International Association for Food Protection WEBINAR

Impact of Water Use and Reuse in Food Production and Processing on Food Safety at the Consumer Phase: Focus on the Dairy Products Sector

IAFP's Water Safety and Quality PDG, International Food Protection Issues PDG, and Dairy Quality and Safety PDG

Moderator: Leon Gorris, Food Safety Futures

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International Association for Food Protection

Webinar Series

Impact of Water Use and Reuse in Food Production and Processing on Food Safety at the Consumer Phase: Focus on the Fish and Fishery Products Sector
Feb 27, 2024

Impact of Water Use and Reuse in Food Production and Processing on Food Safety at the Consumer Phase: Focus on the Fresh Fruit and Vegetable Products Sector
Dec 14, 2023

Webinar Housekeeping

International Association for Food Protection® WEBINAR

- **It is important to note that all opinions and statements are those of the individual making the presentation and not necessarily the opinion or view of IAFP.**
- **All attendees are muted. Questions should be submitted to the presenters during the presentation via the Questions section at the right of the screen. Questions will be answered at the end of the presentations.**
- **This webinar is being recorded and will be available for access by IAFP members at within one week.**

Today's Panelists

International Association for Food Protection WEBINAR

Kang Zhou
Presenter

Claus Heggum
Presenter

Leon Gorris
Panelist & Moderator

Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

Development of international scientific advice on water (re-)use and food safety

Dr Kang Zhou

Food Safety Officer
Food Systems and Food Safety Division
Food and Agriculture Organization of the United Nations (FAO)

Background on safety and quality use of water in food at the FAO

- Many Codex documents make reference to the use of **portable** or '**clean**' water

Challenge

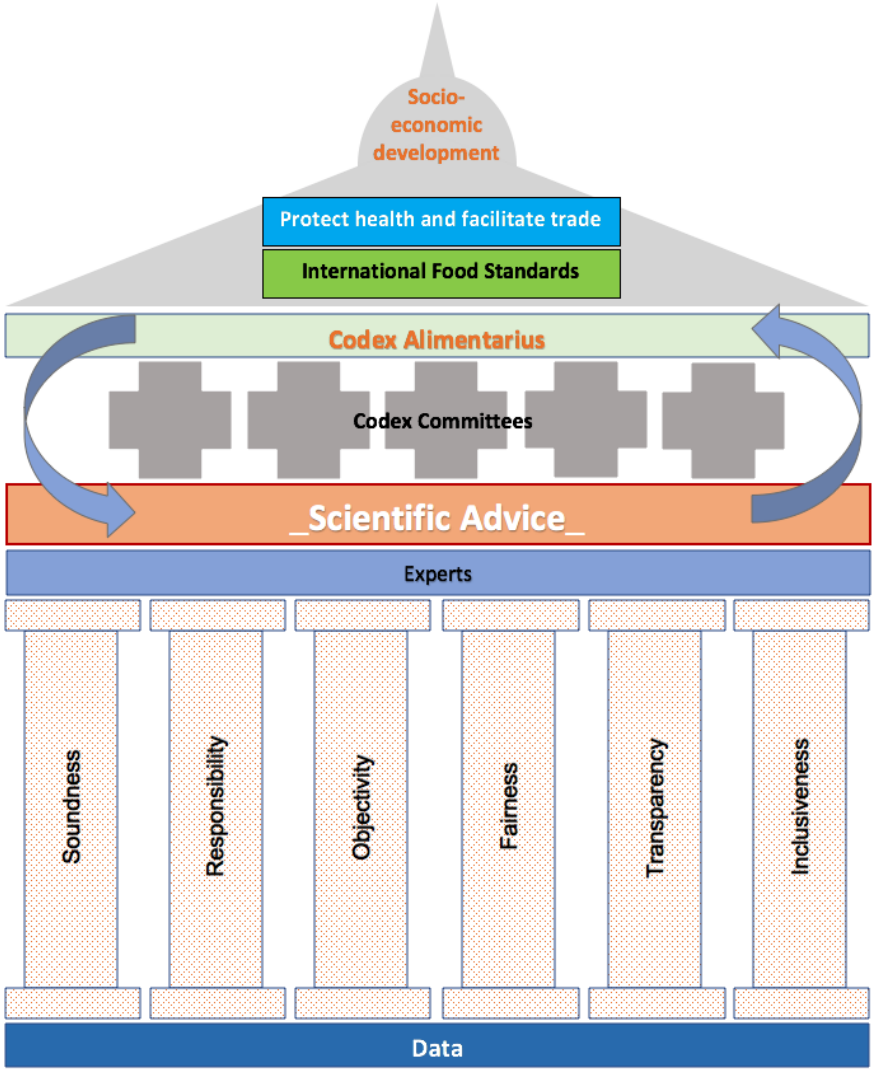
How to turn the Codex current definition clean water "*water which does not compromise the safety of food in the context of its use*" into operational guidance/target for water use and re-use by food producers and processors

- Water is a **dwindling resource** worldwide and not all food producers and processors have access to safe water sources, or this access may be limited.

- Codex Committee on Food Hygiene (CCFH) noted the importance of water quality in food production and processing (48th session in November 2016), requested JEMRA to provide guidance processing water, in particular, "clean water" for irrigation water, clean seawater, and on the safe reuse of water

Joint FAO/WHO Scientific Advice Programme

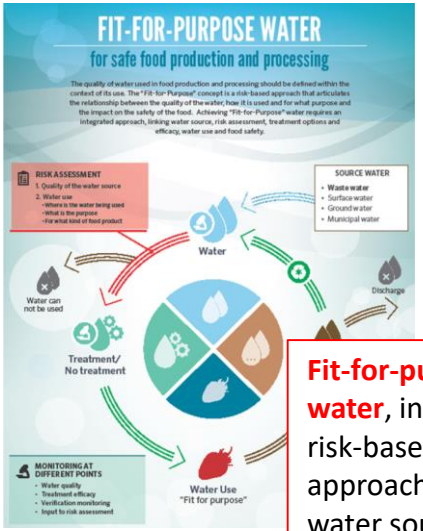
- **JEMRA**: Joint FAO/WHO Expert Meeting on Microbiological Risk Assessment
  - Established in 2000
  - Scientific advice on microbiological risk assessment
  - Expert meetings based on requests from Codex (CCFH) and as we deem necessary
- JECFA, JMPR, JEMNU, ad hoc

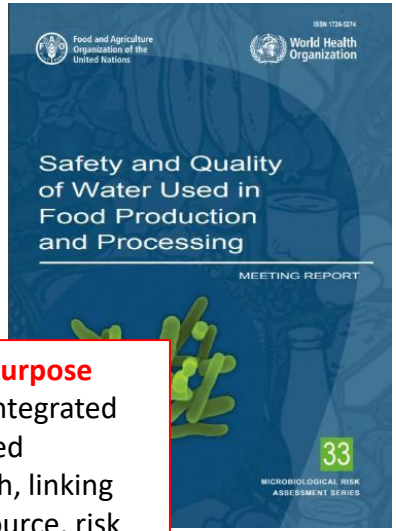


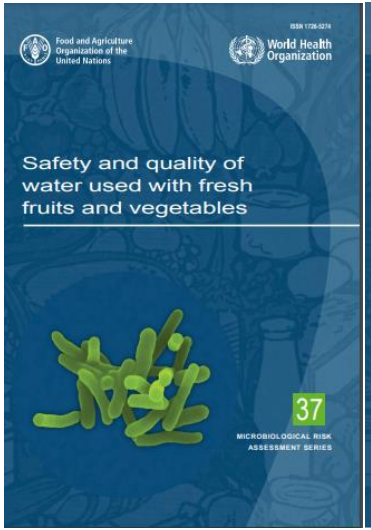
- Place a greater emphasis on a *risk-based approach to safe water* use.
- Instead of specifying use of potable water (or in some instances other water quality types) a risk-based approach and assessment of the *fitness of the water for the purpose* intended should be articulated.
- One size does not fit for all.

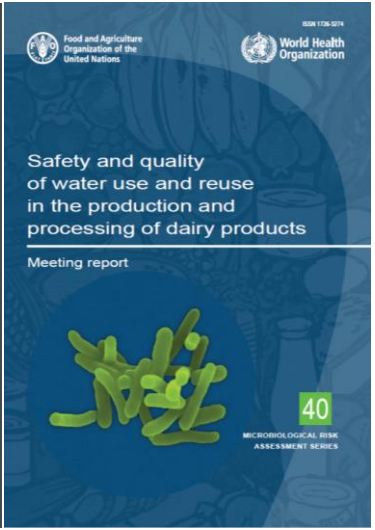
Pathway Forward

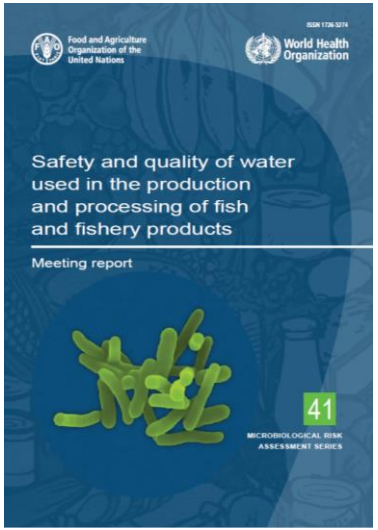
Workshop in **Honduras** to evaluate the decision tree and concepts from JEMRA, in October 2022











Fit-for-purpose water, integrated risk-based approach, linking water source, risk assessment, treatment options and efficacy, water use and food safety.

