REALM

Policy brief on the regulatory framework for water discharge and reuse

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Summary

One of the main goals of the REALM project is to contribute to circular economy by reducing the nutrient charge of agricultural effluents thus enabling water discharge or reuse. Therefore, EU water policy will be identified and carefully examined to ensure regulatory compliance. This information is relevant for the whole consortium and key to WP2 and WP3 to adapt the process design to improve compliance with the referred water discharge/reuse regulations. Concurrently, we will also include the national legal and regulatory framework regarding water discharge and reuse, and water quality of the countries implementing pilot or demo facilities in REALM. These are Portugal, Spain, the Netherlands and Finland. This legislation, policy, and regulation reviews will allow:

(i) compliance with water-related regulations (Council Directive 91/271/EEC concerning urban waste-water treatment and the new Directive 2024/3019 published in November 2024; EU Regulation 2020/741 of the European Parliament and the Council on minimum requirements for water reuse);
(ii) identify the minimum water quality requirements for safe reuse;
(iii) identify commercial activities compatible with water reuse, as the class of reclaimed water quality depends on the intended agricultural use and irrigation method;
(iv) identify technological solutions which may be required in the process to comply with the legal requirements.

This deliverable summarises the environmental legislation applicable to water treatment facilities based on microalgae biotechnology associated with the REALM project, the quality criteria for reclaimed water for direct reuse in agricultural activities, and the maximum allowable concentrations of pollutants if the treated water is finally discharged into receiving waters. Additionally, preliminary input on this issue is offered to policy makers based on the results of the project.

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Acronyms

Abbreviation	Meaning
BOD	Biochemical Oxygen Demand
BOD_5	Five-day BOD
COD	Chemical Oxygen Demand
EQS	Environmental Quality Standards
EQSD	EQS Directive
N	Nitrogen
NVZ	Nitrate Vulnerable Zones
P	Phosphorus
p.e.	Population Equivalent
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
POPs	Persistent Organic Pollutants
RMP	Risk Management Plan
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorous
TSS	Total Suspended Solids
UWWTD	Urban Wastewater Treatment Directive
WFD	Water Framework Directive
WRR	Water Reuse Regulation

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1. Environmental legislation about water quality, water discharge and reuse. Relationship with the REALM project

1.1. The environmental review regulations and new approaches to European strategies

With an ageing population and strong competitive pressures from globalisation, Europe's future economic growth and employment will increasingly depend on innovation in products, services and business models.

Agriculture produces a large amount of waste and wastewater that contains high levels of pollutants such as nitrogen (N), phosphorus (P), and organic matter. Run-off from agricultural irrigation and novel technologies for agro-industrial production has been considered the primary cause of excess nutrients in water bodies, and can be a major contributor to the eutrophication of groundwater and surface water bodies.

In the European Union, the protection of water against pollution caused by agricultural sources has been developed for more than 30 years through interconnected directives which are being adopted by the Member States and which are supported by effective programmes for monitoring and improving (or at least maintaining) the quality status of water; and for agricultural activities, generating guidelines or recommendations for good practices in the use of water and increasing N use efficiency in crops.

The running of the REALM project coincides with major revisions of EU environmental policy, resulting from implementing essential strategies to tackle the climate crisis and to safeguard ecosystems and natural resources from environmental pollution. These strategies are led by the "**European Green Deal**" (COM(2019) 640 final). The European Green Deal has a direct impact on water quality in the European Union, as many of its strategies and objectives are aimed at reducing pollution and promoting sustainable use of water resources:

Reduction of pollutants and chemicals. Through the "Zero Pollution Strategy", the Green Deal seeks to eliminate water pollution by setting stricter limits and regulations on using chemicals and toxic substances, such as pesticides, fertilisers and pharmaceuticals that pollute rivers, lakes and aquifers. That establishes the need to update the Water Framework Directive (WFD; 2000/60/EC) and its daughter directives to reduce the allowed concentration of pollutants in surface water and groundwater. This implies that certain chemicals and pesticides will have lower concentration limits or even be banned in cases of high toxicity.

Sustainable agriculture. Through the "Farm to Fork" strategy, the Green Deal encourages the reduction of fertilisers and pesticides in agriculture, a sector that contributes significantly to water pollution. That includes reducing the use and risk of pesticides by 50% by 2030 and reducing the run-off of these chemicals into water bodies. It also encourages the use of more sustainable and less polluting agricultural practices, which will help reduce the leaching of nutrients and pesticides into water resources.

Protection of aquatic ecosystems. The "Biodiversity Strategy 2030", part of the Green Deal, promotes the protection and restoration of ecosystems, including aquatic ecosystems. This involves the enhancement of freshwater habitats and the protection of species that depend on these ecosystems. In addition, it supports the restoration of rivers and wetlands, areas that are

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critical to the health of aquatic ecosystems and can act as natural filters, improving water quality.

Wastewater treatment. Updates to the Urban Wastewater Treatment Directive (UWWTD; COM(2022) 541 final; 91/271/EEC) seek to improve the ability of treatment plants to remove pollutants before water is discharged into the environment. This includes treating micropollutants such as pharmaceuticals and other hard-to-remove compounds. The new directive will mandate tertiary treatment to limit N and P levels, particularly in large treatment plants and in areas vulnerable to eutrophication. It introduces strengthened emission limits for N and P to address outdated standards and aligns with technological advancements and best practices. In addition, the Green Deal encourages the reuse of treated water for agricultural and industrial uses, which helps reduce demand for drinking water and avoids the discharge of untreated wastewater.

In summary, the **European Green Deal positively affects water quality** by reducing sources of pollution, supporting the restoration of aquatic ecosystems and promoting the sustainable use of water resources, thus contributing to a healthier environment and preserving aquatic biodiversity in the continent.

These regulatory changes or updates, which are expected to become effective in the coming months or years, affect the REALM project in terms of treatment objectives, discharge levels, monitoring of the environment and environmental quality of water.

The REALM project is currently implementing (sizing, constructing, and operating) technology aligned with the European Green Deal. While acknowledging the ongoing process of updating environmental standards, it is imperative that the project progresses in a timely manner. So, it is necessary to conduct a comprehensive review and analysis of the existing directives (and those that are imminent) to identify and consider those pertinent to the project, particularly those that regulate the concentrations of N and P, and water reuse. The following sections present a review of the current implementing legislation and the key contents for the REALM project.

So, the principal regulations for controlling N and P (and other pollutants) in water bodies, discharge and reuse of wastewater treated in the European Union are:

1. Nitrates Directive 91/676/EEC
2. Water Framework Directive 60/2000/CE, and related Directives [WFD]
3. Groundwater Directive 2006/118/EC [GWD]
4. Urban Wastewater Treatment Directive 91/271/ECC, (and New Directive 2024) [UWWTD]
5. Water Reuse Regulation 2020/741 [WRR]

1.2. Nitrates Directive

The **Nitrates Directive** aims to protect water quality across Europe by preventing nitrates from agricultural sources that pollute ground and surface waters and by promoting good farming practices.

The Nitrates Directive constitutes a basic measure under the WFD which requires all European surface waters – lakes, rivers, transitional and coastal water, and groundwater – to reach "good status" by latest 2027. Together with the UWWTD, the Nitrates Directive plays a key role in improving the status of EU water bodies, as nutrient pollution is one of the main causes for failure of good status.

