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Ministry of Health

National Standard Operating Procedure for Water Quality in Health Care Facilities

Ministry of Health

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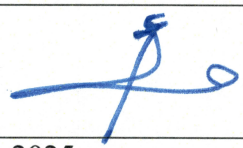
Signature		Signature	
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1. TABLE OF CONTENT

1. TABLE OF CONTENT 2
.2 ACKNOWLEDGMENTS 4
3. ACRONYMS 5
4. PURPOSE 6
5. SCOPE 6
6. DEFINITIONS 6
7. DETAILS: PROCEDURE 8
7.1 Water Safety Plans (WSPs), Water Safety Group (WSG) & Risk Assessment to Water System 8
7.2 WATER QUALITY IN HEALTHCARE FACILITIS SOP 8
7.2.1 Site of Water Sample Collection 8
7.2.2 Frequency of Drinking Water Sampling Based on Risk Assessment 9
7.2.3 Water sampling bottles and type of tests 10
7.2.4 Sample Storage and Transportation Requirements of Bacteriological Test Samples 41
7.2.5 Sample Labeling 43
7.2.6 Health and safety considerations during water collection 45
7.2.7 Interpretation of Results 45
7.2.8 Corrective and Remedial Action 66
7.3 INVESTIGATION OF WATER BORNE PATHOGENS OUTBREAK AND SPECIAL CONSIDERATION FOR LEGIONELLA OUTBREAK 74
7.4 INFECTION PREVENTION & CONTROL IN High Risk areas 74
7.5 DIALYSIS WATER QUALITY 74
7.5.1 Components/ Stages of the dialysis water treatment process 75
7.5.2 Performance requirements 78
7.5.3 Water testing 78
7.5.4 Bacterial analysis of dialysis water 81
7.5.5 Endotoxin analysis of dialysis water 85
7.5.6 Chemical analyzes of dialysis water 88
7.5.7 Corrective measures 90
7.5.8 Bacterial Control Devices 94
7.5.9 Installation and validation of water treatment systems for hemodialysis 94
7.5.10 Training 97
7.6 RECORD KEEPING FOR WATER QUALITY 97
7.7 TRAINING AND COMPETENCY REQUIREMENTS 98
8. ROLES & RESPONSIBILITIES 99
9. DOCUMENT HISTORY AND VERSION CONTROL 103

10. REFERENCES 103
11. ANNEXES 106
11.1 ANNEX-1: WATER SAFETY PLAN (WSP) 106
11.2 ANNEX-2: SUMMARY STEPS OF PROCEDURE FOR WATER SAMPLING 143
11.2.1 Annex-2a: Steps of Tap Water Sampling for Bacteriological test 143
11.2.2 Annex-2b: Water Sampling-Chemical test 144
11.2.3 Annex-2c: Dialysis water Sampling for Bacteriological test 145
11.3 ANNEX-3: INVESTIGATION OF WATER BORNE PATHOGENS OUTBREAK AND SPECIAL CONSIDERATION FOR LEGIONELLA OUTBREAK 147
11.3.1 Annex-3a: investigation of legionellosis cases in community 147
11.3.2 Annex-3b: investigation of water borne pathogens outbreak in healthcare setting 155
11.3.3 Annex-3c: Investigation and management of legionella outbreak in the healthcare facilities 159
11.4 ANNEX-4 INFECTION PREVENTION AND CONTROL FOR WATER QUALITY IN HEALTHCARE SETTING AND SPECIAL COSIDERATION FOR HIGH RISK AREAS 161
11.4.1 Annex-4a: Infection Prevention and Control for Water Quality In Healthcare Setting 161
11.4.2 Annex-4b: Infection Prevention and Control For Water Quality In High Risk Areas 167

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Their expertise and dedication were instrumental in the successful completion of this document.

3. ACRONYMS

AAMI	Advancement of Medical Instrumentation
AC	Air conditioning
ANSI	American National Standards Institute
Cfu/ml	colony-forming unit/ milliliter
EU/ml	Endotoxin Units per milliliter
EOH	Environmental & Occupational Health
HDF	Haemodiafiltration
HSE	Health, safety, environment
IPC	Infection prevention and control
MOH	Ministry of Health
Ppm	part per million
RDU	Renal Dialysis Unit
RO	reverse osmosis
SOP	Standard Operating Procedure
UV	ultraviolet radiation
WSG	Water Safety Group
WSP	Water Safety Plan

4. PURPOSE

Water quality standards at healthcare facilities including hospitals, health centers, dental offices and dialysis units must be maintained to protect patients, staff, visitors, and the whole community.

This SOP addresses issues related mainly to water quality in healthcare facilities at MOH in order to maintain water quality standards and protect patients, staff, visitors, and the whole community. The main objective of this SOP is to assist and inform various stakeholders by providing a comprehensive reference document about water quality details to use in healthcare institutions as well as outbreak investigation of water-borne diseases (legionnaire's disease).

It is recognized that SOPs are subject to regular review and that advice given here will eventually be superseded by future publication.

5. SCOPE

This SOP is for all stakeholders responsible of maintaining water quality in healthcare facilities and the Directorate Generals, in-order to maintain and improve the water quality in healthcare settings of Ministry of Health (MOH).

6. DEFINITIONS

AAMI	Association for the Advancement of Medical Instrumentation.
ANSI	American National Standards Institute, Arlington, Virginia.
Bacteria	Specifically referring to microscopic organisms.
Biofilm	A protective slime coating that bacteria secrete. Possible to form inside distribution loops causing bacterial contamination.
Brine tank	Vessel used to house a solution of salt and water that is used by the softener to condition 'hard' water. Dry salt is added, when required.
Central water plant (CWP)	Plant that produces reverse osmosis (RO) water. The equipment generally has process control devices that measure, monitor and control.
Chloramine	A combined chlorine that cannot combine with other chemicals that has become the major disinfectant of drinking water.
Chlorine, combined	Chlorine that is chemically combined, such as in chloramine compounds. No direct test exists for measuring combined chlorine, but it can be measured indirectly by measuring both total and free chlorine and calculating the difference.
Chlorine, free	Dissolved molecular chlorine.
Chlorine, total	Chlorine plus chloramine.
Component	An individual part of a water purification unit, such as a softener, carbon tank, or reverse osmosis (RO) unit.
Conductivity	A measure of the ability of an aqueous solution to conduct electricity. This is directly related to the concentration of dissolved salts/ions in the water, and therefore water purity. The premise being that pure water is a poor conductor, hence its low conductivity reading, expressed in microSiemens per cm (µS/cm). Testing is required to monitor the performance of components.

Dialysate	A mixture of treated water and specifically formulated fluid. Used to create a fluid environment to assist in the migration of solutes across a dialyser.
Dialysis facility	Building where patients attend dialysis treatment.
Disinfection	The destruction of pathogenic and other kinds of micro-organisms by thermal or chemical means. Disinfection is a less lethal process than sterilization, since it destroys most recognized pathogenic micro-organisms, but not necessarily all microbial forms. This definition of disinfection is equivalent to low-level disinfection in the Spalding classification.
Disinfection, chemical	The destruction of pathogenic and other kinds of micro-organisms by chemical means. The most common chemicals are chlorine and peracetic acid, which attack cell structure preventing the cell from multiplying.
Disinfection, heat	The destruction of pathogenic and other kinds of micro-organisms by thermal means. Typically, heating the fluid levels to approximately 90 degrees Celsius for a fixed time period will destroy most micro-organisms.
Endotoxins	Substances that are a major component of the outer cell wall of gram-negative bacteria that produce an inflammatory host response. Endotoxins are lipopolysaccharides, consisting of a polysaccharide chain covalently bound to lipid A. Endotoxins can acutely activate both humoral and cellular host defences, leading to a syndrome characterized by fever, shaking chills, hypotension, multiple organ failure, and even death if allowed to enter the circulation in a sufficient dose. Long-term exposure to low levels of endotoxin has been implicated in a chronic inflammatory response, which may contribute to some of the long-term complications seen in haemodialysis.
Filter, carbon	Inert vessel containing granular activated or catalytic carbon appropriately sized to remove chlorines or chloramines by adsorption from the feed water supply. Will also remove microcystins, some organic matter, taste and odour.
Filter, multimedia	Inert vessel containing granular gravels appropriately sized to remove sediment from the feed water supply.
Osmosis, reverse (RO)	The process of forcing water from one side of a semi-permeable membrane to the other, producing purified water by leaving behind the dissolved solids and organic particles. The equipment that performs this process is frequently referred to as the RO.
Permeate	Water that has been processed completely through a water pre-treatment system and distributed to haemodialysis equipment. Also known as product water.
Softener	Inert vessel containing resin beads that will react to remove calcium and magnesium by ion exchange.
Total dissolved solids (TDS)	The sum of all ions in a solution. Approximated by electrical conductivity or resistivity measurements. Expressed in terms of CaCO3 or NaCl (parts per million [ppm]). Used to assess performance of reverse osmosis (RO) units.
UV irradiator	A disinfection device that uses radiant energy to destroy bacteria.
Water, dialysis	Water that has been treated to meet the requirements of ISO13959 and that is suitable for use in haemodialysis applications.
Water, feed	Water supplied to a water pre-treatment system. Usually will be pressure-controlled, may be temperature-controlled.
Water, hard	High levels of calcium and magnesium in the feed water cause the water to be termed ‘hard’. Hardness is measured in grains per gallon (gpg; ‘grain’ literally taken from the precipitate left from evaporated water being the size of a grain of wheat) or mg/L and is generally expressed in terms of CaCO3 (calcium carbonate) for uniformity purposes.
Water, product	Water that has been processed completely through a water pre-treatment system and distributed to haemodialysis equipment. Also known as permeate.

Water, reject	Considered to be filtered water that has passed through the CWP/RO system, but not through the RO membrane. Many options exist for the re-use of this water, such as use in flushing, irrigation or cleaning.
Water, source	Water entering a dialysis facility from an external supplier, such as a municipal water supply.
Water, pre-treatment system	A collection of water purification devices and associated piping, pumps, valves, gauges, etc., including the reverse osmosis (RO) plant, that together produce water for haemodialysis applications and deliver it to point of use.

7. DETAILS: PROCEDURE

This SOP will cover the following areas:

1. The Water Safety Group (WSG); Water Safety Plans (WSPs) and the risk assessment to water system
2. Water quality in healthcare facilities SOPs
3. Investigation of water borne pathogens outbreak and special consideration for Legionella outbreak
4. Infection Prevention and Control for Water-Borne Infection in high risk areas
5. Dialysis water quality
6. Records keeping for water quality
7. Training and competency requirements
8. Roles and responsibilities

7.1 WATER SAFETY PLANS (WSPS), WATER SAFETY GROUP (WSG) & RISK ASSESSMENT TO WATER SYSTEM

Please check annex-1 for manuscript of this section.

7.2 WATER QUALITY IN HEALTHCARE FACILITIS SOP

In the following section, details of water quality in healthcare facilities will be provided.

7.2.1 Site of Water Sample Collection

- All samples collected for analysis must be representative of the water facility being examined.
- Higher counts of bacteria in water system tend to be found in water, which is stagnant or stationary for long periods, e.g. tanked supplies, inactive water points, dead legs, infrequently used parts of buildings. It is therefore important to use a risk-based approach to the selection of appropriate sampling points, and to collect sufficient volumes of water to enable adequate assessment of the water quality.
- If the quality of water as delivered from the tap (i.e. including any bacteria that are colonizing the tap) is of interest, then the tap should not be sanitized and the sample should be drawn the

very first portion of water delivered preferably immediately after a period of no, or minimal use (Pre-flush). If only bacteria present in the system prior to the tap are sought, the tap should be sanitized and run for 2 – 3 minutes before sampling (Post-flush). When attempting to ascertain the origin of contamination, samples before and after sanitization and flushing may be appropriate (Pre and Post-flush).

- Choose a suitable tap for water sample collection; preferably an unpainted metal tap that is not leaking. It should also be one that is used regularly and is not subject to contamination, for example from greasy hands.
- Taking post-flush sample from taps should be free of aerators, hose attachments, strainers and mixing type faucets.
- The water lines should be flushed prior to sample collection to eliminate the effects of local residential plumbing.
- If taking a chemical sample to check if lead is leaching from the tap or plumbing fittings, the tap should not be flushed, and first flush of water from the tap should be collected, confirming that it has not been used for 12 hours.
- When you are conducting an investigation, samples should be taken from more than one location.

7.2.2 Frequency of Drinking Water Sampling Based on Risk Assessment

- Sampling and analysis for microbes is more frequently required as compared to chemical constituents. This is because even minor episode of microbial contamination can lead directly to illness in consumers, whereas incidents of chemical contamination that would constitute an acute health concern, in the absence of a specific event are rare e.g. chemical overdosing at a treatment plant.
- Frequency of water sampling for both microbiological and physico-chemical tests are summarized as following:

A-Microbiological Tests	B-Physical & Chemical Tests
Frequency of sampling is based on risk assessment of water system carried out under the water safety plan.	Generally, the test for drinking water supply should be done annually. Currently, the practice of taking drinking water sample for physic-chemical test is every 6 months from healthcare facilities of the Ministry of Health is to ensure proper water quality. The frequency can be increased (e.g. less than 6 months) or decreased (more than 6 months) if indicated.

The frequency should also be increased in case of detected microbial contamination or epidemic until pattern is known.	The interval period will be reduced where higher frequencies of sampling is required in the following situations: -When results of the water testing are abnormal, -Initial monitoring of a new supply system, -Epidemiological findings of a waterborne disease, -Remedial actions identified during audits and preparation of water safety plans, operational failure, or any other unsatisfactory situations.

7.2.3 Water sampling bottles and type of tests

When sampling drinking water the following shall be observed:

- Refrain from eating, talking, coughing or smoking while working with water samples.
- Exhaust fumes and cigarette smoke can contaminate samples with heavy metals.
- Air conditioning (AC) units can also be a source of trace metal contamination so keep the sample away from direct AC flow.
- The collection and handling of samples is crucial to obtain valid data. Person(s) collecting water samples should be properly trained on proper sample handling, collection, labelling, packaging and transportation.
- The following table summarizes the water sampling bottles specifications of both physico-chemical and microbiological tests.

Table-1: Summary of the water sampling bottles specifications of both physico-chemical and microbiological tests

Sampling for Physical & Chemical Tests	Sampling for Microbiological Tests
• Sample bottle and its closure should be made of neutral color-less chemically resistant material e.g. plastic and fitted with tight stoppers. Glass bottles are not recommended due to risk of breakage during transport, figure-1 • Bottles must be capped at all times. • Bottles must be clean free from any surface dirt before use, devoid of contamination. • Bottles should be kept in a clean environment e.g. clean shipping containers (cool box), away from dust, dirt, fumes and grime both before and after the collection of the sample. • The bottle shall be thoroughly washed at least three times with the water to sample before it is filled.	• Use a water sample bottle for bacteriological test provided by the Central Public Health Laboratories figure-2. ○ Use sterilized bottles only. It is 100-120 ml capacity. ○ It is made of plastic. ○ It has tight stoppers with wrap seal ○ It is containing an appropriate neutralizer/ de-chlorinating chemical (sodium thiosulphate [Na2S2O3]) to neutralize any residual disinfectant in the water to neutralize these substances in the sample and prevent the chlorine from continuing to disinfect the water sample before it is tested. • Do not rinse the contents from the container. • Do not use bottles with broken or damaged sterile seal. • Do not use the sample for the measurement of temperature or any other field parameter, as this may contaminate the sample.

• If the water suspected to contain elevated levels of heavy metals (e.g. change in water color or deposits in the pipes), then a chelating agent shall be added to the specimen. Samples container shall be rinsed with 50% HNO_3, and wash it thoroughly before collection of the samples with distilled water free from ions. • Sample size, containers type and kind of test which carried out on the un-bottled water shall be determined according to table-2. • The water sampling should be accompanied by a sampling request form from chemistry lab as shown in table-2.	• Wear clean clothing • Watch for contamination sources nearby activities – soil disturbances- animals/manure • Avoid talking and disturbing the air while collecting (sneezing/coughing). If you did while it is open, use a fresh bottle. • Don't eat or smoke while working with water samples. • Always take extra bottles along for use when needed.
Figure-1: Water sample bottle for chemical testing 	**Figure-2: Water sample bottle for bacteriological testing** 

• Table-2 summarizes the standard physico-chemical test of drinking water, specimen information and chemical analysis request form.

Table-2: Chemistry tests parameteres and specimen information for drinking water

Laboratory Tests		Specimen Information			
		Minimum Volume	**Container**	**Preservation**	**Transport information**
Physico-Chemical	Color	1000 ml	Clean Plastic/ Glass	Keep refrigerated at 4-8 °C	Send the sample to the laboratory as soon as possible at 4-8°C temperature
	Turbidity				
	pH				

	Conductivity		(Rinse container with the water sample three times)		
	Total Dissolved Solids				
	Ammonia				
	Nitrate				
	Nitrite				
	Chloride				
	Total Hardness				
	Calcium				
	Magnesium				
	Total Alkalinity				
	Residual Chlorine				
Metals	Lead	1000 ml	Clean Plastic/ Glass (Rinse container with 50% HNO_3)		

Figure-3: Request form for water chemical analysis

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Ministry of Health
Directorate General of Health Affairs
Department of Laboratories

سلطنة عُمان
وزارة الصحة
المديرية العامة للشؤون الصحية
دائرة المختبرات

نموذج يرسل مع عينة المياه للتحليل الكيميائى

REQUEST FORM TO BE SENT WITH WATER SAMPLE FOR CHEMICAL ANALYSIS

Sample Code : ..... : رقم العينة

Name of Sample Owner : ..... : اسم مالك مصدر العينة

Address : ..... : عنوانه

Source of Sample : ..... : مصدر العينة

(Well - Tank - Tap - Other) (بئر مياه – خزان مياه – صنبور – أخرى تذكر)

Required Chemical Analysis : ..... : نوع التحليل الكيماوي المطلوب

Sample Size : ..... : حجم العينة

Date of Sampling : / / ٢٠ : تاريخ أخذ العينة

Time of Sampling : ..... (صباحا/مساء) : وقت أخذ العينة

Name & Occupation of Sampler : ..... : اسم ووظيفة آخذ العينة

Notes : ..... : ملاحظات

.....

إقرار : وردت العينة للمعمل (مختومة/غير مختومة) بتاريخ / / ٢٠ (محاطة بالثلج /غير محاطة بالثلج)

توقيع مستلم العينة :

7.2.3.1 Water quality parameters for different applications in healthcare System

- The following table represent **an example** of the different examinations required for the different water sources in the healthcare facility environment are listed in Table-3.

Table-3: Examples of water quality parameters for different applications in healthcare System

Healthcare area	Purpose	Physical, chemical quality indicators	Microbial quality indicators	Hazards (based on an assessment for each system)	Frequency for microbiological test
All settings	Wholesome water for drinking, cooking, food preparation and washing	• **Physical:** Odor, color, taste • **Chemical:** -Heavy metals (only done for RDU water and Endoscopy water in CPHL, not done as routine test for all drinking water sample). -Nitrates, -Orthophosphates (Not available in CPHL), -Pesticides (Not available in CPHL) -Surfactants (Not available in CPHL)	• **Biological:** Coliform bacteria, E. coli		
	Circulated hot water systems and cold water systems		• Legionella spp.: colony counts per litre • Pseudomonas aeruginosa colony counts per 100 mL	• Legionella spp., Pseudomonas aeruginosa and other waterborne pathogens	Frequency is determined by risk assessment
Water dispensers, and mains supplied water coolers / filtered water units	Drinking water		• Total viable bacteria count • Enumeration of Pseudomonas Aeruginosa • Enumeration of coliforms and E. coli		Frequency is determined by risk assessment
Flexible endoscope reprocessing units	Initial flush	Hardness			
	Intermediate flush	Hardness			
	Tap water and Final rinse-water in AER	• Hardness • Total organic carbon • Electrical conductivity • Appearance • pH	• Total viable count • P. aeruginosa • Environmental mycobacteria		Weekly Quarterly Quarterly
Renal units and satellite dialysis units	Water for haemodialysis	• Chemical test (yearly)	• Total viable counts and endotoxin concentrations		Monthly
Intensive care units			• Pseudomonas aeruginosa:		

[Standard Operating Procedure for Water Quality in Health Care Facilities]

			Colony counts per 100 mL		
Aquatic therapy pools		• pH, free residual halogen, total and combined halogen and other treatment parameters.	• Coliforms, E.coli, Pseudomonas aeruginosa and TVCs	• Staphylococus • Legionella	Weekly for hydrotherapy pool water
Spa pools and whirlpools		• pH, free residual halogen and other treatment parameters			
Sterile services departments	Final rinse	• Appearance • pH • Conductivity at 25ºC • Total dissolved solids • Total hardness • Chloride, Cl • Heavy metals, determined as Lead (Pb), Iron (Fe) • Phosphate, P2 O5 • Silicate, SiO_2	• Total viable count at 22ºC • Total viable count at 37ºC • Bacterial endotoxins		
	Other stages	• Total hardness • Chloride, Cl • Silicate, SiO_2			
Laundries	Final rinse	• Hardness (total $Ca2+/Mg_2+$) • pH • Turbidity • Colour • Iron • Manganese • Copper • Surfactant (Not availavle in CPHL) • Residual chlorine: According to the national policy and procedure in laundry services: Monitor and control the amount of residual chlorine “bleach” between 50 to 150 ppm)	• Bioburden (TVC)	• Clostridium difficile • Bacillus cereus.	
Dental facilities	Dental unit water lines and water systems		• Total viable aerobic heterotrophic bacterial count • Legionella spp.: colony counts per litre • Pseudomonas aeruginosa colony counts per 100 mL	Legionella spp. Pseudomonas aeruginosa and other waterborne pathogens	Frequency is determined by risk assessment

7.2.3.2 Procedure for Collecting Water Sample

The location and manner in which a sample is collected and handled in the field is the first step to ensure representative and reliable analytical data. Necessary precautions shall be taken to protect the sample, their sources, the sampling instrument, and sample containers from any accidental contamination. Samples shall be collected, packed, transported and manipulated prior to analysis in a manner that safeguards them against change in constituents or properties to be examined. Samples shall be collected with great care to ensure that they represent the source to be examined, and to avoid accidental contamination of the sample during collection.

7.2.3.2.1 Tap water

The water sampling must be conducted in accordance with the following steps:

a. Assemble all of the sampling supplies listed in table-4, figure-4

Table-4: Equipment needed for water sampling

S.N	Equipment name
1.	Water sample bottles (bacteriological/chemical)
2.	Labels
3.	Laboratory sample request forms (bacteriological/chemical)
4.	Water system map, list of sampling points
5.	Permanent waterproof marker pens
6.	Gloves
7.	Hand sanitizer/soap
8.	Alcohol wipes/swabs or sodium hypochlorite solution or ignition source
9.	Cool box
10.	Ice packs
11.	Buckets to collect the water during flushing if there is no drainage
12.	Food grade plastic bags; sterile scissors and elastic bands (for taking shower samples)
13.	+/- Electronic thermometer with probe /colorimetric (chlorine test kit)/pH test kit
14.	Timer
15.	Camera (optional)
16.	Tape and scissors for sealing of the cool box
17.	50% HNO3 to rinse the container if collecting sample for lead
18.	Chlorine testing equipment

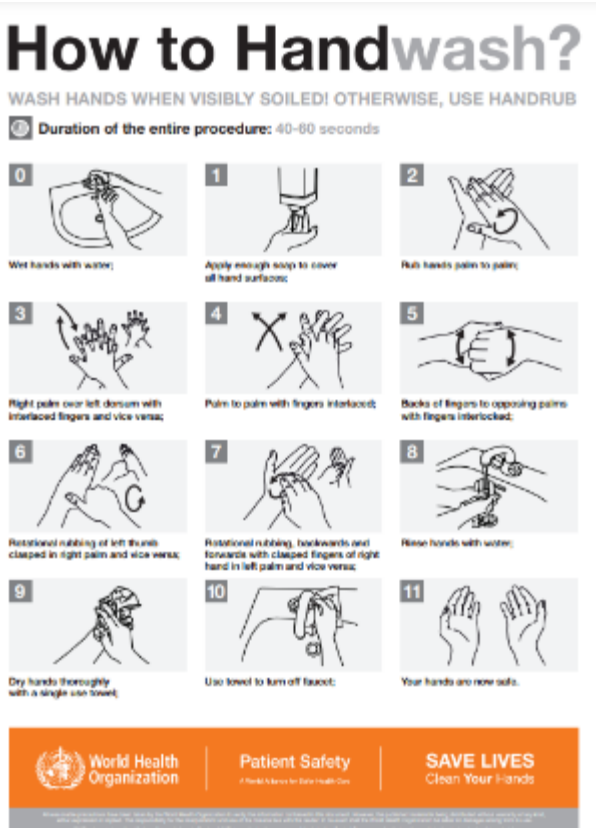
Figure-4: Equipment assembled for water sampling

b. Before you begin, clean your hands properly with antiseptic soap and water or alcohol-based hand rub - if hands are visibly clean - before handling supplies as shown in figure-5-7.

Figure-5: Washing hands before sample collection

Figure-6: Steps of hand rub

Figure-7: Steps of hand wash



c. Sample collectors can wear gloves (latex or plastic) when sampling in-order to protect the sampler from contaminants in the ambient waters, and from coming into contact with preservatives. figure-8.

Figure-8: Wearing gloves before water sampling

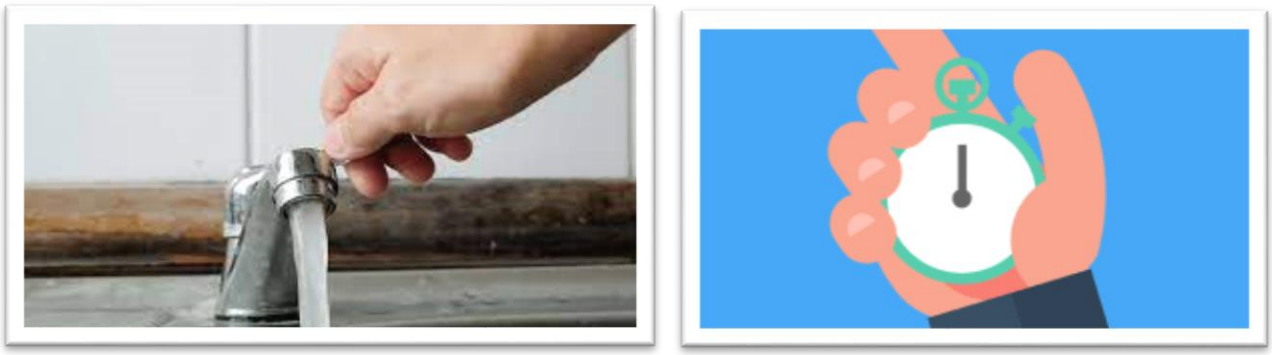
d. If pre-flush water sample is required, take the pre-flush sample at this step. Pre-flush sample should be taken from a tap at a time of no use (at least 2 hours or preferably longer) or, if that is not possible, during a time of its lowest usage.

e. Ensure that the tap is in good condition, with no leaks and do not sample taps with leaking spindles. Remove any internal and external fittings such as hosing (e.g. aerators, hose attachments). Scrape off any dirt (scale, slime, grease or other extraneous matter) which could fall off, before filling the bottles, figure- 9.

Figure-9: Removing internal and external fitting before water sampling

f. Flush Tap 1 to 10 minutes by opening the cold water fully and allow running to waste as per the location and the frequency of use to adequately flush the water line of any debris, figure-10.

Figure-10: Flushing tap water



g. Measure chlorine residual at this point using colorimeter.

h. Turn off the tap, figure-11.

Figure-11: Turning off taps

i. Disinfect the end of the tap (nozzle) thoroughly and carefully either chemically or by flaming.

Disinfection of the tap can be carried out by different methods as elaborated in table-5.

Table-5: Different methods of disinfections of the nozzles during water collection process

S. N	Ways of disinfections	Methods	Demonstration figures
1	Hypochlorite solution: preparing a hypochlorite solution by using 500-600 ppm chlorine sodium hypochlorite (1:100 v/v dilution of chlorine bleach).	a) Dip the mouth of the tap using a measuring jug/beaker and suspending it under the tap, such that the end of the tap is immersed in the solution for 2 to 3 minutes, figure-12	**Figure-12: Dip the mouth of the tap using a measuring jug/beaker**  
		b) Use a wash bottle to spray hypochlorite solution to the outside and inside of the tap spout. If a wash bottle is used, this should produce a directed spray but not a fine mist. Leave for 2-3 minutes before rinsing, figure-13	**Figure-13: Wash bottle used to spray hypochlorite solution to the outside and inside of the tap spout** 
		c) Swab the tap from inside and outside. Leave for 2-3 minutes before rinsing, figure-14	**Figure- 14: Swab the tap** 

		d) Wipe the tap from inside and outside (Figure-15). Leave for 2-3 minutes before rinsing	**Figure-15: Wiping the tap from inside and outside** 
2	Disinfect the end of the tap by 70% isopropyl alcohol	Wait a minimum of two to three minutes before taking the required sample. This waiting period allows the ethanol solution to evaporate otherwise the ethanol will falsely affect the test results.	
3	Disinfection by flaming: For metal taps without plastic fittings or other heat-sensitive components, igniting a piece of cotton wool soaked in a methyl alcohol and held close to the nozzle until the tap is unbearably hot to touch. Flame the tap, starting at the nozzle and working back to the body of the tap. After flaming, run the water to waste until cool before taking the sample (figure-16&17)		**Figure-16 Disinfection by flaming**  **Figure-17: Steps of water sample collection and site disinfection using ignition** 

j. Turn on the tap and let cold water run for a few seconds to ensure that the water has no residual thermal or disinfectant effect.

k. Then reduce to a gentle flow to permit filling the bottle without splashing, figure-18

Figure-18: Reducing water flow

l. Open the water bottle:

- Remove the plastic shrink wrap seal by pulling down on the red strip and pealing the shrink wrap from both the cap and bottle, figure-19
- Discard the shrink wrap. Do not attempt to open the cap with shrink wrap still attached.
- Grasp cap along top edge and remove carefully.
- Holding the bottle near its bottom.
- Hold the cap with the opening facing downwards (to prevent entry of dust that might carry microorganisms).
- Do not touch the inside of the bottle or the cap with your fingers or allow the bottle to touch the sample tap. It is not allowed to touch the stopper and neck of the bottle with anything when filling the sample. Hold the bottle in one hand and the cap in the other. If the inside of the sampling container or the cap is touched, it must be considered contaminated and should not be used.
- Do not put the bottle or cap down.
- Do not place the cap in your pocket.

Figure-19: Opening the water bottle

m. Collect the water sample**:**

- The sample bottle shall be filled from a regular stream of water; avoiding splashing.
- Do not change the flow rate while filling the bottle, as deposits may be dislodged.
- Take great care in handling it. Start filling the bottle carefully so that water entering the bottle will not come in contact with your hands or the outside of the bottle as in figure-20.

Figure-20: The proper way to handle the sample bottle

- Fill the bottle until the water sample level is between the two lines on the bottle (100 – 120 ml), leave an airspace. Preferably, the sample level should be at or just slightly above the 100 ml line.
- Sample levels below the 100 ml (lower) line will not be tested due to insufficient sample volume. Sample levels above the 120 ml (upper) line will not be tested due to overfilled bottle. Figure-21. If you overfill the bottle, start over with a fresh bottle.
- If taking both a microbiology and chemistry sample, take the microbiology sample first, to avoid the danger of contamination of the sampling point during collection of the other samples for other tests.

Figure-21: Proper filling of water sample

n. Close the water bottle: Place the cap on the bottle and screw it down tightly, figure-21

Figure-22: Closing the water bottles

o. Invert or shake to mix the neutralizer with the collected water. This sample is a post-flush water sample.

p. Label each Sample Bottle: Sample site, date and time shall be written on the label of each sample. It is advisable to pre-label all sample containers prior to taking the sample or to label each container immediately after the sample is taken to prevent confusion. Permanent waterproof marker or pen should be used and the material from which the label is comprised should be able to withstand water. Sample containers may have labels affixed to the container itself; alternatively, the label or sample tag may be provided separately and attached to the container after the sample is collected. If the tags/labels are separate, the sampler should attach them prior to or immediately after taking the sample to prevent incorrect labeling. Exact location where sample is taken from should be clearly written on the containers e.g. ABC hospital/Female surgical ward/water cooler A. See section of instructions on properly completing the sample collection form and for shipping instructions.

q. Fill out the Sample Collection Form using waterproof ink as shown in figure-23&24.

Figure-23: Bacteriological Examination form of water samples

SULTANATE OF OMAN
MINISTRY OF HEALTH
Center for Disease Control & Prevention
Department of Central Public Health Laboratories
Food Borne-Illness and Food Poisoning Laboratory

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سلطنة عمان
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مركز مراقبة الأمراض والوقاية منها
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مختبر الفاشيات الغذائية و التسمم الغذائي

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تحليـــــل عينـــات المياـــاه بكتريولـوجيـــــاً

BACTERIOLOGICAL EXAMINATION OF WATER SAMPLES

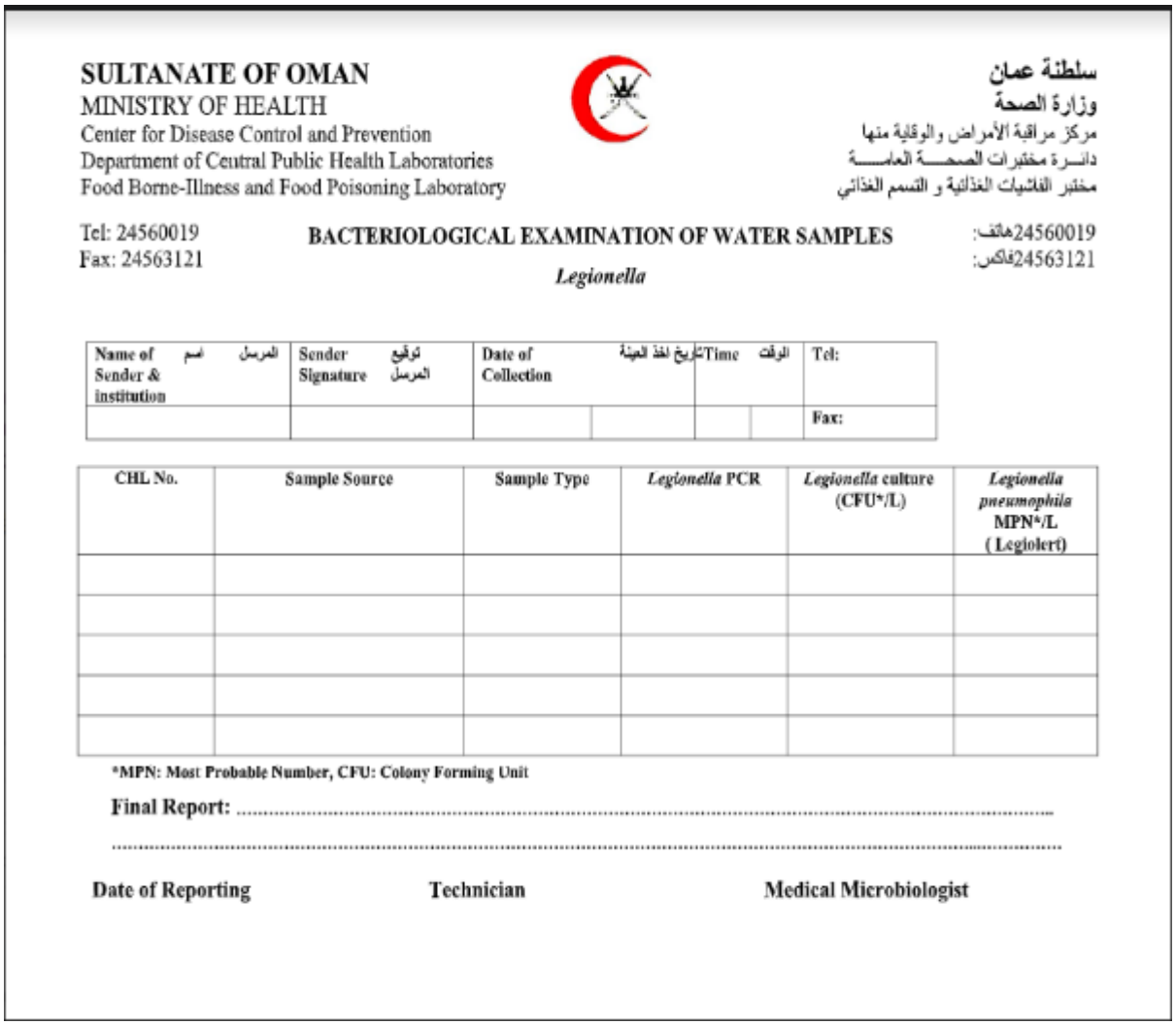
Name of Sender & institution اسم المرسل	**Sign. Sender** توقيع المرسل	**Date of Collection** تاريخ أخذ العينة	**Time** الوقت	**Sample type** نوع المياه	**Additional tests needed**	**Tel:**
						Fax:

Sender's Reference Number and description of sample رقم ومكان أخذ العينة	Lab. No. رقم المختبر	**Laboratory Report**						
		Total Aerobic Count **(CFU/100 ml)**			Most Probable No./100 ml **(MPN/100 ml)**		Others **(CFU/100 ml)**	Normal range
		22° C	**37° C**	Normal range	Coliforms	Faecal Coliforms		

- **Note: above results are per 100 ml. If CFU per ml needed, please convert above count by dividing it by 100**
- **For interpretation and action needed, please refer to the National SOP for water quality in healthcare facilities**

Date Reported Technician Medical Microbiologist

Figure-24: Bacteriological Examination form of water samples for Legionella



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سلطنة عمان
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مختبر الفاشيات الغذائية و التسمم الغذائي

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BACTERIOLOGICAL EXAMINATION OF WATER SAMPLES

Legionella

Name of Sender & institution اسم المرسل	Sender Signature توقيع المرسل	Date of Collection تاريخ اخذ العينة	Time الوقت	Tel:
				Fax:

CHL No.	Sample Source	Sample Type	*Legionella* PCR	*Legionella* culture (CFU*/L)	*Legionella pneumophila* MPN*/L (Legiolert)

*MPN: Most Probable Number, CFU: Colony Forming Unit

Final Report: .....