2017 meeting and infographic

2018 meeting 2019 report

2019 meeting 2021 report

2021 meeting 2022/2023 report

Codex Alimentarius – international food standards

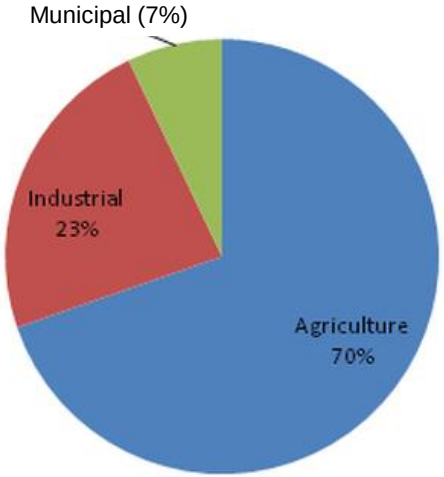
- **General Principles of Food Hygiene (2022)**
- **Guidelines for the safe use and reuse of water in food production and processing (2023)**
  - Provide guidance for **food business operators** (FBOs) and **competent authorities** on the application of a risk-based approach for the use and reuse of water that is fit for purpose.
  - Provide practical **guidance and tools** (e.g. DTTs) and risk-based microbiological **criteria** as examples to help FBOs evaluate risks and potential interventions of water as part of their food hygiene system.
  - Annexes: **fresh produce**, **fishery products**, **dairy products**.

Food and Agriculture Organization
of the United Nations

Principles and Frameworks for Risk-based, Fit-for-purpose Management of Water (re)use in the Dairy products Sector

Dr Leon Gorris
Food Safety Futures
FAO-WHO-JEMRA expert

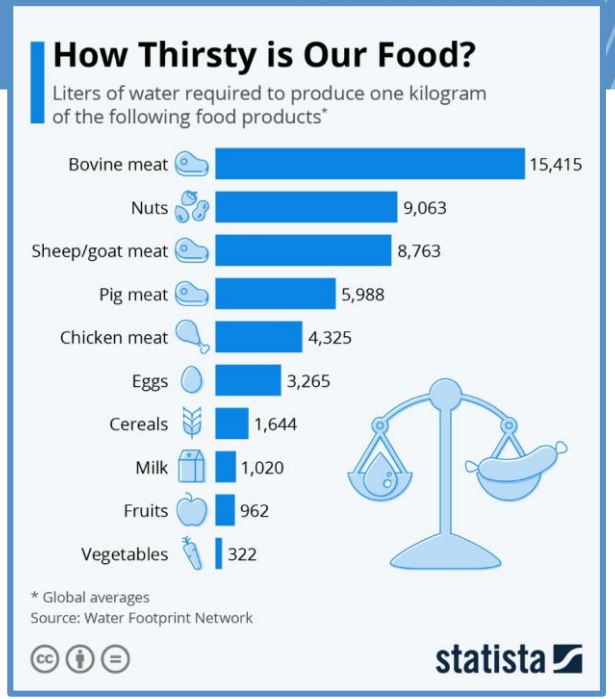
Global Water Use



Sector	Global Water Footprint
Meat Processing	○○
Dairy Products	○○○
Fruits & Vegetables Processing	○○
Soft Drinks & Bottled Water	○○○
Brewing, Wine & Spirits	○○○
Cooking Oils & Fats	○

Key: ○○○ High ○○ Medium ○ Low

Source: Frost & Sullivan analysis



https://www.statista.com/chart/9483/how-thirsty-is-our-food/





Addressing water insecurity

1. **Optimization of (first-) water use and re-use**
   - less potable water is used per food processed
   - less potable water is wasted

2. **Targeted re-use of water from sources within the food operation**
   - use that quality of water for specific purposes in food production, processing and handling that is functional but does not compromise food safety

Examples of water use purposes in dairy operations

Direct food contact purposes

- Washing, cleaning, rinsing of raw materials, foods, food contact equipment
- Transporting raw materials and foods (food components, final food product, etc)
- As food ingredient or for processes transforming raw materials/ingredients

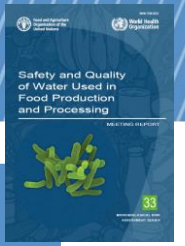
Indirect food contact purposes

- Cleaning and disinfection of equipment, floors, walls, etc
- Heating and cooling steps during processing
- Personal uses: handwashing inside food production/handling/operation

Not for food contact purposes

- Water for making technical steam
- Water for washing external of trucks or for firefighting
- Sanitary use and heating/cooling applications in offices, factory buildings, etc

Terminology: water types



Water type	Description/Examples
First-use water	**Potable** water from an **external source** that **can be used in any food processing operation**
Re-use water	Water that is or has been **recovered from an internal source (e.g. food materials, a processing step or operational activity**, and that (where necessary after reconditioning treatment(s)) can be used in the same, a prior, or a subsequent food processing step or operation.

Water sources for water reuse in dairy operations

Sources from within the FBO's operation

- (First use) Drinking water (from external supplies) that is recycled until it is no longer suitable as drinking water
- Water being part of milk and/or milk products
- Water that has been used for cleaning purposes
- Water that is otherwise discarded as dairy effluents
- Other sources, e.g. rainwater

Sources from elsewhere

- Reusable, conditioned water provided by a third party
- Other external water sources

Matching reusable water sources with reuse purposes

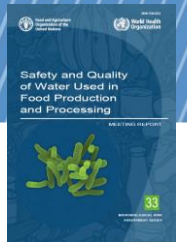
Water reuse purposes *– and likelihood of contact between food and re-use water:*

- **Water as ingredient** – definite contact
- **Direct contact water** – definite contact
- **Indirect contact water** – contact is possible/likely
- **Not for contact water** – contact impossible/unlikely

Key factor concerning the safety of the food being produced or processed in the operation reusing water =

- The exposure of consumers to hazards from the reusable water source or from the operation reusing water, which depends on:
  - nature of the food product and its consumers
  - the reusable water source deployed, its (re-)conditioning, food processing
  - the point/step at which reuse water is used and
  - the impact of all hazard control measures until consumption

Terminology: Re-use water types



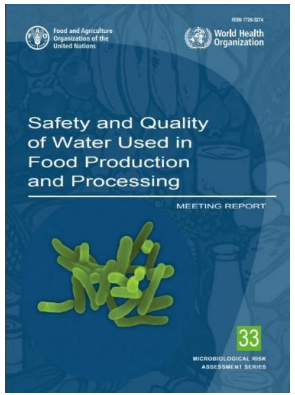
Water type	Description/Examples
Reclaimed water	**Water that was originally a constituent of a food material**, that has been removed from that food material and is subsequently used in a food processing operation
Recycled water	**Water, other than first-use or reclaimed water,** that has been obtained from a food processing operation and applied in a different operation.
Recirculated water	**Water re-used for the same processing operation** (example: counterflow, single unit vegetable washing; a cooling or heating system in which water circulates, e.g. condenser or pasteurizer cooling water)

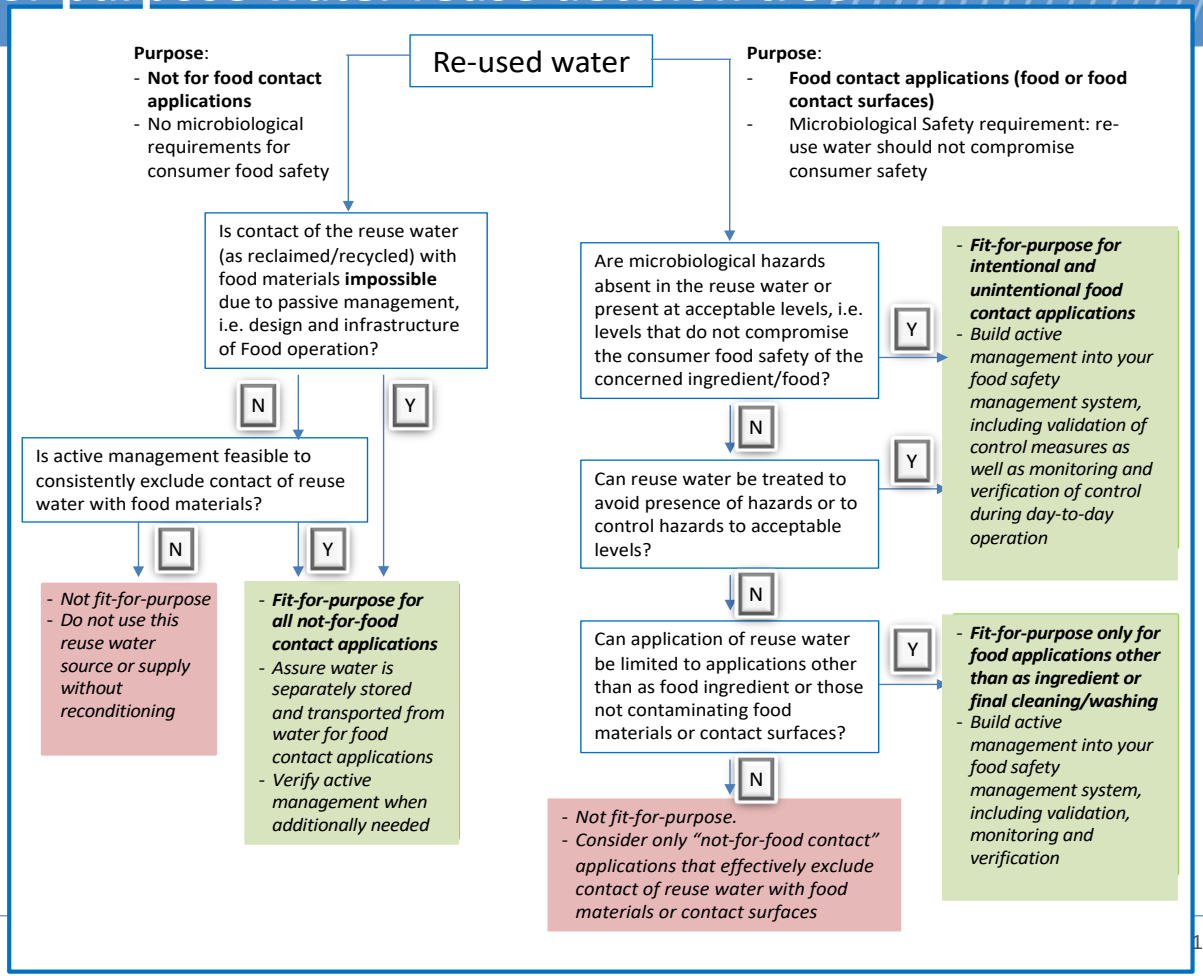
Fit for purpose water reuse decision tree