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The Nitrates Directive requires Member States to:

- Identify water bodies affected and at risk of being affected by nitrate pollution as well as designate as **Nitrate Vulnerable Zones (NVZ)** the surrounding areas where agriculture significantly contributes to this pollution;
- Develop **action programmes** with measures to reduce and prevent nitrate pollution, apply such programmes to NVZ or to the whole territory, and reinforce these measures promptly if they prove insufficient to achieve the objectives of the Directive.

Several Member States have opted to apply their action programme throughout their territory. Austria, Denmark, **Finland**, Germany, Ireland, Lithuania, Luxembourg, Malta, the **Netherlands**, Poland, Romania, Slovenia and Belgium have followed this approach. Other Member States are reconsidering and extending their NVZ as they are either near catchment areas, or they are defined as very limited areas that do not consider the whole water catchment area, resulting in a very fragmented designation and a reduced efficiency of action programmes (that is the case of **Portugal** and **Spain**, among others).

The European Green Deal enhances the Nitrates Directive by setting broader sustainability goals that encourage the reduction of agricultural pollution, particularly from N and P. It aligns with the Nitrates Directive through key initiatives, primarily the *Farm to Fork Strategy* and the *Zero Pollution Action Plan*, which aim to minimize chemical fertiliser use and protect water quality. Key impacts include:

1. **Reducing fertiliser use**: The Green Deal targets a 20% reduction in fertiliser use by 2030, reinforcing the Nitrates Directive's limits on nitrate pollution.
2. **Protecting vulnerable zones**: It advocates stricter measures for Nitrate Vulnerable Zones to safeguard drinking water and ecosystems.
3. **Encouraging sustainable practices**: Through the *Farm to Fork Strategy*, it aligns with the directive's goals by promoting organic and integrated farming.
4. **Advancing green technologies**: Precision farming technologies are encouraged to minimize nutrient runoff, supporting the directive's pollution-reduction targets.
5. **Improving monitoring and compliance**: The Green Deal enhances monitoring and enforcement, complementing the directive's focus on water quality.

1.2.1. Why is it important to consider the Nitrates Directive in the REALM project?

The trend in many Member States is to consider their water bodies as NVZ. In addition, the new directive that replaced Directive 91/271/EC imposes a greater control of N and P in discharges of treated water and must have special monitoring in areas declared as NVZ.

Therefore, for a better and wider application of the REALM project, its possible discharges should be considered to be in NVZ.

1.3. Water Framework Directive, and related or "daughters" Directives

The **WFD** is the main EU legal instrument for water protection. It is supported by the so-called daughter directives on the quality and quantity of groundwater and on the quality of surface water.

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- Directive 2006/118/EC, on the protection of groundwater against pollution and deterioration. It sets out criteria for assessing the chemical status of groundwater and measures to prevent or limit the introduction of pollutants.
- Directive 2007/60/EC, on the assessment and management of flood risks. Aims to reduce and manage the risks posed by floods to human health, the environment, infrastructure and property.
- Directive 2008/105/EC, on environmental quality standards in the field of water policy. It sets maximum allowable concentrations in surface water for certain priority substances that pose a significant risk to the aquatic environment.
- Directive 2013/39/EU amends the previous directives on priority substances in the field of water policy, updating the list of pollutants and their permitted concentrations.
- Directive 2014/101/EU introduces specific amendments to Directive 2000/60/EC to improve its implementation and consistency with other water management legislation.

Under the WFD, **pollutants** and **priority substances** are chemicals or elements identified as significant risks to aquatic ecosystems, human health, or the environment due to their toxicity, persistence, or ability to bioaccumulate.

Pollutants are substances, or groups of substances, present in water that can harm aquatic ecosystems and water intended for human consumption (and other uses). The WFD regulates a broad set of pollutants, including:

- **Nutrients** such as nitrogen (N) and phosphorus (P), which contribute to eutrophication.
- **Pesticides** used in agriculture that can leach into water sources.
- **Heavy metals** which are toxic and can accumulate in aquatic organisms.
- Other harmful substances from industrial, agricultural, or urban sources.

Priority substances are a specific subset of pollutants identified in the Environmental Quality Standards Directive (2008/105/EC) and later amendments due to their high risk to water ecosystems and human health. They are selected based on criteria such as toxicity, persistence, and bioaccumulation potential, which make them particularly hazardous. The list includes:

- **Heavy metals**: such as cadmium, mercury, and lead.
- **Pesticides**: including compounds like chlorpyrifos and atrazine.
- **Persistent organic pollutants** (POPs): such as polychlorinated biphenyls (PCBs) and certain polycyclic aromatic hydrocarbons (PAHs).
- **Pharmaceuticals and emerging contaminants**: recent updates have added certain pharmaceuticals that show harmful effects on aquatic life.

In the daughter Directives, of the **45 chemical pollutants currently identified as priority substances**, including industrial chemicals, pesticides and metals, **21 are identified as priority hazardous substances** due to their persistence, bioaccumulation and toxicity. Under the WFD, measures must be taken to reduce emissions, discharges and losses of priority substances to water and to phase out priority hazardous substances within 20 years of their designation.

Pesticides include both active substances from plant protection products and biocides as well as their relevant metabolites. Pesticides can contaminate surface waters and groundwater and if their concentrations are above critical thresholds, they can be harmful to the environment. In the WFD, certain pesticides have been identified as **priority hazardous substances** due to their high toxicity, persistence in the environment, and potential to bioaccumulate, e.g. atrazine, chlorpyrifos, simazine, diuron and isoproturon. These pesticides are subject to strict concentration limits set by the **Environmental Quality Standards** (EQS).

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For superficial waters, the Environmental Quality Standards Directives (Directive 2008/105/EC and Directive 2013/39/EC: EQSD) set two types of EQS for priority substances: *annual average concentrations* and *maximum allowable concentrations*. The first protects against long-term chronic pollution problems, the second against short-term acute pollution. **Good surface water chemical status means that the concentrations of all priority substances do not exceed the EQS.**

To assess the chemical status of groundwater, a precautionary quality standard of 0.1 µg/L is set for pesticides according to the Groundwater Directive, reflecting the desire to keep pesticide concentrations in groundwater at low levels.

Once transposed into the Member States' national legislation, the EQS are included in the management plans of their river basins to achieve good surface water chemical status. The first assessment was carried out by the end of 2021. For new substances that are recently added, these should be included in the monitoring programmes of each country to achieve good surface water chemical status for these substances by December 2027.