.....

Date of Reporting **Technician** **Medical Microbiologist**

r. Water samples must be kept in cold (approximately 4^{o}C) and in the dark by placing it in a chilly bin complete with chilled cooler pads **(**Figure-25, 26, 27). Seal the cool box with a single strip of tape and affix the return address label to the top of the box and sent immediately to the designated laboratory within 24 hours (ideally within six hours) from the time of sampling. If these conditions were not met, this will subject the samples to rejection. Note**:** cold packs should not be used for Legionella samples

s. Test for chlorine residual on site

t. Direct contact with the laboratory is essential to keep all parties aware of the sample's progress.

Figure-25: Ice pack

Figure-26: cooling box

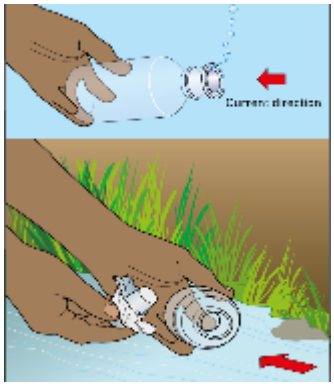
Figure-27: Water samples stored inside cool box

For Summary steps of Procedure for Sampling Water from Tap Water, check annex-2.

7.2.3.2.2 Reservoir, watercourse such as stream, river or spring

- The sample shall be representative of the water used for human consumption. It is therefore undesirable to take samples very close to the bank or too far from the point of draw off; and should not be taken from too great a depth, in a stream. Areas of stagnation should be avoided.
- Wash your hands thoroughly
- Carefully open the bottle cap, without touching the neck of the bottle, to avoid possible contamination.
- Holding the bottle by the base, submerge it to a depth of about 30 centimeters with the mouth facing slightly upwards.
- If there is a current, the bottle mouth should face towards the current.
- If no current exists as in reservoirs, one should be artificially created by pushing the bottle horizontally forward, and then the bottle is filled and immediately closed (Figure-28).
- Replace the cap or stopper carefully without touching the neck of the bottle.
- Shake, label, keep in the cool box with icepacks (except if the test is for legionella) and transport to the laboratory as soon as possible.

Figure-28: Taking a sample from a watercourse or reservoir



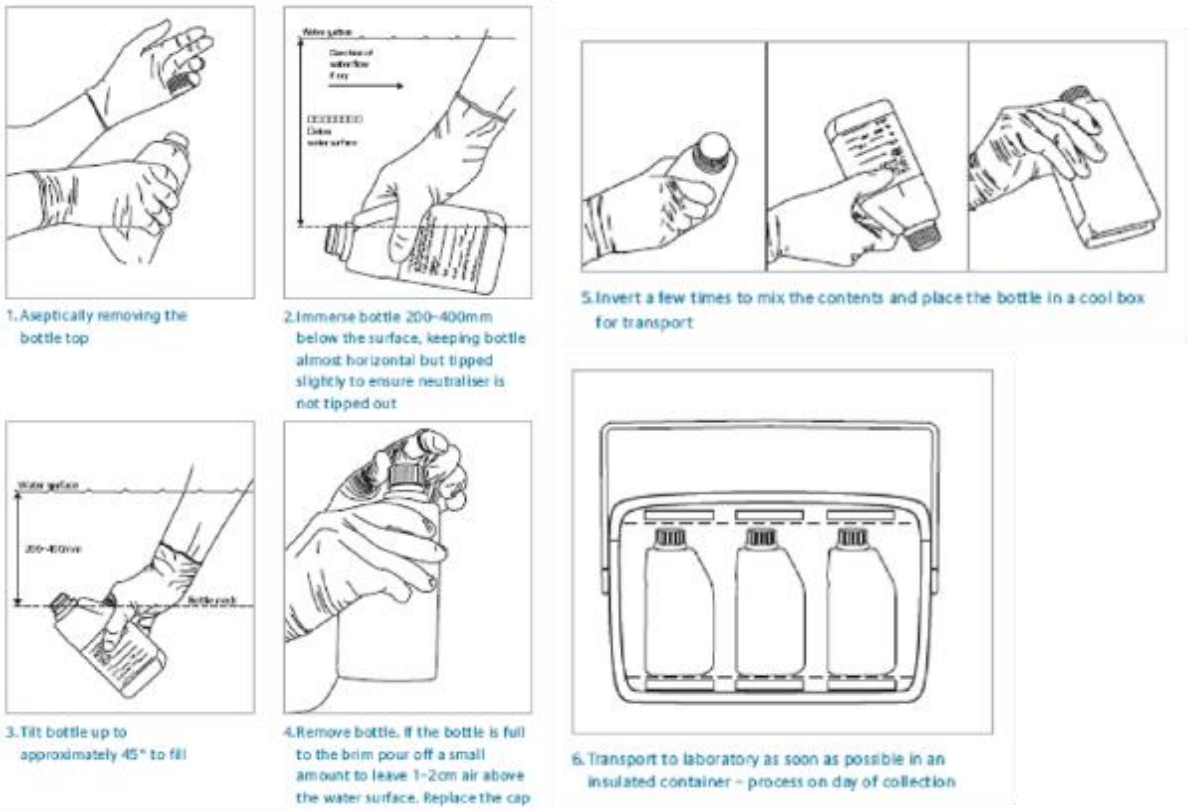
7.2.3.2.3 Swimming, spa and hydrotherapy pool

- Normally a single sample of pool water is taken.
- The most appropriate site for taking a single sample from a pool is where the water velocity is likely to be at its lowest and away from fresh water inlets or outlets. Depending on the size of the pool, it may be advisable to take samples from other sites to establish whether there are "dead spots" in the water circulation.
- During investigations of poor water quality, it is recommended that a sample is taken from the balance tank and skimmers, and that swabs are taken from inside/behind any jets and from the lid or cover for the pool if used.
- The following steps should be followed:

i. Outside shoes should be removed or plastic shoe coverings worn if entering swimming pool areas.
ii. Label with a waterproof marker or biro (indicating the location and sample details, sender's reference, sampling officer and date and time of sampling).
iii. Aseptically open the bottle.
iv. Immerse the bottle, keeping the long axis approximately horizontal but with the neck pointing slightly upwards to avoid loss of the neutralising agent (see Figure-29).
v. Once the bottle is immersed to about 200-400 mm below the surface, tilt the bottle to allow it to fill, leaving a small headspace.
vi. On removal from the water, immediately replace the cap and shake the sample to disperse the neutralizing agent.
vii. Water samples (except for Legionella samples) must be stored between 1 and 8^{o}C, and submitted to the laboratory in a timely way to ensure that they are examined on the day of collection or at least within 24 hours of the collection.
viii. If both routine testing parameters and Legionella are required, then separate 1 litre and 500 ml samples should be collected.

- It is good practice to determine total and combined disinfectant levels and pH value from the same site as the microbiological sample. These should be determined in a separate sample collected in a bottle without any neutralizing agent (e.g. a sterile plastic universal) and the tests carried out at the pool-side. These results together with information on the number of users in the pool at the time of sampling should accompany the sample to the laboratory. It is important to also note the type of disinfectant in use in the pool.

Figure-29: Illustration of how to collect a swimming /spa pool sample



Note that cold packs are not required for collection of samples for Legionella which should be stored at ambient temperature (approximately 20°C) in the dark.

7.2.3.2.4 Well with no pump:

To draw a sample from an open well, a weighted bottle or shallow sampling device may be used.

- First, with a piece of string, attach a clean and washed stone to the sterilized sampling container (Figure-30)

Figure-30: Stone attached to the bottle

- Then attach the bottle to a longer length of clean string or wire rolled around a stick and tie this onto the first piece used to attach the stone to the bottle (Figure-31). The second length may need to be several metres long, depending on the distance from the surface to the water level in the well

Figure-31: Attach string to the bottle

- Once the bottle is securely attached to the coiled string or wire, open the bottle, figure-32

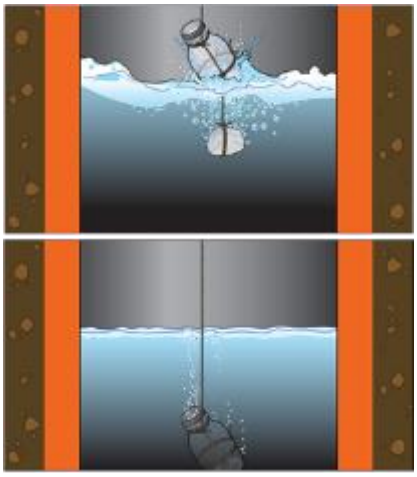
Figure-32: Open the bottle

- Lower the bottle into the well, weighted down by the stone, unwinding the string slowly. Do not allow the bottle to touch the side of the well (Figure-33).

Figure-33: Lower the bottle into the well

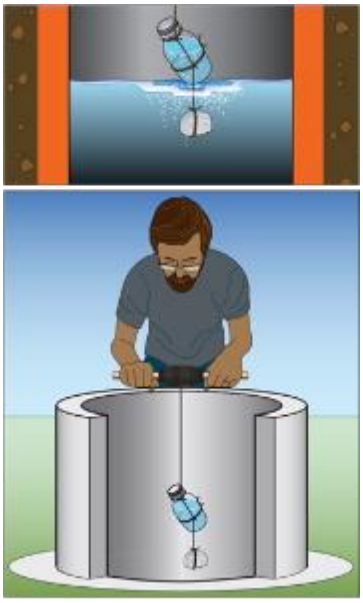
- Immerse the bottle completely in the water and lower it to the bottom of the bottom of the well (Figure-34)

Figure-34: Immerse the bottle completely



- Once the bottle is filled, rewind the string around the stick to raise the bottle (Figure-35).

Figure-35: Raise the bottle



- Replace the cap or stopper on the bottle. Process the sample in the same way you would do for a sample drawn from a tap.

7.2.3.2.5 Well fitted with a hand-pump sampling and boreholes fitted with a pump

- For wells and boreholes equipped with a pump, the pump should be operated for at least 5 minutes, depending on the depth and diameter of the borehole, to clear any standing water in a water column (Figure-36).
- Clean the pump outlet thoroughly and, using the same process described earlier, sterilize for a minute with a flame unless the spout is made from plastic in which case wipe thoroughly with a solution of hypochlorite or an alcohol wipe if no hypochlorite solution is available (Figure-37).

- Operate the pump for a further two minutes and take a sample from the flowing stream of water. To protect the container from contamination, follow the same precautionary process that you would use if drawing a sample from a tap.

Figure-36: Pump for at least five minutes

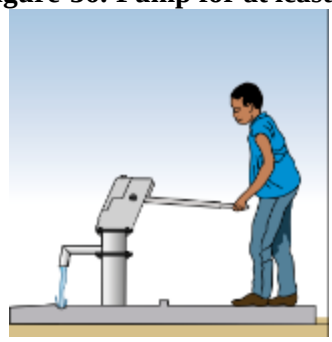
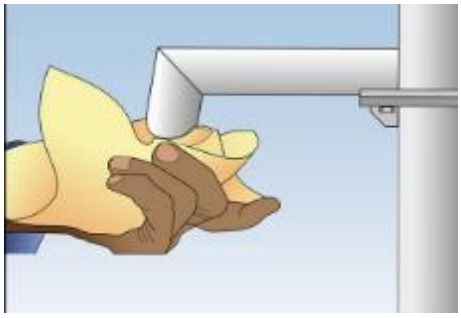


Figure-37: The disinfection procedure



7.2.3.2.6 Well fitted with a mechanical pump

- The sample shall be taken from a tap on the rising main or from a nearby tap, before the passage of water into the tank.
- The disinfection and the sampling procedure shall be carried out as before.

7.2.3.2.7 Water container

- A sample from a water carrier's pot or bucket may be more representative of what is actually being drunk, so a sample should be taken from that as well.
- If the water is stored in the house, then the household container would also need to be sampled.
- Positive results showing contamination from a sample of the household container alone would indicate poor hygiene in the home and not that the original source of the groundwater is polluted.
- If a bottle can be immersed in the container, then a sample can be taken by fully immersing the sample bottle (figure-38).

Figure-38: Immerse the bottle completely

- If this is not possible, then a quantity of water can be poured from the container into the sample bottle (Figure-39).
- In both cases, the sample bottle should be clean and sterile. Wash your hands before collecting a sample.
-

Figure-39: Sample poured into a bottle

7.2.3.2.8 Endoscopy Washer Disinfector Final Rinse Waters

- Essentially, the user should define the standard of disinfection required in consultation with the Infection Control Department. For most endoscopic procedures, Final rinse water from automated washer/disinfectors should be sterile or very nearly so.
- However, rinse water for endoscopes which enter normally sterile body cavities e.g. arthroscopies will need to be of a higher standard, so it is safest to ensure that final rinse water from automated washer-disinfectors has low microbial counts and does not present a potential hazard to the patient either through infection or by leading to an incorrect diagnosis.
- Great care is therefore needed during collection of water samples in order to ensure that contamination is not introduced.
- The exact procedure will vary from one model to another, but in general, the machine should be run on a special cycle that allows the cycle to be stopped in the rinse phase and a sample collected via a sterile sampling tube.
- If this is not feasible, use a sampling point on the machine, disinfect the sampling point with 70% alcohol and run approximately 500 ml rinse water to waste before aseptically collecting at least 100 ml (and preferably 400 ml) in a sterile container.
- The sample should be stored between 2 and 8^{o}C and processed as soon as possible.
- It is essential that microbiological results are monitored sequentially in order to identify normal variation and trends so that early action may be taken if problems arise.
- During investigations of poor results, investigate the method used for sampling and collection of water samples prior to the final treatment process (e.g. supply water and break tank water) should be considered. In addition, the efficacy of filters should be checked, if relevant and that the correct filters are properly fitted and are included in the daily self-disinfection cycle of the washer/disinfector, and that a regular schedule of maintenance and replacement of the filters is in place.
- The exact procedure will vary from one model to another, but advice should be sought from the manufacturer on the appropriate sampling procedure.
- The sample should be kept refrigerated if there is any delay before submitting to the laboratory.

- The guidance documents generally recommend weekly testing of final rinse water for Total Viable Count (TVCs and *P. aeruginosa*. However, after establishing initial guidance compliance by trend analysis of such results, it would be reasonable to consider reducing the frequency of such testing (e.g. monthly) provided no alteration has occurred to the endoscopy washer disinfector or its water supply.

7.2.3.2.9 Dental Unit Waterlines

Where monitoring of Dental Unit Water Lines (DUWL) is undertaken, the following procedure should be followed:

- Dental units have dental waterlines supplying several instrument hoses, three-in-one air/water syringes, patient cup filler and cuspidor bowl rinse outlets. All these waterlines are interconnected.
- Label sterile water bottle (usually 100 ml tubes/bottles containing neutraliser). The labelling information should contain details of each waterline to be sampled, sender's reference, person sampling, date and time of sampling.
- Purge the 3:1 air/water syringe waterline, instrument hose waterline, patient cup filler waterline (where present) and cuspidor rinse waterline (where present) outlets of the dental unit for 2 minutes before collecting water samples.
- Aseptically open the tube/bottle and collect 100 ml of water from each outlet.
- Samples of water should also be taken from independent water reservoir bottles where used.
- Store the water between 1 and 8˚C and return to the microbiology laboratory for analysis ideally within 24 hours of collection.

7.2.3.2.10 Heater cooler units

- Heater cooler units used in cardiopulmonary bypass and Extracorporeal Membrane Oxygenation (ECMO) procedures have been the focus of attention since 2015, due to an outbreak of Mycobacterium chimaera infections associated with these machines.
- Water sampling from these machines, steps are summarized below:

➢ The heater cooler machine should be connected and running for a minimum of 5 minutes before water sampling is performed.

➢ Ideally the water sampling should take place just prior to the machine undergoing its disinfection cycle.

➢ Bottles containing sodium thiosulphate should be used.

➢ Water should be sampled from both circuits i.e. the 'patient' circuit and the 'cardioplegia' circuit via the tubing systems. Ensure that sterile tubing/fittings are available for each machine being tested.

➢ A volume of 100 ml per sample is suggested if only an environmental mycobacteria test is required. However, more water volume will be required if tests for a range of different parameters are to be undertaken.

➢ If the water is not processed immediately, it should be stored between 1°C and 8°C for up to 24 hours.

7.2.3.2.11 Shower Water Samples

- If a water sample from a shower is required, then place a sterile bag over the outlet.
- Using a sterile scissors, cut a small section off the corner of the bag and collect the sample in a sampling container.
- Appropriate precautions should be taken to minimize aerosol production.
- The collected water should be processed within 2 hours. If that is not possible, then it should be refrigerated at 2-8˚C within 2 hours and processed within 24 hours.

7.2.3.2.12 Tap Swabs

- To take a swab sample, remove a sterile swab from its container and insert the tip into the nozzle of the tap (Figure-40).
- Care should be taken to ensure no other surfaces come into contact with the tip of the swab.
- Rub the swab around – that is, move it backwards and forwards and up and down, as much as possible, on the inside surface of the tap outlet or flow straightener.
- Replace the swab carefully in its container, again ensuring no other surfaces come into contact with the tip of the swab.
- Place the swab in a transport medium or maximum recovery diluent (MRD) and send to the laboratory.

Figure-40: Swabbing the Inside Surface of the Tap Outlet or Flow Straightener

7.2.3.2.13 Testing for Legionella

- During investigations, sampling must not be carried out in isolation but should be done in conjunction with a review of the risk assessment, up-to-date schematics of the water systems, and a

review of previous monitoring results (both microbiological and temperature) and a review of current control measures. Sampling must be carried out based on the perceived risk. For example, water should be sampled from the areas where *Legionella* are likely to multiply, such as the warmest parts of a cold system, the coolest parts of a hot system or areas where there is low usage/ stagnation. Where there are several floors in the building under investigation, flow and return temperatures should be taken on each floor and to and from the calorifier or other heat source.

- It is good practice to establish the water temperature at the time of sampling. This is particularly important if an investigation is being carried out to determine the source of *Legionella* in a clinical case or as part of a risk monitoring process. Hot water should reach 50°C within 1 minute at outlets, whilst cold water should be 20°C or below after running the water for two minutes. A calibrated stopwatch and calibrated probe thermometer must be used to measure the temperature of the water to ensure conformity with these SOPs. This information should be recorded along with the identity of the site and whether or not the outlet was intended to be hot or cold. For taps with a thermostatic mixer valve (TMV) it will be necessary to take the temperature of the water upstream of the TMV.
- **Safety Note:** When investigating a *Legionella* case or outbreak, it is *essential* that an assessment of risks associated with sampling is carried out in discussion with suitably experienced staff before samples are collected and that a sampling plan is drawn up in consultation with other experts e.g. site engineers, Health Safety Environment (HSE) technician & Infection Control officers
- Water sampling for *Legionella* should not be carried out in isolation but should be done in conjunction with a review of the risk assessment, up-to-date schematic of water systems and review of relevant paperwork, previous monitoring results (both microbiological and temperature controls) and a review of current control measures. Sampling must be carried out on a risk basis. For example, water should be sampled from the areas where *Legionella* are likely to multiply, such as the warmest parts of a cold system, the coolest parts of a hot system or areas where there is low usage/ stagnation. Where there are several floors in the building under investigation, flow and return temperatures should be taken on each floor and to and from the calorifier or other heat source.
- Individual staff members who may be particularly prone to an increased risk of *Legionella* infection due to underlying conditions or immunosuppression should not be involved in sampling operations. Personal Protective Equipements (PPES) and respiratory filter masks should be worn based on a risk assessment.

7.2.3.2.13.1 When to sample water outlets for Legionella

- Legionella monitoring should be carried out where there is doubt about the efficacy of the control regime or where the recommended temperatures, disinfectant concentrations or other precautions are not consistently achieved throughout the system. The Water Safety Group should use risk assessments to determine when and where to test, which may include the following circumstances:

1. When storage and distribution temperatures do not achieve those recommended and systems are treated with a biocide regime, testing should be carried out monthly, although that frequency may be altered depending on the results obtained.

2. In systems where the temperature or biocidal control regimes are not consistently achieved, weekly checks are recommended until the system is brought under control, after which the frequency of monitoring can be reviewed.

3. When a nosocomial outbreak is suspected or has been identified.

4. Where there are at-risk patients with increased susceptibility.

7.2.3.2.13.2 Where to sample water outlets for Legionella

- As a minimum, samples should be taken as follows:

- from the cold water storage and the furthermost outlet from the tank;
- from the calorifier flow, or the closest tap to the calorifier, and the furthermost tap on the hot water service circulating system;
- additional samples should be taken from the base of the calorifier where drain valves have been fitted;
- additional random pre- and post-flush samples may also be considered appropriate where systems are known to be susceptible to colonization.

7.2.3.2.13.3 How to collect water sample for Legionella testing?

Pre-flush Sample

- A pre-flush sample is water collected immediately after the tap or fitting is opened. The tap or fitting should not have previously been disinfected, or water run to waste. The pre-flush sample represents water held within the tap or fitting and ideally, should be taken when the tap has not been used for several hours.
- Note that a pre-flush sample is useful from taps, as *Legionella* may flourish in any standing water in the outlet.

Post-flush Sample

- A post-flush sample is water collected after the tap or tap fitting has been disinfected and water in the fitting has run to waste. The post-flush sample represents the quality of circulating water supplied to the tap or fitting.
- A pre-and post-flush sample should be taken at all outlets sampled.
- **Note:** Fill the bacteriological examination form of water samples for Legionella as shown in **Figure-24.**

7.2.3.2.13.4 Sample transportation and labelling for Legionella testing

- Following sampling, all water samples for *Legionella* analysis should be stored at an **ambient temperature** (approximately 20°C), in the **dark**, and be transported to the laboratory as soon as possible, preferably the **same day.**
- Additional information should be gathered to help interpret the results. At a minimum, the following information should be included on the request form:

– The site and sample point

– The sample references and date

– The reason for sampling

– The temperature of the sample source (e.g. the temperature of a hot-water system at one minute after turning on the tap and at two minutes after turning on the cold tap)

– Any biocide used

– The timing of the dosage in relation to sampling

– The concentration detected at the time of sampling

– Any other risk factors of importance (e.g. closed system opened for maintenance)

– High risk of nutrient present, such as in plastics manufacturing plants

– Any cases associated with the site.

- During the sampling all details that may help the implementation of possible remedial measures should be recorded. For example, obvious pressure and temperature drops or rises in the water circuits, the presence of iron sediment or sludge, the condition of the aerator and taps, the occurrence of scale, corrosion and the presence of various rubber and plastic attachments.

7.2.3.2.14 Testing for P. aeruginosa

- *P. aeruginosa* may be present within the water storage, distribution and delivery systems and also in the water supplied to the healthcare facility.
- The sampling protocol is intended to help healthcare providers establish whether the water in High-Risk Areas is contaminated with *P. aeruginosa* and, if it is, to help locate its origin and to monitor the efficacy of remedial measures.
- *P. aeruginosa* contamination is generally found in the last two metres of the point of water delivery; therefore, pre-flush samples should be collected to assess the highest risk to outlet users and at-risk patients.
- If P. aeruginosa has been found in a preflush sample, take a second paired set of samples (pre- and post-flush samples). A substantially higher bacterial count in the pre-flush sample, compared with the post-flush, should direct remedial measures towards the tap and associated pipework and fittings near to that outlet. A similar bacterial count in preflush and post-flush samples indicates that attention

should focus on the whole water supply, storage and distribution system. A more extensive sampling regime should be considered throughout the water distribution system, particularly if that result is obtained from a number of outlets.

- Although water sampling is the principal means of sampling, there may be occasions when water samples cannot be obtained immediately for analysis. In the event of a suspected outbreak, swabbing water outlets to obtain strains for typing may provide a means of assessing a water outlet, but this does not replace water sampling.

7.2.3.2.14.1 Where to sample water outlets for P. aeruginosa

- The water outlets to be sampled should be those that supply water which:

– has direct contact with patients;

– is used to wash staff hands; or

– is used to fill or clean equipment that will have contact with patients as determined by risk assessment.

- The water outlet must be clearly identified; system schematics indicating each numbered outlet to be sampled are helpful in this respect.
- The main strategy for sampling is to take the first sample of water (pre-flush) delivered from a tap at a time of no use (at least 2 hours or preferably longer) or, if that is not possible, during a time of its lowest usage. This will normally mean sampling in the early morning, although a variety of use patterns may need to be taken into account. A 500mL is required.
- If *P. aeruginosa* has been found in a pre-flush sample, take a second paired set of samples. The first would be a pre-flush sample as before. Then run the tap for two minutes and take a second identical post-flush sample. Bacteria in this second sample (termed post-flush) are more likely to originate further back in the water system. A substantially higher bacterial count in the pre-flush sample, compared with the post-flush, should direct remedial measures towards the tap and associated pipework and fittings near to that outlet. A similar bacterial count in pre-flush and post-flush samples indicates that attention should focus on the whole water supply, storage and distribution system. A more extensive sampling regimen should be considered throughout the water distribution system, particularly if that result is obtained from a number of outlets.
- Although water sampling is the principal means of sampling, there may be occasions when water samples cannot be obtained immediately for analysis. In the event of a suspected outbreak, swabbing water outlets to obtain strains for typing may provide a means of assessing a water outlet, but this does not replace water sampling.
- The tap should not be disinfected by heat or chemicals before sampling (pre- or post-flush) nor should it be cleaned or disinfected immediately before sampling.

7.2.3.2.14.2 When to sample water outlets for P. aeruginosa

- Sampling should be undertaken by staff trained in the appropriate technique for taking water samples including the use of aseptic technique to minimize extraneous contamination.
- The outlets identified above should be sampled to provide an initial assessment of contamination levels. There is no need to sample all taps that are due to be sampled on the same occasion; samples can be taken in batches on separate occasions. It may assist the receiving laboratory if the sampling schedule is agreed beforehand.

7.2.3.2.14.3 How to collect water sample for Pseudomonas aeruginosa testing in High Risk Areas and healthcare settings

- Label a sterile collection container (200-1000 mL volume) containing neutralizer. The labelling information should contain details of the tap location, hot/cold/blended outlet, sender's reference, pre- or post-flush, person sampling, date and time of sampling.

Pre-flush sample

- Take the pre-flush sample from a tap at a time of no use (at least 2 hours or preferably longer) or, if that is not possible, during a time of its lowest usage. This will normally mean sampling in the early morning, although a variety of use patterns may need to be taken into account. Water outlets can give very different results and may be negative if water from the tap has been used before a sample is collected.
- The tap should not be disinfected by heat or chemicals before pre-flush sampling nor should it be deliberately cleaned or disinfected immediately before sampling.
- Ensure samples are taken aseptically using clean hands or sterile gloves and that no contamination from the outer surface of the tap reaches the sample. Aseptically (that is, without touching the screw thread, inside the cap or inside of the collection bottle) collect at least 200mL water in a sterile collection bottle containing neutraliser. Replace the cap and invert or shake to mix the neutraliser with the collected water.
- For separate hot- and cold-water outlets, each outlet is individually tested with its own collection bottle and outlet identifier.
- For blended outlets (that is, where both hot and cold water come out of the same outlet):

– sample water with the mixing tap set to the fully cold position using an individual collection bottle and outlet identifier, and note the temperature setting

– sample the blended outlet set to the maximum available hot water temperature using an individual collection bottle and outlet identifier, and note the temperature setting

Post-flush sample

- Where this is required, allow the water to flow from the tap for 2 minutes before collecting at least 200 mL water in a sterile collection vessel with neutraliser.
- Replace the cap and invert to shake to mix the neutraliser with the collected water. This sample, when taken together with the pre-flush sample, will indicate whether the tap outlet and its associated components are contaminated or if the contamination is remote from the point of delivery.

7.2.3.2.14.4 Sample transportation and labelling for P. aeruginosa testing

- The labelling information should contain details of the tap location, sender's reference, the type of samples (pre- or post-flush), outlet such that the outlet can be clearly identified; person sampling, date and time of sampling.

7.2.4 Sample Storage and Transportation Requirements of Bacteriological Test Samples

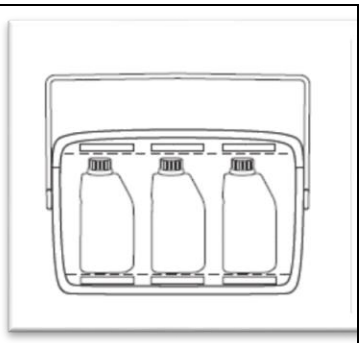
- Sample bottles should be kept in a clean environment, away from dust, dirt, fumes and grime.
- Bottles must be stored in clean shipping containers (cool box) both before and after the collection of the sample.
- Bottle should be kept clean, closed until is to be filled.
- Vehicle cleanliness is an important factor in eliminating contamination problems.
- Samples must never be permitted to get warm and should be stored in a cool, dark place.
- Samples must be cooled to 4 to 10°C using adequate amount of ice packed in leak-proof containers and shipped in insulated boxes/coolers accompanied with a report including all the relevant points.
- Although samples must be cool, it is important to ensure that samples for microbiological testing do not freeze during shipment.
- Samples should be transported to the laboratory without delay.
- Samples should be kept cool (refrigerated) if immediate shipping is not possible.
- The sample container should be sealed for transportation. Doing so will help make obvious any evidence of tampering. This may simply involve the use of a label or similar item that must be torn to open the cool box.

7.2.4.1 Packing Water Bottles Inside a Cool Box

Table-6 summarizes all steps for packing water bottles inside a cool box

Table-6: summary of all steps for packing water bottles inside a coolbox

SN	Steps	Figures
1.	Good quality cool box that is expected to hold a temperature of between 5^{o}C and 15^{o}C for a minimum of 24hrs.	
2.	Insert frozen (minimum -18 ˚C for 24hr) cold pack(s) to cover the base and sides of the cool box. A minimum of 10% of the total cool box volume of frozen cold packs that have been frozen at -18^{o}C for a minimum of 24 hours e.g. 6 x 500 ml cold packs (or equivalent) in a 30 liter box.	
3.	Ensure that the samples are not in direct contact with the cold packs by placing a separating (non-insulating) layer over the cold pack(s). Use of sample separators is recommended to prevent direct contact of the samples with the frozen cold packs and facilitate air circulation inside the cool box. Alternatively cover the ice packs with a non-insulating layer before adding samples.	
4.	Place the samples inside the cool box to allow adequate air circulation between samples. Do not over load the cool box. You can place the filled and labeled bottle in a wire rack in the cool box.	**Racks can be used for water bottles in the cool box** 
5.	The cold packs must be evenly distributed within the cool box to achieve the necessary cooling of samples. Add the remaining frozen cold packs over the top of this layer.	**Evenly distribute icepacks inside the cool box**

		
6.	Securely close the cool box with a single strip of tape and affix the return address label to the top of the box	
7.	Place sample paperwork (request forms complete with sample details) along with the cool box cool box	
8.	**Special Considerations** • Legionella water samples should be transported at ambient temperature and protected from daylight. Cold packs should not be placed in the box. • Water samples must be transported in a separate cool box to food and environmental samples.	

7.2.4.2 Cool Box and Icepacks Cleaning & Disinfection

- It is the responsibility of the person collecting the samples to ensure that the cool box and ice packs are clean prior to use.
- Cool box and ice packs cleanliness is an important factor in eliminating contamination problems.
- Cool box should be cleaned and disinfected before, after every use and when needed.
- An approved disinfectant need to be used to disinfect the cool box and ice packs.
- The collector should ensure that cool box and ice packs is clean and free from any obvious dirt before each use.
- It should be stored in a clean place away from sun exposure or extreme heat.
- When cleaning and disinfecting the cool box start from inside, cover the entire inner surface and then move outside. All corners and grooves must be covered.
- A cool box with cracks, fissures or any other obvious damage must not be used for water samples storing or/and transportation. These conditions might affect the integrity of the item thus subject the samples to falls results.

7.2.5 Sample Labeling

- Accurate and complete labeling of samples ensures that the sample's identity is maintained. This is very important for sample tracking and data interpretation and is mandatory for sample data reporting.

- It is advisable to pre-label all sample containers prior to taking the sample or to label each container immediately after the sample is taken to prevent confusion and incorrect labeling.
- Permanent marker or pen should be used and the material from which the label is comprised should be able to withstand water.
- Sample containers may have labels affixed to the container itself; alternatively, the label or sample tag may be provided separately and attached to the container after the sample is collected.

7.2.4.1 Important sample Information

The following information should ideally be known for water samples:

1) Name and address of authority requesting the examination.
2) Name and address of the person who draw the sample.
3) Date and time of collecting the sample.
4) Reasons for examination and whether it is a routine examination or otherwise.
5) Source of water (well, spring, stream, public supply system, tap water, well, wadis, falaj... etc.).
6) Exact location where sample is taken from should be clearly written on the containers e.g. ABC hospital/Female surgical ward/water cooler A or, RDU-Saeb/Hall 2/Bed 1
7) The method of purification and sterilization used, if any (give details of dose of chemicals, point of treatment, quantity treated... etc.).
8) Temperature of sample when drawn.
9) Weather conditions at the time of sample collection.
10) If the sample is taken from a well the following additional information shall be mentioned:

a) Depth of well, and level of water from ground surface.
b) Whether the well is covered or uncovered, and type, and construction of cover if any.
c) Whether, the well is newly constructed and if there are any recent alterations which might affect the condition of water.
d) Type of construction and type of protective material circulating the well.
e) Proximity of drains, cesspools or other possible sources of pollution, and their position with respect to the well.
f) Whether the well is fitted with a pump; if so (manual or mechanical)

11) If the sample is taken from a spring, it shall be stated whether the sample is directly from the spring or from a collecting chamber.
12) If the sample is taken from a stream or wadi the following additional information shall be mentioned:

a) The depth at which the sample is taken.
b) The place from which the sample is taken (middle or side).

c) Level of water (above or below the average).

d) Weather conditions at the time of sampling, and whether floods or heavy rains have lately occurred.

e) Proximity of any possible source of pollution and its position with respect to the spring or wadi.