Combines

- **Risk-based framework +**
- **Fit-for-purpose +**
- **Contact or not contact reuse**

Report 33





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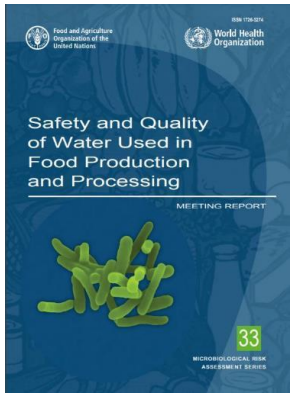

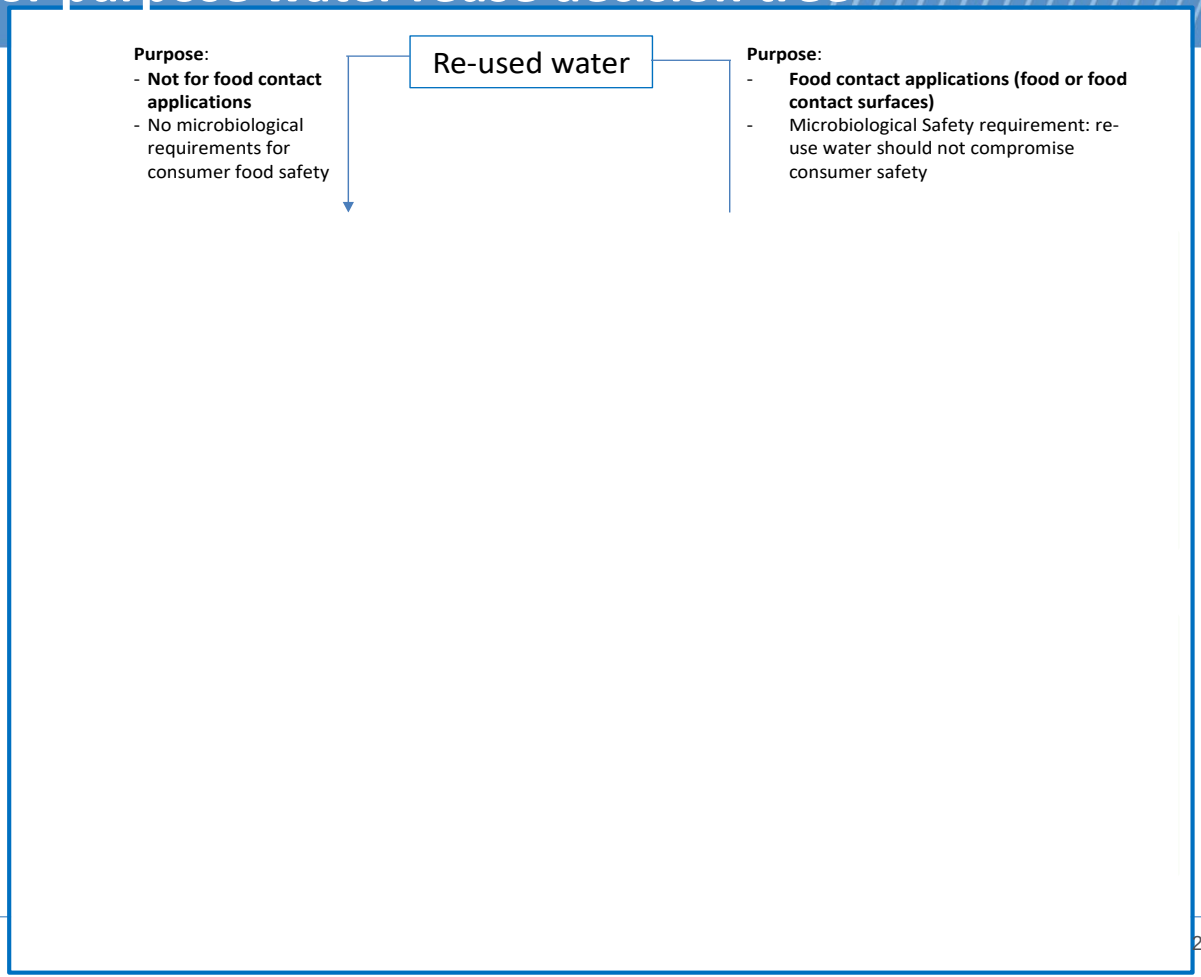

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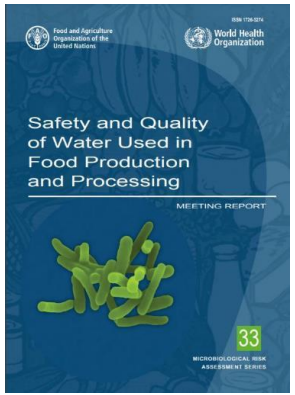

