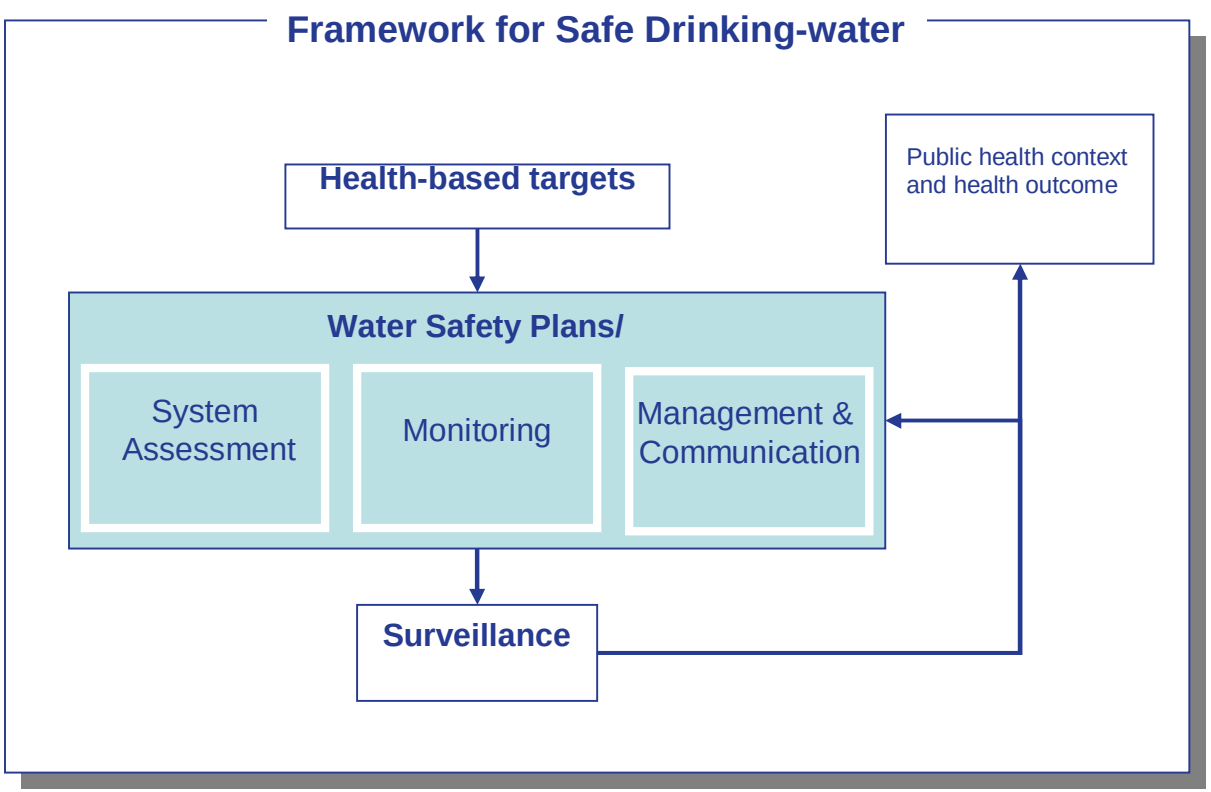
Introduction

- Overview of WSPs
- WSP steps in more detail
- Summary

WHO Water Safety Plans

- Find high-level guidance in Chapter 4 of 3rd Edition of the WHO Guidelines for Drinking-water Quality 2004
- Find detailed guidance in the WSP Monograph on www.who.int