7.2.6 Health and safety considerations during water collection

Collection of water in the community can occur in different location like wadis, falages, wells, water tanks etc. Collection of water samples in hospitals and healthcare institutions may occur in a variety of locations, e.g. wards, operating theatres, equipment decontamination and preparation areas, plant rooms or cooling towers. Each location and reason for sampling will be associated with its own risks. It is important to make an assessment of these risks and put appropriate control measures in place before any sampling is carried out. Examples of hazards include:

- Wet floors that present a slip hazard when sampling from swimming and hydrotherapy pools or from kitchen areas
- Working at heights when ladders/steps are required to reach sampling points
- Manual handling when carrying large amounts of sampling equipment to and from the site of sampling. Fully loaded cool boxes present a potential manual handling hazard and it is recommended that those involved in sampling and transport receive manual handling training. Cool boxes must not be over loaded and it is recommended that a maximum full weight of 15 kg be observed.
- Working in confined spaces when sampling from difficult-to-reach parts of water systems
- Exposure to aerosols when sampling from cooling towers and showers. Appropriate precautions should be taken to minimize aerosol production. For example, running taps gently to reduce splashing; using a sterile plastic bag with one corner cut off to enclose the shower head and to funnel the water into a sampling container; and sampling cooling towers from sampling points on the return service of the cooling water to the tower, rather than the tower itself.
- Lone working in isolated areas such as plant rooms.

7.2.7 Interpretation of Results

The following section elaborates on the Characteristics of Drinking Water &Interpretation of Drinking Water Laboratory Results for both physico-chemical and microbiological tests.

7.2.6.1 Physico-Chemical Characteristics of Drinking Water

- The water shall be aesthetically acceptable to consumers.
- The Drinking water shall not contain any substances that affect its color odor or taste. Unusual taste and color might be an indication of potential contamination.

- It shall be completely free from foreign substances or impurities, which can be seen with the naked eye whether such earth, sand, hair or other impurities.
- The maximum allowable limits of physical and chemical parameters of drinking water should comply with the Omani standard for Un-Bottled Drinking Water.
- Table -7 shows various phyisco-chemical parameters and some examples on how to interpret value of chemical for drinking water if exceeded the allowable level and remedies.

Table-7: Various Parameters quality levels

Substances or characteristics	Quality level	Maximum level	Unit	What it means	Remedies
a) Organoleptic parameter					
Colour	None	<15	True colour unit	Some waters are slightly yellow. This can be due to decaying plant matter or from the presence of iron and/or manganese. The color itself is not a health risk but can interfere with disinfection systems.	Activated carbon filter for decaying plant matter. Iron and manganese removal usually requires some form of pH adjustment followed by filtration.
Turbidity	1	<5	Nephelometric turbidity unit	This is a measure of the cloudiness of the water, mainly particles in it that are too small to settle out. Disinfection treatment does not work properly in turbid waters, including UV and chlorination.	Simple filtration. Protect the source from pollution to stop the particles getting into the water.
Taste	Not offensive	Acceptable		Any noticeable odour indicates a problem with the supply. This may be due to pollution or stagnation, which	Protect the source. Aeration. Activated Carbon Filter.

				sometimes produces a smell of hydrogen sulphide (bad eggs). Odor is not by itself a health problem.	If the problem is severe an expert may be needed
Odour	Not offensive	Acceptable		This is highly subjective and not necessarily a health issue. If you find it is unacceptable, treatment may be required. This test will only be carried out on samples known to be of good bacterial quality.	Protect the source. Activated Carbon Filter will normally remove bad tastes.
Temperature	Not offensive	Acceptable			
Conductivity				This is a measure of the general amount of mineral salts dissolved in the water.	pH balance, fine filtration or reverse osmosis.
b) Inorganic constituents					
Ammonia*	-	1.5	mg/L	Ammonia is formed in rotting material and shows that the water is stagnant or contaminated by faces or fertilizers. It can interfere with disinfection processes and gives the water a strange taste and smell. In the absence of bacterial contamination, it poses no health threat.	Protect the source. Cation exchange filtration.
Chloride (not done for routine drinking water test in CPHL)	≤ 250	600	mg/L		

Sodium (not done for routine drinking water test in CPHL)	≤ 200	400	mg/L		
Sulphate(not done for routine drinking water test in CPHL)	≤ 250	400	mg/L		
Total hardness	≤ 200	500	mg/L	This is the amount of dissolved calcium and magnesium. There is evidence that soft water (low hardness) is associated with an increased risk of cardiovascular disease.	It is best not to drink water that has been through a softener, particularly if you are on a low sodium diet.
Total dissolved solids	120-600	1000	mg/L		
Nitrate (as NO_3)		50	mg/L	These get into the water as a result of the application of chemical or natural fertilizers. They can cause the disease methaemoglobinaemia in babies under three months old.	Protect the source. Anion exchange. Reverse osmosis.
Nitrate (as No2)		3 Short-term exposure			
		0.2 long-term exposure			
Hydrogen sulphide	≤ 0.05	0.1	mg/L		
pH	6.5-8 for natural water 6.5 – 8.5 for desalinated water	9		pH is a measure of the natural acidity of the water. pH 7.0 is neutral. pH values less than 7.0 are acid and can lead to corrosion of pipe	A treatment unit can be fitted to "balance" the pH and bring it back to neutral. Most often this

				work, pH values greater than 7.0 are alkaline.	will be to make it less acid.
Fluoride (not done for routine drinking water test in CPHL)	Quality Level 0.6 – 0.8 as for desalinated water	1.5	mg/L		
Magnesium (not done for routine drinking water test in CPHL)		30 if sulphites ≤250	mg/L		
		150 if sulphites < 250	mg/L		
Total alkalinity			mg/L of sodium carbonate	There is a distinction between "alkaline" and "alkalinity". "Alkaline" means that the water has a pH greater than 7.0 but acid water may still have a measurable "alkalinity" measured by its carbonate content. It is only a problem if it is too low as sometimes happens in softened water.	If the water has been softened, it may need mixing with normal water or re-mineralizing.
Calcium		200	mg/L	Too much calcium can lead to furring of service pipes, kettles, etc.	Soften the water to protect fittings. Try to drink water that has not been softened.
Total iron		1	mg/L	High iron levels can be found naturally but can also be a sign of corrosion, particularly in iron pipes. In mains water iron comes primarily from the corrosion of iron mains pipes. It is	Iron/manganese filtration.

				not a health hazard. Dissolved iron will precipitate as a brown solid on exposure to air. It may make the water taste bitter and may cause staining of clothes and sanitary fittings.	
Manganese (not done for routine drinking water test in CPHL)		0.4	mg/L		
Copper (not done for routine drinking water test in CPHL)		2	mg/L	Copper is rarely present. It can, however, be leached from copper pipes or brass fittings. In high concentrations, it can stain clothes and give a taste and a surface film to the water.	Replace pipes with plastic. Make the supply less acid. Cation exchange filtration.
Lead (not done for routine drinking water test in CPHL)		0.01	mg/L	Lead in drinking water is usually caused by leaching of lead from lead pipes (rare) or from lead-based soldered joints. Lead is a serious health risk in water and action should be taken to make sure it is not present.	Replace lead pipe work. Cation exchange filtration.
Arsenic (not done for routine drinking water test in CPHL)		0.01	mg/L		
Chlorine		5 For effective disinfection, there should	mg/L		

		be a residual concentration of free chlorine of >0.5 mg/litre after at least 30 min. contact time at pH			

7.2.6.1.1 Total Residual Chlorine in drinking water

- Total residual chlorine concentration in drinking water shall be sufficient to kill all microbes therein, provided that the chlorine concentration shall range between 0.2mg/L and 0.5mg/L.
- Concentration of chlorine shall be increased in case of epidemics up to not exceed 5.0mg/L.

7.2.6.1.2 Inter-relationships of Different Variables

When testing water quality in an ambient sample, there is a wide array of potential assays from which to choose, and many provide the same information. In other situations, in order to fully understand the significance of one variable, it may be necessary to test a variety of variables this can maximize the interpretation of the data. The following section will describe several of these variables as shown in table-8.

Table-8: Summary of inter-relationships of some key variables

Variable (s)	Second Variable (s)	Relationship
Specific Conductivity (SC)	Dissolved Solids (TDS)	TDS is the sum of constituents such as chloride, sulphate, etc. Both specific conductivity and dissolved solids provide a measure of the contribution of different salts that may be present in the sample; this may include *potassium*, *sodium*, *chloride*, *sulphate* and others. SC and TDS are usually related for each water body.
Turbidity	Suspended Solids (TSS)	Turbidity is a measure of the light penetration in the sample. The turbidity of the sample depends on the size and distribution of the suspended solids in a sample. Turbidity and specific conductivity can provide estimates of the amounts of suspended or dissolved solids that may be present.

Temperature	Dissolved Oxygen	The amount of oxygen in water increases with cooler temperatures.
pH and Temperature	Ammonia	The toxicity of ammonia in water increases with higher pH and temperatures. Therefore these variables must be measured and recorded.
Chloride	Nitrite	The toxicity of nitrite in water decreases with increased concentrations of chloride
Hardness	Alkalinity	Alkalinity and hardness often have similar concentrations in water
Hardness, Dissolved Organic Carbon (DOC)	Metals	The toxicity of some metals (e.g.,copper, zinc) decreases with increasing hardness and DOC

7.2.6.2 Biological Characteristics of Drinking Water According to The Omani Standard of Un-Bottled Water

- It is important that drinking water is monitored for the presence of faecal contamination which is the main source of water borne disease. Biological Characteristics of drinking water according to the Omani standard of un-bottled water is shown in table-9.

Table-9: Biological Characteristics of drinking water according to the Omani standard of un-bottled water

Biological Characteristics	Drinking water shall be completely free from algae, molds, parasites, insects, and their eggs, larvae, vesicles, parts and free from protozoa.
Microbiological Characteristics	Un-bottled drinking water shall be completely free from pathogenic and faecal microbes and viruses which may be hazardous to public health.
Treated Water Entering the Distribution System	It shall be free from coli-form bacteria and E.coli bacteria in any 100ml examined sample.
Treated Water in the Distribution System	It shall be free from E.coli bacteria in any 100ml examined sample. It shall be free from coliform bacteria in any 100 ml of examined sample, in 95% of the samples examined throughout the year, in the case of large supplies when sufficient samples are examined.

Untreated Underground Water	It shall be free from E.coli bacteria in any 100ml examined sample. Coliform shall be not exceed 10 colonies/ 100ml of examined sample provided that it does not occur repeatedly.
Water Distributed by Tanker Vehicles (Un-piped Water Supplies)	It shall be free from E.coli bacteria in any 100 ml examined sample. Coliform shall not exceed 3 colonies / 100ml of examined sample but not in two consecutive occasions.

- Interpretation of the microbial test results can be done using tables-10

Table-10: Microbiological parameters maximum concentration values & their remedies

Parameter	Prescribed Concentration or Value (maximum unless otherwise stated)	What it means	Remedies
Total coliforms	0/100 ml	These consist of a range of similar organisms that may, but do not always, mean there are faeces in the water. Their presence indicates that the water is polluted. It may also be a health risk.	Protect the source. Install disinfection such as ultra violet, chlorination or reverse osmosis, etc.
Faecal coliforms	0/100 ml	These mean that the water is contaminated with faecal matter and that there is a risk of other, even more dangerous bacteria, viruses and parasites in the water. Water contaminated with faecal coliforms is a health risk. Faecal matter might not be of human origin.	Protect the source. Install disinfection such as ultra violet, chlorination or reverse osmosis, etc.
Colony Count under certain circumstances based on risk assessment	No significant increase over that normally observed.	A general indication of the bacteria levels in the water. It therefore shows the hygienic quality of the supply. In practice, changes in colony count are more important than the actual numbers as different supplies have different background levels. If the normal numbers go up, this	Investigate the source. Protection and treatment system if the count goes up – particularly if this happens after heavy rain.

(Not done routinely at CPHL **Not in Omani standards or WHO recommendations)**		indicates that something may be wrong and should be investigated.	

7.2.6.2.1 Microbiological Parameters

- The microbiological examination of water from the healthcare facility environment is necessary both in the routine monitoring of decontamination procedures and in the investigation of contamination incidents and outbreaks of healthcare associated infection.
- For example, regular monitoring of the microbiological quality of renal dialysis water, hydrotherapy water and endoscopy rinse water plays an important role in protecting patients from exposure to potentially infectious waterborne microorganisms.
- Similarly, microbiological testing of the water system at defined intervals for Legionella species helps to ensure that healthcare facilities' water system is well controlled and that water used for the care and management of patients does not pose a risk to those patients and/or staff.
- Monitoring of water supplying High Risk Areas for Pseudomonas aeruginosa may be required based on risk assessment.
- Patients and staff of the healthcare facility may also be exposed to potential infectious risks from drinking water which should be examined for potable quality.
- In recent years drinking water in many healthcare facilities is provided by way of bottled water, dispensers or cooled/chilled and/or filtered water supplied with mains water. Concerns have been raised over the quality of water from water dispensers, coolers and filtered water units due to their potential to transmit infection, especially to immune-compromised individuals. Water dispensers, water coolers and filtered water units can themselves act as reservoirs of contamination of output water intended for human consumption if the equipment is not well maintained and subjected to regular planned preventative cleaning and maintenance. Consideration should also be given to the frequency of their use and location. Poorly maintained and infrequently used water dispensers, water coolers and filtered water units maybe particularly problematic due to water stagnation and environmental heat gain depending on their physical location. Their unit taps and associated pipe work are frequently manufactured from plastic materials, which are particularly prone to microbial biofilm contamination. These units and the water they provide should be subject to periodic microbiological testing to ensure good water quality.

- All water and water systems in healthcare facilities should be risk-assessed according to their intended use and patient immune status taking into account any identified inherent hazards within the facility and the quality of the water supply to the systems being assessed. The assessment of risk should take account of the most vulnerable population likely to be exposed to each potential source.
- Where there are taste or odour problems, microbiological monitoring for total viable counts (TVCs) may be considered necessary.
- If performed, TVCs may be used to analyse trends. Counts taken before and after disinfection (samples at least 48 hours post-disinfection) can give an indication of the efficacy of a disinfection procedure.
- The following tables show the testing requirements, interpretation of results for different types of water used at healthcare setting. If any further tests required based on special circumstances e.g outbreak, the end user to communicate with the testing facility before sending the samples. The request for such special requirement to be put clear in the request form.

7.2.6.2.2 Hot and cold water systems in hospital setting

Table-11 highlight testing requirement, interpretation of results and action for hot and cold water systems in hospital setting.

Table 11: Testing requirement, interpretation of results and action for hot and cold water systems in hospital setting

Hazard / Hygiene Indicator	Timing / Frequency of Testing	Result	Interpretation	Action
Legionella	As indicated by risk assessment	≥1000 cfu/l	Unsatisfactory	The system should be re-sampled and an immediate review of the control measures and risk assessment carried out to identify any remedial actions, including possible disinfection of the system. Retesting should take place three days following systemic chemical or thermal disinfection and at frequent intervals thereafter until a satisfactory level of control is achieved as agreed by the WSG.
		≥100 - <1000 cfu/l	Undesirable	(a) If only one or two samples are positive, system should be re-sampled. If a similar count is found again, a review of the control

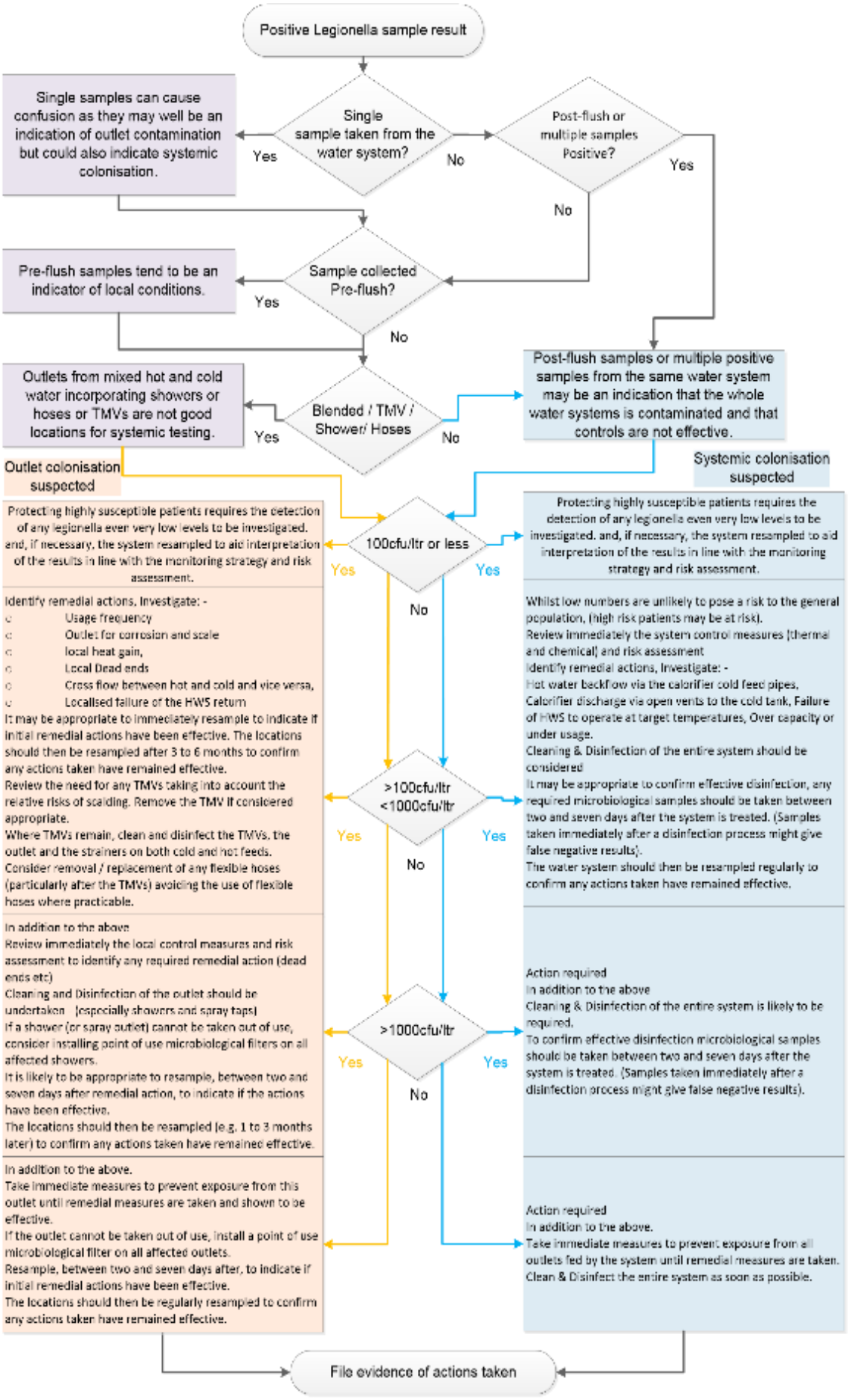
				measures and risk assessment should be carried out to identify any remedial actions (b) If the majority of samples are positive, the system may be colonized, albeit at a low level, with legionella. Disinfection of the system should be considered but an immediate review of control measures and risk assessment should be carried out to identify any other remedial action required.
		<100 cfu/l	Satisfactory	No action; system under control
*Pseudomonas aeruginosa**	In augmented care wards, as indicated by risk assessment (sample to be collected without pre-flushing)	>10 in 100 ml	Unsatisfactory	Investigate cause and put corrective actions in place. Re-sample after 3 weeks.
		1-10 in 100 ml	Undesirable	Re-test and refer back to those responsible for the Water Safety Plan to determine what actions may be needed.
		0 in 100 ml	Satisfactory	No action needed, system under control

*Investigation of water supplies for other *Pseudomonas* species may be required during outbreak investigations.

7.2.6.2.2.1 Interpretation and Action Following Legionella Sampling in Hot and Cold Water Systems

- Examples of action following Legionella sampling in hot and cold water systems is given in the figure-41.

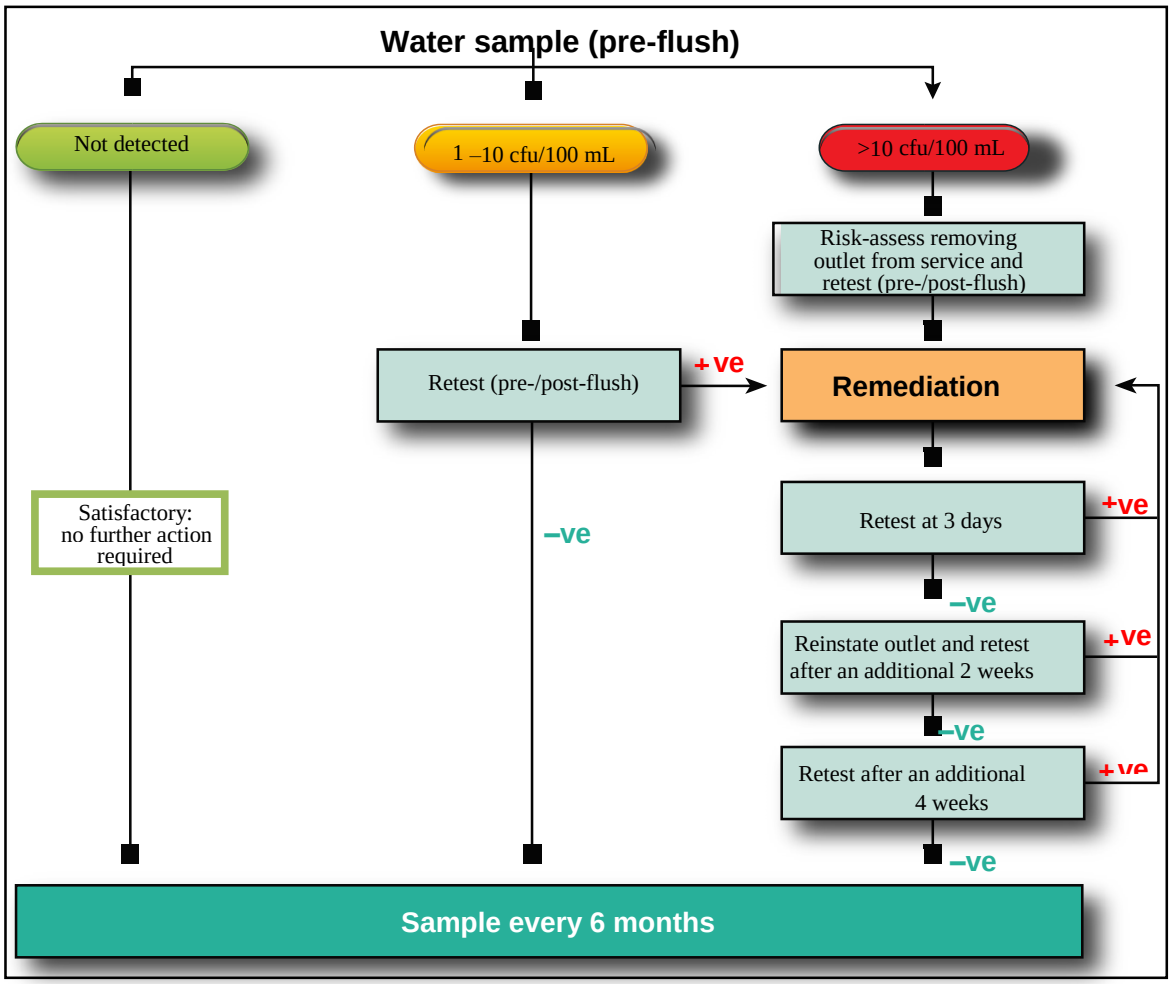
Figure-41: Example of action levels following Legionella sampling in hot and cold water systems



7.2.6.2.2.2 Interpretation and Action Following P. Aeruginosa Sampling

- It is recommended that water outlets in High Risk Areas are tested every 6 months as indicated by risk assessment and more frequently if results prove to be unsatisfactory.
- If test results are satisfactory (not detected), there is no need to repeat sampling for a period of six months unless there are changes in the water distribution and delivery systems components or system configuration (for example, refurbishments that could lead to the creation of dead-legs) or occupancy.
- In addition, the group responsible for water safety in the institution could indicate that water sampling is required within six months if there are clinical evidence-based suspicions that the water may be a source of patient colonization or infection with *P. aeruginosa (*or other potentially waterborne pathogens).
- If tests show counts of 1 to 10 cfu/100 mL, the WSG should risk-assess the use of water while simultaneously retesting the water outlet.
- If test results are not satisfactory (>10 cfu/100 mL), further sampling along with an engineering survey of the water system could be used to identify problem areas and modifications that may be implemented to improve water quality.
- After such interventions, the water should be resampled.
- Figure-42 gives an example of sampling frequencies. Sampling may be undertaken more frequently according to the risk assessment.

Figure-42: Summary of suggested water sampling and testing frequencies



- High counts in pre-flush samples but with low counts or none detected at post-flush could indicate that areas/fittings at or near the outlets are the source of contamination.
- A few positive outlets, where the majority of outlets are negative, would also indicate that the source of contamination is at or close to the outlet.
- If both pre- and post-flush samples from a particular outlet are >100 cfu/100 mL and other nearby outlets have no or low counts, this shows that the single outlet is heavily contaminated, despite the high post-flush count. This could be explored by testing dilutions of pre- and post-flush water samples from this outlet or by using an extended flush such as for five minutes prior to post-flush sampling or by taking a post-flush sample after disinfection of the outlet as occurs with *Legionella* post-flush sampling.
- If the sampling indicates that the water services are the problem, then most outlets would possibly be positive and other points in the water system could then be sampled to assess the extent of the problem (see Table-12).

Table-12: Interpretation of pre- and post-flush counts

High P. aeruginosa pre-flush count (>10 cfu/100 mL) and low post-flush count (<10 cfu/100 mL)	Suggestive of a local water outlet problem
High P. aeruginosa pre-flush count (>10 cfu/100 mL) and high post-flush count (>10 cfu/100 mL)	Suggestive of a problem not related to a local water outlet but to a wider problem within the water supply system

7.2.6.2.3 Endoscopy Water Quality Monitoring in Hospital Setting

7.2.6.2.3.1 Endoscopy bacteriological Water Quality:

- Conduct bacteriological testing at least monthly.
- Should be free from Coliform, Pseudomonas, and organisms subject for risk assessment e.g. Legionella and Mycobacteria (see table-13).

Table-13: summarize the normal value of the endoscopy water

Water type	Normal value
Tap Water supply	≤ 100 cfu/ml
Final rinse water from Automated Endoscopy Reprocessor (AER)	≤ 10 cfu/ml

7.2.6.2.3.2 Endoscopy chemical Water Quality:

The following tables-14&15 summarizes the categories and recommended levels of water quality for medical device reprocessing and the details of the required different tests.

Table-14: Summary of the categories and recommended levels of water quality for medical device reprocessing

Type of Water		**Utility Water**		**Critical Water**
Water Use		**Flushing/Washing/Rinsing**		**Final Rinse/Steam**
Specifications:				
	Units			
Hardness	mg/L	< 150		< 1
Conductivity (mg/L = ppm)	S/cm	< 500		< 10
pH		6 – 9		5 – 7
Chlorides	mg/L	< 250		< 1
Bacteria	cfu/mL	n/a	< 10	<10
Endotoxin	EU/mL	n/a	< 10	<20

Source: AAMI TIR34: 2014/(R)201

Table-15: Summary of the required type of test, sample site, frequency and personnel for endoscopy

Characteristic	Type of testing	Sample site	Samples taken and analyzed by	Suggested frequency of testing
Bacteria	Heterotrophic plate count [1)]	Reprocessing area, storage tanks (if used), immediately downstream of water treatment process	Maintenance personnel	Monthly
Endotoxins	LAL test	Reprocessing area, storage tanks (if used), immediately downstream of water treatment process	Maintenance personnel	On installation, modification, or repair of the Critical Water treatment system or when persistent increased microbial levels are detected by heterotrophic plate count, ATP, or TOC
Total organic carbon	TOC test	Reprocessing area	Maintenance personnel	Monthly or quarterly
pH	pH meter Colorimetric dipsticks	Reprocessing area Reprocessing area	Maintenance personnel/ Reprocessing personnel	Monthly Monthly
Water hardness	Determination of ppm $CaCO_3$ Colorimetric dipsticks	All main water feedlines into the facility Reprocessing area	Maintenance personnel/ Reprocessing personnel	Annually [2)] Annually [2)]

Resistivity meter	Resistometer	Reprocessing area, storage tanks (if used), immediately downstream of water treatment process	Maintenance personnel (reprocessing personnel if point-of-use water treatment is used)	Monthly
Ionic contaminants	Specific tests for chloride, iron, copper, manganese	All main water feedlines into the facility	Maintenance personnel	Annually [2)]
Color and turbidity	Visual inspection	Reprocessing area, storage tanks (if used), immediately downstream of water treatment process	Maintenance personnel and reprocessing personnel	Daily

Source: AAMI TIR34: 2014/(R)2017

NOTE 1—The specifications presented in this table should be tested to the parameters specified in Table-14, where applicable.
NOTE 2—This characteristic should initially be monitored quarterly for one year or until there are four consecutive quarters with no out-of-specification readings. Monitoring should be conducted annually thereafter or as appropriate based on the assessment of the previous year's validation.
NOTE 3—The recommendations for frequency of testing in this table are the recommended minimum frequency. If problems or issues arise with the water quality, it might be necessary to increase the frequency until they are resolved.

The following table summarizes the categories and PQ Levels of Water Quality for Medical Device Processing

Table-16: summary of the categories and PQ Levels of Water Quality for Medical Device Processing

Water quality measurement	Units	Utility water	Critical water	Steam*
pH @ 25 °C:	pH	6.5–9.5	5.0–7.5	5.0– 9.2†
Conductivity	µSiemens/cm	<500	<10	<10
Total alkalinity	mg $CaCO_3$/L	<400	<8	<8
Hydroxide alkalinity	mg $CaCO_3$/L	<40	<1	<1
Carbonate alkalinity	mg $CaCO_3$/L	<400	<8	<8
Bicarbonate alkalinity	mg $CaCO_3$/L	<400	<8	<8
Chloride	mg/L	<250	<1	<1
Nitrate	mg/L	<10	<1	<1
Phosphate	mg/L	<5	<1	<1
Sulfate	mg/L	<150	<1	<1
Silicate	mg/L	<50	<1	<1
Iron	mg/L	<0.1	<0.1	<0.1
Copper	mg/L	<0.1	<0.1	<0.1
Manganese	mg/L	<0.1	<0.1	<0.1
Aluminum	mg/L	<0.1	<0.1	<0.1
Zinc	mg/L	<0.1	<0.1	<0.1
Total Hardness	mg $CaCO_3$/L	<150‡	<1	<1
Bacteria	cfu/mL	N/A§	<10	N/A
Endotoxin	EU/mL	N/A§	<10	N/A
TOC	mg/L	N/A	<1.0	N/A
Colour and turbidity	Visual	Colourless, Clear, no residues	Colourless, clear, without sediment	Colourless, clear, without sediment

Source: *ANSI/AAMI ST108.*

** Values for steam condensate utilizing critical water as feed water. Values will be different for house steam utilizing utility water as feed water.*

† For boiler-treated steam, most boilers should be treated to maintain a pH of 7.5 to 9.2.

‡ If hardness is greater than 150 mg/L, a water softener should be used unless used for washing where the cleaning chemistry is capable of handling higher levels of hardness.

§ Unless used after chemical HLD as a final rinse, then bacteria should be <10 CFU/mL and Endotoxin should be <20 EU/mL

7.2.6.2.4 Dental unit water lines in hospital setting

Table-17 summarizes the testing requirements and interpretation of results for the dental chair unit waterline output water samples in hospital setting and required action.

Table-17: Testing requirements and interpretation of results for dental chair unit waterline output water samples in hospital setting and required action

Microorganisms	Timing / Frequency of Testing	Result	Interpretation	Action
Aerobic colony count	At least twice yearly provided effective periodic or residual waterline disinfection protocol in place. Otherwise monthly.	>200 /ml	Undesirable	Investigate waterline contamination control measures. Immediate disinfection of waterlines and cleaning and disinfection of reservoir bottle (where used) with effective waterline disinfectant and protocol recommended by the dental unit manufacturer. Retest following disinfection.
		100 – 200 /ml	Acceptable	Ensure appropriate control measures are in place
		<100/ ml	Satisfactory	No action; system under control

7.2.6.2.5 Hydrotherapy Water Samples

Table-18 summarizes the testing requirements and interpretation of results for hydrotherapy water samples and required action.

Table-18: Testing requirements and interpretation of results for hydrotherapy water samples and required action

Microorganisms	Timing/ Frequency of Testing	Result	Interpretation	Action
Escherichia coli	Weekly (collect sample while pool is in use)	>0 in 100ml	UNSATISFACTORY	Investigate immediately and take repeat sample
		0 in 100 ml	SATISFACTORY	No action; system under control
Coliform bacteria (Total coliforms)	Weekly (collect sample while pool is in use)	>10 in 100ml	UNSATISFACTORY	Investigate immediately and take repeat sample

		1 - 10 in 100ml	ACCEPTABLE	*This level is considered acceptable provided that Aerobic Colony Count is <10/ml, *E. coli* is not detected, disinfectant & pH values are acceptable and coliforms are absent in repeat samples
		0 in 100ml	SATISFACTORY	No action; system under control
Pseudomonas aeruginosa	Weekly (collect sample while pool is in use)	>50 in 100ml	UNACCEPTABLE	Close pool and seek advice on remedial actions required
		>10 - 50 in 100ml	UNSATISFACTORY	Investigate and take repeat sample
		1-10 in 100ml	BORDERLINE	Take repeat sample
		0 in 100ml	SATISFACTORY	No action; system under control
Aerobic Colony Count	Weekly (collect sample while pool is in use)	>100/ml	UNSATISFACTORY	Immediate investigation required
		>10 - 100/ml	BORDERLINE	Take repeat sample. Acceptable in the absence of *E. Coli* or coliforms. Repeated raised counts require further investigation.
		0 - 10/ml	SATISFACTORY	No action; system under control
Staphylococcus aureus	As part of wider investigations only – in discussion with local microbiologist	>0 in 100ml	UNSATISFACTORY	Investigate immediately and take repeat sample
		0 in 100ml	SATISFACTORY	No action; system under control
Legionella	Quarterly (depending on risk assessment) and before pool used for first time / after it has been shut down	> 1000 in 1 litre	UNSATISFACTORY	Close pool immediately. Shock dose then drain, clean and disinfect. Review risk assessment. Re-test before re-opening
		20 – 1000 in 1 litre	BORDERLINE	Take repeat sample. Drain, clean and disinfect pool and review risk assessment and controls.
		<20 in 1 litre	SATISFACTORY	No action; system under control

7.2.6.2.6 Heater cooler unit water

Table-19 summarizes the testing requirements and interpretation of results for heater cooler unit water samples and required action.

Table-19: Testing requirements and interpretation of results for heater cooler unit water samples and required action

Microorganisms	Timing/ Frequency of Testing	Result	Interpretation	Action
Environmental mycobacteria	Quarterly	Detected in 100 ml	UNSATISFACTORY	Take out of use, disinfect and retest
		Not detected in 100 ml	SATISFACTORY	No action; system under control
Legionella	Monthly	≥1000 cfu/l	UNSATISFACTORY	Any detection of legionella should be investigated and, if necessary, the system resampled to aid interpretation of the results in line with the monitoring strategy and risk assessment
		Up to 1000 cfu/l	UNDESIRABLE*	
		Not detected	SATISFACTORY	No action; system under control

7.2.8 Corrective and Remedial Action

Any contamination / complaint shall necessitate a complete investigation and immediate appropriate corrective action by Environmental Occupational Health, Infection Prevention and Control and Engineering department (maintenance) and involvement of other concerned department e.g. quality department and administration department.

7.2.7.1 When Should Cleaning & disinfection of Drinking Water Tanks

Table-20 highlights the conditions in which cleaning and disinfection of drinking water tanks should be done.