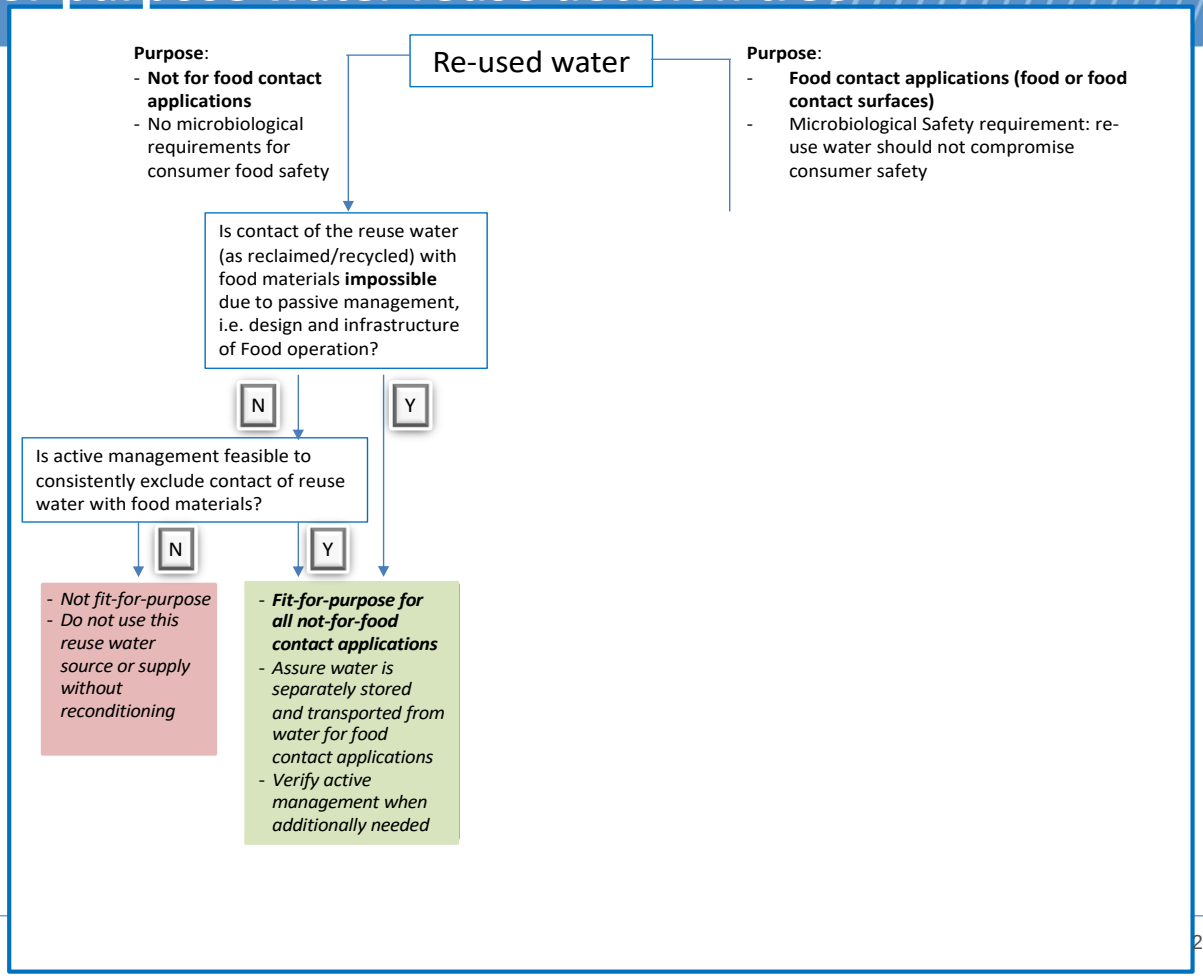

Fit for purpose water reuse decision tree

Combines

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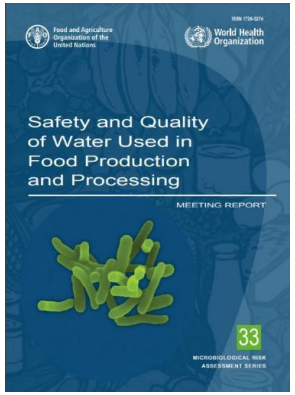
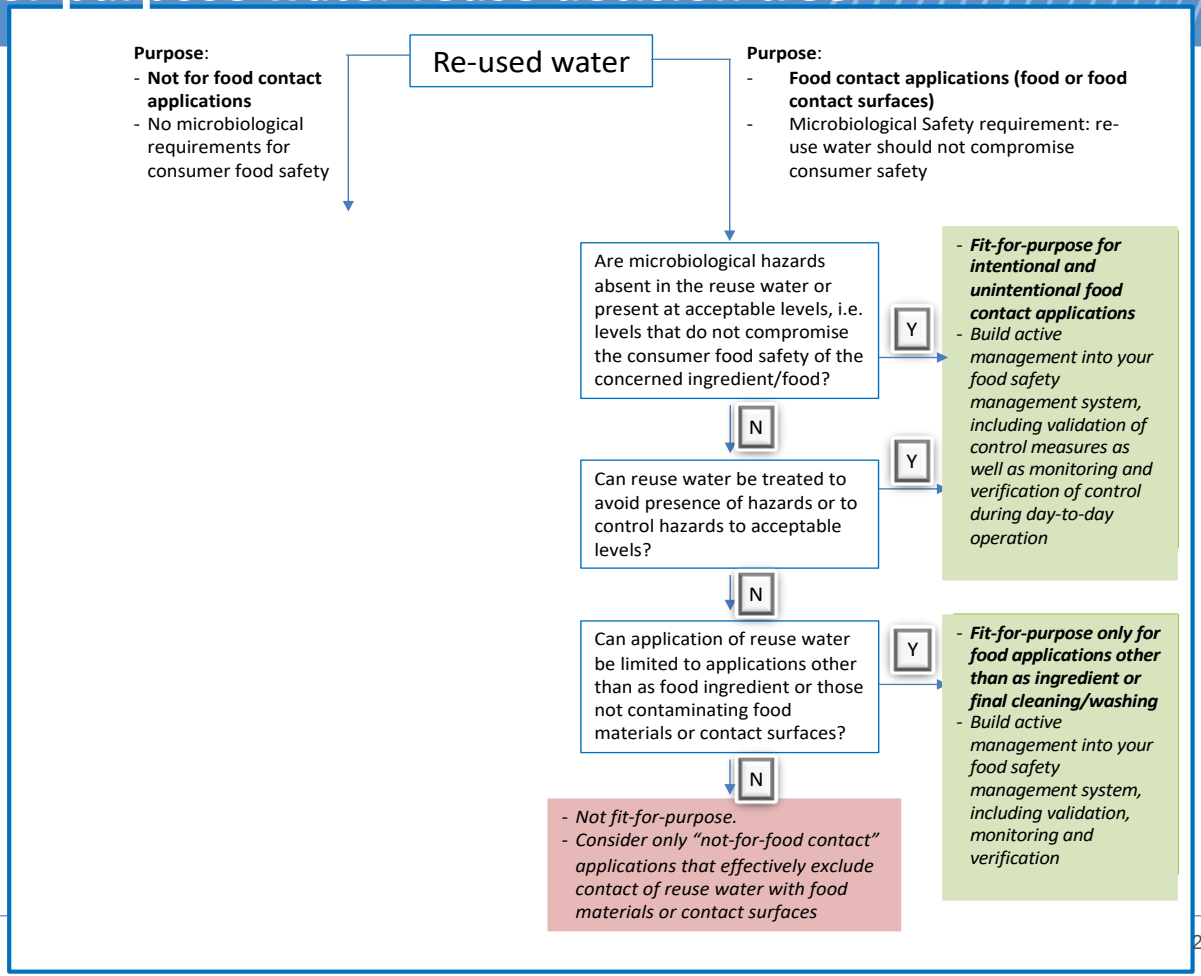




Fit for purpose water reuse scenarios

Report 40

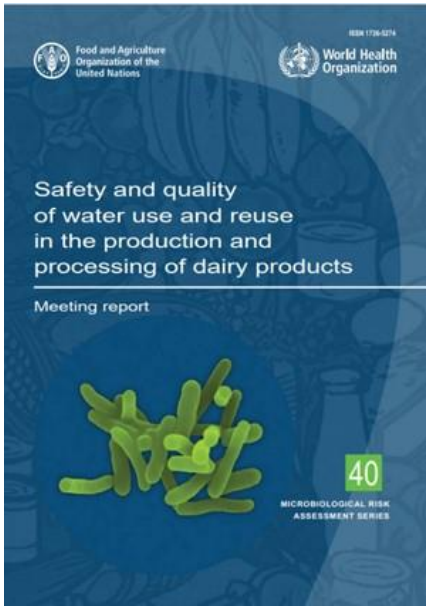


TABLE 2 Overview of fit-for-purpose considerations for different water use purposes and types of water reuse

PURPOSES	FIRST-USE WATER	RECIRCULATED WATER	RECLAIMED WATER	RECYCLED WATER
e.g.	**Potable source**	**Closed loop**	**Recovered from a food material**	**Recovered from a process step**
Food ingredient	Fit-for-purpose as sourced	No likely application	Fit-for-purpose if no significant hazards present either as recovered, or after reconditioning	Fit-for-purpose if no significant hazards present either as recovered, or after reconditioning
Direct food contact	Fit-for-purpose as sourced	No likely application	Fit-for-purpose if no significant hazards present either as recovered, or after reconditioning	Fit-for-purpose if no significant hazards present either as recovered, or after reconditioning
Unintended food contact	Fit-for-purpose as sourced	Fit-for-purpose as recovered if no significant hazards are present, or food contact is avoided	Fit-for-purpose as recovered if no significant hazards are present, or food contact is avoided	Fit-for-purpose as recovered if no significant hazards are present, or food contact is avoided
Not for food contact	Fit-for-purpose as sourced	Fit-for-purpose as sourced	Fit-for-purpose as sourced	Fit-for-purpose as sourced

Water reuse scenarios in dairy operations

Various scenarios may apply for a single FBO matching source to purpose, some examples:

(risks vary with not-for-food-contact or for-food-contact reuse purposes from low to moderate to high):

- Reuse of drinking water by recirculation or recycling
- Reclaim and reuse of milk water from dairy production/processing
- Recovery of condensate
- Casein wash water
- Whey/whey permeate

for-food-contact purpose?

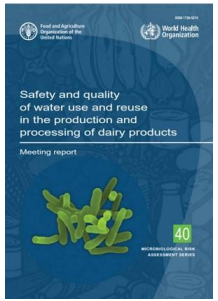
- Product flush/rinse water
- Recovery and reuse of water from Cleaning-In-Place (CIP) systems
- Recovery and reuse of dairy effluents
- Water recovery and reuse from non-food manufacturing operations

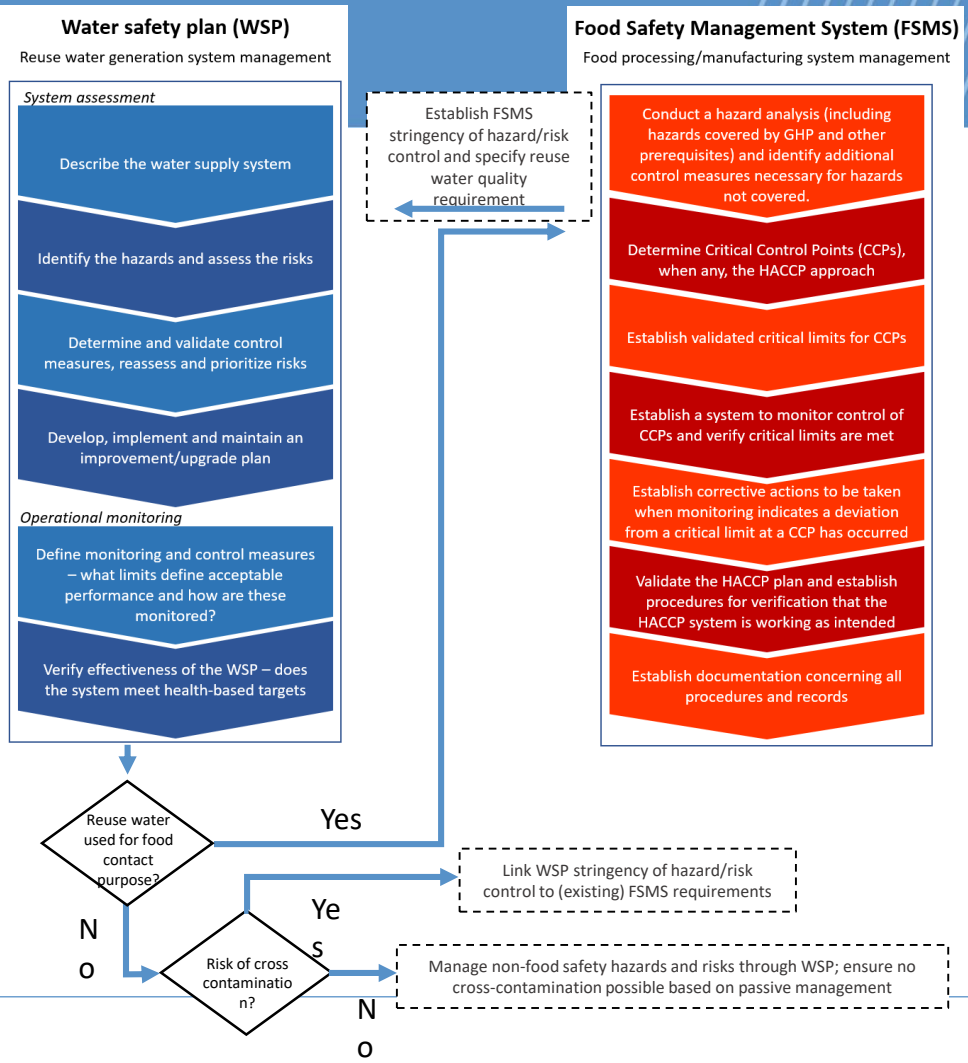
not-for-food-contact purpose?