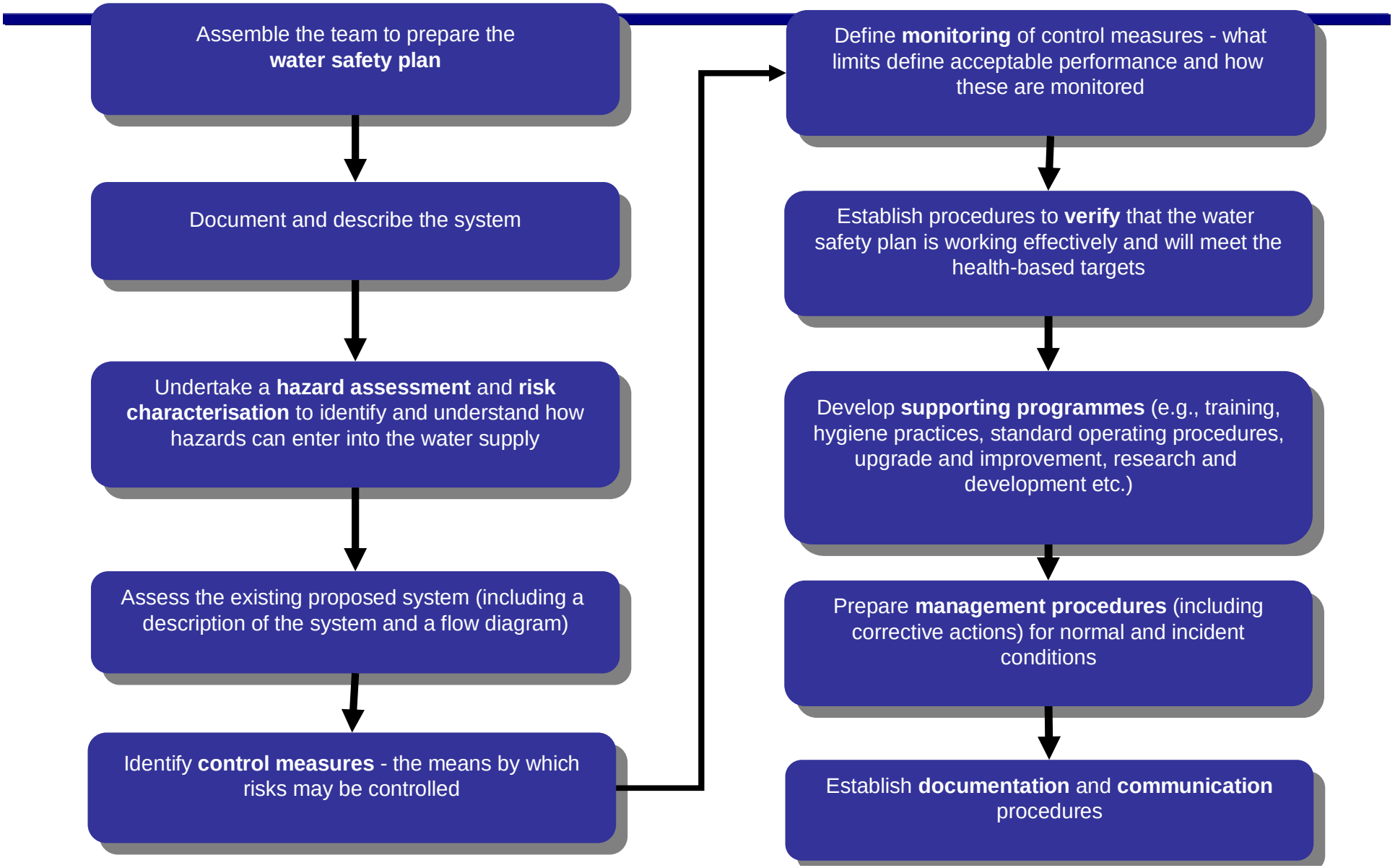
Framework for Safe Drinking-water



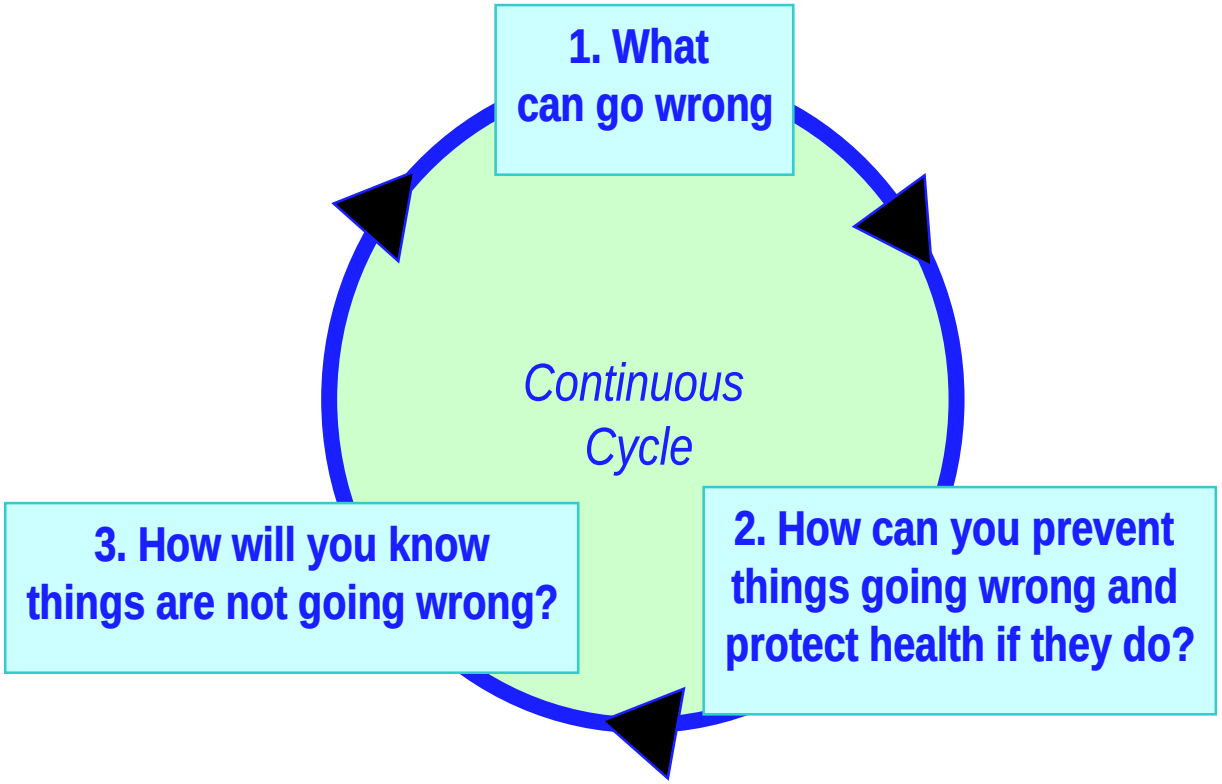
Health-based Targets

- Targets to be met based on protecting health
- Set nationally at a tolerable level for the community based on cost and benefit
- Can be coordinated with national guidelines, standards or WHO guidelines
- Usually expressed as technology requirements, treatment requirements and water quality requirements

WSP - 10 Steps


Assemble the team to prepare the **water safety plan**
Document and describe the system
Undertake a **hazard assessment** and **risk characterisation** to identify and understand how hazards can enter into the water supply
Assess the existing proposed system (including a description of the system and a flow diagram)
Identify **control measures** - the means by which risks may be controlled
Define **monitoring** of control measures - what limits define acceptable performance and how these are monitored
Establish procedures to **verify** that the water safety plan is working effectively and will meet the health-based targets
Develop **supporting programmes** (e.g., training, hygiene practices, standard operating procedures, upgrade and improvement, research and development etc.)
Prepare **management procedures** (including corrective actions) for normal and incident conditions
Establish **documentation** and **communication** procedures

WSP - Plain Language



Source: Deere DA, Davison AD. 2005. The Ps and Qs of Risk Assessment, *Water*, March: 38-43

Before Starting

- Identify the organisation leading the WSP process
- Gain commitment from other key organisations