Table-20: Conditions required cleaning & sterilization of drinking water tanks

SN.	When should cleaning & disinfection of drinking water tanks
1.	When using the water tank for the first time (new)
2.	Change in water source
3.	To ensure the safety and cleanliness of the water tank on an ongoing basis and this will be twice a year.
4.	When there is contamination of the source water that feeds the water tank, whether it is from the public network or through wells (When water quality analysis confirms that water tested positive for Total Coliform or E. coli bacteria)
5.	If there are any noticeable changes in water quality (taste, odor, color issues)
6.	If sediments growth is observed inside the tank.
7.	When contamination of the water tank as a result of one of the following reasons: ➢ The presence of cracks in the walls of the tank led to the nominated water or sewage water into the tank. ➢ No cover for the tank or a cap with no sealing or the presence of holes surrounding the area cover, which resulted in the entry of insects or fouling or contaminated water into the tank and dirt after heavy rain. ➢ When dead animals or birds have been found in the tank ➢ Problems observed during periodic inspection of the piping system or joints e.g. leaking or algae growth. ➢ If any repairs or modifications are done to the water system (maintenance work cause direct manipulation of the internal content of pipes or tank).

7.2.7.2 Frequency of cleaning and disinfection of drinking water system

- Overall, drinking water system should be cleaned and disinfected twice a year.
- There are some considerations for very large sizes reservoirs which need to be taken when deciding the frequency of cleaning and sterilization e.g.

– Amount of water, which will be consumed for cleaning process.

– Lack of an alternative water source for the healthcare institution during the cleaning of these reservoirs as they could feed sensitive places in the health institutions like renal dialysis units where it is not practical to shut down the water source without alternatives for long period.

– Refilling the water tank with fresh water will take long time.

- In such case, prior discussion with Environmental & Occupational health and infection prevention and control departments is needed to decide about the frequency and procedure of cleaning and disinfection including how to reuse the drained water.

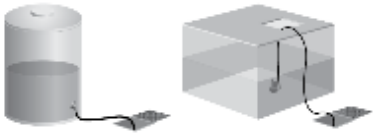
7.2.7.3 Steps of Drinking Water Tank Disinfection

The recommended steps for properly cleaning, disinfecting, and flushing potable water storage tanks are as explained in table-21

Table- 21: Steps of cleaning and disinfection of accessible water storage tanks

SN.	Steps	Figures
1.	Secure access and required authorizations to enter building and conduct the Tank Cleaning.	
2.	Notify tenants of the proposed Tank Cleaning date and time at least 48 hours prior to Cleaning. The cleaning and disinfection of water tanks is preferred to be performed when the fewest building occupants are present, such as nights, weekends, public holidays.	 Examples of public notices
3.	Shut off inlet valve at least 24 hours prior to Cleaning to allow maximum water to be used (to ensure less wastage of water). Leave the tank half-filled to use it for cleaning.	
4.	Prepare all necessary Tank Cleaning equipment, Cleaning Chemicals and concentrations, and personal protective equipment (PPE) off-site and prior to Cleaning. Typical Cleaning equipment may comprise the following: • Clean uniforms suitable long (overalls) and preferably light color so that any dirtiness will be obvious. • Facemasks. • Plastic headdress. • Large rubber gloves (heavy duty). • Rubber boots with a long neck.	 Proper PPE and equipment

	• Clean towels for workers to dry themselves. • Mobile air battery-operated fans to suction indoor air renewal in the tank commensurate with its size and its use is safe. • Saddle or the so-called (Harness) is recommended to wear for a worker who will clean up a very large reservoirs and in application of the foundations of safety when entering the confined places such as very large water storage tanks in order to be saved as soon as possible in emergency situations without resorting to enter someone else putting him at the same risk. • Suitable source of illumination is identical to the safety requirements for use within the water tanks in order to inspect and monitor the tank clearly and spot any dirt or any malfunction, and also so that the worker a clear vision to properly clean the reservoirs. • A set small and large solid brush/scrubbers to be of a long stick for cleaning. • Disinfectant • The high- water pressure jet pipe. • Provide a source of water used for cleaning. • Buckets. • Rope to pull the buckets (packed deposits and remnants of the tank when cleaning). • A device for measuring chlorine ratio (cholrimeter). • Sump pump or a device to speed up the withdrawal of the amount of water in the reservoir. • Ladders; scaffolding (with platforms).	
5.	Arrive on-site and notify building in-charge, residents and tenants through notices of the Cleaning and expected duration and precautions they should take.	
6.	Place safety barriers around Cleaning equipment and working area, if required.	
7.	If the Tank inlet valve has not already been turned off previously to allow Tank to empty, then turn off the water inlet.	

8.	Lock-out/ tag-out all Tank inlets and outlets and make sure signs are placed notifying that they should not be opened.	 Proper 'lock-out tag-out' procedure and signage
9.	Open the Tank cover and allow the Tank to vent for 20 minutes.	
10.	Drain the Tank down using either the outlet valve (if available) or sump pumps (if outlet valve is not available) to at least 1/4 full.	 Different draining arrangements
11.	Set up equipment, including any fall protection and confined spaces equipment and PPE.	 Proper confined space and fall protection procedure and equipment
12.	Visually inspect the outside and inside of the Tank to assess structural integrity and safety to look for the following: ○ Sediment/ Sludge ○ Algae growth ○ Micro-film or oils ○ Dead animals or insects ○ Corrosion ○ Other signs of contamination. If any damage is observed, repair at the same time.	

13.	Scrub by brush or pressure hose and clean dirt and grime from Tank surfaces, including outside the tank, Tank cover, entry points, the sides and bottom of the tank. Use approved Cleaning Chemicals if necessary. This step is important to physically remove any built up debris, algae corrosion, bio-film and/or sediments accumulated in the tank.	 Cleaning Non-Man-Entry Tanks with brush  Cleaning Man-Entry Tanks with pressure jet wash  Cleaning Man-Entry Tanks with brush
14.	Rinse the Tank and drain the Wastewater, using a portable pump or drain to flush out dirty water from the tank or empty the tank to waste.	 Rinsing Man-Entry Tank interior after cleaning

15. Determine and prepare the amount of chlorine bleach to add to the tank in enough quantity to wash the walls and roof. Liquid sodium hypochlorite, commonly known as bleach, can be effectively used for water disinfection. Add hypochlorite solution to the tank. The amount of hypochlorite added to the tank should be sufficient to achieve a minimum of 10 mg/L free chlorine in the water tank when the tank is filled to its normal operating level and a free chlorine residual of at least 2 mg/L throughout the water system. The pH of the water should be maintained between 7.0 and 8.0.

The amount of chlorine should be adjusted relative to the size of your water storage tank. Thoroughly mix the hypochlorite solution in the tank.

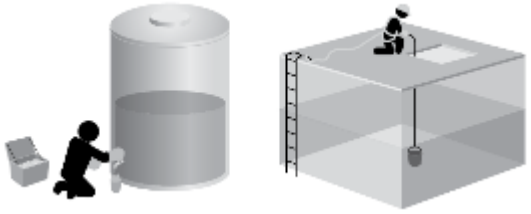
Use the table below to determine how much hypochlorite solution to use to obtain 10 mg/L. Double the amount to achieve a 20 mg/L dosage (If the water has a higher than normal chlorine demand (such as waters with high iron, manganese, or color).

Tank Volume (gallons)	5.25% Hypochlorite	
	Ounces	Gallons
500	20	
1000	30	
2000	50	
3000	80	
4000	110	
5000	130	1
10000	250	2
20000	510	4
30000	760	6
40000	1020	8
50000	1270	10
100000	2540	20

16. There are two methods for disinfecting the water tank:

a. Spray disinfectant on all Tank surfaces, including corners, roof, Tank cover and any internal ladders ensuring maximum coverage. Allow the disinfectant to remain for a minimum of 30 minutes. Rinse the disinfectant and empty the Tank.
b. Fill the tank to the overflow level with water. Add the calculated amount of bleach to the filled- tank. Each outlet should be flushed until the odor of chlorine is detected. Leave the tank filled for a minimum of 2 hours. Then flush out/empty the storage tank. Refill the tank till half meter with clean water use it to spray

Spraying disinfectant on Man-Entry Tank internal surfaces

	and clean the tank from chlorine residual and debris. Flush all affected taps until chlorine can no longer be smelled. Repeat the refill if needed. If a portable pump is used, ensure that the intake hose is clean and wiped down with bleach to prevent contamination. Continue flushing until the waste water is clear and no chlorine odor is evident.	 Spraying disinfectant on Non- Man-Entry Tank internal surfaces
17.	Fill the Tank with potable water.	
18.	Test for free chlorine residual to ensure it is in the safe level (0.2-0.5ppm), using an approved chlorine measurement equipment.	
19.	Take a water sample and send for analysis if the disinfection is done due to prior abnormal water results (emergency disinfection not periodic disinfection).	 Sampling following Cleaning and Disinfection
20.	Cover tank and close it firmly.	
21.	If water samples are compliant, the drinking water is considered safe to use and drink. Retain records on file for five years.	
22.	If water tests are not compliant, repeat Cleaning and Disinfection within 48 hours and notify tenants that the water is 'not safe for drinking' and next intended date and time for Cleaning.	

7.2.7.4 General considerations

a. All reservoirs cleaners should be in good appearance with strict hygiene care of their bodies and they should trim their nails and hair.

b. All reservoirs cleaners should be wearing a clean uniform.

c. Banning smoking in the workplace and stay away from bad habits.

d. Reservoirs cleaners should be free from infectious diseases.

e. Any worker showing symptoms of illness or appear in his hands blisters or cuts/injury or contagious disease, should be removed from work until he is treated and be free from his symptoms decided by competent health authorities. The supervisor should work to inform the competent health authorities in the case of the emergence of any infectious disease to any worker.

f. Cleaning and disinfection of water tanks should be under supervision of experience technician in the field of water disinfection.

g. The team in charge of cleaning and disinfection process must be equipped with all the hardware and equipment needed to carry out this work.

h. The team must have experience and skill in the tank cleaning and disinfection.

i. There must be another worker out of the water tank to monitor the cleaning process at all times for fast acting during the emergency.

j. In case that any worker experience shortness of breath during the cleaning process immediately to be removed from the tank and exposed directly to the open air after takeoff the mask and then to be reviewed by a doctor.

k. Sodium hypochlorite is highly corrosive. Nitrile gloves and goggles should be worn, In the event that any individual eye exposed to chlorine (liquid or powder), should immediately wash the eye with clean water several times and review the doctor immediately.

l. Do not pour water onto chlorine. Always add chlorine to water.

7.3 INVESTIGATION OF WATER BORNE PATHOGENS OUTBREAK AND SPECIAL CONSIDERATION FOR LEGIONELLA OUTBREAK

The document is attached to the annex-3

7.4 INFECTION PREVENTION & CONTROL IN HIGH RISK AREAS

The document is attached to the annex-4

7.5 DIALYSIS WATER QUALITY

Appropriate water quality is one of the most important aspects of ensuring the safe and effective delivery of haemodialysis. Haemodialysis may expose the patient to more than 300 litres of water per week across the semi-permeable membrane of a haemodialyser. Healthy individuals seldom have a weekly oral intake of water above 12 litres. The near 30 times increase in water exposure to dialysis patients requires control

and monitoring of water quality to avoid excesses of known or suspected harmful elements being carried in the water and transmitted to the patient. The water to be used for the preparation of haemodialysis fluids needs treatment to achieve the appropriate quality. The water treatment is provided by a water pre-treatment system, which may include various components, such as sediment filters, water softeners, carbon tanks, micro-filters, ultraviolet disinfection units, reverse osmosis (RO) units, ultrafilters and storage tanks. The components of the system will be determined by the quality of feed water and the ability of the overall system to produce and maintain appropriate water quality. Failure to ensure adequate water quality may have dire consequences for patient safety and welfare. Patients undergoing haemodialysis may show signs and symptoms related to water contamination, which can lead to patient injury or death

7.5.1 Components/ Stages of the dialysis water treatment process

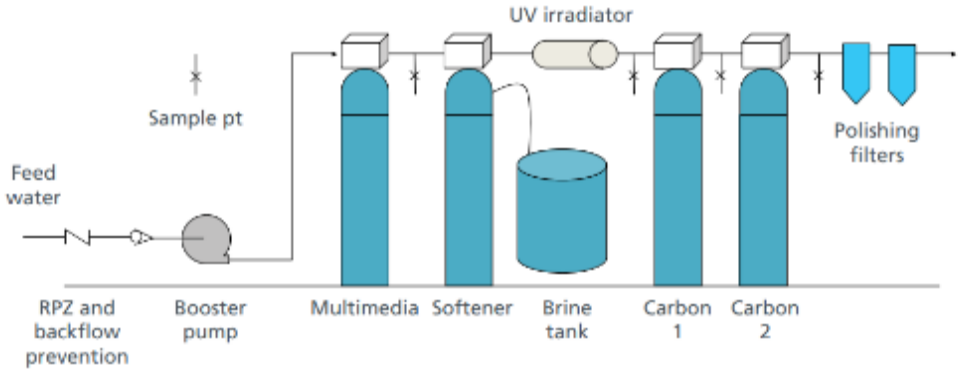
- The stages of dialysis water treatment differ depending on the operating company, however In general, thetreatment process takes place in three stages:
  - **The first phase: The** pre-treatment stage is called Pre-Treatment A stage consisting of several filters, which often includes the following filters:
    - Sand filter to remove impurities.
    - Carbon filter to remove chlorine.
    - Water Softer filter removes magnesium and calcium.
  - **The second phase:** The treatment stage is called the reverse osmosis stage: The reverse osmosissystem uses a pump to push water through a semi-permeable membrane or filter that removes almost all contaminants, including bacteria and viruses.
  - **Third phase:** This is called the post-treatment or disinfection stage.

Figures-43-49 demonstrate the phases and types of renal dialysis units.

Figure-43: Renal dialysis plant

Figure-44: Renal dialysis patient side

Figure-45: Pre-treatment filters



Note: The UV irradiator can also be located after the polishing filters.

Reduced pressure zone (RPZ) A device that controls pressure in the feed water system

Figure-46: Water plant and distribution

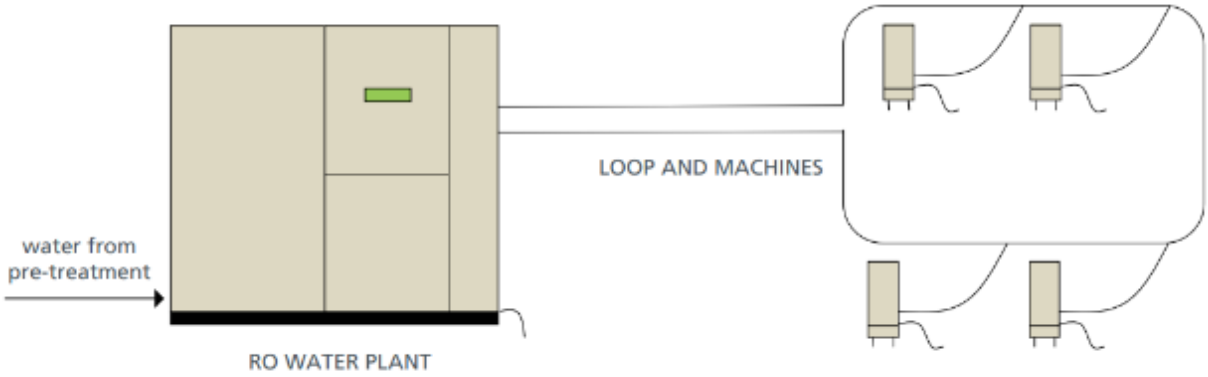


Figure-47: Typical central RO configuration

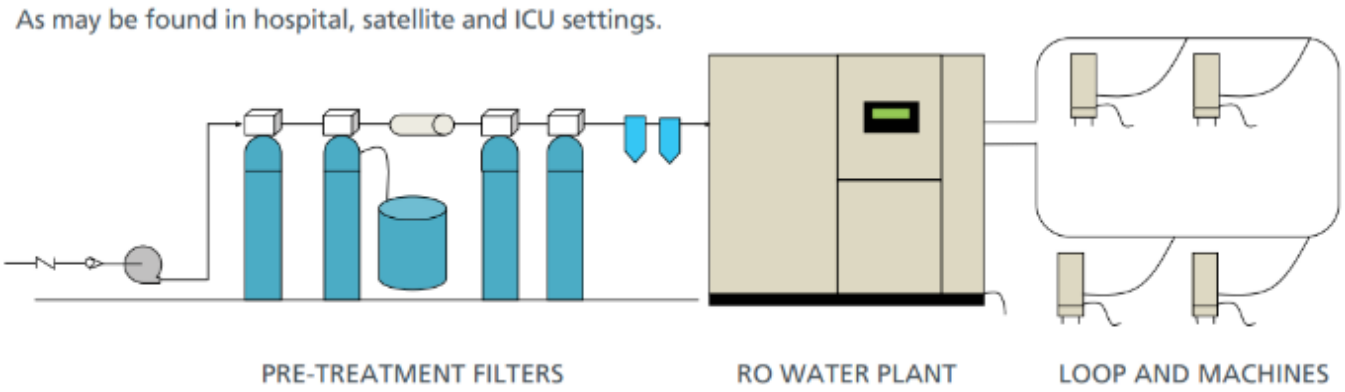


Figure-48: Multiple single portable RO configuration

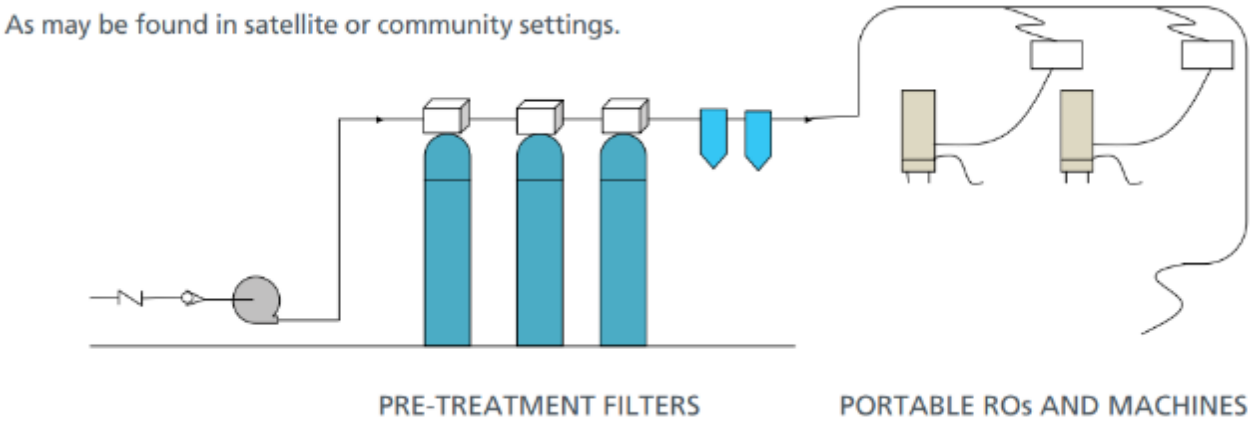
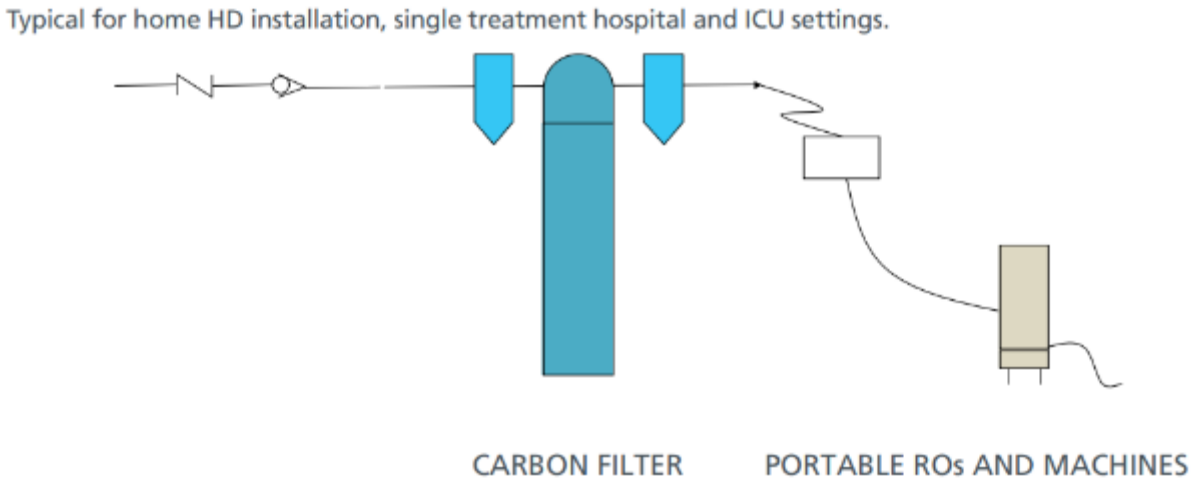


Figure-49: Single portable RO configuration



7.5.2 Performance requirements

- The quality of the product water, as specified shall be verified upon installation of a water pre-treatmentsystem. Regular testing of product water quality and monitoring of any trend in the results shall be carried out. This will provide an analytical dataset allowing potential problems to be resolved early. There are components within the dialysis water pre-treatment system that are able to remove or lower the concentration of the listed contaminants. The "X" in table-22 indicates which contaminant isremoved by each component of the dialysis water pre-treatment system.

Table-22 Contaminant removed by each component of the dialysis water pre-treatment system

Contaminant	Component of water pre-treatment system				
	Sand filter	Softener	Carbon tank	RO unit	UV irradiation
Aluminium				X	
Arsenic				X	
Barium				X	
Cadmium				X	
Calcium		X		X	
Chloramines			X		X
Chlorine			X		
Chromium				X	
Copper				X	
Fluoride				X	
Lead				X	
Magnesium		X		X	
Mercury				X	
Microcystins				X	
Nitrate				X	
Potassium				X	
Selenium				X	
Silver				X	
Sodium				X	
Sulphate				X	
Zinc				X	
Viruses				X	
Organic contaminants				X	
Endotoxins				X	
Bacteria				X	X
Particles	X			X	

7.5.3 Water testing

- Water testing routines are based on system performance recommendations, including historical andtrending data.
- Table-23 Summarized recommended water testing type, location and frequency for dialysis water.

Table-23: Summary of recommended water testing type, location and frequency for dialysis water

Name of Test	Location	Frequency
Bacteria and Endotoxin	1.Storage water tanks 2.Post RO to the end distribution water loop 3.Post Dialysate machine	**Routinely**- once a month before performing on the day of the routine disinfection. **Weekly** – for one month during: - Maintenance work. - Outbreak **If Patients** develops signs and symptoms, perform (blood culture of patients) and test dialysate (from the patient's machine).
Chemical contaminant and heavy metal levels	1.Feed water 2.Pre- softener 3.Post-softener 4.Between the two carbon tanks 5.Post-lag (second) carbon tank 6.At a point chosen so that the effects of the water pre- treatment system and the piping are completely included (Post RO, Post water loop)	**Commissioning** - 3 – monthly until results is acceptable limits -After maintenance work: e.g. carbon or reverse osmosis (RO) unit change.
Daily field measurements of dialysis water (via the company)	-Chlorine and Chloramines –after each carbon filter -pH -Hardness - after softener. -Conductivity	Daily
	Chloramine – before wash load	Every four hours

Notes:

- It should be remembered that water testing results will not be available immediately (can take average of 5 days for return of results) and this time delay should be considered before booking patients for hemodialysis when commissioning a hemodialysis water plant or when re-starting the hemodialysis services after RO plant maintenance.
- It is preferable that samples be taken before performing the routine disinfection of the dialysis station. For example, if the routine disinfection process takes place once a month, then the samples are taken on the last day before the disinfection process.
- Samples are taken also from 10% of the dialysis machine every month, provided that a sample from each machine is examined at least once a year for bacteria and endotoxin,where regular testing is conducted on a different machine each month (machines are tested on a rotation). All results are documented and recorded in designated forms, provided that a copy of these forms is available in the dialysis unit.

Figure-50: Bacteriological examination of dialysis water samples

SULTANATE OF OMAN
MINISTRY OF HEALTH
Center for Disease Control and Prevention
Department of Central Public Health Laboratories
Food Borne-Illness and Food Poisoning Laboratory

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سلطنة عمان
وزارة الصحة
مركز مراقبة الأمراض والوقاية منها
دائرة مختبرات الصحة العامة
مختبر الفاشيات الغذائية و التسمم الغذائي

هاتف: 24560019
فاكس: 24563121

التحليـــــل البكتريولـوجي لعينـــات مياه غسيل الكلى
Bacteriological Examination of Dialysis Water Samples

Name of Sender اسم المرسل	توقيع المرسل Sign. Sender	Date of Collection تاريخ أخذ العينة	Time الوقت	Tel:
				Fax:

Sender's Reference Number and description of sample مكان أخذ العينة	Shifa No.	Lab. No. رقم المختبر	Laboratory Report Aerobic Colony Count (CFU/ ml) at 22° C

Reference Range	Interpretation
> 100 / ml	Unsatisfactory
> 50 – ≤ 100 / ml	Borderline
0 – ≤ 50 / ml	Satisfactory

* Above values are based on Public Health England guidelines, 2020

Please refer to the National Guidelines of Infection Prevention & Control Practices in Hemodialysis Units for any action needed.

Final Report: _____ التقرير النهائي:

_____

Date Technician Medical Microbiologist

7.5.4 Bacterial analysis of dialysis water

The following sections highlight the bacterial specification and steps of water collection for dialysis water

7.5.4.1 Bacterial specifications for produced dialysis water

- The Total Viable Count of bacteria must not exceed 100 CFU/ML (one colony per ml of dialysis water produced after treatment according to the common standards of the American Association for the Advancement of Medical Instrumentation (AAMI) and the American National Standards Institute (ANSI), which are internationally approved standards.
- The dialysis center must stop providing dialysis service to patients if it is confirmed that the level of bacteria exceeds the permissible limits (100 CFU/ML) after taking a second confirmatory sample. The service shall not be restored except after completing the corrective procedures and re-examination that confirms that the number of bacteria has returned to the permissible level.
- Therefore, there is a level called the Correction Level, which is the level of bacteria at which, after confirmation, corrective measures are initiated while continuing to provide the service. It is equal to 50 colonies per milliliter of water (50 CFU/ML), which is half the permissible level.
- Thus, when the level of bacteria reaches the correction level, it reflects that there is a defect in the treatment process that must be corrected and treated. The following table shows the maximum permissible level and correction level for live bacteria in produced dialysis water.

Table-24: the maximum permissible level and correction level for live bacteria in produced dialysis water.

Item	Maximum allowable bacterial	Correction Level (action level)
Total Viable Count	<100 CFU/ml	≥ 50 CFU/mL

Note-1: Action level: Concentration of a contaminant at which steps should be taken to interrupt the trend toward higher, unacceptable levels. If action level are observed, disinfection and retesting shall be done immediately to restore the quality into acceptable level. Those action levels allow the user to initiate corrective action before levels exceed the recommended maximum levels.

Note-2: Dialysis water samples should be negative for any fungal growth.

The following table shows detailed bacterial level result interpretation for renal dialysis fluid and water used for the preparation of dialysis fluid and when action is needed.

Table-25: Detailed bacterial level result interpretation for renal dialysis fluid and water used for the preparation of dialysis fluid and when action is needed

Hazard / Hygiene Indicator	Timing / Frequency of Testing	Result	interpretation	Action
Aerobic Colony Count	Monthly (or more frequently if necessary)	>100 / ml	UNSATISFACTORY	Take out of use until corrective action implemented
		>50 - ≤100 / ml	BORDERLINE	Investigate cause and put corrective action in place
		0 - ≤50 / ml	SATISFACTORY	N/A

* Public Health England guidelines, 2020 (Currently Health Security Agency)

7.5.4.2 Steps for taking samples of dialysis water produced for bacterial examination

- Table-26 summarizes the basic steps for collecting dialysis water samples:

Table-26: Summary of the basic steps for collecting dialysis water samples from dialysis water port and machine for bacterial examination

SN.	Steps	Figures
1.	The sample must be taken by a person trained in the correct method of taking dialysis water samples	
2.	There must be an approved, written, and documented plan for taking samples to conduct the required periodic analyzes, specifying the points of taking and how to take them and type of tests and how to interpret the results and action if abnormal results are detected.	
3.	Prior coordination must be made with the relevant authorities before taking samples, for example, central public health laboratories, maintenance department, or medical engineering department, in order to ensure that the supplies are available and that the samples will be received and examined.	
4.	Sample taking supplies must be available, which include the following (sterile gloves - mask - alcohol swabs - ice box - ice bags - 100 ml sterile bottle).All safety and sterilization precautions must be taken when taking samples.	

5.	Before taking samples, hands must be washed well according to hand washing protocols, or rubbed with alcohol, then wear a mask and gloves to ensure that the sample is not contaminated.	
6.	Wear a mask and sterile gloves	
7.	**For dialysis ports water:**	
a.	Clean the nozzle end of the sampling port three times with alcohol wipes, then wait for the nozzle to dry.	  
b.	Connection of sampling port with the connector. Should the connector be used for sampling – the connectors will require disinfection using 70-90% ethanol solution in a spray container or alcohol swab. The dialysate should be run through the connectors initiating dialysate flow. Allow at least 200mls to flow through connectors prior to taking a mid-stream sample.	
c.	Open the water valve and let it flow for 2 to 3 minutes to pass the water through before taking the sample.	

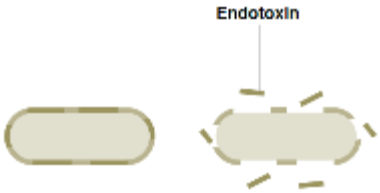
d.	Open the lid of the sterile container to take a water sample without touching the sample taking point. The container is not rinsed and the lid is not placed on the surface, but rather it is held with the hand from its outer side only.	
e.	Fill the bottle to the 100 ml line, leaving airspace.	
f.	Immediately cover the bottle tightly and then place it in the cool box.	
8.	**For dialysis machines:**	
A.	Prepare two sterile 30 ml syringes and a sterile water bottle to collect the sample.	
B.	Clean the sampling port site three times with alcohol wipes till dry	
C.	Attach the sterile 30 ml syringe to the sampling port and withdraw 30 ml of liquid and discard.	
D.	Connect another new 30 ml sterile syringe to the sampling port and withdraw another 30 ml and place it in the sterile water bottle (endotoxin – free) and cap it securely.	
E.	Cover the sample bottles and check for leaking	
9.	The name of the health facility, the sample number, the place it was taken, the date and time the sample was taken, and the name of the person who took the sample must be written on the bottle and laboratory request form.	
10.	When writing sample information, a material and pen must be used that cannot be removed or erased by wetness or humidity.	
11.	Water samples must be kept cold at a temperature of (1-4°C) and not frozen. They must be sent immediately to the laboratory. It is preferable that the sample be sent within a maximum period of twenty-four (24) hours.	

12.	Follow up on receiving sample results from the laboratory.	
13.	Recording and keeping the results of the samples in special records with the public health or environmental health department and within the facility by maintenance department or the concerned focal point and providing other departments with the results as relevant.	
14.	The maintenance department must inform the environmental health department when any interruption occurs in the water of the dialysis water treatment plant, planned or unplanned, or when any damage occurs to the dialysis water network that could cause water contamination.	

Summary of the steps for collecting dialysis water samples from dialysis ports and machines for bacterial examination is attached in annex-2c

7.5.5 Endotoxin analysis of dialysis water

- It is a heat-stable glycolipid found in the outer membrane of Gram-negative bacteria that is released from the cell when it dies. The following figure shows the location of endotoxin in the bacterial cell.



- Endotoxin can pass through the pores of the semi-permeable membrane in the dialysis machine into the patient's blood and cause complications for the patient.
- The sample is taken for endotoxin testing from the treated water produced (final output) after the final disinfection stage (thermal) and after the endotoxin filters, if any.
- The endotoxin test must be performed in conjunction with the bacteriological test
- Samples must be tested for endotoxin (Endotoxin) within four hours of collection, or within twenty-four hours at most if they are stored directly in the refrigerator.

7.5.5.1 Permissible endotoxin level

- The level of endotoxin in treated water must not exceed 0.25 EU/ml (maximum allowable endotoxin level) as shown in table-27.
- In the event that it is confirmed that the endotoxin level exceeds the permissible limits, this is done by taking a sample again from the same place, and the service will not be restored until after completing the correction procedures and re-examination.
- Therefore, there is a level called the correction level, which is the level of toxin at which corrective measures are initiated while continuing to provide the service. It is equal to (0.125 EU/ml) toxin unit per milliliter of water, which is half the permissible level, as reaching the level of Toxicity to the level of correction reflects that there is a defect in the treatment process that must be corrected and treated.

Table-27: the maximum allowable and correction level of endotoxin in treated water

Item	**Maximum allowable endotoxin contaminant level**	**Correction Level (action level)**
Endotoxin Count	< 0.25 EU/ml	≥ 0.125 EU/ml

Note: If action levels are observed; disinfection and retesting shall be done immediately to restore the quality into acceptable levels.

The following table show detailed endotoxin result interpretation for renal dialysis fluid and water used for the preparation of dialysis fluid and when action is needed.

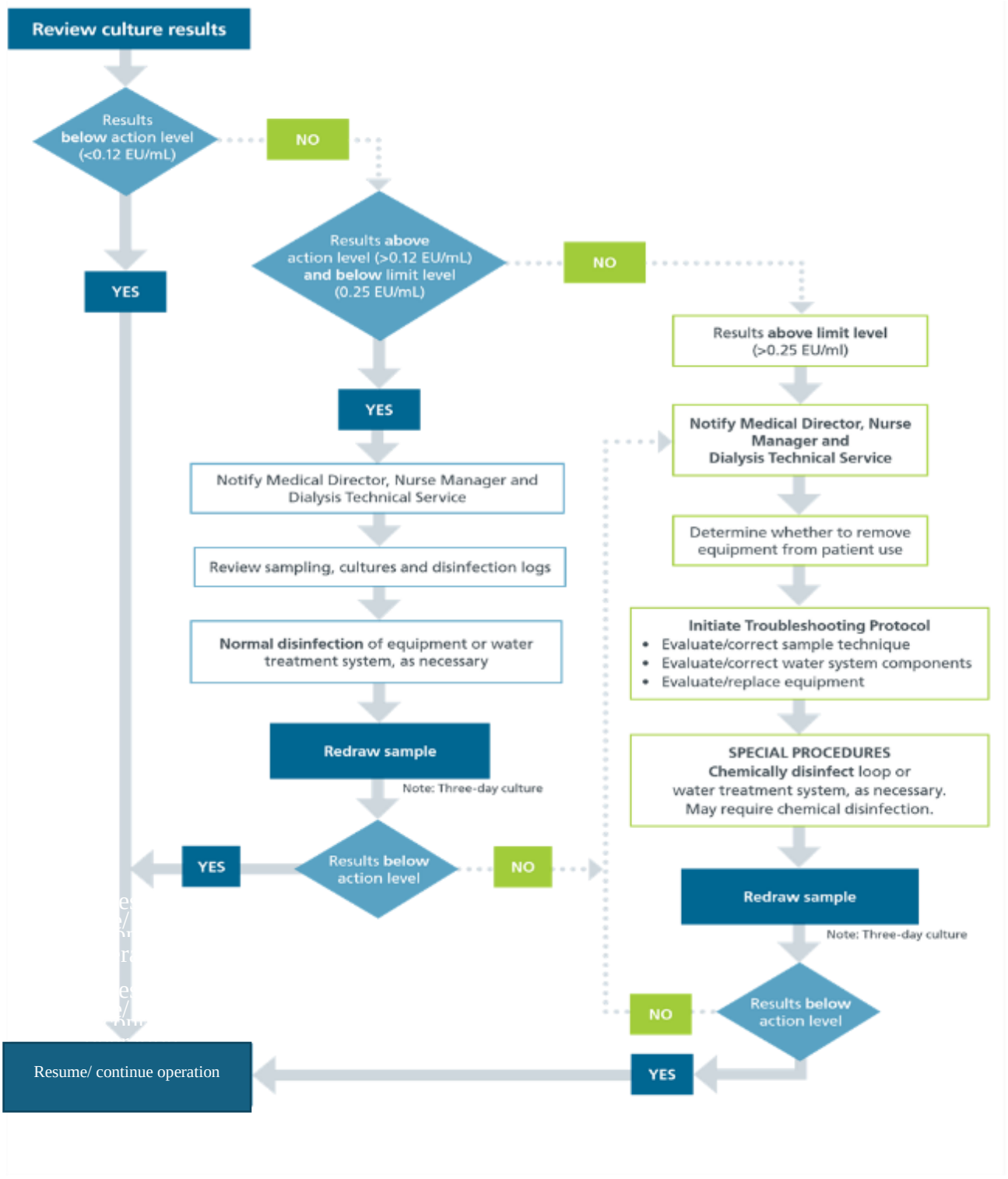
Table-28: details of the endotoxin result interpretation for renal dialysis fluid and water used for the preparation of dialysis fluid and when action is needed

Hazard / Hygiene Indicator	**Timing / Frequency of Testing**	**Result**	**interpretation**	**Action**
Endotoxin /ml		>0.25 EU/ml	UNSATISFACTORY	Take out of use until corrective action implemented
		>0.125 - ≤0.25 EU /ml	BORDERLINE	Investigate cause and put corrective action in place
		<0.125 EU/ml	SATISFACTORY	No action

7.5.5.2 Steps for taking dialysis water samples to test for endotoxin

- Same like steps for taking samples of dialysis water produced for bacterial examination
- Figure-51 give an example of decision flow chart for endotoxin contamination (EU) Haemodialysis (HD) machines, distribution loop

Figure-51: Decision flow chart for endotoxin contamination (EU) distribution loop



7.5.6 Chemical analyzes of dialysis water

- Routine chemical examination is carried out by examining water samples every three months (as shown in table-29).
- The frequency of the chemical examination shall be increased if any of the following cases occur:

a. If the results of the chemical analysis of the treated water show that the concentration of any one or more inorganic chemical pollutants exceeds the recommended concentration.

b. If there are changes in the water treatment system, such as replacement or maintenance.