Subsequent to the implementation of this set of Directives, the European Green Deal strengthens the WFD by promoting sustainable water management, reducing pollution, and enhancing the protection of aquatic ecosystems. Key impacts include:

1. **Reducing pollutants**: The Green Deal pushes for a reduction in harmful chemicals and nutrient pollution (e.g., N and P) that impact water quality, supporting the WFD's goal of maintaining "good status" in all water bodies.
2. **Updating water quality standards**: It encourages a review of environmental quality standards under the WFD to include emerging contaminants and align permissible levels with recent scientific findings.
3. **Promoting sustainable agriculture**: The *Farm to Fork Strategy* advocates for reduced pesticide and fertiliser use in agriculture (50% by 2030), which helps prevent agricultural runoff and aligns with the WFD's goals of reducing diffuse pollution sources.
4. **Protecting aquatic biodiversity**: The *Biodiversity Strategy* for 2030 promotes the protection and restoration of aquatic habitats, like rivers and wetlands, which improves water quality and supports the WFD's objectives to safeguard biodiversity.
5. **Strengthening wastewater treatment:** The EU is in the process of updating this directive to better tackle water pollution and protect public health. Proposals include improvements in the capacity of treatment plants to remove pollutants before water is discharged into the environment, as well as the incorporation of advanced technologies to treat micropollutants such as pharmaceuticals.
6. **Encouraging water reuse**: The Green Deal promotes water reuse in agriculture and industry to ease pressure on freshwater resources, enhancing the WFD's focus on efficient and sustainable water use**.**

The WFD Directive (and its daughter Directives) must periodically review the list of hazardous substances and EQS. A further review was carried out in 2019, and to integrate the strategies associated with the European Green Deal, it was considered to initiate a substantial revision. The proposal, **COM (2022) 540 final**, is being drafted and discussed. It **includes new pesticides and their environmental quality criteria**, which implies their inclusion in European and national environmental monitoring programmes. The reference of the last text proposed is:

- Proposal for a Directive amending Directive 2000/60/EC establishing a framework for Community action in the field of water policy, Directive 2006/118/EC on the protection of groundwater against pollution and deterioration and Directive 2008/105/EC on environmental quality standards in the field of water policy [COM/2022/540 final].

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1.3.1. Why is it important to consider the Water Framework Directive for the REALM project?

WFD is the primary legislation on water protection in the EU. The WFD states that water protection from pollution from any source (point or diffuse) should be based on the "combined approach" principle.

The **"combined approach"** refers to the use of both emission controls and water quality standards to protect water bodies from pollution, regardless of whether the pollution originates from a point source (e.g., a wastewater treatment plant) or a diffuse source (e.g., agricultural run-off).

The combined approach should be considered in the REALM project and compile all applicable regulations, discharge limits and EQS.

The Proposal COM (2022) is still under discussion. However, it is essential to consider the progress made thus far, the already drafted text, and its implications on EQS and water monitoring. Also, the Proposal is entirely consistent with other water legislation, particularly with two pieces of legislation that directly affect the objectives of the REALM project. About the UWWTD, the proposal for adoption is in its final stage, and the treatment of micropollutants and the reduction of N and P concentrations in discharges are key challenges. By increasing treatments, the new Directive will also benefit from the potential for water reuse, including irrigation purposes, in line with the new regulation on minimum requirements for water reuse, called Regulation (EU) 2020/741.

The REALM project aims to establish a microalgae-based technology that reduces the nutrient concentration of surplus water from hydroponic-based agriculture. This water may contain pesticides on the priority substances list requiring environmental monitoring. Moreover, in the treatment envisaged in the project, pesticides may inhibit microalgae growth. This treatment can also contribute to reducing the pollutant loads of these substances in the water, allowing better use of the water, whether used for reuse in agriculture or finally discharged into the receiving environment. In either case, it should be under the surveillance of the WFD and the relevant river basin plans.

So, to check the correct functioning of the concept proposed in the project, it is advisable to carry out a detailed characterisation of the water to be treated, both at the inlet and outlet, not only of the nutrients but also of the pollutants (i.e. pesticides regulated in WFD and the forthcoming directive) that may be present in the water to be treated.

1.4. Groundwater Directive

Groundwater is a precious resource hidden from sight, where pollution poses a serious threat. Groundwater provides the steady base flow of rivers and wetlands, is of extreme importance for these natural ecosystems, and is, at the same time, the **main source of water for human consumption, agriculture and industry**. As groundwater moves slowly, the impact of human activities lasts for a relatively long time, meaning that pollution that occurred some decades ago is still threatening groundwater quality today. The accumulation of some pollutants will continue for several generations to come. Remediation of groundwater to remove pollutants is very difficult, as is locating and measuring the presence and impacts of pollution on groundwater. This leads to a lack of awareness and evidence of its extent. Groundwater resources are also under increasing pressure from water abstraction and climate change. To meet demand and ensure sufficient quality for its use in human activities, groundwater needs to provide a safe and long-term sustainable source of water. As a finite resource, groundwater needs to be protected from pollution and over-exploitation.

The EU legislation on protecting groundwater, the **Groundwater Directive**, focuses on achieving good chemical status and good quantitative status. Measures must also be taken to prevent and limit the

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input of pollutants and reverse deteriorating trends in groundwater quality. Groundwater is considered to have a good chemical status when, among other criteria:

- measured or predicted **nitrate levels do not exceed 50 mg/L**, while those of active pesticide ingredients, their metabolites and reaction products do not exceed 0.1 µg/L (a total of 0.5 µg/L for all pesticides measured);
- the levels of certain high-risk substances are below the threshold values set by EU countries; at the very least, this must include arsenic, cadmium, lead, mercury, ammonium, chloride, sulphate, nitrites, phosphorus (total), phosphates, trichloroethylene and tetrachloroethylene, as well as conductivity (the electrical conductivity of water enables the concentrations of the various minerals dissolved in it to be measured). These threshold values must be included in the River Basin District Management Plans provided in the WFD.

1.4.1. Why is the Groundwater Directive important for the REALM project?

Any activity involving a risk of groundwater contamination must be subject to special vigilance, including indirect discharges after percolation through soil or subsoil. The precautionary principle must take precedence in the control of discharges and the application of environmental quality criteria. Environmental monitoring should include groundwater. The protection of groundwater is of significant importance to the EU. If necessary, special monitoring measures must be implemented when agricultural practices that may alter groundwater are applied.

The REALM project should include measures to avoid polluting water in general and groundwater in particular. Measures should include proper management and handling of water from hydroponic crops (or any other water for treatment) and reclaimed water resulting from the application of the selected technologies.

It is recommended that a manual of good practices be implemented, including both procedures for correctly handling water to avoid spills into the ground and monitoring programmes for groundwater that may be affected by the activity.

Control of N loads is highly recommended if the water resulting from the treatments is to be used as irrigation water. The nitrate concentration in the groundwater in the area of reclaimed water application should be monitored before application. If the results are higher than 50 mg/L nitrate, the environmentally competent authorities should be consulted before the irrigation with reclaimed water. If an increase in concentrations is observed during regular groundwater monitoring, the causes must be investigated, and appropriate measures must be taken (also with other pollutants).

1.5. Urban Wastewater Treatment Directive

Urban wastewater is one of the main sources of water pollution if it is not collected and treated according to EU rules. It **contains high loads of organic matter, nitrogen (N) and phosphorous (P)**. These are minimised when properly treated, otherwise they can lead to eutrophication. It also can be contaminated with harmful chemicals, microplastics, pharmaceuticals, personal care products, bacteria and viruses, which, when untreated and discharged into the environment, affect and damage our health and ecosystems.

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The **UWWTD (Directive 91/271/EEC)** aims to protect human health and the environment from the effects of untreated urban wastewater. It therefore requires EU countries to ensure that towns, cities and settlements properly collect and treat wastewater. Namely, it requires for the:

- collection and treatment of wastewater in all urban areas of more than 2,000 p.e. (population equivalent; 1 p.e. means the organic biodegradable load having a five-day biochemical oxygen demand [BOD_5)] of 60 g of oxygen per day); secondary treatment of all discharges from urban areas of more than 2,000 p.e., and more advanced treatment for urban areas of more than 10,000 p.e. in catchments with sensitive waters;
- pre-authorisation of all urban wastewater discharges, discharges from the food-processing industry and industrial discharges into urban wastewater collection systems;
- monitoring of the performance of treatment plants and receiving waters;
- controls of sewage sludge disposal and reuse;
- treated wastewater reuse whenever it is appropriate.