Resource Commitment

- Commit to WSP implementation and maintenance
- Identify and allocate the resources required

WSPs for Multiple Systems

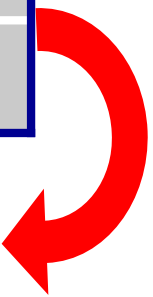
- Precisely identify distinct ‘water supply systems’
- Decide how systems will be grouped for WSP(s)

Preliminary System Assessment to Meet Targets

- Describe health-based targets in relevant terms
- Assess system capability to meet health-based targets

3. System Assessment

- Assemble the team to prepare the Water Safety Plan
- Document and describe the system



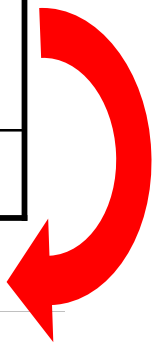
Where does water come from?
Where does it go to?
Guidelines/health targets to be met
Description of water

3.1 Assemble a Team

- Team will:
  - Plan, develop, verify and implement the WSP
- Team should be:
  - Multidisciplinary including those who know about the system, those with ability to make decisions, outside “experts” if necessary

3.1.1 Example Team Details

Job Title	Work Team	Expertise
Senior Engineer/ Team Leader	Water Quality Planning	Water Quality Engineering
Principal Scientist	Water Quality Planning	Microbiology



Include: Name, affiliation, title, role in WSP, contact information

3.2 Document and Describe the System

- Important to:
  - Ensure that hazards and risks are adequately assessed and managed

3.2.1 Describe the System and Water Quality Requirements

- Should include:
  - Source of water including the runoff and/or recharge processes;
  - If water is stored or treated anywhere and how;
  - What is added to the water;
  - How the water is distributed; and
  - A water quality specification for each type of water produced.

3.2.1 Example Description

Product Description

XYZ utility will produce safe potable water that when delivered to the consumer meets health-based & other objectives.

Objectives are captured in:

- *The Operating Licence;*
- *Customer Charter/Contract; &*
- *Current & relevant drinking water guidelines*

3.2.2 Identify the Range of Uses and Users of Water

- How is product to be used?
- Consumer instructions for product use?
- Who is product intended for e.g.:
  - (Young Old Pregnant Immunocompromised)?

3.2.2 Example Intended Use

Intended Use	Intended Users
The water supplied is intended for general consumption by ingestion. Dermal exposure to waterborne hazards through washing of bodies and clothes, and inhalation from showering and boiling are also exposure routes for waterborne hazards. Foodstuffs may be prepared from the water.	The organisation provides water to the general population. The intended consumers do not include those that are significantly immunocompromised or industries with special water quality needs. These groups are advised to provide additional point-of-use treatment. Fish and amphibians may be intoxicated by the chlorine and chloramine present in the water.

3.2.3 Construct a Flow Diagram

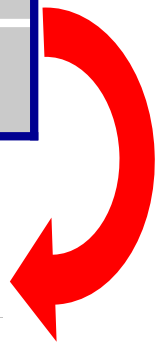
- Objectives of this step are:
  - To conceptually understand the water supply process through building a process flow diagram;
  - To identify the linkages, water flow direction and responsibilities in the water supply process;
  - ; and
  - To go over how to take the process flow diagram ‘out of the office’ and verify it on site.

3.2.3 Example Flow Diagram

Code	Step	Description	Responsibility
W1		Catchment	Multiple stakeholders
W2		Primary storage	Utility
W3		Bulk water transfer (gravity)	Utility
W4		Settling/clarification	Utility
W5		Filtration	Utility
W6		Ozone/BAC	Utility
W7		Chlorination (HOCl)	Utility
W8		Distribution	Utility
W9		Booster chlorination (HOCl)	Utility
W10		Distribution	Utility
W11		Meter box	Utility
W12		Household use	Customer

4. Hazard Identification and Risk Prioritisation

- Undertake a hazard identification and risk prioritisation
- Identify additional control measures required