- Samples are sent to the toxicology laboratory to conduct the required chemical tests, provided that compliance with the requirements for transporting and preserving the sample is taken into account, and ensuring its arrival to the laboratory on time, not exceeding 24 hours, and using designated forms. Prior coordination is made with the laboratory before sending the samples.
- It is not permitted to use treated water in the dialysis process if the level of any of the chemical pollutants is above the permissible level. The treated water should not be reused except after taking the necessary corrective measures (according to the type of each pollutant) by the company operating the treatment plant or the medical engineering department. And re-examine again and receive the results that show that the level of the chemical pollutant has returned to normal concentration.
- Taking corrective measures in the event that any of the chemicals exceed the permissible limits, this is done in accordance with the regulations in force in the Engineering Department or the operating company for each chemical pollutant.
- After receiving the results, copies of them are kept in special records in the renal dialysis unit and the environmental health unit, and the results are provided to other departments as appropriate.

7.5.6.1 Method of taking a sample for chemical examination

The following table highlights the methods of taking a sample for chemical examination.

Table-29 method of taking a sample for chemical examination

SN	STEPS
1.	Coordination is made with the specialists in the company responsible for the treatment and the Engineering Department, and they are notified of the date of taking the sample. Prepare the required supplies for the process of taking the sample for chemical examination (plastic bottle, gloves, mask).
2.	Wash hands with soap and water or rub them with alcohol.
3.	Wear gloves and the mask.
4.	Open the water valve and let the water flow for 2-3 minutes.

5.	Rinse the bottle and its cap three times from the same place from which the sample is to be taken, then fill it, leaving a space at the top of the bottle.
6.	The sample is stored in a cool box.
7.	The sample data is recorded in the chemical request form and a copy is kept in the designated register. Then the sample is sent to the toxicology laboratory and delivered with the signature of the person receiving the sample indicating the time and date of receipt of the sample.
8.	Follow-up is carried out to receive the results
9.	Keep a copy of the results in the designated register.
10.	Begin taking the necessary corrective measures if necessary, as described below

7.5.6.2 Normal chemical specifications of dialysis water

- The most required and widely used standards are those recommended by the American Association for the Advancement of Medical Instrumentation (AAMI). Table-30 shows the normal levels of chemical contaminants allowed in dialysis water:

Table-30: Maximum allowable chemical contaminant levels in water used to prepare dialysate and concentrates from powder at a dialysis facility and to reprocess dialyzers for multiple uses

Contaminant	**Dialysis Water: AAMI/ANSI Maximum Allowable** **Chemical Contaminant Levels, mg/L**
Calcium	2 (0.1 mEq/L)
Magnesium	4 (0.3 mEq/L)
Potassium	8 (0.2 mEq/L)
Sodium	70 (3.0 mEq/L)
Antimony	0.006
Arsenic	0.005
Barium	0.10
Beryllium	0.0004
Cadmium	0.001
Chromium	0.014

Lead	0.005
Mercury	0.0002
Selenium	0.09
Silver	0.005
Aluminum	0.01
Chloramines	0.10
Free Chlorine	0.50
Copper	0.10
Fluoride	0.20
Nitrate (as N)	2.0
Sulfate	100
Thallium	0.002
Zinc	0.10

(Reproduced from ANSI/AAMI RD62:2001)

7.5.7 Corrective measures

- Environmental and Occupational health section in collaboration with Infection Prevention and Control section and Engineering and Maintenance department in each Directorate Generals (DGs) should be an active part in the investigation process of abnormal water results in all healthcare institutions under their DGs.

7.5.7.1 Corrective measures when bacterial /endotoxin analysis results exceed the permissible level or correctionlevel:

- Inform the medical director of the dialysis unit, the head of the nursing department, the head of the maintenance department, the supervisor of the company responsible for water treatment and the head of the infection control section and Environmental and Occupational health section.
- A confirmation sample is taken and sent to the laboratory. It may also be necessary to increase the points where water tests are taken to pin point the area of possible contamination. If routine sampling points identify an elevated result, then increased testing is required using the following testing points:

1. Feed water

2. Post pre-treatment (post softener and post carbons)
3. Post UV irradiation (if applicable)
4. Post RO
5. Start of distribution loop
6. Random outlets on loop
7. End of loop
8. Post machine
9. Dialysate

- If the result of the confirmation sample is above the permissible level or above the correction level, disinfection and rinsing procedures are implemented by the company responsible for the dialysis water treatment plant according to the company's standards, and the possibility of the presence of biofilms is identified as one of the reasons for the high percentage of germs
- After completing the procedures, a sample is taken again, and if it is within the normal level, that is sufficient. However, if the level is above the permissible level, the investigation is continued, searching for the source of the contamination and treating it.

Figure-52, 53 give examples on decisions for abnormal bacteriological /endotoxin water sample results in dialysis unit.

Figure-52: Decision flow chart for bacterial contamination (CFU) distribution loop

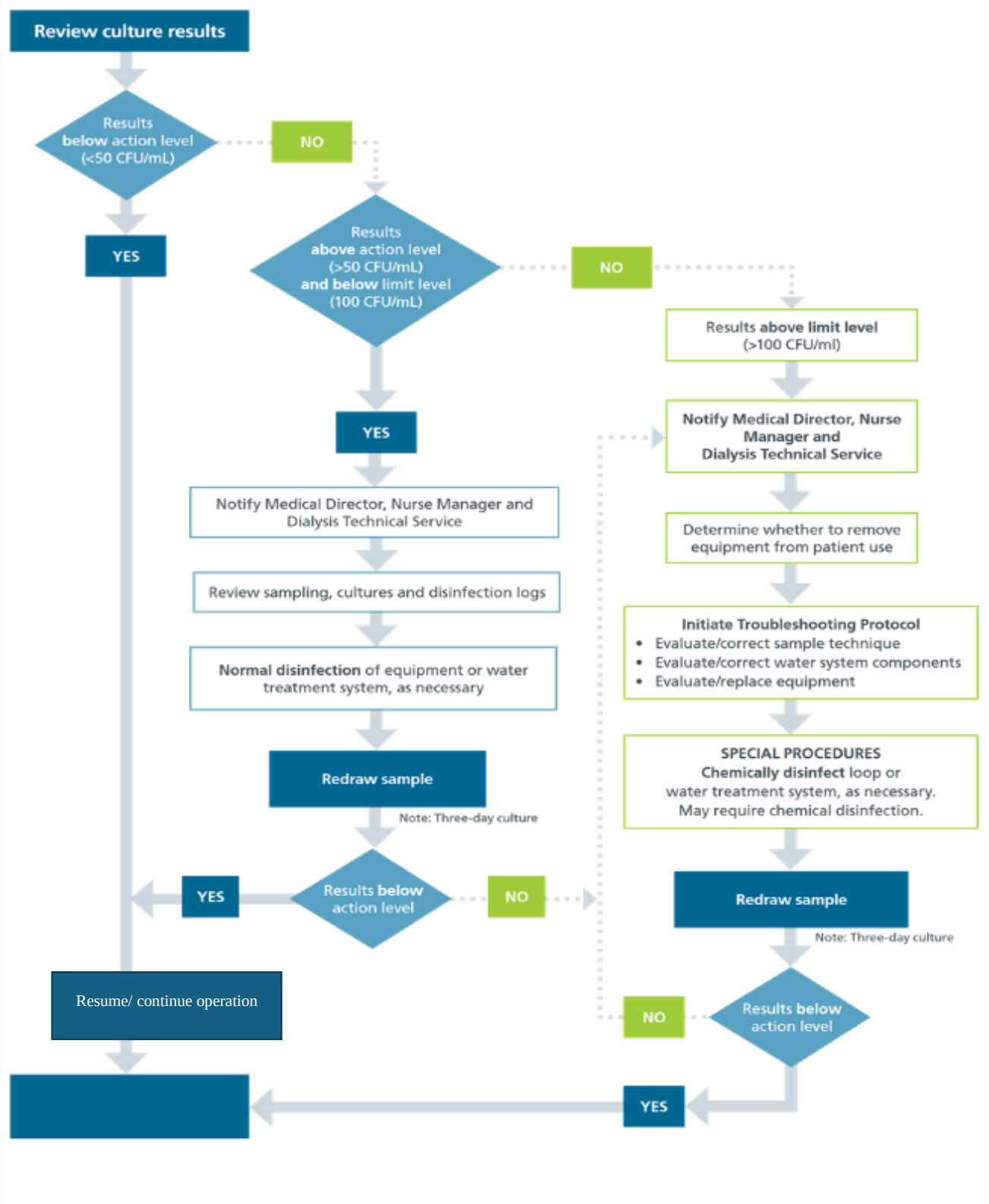
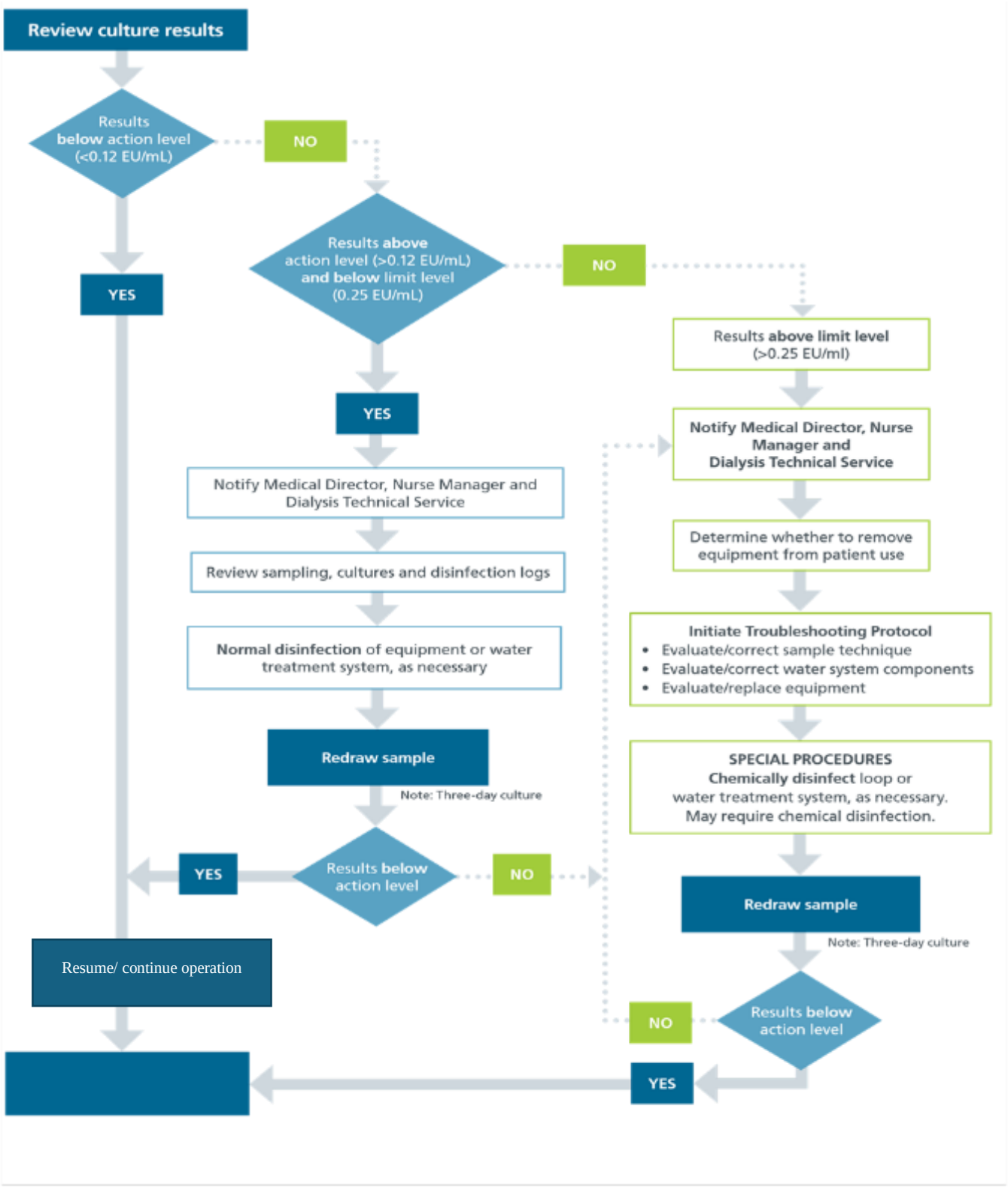


Figure-53: Decision flow chart for endotoxin contamination (EU) distribution loop



7.5.7.2 Corrective measures in the event of abnormal results of the chemical examination

- A sample must be taken again from the same place to ensure that the water does not meet the specifications and that the readings obtained are correct.
- After it is confirmed that the result does not conform to the required specifications through the second sample, appropriate corrective measures must be taken immediately, without any delay, as recommended, and in cooperation with the renal dialysis center management, the maintenance department, and the company responsible for treating dialysis water when there is evidence of contamination and dialysis water does not conform to the required chemical specifications.

7.5.8 Bacterial Control Devices

The following section highlight on the bacterial control devices

7.5.8.1 Ultraviolet Irradiators

Ultraviolet irradiators intended for use as a direct means of bacterial control shall be monitored for radiant energy output. UV irradiators are available equipped with radiant energy intensity sensors. A visual alarm or an output meter is acceptable for determining if the UV lamp is emitting sufficient radiant energy. UV irradiators should be monitored at the frequency recommended by the manufacturer. Because the radiant energy decreases with time, annual lamp replacement is typically required. Periodic cleaning of the quartz sleeve may also be required, depending on the water quality. A log sheet should be used to indicate that monitoring has been performed.

7.5.8.2 Hot Water Disinfection Systems

Hot water disinfection systems should be monitored for temperature and time of exposure to hot water as specified by the manufacturer. Also, hot water disinfection should be performed at least as often as recommended by the manufacturer. The temperature of the water should be recorded at a point farthest from the water heater-that is, where the lowest water temperature is likely to occur. It is recommended that the water temperature be measured each time a disinfection cycle is performed. A record that verifies successful completion of the heat disinfection should be maintained. Successful completion is defined as meeting temperature and time requirements specified byte equipment manufacturer.

7.5.8.3 Chemical Disinfection

Chemical disinfection should be specified by the manufacturer to indicate the type of chemical used and frequency of disinfection. A record of all chemical disinfection should be maintained.

7.5.9 Installation and validation of water treatment systems for hemodialysis

- Each phase of the installation, operational and performance qualification should be documented and signed off by the manufacturer and the water safety committee for water quality.

7.5.9.1 Installation

- The installation of the water treatment infrastructure should be by qualified personnel in line with the manufacturer's recommendations. Upon competition the stakeholder should provide:

➢ Full system documentation should be available including system flow diagrams, layout, log books and operator's manuals.

- A schematic diagram should identify components, valves, sample ports, and flow direction.

➢ Major water system components should be labeled in a manner that not only identifies a device but also describes its function

- How performance is verified
- What actions to take in the event performance is not within an acceptable range.

➢ An installation qualification report to define and provide documented proof that the system in accordance with the approved plans and the manufacturer's technical requirements and specifications.

➢ An example of the type of labelling required for each component to describe how each component is tested and its action limits.

Example of label

- Water softener protects RO by removing calcium and magnesium hardness ions adding sodium ions in their place
- Test for hardness at the end of each treatment day
- Check the brine tank daily to ensure it is half filled with salt, add if necessary
- Check timer daily to ensure it is the correct time of the day, incorrect timer setting may cause the softener to regenerate during dialysis and can result automatic shutdown of RO

7.5.9.2 Performance validation and system verification

- The healthcare facility should document that the dialysis water treatment and dialysis fluid production systems, when installed and operated are according to the manufacturer's recommendations and it met the required quality levels and it "fit for purpose".
- The third party contractor of the water treatment system should draw up the validation plan (figure-54), which must be submitted to and approved by hospital engineering and maintenance, water safety committee and other designated stakeholders.
- Upon completion of the performance validation the following documents should be available:

➢ Test records

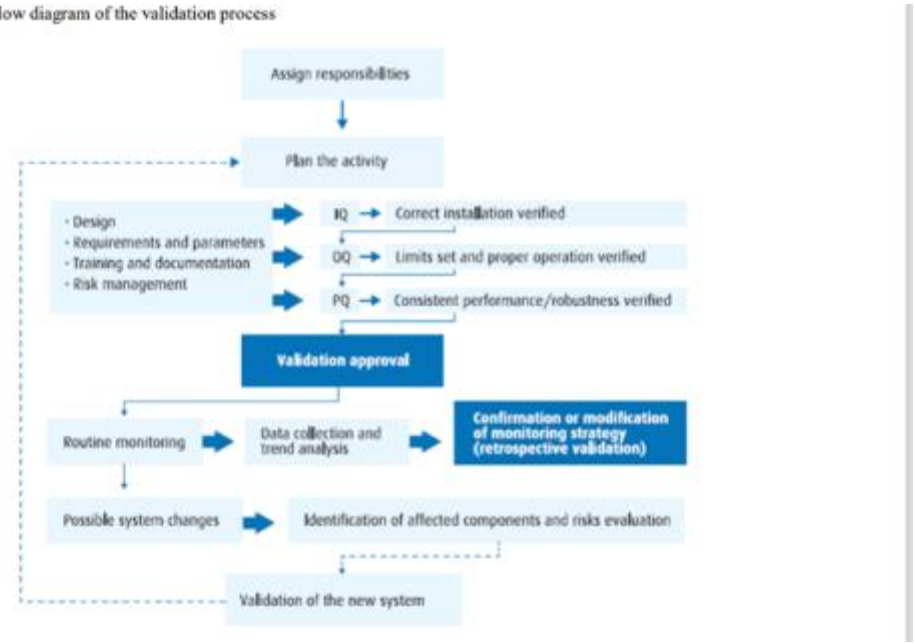
➢ Chemical and Microbial analyses

➢ Key performance indicators [for example, pretreatment efficiency, reverse osmosis (RO) recovery/rejection rate, etc.]

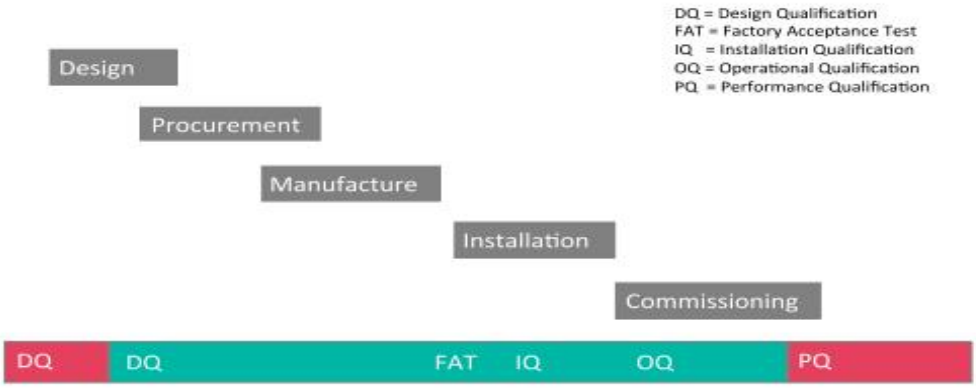
➢ (initial) trend analysis

Figure-54: flow diagram of the validation process of new dialysis plant

A flow diagram of the validation process



A typical validation timeline



A detailed diagram of the validation process is given in BS EN ISO 23500; 2015: *Guidance for the preparation and quality management of fluids for haemodialysis and related therapies*. It is also detailed in Boccato C., Evans D., Lucena R., Vienken J. "Water and Dialysis Fluids – a quality management guide". PABST, 2015 [3]

Reference Guideline on water treatment systems, dialysis water and dialysis fluid quality for haemodialysis and related therapies Clinical Practice Guideline Prepared on behalf of The Renal Association1 and The Association of Renal Technologists2 January 2016 Review Date January 2020

7.5.9.2 Completion of installation of water treatment system

- The water treatment facility or infrastructure when completed should be confirmed to have met all aspects of the design specification. **This needs to be agreed and signed off by the installer, hospital engineering and maintenance, and water safety committee.**

- The RDU head (with the EOH and IPC clearance) may authorize use of dialysis fluid for patient treatments once chemical and microbiological test results are acceptable with the quality requirements in the manufacturer's specifications, and any applicable regulatory requirements.

7.5.10 Training

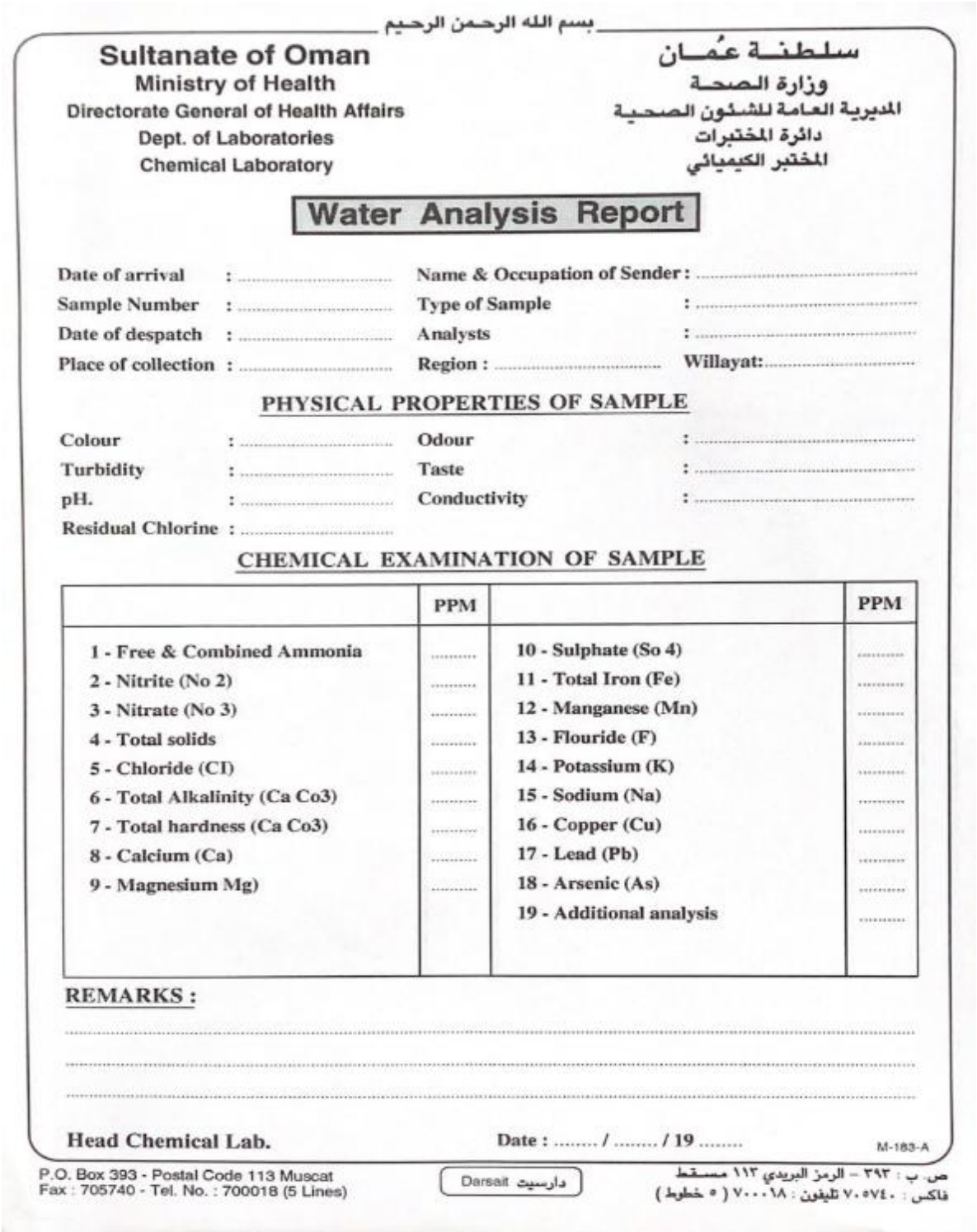
Training of operators of the water treatment facility:

- Should be trained in the use of the water treatment equipment by the manufacturer
- The training should be specific to the functions performed
- Competence with procedures should be assessed and documented.
- Periodic audits of the operators' compliance with procedures should be undertaken and documented and there should be an ongoing training programme to maintain the operator's knowledge and skills.
- Conduct continuing education and development.

7.6 RECORD KEEPING FOR WATER QUALITY

- Records of laboratory results related to water quality monitoring and any corrective and preventive action related to water quality shall be maintained by EOH, IP&C, Engineering and other concerned departments e.g. public health/HSE.
- The results of both microbial and physicochemical tests must be shared the concerned health institution, environmental & occupational health, infection prevention & control unit and maintenance sections at governorate level.
- Records of water quality sampling results, laboratory reports, and chemicals used for treatment must be available at all times and be retained for a period of **at least five years.**
- Water results are released by Central Public Health laboratories on the designated forms for bacteriological and chemical testing showed in Figure-23,24, 50&55

Figure-55: Chemical Examination form of water samples



بسم الله الرحمن الرحيم

Sultanate of Oman
Ministry of Health
Directorate General of Health Affairs
Dept. of Laboratories
Chemical Laboratory

سلطنة عُمان
وزارة الصحة
المديرية العامة للشئون الصحية
دائرة المختبرات
المختبر الكيميائي

Water Analysis Report

Date of arrival : .....
Name & Occupation of Sender : .....
Sample Number : .....
Type of Sample : .....
Date of despatch : .....
Analysts : .....
Place of collection : .....
Region : .....
Willayat: .....

PHYSICAL PROPERTIES OF SAMPLE

Colour : .....
Odour : .....
Turbidity : .....
Taste : .....
pH. : .....
Conductivity : .....
Residual Chlorine : .....

CHEMICAL EXAMINATION OF SAMPLE

	PPM		PPM
1 - Free & Combined Ammonia	.....	10 - Sulphate (So 4)	.....
2 - Nitrite (No 2)	.....	11 - Total Iron (Fe)	.....
3 - Nitrate (No 3)	.....	12 - Manganese (Mn)	.....
4 - Total solids	.....	13 - Flouride (F)	.....
5 - Chloride (CI)	.....	14 - Potassium (K)	.....
6 - Total Alkalinity (Ca Co3)	.....	15 - Sodium (Na)	.....
7 - Total hardness (Ca Co3)	.....	16 - Copper (Cu)	.....
8 - Calcium (Ca)	.....	17 - Lead (Pb)	.....
9 - Magnesium Mg)	.....	18 - Arsenic (As)	.....
		19 - Additional analysis	.....

REMARKS :

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.....

.....

Head Chemical Lab.

Date : ..... / ..... / 19 .....

M-183-A

P.O. Box 393 - Postal Code 113 Muscat
Fax : 705740 - Tel. No. : 700018 (5 Lines)

Darsait دارسيت

ص.ب : ٣٩٣ – الرمز البريدي ١١٣ مسقط
فاكس : ٧٠٥٧٤٠ تليفون : ٧٠٠٠١٨ (٥ خطوط)

7.7 TRAINING AND COMPETENCY REQUIREMENTS

The Responsible focal points in each Directorate General shall ensure that they provide proper training to all employees engaged in the water safety plan. Training can be targeted according to the assigned roles and responsibilities of each employee in water safety plan. For example, water sample collector should receive training on the risk assessment process, items required for water sampling, site of collection,

frequency of collection, type of tests, detailed steps of collection procedure, proper labelling, laboratory request forms, sample storage and transportation requirements, cool box & icepacks cleaning and disinfection, health and safety consideration during water collection and receiving and communicating laboratory test results, records keeping and documentation process, etc. Training should be conducted through theoretical and practical methods with hands-on training in the field. Training should be followed by periodic supervisory and auditory visits to the trainees.

8. ROLES & RESPONSIBILITIES

Table-31 highlight the main responsibilities of stakeholders which be held responsible for implementation of the water quality SOPs in the healthcare institutions

Table-31: the main responsibilities of stakeholders which be held responsible for implementation of the water quality SOPs in the healthcare institutions

Stakeholder	Responsibilities
Environmental & Occupational Health (EOH) department	1. Issuing and updating water quality SOPs in collaboration with other stakeholders. 2. Managing water quality monitoring program. 3. Supervising and auditing the extent of the commitment of water safety teams in the Directorate Generals (DGs) in performing its tasks related to water quality according to this SOP and their water safety plan. 4. Follow up on the availability of required work tools and equipment's in collaboration with other concerned stakeholders. 5. Implementing training programs related to monitoring water quality in collaboration with other stakeholders. 6. Coordination with stakeholders related to the water-monitoring program. 7. Receiving the results of statistical reports on water from DGs and their analysis and action. 8. Feedbacks and report from/to the governorates related to water quality. 9. Conducting researches in water quality in collaboration with other stakeholders.
Infection prevention& control department	1. Collaborate with stakeholders in issuing and updating the guidelines/SOP of water quality. 2. Collaborate with other stakeholders to ensure that this policy and procedure are implemented in the healthcare facilities 3. Collaborate with stakeholders in ensuring that water quality is monitored periodically and results are kept and maintained. 4. Collaborate with stakeholders for the action to be taken when in case of unacceptable results. 5. Collaborate with stakeholders in conducting complete investigation and immediate appropriate corrective action for any contamination complaint. 6. Collaborate with stakeholders in developing a corrective action plan responding to various disease outbreaks or water contamination incidents. 7. Collaborate with stakeholders in following immediate and appropriate corrective action if pathogenic bacteria are present in the water system.

	8. Write water contamination incident report to engineering and maintenance, water safety committee for analysis and action. 9. Collaborate with stakeholders in reviewing each unscheduled maintenance event carefully to proceed without compromising the facility water supply. 10. Collaborate with HSE and designated department to ensure the chemicals to be used for water treatment programs are recommended by manufacturers IFUs. 11. Collaborate with stakeholders in their area of expertise when training and improving skills of staff in water quality is required.
Directorate General Of Projects And Engineering Affairs	1. Supervise and follow up the availability of required work tools and equipment's in the DGs to maintain high standards of water quality in healthcare facilities and RDUs. 2. Collaborate with other stakeholders in supervising and auditing the extent of the commitment of water safety teams in the Directorate Generals in performing its tasks related to water quality according to this SOP and their water safety plan. 3. Collaborate with other stakeholders in their area of expertise when training and improving skills of staff in water quality is required. 4. Follow up the proper implementation and monitoring of the preventive and control measures in water quality program according to the water safety plan in healthcare facilities in routine and emergency bases e.g. water system regular maintenance and water tank cleaning and disinfection. 5. Communicate with other stakeholders as required in all issues related to water quality. 6. Receiving periodic report from DGs on proper implementation of water safety programs and any challenges in water quality. 7. Providing expert recommendation and action for issues related to water quality.
Environmental & Occupational Health (EOH) section / Infection Prevention& Control sections in Directorate Generals (DGs)	1. Conducting water quality risk assessment in their institutions. 2. Preparing water safety plan in their DG with other stakeholders. 3. Be a member &/or leader of the water safety committee/team in their institutions. 4. Conducting the necessary water quality related surveillance system in their institutions. 5. Follow-up and supervision of the water quality-monitoring program in health facilities by carrying out field visits to the healthcare institutions and especially to the Renal Dialysis centers once a month or whenever necessary. 6. Continuous coordination with the stakeholders implementing the water quality program in healthcare institutions (Environmental& Occupational Health, Nephrology departments, Engineering & Maintenance, laboratories, contracting companies, others as required. 7. Ensure that the required samples are taken from the healthcare institutions and elsewhere when required according to plans prepared by them. 8. Ensure that samples are sent to the designated laboratories on time. 9. Follow up on receiving water test results.

	10. Follow up on supervising the process of taking corrective measures in the event of positive samples in coordination with the relevant authorities and stakeholders. 11. Work on training employees of public health units and Renal Dialysis centers and other concerned department in hospitals on the correct methods for taking samples, and on the interpretation analysis results and required corrective actions. 12. Coordinating with the proper concerned stakeholders in the DG/Hospitals to ensure that healthcare institutions adhere to the requirements for monitoring and control measures of the water quality. 13. Coordination with the concerned stakeholders to provide all the necessary requirements for implement water quality program. 14. Discussing and providing possible solutions to the obstacles facing the implementation of the water quality program in coordination with the relevant authorities in the Directorate General. 15. Any other tasks related to monitoring the quality of water as deemed appropriate by the concerned authority.
Public Health Units staff	1. Follow up on the implementation of the water quality monitoring program within the health care facilities in their area periodically as agreed by the water safety committee/team at their DG. 2. Ensure that the required samples are taken and sent for examination according to the water safety plan and when required. 3. Follow up on the results of the tests, share them with the concerned water safety committee/team at their DG e.g. EOH, IPC & Engineering and keep copies of them in the department. 4. Follow up closely on taking the corrective measures required by the concerned water safety committee/team at their DG in the event of non-conforming samples and keep record of these in the department. 5. Coordination with relevant water safety committee/team at their DG in implementing a water quality monitoring program inside the healthcare facilities e.g. water tanks cleaning and disinfection. 6. Submitting periodic reports to the Environmental &Occupational Health Department of the DG/Governorate on the implementation of water quality programs. 7. Contributing to the implementation of other tasks assigned to them according to the nature of the work.
Environmental and Occupational Health program focal points in the healthcare institutions	1. Should regularly follow up the water samples results and implementation of any recommendations or control measures e.g. cleaning and disinfection of water tanks concerning water quality in their healthcare institutions. 2. They should also report any issues related to water quality in their facility. 3. The EOH focal points should help in increasing staff and public awareness regarding water quality.

Nephrology department at RDUs	1. Collaborate with the concerned team in establishing and following up the surveillance methods for detecting healthcare-associated infection related to water quality. 2. Identifying patients who are suspected to develop adverse events related to water quality and communicated with concerned team for further investigation and management. 3. Collaborate with other team members to manage water quality at renal dialysis units each in their areas of expertise.
Head of the healthcare institutions	Responsible to assist & facilitate the EOH program focal points and other stakeholders work in their responsibilities for all issues related to water quality.
All healthcare workers	1. Responsible to report any issues related to water quality to the EOH program focal point in their facility or in the community. 2. They should also help in increasing public awareness regarding water quality.
Engineering affairs and maintenance departments in Directorate Generals (Hospitals and governorates)	1. Be member of water safety committee/team of the DG/healthcare facilities 2. Help in conducting the appropriate risk assessment of water system in healthcare facilities and preparing water safety plan in their DG/healthcare facilities. 3. Responsible for implementing and monitoring preventive and control measures in water quality program according to the water safety plan in healthcare facilities in routine and emergency bases e.g. water system regular maintenance and water tank cleaning and disinfection. 4. Ensure the availability of required work tools and equipment's to maintain high standards of water quality in healthcare facilities and RDUs in collaboration with other concerned stakeholders. 5. Conducting and managing the operation and maintenance of water system in healthcare facilities and renal dialysis centers. 6. Communicate with other stakeholders as required in all issues related to water quality in healthcare facilities. 7. Collaborate with other stakeholders in their area of expertise when training and improving skills of staff in water quality is required.
Central Public Health Laboratories	1. Collaborate with other stakeholders in issuing and updating the guidelines/SOP of water quality. 2. Responsible for the analytical testing of water samples (physio-chemicaland microbiological testing). 3. Provision of the bottles required for the water testing. 4. Communication of the results with the concerned parties. 5. Collaborate with other stakeholders when training and improving skills of staff in water testing is required. 6. Reporting any issue related to improper transportation and bad conditions on receiving water samples to the concerned stakeholders. 7. Conducting researches in water quality in collaboration with other stakeholders to improve the program.