Managing a water reuse scenario

Operator options/choices

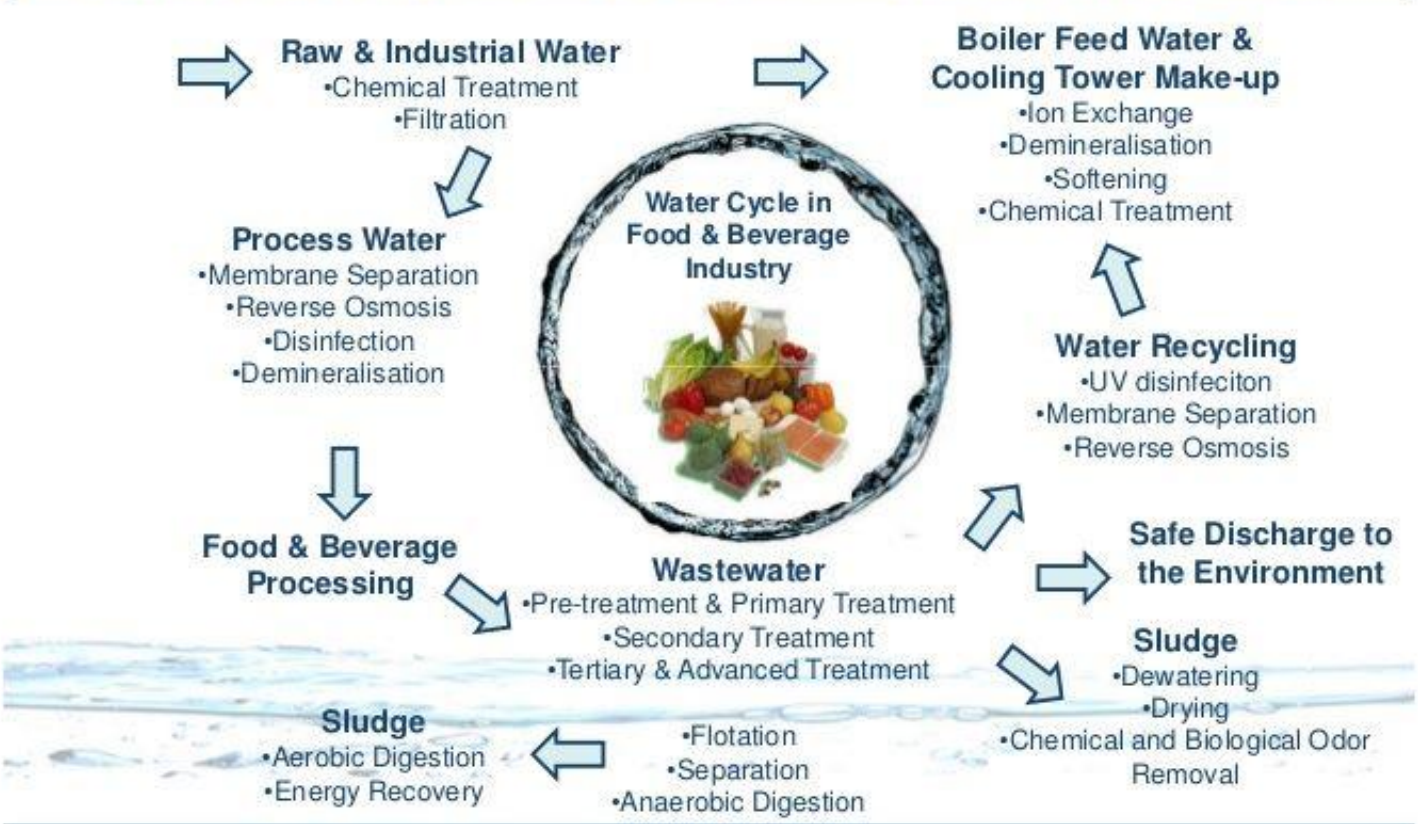
- **Not-for-food-contact reuse management through Water Safety Plan**
- **For-food-contact reuse management through Food Safety Management System (incl. GHP/HACCP)**
- **Both purposes through the latter**





Water Cycle in Food & Beverage Industry

Given the Significant Volume of Water Required for Food & Beverage Production, There is a Vast Need to Implement Advanced Treatment Technologies and Solutions



Technologies for reclaiming and reconditioning reusable water

Technology information in Annexes 1, 2 and 3 of the JEMRA report

1. Water recovery technology

a) Recovery by condensation
b) Recovery by sedimentation, coagulation and centrifugation

2. Water purification technologies

a) Reverse Osmosis (RO) or RO Polishing (ROP)
b) Ultrafiltration (UF)
c) Activated carbon water filtration (ACWF)
d) Aerobic digester technologies
e) Membrane Bioreactors (MBR) technology

3. Microbiocidal treatments

a) UV treatment
b) Heat treatment
c) Chemical treatment (disinfection)

FFP water reuse scenario design requires:

- Understanding of the water quality suited for the purpose
- Understanding the quality of water recovered, reclaimed, etc
- Understanding the need for applying antimicrobial/biocidal treatment; ability to implement necessary technologies
- Understanding the antimicrobial/biocidal performance of individual and combined technologies
- Understanding impact of “residuals” (e.g. nutrients; technical aids/chemicals)

Case studies on water reuse in the dairy sector

Illustrative examples in Annex 4 of the JEMRA report

a) Use of contaminated water from FBOs own wells

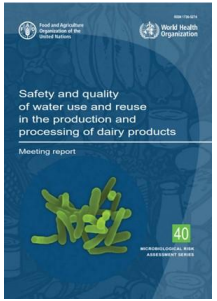
b) Recirculation of water used for cooling of cheese

c) Recovery and reuse of water from CIP systems

d) Recovery of water from whey using RO or ROP

e) Recovery of water from dairy effluents using MBR and RO

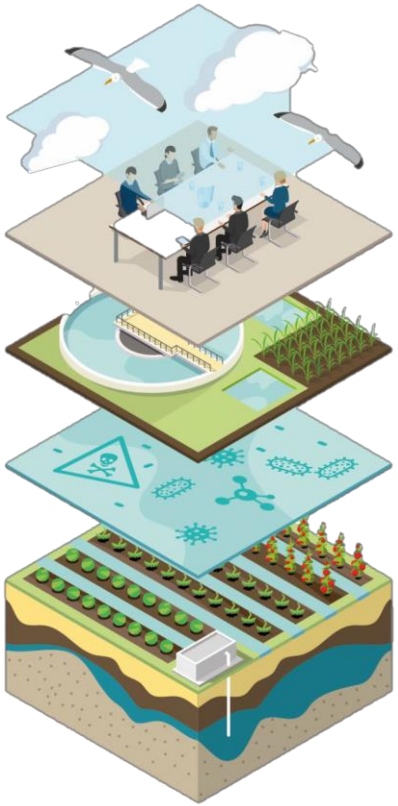
Details in the next presentation



General Recommendations

- It is recommended that each water reuse scenario considered by an operator be carefully tailored to the conditions of its particular food operation.
- Assess the hazards and the potential risks associated with applying water from a specific reusable water source for a particular purpose (case-by-case).
- Select the most robust water reuse scenario given the design and control options available to the operator.
- Validate the reuse water generation system according to the intended application purpose(s).
- Establish adequate monitoring parameters and verification procedures to assess the effectiveness (or loss) of operational control of the reuse water production and use, and that allow for the operator to take timely action when necessary.

Industrial water re-use is a multi-layered issue



- Reusable water sources available
- **Microbiological risks**
- **Chemical risks**
- **Occupational risks**
- **Environmental risks**
- Treatment technologies & capabilities
- Storage facilities and times
- **Business case and operational feasibility**
- **Regulation and legislation**
- **Social acceptance and perceptions**
- and more

Food and Agriculture Organization
of the United Nations

Thank you!