Identify significant hazards in the process

A significant hazard is a hazard that **must** be prevented, eliminated or reduced to acceptable levels to produce safe drinking water

4. Steps in Hazard Identification and Risk Prioritisation

- 1. Identify potential hazards and the hazardous events that can lead to introduction of hazards into water
- 2. Determine control measures
- 3. Conduct hazard analysis

4.1.1 Identify Potential Hazards

- A hazard is:
  - A biological, chemical or physical property which may cause a product to be unsafe for consumption
- Examples:
  - Biological - *Cryptosporidium*
  - Chemical - Disinfection byproducts
  - Physical - pH/temperature
- A hazardous event is:
  - A practice or outcome that causes the hazard to become a problem by its introduction into or proliferation in the water product

4.1.2 Determine Existing Control Measures

- Control Measure:
  - Any action or activity that can be used to prevent or eliminate a water supply quality/safety hazard or reduce it to a tolerable level
  - Physical, chemical, or other factors that can be used to control an identified hazard
- Identify control measures already in place as barriers to hazards (existing risk potential of the system)

4.1.3 Risk Prioritisation

- Use risk analysis to determine which hazards and hazardous events are significant
- Can use best judgement or a risk matrix
- Risk analysis simply means:
  - Separating the bad from the not so bad i.e. prioritising your hazards

4.1.3.1 Simple Risk Analysis

Descriptor	Meaning	Notes
Significant	Clearly a priority	The risk should be considered further by the team to define whether additional control measures are required and whether a particular process step should be elevated to a key control point in the system.
Uncertain	Requires further consideration by the team be kept.	The risk may require further studies to understand if the event really is a significant risk or not. An example of an uncertain risk includes endocrine disruptors for which it is suggested that a watching brief
Insignificant	Clearly not a priority	Note that the risk will be described and documented as part of a transparent and diligent process and will be revisited in future years as part of the WSP rolling review

4.1.3.2 Semi-quantitative Risk Analysis

Risk Factor Matrix:		Severity or Consequence				
		Insignificant No impact / not detectable Rating: 1	Minor Compliance Impact Rating: 2	Moderate Aesthetic Impact Rating: 3	Major Regulatory Impact Rating: 4	Catastrophic Public Health Impact Rating: 5
Likelihood or frequency	Almost Certain Once a day Rating: 5	5	**10**	**15**	**20**	**25**
	Likely Once a week Rating: 4	4	**8**	**12**	**16**	**20**
	Moderate Once a month Rating: 3	3	**6**	**9**	**12**	**15**
	Unlikely Once a year Rating: 2	2	4	**6**	**8**	**10**
	Rare Once every 5 years Rating: 1	1	2	3	4	**5**

4.1.3.2 Example Output

Hazardous Event	Hazard Type	Likeli-hood	Severity	Risk	Control Measure	Technical Basis
Cattle defecation followed by a large storm transporting pathogens to reach unacceptable concentrations at the surface water abstraction point	M (pathogens) C (nutrients)	2	5	10 **S**	Stakeholder identification and liaison programs Catchment Management Board representation State program for implementation of Ecosystem Services Practices Filtration of water Boil water advisory	Waterborne disease outbreaks have arisen from pathogens from cattle including *Cryptosporidium* and *E. coli* O157 during similar scenarios Catchment liaison programs are in place but cattle are still allowed to graze close to streams

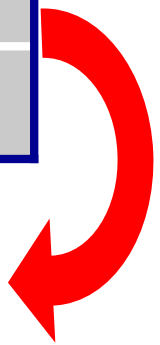
4.2 Identifying Additional/Improved Control Measures

All significant risks need to be further investigated to ensure that risk is reduced to a tolerable level