9. DOCUMENT HISTORY AND VERSION CONTROL

Version	Description	Review Date
1	Initial Release	March 2028

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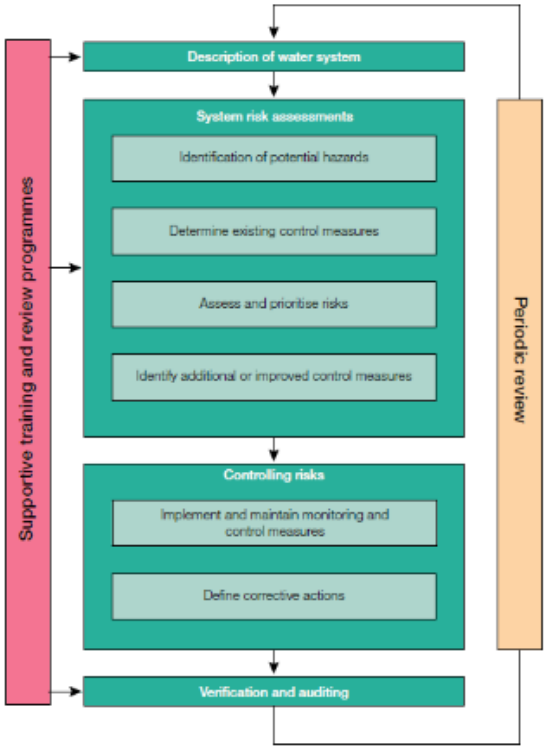
11. ANNEXES

11.1 ANNEX-1: WATER SAFETY PLAN (WSP)

- Water safety plan (WSP): is A risk-management approach to the safety of water that establishes good practices in local water distribution and supply. It will identify potential hazards, consider practical aspects, and detail appropriate control measures.
- The WSP is a holistic approach to manage water for all uses (including diagnostic and treatment purposes) so that it is safe for all users including those most at risk of waterborne infections as a consequence of their illness or treatment.
- Healthcare organizations should develop a WSP, which provides a risk-management approach to the safety of water and establishes good practices in local water usage, distribution and supply.
- The plan should be kept under continual review. The WSP should be reviewed on an annual basis and when there are alterations, repairs, changes of use, building works, or critical incidents.

- The content of a WSP will depend on the size and complexity of the healthcare institution's water system. The plan should incorporate basic elements as shown in figure-56.

Figure-56: Basic elements of the water safety plan



11.1.1 Healthcare facility water management program checklist

This checklist is intended to assist in the development of an all-hazards approach to water management in a healthcare facility. Please follow the steps below.

11.1.1.1 Establish a Water Management Program Team

- For all facility types, establish clear lines of communication to facilitate dialogue with representatives from the water utility/drinking water provider, as well as the local health department, on an as needed basis.

☐ Define membership (at a minimum, the following 'roles' should be represented; may include others depending on facility size, type:

- Facility administration
- Facilities management
- Facilities engineer
- Infection prevention
- Environmental &Occupational Health professional

☐ Develop a charter (table-32) that defines roles and responsibilities of members, chair, meeting schedule, etc.

☐ Have you identified team members who should:

☐ Y ☐ N Be familiar with the facility water system(s)

☐ Y ☐ N Identify control locations and control limits

☐ Y ☐ N Identify and take corrective actions
☐ Y ☐ N Monitor and document program performance
☐ Y ☐ N Communicate to staff, health department, and representatives of the drinking water supplier (if needed)
☐ Y ☐ N Oversee the program
☐ Y ☐ N Access necessary resources to implement changes
☐ Develop the Water Management Policies and Procedures, Plans, and Protocols

Table-32: Water Management Team

Name	organization	Position	Responsibilities	Skills, knowledge, and experience (reasons for being in team)	Phone Number	Email Address

11.1.1.2 Describe your building and water systems

☐ Text description of the facility building and water systems, campus water systems, etc.
☐ Develop flow diagrams that describes these systems

Table-33 is a guide on Facility building description and Inventory of System Components.

Table-33: Facility building description and Inventory of System Components (edit, add, or delete as needed)

Component	Characteristic	Details
Facility building description	Type of healthcare facility	
	Address/Location	
	Year built	
	Number of floors/buildings/wards	
	Number of beds	
	Number of intensive care unit beds (including surgery, coronary care, etc.)	
	Do you have a solid organ transplant program?	Yes No
	Do you have a bone marrow transplant program?	Yes No
	Can windows in patient rooms be opened?	Yes No
	If windows in patient rooms can be opened, are cooling towers visible from these windows?	Yes No
	Are patients exposed to portable humidifiers?	Yes No
	Do any patients use aerosol generating devices, such as CPAP, BiPAP, or nebulizers?	Yes No
	Are there therapeutic whirlpools/spas on site?	Yes No
	Has your facility previously experienced Legionnaires' disease cases that were "possibly" or "probably" facility acquired? If yes to a Legionnaires' disease case, enter the year of the most recent case	Yes No
Uses of Water	□ Drinking and food preparation (includes water being fed into ice machines and water/soda dispensers) □ Clinical uses such as renal dialysis, hydrotherapy, dental services, birthing tubs, and cardiac bypass units, burn unit, respiratory therapy, □ Pharmaceutical preparations □ Central sterilization services, endoscopy washers □ Laboratories services	

	□ Showers/sinks for personal hygiene, hand hygienec, wash for prayers □ Toilet flushing □ Laundry □ Utensils cleaning □ Environmental cleaning □ Sprinklers (fire suppression and irrigation) □ Decorative fountains □ Heating or cooling units (cooling tower, swamp cooler, humidifier) □ Recreational water (pool, hot tub) □ Emergency services e.g. fire-fighting, eye-wash □ Irrigation system	
Water users	Number of inpatient/outpatient	e.g. 50/100/day
	Staff	e.g.10 staff members
	Residential functions (number of residents)	e.g.20 residents
	Guests/Visitors	e.g.50 visitors/day
Hot water heater(s)	Number	
	Location	
	Capacity	
	Type of heating	e.g. solar, gas, instant
	Max temperature	
	Average temperature	
	Age of units	
Water storage tank(s)	Number (Separate tanks should also be provided for storage of different water supplies, for example central-heating header tanks, cold water storage, softened water, firefighting water, and high-risk areas e.g. Laboratories, pathology and mortuary)	
	Location (should not be located where there is any likelihood of flooding, excessive heat gain or any other factor that could affect the contents of the tank)	
	Capacity	
	Material (as different materials hold differing risks and react differently to chemicals)	e.g. concrete, steel, plastic

	Water age (time since disinfection)	
	Is there a regular cleaning/disinfection/maintainance of the water storage tanks? If yes attach the schedule	
Incoming water provide details of incoming water, both potable and non-potable	Company name	e.g. water utility company
	Water supplier contact information	
	Source: What is the source of the incoming water?	(e.g. governmental supply, well, surface, rainwater)
	Disinfection type: What treatment processes (filtration, chlorine/monochloramine disinfection) does the incoming water undergo before entry into the facility?	e.g. chlorine, monochloramine
	Entry point: Where are the entry points for the incoming water into the facility?	
	Reliability: How reliable is the incoming water? Are there often water shut offs, loss of pressure, burst pipes...etc. in the past 6 months? If yes, explain.?	
	Emergency supply: Is there an emergency supply of water like in water storage tanks? What is the source and quality of this water? Note: Where a dual supply exists, the public supply should take precedence and the private source should only be used as back-up. Before commissioning or re-commissioning a back-up supply, it should be subject to flushing and testing, to ensure potability.	
Quality of Incoming Water Describe the typical water quality characteristics of the incoming water	Disinfection residual in the water entering the facility	
	Temperature	
	pH	
	Bacteriological quality	
Facility water treatment Is the water treated within your facility,	Type	e.g. chlorine dioxide
	Location	
	Dose rate (if chemical treatment)	e.g. X mg/L

like a secondary disinfection system?	Target residual at most distal point in water system (if chemical treatment)	e.g. X mg/L
Pipework	Age	
	Material e.g. copper, steel, stainless steel and plastics	
	Type and extent of insulation	
	Number of dead legs and their locations	
	Areas of low flow	
	% of pipework that is accessible	
	Materials made by pipe joints and fixtures	
	Condition: sign of leakage or corrosion or limescale	
	Is there a regular removal/cleaning/descaling/ maintainance/ replacement of the water pipes?	
Hot water system	Number	e.g. 5 sinks and 5 showers in 1st floor bathroom, 2 sinks in kitchen, 2 sinks in 2nd floor bathroom
	Type	
	Location of hot water outlets	
	Are cisterns and/or water storage holding tanks used to store potable water before it is heated? If yes, explain.	
	Is there a recirculation system? If yes, describe where it runs and delivery/return temperatures if they are measured.	
	Type of system	e.g.: instantaneous heater, hot water heater, solar heating…etc.
	Describe the manufacturer details about the system. Include manufacturer and date of installation.	
	Total capacity	

	Usual temperature setting	
	What is the maximum hot water temperature at the point of delivery?	
	Are hot water temperatures ever measured at the points of us? If yes, how it is recorded.	
Cold water outlets	Number	
	Type (e.g. sink, shower, toilet, bathtub)	
	Location	
	Is there a regular removal/cleaning/descaling or replacement of the water outlets, hoses and other components?	
Potable Water System Monitoring	Are cold water temperatures ever measured at the points of use? If yes, how it is being recorded?	
	Do you have a supplemental disinfection system? If yes, describe.	
	Are potable water disinfectant levels ever measured at the points of use? If yes, how it is being recorded?	
	Are potable water pH levels ever measured at the points of use? If yes, how it is being recorded?	
	Do you perform routine flushing of the water system?	
	Do you perform routine Legionella testing?	
Warm water outlets	Number	
	Type	
	Location	
TMVs and tempering valves	Type	
	Number	
	Age	
	Location	
	Distance from outlets	

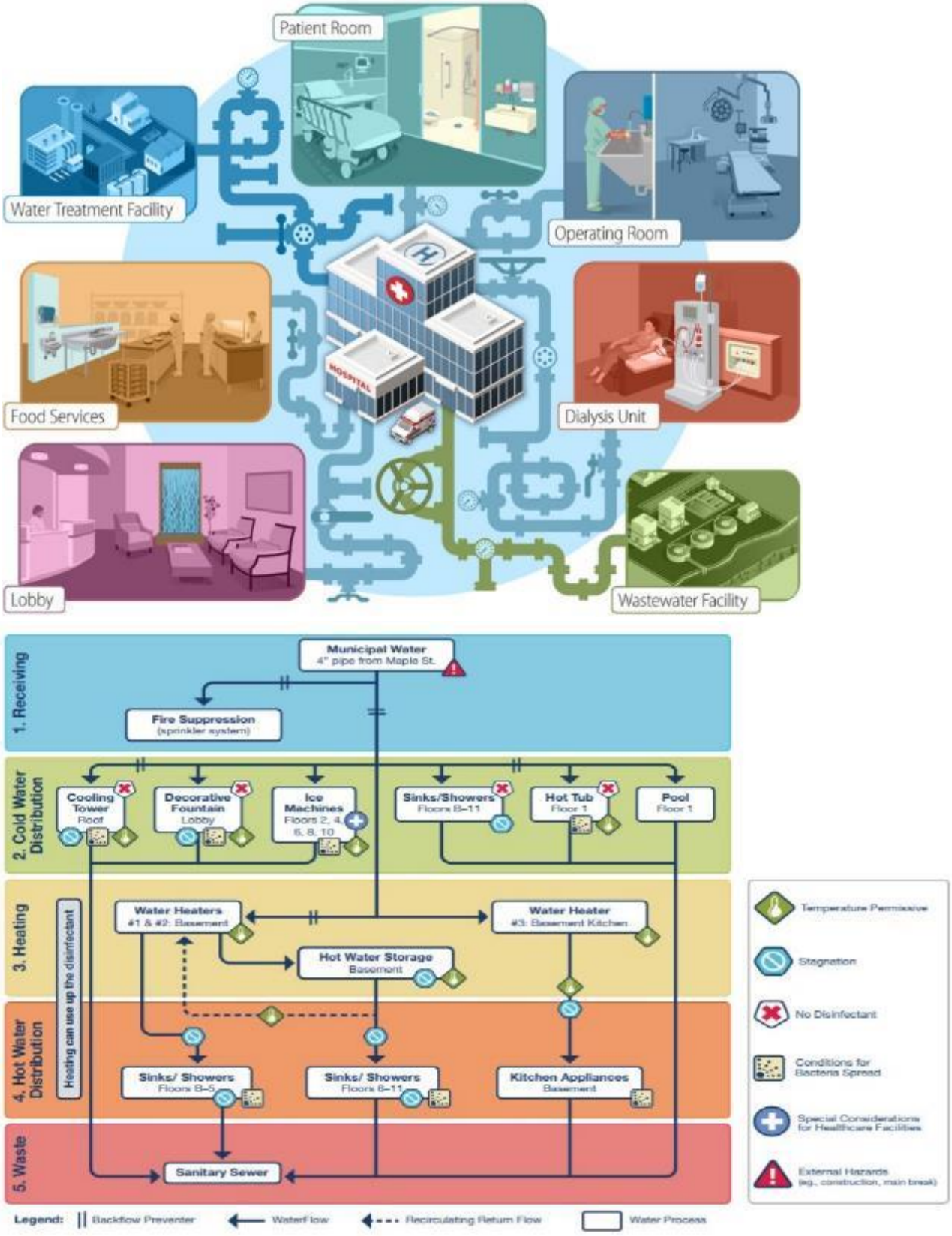
	Date of last service	
	Accessibility	
	Maximum temperature at outlet	
	Is there a regular removal/cleaning/descaling or replacement of the TMVs?	
Backflow prevention	Number and location	
	Date of last inspection	
Type of emergency water systems	e.g. building 1: fire sprinklers, safety shower, eye wash station Building 2: none	
Cooling System (i.e. Cooling Towers/Swamp Coolers/Evaporative Condensers)	Cooling System type e.g.: cooling tower, central AC	
	Location	
	Number of Cells	
	Time of Operation (Months/Year)	
	Makeup Source	
	Purpose (e.g. refrigeration or residential cooling)	
	Cooling equipment flow/schematic diagram: □ Cooling towers with their individual number of cells and circulation pumps marked □ System pump and control valves □ Standby equipment, e.g. spare pumps □ Location of system bleed valves □ Associated storage tanks □ Associate pipework □ Location of chemical dosing points and/or injection points □ Location of System drain valve □ Any parts that may be temporarily out of use □ Other systems □ Water quality monitoring points for water quality measurements, bacteriological indicator sampling, and Legionella sampling	
	Cooling Equipment Water Quality Monitoring	
Central humidifier	Type e.g. Whole building humidifier	

Ice Machine	Building/location	
	Manufacturer	
	Model	
	Filter type (e.g. stainless steel, pleated, carbon)	
	Filter's micron cut-off	
	Is this machine also a water dispenser?	Yes No
	Who is responsible for maintaining ice machines?	
	How often are ice machines cleaned? (e.g. daily, weekly, monthly)	
	What are the cleaning protocols, including description of steps taken and chemicals used?	
	How often are ice machines sanitized?	
	What are the sanitization protocols, including description of steps taken and chemicals used?	
Respiratory Therapy Use, Respiratory Aerosolized Care	What sterile solutions are used for nebulization?	
	If multi-dose vials are used, describe manufacturer's instructions for handling, storing, and dispensing the medications.	
	Are jet nebulizers used for only one resident?	
	How are jet nebulizers cleaned, dried, and stored?	
	How are mesh nebulizers that remain in the ventilator circuit cleaning, disinfected, and changed?	
	Who is responsible for maintaining aerosolized care equipment?	
	How is oxygen equipment cleaned, and sanitized?	
	Who is responsible for cleaning and maintaining oxygen equipment?	
	For Mechanical Ventilation or Tracheostomy: Describe protocols for ensuring condensate does not drain towards the resident.	

	For Mechanical Ventilation or Tracheostomy: Are single-use open-system suction catheters used?	
	For Mechanical Ventilation or Tracheostomy: Describe protocols for how sterile fluid is used to remove secretions from the suction catheter if the catheter is used for re-entry into the resident's lower respiratory tract	
	For Mechanical Ventilation or Tracheostomy: How are machines or equipment maintained and cleaned?	
	For Mechanical Ventilation or Tracheostomy: Who is responsible for cleaning and maintaining equipment?	
Water softener	Type (knowing type is important as Softeners using salt-regenerated ion-exchange resins increase the sodium content of the water during softening, and this may be undesirable for children and infants (including the making up of babies' bottles) and anyone on strict salt-restricted diets)	
	Number	
	Purpose and location of the softener e.g. steam boilers (to prevent sludge and limescale building up), hot water services (where outlets particularly showers are affected by limescale), laundries (high maintenance costs and the uneconomic uses of soap or detergents are caused by the presence of hardness)	
Water metering	Daily water consumption	
	Peak demand and the rate of make-up from source of supply	
Pressurized/supply pumps	Number	
	Location	
Other components	Irrigation system	
	Hydrotherapy/birthing tubs	
	Decorative water fountain	

Figure-57 you will find an example of schematic drawings for reference.

Figure-57: Example of a schematic drawing of a building water system



11.1.1.3 Identify external hazards (compromised supply) and describe plans for mitigating or managing these events:

☐ Trace or no disinfectant residual upon entry into the building
☐ Water main breaks
☐ Low-pressure events
☐ Flushing hydrants
☐ Nearby construction
☐ Other (specify):

11.1.1.4 Identify areas where biofilms may be present and areas where opportunistic pathogens of premise plumbing may grow and spread

☐ Identify storage tanks and describe (water turnover rates, residence times, etc.)
☐ Identify areas of stagnation (dead legs, vacant units/rooms, etc.)
☐ Identify areas with hand-held showers, faucets with aerators/flow restrictors,
☐ Identify areas with no residual disinfectant
☐ Identify areas where temperatures can support microbial growth
☐ Identify locations of commodes and hoppers
☐ Y ☐ N Do all commodes and hoppers have covers that can be closed when flushing?
☐ Y ☐ N If no cover present, are they located in a separate room with a door that can closed?
☐ Identify sinks and sink locations
☐ Y ☐ N Do sinks in patient care areas have aerators and flow restrictors.
☐ Y ☐ N Identify electronic sinks/faucets and temperature setting for mixing valve
☐ Y ☐ N Do all sinks in patient care areas have drains that are offset from faucet flow stream?
☐ Y ☐ N Are there barriers (splash guards) between sinks and adjacent medication preparation areas and patient supplies?
☐ Y ☐ N If splash guards are not present, is medication prep and clean supply storage > 3 feet from sinks?

Table-34 below lists some examples of potential hazardous events commonly associated with a facility's water system.

Table-34: Examples of potential hazardous events commonly associated with a facility's water system

System Components	Event	Control Measure(s)
Incoming water	Incoming water contamination	
	Loss of supply	
	Failure of backflow prevention device	
Solar preheat systems	Water stored at or below 60^{o}C	
	Booster failure	
Hot water storage	Heater failure or under capacity	

	Build up of sludge in tank	
	Thermal stratification	
	Storage temperature too low(60^{o}C)	Ex: Increased stored water temperature
Cold water storage	Water stagnation	
	Contamination of storage tank	
	Build up of sludge in tank	
	Water temperature above 20^{o}C	
Pipework/plumbing	Dead legs and capped pipes	
	Cross connections between potable and non-potable pipes	
	Deterioration of insulation (lagging) around pipes	
	TMV malfunction or inadequate maintenance	
	Long distances between TMVs or tempering valves and outlets	
	Corrosion due to deterioration of materials	
	Pipe leaks due to age	
	Heating of cold water in pipes (>20^{o}C)	
	Low flow in recirculating loops	
	Lack of accessibility for repairs and maintenance	
Outlets	Poorly maintained outlets	
	Unused outlets	
	Flow restrictors	
	Aerators	Ex: remove aerators
	Outlets that hold water after use (e.g. shower heads or hoses)	
Treatment systems	Dosing failure	

	Insufficient dosing	Ex: Increase dosing frequency
	Running out of disinfectant	

11.1.1.5 Conduct an Infection Control Risk Assessment (ICRA Adapt for potential water exposures both direct and indirect)

- It is especially critical that healthcare facilities complete an environmental risk assessment prior to developing a water management plan.
- A risk assessment forms an integral component of the WSP to identify potential hazards (which may be microbial, chemical or physical) in the system, risks of infection to patients, staff and visitors, and other indicators of water quality (for example, taste, odour, flavour and appearance if intended for drinking). Follow the steps below for more detaisl:

☐ Identify patients at increased risk (e.g., burn patients, patients with immune suppression, patients with lung disease/injury, patients with indwelling devices (e.g., central venous catheters, peritoneal dialysis catheters, etc.), patients with open wounds, patients undergoing endoscopy, etc.)

☐ Risk stratify procedures and processes

☐ Identify potential exposures to water

- The following sections describe the water infection control risk assessment and environmental risk assessment. Both assessment should be used.

11.1.1.5.1 water infection control risk assessment (WICRA)

- A water infection control risk assessment (WICRA) is a critical component of water management programs (WMP) in healthcare settings (Figure-58). WMP team members can use a WICRA to evaluate water sources, modes of transmission, patient susceptibility, patient exposure, and program preparedness.
- A WICRA may be conducted during the initial development of a WMP and updated over time. The frequency of subsequent assessments should be informed by and defined in the WMP.
- Performing a WICRA using this tool will generate numerical scores of perceived risk, which can assist in prioritizing WMP activities such as monitoring and mitigation efforts. Total risk scores are intended for internal prioritization and do not hold significance outside the context of each site-specific WMP. Typically, the risks with highest scores will be used for priority focus, though some with lower scores may be given special consideration (e.g., mitigation can be quickly and easily implemented). Specific risk management actions should be determined in accordance with WMP activities.

Figure-58: Water Infection Control Risk Assessment (WICRA) for Healthcare Settings

Facility Name: **Assessment Location:**

Performed by (names): **Assessment Date:**

WMP Team Role(s) *(check all that apply):*

- ☐ Hospital Epidemiologist/Infection Preventionist
- ☐ Facilities Manager/Engineer
- ☐ Environmental Services
- ☐ Compliance/Safety Officer
- ☐ Risk/Quality Management Staff
- ☐ Infectious Disease Clinician
- ☐ Consultant
- ☐ Equipment/Chemical Acquisition/Supplier
- ☐ Other *(please specify):*

Location	Water Source: – Sinks – Toilets – Endoscopes – Lactation equipment – Hoppers – Heater cooler devices – Enteral feeding – Humidification devices – Ice machines – Bathing procedures – Drain – Mechanical ventilators	Modes of Transmission: – Direct contact *(e.g., bathing, showering)* – Ingestion of water *(e.g., consumption of contaminated ice)* – Indirect contact *(e.g., from an improperly reprocessed medical device)* – Inhalation of aerosols dispersed from water sources *(e.g. faucets with aerators)*	Patient Susceptibility Highest = 4 *(e.g., BMT, solid-organ transplant, hematology, medical oncology, burn unit, NICU)* High = 3 *(e.g., non-transplant ICUs, ORs)* Moderate = 2 *(e.g., general inpatient units)*	Patient Exposure High = 3 *(e.g., high frequency, magnitude, and duration)* Moderate = 2 *(e.g., combination of high and low frequency, magnitude, and*	Current Preparedness Poor = 3 *(e.g., limited policies and procedures, staff practice, and mitigation strategies)* Fair = 2 *(e.g., some policies and procedures, staff practice, and mitigation strategies)* Good = 1	Total Risk Score = Patient Susceptability x Patient Exposure x Preparedness	Comments

	– Indoor decorative fountains – Oral care – Showers	– Aspiration of contaminated water *(e.g. use of tap water to flush enteral feedings)*	Low = 1 *(e.g., waiting rooms, administrative office areas)*	*duration)* Low = 1 *(e.g., low frequency, magnitude, and duration)* None = 0 *(e.g., patients are not exposed to the water source)*	*(e.g., robust policies and procedures, staff practice, and mitigation strategies)*		

- This following WICRA tool (Figure-59) provides a completed example for a Burn Intensive Care Unit (BICU). This may be used as a reference when completing the fillable document, which is intended to be flexible for different WMP needs.

Figure-59: A completed example for a Burn Intensive Care Unit (BICU)

Water Infection Control Risk Assessment (WICRA) for Healthcare Settings

Facility Name: Hospital A **Assessment Location:** Burn ICU

Performed By (names): Jane Smith and John Doe **Assessment Date:** 10/01/2020

WMP Team Role(s) *(check all that apply):*

- ☑ Hospital Epidemiologist/Infection Preventionist
- ☐ Risk/Quality Management Staff
- ☐ Equipment/Chemical Acquisition/Supplier
- ☑ Facilities Manager/Engineer
- ☐ Infectious Disease Clinician
- ☐ Other *(please specify):*
- ☐ Environmental Services
- ☐ Consultant
- ☐ Compliance/Safety Officer

Location	Water Source	Modes of Transmission	Patient Susceptibility (Highest = 4, High = 3, Moderate = 2, Low = 1)	Patient Exposure (High = 3, Moderate = 2, Low = 1, None = 0)	Current Preparedness (Poor = 3, Fair = 2, Good = 1)	Total Risk Score (= Patient Susceptability x Patient Exposure x Preparedness)	Comments
BICU Inpatient Rooms	Sink counter storage of patient care supplies	Indirect contact; splashing onto supplies	4	3	3	36	Install splash guards; QI for sink hygiene; and flushing
BICU Inpatient Rooms	Toilets without lid	Direct contact	4	3	2	24	Place lid on toilet if in patient room
BICU Soiled Utility	Hopper, no lid, behind closed door	Indirect contact	4	2	1	8	Automatic door closure; appropriate soiled equipment storage
BICU Medication Preparation Room	Sink with aerator, no splash guard	Aerosolization, and potential for splashing	4	2	3	24	Install splash guards; evaluate removing aerator
BICU Hydrotherapy Room	Debridement showers	Direct contact	4	3	1	12	Monthly EVS audits room indicating 95% adherence to policies
BICU Nurses Station	Sink closest to door	Indirect contact; HCW hands; devices	4	2	3	24	Install splash guards or move IV bags storage

WATER INFECTION CONTROL RISK ASSESSMENT (WICRA) FOR HEALTHCARE SETTINGS

11.1.1.5.2 Environmental Risk Assessment

This section includes qualitative measures of likelihood and consequence to allow you to calculate the level of risk for different potential adverse outcomes in your facility tables-35 a-c. Remember that some controls will be insufficient in themselves to get the level of risk down to low, so keep adding controls until the risk is acceptable.

Table 35A- Qualitative Measures of Likelihood

Level	Descriptor	Example description
A	**Almost certain**	Is expected to occur in most circumstances
B	**Likely**	Will probably occur in most circumstances
C	**Possible**	Might occur or should occur at some time
D	**Unlikely**	Could occur at some time
E	**Rare**	May occur only in exceptional circumstances

Table-35B: Qualitative Measures of Consequence or Impact on Facility

Level	Descriptor	Example description
1	**Insignificant**	Insignificant impact, little disruption to normal operation, low increase in normal operating costs (e.g. temporary low chlorine residual that can be resolved via increased flushing)
2	**Minor**	Minor impact for part of facility, some manageable disruption to normal operation, some increase in operating costs (e.g. several rooms or one wing with total bacterial count >500 colony forming units (CFU)/mL, requiring more frequent flushing to maintain chlorine residuals)
3	**Moderate**	Minor impact for most of facility, significant but manageable modification to normal operation, increase in operating costs, increased monitoring (e.g. extensive bacterial growth with some *Legionella*, requiring extensive flushing and additional controls)
4	**Major**	Major impact for part of facility, systems significantly compromised, abnormal (if any) operation, high level of monitoring required (e.g. temporary closure of part of facility requiring extensive disinfection)
5	**Catastrophic**	Major impact for whole of facility, complete failure of systems (e.g. extensive *Legionella* colonization, with possible cases of Legionnaires' disease)

Table-35C. Qualitative Risk Analysis Matrix – Level of Risk

Likelihood	Consequences				
	1 (Insignificant)	**2 (Minor)**	**3 (Moderate)**	**4 (Major)**	**5 (Catastrophic)**
A (Almost certain)	Moderate	High	Very High	Very High	Very High
B (Likely)	Moderate	High	High	Very High	Very High
C (Possible)	Low	Moderate	High	Very High	Very High
D (Unlikely)	Low	Low	Moderate	High	Very High
E (Rare)	Low	Low	Moderate	High	High

Table-36 provides an example of Hazard Identification and Environmental Risk Assessment Table.

Table-36: Example of Hazard Identification and Environmental Risk Assessment Table

System component	Hazard and hazardous event	Risk score	Possible control measures
Incoming water	Supply of water with low chlorine residual	Medium	Install onsite chlorination to achieve 0.5 mg/L at all high risk outlets
Hot water system	Water temperature too low (to inhibit growth of *Legionella* and other opportunistic pathogens)	Medium	Measure temperature daily and adjust if too low
Warm water system	Distance from TMV to outlet > 6 m leading to *Legionella* detections in high risk location	High	Move TMV closer to outlet or install point of use filter on outlet

Pipework	Low flow in several areas (allows adherence and proliferation of *Legionella* and other opportunistic pathogens)	High	Weekly flushing of water in areas of low use

11.1.1.6 Identify control point locations and determine how control measures will be applied using both the environmental assessment and ICRA

Decide how to monitor control measures. some examples:

☐ Water temperature
☐ Residual disinfectant
☐ Heterotrophic plate count (HPC)
☐ Review trend data and report out of control results
☐ Determine frequency for monitoring
☐ Other (specify):

- All control measures and monitoring activities, whether they are regular maintenance, operational practices, or corrective actions, require written procedures detailing how to undertake the required tasks.
- Complete Table-37 below with control measures identified in the hazard identification and risk assessment table and operational procedure.

Table-37: Example of Environmental Risk Management Program Procedures

System component	Control measure	Procedure
e.g. pipework	Regular (weekly) flushing of low use areas	e.g. Flushing of pipes in Wing 2
e.g. treatment	Changing dose rate of disinfectant	e.g. Adjustment of chlorine dose
e.g. outlet — TMV	Regular maintenance of TMV	e.g. Cleaning of TMV and thermal disinfection of all pipework and outlets downstream of TMV - yearly
e.g. outlets	Collecting water samples for *Legionella* testing	e.g. Sample collection for *Legionella* – water **AND** e.g. sample storage and transportation to a laboratory

- A temperature control regime is the traditional strategy to control *Legionella* and other waterborne pathogens. This will require monitoring on a regular basis (Table-38).

- In Table-38 the suggested frequencies of inspecting and monitoring the hot and cold water systems will depend on their complexity and the susceptibility of those likely to use the water, and are for guidance only. The risk assessment should define the frequency of inspection and monitoring depending on the type of use and user and particularly where there are adjustments made by the assessor to take account of local needs. The water quality and evidence base will influence the risk assessor's decision.

Table-38 Checklist for hot and cold water systems and other risk systems

Services	Action to taken	Frequency
Calorifiers	Inspect calorifier internally by removing the inspection hatch or using a borescope, and clean by draining the vessel. The frequency of inspection and cleaning should be subject to the findings and be increased or decreased based on conditions recorded	Annually, or as indicated by the rate of fouling
	Where there is no inspection hatch, purge any debris in the base of the calorifier to a suitable drain Collect the initial flush from the base of hot water heaters to inspect clarity, quantity of debris and temperature	Annually, but may be more frequent as indicated by the risk assessment or result of inspection findings
	Check calorifier flow temperatures (thermostat settings should modulate as close to 60°C as practicable without going below 60°C) Check calorifier return temperatures (not below 50°C).	Monthly
Hot water services	For non-circulating systems: take temperatures at sentinel points (nearest outlet, furthest outlet and long branches to outlets) to confirm they are at a minimum of 55°C within one minute	Monthly
	For circulating systems: take temperatures at return legs of principal loops (sentinel points) to confirm they are at a minimum of 55°C. Temperature measurements may be taken on the surface of metallic pipework	Monthly
	For circulating systems: take temperatures at return legs of subordinate loops; temperature measurements can be taken on the surface of pipes, but where this is not practicable, the temperature of water from the last outlet on each loop may be measured, and this should be greater than 55°C within one minute of running. If the temperature rise is slow, it should be confirmed that the outlet is on a long leg and not that the flow and return has failed in that local area	Quarterly (ideally on a rolling monthly rota)

	All HWS systems: take temperatures at a representative selection of other points (intermediate outlets of single pipe systems and tertiary loops in circulating systems) to confirm they are at a minimum of 55°C to create a temperature profile of the whole system over a defined time period	Representative selection of other sentinel outlets considered on a rotational basis to ensure the whole system is reaching satisfactory temperatures for Legionella control
POU water heaters (no greater than 15 litres)	Check water temperatures to confirm the heater operates at 55°C, or check the installation has a high turnover	Monthly–six monthly, or as indicated by the risk assessment
Combination water heaters	Inspect the integral cold water header tanks as part of the cold water storage tank inspection regime; clean and disinfect as necessary. If evidence shows that the unit regularly overflows hot water into the integral cold water header tank, instigate a temperature-monitoring regime to determine the frequency, and take precautionary measures as determined by the findings of this monitoring regime	Annually
	Check water temperatures at an outlet to confirm the heater operates at 55°C	Monthly
Cold water storage cisterns	Inspect cold water storage cisterns and carry out remedial work where necessary	Annually
	Check the cistern's water temperature remote from the ball valve and the incoming mains temperature. Record the maximum temperatures of the stored and supply water recorded by fixed maximum/minimum thermometers where fitted	Annually (summer) or as indicated by the temperature profiling
Cold water services	Check temperatures at sentinel taps (typically those nearest to and furthest from the cold cistern, but may also include other key locations on long branches to zones or floor levels). These outlets should be below 20°C within two minutes of running the cold tap. To identify any local heat gain, which	Monthly

	might not be apparent after one minute, observe the thermometer reading during flushing	
	Take temperatures at a representative selection of other points to confirm they are below 20°C to create a temperature profile of the whole system over a defined time period. Peak temperatures or any temperatures that are slow to fall should be an indicator of a localised problem	Representative selection of other sentinel outlets considered on a rotational basis to ensure the whole system is reaching satisfactory temperatures for Legionella control
	Check thermal insulation to ensure it is intact, and consider weatherproofing where components are exposed to the outdoor environment	Annually
Showers and spray taps	Dismantle, clean, descale and disinfect removable parts, heads, inserts and hoses where fitted	Quarterly or as indicated by the rate of fouling or other risk factors, e.g. areas with high-risk patients
POU filters	Record the service start date and lifespan or end date and replace filters as recommended by the manufacturer (bacterial-retention filters should be used primarily as a temporary control measure while a permanent solution is developed, although long-term use of such filters may be needed in some healthcare applications)	According to manufacturer's guidelines
Base exchange softeners	Visually check the salt levels and top up salt, if required. Undertake a hardness check to confirm operation of the softener	Weekly, but depends on the size of the vessel and the rate of salt consumption
	Service and disinfect	Annually, or according to manufacturer's guidelines
Multiple-use filters	Backwash and regenerate as specified by the manufacturer	According to manufacturer's guidelines
Infrequently used outlets	Consideration should be given to removing infrequently used showers, taps and any associated equipment that uses water. If removed, any redundant supply pipework should be cut back as far as possible to a common supply (e.g. to the recirculating pipework or the pipework supplying a more frequently used upstream fitting) but preferably by removing the feeding 'T' Infrequently used equipment within a water system (i.e. not	Weekly, or as indicated by the risk assessment

	used for a period equal to or greater than seven days) should be included on the flushing regime Flush the outlets until the temperature at the outlet stabilizes and is comparable to supply water and purge to drain Regularly use the outlets to minimize the risk from microbial growth in the peripheral parts of the water system, sustain and log this procedure once started	
TMVs	Where integral, inspect, clean, descale and disinfect any strainers or filters associated with TMVs. To maintain protection against scald risk, TMVs require regular routine maintenance carried out by competent persons in accordance with the manufacturer's instructions.	Annually or on a frequency defined by the risk assessment, taking account of any manufacturer's recommendations
Inline strainers	Where fitted, inspect, clean, descale and disinfect any strainers or filters associated with TMVs or other sensitive equipment.	Annually or on a frequency defined by the risk assessment, taking account of any manufacturer's recommendations
Pressurisation and expansion vessels	Where practical, flush through and purge to drain. Where removable, bladders or diaphragms should be changed according to the manufacturer's guidelines or as indicated by the risk assessment	Monthly–six monthly, as indicated by the risk assessment
Biocidal treatment systems	Check the dosing and control system operation including alarms	Weekly
	Measure the treatment parameters to establish the required values are being achieved at representative outlets including	Weekly

	sentinel outlets	
Water softeners	Clean and disinfect resin and brine tank- check the manufacturer what chemicals can be used to disinfect resin bed	As recommended by manufacturer
Emergency showers, eyebaths and face-wash fountains	Flush through and purge to drain ensuring three to five times the volume of water in the stagnant zone is drawn off	As indicated by risk assessment but at least every six months
	Inspect water storage tank (where fitted)	Monthly
	Clean and disinfect shower heads, nozzles, roses, "Y" strainers and water storage tank (where fitted)	Quarterly, or more frequently as indicated by the risk assessment
Sprinkler and hose reel system	When witnessing tests of sprinkler blow-down and hose reels ensure that there is minimum risk exposure to aerosols	As directed
Dental equipment	Drain down, clean, flush and disinfect all system components, pipework and bottles	Twice daily (typically at the start and finish of each working day). Disinfect contact time as recommended by the manufacturer
	Clean storage bottle, rinse with distilled or Reverse Osmosis (RO) water, drain and leave inverted overnight	Daily
	Take microbiological measurements	As indicated by risk assessment
Fountains and water features	Clean and disinfect ponds, spray heads and make-up tanks including all wetted surfaces, descaling as necessary	As indicated by risk assessment, and depending on condition

11.1.1.7 Set control limits for control measures that will be monitored (water temperature, residual disinfectant, HPC, and/or total organic carbon).