The effectiveness of the measures introduced by this directive is based on the reduction, by treatment, of three overall pollution parameters representing the pollutant loads of urban wastewaters**: BOD_5, chemical oxygen demand (COD) and total suspended solids (TSS)**. The permissible discharge limits for these three parameters have been fixed since 1991 and remain unchanged. The subsequent Directive 98/15/EC sets discharge limits for **total nitrogen (TN) and total phosphorus (TP) concentrations in areas susceptible to eutrophication**.

While the directive mainly addresses urban wastewater, it includes provisions for some industrial activities with high loads of organic matter, solids and nutrients in those wastewaters. Industrial activities mentioned explicitly in the directive are the food-processing industry and have equal control requirements as urban wastewater.

For example, requirements for urban (or industrial and agri-food) wastewater treatment plants of 10,000 p.e. and above and discharges to waters sensitive to eutrophication require discharge limits of 25 mg/L BOD_5, 125 mg/L COD, 35 mg/L TSS, 2 mg/L TP, and 15 mg/L TN.

Since the adoption of the Directive in 1991, EU Member States have adapted the Directive to their national legislation, invested in the construction and maintenance of collection systems and wastewater treatment plants, declared areas sensitive to eutrophication and developed water monitoring plans.

1.5.1. How has this legislation been implemented in the REALM project countries?

EU Member States incorporate the UWWTD into their environmental legislative hierarchy and develop additional legislation or national or regional plans for implementation and monitoring. A comprehensive review of the legislative hierarchy of all countries is a disproportionate task. However, it is crucial to know the primary legislative references of the transposition in each country, and the implementation results obtained during this period 1992 - 2024. It should be noted that the **minimum criteria for the application of the technology, the monitoring parameters and concentrations are homogeneous and comparable among all member countries.**

[The order of the countries below is from highest to lowest flow of wastewater generated, number of treatment plants and volume of sludge generated].

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Spain

In Spain, the UWWTD was transposed into Spanish law by **Royal Decree-Law 11/1995** of 28 December 1995 and **Royal Decree 509/1996** of 15 March 1996, which developed the rules applicable to urban wastewater treatment. To implement and comply with the Directive, Spain has designed several national water quality and sanitation plans (1995-2005; 2007-2015; 2014-2023; *Ministerio para la Transición Ecológica y el Reto Demográfico*). The "National Plan for Depuration, Sanitation, Efficiency, Savings and Reuse" (Plan DSEAR 2014-2023) incorporates measures to meet the standards for depuration and reuse of reclaimed wastewater. The country has made significant progress in the coverage of sanitation services. According to data from the National Statistics Institute (INE), in 2020, 99.5% of the Spanish population had sanitation services, and 97.4% of urban wastewater received treatment. However, the European Commission has pointed to failures in the implementation of the directive. In the "WISE-Freshwater Information System for Europe", **84% of wastewater in Spain is treated in line with EU legislation** (that is above the EU average of 76%).

In Spain, households and certain industries in 2,059 urban areas generate 64.5 million p.e. of wastewater every day, an amount equivalent to 12.91 million m^3. Urban wastewater is treated in 1,799 plants across the country before it is discharged. Of those, 1,036 have biological treatment with N and P removal. Further efforts have to treat 3.92 million p.e. of urban wastewater with biological treatment with N and/or P removal. Urban wastewater treatment generates over **552,310 tonnes of wastewater sludge** (data of 2018), of which **76.7% was reused in agriculture**.

(https://www.miteco.gob.es/es/agua/temas/saneamiento-depuracion.html; data from WISE-Freshwater in https://water.europa.eu/freshwater/countries/uwwt/spain).

Portugal

In Portugal, the UWWTD has been transposed by **Decree-Law no. 152/97** of 19 June 1997, which defines the obligations and standards to ensure environmental and public health protection. In the first implementation phase, Portugal made significant progress in the coverage of sanitation services in line with the "Strategic Programme for Water Supply and Wastewater Sanitation" (PEAASAR). This Plan has recently been renewed with the **Strategic Plan for Water Supply and Wastewater and Rainwater Sanitation** (PENSAARP 2030), which sets out a strategy for the upgrading of technology, management and use of water resources throughout the territory for this decade 2021-2030. PENSAARP 2030 was approved in the Council of Ministers **Resolution no. 23/2024** of 5 February and amended in the Council of Ministers **Resolution no. 109/2024** of 22 August. The strategy aims to ensure the long-term sustainability of the sector and is the guiding instrument for policies on the urban water cycle, particularly in response to the challenges posed by climate change.

The European Commission WISE-Freshwater platform indicates that **92% of sewage in Portugal is treated in line with EU legislation** (that is above the EU average of 76%).

In Portugal, households and certain industries in 453 urban areas generate 13.0 million p.e. of wastewater every day, which is an amount equivalent to 2.59 million m^3. Urban wastewater is treated in 478 plants across the country before it is discharged. Of those, 83 have biological treatment with N and P removal. Further efforts have to treat 0.24 million p.e. of urban wastewater with biological treatment with N and/or P removal. The WISE-Freshwater platform does not have data about sludges in Portugal.

(https://apambiente.pt/agua/PENSAARP2030; data from WISE-Freshwater in https://water.europa.eu/freshwater/countries/uwwt/portugal).

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Netherlands

The Netherlands transposed the UWWTD into national legislation through the "**Surface Waters Pollution Act**" (*Wet verontreiniging oppervlaktewateren*). This act established the legal framework for the collection, treatment, and discharge of urban wastewater, aligning with the directive's objectives to protect the environment from adverse effects of wastewater discharges. Over time, the Surface Waters Pollution Act was integrated in 2009 into broader environmental legislation, such as the **Water Act** (*Waterwet*), to streamline water management and environmental protection efforts. The Water Act forms the basis for standards that can be imposed on water systems. Standards for national waters are included in the **Water Decree** or **Water Regulations**. For regional waters, provincial ordinances and plans will contain standards.

The Netherlands has an extensive sewerage system connected to urban wastewater treatment plants. Most of the sewer wastewater comes from Dutch households. A small volume comes from industries and rainwater drainage. Not all the wastewater is collected in a sewer system. Outlying households discharge on surface water or on soil. Before discharge, this wastewater is always treated in an individual wastewater treatment system (a septic tank or a small biological wastewater treatment facility). The European Commission WISE-Freshwater platform indicates that **100% of sewage is treated in line with EU legislation**. In the Netherlands, households and certain industries in 309 urban areas generate 19.7 million p.e. of wastewater every day, which is an amount equivalent to 9.94 million m^3. Urban wastewater is treated in 319 plants across the country before it is discharged. Of those, 318 have biological treatment with N and P removal. Urban wastewater treatment generates over 303.8 tonnes of wastewater sludge (data of 2018). **The wastewater sludge is not used in agriculture. Incineration is its main destination.**

(https://rwsenvironment.eu/subjects/water/urban-waste-water/; data from WISE-Freshwater in https://water.europa.eu/freshwater/countries/uwwt/netherlands).

Finland

Finland's implementation of the UWWTP is mainly regulated through the **Environmental Protection Act** (*Ympäristönsuojelulaki*), which lays down the basis for environmental protection and waste management, including wastewater. This Act is supplemented by the **Environmental Protection Decree** (*Ympäristönsuojeluasetus*), which details specific rules for the treatment and discharge of wastewater.