MRA 33 Safety and quality of water used in **food production and processing**.
https://www.fao.org/documents/card/en/c/ca6062en/

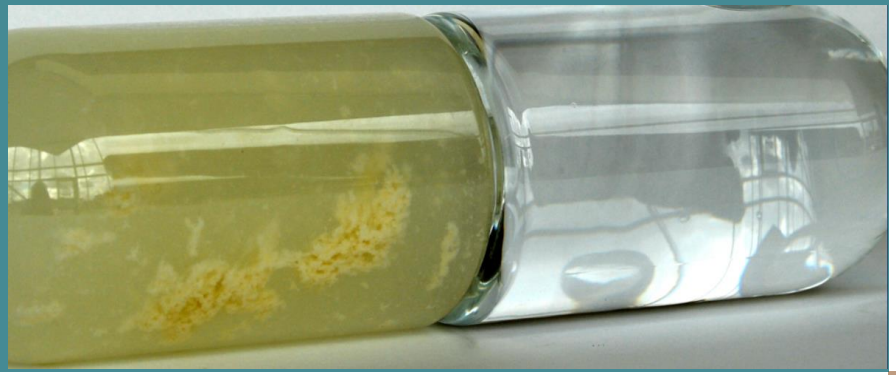
MRA 37 Safety and quality of water used with **fresh fruits and vegetables**.
https://www.fao.org/documents/card/en/c/cb7678en/

MRA 40 Safety and quality of water use and reuse in the production and processing of **dairy products**.
https://www.fao.org/documents/card/en/c/cc4081en

MRA 41 Safety and quality of water used in the production and processing of fish and **fishery products**.
https://www.fao.org/documents/card/en/c/cc4356en

Practice Session: Impact of Water Use: Focus on the Dairy

IAFP's Webinar
23 May 2024



Claus Heggum
International Dairy Federation
(FIL/IDF)

THE WATER-FIT-FOR-PURPOSE APPROACH

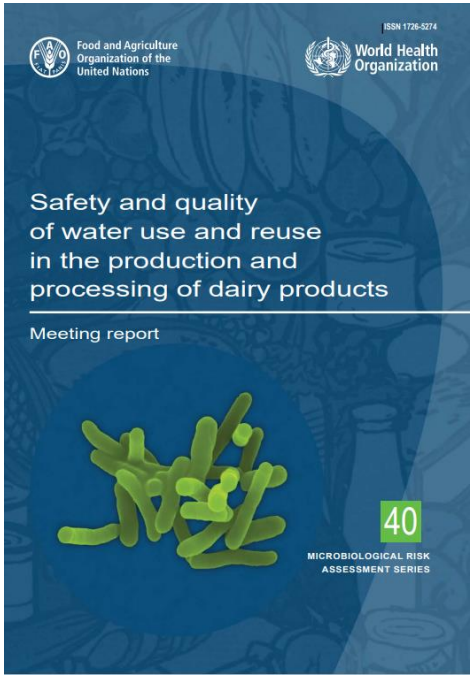
Definition:

Water that is determined to be safe for an intended purpose through the identification, evaluation, and understanding of potential microbiological hazards and other relevant factors (e.g. history of use, the intended use of the food, etc.,) including the application of control measures such as treatment options and their efficacy to ensure effective elimination or mitigation of such hazards.

JEMRA MRA 40 – SCOPE AND AIM

Develop clear and practical guidance on fit-for-purpose sourcing, use and reuse of water in the dairy sector, including:

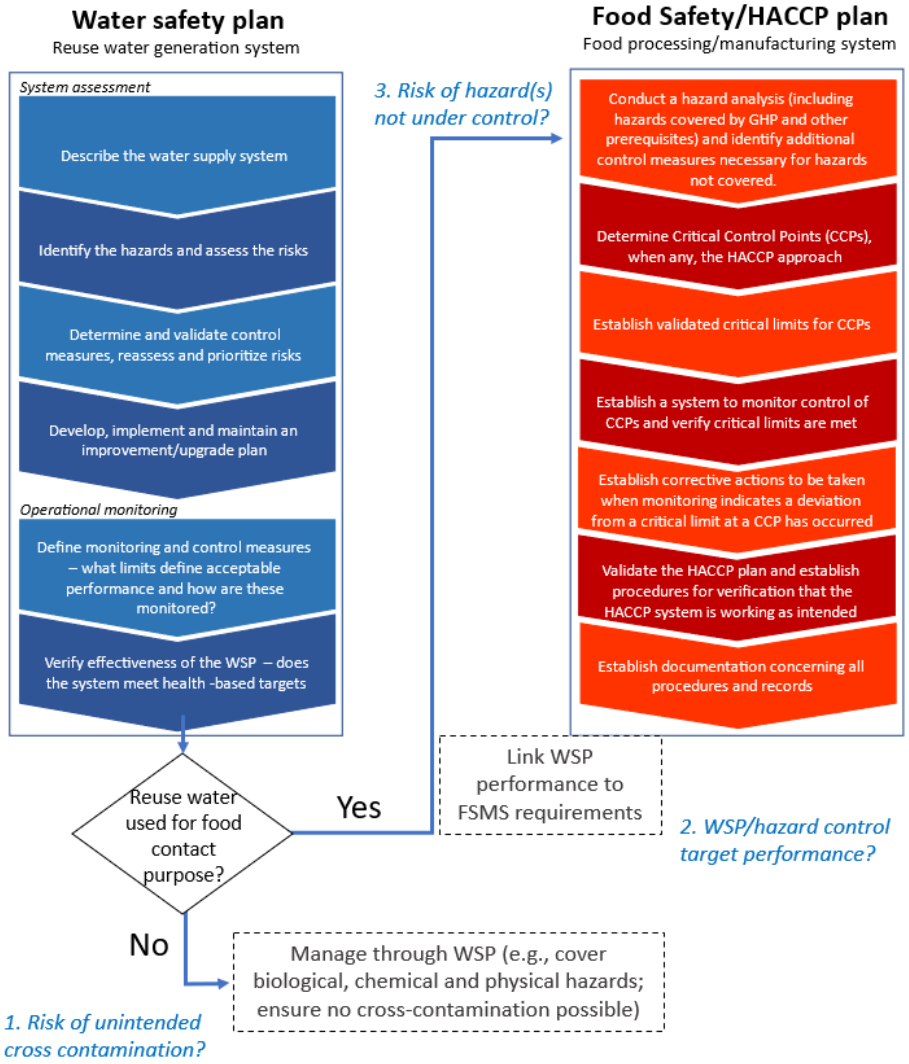
- Discuss microbiological aspects of the water used
- Consider potential reusable water sources that can be exploited to reduce the volume of first-use water
- Consider different microorganisms (utility organisms, indicator organisms, human pathogens), microbiological parameters (thresholds or criteria) and their levels that would be appropriate for assessing the fitness of a water supply for its intended purpose or for validation and verification of operational control over reuse water generation and use.
- Illustrate water sourcing, use and reuse approaches in the dairy sector with examples of case studies.



MANAGEMENT OF WATER SAFETY

WSP should include:

- Effective PRPs
- Insight in the impact of water recovery and reconditioning processes
- A hazard control plan specific to each scenario



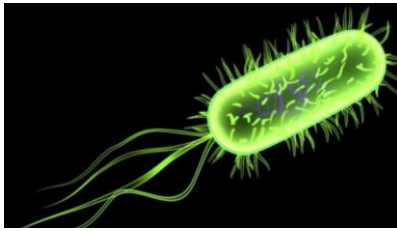
EXAMPLES OF PRPs

- Provision of a drinking water supply as back-up
- Proper maintenance and regular inspection that ensures the reliability of equipment
- Prevention of cross-contamination (e.g. identifiable pipes, inspection of gaskets & membranes. However, milk water can be circulated in pipes used for milk products
- Equipment designed to be CIP'able incl. being able to withstand heat and pH 1-13

- Storage at room temperature (15-20 ^{o}C), cold (<7 ^{o}C) or hot (> 60 ^{o}C)
- No dead-ends or -pockets in the water distribution system
- All taps should be secured against backflow of CIP liquids, product, and water

TESTING PRINCIPLES

Pathogens in reuse water



- Occur at very low levels
- Routine testing is normally not useful, except:
  - For validation
  - In unexpected situations, e.g., in cases of system deviation or loss of control

Indicator/utility organisms in reuse water

- Normally harmless contaminants introduced due to inadequate control, such as *Enterobacteriaceae,* coliforms*, Pseudomonas* spp*.* and aerobic plate count. Some may indicate the presence of pathogens (e.g., STEC and *S. aureus*)
- Useful to signal situations where the operation is not fully under control

ANNEXES 1-3 - TECHNOLOGIES

1. Water recovery technology

1. Recovery by condensation
2. Recovery by sedimentation, coagulation and centrifugation

2. Water purification technologies

1. Reverse Osmosis (RO) or RO Polishing (ROP)
2. Ultrafiltration (UF)
3. Activated carbon water filtration (ACWF)
4. Aerobic digester technologies
5. Membrane Bioreactors (MBR) technology