11.1.1.7.1 Corrective Actions (some examples)

☐ Eliminate dead legs, unused branches

☐ Remove or repurpose high risk features (e.g., water features, decorative fountains)

☐ Flush taps/fixtures in vacant rooms

☐ Decontamination (shock treatment or remediation using supplemental treatment for short period of time)

☐ Change fixtures/hand held showers

☐ Point of use filtration; supplemental building disinfection systems

☐ Raise hot water temperature if in tepid zone (16°C - 38°C)

☐ Other (specify):

The following highlight on the examples of corrective actions:

a. Removal of redundant pipework and services: In existing systems or during refurbishments, water systems should be inspected to identify redundant pipework (often referred to as blind ends) or services. In such cases, pipework should be cut back to the connection point including replacing the branch T with a straight coupling to ensure all redundant pipework is removed and to eliminate any opportunity for stagnation to occur.

b. Taps: Taps should not be aligned so that water flows directly into the waste water outlet (drain) as splashing would result in dispersal of contaminated droplets. Taps should ideally be removable and easily dismantled for cleaning and disinfection. Non-touch / infra-red / sensor taps: Although sensor taps are recommended to improve hand hygiene, evidence suggests that there is a greater risk of internal surfaces and components of these types of taps becoming contaminated with microorganisms and biofilm in comparison to manually operated taps. In addition, routine flushing of sensor taps requires personnel to remain at the tap for the duration of flushing. If considering installing or using sensor taps, a risk assessment should be undertaken, particularly if considering use in High Risk Areas (ACUs). They are not recommended where the frequency of use is low. If required, sensor taps with automated programmable flushing capability could be considered but records of remote flushing must be maintained. Because of the risk of contamination these types of taps may require additional routine maintenance. It may be appropriate to sample water from sensor taps to ensure they are being adequately maintained.

c. Water Outlet Flushing: Healthcare staff should be aware that under-utilized outlets may increase the risk of water stagnation and subsequent contamination. It must be ensuring by the responsible person that all infrequently used outlets are flushed at least once per week. Outlets in High Risk Areas that are not in frequent daily use must be flushed on a daily basis. This may be determined by local risk assessment in the first instance and should include en-suite facilities in isolation rooms and in clinical areas when temporary service closures take place. To support healthcare facilities, the following table-39 template is a minimum guide which should be considered further with local risk assessment as it is acknowledged there may be significant variances in each healthcare facility with types of taps and showers, water pressure and contamination levels.

Table-39: Template of the minimum guide of frequency of water outlet flushing which should be considered further with local risk assessment

Frequency of flushing	Weekly	Daily
Location	Flushing of infrequently used water outlets	In augmented care settings flushing of infrequently used water outlets
Details	• Run cold for three minutes • Run hot for three minutes once water is hot	• Run cold for one minute • Run hot for one minute once water is hot • Keep a central register of the flushing regimes for each department including frequencies and ensure signed record of the flushing procedure is available in each clinical area.
Notes	• The door(s) to en-suite facilities and bathrooms should remain closed during the flushing period, and a notice should be affixed to the door indicating that cleaning is in progress and that the facility is out of use. • The following staff should be excluded from the flushing procedures: ○ Staff with cancer, chronic lung or kidney disease, immunosuppression, especially those on long-term steroid therapy, and staff who have had an organ transplant.	

d. Decorative Water Features: Decorative water features have been associated with outbreaks of Legionnaires' disease and other healthcare associated infections. Such decorative features pose unwarranted risks in any healthcare setting and should never be installed in any area of a healthcare facility. Healthcare facilities with existing decorative water features in non-clinical areas should regularly test and maintain the feature.

e. Ice-Making Machines, Bottled Water Coolers, Plumbed-In Water Coolers and Water Fountains: Ice-making machines have occasionally been implicated in healthcare associated infection. When ice is required, use an automatic dispenser and avoid open chest storage compartment.The microbiological quality of potable mains water (drinking water) supplied to plumbed-in water coolers and water fountains that are connected to mains water can deteriorate rapidly. Deterioration in water quality may occur due to stagnation or to biofilm formation in taps, filters and/or drip trays, especially if taps are manufactured from plastic. All ice and drinking water units should be subject to routine cleaning and disinfection to minimise potential infectious risks to patients, healthcare staff, visitors and other individuals and to ensure output water is of potable quality. The external surfaces and dispensing taps must be cleaned frequently, according to local policy. The critical internal water-contact areas must be cleaned and disinfected regularly (at least monthly in healthcare settings) including the internal water reservoir or chill-tank, the waterways and the dispensing taps.

f. Hot water storage and distribution

- To control possible colonisation by waterborne pathogens including Legionella, it is essential to maintain the temperature within the hot water circulating system. To some extent, if properly maintained, the calorifier/water heater will provide a form of barrier to microbial growth.
- The minimum flow temperature of water leaving the calorifier/water heater should be 60°C. The minimum water temperature at the connection of the return to the calorifier/water heater should be 50°C. To achieve the required circulating temperatures, it will be necessary to maintain the balance of flows to individual pipe branches and draw-off points.
- Calorifiers should be subjected to regular procedures that include the following:
  - Inspection, cleaning and maintenance at least annually, or as indicated by the rate of fouling.
  - Quarterly drain flushing to minimise the accumulation of sludge. This may be extended to annual draining if, during inspection, it is found that there is little accumulation of debris.
  - Whenever dismantled for statutory inspection, or every year in the case of indirect calorifiers, calorifiers should be thoroughly cleaned to remove sludge, loose debris and scale.
  - Whenever a calorifier is taken out of service, it should be refilled, drained, refilled again and the entire contents brought up to, and held at, the nominal operating temperature of 60°C for at least an hour.
  - The calorifier should remain isolated until the procedure is completed. When bringing calorifiers back on line, it is important that service valves are opened slowly to avoid any disturbance of sediment debris. Calorifiers that are to be taken out of service for more than a few days should be drained and should not be refilled until ready to return to service. The drain valve should be left open while the calorifier is out of use.
- Where it is known or established that gross over-capacity exists in a calorifier, and where it is practicable to do so, it should be replaced by a calorifier of the appropriate size.
- Hot water circulating pumps should be of adequate performance to ensure a minimum available temperature at draw-off points of 55°C and an absolute minimum of 50°C at the return connection to the calorifier. It is undesirable to have standby pumps owing to stagnation risks. If, however, an existing installation includes a standby pump and it is impracticable to remove it from service, it should be automatically controlled so that each is regularly brought into operation as determined by the risk assessment.
- Instantaneous water heaters for single or multi-point outlets. These devices usually serve one draw-off only and are electrically heated. In essence: a. the flow rate is limited and is dependent on the heater's hot water power rating; b. where restricted rates of delivery are acceptable, the heater can deliver continuous hot water without requiring time to reheat; c. they are susceptible to scale formation in hard water areas where they will probably require frequent maintenance; d. this form of hot water heating should only be considered for smaller premises or where it is not economically viable to run hot water distribution to a remote outlet; e. they should be monitored to ensure they operate above 55°C

g. Safe hot water delivery devices:

I. Thermostatic mixing devices

- Thermostatic mixing devices should only be installed where a risk assessment indicates their need (Showers and hair-wash facilities, Unassisted baths, Baths for assisted bathing, Bidets).
- It is essential to check the temperature settings and operation of water mixing devices regularly.
- The purpose of TMVs is to deliver water to an outlet at a lower temperature (typically 41°C) than the circulating temperature. However, this means that water distal to the TMV will not be thermally controlled and the outlet cannot be flushed with water of a sufficiently high temperature.
- The internal structure of a TMV is complex consisting of different components and materials. The greater the complexity within the design of an outlet the greater the risk of contamination.

- A risk assessment is required to decide where TMVs are required and whether or not there is a need to remove TMVs in some areas.
- Installation of non-TMV taps may be preferable in High Risk Areas where patients are unlikely to be using wash-hand basins.
- Ideally, if TMVs are used, they should be situated within the body of the tap or if not, they should be sited as close as possible to the point of use.
- The branch supply to each TMV should be fitted with a non-return valve on both the hot and cold supply as close to the outlet as possible.
- A single TMV should not serve multiple tap outlets.
- Where a single TMV serves multiple shower heads, it is important to ensure that these showers are flushed frequently.

II. Rosettes / flow straighteners

- Rosettes are used in taps to generate a straightened flow of water to enhance hand washing. However, a detailed inspection of rosettes taken from tap outlets in neonatal units in some countries during the outbreak of *Pseudomonas aeruginosa* found them to be heavily colonised. *Pseudomonas aeruginosa* growth was lower on less complex rosettes or those made of metal. A risk assessment will determine if rosettes or flow straighteners should be removed.

III. Aerators and strainers

- Aerators and strainers have been demonstrated to be associated with an increased risk of contamination due to the capture of biofilm. A risk assessment will determine if they should be removed.

IV. Showers

- Showers (excluding safety showers) should not be fitted where they are likely to be used less than once a week. In existing builds a risk assessment may indicate the need to remove some outlets.
- Shower cubicle design should allow for adequate cleaning and not leak or accumulate water.
- Safety and emergency showers should not be installed on the end of lines and should be flushed regularly .
- Disinfection of showerheads and angle valve strainers has only a short-lived effect on microbial colonization and growth. Manual cleaning to remove scale and other deposits or replacement of disposable showers should be carried out as based on the risk assessment. Traditionally this has been a quarterly task but the water quality and evidence base will influence the risk assessor's decision of the actual frequency implemented. Regular flushing of showers reduces microbial growth, but counts can significantly increase if regular flushing should cease. The most effective management of showers will be achieved by the removal of unnecessary ones and the regular use of others. Where showers are removed, it is important to cut back and remove all associated pipework on the removal of redundant pipework.
- It is important to note the distinction between self-purging and self-draining showers. Self-purging showers can be an effective Legionella control procedure, while self-draining showers can support the proliferation of Legionella.

11.1.1.7.2 Monitoring

Operational Monitoring

 Many control measures that manage risk in the water supply are in fact corrective actions to measured parameters at particular frequencies and locations when such parameters exceed a critical limit.

 Fill out Table-40below with all the operational (i.e. 'real time') monitoring undertaken in the facility.

Table-40: Example of Operational Monitoring

System component	Risk	Parameter	Frequency	Location	Critical limit	Record *(where is the measurement recorded)*	Corrective action
Incoming water	Low Disinfectant residual	Chlorine residual	Weekly	Point of entry into facility	Less than 0.5 mg/L	Chlorine residual record sheet	Increase chlorine dose within facility
Hot Water	Low temperature	Temperature	Weekly	Hot water Outlet in kitchen (sink tap at far right corner)	Temperature less than 140 °F	Weekly temperature kitchen record sheet	Increase temperature of water heater
Warm water	Water temperature that supports *Legionella* growth	Temperature	Daily	Outlet furthest from water heater (wash basin tap in room xx)	Temperature greater than 68 °F and less than 140 °F	Daily temperature – ward 2 record sheet	Check heater temperature and adjust if required, check pipework for loss of heat, check operation of TMV

11.1.1.7.3 Mitigation and Remediation

11.1.1.7.3.1 Heat and Flush

1. Check if thermostatic mixing valves are present. If yes, either remove or bypass them.
2. Remove aerators from faucets.
3. Raise hold water temperature to 160-170F.
4. Open all hot was faucets and water sources and let the hot water run at a low flow to bring the hot water to the taps.
5. Starting at the outlets in the water system closest to the water heater, start running taps to distribute hotter water throughout for a minimum of 5 minutes for routine mitigation or a minimum of 10 minutes if in response to a case of Legionnaires' disease.

A. Use a thermometer to measure and document the temperature, tap location, and time of initial reading to ensure proper temperature is maintained. Use Table 60 to record this information.
B. The number of outlets that can be flushed simultaneously will depend on the capacity of the water heater and the flow capacity of the system.
C. Local building and sanitary codes should be checked for any temperature limits of water discharged to the sewer.
D. Appropriate safety procedures to prevent scalding are essential.
a) If possible, flushing should be performed when the fewest building occupants are present, such as nights or weekends.
b) Signs should be posted to indicate the elevated temperature of the water.
c) Residents or guests of the building should be notified.

11.1.1.7.3.2 Superheating

1. Check if thermostatic mixing valves are present. If yes, either remove or bypass them.
2. Remove aerators from faucets.
3. Raise hold water temperature to 160-170F.
4. Open all hot was faucets and water sources and let the hot water run at a low flow to bring the hot water to the taps.
5. Turn off the taps and hold the hot water in the system for a minimum of 2 hours. Add 1 hour for every 10 years of age of the building.
6. After the holding period, starting at the outlets in the water system closest to the water heater, start running taps to distribute hotter water throughout for a minimum of 10 minutes if in response to a case of Legionnaires' disease.

A. Use a thermometer to measure and document the temperature, tap location, and time of initial reading to ensure proper temperature is maintained. Use Table 60 to record this information.
B. The number of outlets that can be flushed simultaneously will depend on the capacity of the water heater and the flow capacity of the system.
C. Local building and sanitary codes should be checked for any temperature limits of water discharged to the sewer.
D. Appropriate safety procedures to prevent scalding are essential.
a) If possible, flushing should be performed when the fewest building occupants are present, such as nights or weekends.
b) Signs should be posted to indicate the elevated temperature of the water.
c) Residents or guests of the building should be notified.

11.1.1.7.3.3 Hyperchlorination (Building Water System)

1. Remove aerators from faucets.
2. Chlorine should be added to achieve a free chlorine residual of at least 2 mg/L throughout the system.
A. This may require chlorination of the water heater or tank to levels to 20 to 50 mg/L.
3. The pH of the water should be maintained between 7.0 and 8.0.
4. Each outlet should be flushed until the odor of chlorine is detected.
5. The chlorine should remain in the system for a minimum of 2 hours, but no more than 24 hours.
A. High levels of chlorine can cause corrosion of metal pipes and precautions should be taken if using this mitigation method.

B. Appropriate safety procedures to prevent injury are essential.

a) If possible, hyperchlorination should be performed when the fewest building occupants are present, such as nights or weekends.

b) Signs should be posted to indicate the elevated chlorine concentration in the water.

c) Resident or guests of the building should be notified.

6. Record start/stop times and measured chlorine/pH levels in Table 61 below.

7. The system should then be flushed to restore chlorine levels to their standard concentration.

11.1.1.7.3.4 Point-of-Use Filters

 Point-of-use (POU) filtration should be considered and agreed by the WSG only as an interim safeguard where control measures e.g. hyperchlorination or superheating have been ineffective or not possible, prior to and during engineering remedial works, during periods of plumbing refurbishments and maintenance works, and where additional protection is required for vulnerable patients

 Point-of-use (POU) *Legionella* filters may be installed in sink faucets, shower heads, and ice machines to reduce risk.

 POU filters require regular maintenance and replacement which varies depending on the brand that is used.

A. Some filters are meant for short-term use, sometimes as short as 7 days.

B. Others can be rated for longer term use such as 90 days to 6 months.

C. Continuous long-term use of POU filters is not recommended, except where there is no effective alternative

POU filters should be rated for the removal of waterborne pathogens including *Legionella.*

The WSG should review their continued use and ensure an action plan is created and enacted to make certain they are changed at the intervals specified by the manufacturer.

11.1.1.7.3.5 Physical Features Disinfection- shower heads, sink faucets, ice machines, decorative water fountains

1. Using a 50 mg/L chlorine bleach solution, scrub water features to remove biofilm and algae accumulation.

2. After scrubbing is complete, rinse the features to remove the bleach residue and biofilm remnants.

A. Appropriate safety procedures to prevent chemical injuries or inhalation of harmful materials are essential.

a) An appropriately fitting mask capable of mitigating risk of inhaling pathogens and gloves should be worn during the duration of the disinfection process.

b) If possible, disinfection should be performed when the fewest building occupants are present, such as nights or weekends.

11.1.1.7.4 Cleaning and disinfection

11.1.1.7.4.1 Cleaning

Cleaning is a prerequisite for disinfection and must precede disinfection to remove biomass, deposits and other contaminating substances. The effectiveness of any disinfectant will be reduced in the presence of biofilm, chemical and inorganic deposits within the water distribution network and corrosion within the system. The frequency and method of routine cleaning should be identified during the risk assessment.

It is essential that there is a regular programme for cleaning and descaling, or replacement of water outlets, hoses and TMVs where there may be direct or indirect water contact with patients. Manual cleaning of showerheads and hoses to remove scale and other deposits should be carried out at least quarterly and more frequently if required.

TMVs should be cleaned and descaled as per manufacturers' recommendations. Water storage tanks and hot water calorifiers should be cleaned annually.

11.1.1.7.4.2 Secondary Disinfection

Secondary disinfection of water distribution systems is only part of an overall prevention and control strategy. Before any secondary disinfection method is considered, a risk assessment should be carried out to verify that there are no management processes or mechanical steps that can be taken regarding plant, equipment or pipework configuration that would avoid the need for a secondary disinfectant. Cleaning must precede disinfection.

The effects of disinfection methods on planktonic bacteria differ significantly to the effects on sessile bacteria contained within biofilms. It has been estimated that 95% of all microbial cells present in drinking water distribution systems exist within biofilms that are adherent to pipe surfaces. Only 5% exist in the water phase. Every effort should be made to ensure that new water systems and equipment are supplied free of biofilm. Sustained eradication of biofilm in existing complex water systems is challenging.

The ideal disinfection method should achieve the following:

1. Inactivate microorganisms in circulating water
2. Control/prevent/remove biofilm and inactivate associated biofilm microorganisms
3. Have minimal adverse effects on the fabric of the water distribution network and be safe for human contact.

11.1.1.8 Outbreak and Contingency Response Plans

☐ Ability to detect, investigate, and respond to a sentinel infection or cluster that is potentially linked to a water source

☐ Collect epidemiologically linked samples

☐ Notify Health Department

☐ Arrange for molecular typing or relatedness testing

☐ Reassess water control measures and apply corrective actions

Full section on outbreak investigation is included in the annex- 3 in this guideline.

11.1.1.9 Verification: has the plan been implemented as designed and are you following it?

- Verification monitoring involves the taking of samples for analysis of a particular parameter. The results of the samples confirm that control measures are effective and water quality risk is being managed.
- All verification monitoring results that are outside quality standards or critical limits, and confirmed cases of legionellosis, require responses.
- Fill out Table-41 below with all the verification monitoring undertaken in the facility.

Table-41: Example of Verification Monitoring

Parameter	Frequency	Location	Limit	Reported to	Operational response to exceedance of critical limit	Clinical response to exceedance of limit
Heterotrophic plate count	Monthly	Distal warm water taps — wash basins in rooms xxx	Greater than 500 CFU/mL	Building, engineering and maintenance services (BEMS) supervisor	1. Check operational measurements (temperature, pH, turbidity, disinfectant residuals and dose), maintenance schedules, and structural integrity 2. Flush water through until sufficient disinfectant residual is achieved 3. Resample after responses are completed	None
Legionella spp.	Quarterly	Distal warm water taps – wash basins in room with low risk patients	Greater than 10 CFU/100 mL	BEMS manager and CEO	1. Check operational measurements, maintenance schedules and structural integrity of system 2. Clean and sanitise TMV and outlet fitting 3. If resample positive, move to next row	Remove patient/s from affected room

Legionella spp.	Quarterly	Distal warm water taps — wash basins in room with high risk patients	Greater than 10 CFU/mL	BEMS manager and CEO	1. Check operational measurements, maintenance schedules and structural integrity of system 2. Clean and sanitize TMV and outlet fitting 3. Clean pipework 4. Hyperchlorinate system	Remove patient/s from affected room

11.1.1.10 Validation: Determine what conditions, outcomes inform you that your program is effective

☐ Perform clinical surveillance for infections due to opportunistic pathogens of premise plumbing

☐ Identify clusters and conduct an epidemiologic investigation

☐ Routine environmental sampling for Legionella (optional consideration). Base decisions on building environmental assessment, water quality data, and context of whether disease is present or absent

11.1.1.11 Documentation

☐ **Team Roster:** Names, titles, contact info, team responsibility, member roles

☐ **Building Description:** Location, building age, use, occupants, visitors, bed occupancy rate, additions or renovations, etc.

☐ **Water system description:** both text and process diagrams, location of attached equipment

☐ **Control Measures:** identify control measures, locations in the system where critical limits can be monitored and where controls can be monitored and applied

☐ **Confirmatory procedures:** verification steps, and validation to show effectiveness of the water management plan as designed

☐ **Sampling and testing:** document collection and transport methods, chain of custody, and laboratory identified performing assays if environmental testing is conducted, results

☐ Any important incidents or event related to water quality

Example on documentation during construction and water service events

- Be sure to thoroughly document all construction or events (planned and unplanned) that impact the facility's water system.
- This includes new construction, plumbing repairs, disruptions to water system (pipe break/shut off), or treatment.
- Routinely update documentation about constructions and water service events to ensure up-to-date information is available. Use Table-42 below to document each construction/water service event.

Table-42: Construction/Water Service Event Documentation

Component	Response
Name of new or affected building	
Date construction/event began	
Completion date/expected completion date	
Date water service began or was restarted	
Relationship to existing potable water system	Ex: New/Independent Ex: Extension of existing system
Number of stories involved	
Was temporary water service provided to the construction area? If yes, explain.	Ex: Separate meter used for new construction
Was jackhammering or piledriving used?	
Did the potable water change in terms of taste and/or color?	
Before occupying any new/remodeled area, was a commissioning/walk-thru process undertaken?	
Do you have a Standard Operating Procedure for shutting down, isolating, and refilling/flushing water service areas that were impacted?	
In the past 6 months, have there been any interruptions of service, potable water malfunctions, or nearby water main breaks or repairs?	

11.1.1.12 Communication Plan

☐ Notification to building staff/occupants that a plan is in place and provide team's contact info; issue regular updates as plan is implemented or modified

☐ Reports to team, infection control, hospital administration, other affected parties if control limits are exceeded, and corrective actions to be applied

☐ Consider quarterly and annual reports: reports to management and occupants, consider part of facility quality review; since activity is part of Continuous Quality Improvement (CQI).

☐ Notification protocols with public health points of contact for when a sentinel infection or cluster is detected.

11.2 ANNEX-2: SUMMARY STEPS OF PROCEDURE FOR WATER SAMPLING

11.2.1 Annex-2a: Steps of Tap Water Sampling for Bacteriological test

Table-43: summary of steps of Tap Water Sampling for Bacteriological test

No.	Steps
1.	**Plan** and decide the location, number of water samples and type of tests required
2.	**Inform** the laboratory and your team about your plan
3.	**Prepare** the equipment and forms required for the water collection
4.	**Hands hygiene +/- gloves:** Clean/disinfect your hands properly with antiseptic soap and water or hand rub with alcohol based hand rub -if hands are visibly clean - before handling supplies
5.	**Check** and ensure that the tap is in good condition, with no leaks
6.	**Take pre-flush** sample as required. Label the sample.
7.	**Remove** all internal and external fittings from the faucet including the aerator, rubber washer and any hoses
8.	**Flush** the tap for at least 1-10 minutes based on the location and frequency of use
9.	**Turn off** the tap
10.	**Disinfect** the end of the tap by proper method
11.	**Flush** the tap for a few seconds
12.	**Remove the plastic shrink-wrap seal** by pulling down on the red strip and pealing the shrink-wrap from both the cap and bottle. Discard the shrink-wrap.
13.	**Grasp cap** along top edge and remove carefully
14.	**Hold** the bottle in one hand near its bottom and the cap in the other hand pointing downward
15.	**Fill** the bottle until the water sample level is between the two lines on the bottle (100 – 120 ml), leave airspace This is a **post-flush sample**

16.	Place the cap on the bottle and **screw** it down tightly
17.	**Invert or shake** gently to mix the neutralizer with the collected water.
18.	**Label** each sample with the tap location, hot/cold/blended outlet, pre- or post-flush, date and time of sampling. This step can be done at the beginning.
19.	Fill the **Laboratory request form** completely
20.	Keep water samples in **a cool box lined with ice packs** (except if the sample is for ***Legionella*** test)
21.	Test for **chlorine residual** on site
22.	**Transport** the water samples with the laboratory request forms immediately to the designated **laboratory** preferably within 24 hours

11.2.2 Annex-2b: Water Sampling-Chemical test

Table-44: summary of steps of Water Sampling for chemical test

No.	Steps
1.	**Plan** and decide the location, number of water samples and type of tests required.
2.	**Inform** the laboratory and your team about your plan.
3.	**Prepare** the equipment and forms required for the water collection.
4.	**Hands hygiene:** Clean/disinfect your hands properly with antiseptic soap and water or hand rub with alcohol based hand rub -if hands are visibly clean - before handling supplies.
5.	**Gloves** can also be used when collecting samples.
6.	**Remove cap** of sample bottle just before collecting sample.
7.	**Rinse the bottle 3 times** with the water to be sampled.
8.	If the water suspected to contain elevated levels of heavy metals (e.g. change in water color or deposits in the pipes), then samples containers shall be **rinsed with 50% HNO_3** (Nitric acid), and then washed thoroughly before collection of the samples with distilled water free from ions.

9.	If taking a chemical sample to check if lead is leaching from the tap or plumbing fittings the tap should not be flushed, as it is necessary to collect the first flush of water from the tap after it has **not been used for 12 hours.**
10.	**Fill container** without overflowing.
11.	Place the cap on the bottle and **screw** it down tightly.
12.	**Label** each sample with sample site, date, and time.
13.	**Laboratory request form** is filled completely.
14.	Keep water samples in **a cool box.**
15.	**Send** the water samples with the laboratory request forms immediately to the designated **laboratory** preferably within 24 hours.

11.2.3 Annex-2c: Dialysis water Sampling for Bacteriological test

Table-45: summary of steps of dialysis Water Sampling for Bacteriological test

S.N	Steps
1.	**Ensure that the sample must be taken by a trained person**
2.	Check water safety plan of the facility to check on locations, types and number of water samples to be collected
3.	Coordinate with CPHL and other stakeholders
4.	Ensure the materials are available (gloves - alcohol swabs - ice box - ice bags - 100 ml sterile bottle and endotoxin free)
5.	Perform handwashing or use alcohol based hand rub and use gloves if needed
6.	Wear a mask and sterile gloves
7.	**For dialysis ports water**
a.	Clean the nozzle end of the sampling port three times with alcohol wipes or sterile gauze + 70% alcohol then wait for the nozzle to dry.
b.	Should the connector be used for sampling – disinfect using 70-90% ethanol solution

c.	Open the water valve and let it flow for 2 to 3 minutes to pass the water through before taking the sample.
d.	Open the lid of the sterile container in aseptic technique without touching the sample taking point.
e.	Fill the bottle to the 100 ml line, leaving airspace.
8.	**For dialysis machines:**
a.	Prepare two sterile 30 ml syringes and a sterile water bottle to collect the sample.
b.	Clean the sampling port site three times with alcohol wipes till dry
c.	Attach the sterile 30 ml syringe to the sampling port and withdraw 30 ml of liquid and discard.
d.	Connect another new 30 ml sterile syringe to the sampling port and withdraw another 30 ml and place it in the sterile water bottle (endotoxin – free) and cap it securely.
e.	Cover the sample bottles and check for leaking
9.	Label the sample with permanent ink pen: name of the health facility, the sample number, location, date, time, collector name and fill up the laboratory request form.
10.	Keep cold at a temperature of (1-4°C) and not frozen. They must be send immediately to the laboratory or within a maximum period of twenty-four (24) hours.
11.	Follow up on receiving sample results from the CPHL.
12.	Keep records of the results in IPC or HSE department and inform the concerned focal point with the results as relevant.

11.3 ANNEX-3: INVESTIGATION OF WATER BORNE PATHOGENS OUTBREAK AND SPECIAL CONSIDERATION FOR LEGIONELLA OUTBREAK

11.3.1 Annex-3a: investigation of legionellosis cases in community

11.3.1.1 Introduction

Incidents of Legionnaires' disease are classified for purposes of surveillance as:

- Sporadic: a single case not associated with any other cases
- Outbreak: two or more cases associated with a single source with dates of onset within six months of each other.

Each case warrants full investigation in order to identify and eliminate possible sources of infection.

11.3.1.2 Response to a single (sporadic) case of Legionnaires' disease

As part of the epidemiological investigation, five key steps should be taken following the diagnosis (clinically and microbiologically) of a single case of probable or confirmed Legionnaires' disease including:

1. Confirm the diagnosis
2. Report the case to the appropriate MOH
3. Identify potential sources of infection
4. Search for links with other cases
5. Investigate possible sources of infection.

11.3.1.3 Identify potential sources of infection

For each confirmed or probable case of legionnaires' disease, the patient's movements during the incubation period should be recorded. It is essential to detail the patient's movement accurately to facilitate identification of possible sources of infection. Although the incubation period in Legionnaires' disease is between two to ten days, given that the exact onset of an illness is not always certain, enquiries should be made for the two weeks before the onset of illness. Patient risk factors for Legionnaires' disease e.g. immune-suppression treatment, diseases associated with impaired immune response should be specifically enquired about and recorded. Details of the patient's movement in the two week period prior to the onset of illness including full address of places of residence/overnight stays, places of work, places of leisure and travel details should be obtained. Exposure to any recognized potential environmental sources of Legionella should also be specifically asked about and recorded including:

- Water systems incorporating a cooling tower
- Water systems incorporating an evaporative condenser
- Hot and cold water systems

- Spa pools
- Natural thermal springs and their distribution systems
- Respiratory and other therapy equipment
- Humidifiers
- Dental chair unit waterlines
- Fountains/sprinklers
- Water-cooled machine tools
- Water mist fans
- Vehicle washes
- Potting compost/soil in warmer climates
- Other plants and systems containing water which is likely to exceed 20°C and which may release a spray or aerosol (i.e. a spray of droplets and/or droplet nuclei) during operation or when being maintained.

A diary (table-46, 47) of every place the patient has visited for the two weeks prior to onset of illness should be filled out by the patient (or surrogate if too ill). The list of potential environmental sources and locations in Checklist-2 can be used to maximize the likelihood of identifying possible risk sources.

Table-46. Diary of patient's movements in the 14 days prior to onset of symptoms

Date (count back 14 days from onset of symptoms)	Morning	Afternoon	Evening	Night

Table-47: Checklist of patient's exposures in the 14 days prior to onset of symptoms

Did the patient	Details	Dates
Visit a sports center or club that had a whirlpool spa		
Use a whirlpool spa anywhere else		
Use a shower (at home or elsewhere)		
Attend a dentist or dental hygienist		
Use a nebuliser (not an inhaler)		
Spend any time near building works		
Spend any time near fountains (indoors or outdoors)		
Attend a garden show		
Visit a public building, e.g. attend a seminar, cinema, theatre, hotel, hospital		
Visit a commercial car wash		
Work near/involving cooling towers		
Work with water/water storage systems		
Spend time aboard a ship		
Use pressure water spraying equipment e.g. home car wash pressure cleaner		

Is the patient aware of anyone else with Legionnaires' disease, now or in the past? If yes, give details _____ Is the patient aware of anyone with similar symptoms to themselves?
If yes, give details _____

11.3.1.4 Search for link with other cases

The MOH will check for links with other cases based on other patient laboratory results from nearby hospitals.

11.3.1.5 Investigate possible sources of infection

The key to the investigation of Legionnaires' disease is in the detailed enquiry of the case's exposure to potential environmental sources of Legionella in the two weeks prior to the onset of symptoms.

11.3.1.6 Community-acquired case – single case

Legionella are widespread in the environment. Aerosols containing the organism can be dispersed into the atmosphere and travel distances of up to several hundred meters from their source.

If the patient has a history of exposure to a recognized potential source of Legionella infection outside of hospital or a domestic premises, examination of the maintenance records of these systems including water systems should be requested. With the diagnosis of a confirmed/probable case sampling of potential environmental sources to which the patient was exposed should be carried out based on a risk assessment. Pending results of the sampling, and subsequently when sample results are available, steps may need to be taken to prevent risk to others and to identify other cases – possibly undiagnosed. For all locations where water is the potential source, the water system risk assessment should be reviewed, maintenance records checked and a search made for other cases. Any deficiencies identified by the risk assessment should be remedied as soon as possible. Interim measures may need to be put in place until these remedial measures are fully in place. If precautionary disinfection of parts of the water systems is considered necessary, this should only be undertaken after taking relevant samples. The latter should be done as a matter of urgency. In addition, if the patient's place of work is a potential source of infection, the co-operation of management or the relevant occupational health department, if appropriate, should be sought to identify recent levels of sick leave or respiratory symptoms among the workforce to identify other potential cases. If the patient lives in a residential home/institutional setting, the water systems should be assessed as above. As part of the search to identify other cases, checks should be made about unexplained respiratory symptoms among other residents, current and past. The time period to review should be informed by the likely duration of any identified potential source of infection including water system deficiency. Water under pressure as found in spa pools, fountains, sprinklers, etc. is a recognised source of legionnaires' disease.

11.3.1.7 Domestic premises

A proportion of sporadic cases of legionnaires' disease may be residentially acquired. This is more likely to occur if a patient uses for example a shower after it has been out of use for some time e.g. a week or more.

There is a possibility of identifying Legionella in any domestic system; sampling of an individual's home should not be a routine response to a notification of a sporadic case unless there are other factors which can be taken into account. Such sampling may lead to isolation of the organism with consequent pressure for its elimination, a process that is technically problematic and may well be unsuccessful. If domestic water sampling is contemplated there must be a clear rationale for doing so which considers in advance what action, if any, will be taken in the event of identifying the organism in the supply.