The Directive was tailored to accommodate its unique population distribution and rural landscape. In Finland, about 18% of the population lives in urban areas with fewer than 2,000 inhabitants, often in dispersed settings, and approximately 1 million seasonal visitors add to the demand in these areas. This geographic and demographic situation has led Finland to establish extensive regulations for Individual or Appropriate Systems (IAS), which are small-scale, local wastewater treatment systems, such as septic tanks or small treatment plants, to manage wastewater in these less densely populated regions. The European Commission WISE platform indicates that **97% of sewage is treated in line with EU legislation** (that is above the EU average of 76%).

In Finland, households and certain industries in 205 urban areas generate 5.6 million p.e. of wastewater every day, which is an amount equivalent to 1.11 million m^3. Urban wastewater is treated in 152 plants across the country before it is discharged. All of them have biological treatment with N and P removal. **Finland generated over 138,000 tonnes of wastewater sludge in 2018, and 100% was reused in agriculture**.

(https://ym.fi/en/environmental-protection-legislation; data from WISE-Freshwater in https://water.europa.eu/freshwater/countries/uwwt/finland).

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1.5.2. An important revision of the "old" Directive 91/271/CE: The New Urban Wastewater Treatment Directive

The UWWTD is more than 30 years old. EU countries have transposed the Directive into their environmental legislation, developed their wastewater and sewage sludge management plans, invested in infrastructure by creating collecting systems and wastewater treatment plants with the help of EU funds, and in short, progress has been made in water treatment and environmental quality. Since its adoption, the quality of European rivers, lakes and seas has significantly improved. In 2019 the Commission evaluated the Directive, concluding that it has been very effective when fully implemented. The implementation of the Directive has been costly, but the benefits clearly outweigh the costs.

However, it has been found that pollution still needs to be addressed. That includes pollution from smaller agglomerations, stormwater overflows and micropollutants, including pharmaceuticals, personal care products and microplastics, which end up in the environment and must be treated. As a result of this analysis, and to comply with the European Green Deal and associated strategies, in 2019, the EU started working on the text of a new regulation, which has gone through all the committees and procedures. **On 5 November 2024, the Commission adopted the final text, which was published in the Official Journal of the EU.**

- Directive (EU) 2024/3019 of the European Parliament and of the Council of 27 November 2024 concerning urban wastewater treatment (recast).

So, the new UWWTD aims to improve wastewater management to benefit both the environment and human health, while also advancing climate goals and resource efficiency within the European Union. The objectives include:

1. **Environmental Protection**: Establishing new or best rules on the collection, treatment, and discharge of urban wastewater to safeguard the environment. This aligns with a "One Health" approach, which considers the **interconnected health of humans, animals, and ecosystems**.

2. **Public Health**: Improving public health by ensuring treated wastewater does not adversely affect human health, particularly in areas with high human use, such as bathing waters and water bodies used for drinking water abstraction. **Allow the use of wastewater parameters to support public health actions** (COVID-19 or other health crises).

3. **Climate and Energy Efficiency**: Contributing to climate neutrality by progressively reducing greenhouse gas emissions, promoting energy efficiency, and supporting the use of renewable energy sources in wastewater treatment plants. The directive aims for **energy neutrality in the sector by 2045.**

4. **Circular Economy and Resource Reuse**: Enhancing the transition to a circular economy by encouraging the **reuse of treated wastewater, especially in water-scarce regions**. The directive emphasizes reducing freshwater abstraction and encourages the **recycling of nutrients, like N, for agricultural use** (that is especially significant for the REALM project, whose objectives are aligned with the new directive).

5. **Transparency and Public Access to Information**: Ensuring transparency by requiring the urban wastewater sector to make information on wastewater collection and treatment publicly accessible. This includes details on treatment standards, costs, and environmental impact.

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The **new UWWTD expands the scope of the Directive to smaller agglomerations (or urban or industrial activities) with a population above or equal to 1,000 p.e**. So, the Member States would need to ensure the collection of urban wastewaters and the application of secondary treatment for those agglomerations by the end of 2030.

In the new Directive, **N and P removal treatments will be extended and called tertiary treatments**. Stricter standards for N and P removal will be introduced.

For 10,000 population equivalent (p.e.) and above, but below 150.000 p.e: TN in wastewater discharges must be reduced to concentrations of 10 mg/L and TP to 0.7 mg/L.

For 150,000 p.e. and above: TN must be reduced to 8 mg/L, and TP to 0.5 mg/L.

According to the population size, wastewater treatment plants will have to adapt their technology to meet these requirements between 2035 and 2040. **By 2045 these criteria will be mandatory for agglomerations above 10,000 p.e. discharging into areas subject (or at risk) of eutrophication.** The criteria for designating such areas will be redefined to unify with the other essential water environmental legislation (Marine Strategy and WFD, including the Nitrates Directive) and the outcome of their environmental monitoring programmes. **Member States must draw up their lists of areas sensitive to eutrophication by the end of 2027 and update them every six years**. Each zone shall be specified whether they are sensitive to N, P, or both. In addition to usual parameters and vulnerable zones classification, new treatments (quaternary treatments) and limits or environmental criteria would be incorporated for micropollutants, and areas sensitive to this kind of pollution (additional areas classification) will be defined and listed at the national level.

In summary, treatment must be applied in very small population agglomerations, treatment and control of N and P discharges is increased, and treatment is made compulsory to reduce micropollutant concentrations, defining new areas sensitive to this pollution.

Due to the requirements for urban (or industrial and agri-food) wastewater treatment plant of 10.000 p.e. and above, and discharges to waters sensitive to eutrophication, the limits in discharges are: 25 mg/L BOD_5 (or 37 mg/L TOC, that is, total organic carbon); 125 mg/L COD, 35 mg/L TSS; 10 mg/L TN; 0.7 mg/L TP.

1.5.3. Circularity of the new Urban Wastewater Treatment Directive

The new UWWTD is aligned with the European Green Deal and related strategies. This Directive advances in the circularity of the water treatment process by **promoting water reuse in all treatment plants and the use of sludge generated in the treatment process. Water reclamation is important, and reclaimed flows should be included in integrated water management plans as an additional resource. Reclaimed water should be used as a priority for agricultural irrigation and should meet the requirements of the Water Reuse Regulation (WRR).**

To complete circularity, the use of sludge should be improved by following the waste management strategy, i.e. an order or hierarchy of management should be followed. Prevention, reuse and recycling should be maximised in that order. Wastewater contains valuable materials and elements as well as water. Nutrients used in agriculture, such as P and N, are recycled from irrigation with reclaimed water and soil application of sludge. With the new Directive, activities enabling circularity, including

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consideration of the recoverability of these elements (i.e. REALM project), should be extended and improved.

1.5.4. Why is the Urban Wastewater Treatment Directive important for the REALM project?

The discharge limits of UWWTD are mandatory for waters with high concentrations of organic compounds, suspended solids and nutrients. Those maximum allowed concentrations have been references for more than three decades. Any anthropogenic polluting activity, not only urban activities but also agri-food industries and others with high loads of organic compounds or nutrients, have these parameters and limits as a reference, and many discharge authorisations have been established around them. They should continue to be a reference for existing or new activities and their wastewater and treatments, as in the REALM project.