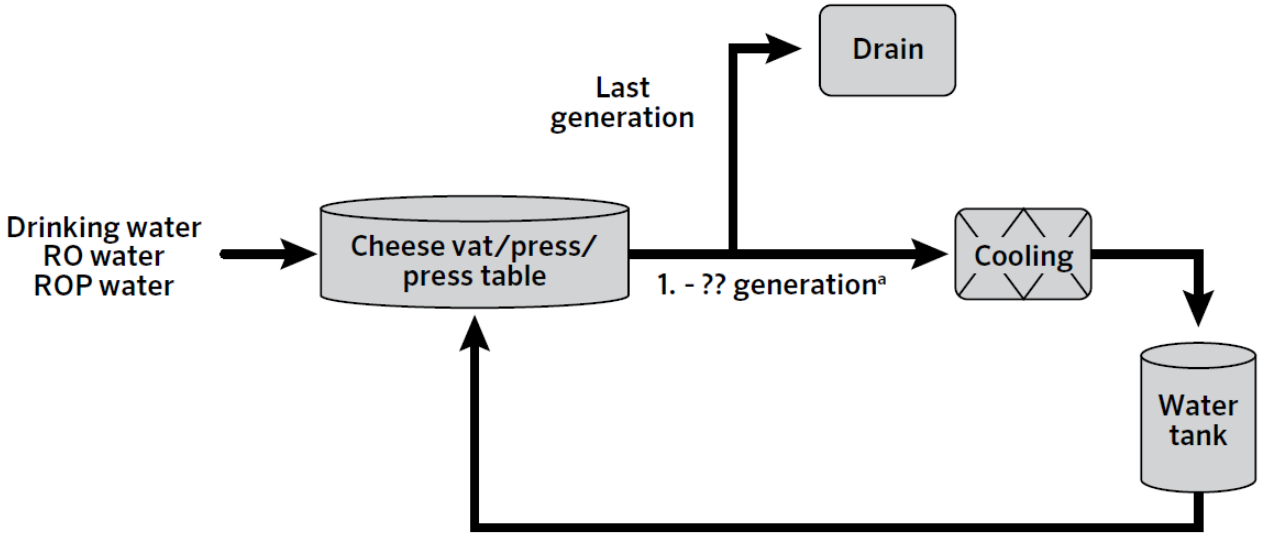
3. Microbiocidal treatments

1. UV treatment
2. Heat treatment
3. Chemical treatment (disinfection)

ANNEX 4: 5 CASE STUDIES ON REUSABLE WATER SOURCES

1. Use of contaminated water from FBOs own wells
2. Recirculation of water used for cooling of cheese
3. Recovery and reuse of water from CIP systems
4. Recovery of water from whey using RO or ROP
5. Recovery of water from dairy effluents using MBR and RO

RECIRCULATION OF WATER USED FOR COOLING CHEESE



[a] In this scenario, multiple recirculations/recycles may apply. So, if recirculate the fist-use water for a new reuse, it will be the 2nd, generation, 3rd generation, etc., and when the number of recirculations has reached its maximum (based on microbial testing) then the water is to be discarded as waste (last generation).

Source: Reproduced with permission from **Heggum, C.** 2020. Dairy Sector Guide - Recommendations of the Danish Agriculture & Food Council on implementation of food safety management systems in Danish dairy plants.

RECIRCULATION OF WATER USED FOR COOLING CHEESE

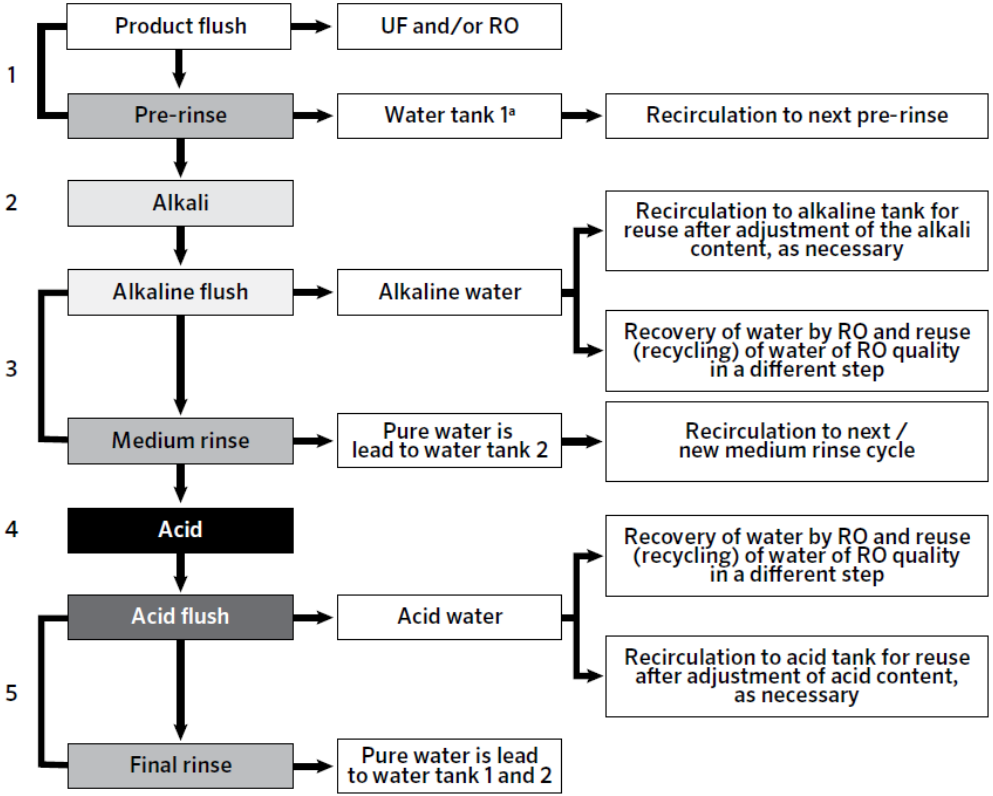
TABLE A6 Specific details of a verification plan for using recirculated water to cool cheeses (cont.)

PARAMETER	RATIONALE/ PURPOSE	METHOD	RECOMMENDED FREQUENCY	TYPICALLY ACCEPTABLE RESULT[#]	FOLLOW-UP
***Listeria* spp.**	Cross-contamination	Presence/ absence test; Sample taken from the place of use	Frequency should be in line with the number and volume of batches of reuse water supply being generated with the aim to obtain a timely signal of control or potential loss of control	e.g. Not detected in 25 ml, n=1[#]	If detected, serotype the isolate and if identified as *L. monocytogenes*, pipes and tanks are emptied and cleaned. If the water has been in contact with food products, test affected batches of products for *L. monocytogenes*. If detected, designate and handle the food product as potentially unsafe In case of regular findings, reduce the number of generation cycles and investigate root-cause of the contamination to resolve the issue.

[#] level of microorganisms pre-defined by appropriate validation under operational conditions for the specific water reuse scenario. It can be a maximum value for one of more specified volumes of water tested or it can be a sampling plan with the statistical parameters n, c, m and M pre-defined (**ICMSF.** 2018. Microorganisms in Foods 7. Microbiological Testing in Food Safety Management. Second Edition. Springer, Cham, Switzerland. **FAO & WHO.** 2013a. Codex Alimentarius. Principles and guidelines for the establishment and application of microbiological criteria related to foods. CAC/GL 21 - 1997. Rome, FAO. Accessed 24 July 2022. https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%2 52Fcodex%252FStandards%252FCXG%2B21-1997%252FCXG_021e.pdf). The values for the levels and parameters must be specified in the plan that is being operationalized.

[a] Split sampling refers to taking the required number of samples (n) over a certain period of time.

Reuse of water streams in a 5-step CIP system, incl. recovery of RO water from CIP fluids.



[a] When flushing of non-pasteurized product, the water should be pasteurized before reuse. Alternatively, it is led to the drain.

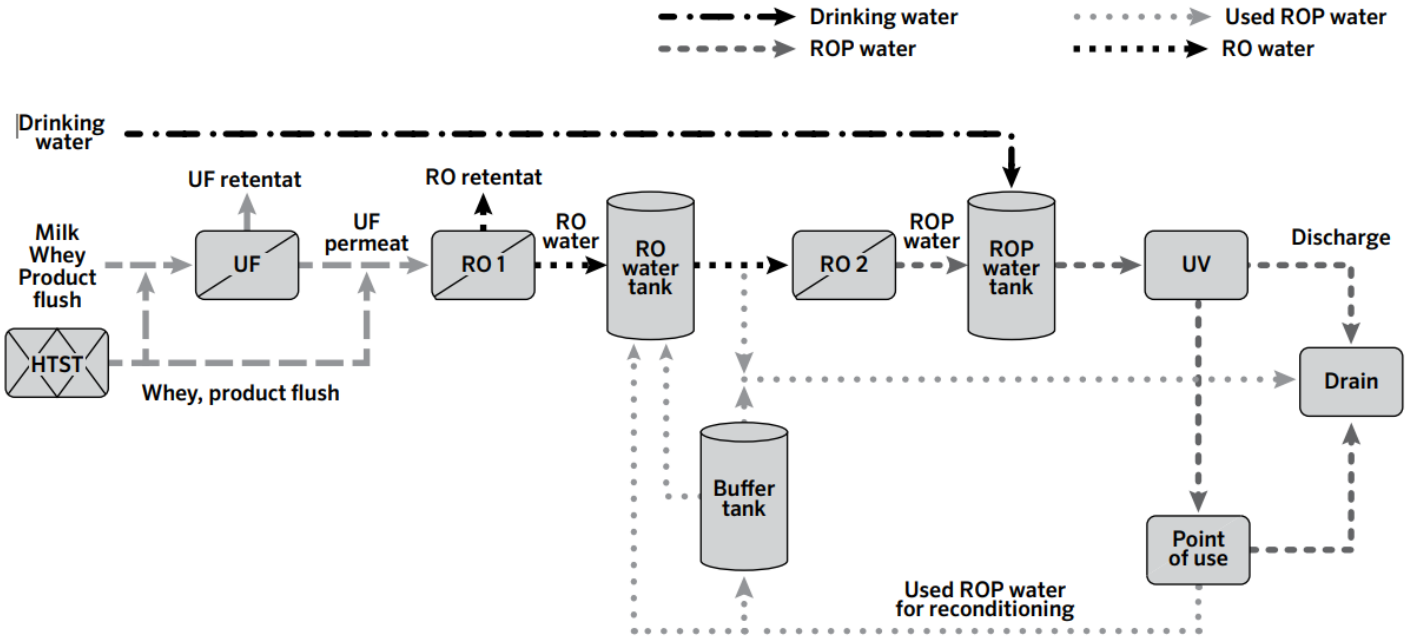
Source: Adapted from **Heggum, C. 2020.** Dairy Sector Guide - Recommendations of the Danish Agriculture & Food Council on implementation of food safety management systems in Danish dairy plants.