Issue Identified		Action Required	Procedures or Records	Responsibility	Time Frame	Signed Off By:
No:	Issue					
1	Wellhead is unprotected	Liaise with landholder and fence off buffer zone around wellhead	Catchment liaison documents and stakeholder records	Catchment officer	Within three months	Signature here.
		Protect wellhead by building secure premises	Works schedules	Manager Water Supply Systems	Within one year	Signature here

5. Operational Monitoring to Support Risk Management

- Define monitoring of control measures
- Develop corrective actions



Monitoring shows that:

- Control measure is effective and if not;
- Allows measures to be put in place in good time to prevent health-based targets being compromised

5.1.1 Operational Monitoring

- The act of conducting a planned sequence of observations or measurements, to assess whether the control measures applied at a point in the system are achieving their objectives
- Effective monitoring relies on establishing:
  - What will be monitored;
  - How it will be monitored;
  - Where it will be monitored;
  - When it will be monitored;
  - Who will do the monitoring.

5.1.2 Corrective Actions

- Action to be taken when the results of monitoring at a control point indicate a loss of control.
- Corrective actions and monitoring form the ‘control loop’ to ensure that unsafe drinking-water is not consumed
- Involves:
  - Action;
  - Responsibility;
  - Disposition of contaminated water;
  - Root cause of problem;
  - Records of what happened and what was done.

5.1.2 Example Output ‘Control Loop’

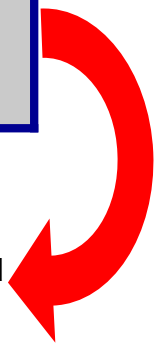
Process Step/ Control Measure	Operational Limit	Monitoring					Corrective Action
		What:	Where:	When:	How:	Who:	
Treatment/ chlorination at water treatment plant	Chlorine concentration leaving plant must be > 0.5 and < 1.5 mg/L	Disinfectant residual	At entry point to system	On line	Chlorine analyser	Water Quality Officer	Activate chlorine exceedance protocol

5.1.3 Incidents and Emergencies

- The response to a major water quality incident:
  - Issuing a boil water order to the population of a city would be part of an incident or emergency response
  - Note that this is a more extreme response than a simple operational corrective action

6. Verification

Establish procedures to verify that the water safety plan is working effectively and will meet the health-based targets



- Builds a body of evidence that water produced by the water supply system is compliant with the water quality objectives;
- To confirm that the WSP is being implemented in practice as it was designed to be; and
- To confirm that the critical limits and other important values are appropriate for controlling the identified risks so that the system is capable of producing water fit for intended uses.

6.1.1 to 6.1.4 Types of Verification

- 6.1.1 Water Quality Testing
- 6.1.2 Internal and External Auditing
- 6.1.3 Consumer Satisfaction
- 6.1.4 Validation of System Capability

6.1.3 Example Output Verification

Activity	Description	Frequency	Responsible Party	Records
Water quality monitoring	*E. coli* is monitored in finished water samples in all zones at tap sites	Weekly in each zone	Independent laboratory of the Ministry of Health	Ministry of Health water quality database
Audit of instrument calibration	Calibration records are audited at all sites for instruments that monitor operational limits	Quarterly for all instruments	Independent auditor approved by the Ministry of Health	Ministry of health audit report

6.1.4 Example Output Validation

Item Validated	Validation	Reference
Chlorine residual critical limit values	USEPA CT regulatory requirements for disinfection of *Giardia* by chlorine	USEPA Disinfection Guidance Manual
Mains minimum pressure requirement	Hydraulic system design to prevent negative pressure zones	Hydraulic engineering system design manual and modelling

7 Management Plans and Supporting Programs

- Management Plans:
  - Documented plan of system management and operation
  - Must address both routine normal operating conditions and incident and unusual conditions
- Supporting Programs
  - Programs that support the water safety plan
  - Includes training, community liaison, instrument calibration, supplier quality assurance

8 Documentation and Records

- Documentation:
  - Managing documents to make sure they are up to date, available when required and accurate
- Records:
  - To provide information that can be used to identify trends and to demonstrate that the WSP has been followed