In the short and medium terms, areas vulnerable to eutrophication will be updated and monitoring of N and P discharges in larger geographical areas will be increased. In all polluting activities it is advisable to include monitoring of N and P in discharges. It is recommended for the environmental monitoring of receiving waters and to analyse the impact of the activity in the context of water quality regulations.

For discharges from hydroponic-based farms, the legislation that can best protect water bodies from their pollution is Directive 91/271/EEC and the new Directive approved and scheduled for publication by the end of 2024. The rejected water of those farms contains few biodegradable matters but a high concentration of nutrients, and could contain pesticide residues or other chemicals and elements used in farming.

The REALM project must take as reference the parameters and concentrations allowed in the New Directive, not only those related to organic matter and suspended solids but also consider the allowed concentrations of N and P. Also, following the European trend of extending the number of areas sensitive to eutrophication, it must be considered that the final discharge will be made to areas vulnerable to eutrophication. Throughout the EU, the trend is to increase the number of such sensitive areas. **The REALM project must opt for increased protection of waters.**

Perhaps the concentrations imposed in the new regulation are too demanding and are still years away from being implemented. However, if hydroponic wastewater treatments based on microalgae technology were to achieve these concentrations (at least with phosphorus), it would validate this technology even more in the future.

The technology proposed by the REALM project is entirely circular according to the trends in environmental legislation.

The new Directive enhances circularity in water treatment, both in the reclamation of water and its use for agriculture and in the sludge generated. The REALM project aims to reduce N concentrations in rejected water from hydroponic crop farms by transforming the nutrients into **microalgae biomass**, that is, the **sludge of the treatment**. The sludge would be highly valuable as an agricultural product. **Water reclaimed** using this technology can still contain nutrients that are beneficial when used as **irrigation water in agriculture**.

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1.6. Regulation for water reuse

Water is a limited resource in the EU, with one-third of the EU territory experiencing water stress. The growing needs of populations and climate change will make the availability of water in sufficient quantity and quality even more of a challenge in Europe in the future. Water overuse, in particular for agricultural irrigation but also for industrial use and urban development, is one of the main threats to the EU water environment, while the availability of water of appropriate quality is a critical condition to grow in water-dependent economic sectors and society in general.

Data from the WISE-Freshwater platform collected around all the EU countries indicate that 38% of the EU population was affected by water scarcity in 2019, by 2030 water stress and scarcity will probably affect half of Europe's river basins; more than 40,000 million m^3 of wastewater is treated in the EU every year but only 2.4% thereof is further treated to be reused.

Water reuse is considered an effective way of helping to solve the water scarcity and drought issues in the EU, by reducing the contamination burden from wastewater, as well as the costs of treatment. It may also have a lower environmental impact than other alternative water supplies such as water transfers or desalination. Although the reuse of reclaimed water is an accepted practice in several EU countries experiencing water scarcity issues (e.g. Cyprus, France, Greece, Italy, Malta, Portugal, Spain), where it has become an integral and effective component of long-term water resources management, overall, only a small proportion of reclaimed water is currently reused in the EU, including those countries. Hence, there is significant potential for an increased uptake of water reuse solutions. The high investment needed to upgrade urban wastewater treatment plants and the lack of financial incentives for practising water reuse in agriculture have been identified as being among the reasons for the low uptake of water reuse in the countries. That problem needs to be solved at the European level by introducing funding and incentives for improving treatment facilities and the agricultural use of these waters.

The WFD 2000/60/EC is currently the regulation for water protection and management throughout the European Union. The WFD mentions water reuse, in combination with the promotion of water-efficient technologies in industry and water-saving irrigation techniques as one of the additional measures that Member States may choose to implement to achieve good qualitative and quantitative status of surface and groundwater bodies. Furthermore, the UWWTD 91/271/EEC requires the reuse of treated wastewater where appropriate and the text of the new Directive to be adopted by the end of 2024, strengthens the circular approach to water and insists on water reuse and the integration of general flows in the integrated river basin cycle. In line with the European Green Deal and the principles of the Circular Economy, water reuse for agriculture can help preserve our freshwater resources and increase our resilience to water stress by reducing the water abstraction from rivers, lakes and groundwater.

Some EU countries, generally those most affected by water stress, have developed national legislation to regulate water reclamation and reuse for different uses, following the guidelines in both the WFD and the UWWTD. Portugal and Spain are examples of the development of these regulations. However, **at the European level, it has been necessary to approve a harmonised regulation that establishes minimum standards that equalise all countries, and that allows, among other issues, the internal market of products derived from agriculture that can use these waters**. These minimum standards provide legal certainty to all countries. If any Member States promote or have already adopted more demanding reuse regulations, it is an advance in these policies and they can serve as references for subsequent revisions of the general European Regulation.

Regulation 2020/741 on minimum requirements for water reuse for agricultural irrigation (WRR) entered into force in June 2020. The new rules applied from 26 June 2023 on and are expected to encourage and facilitate water reuse in the EU and the marketing of agricultural products from crops using reclaimed water.

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The aim of WRR is to establish minimum requirements for water quality and monitoring to ensure the safe use of reclaimed water for agricultural irrigation. This regulation is intended to:

1. **Protect the Environment and Public Health**: Guarantee that reclaimed water used for irrigation does not pose risks to the environment, human health, or animal health.
2. **Promote Circular Economy**: Facilitate the reuse of water within the EU to reduce dependence on freshwater sources.
3. **Support Climate Change Adaptation**: Address water scarcity issues exacerbated by climate change and reduce pressures on water resources.
4. **Enhance the Internal Market**: Provide harmonised standards that support a coordinated approach to water reuse across EU Member States, promoting consistency and confidence in water reuse practices.

1.6.1. How are EU countries dealing with water reuse regulations? Have water-stressed countries developed complementary or more developed regulations?

The Member States have been preparing for the application of the WRR. Some countries, such as Spain and Portugal, are also regulating new or complementary rules for applications of reclaimed water beyond agricultural irrigation.

The WRR allows Member States to decide not to practice water reuse in their territory or to limit water reuse in certain areas for reasons linked to geographical and climatic conditions, to pressures and status of their water resources or due to the environmental and resource costs of reclaimed water and of other water resources.

Some Member States, where freshwater resources are abundant and irrigation demand is low, have planned not to allow water reuse for irrigation in their countries. Some Member States have not yet made a final decision, as resource and infrastructure costs are still being evaluated. The current situation is illustrated in this map from the WISE-Freshwater platform (**Figure 1**):