Possible valid reasons for considering testing a domestic water supply include:

- Eliminating the house as a source of infection in an individual case for epidemiological purposes only
- Identifying a continuing risk of exposure in situations where there is reason to believe that another occupant of the property might be at increased risk (as opposed to a normal level of risk) of developing illness.
- Some other reasons for considering testing domestic water supply presence of at least one of the following additional criteria:

o Evidence that a Legionella-like illness, has occurred previously amongst occupants of the same house

o Evidence that sampling of the water system would contribute information to inform prevention and control of legionellosis in general terms and which could not otherwise be obtained.

11.3.1.8 Environmental Sampling

Examination of water samples can be a useful method for identifying potential sources of Legionella infection. The objectives of environmental water sampling are as follows:

- Confirmation or exclusion of the implicated site as a source of infection
- Risk assessment of the site's water system(s)
- Distinguishing between local or system-wide colonisation of water system(s)
- Identifying critical sites
- Selecting the right strategy for short-term control of Legionella
- Facilitating a proposal for the long-term control strategy for the whole facility.

11.3.1.9 Sampling criteria

- A successful examination for Legionella depends on several factors:
- The quality of the sample(s)
- The location of sampling points in terms of being representative of the water system being tested

- The timing of the sampling in relation to the normal operating conditions and control measures of the system, including the timing and levels of biocide dosing
- Proper collection, transportation and storage of the sample(s) to ensure that the sample(s) should undergo as little change as possible before the analysis begins.

11.3.1.10 Safety

- Environmental samples for Legionella should be collected by people with knowledge of Legionella ecology and general risk assessment.
- Based on a written risk assessment, in some circumstances, it may be necessary to use respiratory protective equipment.
- Individual staff who may be particularly prone to an increased risk of Legionella infection due to underlying conditions or immunosuppression should not be involved in sampling operations

11.3.1.11Site assessment

The number and types of sites that should be tested to detect Legionella must be determined on an individual system basis because of the diversity of plumbing, heating, ventilation and air-conditioning systems in the various institutions that may be sampled. Samples should be representative of each separate water system. They should be taken from the proximal and distal end of the water system and a number of sentinel points in between, the number and location being based on a comprehensive risk assessment (Table-48). Selection of sampling sites also depends on whether the sampling is for routine monitoring or to investigate an outbreak.

Table-48: Sentinel points for sampling

System	Sample points
Cold water system	-Storage tank -Furthest outlet from the storage tank -Other outlets in areas considered to represent a particular risk e.g. hospital wards with ‘at risk’ patients
Hot water system	-Calorifier outlet or nearest tap to the calorifier outlet -Return supply or nearest outlet to the return supply -Base of calorifier where drain valves have been fitted -Furthest outlet from the calorifier -Other outlets in areas considered to represent a particular risk e.g. hospital wards with ‘at risk’ patients

It is essential to undertake a survey of the site to be investigated prior to taking any sample. All surveys follow a basic pattern. The source and the quality of the water should be determined and the site should be examined to establish the location of all systems using water. These systems should then be reviewed and assessed to determine which systems contain water at temperatures likely to support the growth of Legionella bacteria. In addition, areas within the systems where growth of Legionella bacteria may be expected to be greatest should be reviewed, as should locations where potentially contaminated water might produce aerosols or where aerosols might be released into the environment. The route or pathway of the water through the system should be followed from its entry into the site to the point where it is used or discharged. If a schematic diagram does not exist or is not available, or is known to be or is suspected of being out-of-date, then an up-to-date diagram should be prepared indicating, for example locations of:

- The in-coming water supply, whether of mains or private source
- Storage tanks, expansion or pressure vessels, filters, booster vessel pumps and strainers
- Water softening filters or other storage or treatment facilities
- Calorifiers or water heaters
- The type and nature of materials and fittings, for example taps, showers, water closet cisterns, valves, thermostatic mixer valves, pressure release valves, bathroom radiators and towel rails connected to the domestic water supply (and associated pipework) and the presence of metals, plastics, jointing compounds
- Evaporative cooling towers and condensers or heating circuits
- Air conditioning systems or humidifiers within the building which are supplied with, and store water and which may produce aerosols
- Other equipment that contains water and which might be a potential risk, such as spa pools, humidified display cabinets, machine tools, fountains, etc.
- Equipment that is used infrequently or might not normally be of concern but presents a risk only when the system undergoes maintenance or repair
- The presence of dead-legs or blind-ends.

When all risk sites have been identified the appropriate samples can be collected. There should be discussion with the laboratory which will analyse the samples on the number and type of samples required. Arrangements should also be made for the transportation of the samples to the laboratory.

Aseptic precautions during sampling It is important to take appropriate precautions to eliminate cross-contamination occurring between sampling sites, especially when collecting dip samples from storage tanks, cisterns and cooling towers.

11.3.1.12Sample types

- Two primary sample types should be collected when sampling for Legionella - water samples and swabs of biofilm.
- Water samples capture the planktonic form of Legionella or any disturbed biofilm. Generally, 1.2 litre must be collected for each sample according to CPHL feedback. Samples should be collected in new, unused, capped containers containing sodium thiosulphate to neutralise.
- Swab samples capture the sessile form of Legionella that is associated with biofilms. Swab samples must be taken before water samples when collecting both sample types from the same outlet. Swab samples must be kept moistened with sterile water. Sterile absorbent cotton wool swabs should be used.

11.3.1.13Pre-flush sample

- A pre-flush sample is water collected immediately after the tap or fitting is opened. The tap or fitting should not have previously been disinfected, or water run to waste. The pre-flush sample represents water held within the tap or fitting and ideally, should be taken when the tap has not been used for several hours.
- **A pre-and post-flush sample should be taken at all outlets sampled.**

11.3.1.14 Post-flush sample

A post-flush sample is water collected after the tap or tap fitting has been disinfected and water in the fitting has run to waste. The post-flush sample represents the quality of circulating water supplied to the tap or fitting.

11.3.1.15 Procedure for Obtaining Shower Water Samples and tap swabs

Check details it in the sections above.

11.3.1.16 Sample transport and storage

- All samples should be transported to the laboratory in dark, insulated containers to protect them from extreme temperatures and from light.
- **No ice packs** should be used during sample collection and transportation.
- Analysis should begin as soon as possible after the sample has been taken, preferably on the same day.

- The sample container should be sealed for transportation with a single strip of tape and affix the return address label to the top of the box.
- Storing the sample in a refrigerator at temperatures below 6°C may reduce subsequent recovery of Legionella bacteria since the bacteria may be induced into a non-culturable state.

11.3.2 Annex-3b: investigation of water borne pathogens outbreak in healthcare setting

11.3.2.1 Definition

- An outbreak is suspected when two or more patients with invasive infections are epidemiologically linked. In certain clinical circumstances, an outbreak may be declared following a single invasive case e.g. multi-drug resistant *Pseudomonas aeruginosa* or healthcare associated Legionnaires' disease.
- An outbreak control team (OCT) with multidisciplinary representation should be established by the healthcare facility manager (table-49).

Table-49: Outbreak Control Team (OCT) Membership

– Senior clinical staff from affected area(s)
– Hospital management
– Nursing/Midwifery management
– Infection prevention and control
– Risk Manager/EOH staff/HSE technician
– Engineering Department
– Clinical microbiology consultant / Infectious diseases consultant
– Specialist in Public Health/epidemiologist
– Household / hygiene manager
– The Department of Disease Surveillance &Control [1]

[1] The Department of Disease Surveillance &Control should be informed of the outbreak. The department may be part of the OCT particularly when more than one institution is involved or if there has been transmission to/from the community.

11.3.2.2 Initial Investigation of the Outbreak

The OCT must investigate the potential outbreak by careful assessment of all the epidemiological, microbiological and environmental information available (table-50).

Table-50: Preliminary Investigation of an Outbreak

– Date of onset of symptoms in index case – Date of onset of symptoms in subsequent infected cases (symptomatic cases) – Type of infection(s) – Risk factors for infection including invasive device(s), surgery or other medical procedure(s) – Patient morbidity and mortality – Identification of colonised cases (asymptomatic cases) – Consider look-back for recent laboratory confirmed cases – All affected patients' entire inpatient and outpatient journey including ▪ Unit, ward and bed locations ▪ Staff contact(s)

11.3.2.3 Initial Management of the Outbreak

11.3.2.3.1 Isolation

- All neonatal cases, both infected and colonized infants, should be isolated individually or cohorted together. Adult and older pediatric cases may be isolated or cohorted together if advised by the infection prevention and control team.
- Strongly consider temporary closure of the affected area(s) if the outbreak is associated with high morbidity or mortality or the organism is a multi-drug resistant organism that is not endemic in your institution.
- Timely communication with patients and parents/guardians of paediatric patients is essential, particularly regarding whether they have an infection or are colonised.

11.3.2.3.2 Screening: patients, staff, environment and water testing

- Patients that have been in close contact with cases should be screened. Communicate with other institutions if contacts of affected cases were transferred prior to screening. The infection control team will advise on the appropriate specimens for screening for the specific outbreak organism.
- The environment in the affected area(s) may be implicated in the outbreak or may be heavily contaminated. Consider obtaining swabs and specimens from environmental sites prior to cleaning (table-51).

Table-51: Suggested Environmental Sites for Screening

Site	Example
Moist areas	Sinks and drains Taps/faucets Showers and showerheads Baths

	Sluices
Frequently touched items	Keyboards Telephones Light switches Door handles Infusion pumps Ventilator equipment
Devices used on more than one patient	Blood pressure cuffs Thermometers Stethoscopes Commodes Point-of-care testing machines Portable radiology machines Breast pumps
Water	See section of water testing

- The infection prevention and control team should advise the occupational health department if staff screening is necessary. Staff screening is usually not required for water-associated infections.

11.3.2.3.3 Control Measures

- Inform staff of the outbreak and emphasize the importance of hand hygiene.
- There should be a thorough deep-clean and chlorine disinfection in the affected area(s), paying particular attention to moist areas, sinks and taps, frequently touched items and devices used on more than one patient.
- Sterile water may be considered for washing high risk patients until the results of water testing exclude tap water as the likely source of the outbreak. High risk patients include infants <1500g birth weight with a central venous catheter, endotracheal tubes or other invasive device in place. Following consultation with the infection control team at-risk patients in augmented care units, burns units or other high risk patients may also require washing with sterile water.

- If water from outlets is suspected or confirmed as the source of infection, consider immediate corrective measures such as use of alcohol gels after hand-washing or temporary placement of point-of-use filters and using sterile water in place of tap water for at-risk patients and/or their environment.
- Preventive engineering measures must be prioritized immediately.

11.3.2.3.4 Communications Strategy

- Agree a communications strategy to provide clear, consistent and accurate information and to keep relevant persons appropriately informed e.g. affected patients and their parents/guardians, management, staff in the affected area(s), Director of Public Health, the general public and the media, as required.

11.3.2.3.5 Follow-Up Investigation

- Investigate any change in practice, product or fixture that may have caused or be implicated in the outbreak.
- Review potential risks associated with the water system in the affected area(s)
- Review potential risks associated with the use of invasive devices in the affected area(s)
- Review potential risks associated with the use of all water in the affected area(s) including humidified incubators, incubators, ventilators, nebulizers, medications, enteral feeds, ice, drinking water, bathing, hand hygiene etc.
- Review occupancy levels and nurse to patient ratios.
- Review space between beds/cots/incubators and investigate whether overcrowding may be associated with the outbreak.
- If a source has not been identified after the initial descriptive investigation, consider an analytical study such as a case-control study.

11.3.2.3.6 Follow-Up Measures

- Provide support, advice and guidance to individuals directly involved.
- Review patient, environmental and water screening results.
- Type organisms and store for possible future tests.
- Monitor effectiveness of control measures and ensure that preventive actions take place as soon as possible.
- Declare the outbreak over when it is safe to resume normal services
- Debrief all staff involved.
- Produce a final report on the outbreak.

11.3.3 Annex-3c: Investigation and management of legionella outbreak in the healthcare facilities

This section provides a comprehensive guide to managing a Legionella outbreak in hospitals, incorporating the CDC's recommendations and best practices.

11.3.3.1 Legionnaires' Disease Classification

The CDC classifies Legionnaires' disease associated with healthcare facilities into two categories:

- **Presumptive Healthcare-Associated:** Diagnosed in patients with a continuous stay of ≥10 days in a healthcare facility within 14 days of symptom onset.
- **Possible Healthcare-Associated:** Diagnosed in patients who spent some time in a healthcare facility within 14 days of symptom onset, but don't meet the criteria for presumptive.

Cases identified in outpatients, visitors, and employees are considered possible healthcare-associated and require investigation.

11.3.3.2 Triggering a Full Investigation

The CDC recommends a full investigation for the source of Legionella in a facility upon identification of:

- One case of presumptive healthcare-associated Legionnaires' disease at any time.
- Two or more cases of possible healthcare-associated Legionnaires' disease within 12 months of each other.

11.3.3.3 Importance of a Low Investigation Threshold

Early investigation is crucial due to:

- **High mortality rates** in healthcare settings due to vulnerable populations (elderly, immunocompromised).
- **Minimizing outbreak risk** by promptly identifying and addressing the source.

11.3.3.3 Steps Involved in a Full Investigation

1. **Outbreak Management Team:** Establish a dedicated team with expertise in infection control, epidemiology, and building management.
2. **Line Listing:** Create a detailed list of cases including demographics, medical history, symptoms, treatment, and healthcare exposure details. A CDC template is available.
3. **Additional Case Finding:**
   - **Retrospective:** Review patient charts for the past year to identify potential undiagnosed Legionnaires' disease cases, particularly those with pneumonia.
   - **Prospective:** Alert healthcare workers (HCWs) to test hospital-acquired pneumonia for Legionella using culture, PCR, or urinary antigen tests.
4. **Environmental Assessment:** Identify potential exposure sources based on the 14-day patient history, focusing on:
   - Hot and cold water systems
   - Assisted bathing/shower facilities
   - Cooling towers
   - Nebulizers and respiratory equipment
   - Water features and humidifiers

5. **Microbiological Investigations:**

- **Presumptive cases:** Collect environmental samples from identified sources **before** implementing control measures.
- **Possible cases:** Sample collection depends on the risk assessment.
- Sample sites depend on the environmental assessment and might include: Tap water (pre- and post-flush), showerheads (pre- and post-flush), hot and cold water storage tanks. Refer to the water sample results section for interpretations.

11.3.3.4 Corrective Actions:

- Address **distal/local conditions:** Low usage outlets, corrosion, dead legs, thermostatic mixing valves, and flexible hoses. Actions include regular flushing, cleaning/disinfection, removing aerators, reviewing TMV necessity, and consider taking outlets out of service based on WSG decision.

- Address **systemic conditions:** Stagnation, heater failure, hot/cold water cross-flow, and cleaning schedule non-compliance. Actions include:

  - **Immediate:** Prevent exposure from all outlets if Legionella count is very high, consider cleaning and disinfecting the entire system.

  - **Long-term:** Regularly clean tanks, outlets, and aerators; maintain optimal temperatures (calorifier 60°C, hot water >50°C, cold water <20°C); ensure continuous water circulation (by continuous use or flushing), Maintain optimal chlorination at 0.2-0.5 ppm at the outlet.

11.3.3.5 Follow-Up Measures:

- Repeat water samples 2-7 days after corrective actions.
- Monitor control measure effectiveness every 1-3 months.
- Declare outbreak over when safe to resume normal services.
- Debrief staff involved.
- Produce a final report on the outbreak.
- Review the water safety plan and control measures to prevent future outbreaks.

By following these steps and maintaining a proactive approach to water safety, hospitals can effectively manage Legionella outbreaks and protect patients, staff, and visitors.

11.4 ANNEX-4 INFECTION PREVENTION AND CONTROL FOR WATER QUALITY IN HEALTHCARE SETTING AND SPECIAL COSIDERATION FOR HIGH RISK AREAS

11.4.1 Annex-4a: Infection Prevention and Control for Water Quality In Healthcare Setting

11.4.1.1 It is essential for healthcare facility to develop and implement water preventive measure plan.

It must include:

- Monitoring, inspection, cleaning and disinfection of water supply, sampling schedule and frequency for the following
- Potable water system
- Hemodialysis and emergency water system
- Domestic hot water system
- Showers, faucets, humidifiers, fountains and HVAC drain pans.

11.4.1.2 Recommendations for prevention and control of water contaminations

11.4.1.2.1 Controlling the Spread of Waterborne Microorganisms:

- Practice hand hygiene to prevent the hand transfer of waterborne pathogens, and use barrier precautions (e.g., gloves) as defined by other guidelines.
- Eliminate contaminated water or fluid environmental reservoirs (e.g., in equipment or solutions) wherever possible.
- Clean and disinfect sinks and wash basins on a regular basis by using a MoH approved product as set by facility policies.
- Evaluate for possible environmental sources (e.g., potable water) of specimen contamination when waterborne microorganisms (e.g., NTM) of unlikely clinical importance are isolated from clinical cultures (e.g., specimens collected aseptically from sterile sites or, if post-procedural, colonization occurs after use of tap water in patient
- Avoid placing decorative fountains and fish tanks in patient-care areas; ensure disinfection and fountain maintenance if decorative fountains are used in the public areas of the healthcare facility.

11.4.1.2.2 Routine Prevention of Waterborne Microbial Contamination within the Distribution System

Water temperature

- Monitor the temperature daity

- Maintain hot water temperature at the return at the highest temperature preferably ≥124°F (≥51°C), and maintain cold water temperature at <68°F (<20°C).
- If the hot water temperature cannot be maintained at ≥124°F (≥51°C), explore engineering options (e.g., install preset thermostatic valves in point-of-use fixtures) to help minimize the risk of scalding.[661]
- When local set up do not allow hot water temperatures above the range of 105°F–120°F (40.6°C–49°C) for hospitals or 95°F–110°F (35°C–43.3°C) for nursing care facilities or when buildings cannot be retrofitted for thermostatic mixing valves, follow either of these alternative preventive measures to minimize the growth of *Legionella* spp. in water systems.
- Periodically increase the hot water temperature to ≥150°F (≥66°C) at the point of use.
- Alternatively, chlorinate the water and then flush it through the system.
- Maintain constant recirculation in hot-water distribution systems serving patient-care areas
- Patient care areas of skilled nursing care facilities 95°F-110°F (35°C-43.3°C)
- Kitchen hot water at 120°F (49°C)
- Laundry hot water 160° F (71°C)
- Provide continuously circulated cold treated water in hemodialysis areas

11.4.1.2.3 Construction and Remediation Strategies for Distribution System Repair or Emergencies

- Whenever possible, disconnect the ice machine before planned water disruptions.
- Prepare a contingency plan to estimate water demands for the entire facility in advance of significant water disruptions (i.e., those expected to result in extensive and heavy microbial or chemical contamination of the potable water), sewage intrusion, or flooding.
- When a significant water disruption or an emergency occurs, adhere to any advisory to boil water issued by the water safety committee.
- Alert patients, families, staff, and visitors not to consume water from drinking fountains, ice, or drinks made from tap water, while the advisory is in effect, unless the water has been disinfected (e.g., by bringing to a rolling boil for ≥1 minute).
- After the advisory is lifted, run faucets and drinking fountains at full flow for ≥5 minutes, or use high-temperature water flushing or chlorination.
- Maintain a high level of surveillance for waterborne disease among patients after boil water advisory is lifted. Corrective decontamination of the hot water system might be necessary after a disruption in service or a cross-connection with sewer lines has occurred.
- Decontaminate the system when the fewest occupants are present in the building (e.g., nights or weekends).

- If using high-temperature decontamination, raise the hot-water temperature to 160°F– 170°F (71°C–77°C) and maintain that level while progressively flushing each outlet around the system for ≥5 minutes.
- If using chlorination, add enough chlorine, preferably overnight, to achieve a free chlorine residual of ≥2 mg/L (≥2 ppm) throughout the system.
- Flush each outlet until chlorine odor is detected.
- Maintain the elevated chlorine concentration in the system for ≥2 hrs (but ≤24 hrs).
- Use a very thorough flushing of the water system instead of chlorination if a highly chlorine-resistant microorganism (e.g., *Cryptosporidium* spp.) is suspected as the water contaminant.
- Flush and restart equipment and fixtures according to manufacturers' instructions.
- Change the pretreatment filter and disinfect the dialysis water system with a MoH approved product to prevent colonization of the reverse osmosis membrane and downstream microbial contamination.
- Run water softeners through a regeneration cycle to restore their capacity and function.
- If the facility has a water-holding reservoir or water-storage tank, consult the facility engineer to determine whether this equipment needs to be drained, disinfected, and refilled.
- Implement facility management procedures to manage a sewage system failure or flooding (e.g., arranging with other health-care facilities for temporary transfer of patients or provision of services), and establish communications with the water safety committee and the IPC department to ensure that advisories are received in a timely manner upon release.

11.4.1.2.4 Preventing Legionnaires Disease in Protective Environments and Transplant Units

- Incorporate these specific surveillance and epidemiologic measures in addition to the steps previously outlined
- Maintain a high index of suspicion for Legionellosis in transplant patients even when environmental surveillance cultures do not yield legionellae.
- Conduct a combined epidemiologic and environmental investigation to determine the source of *Legionella* spp.
- If a case occurs in a severely immune-compromised patient,
- or if severely immune-compromised patients are present in high-risk areas of the hospital (e.g., PE or transplant units) and cases are identified elsewhere in the facility
- Implement culture strategies and potable water and fixture treatment measures in addition to those previously outlined
- Maintain heated water with a minimum return temperature of ≥124°F [≥51°C] and cold water at <68°F [<20°C]), or chlorinate heated water to achieve 1–2 mg/L (1–2 ppm) of free residual chlorine at the tap.

- Conduct periodic culturing for legionella in potable water samples from HSCT or solid-organ transplant units as part of a comprehensive strategy to prevent Legionnaires disease in these units.
- No recommendation is offered regarding the optimal methodology (i.e., frequency or number of sites) for environmental surveillance cultures in HSCT or solid organ transplant units.
- Remove, clean, and disinfect shower heads and tap aerators monthly by using a chlorine-based, MoH approved product,(chlorine bleach solution (500–615 ppm [1:100 v/v dilution]).
- In areas with patients at risk, when *Legionella* spp. are not detectable in unit water
- Implement certain measures until *Legionella* spp. are no longer detected by culture
- If *Legionella* spp. are determined to be present in the water of a transplant unit
- Decontaminate the water supply as outlined previously
- Do not use water from the faucets in patient-care rooms to avoid creating infectious aerosols.
- Restrict severely immune-compromised patients from taking showers.
- Use water that is not contaminated with *Legionella* spp. for HSCT patients' sponge baths.
- Provide patients with sterile water for tooth brushing, drinking, and for flushing nasogastric tubing during Legionellosis outbreaks.
- Do not use large-volume room air humidifiers that create aerosols (e.g., by Venturi principle, ultrasound, or spinning disk) unless they are subjected to high-level disinfection and filled only with sterile water.

11.4.1.2.5 Cooling Towers and Evaporative Condensers

- When planning construction of new health-care facilities, locate cooling towers so that the drift is directed away from the air-intake system, and design the towers to minimize the volume of aerosol drift. Implement infection-control procedures for operational cooling towers.
- Install drift eliminators.
- Use an effective MoH approved biocide on a regular basis.
- Maintain towers according to manufacturers' recommendations, and keep detailed maintenance and infection control records, including environmental test results from Legionellosis outbreak investigations.
- If cooling towers or evaporative condensers are implicated in health-care–associated Legionellosis, decontaminate the cooling-tower system.

11.4.1.2.6 Ice Machines and Ice

- Do not handle ice directly by hand, and wash hands before obtaining ice.
- Use a smooth-surface ice scoop to dispense ice.

- Keep the ice scoop on a chain short enough the scoop cannot touch the floor, or keep the scoop on a clean, hard surface when not in use.
- Do not store the ice scoop in the ice bin.
- Do not store pharmaceuticals or medical solutions on ice intended for consumption; use sterile ice to keep medical solutions cold, or use equipment specifically manufactured for this purpose
- Machines that dispense ice are preferred to those that require ice to be removed from bins or chests with a scoop.
- Limit access to ice-storage chests, and keep the container doors closed except when removing ice
- Clean, disinfect, and maintain ice-storage chests on a regular basis.
- Follow the manufacturer's instructions for cleaning.
- Use an hospital approved disinfectant suitable for use on ice machines, dispensers, or storage chests in accordance with label instructions.
- If instructions and hospital approved disinfectants suitable for use on ice machines are not available, use general cleaning/disinfecting procedures.
- Flush and clean the ice machines and dispensers if they have not been disconnected before anticipated lengthy water disruptions.
- Install proper air gaps where the condensate lines meet the waste lines.
- Conduct microbiologic sampling of ice, ice chests, and ice-making machines and dispensers where indicated during an epidemiologic investigation.

11.4.1.2.7 Hydrotherapy Tanks and Pools

- Drain and clean hydrotherapy equipment (e.g., Hubbard tanks, tubs, whirlpools, whirlpool spas, or birthing tanks) after each patient's use, and disinfect equipment surfaces and components by using an EPA-registered product in accordance with the manufacturer's instructions.
- In the absence of an EPA-registered product for water treatment, add sodium hypochlorite to the water:
- Maintain a 15-ppm chlorine residual in the water of small hydrotherapy tanks, Hubbard tanks, and tubs.
- Maintain a 2–5 ppm chlorine residual in the water of whirlpools and whirlpool spas.
- If the pH of the municipal water is in the basic range (e.g., when chloramine is used as the primary drinking water disinfectant in the community), consult the facility engineer regarding the possible need to adjust the pH of the water to a more acid level before disinfection, to enhance the biocidal activity of chlorine.
- Clean and disinfect hydrotherapy equipment after using tub liners.

- Clean and disinfect inflatable tubs unless they are single-use equipment.
- No recommendation is offered regarding the use of antiseptic chemicals (e.g., chloramine-T) in the water during hydrotherapy sessions.
- Conduct a risk assessment of patients prior to their use of large hydrotherapy pools, deferring patients with draining wounds or fecal incontinence from pool use until their condition resolves.
- For large hydrotherapy pools, use pH and chlorine residual levels appropriate for an indoor pool as provided by local and state health agencies.
- No recommendation is offered regarding the use in health care of whirlpools or spa equipment manufactured for home or recreational use.

11.4.1.2.8 Automated Endoscopy Reprocessor (AER) and dental units Connected to Water Systems

- Clean, disinfect, and maintain automated endoscopy reprocessor (AER) equipment according to the manufacturer's instructions and relevant scientific literature to prevent inadvertent contamination of endoscopes and bronchoscopes with waterborne microorganisms.
- To rinse disinfected endoscopes and bronchoscopes, use water of the highest quality practical for the system's engineering and design (e.g., sterile water or bacteriologically-filtered water [water filtered through 0.1–0.2-μm filters])
- Dry the internal channels of the reprocessed endoscope or bronchoscope using a proven method (e.g., 70% alcohol followed by forced-air treatment) to lessen the potential for the proliferation of waterborne microorganisms and to help prevent biofilm formation
- Use water that meets Oman standards for drinking water for routine dental treatment output water
- Take precautions to prevent waterborne contamination of dental unit water lines and instruments.
- After each patient, discharge water and air for a minimum of 20–30 seconds from any dental device connected to the dental water system that enters the patient's mouth (e.g., handpieces, ultrasonic scalers, and air/water syringe).
- Consult with dental water-line manufacturers to 1) determine suitable methods and equipment to obtain the recommended water quality; and 2) determine appropriate methods for monitoring the water to ensure quality is maintained.

11.4.1.2.9 Prevention of water contaminants for emergency and other water system

- Flush weekly the safety shower and eyewash stations
- Shut down, drain, clean and disinfect decorative fountains quarterly
- Maintain hot water temperature in patient care areas within the range 105-120°F (40-49°C)
- Perform shock decontaminate of hot water whenever necessary (e.g. after disruption caused by construction and after cross connection)

- Hot water temperature should be raised 160-170°F (71-77°C)
- Flush the outlet for 5 minutes maintaining the temperature.
- Inform the other concerned departments/units prior to shocking treatment to avoid scalding

11.4.2 Annex-4b: Infection Prevention and Control For Water Quality In High Risk Areas

Patients in high-risk areas (Table-52) are at increased risk of infection with *Pseudomonas aeruginosa* and other related organisms. These infections include intravascular catheter associated infection, ventilator associated pneumonia, sepsis, urinary tract infection and skin and soft tissue infection. The distal ends of water outlets have been identified as a reservoir for *Pseudomonas aeruginosa* and have been linked through molecular typing to high-risk patient clinical infections. Additional control measures and risk assessment are required for patients who are at increased risk for such infections.

Table-52: Clinical settings where patients are high-risk for waterborne infections

High Risk Areas	**Additional clinical settings, based on local risk assessment, that should be included as an augmented care setting for the purposes of this guideline**
All Intensive Care Units including adult, paediatric and neonatal	Profoundly immunosuppressed patients as a result of disease or therapy, including malignancy and recent major surgery
Neonatal High Dependency Units	Patients with extensive breaches in dermal integrity
Burns units	Other patients as determined by local risk assessment
Transplant units	

11.4.2.1 Flushing in high risk areas

All water outlets in High Risk Areas should be in-use multiple times per day. Any water outlet that may not be in frequent daily use should be identified by the unit manager and those outlets must be flushed on a daily basis. Examples of infrequently used outlets may include single en-suite rooms and temporarily closed wards or departments. Outlets that require routine flushing must be documented. Records of flushing must be stored for at least 1 year. See section water outlet flushing. The water safety committee must ensure that regular audit of flushing is performed, documented and all necessary actions taken.

11.4.2.2 Use of Water for Patient Care Activities in high risk areas

Tap water may be used for washing adult or paediatric patients in augmented care units, provided there are no current clinical incidents suggesting water system contamination. Care must be taken during bathing to prevent contamination of invasive devices, as outbreaks of bacteraemia have been described in critical care units following exposure of central vascular catheters to hospital water supply during bathing.

For neonates in high risk areas, see specific guidance of Neonatal Units below.

Potable mains water may be used for drinking, provided there are no current incidents suggesting water system contamination. Caution is advised when considering water coolers for patient use in high risk areas. Deterioration in water quality may occur due to stagnation or to biofilm formation in taps, filters and/or drip trays, especially if taps are manufactured from plastic.

Ice is not recommended for use in High Risk Areasand for patients who are at high risk of water-borne infections. Use of ice has been associated with rare but important infections, outbreaks and pseudo outbreaks.

On occasion, ice may be used for high risk patients when the clinical benefit of using the ice outweighs the risk. In such circumstances, ice should only be used under senior medical instruction.

With respect to the humidifiers in ventilator circuits and continuous positive airway pressure (CPAP) circuits, sterile water must be used.

11.4.2.3 Neonatal Units

Invasive *Pseudomonas aeruginosa* infection in neonatal patients has been linked to contaminated water. Neonates <1500g are particularly vulnerable to such infections, especially if they are placed in a humidified incubator or if they have an invasive device in-situ such as an endotracheal tube or a central vascular catheter. Invasive *Pseudomonas aeruginosa* infection in very low birth weight infants is often associated with a high mortality. Fortunately, such infections are uncommon in infants in the first few months of life.

11.4.2.3.1 Bathing / Washing

The type and frequency of washing (e.g. nappy change, top and tail, bed bath or immersion bath) is determined by the clinical team caring for the infant.

- Infants born at extreme prematurity (less than 28 weeks gestation) may have fragile skin which may breakdown easily during the early days of life; these infants are usually placed in a humidified incubator. Sterile water or saline must be used for washing non-intact skin, including during nappy change.
- Tap water may be used for bathing high risk infants with intact skin, who are not placed in humidified incubators, such as infants <1500g birth weight with central vascular catheters, endotracheal intubation or the presence of other invasive devices, provided there are no current clinical incidents suggesting water system contamination. However, if surveillance of infection identifies an outbreak or increased incidence

of infection with water-borne organisms, sterile water should be used for bathing high risk infants until an infection control investigation and water testing concludes that tap water is safe for bathing.

- Washing with tap water is indicated for neonates with normal healthy skin without invasive devices.

11.4.2.3.2 Incubators

Humidified incubators may be provided for infants less than 28 weeks gestation or birth weight less than one kilogram in order to maintain their body temperature and to reduce fluid loss. These incubators present a potential risk to the occupant for water-associated infection, especially *Pseudomonas aeruginosa*. The neonatal unit manager must ensure that when an incubator is being humidified, a sterile water reservoir and sterile water is used. The reservoir and water must be changed daily. A re-usable reservoir must be cleaned and sterilised between uses in a central decontamination unit.

Non-humidified incubators present a lower risk to the occupant from water-associated infection. All incubators should be regularly cleaned and decontaminated by trained competent personnel (once or twice weekly depending on patient risk and between each patient use). The incubator must be completely dismantled, cleaned, decontaminated and dried before using again as per local agreed procedure. The serial number of the incubator must be recorded. There is no requirement to use sterile water to clean incubators. Tap water and detergent may be used. The critical factor is thorough drying of all parts of the incubator and mattress before use.

11.4.2.3.3 Therapeutic Cooling

A closed system must be used for infants that require cooling. Sterile water must be used in the system. There should be no direct contact between the infant and the water. Ice or ice packs must not be used for passive or therapeutic cooling.

11.4.2.3.4 Infant Feeds

If breast fed, then milk is not used to feed an infant, sterile ready-to-feed formulas are recommended for infants in the majority of healthcare institutions. However, ready-to-feed formula may not be available for all specialised feeds. If a powdered infant formula feed is required, it should be prepared using boiled potable (drinking) water and in accordance with the manufacturer's instructions.

Frozen breast milk may be defrosted safely using one of the following methods:

- Defrost using a warming/thawing device designed to ensure no direct contact with the syringe/bottle and nonsterile water
- Defrost in a designated milk fridge
- Defrost at room temperature and discard any unused milk
- Frozen breast milk must never be defrosted by placing the container in tap water, unless the tap water has been boiled first.

Breast or formula milk may be warmed safely using one of the following methods:

- Use a warming device designed to ensure no direct contact with syringe/bottle and non-sterile water
- Remove from fridge one hour before use
- Use warmed sterile water

Breast or formula milk must never be warmed by placing the container in tap water, unless the tap water has been boiled first.

11.4.2.4 Surveillance of Infection in high risk areas

- Infection prevention and control teams must ensure that high-risk units have an ongoing surveillance system in place whereby unusual clusters of colonisation/infection due to *Pseudomonas aeruginosa* and other related gram negative water-associated organisms (including those due to potential environmental sources) are detected in a timely fashion. Clinical isolates of *Pseudomonas aeruginosa* from High Risk Areasand all clinical isolates of *Legionella* species should be monitored as alert organisms. If such a surveillance system is not already in place, high-risk units should perform a retrospective review of invasive infections to ensure that there has been no recent episode(s) of potential outbreak.
- Ensure full and appropriate investigation of any such outbreak(s), including a risk assessment of water as a potential source.

11.4.2.5 Water Testing

- Monitoring of water supplying an augmented care unit for *Pseudomonas aeruginosa* may be required, based on risk assessment. Water testing is recommended during an outbreak or if surveillance identifies an increased incidence of infection.
- Water testing may also be indicated following a single invasive *Pseudomonas aeruginosa* infection, if the organism is an unusual pathogen in the augmented care unit.
- Furthermore, evidence suggests that there is a greater risk of the internal surfaces and components of non-touch or sensor taps becoming contaminated with microorganisms and biofilm in comparison to manually operated taps. Therefore, water testing may be considered by the environmental monitoring committee for High Risk Areaswith sensor taps.

11.4.2.6 Risk Assessment in high risk areas

A risk assessment should be undertaken in High Risk Areas to mitigate risk and to minimise exposure of patients to contaminated water. The water safety committee or equivalent committee must ensure a safe water system, appropriate materials, fixtures and fittings for all water outlets and documented flushing of infrequently used outlets. Furthermore, the infection prevention and control team must ensure timely surveillance of water-associated infection; that infection prevention and control policies are in place and infection prevention and control audits are conducted. If surveillance of infection indicates a possible outbreak, this should be thoroughly investigated by an outbreak control team including obtaining water samples for testing. Appropriate corrective actions and preventive actions should be agreed.