Reuse of water streams in a 5-step CIP system, incl. recovery of RO water from CIP fluids.

TABLE A9 Details of a verification plan for reuse of RO water supplies recovered from CIP liquids that have been recirculated or recycled (cont.)

PARAMETER	PURPOSE	METHOD	RECOMMENDED FREQUENCY	ACCEPTABLE RESULT	FOLLOW-UP
Water quality – Microbiological parameters					
Total Plate Count (TPC) at 22 °C in water used for final rinse	Control Biofilm formation	Removed from final flush to water tank 1. ISO6222	Monthly	<200 cfu/ml[a]	If exceeded, 3 samples are taken to confirm the result. If confirmed, the CIP program is re-evaluated to determine whether the system should be emptied and cleaned. The effectiveness of the above steps is confirmed and documented by testing 3 new samples.
Coliforms in RO water	Identify microbiological contamination	Presence/ absence test ISO9308-1 or ISO2255	Once per week	Not detected in 100 ml, *n*=1#	Upon detection, a sample is taken from the same batch for *E. coli* analysis.
E. coli	Possibly pathogenic	Presence/ absence test (ISO 9308-1); sample at site of use	Upon detection of coliforms	Not detected in 100 ml, *n*=1#	If detected, the pipes and tank are emptied and cleaned.
	Verification of	Enumeration; split	Once per week	Test result meets	If the preselected value for M is

ROP MILK WATER REUSE SYSTEM



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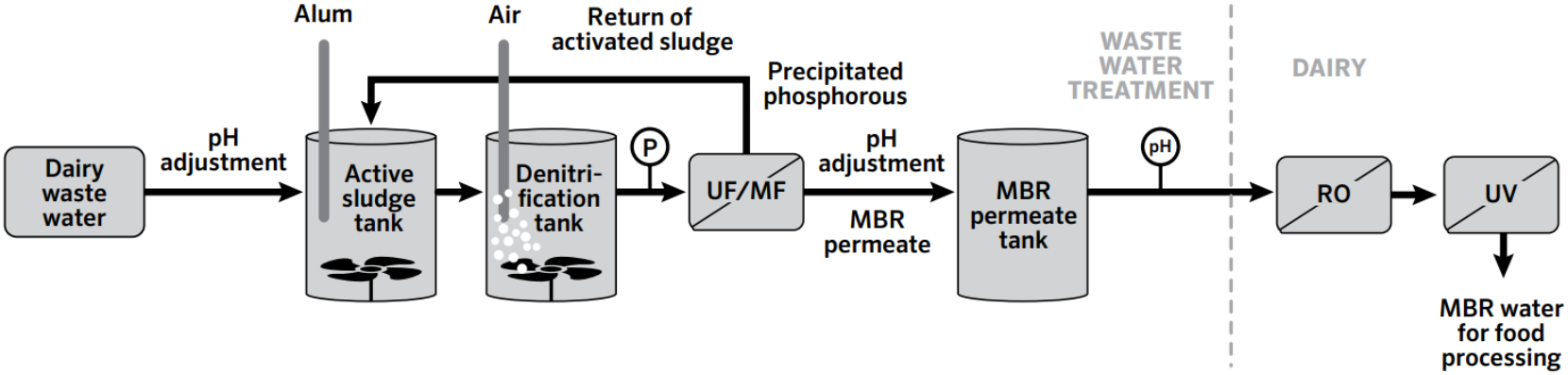
Ex. MICROBIOLOGICAL THRESHOLD VALUES FOR ROP WATER FROM WHEY FOR FOOD CONTACT USE

Water recovered by ROP and stored before use	**General hygiene indicators**		
	Routine testing (e.g. one sample unit per week, may vary with need)	TPC 22°C	n = 5; c = 2; m =10 cfu/ml; M = 200 cfu/ml
	Routine testing (e.g. one sample unit per week):	Coliforms	Absent in 100 ml
	Routine testing (e.g. monthly)	B. cereus (vegetative cells and spores)	< 1 cfu/ml
	Plant specific hygiene indicator selected by validation		
	Routine testing (e.g. one sample unit per week, moving window)	Enterobacteriaceae	n = 5; c = 2; m =1 cfu/ml; M = 10 cfu/ml
		Pseudomonas spp.	n = 5; c = 2; m = absent in 100 ml; M = 10 cfu/100 ml
		Psychotropic count	n = 5; c = 2; m = 10 cfu/ml; M = 100 cfu/ml.
		TPC 22°C	n = 5; c = 2; m = 20 cfu/ml; M= 200 cfu/ml
	Pathogens		
	If the level of the selected hygiene indicator does not meet the microbiological criterion, the system is emptied and cleaned. Water from the batch that has been generated is tested for S. aureus. If detected, the affected water is discarded	S. aureus	Absent in 10 ml

RECLAIM OF WATER FROM DAIRY WASTE-WATER

FIGURE A5 llustration of the recovery of water from dairy effluents using MBR and RO



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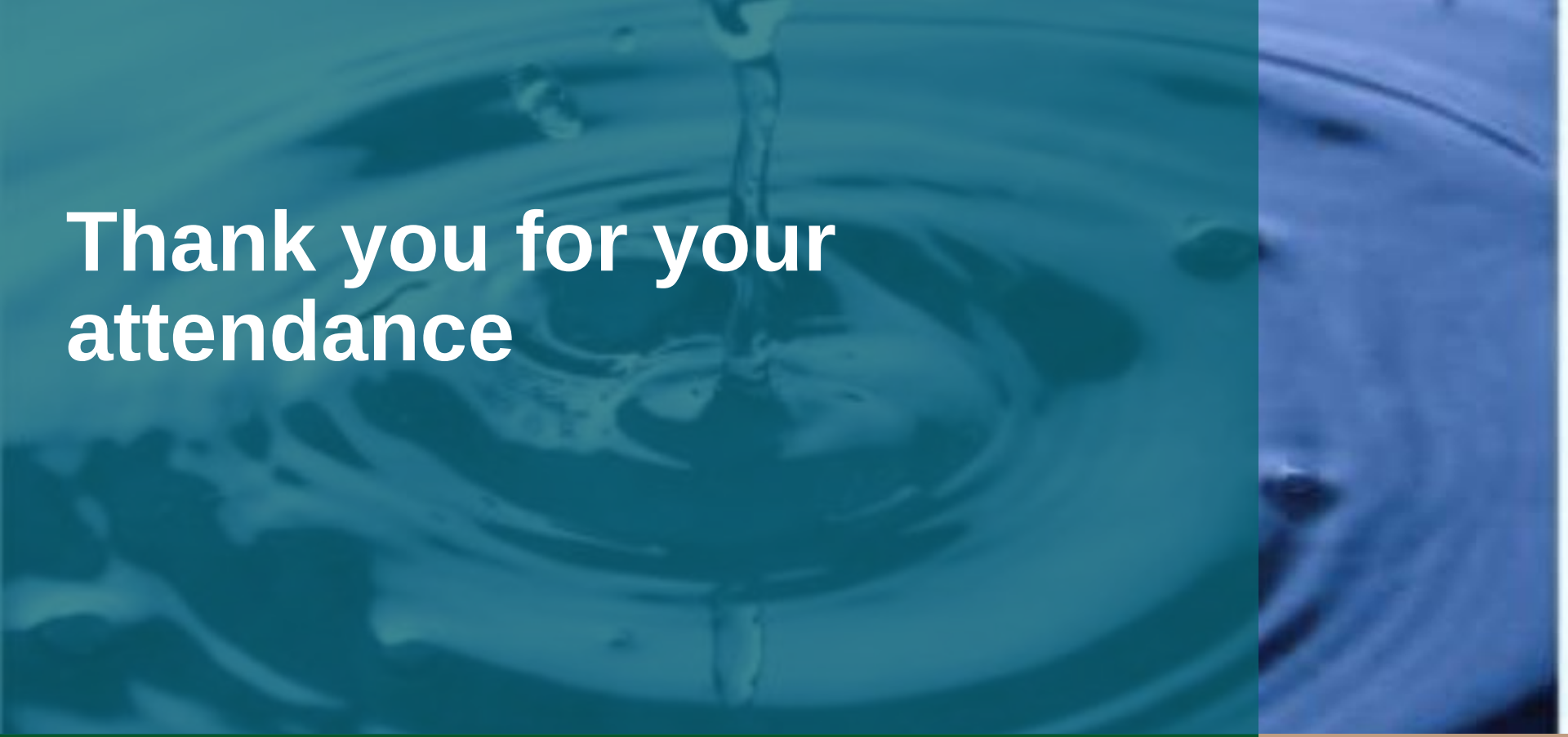
RECLAIM OF WATER FROM DAIRY WASTE-WATER

TABLE A10 Ability of relevant bacterial groups to grow on urea

MICROORGANISM	UREASE FERMENTATION	
	Positive	Negative
Salmonella spp.		✓
L. monocytogenes		✓
Acinetobacter spp.		✓
Bacillus spp.		✓
E. coli		✓
Lactococcus spp.		✓
Klebsiella spp.	✓	
Enterobacter spp.	✓	
Staphylococci	✓	
Proteus spp.	✓	
Pseudomonas spp.	Some are positive	

Source: Adapted from **Heggum, C.** 2020. Dairy Sector Guide - Recommendations of the Danish Agriculture & Food Council on implementation of food safety management systems in Danish dairy plants.

Thank you for your attendance



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