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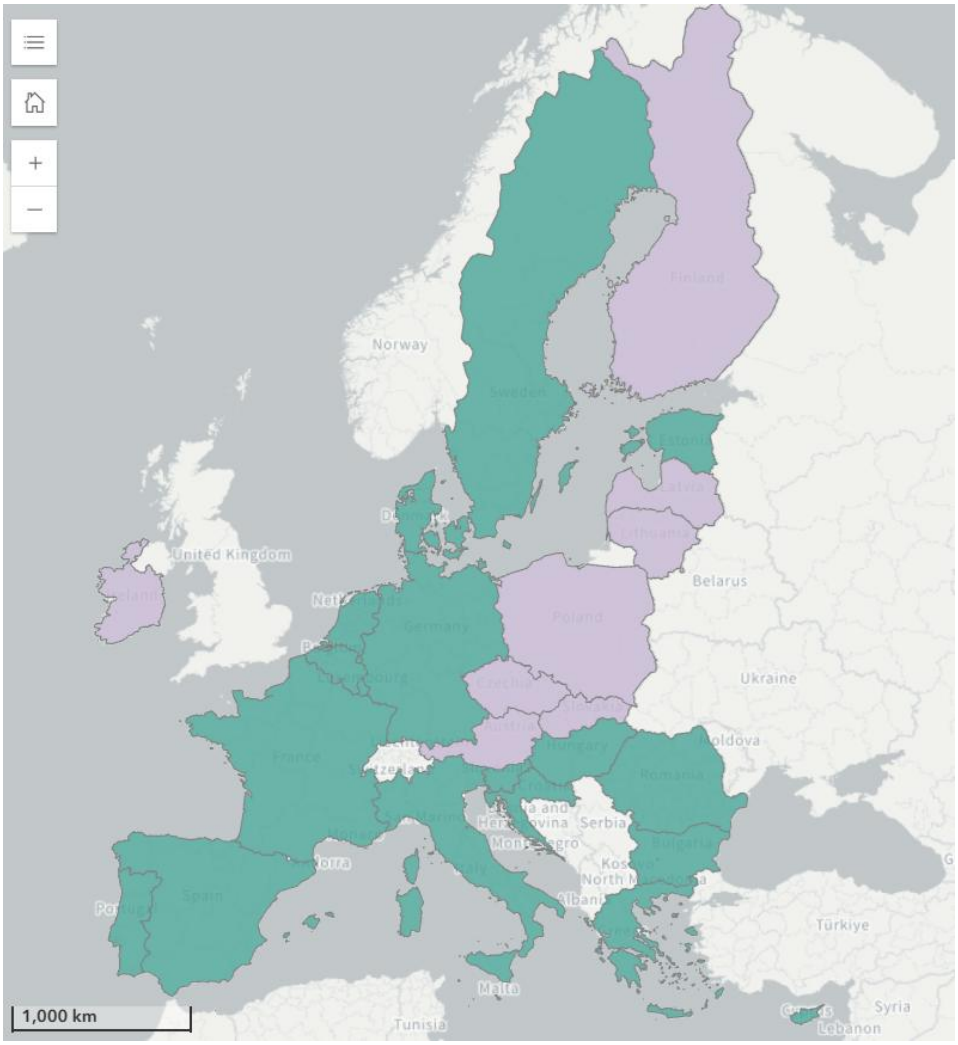

***Figure 1**: Map view: Member States where water reuse for agricultural irrigation is allowed (October 2024). Green colour: water reuse is allowed; purple colour: water reuse is not allowed. https://water.europa.eu/freshwater/europe-freshwater/water-reuse.*

Several European Union Member States have developed their own regulations for wastewater reuse, tailored to their specific environmental conditions and water management needs. Notably, Spain, Portugal, France, Italy, Greece and Cyprus have established national legislation setting specific requirements for the reuse of wastewater. These national frameworks address various aspects of wastewater reuse, including permissible applications, quality standards, and monitoring protocols, ensuring that reclaimed water is used safely and effectively within each country's context.

- **Spain**: In October 2024, Spain approved the **Royal Decree 1085/2024**, which establishes the regulation on water reuse, repealing the previous Royal Decree 1620/2007. This new regulation updates and adapts Spanish regulations to European guidelines, promoting the safe and efficient reuse of reclaimed water. The regulation covers areas such as administrative authorisations, quality standards for different reuse applications (agricultural, industrial, recreational), and monitoring requirements, with a broader application scope than the EU Regulation (EU) 2020/741. The decree specifies **quality standards based on intended uses, including agricultural, urban, industrial applications, recreational uses and**

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environmental uses as aquifer or wetland recharge. It is not allowed for certain uses, such as direct human consumption, use in hospital facilities, culture of filter-feeding molluscs in aquaculture, and recreational use in bathing facilities.

- **Portugal**: In August 2019, Portugal implemented the **Decree-Law no. 119/2019**, which defines the legal regime to produce water obtained from wastewater treatment. This decree promotes the safe and efficient reuse of reclaimed water, ensuring the protection of public health and the environment. The decree specifies quality standards based on intended uses, including **agricultural, urban, and industrial applications**.

- **Italy**: Italy has Ministerial **Decree No. 185/2003**, which establishes technical criteria for the reuse of treated wastewater for various uses, including agricultural irrigation and industrial uses. This decree defines the quality standards and procedures necessary to ensure safe water reuse.

- **France**: France has developed legislation for the reuse of treated wastewater, especially in the agricultural sector. This country has established quality criteria and procedures to ensure safe and efficient water reuse, promoting sustainable water management practices. The **Decree of 2 August 2010**, amended by the **Decree of 25 June 2014** and **Order of 4 July 2014**, specify the quality standards and monitoring protocols for the reuse of treated wastewater, ensuring that reclaimed water meets safety standards for its intended applications. In 2024, this regulation was updated with the Reuse Decree (2024-33). This Decree is according to the Water Plan presented by the French President on 30 March 2023, and its main objective is to promote the reuse of treated wastewater for agricultural, industrial and urban uses.

- **Greece**: Greece has implemented regulations that allow the reuse of treated wastewater, especially in agriculture and aquifer recharge. These regulations establish quality standards and procedures to ensure the safety and sustainability of water reuse**. Joint ministerial decision No 145116/2011**.

- **Cyprus**: In Cyprus, water reuse is regulated by the **Water and Soil Pollution Control Law 106(I)/2002**, together with its associated regulations such as **KDP 772/2003** and **KDP 269/2005**. These regulations set the quality standards and permitted uses for agricultural irrigation and non-potable uses, essential in this country with limited water resources.

It is important to note that although WRR sets minimum requirements for water reuse in agricultural irrigation, its implementation varies between Member States. Some countries, such as **Finland and the Netherlands, currently do not use reclaimed water for agriculture** based on their climatic conditions, abundance of water resources and rainfall. No specific regulations have yet been developed.

1.6.2. Regulatory specifications for research projects using reclaimed water

Article 2 "Scope" of the Regulation 2020/741 sets out guidelines for research projects using reclaimed water. In particular:

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(…) research or pilot projects in relation to reclamation facilities may be exempted from this Regulation where the competent authority establishes that the following criteria are met:

(a) the research or pilot project will not be carried out within a water body used for the abstraction of water intended for human consumption or a relevant safeguard zone designated pursuant to Directive 2000/60/EC.

*(b) **the research or pilot project will be subject to appropriate monitoring**. Any exemption pursuant to this paragraph shall be limited to a maximum period of five years. **Crops resulting from a research or pilot project exempted pursuant to this paragraph shall not be placed on the market.***

1.6.3. Risk management of water reuse projects

The WRR require rigorous risk assessments of water reuse projects, mainly those treating urban wastewater with high pathogen loads. The WRR details what a **Risk Management Plan** (RMP) must have for these water reuse systems, focusing on ensuring the safety of human, animal, and environmental health at all stages of the process, including the final agricultural activity.

Although the REALM project deals with drainage water from hydroponic agriculture with low pathogen risk, for the actual implementation or in the final phase of the project, it should develop a RMP or a **Code of Good Practice**.

A code of good practice could include some of the elements of the RMP, but this should be discussed and elaborated collaboratively in the REALM consortium at a final stage when all results have been analysed and technology and use have been assessed.

This report includes an annex describing the points an RMP should have in compliance with the WRR and recommendations for a possible code of good practice (**Annex: risk management according to the legislation for water reuse**).

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2. Requirements of water reuse according to the Water Reuse Regulation 2020/741 for agricultural irrigation.

2.1. Scope and definitions

Although the different EU countries have developed their water reuse regulations for different uses, the REALM project aims to generate water treatment models from hydroponic agricultural water with microalgae technology to be used across Europe. The model could be exported to all EU countries, not only to the countries that are part of the REALM consortium. Therefore, the regulation to be applied to reclaimed water must be shared, which is the one established in the current Water Reuse Regulation (WRR). The recommendations and parameters must be the same. It could be used for other purposes in those countries most affected by drought and which have defined more criteria for other applications. Based on the analytical results obtained in REALM, Spain and Portugal are encouraged to explore other possible applications according to their legislation.

[This section reviews the main points of the WRR regulations that may affect the REALM project. For a legal implementation of a regeneration installation, it is recommended to read and analyse the whole regulation].

For understanding this report, it is advisable to review some definitions from WRR:

- **Reclaimed water** means urban wastewater that has been treated in compliance with the requirements set out in Urban Wastewater Treatment Directive (UWWTD) and which results from further treatment in a reclamation facility in accordance with criteria approved in WRR.
- **Reclamation facility** means an urban wastewater treatment plant or other facility that further treats urban wastewater that complies with the requirements set out in UWWTD to produce water that is fit for a use specified in WRR.
- **Reclamation facility operator** means a natural or legal person, representing a private entity or a public authority, that operates or controls a reclamation facility.
- **Point of compliance** means the point where a reclamation facility operator delivers reclaimed water to the next actor in the chain.
- **End-user**, a natural or legal person, whether a public or private entity, that uses reclaimed water for agricultural irrigation.
- **Water reuse system** means the infrastructure and other technical elements necessary for producing, supplying and using reclaimed water; it comprises all the elements from the entry point of the urban wastewater treatment plant to the point where reclaimed water is used for agricultural irrigation, including distribution and storage infrastructure, where relevant.
- **Competent authority** means an authority, or a body designated by a Member State to carry out its obligations under Regulation 2020/741 regarding the granting of permits for the production or supply of reclaimed water, regarding exemptions for research or pilot projects and regarding compliance checks.

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2.2 Reclaimed water quality, types of crops and irrigation methods according to the Water Reuse Regulation

2.2.1. Classes of reclaimed water

The WRR defines **four classes of reclaimed water quality (A, B, C, and D) based on its intended agricultural use and irrigation methods**. Each class has specific microbiological and physicochemical quality standards, which are detailed in Annex I of the Regulation.

Class A: Highest Quality. Used for crops that are consumed raw (e.g., lettuce, tomatoes) or where water comes into direct contact with edible parts of the crop.

Class B: Medium-High Quality. For irrigation of crops with restricted human contact, such as processed vegetables or fruit.

Class C: Medium Quality. Suitable for crops not intended for direct human consumption or for irrigation using methods where water does not touch edible parts (e.g., drip irrigation for tree crops).

Class D: Lowest Quality. Typically for non-food crops such as fodder, industrial crops, or energy plants.

Each class has specific requirements for:

- **Treatment methods to achieve the desired quality**. Each class has different minimum treatment standards, with Class A requiring the most advanced treatment to minimise risks (that is, the treatments of the REALM project).
- **Monitoring frequency**. Regular compliance checks for microbiological parameters like *E. coli* and other relevant indicators are required to ensure the reclaimed water meets its designated class (daily, weekly, or based on system complexity).

2.2.2. Types of crops

Reclaimed water can be used for the agricultural irrigation of different types of crops in function of water quality:

1. **Food crops consumed raw**: crops cultivated for human consumption, which will not undergo additional processes. Based on the distance of the edible part of the crop from the ground, further classification includes:

    1.1. **Root crops**: that grow below ground in the soil and the root portion is edible (e.g. carrots, onions, beetroots).
    1.2. **Above-ground low-growing crops**: that grow above ground in partial contact with soil. These crops can be further divided into crops which grow on the soil surface, such as leafy crops (e.g. lettuce) and crops that grow above ground with the edible portion at <25 cm above the soil surface (e.g. tomato, pepper).

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1.3. **Above-ground high-growing crops**: that grow above ground and with edible portions at >50 cm above the soil surface, which therefore do not normally touch the soil (e.g. fruit trees).

2. **Processed food crops**: crops cultivated for human consumption that will undergo additional processes (i.e. cooked or industrially processed) and will not be eaten raw (e.g. rice, wheat).
3. **Non-food crops (fodder)**: crops cultivated not for human consumption but for pastures and forage or in other sectors (industrial, energy and seeded crops).

2.2.3. Irrigation methods

Irrigation methods should be evaluated as pathways that potentially allow contaminants to reach crops. For example, with sprayed systems, crops raised above the ground (e.g. fruit trees) could be exposed to contamination from falling droplets. Localised systems (e.g. drip irrigation) are associated with a lower risk of contamination, as the water is directed to the inedible part of the crops.

Irrigation methods can be generally classified into:

- **Open or gravity-flow irrigation systems**: water is applied directly to the soil surface and is not subject to pressure. This includes flood and furrow irrigation.
- **Sprinkler irrigation systems**: water is sprayed into the air and falls on the soil surface like rainfall.
- **Micro irrigation systems**: water is applied locally with drip or trickle systems (surface or sub-surface) or by micro-spray irrigation.

In general, whatever the method of irrigation, high quality recycled water should be recommended.

2.2.4. Reclaimed water criteria of the Water Reuse Regulation

Table 1 summarises all those requirements of the water reuse regulations about treatment levels, classes, parameters, concentrations, types of crops and types of irrigation allowed according to WRR. Also, Figure 2 shows the two groups of irrigation methods, and the crops according to the water reclaimed quality. Figures are obtained from the "Guidelines to support the implementation of the Regulation 2020/741 on minimum requirements for water reuse" (2022/C 298/01).

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Class	Treatment Level	Main Parameters	Crop types	Irrigation methods
A	Secondary treatment, filtration and disinfection.	***E. coli*** **≤ 10 Nº/100 mL** BOD_5 ≤ 10 mg/L TSS ≤ 10 mg/L Turbidity ≤ 5 NTU	All	All irrigation methods.
B	Secondary treatment and disinfection.	***E. coli*** **≤ 100 Nº/100 mL** BOD_5 ≤ 25 mg/L TSS ≤ 35 mg/L	1.2 1.3 2 3	All irrigation methods.
C	Secondary treatment and disinfection.	***E. coli*** **≤ 1,000 Nº/100 mL** BOD_5 ≤ 25 mg/L TSS ≤ 35 mg/L	1.2 1.3 2 3	Drip irrigation or other method that avoids direct contact with the edible part of the crop.
D	Secondary treatment and disinfection.	***E. coli*** **≤ 10,000 Nº/100 mL** BOD_5 ≤ 25 mg/L TSS ≤ 35 mg/L	3	All irrigation methods.
	CROP TYPES: 1. **Food crops CONSUMED RAW**: 1.1. Root crops, e.g. carrots, onions, beetroots. 1.2. Above-ground low-growing crops, e.g. lettuce, tomato, pepper. 1.3. Above-ground high-growing crops: fruit trees. 2. **PROCESSED FOOD CROPS**, cooked or industrially processed, e.g. rice, wheat. 3. **NON-FOOD CROPS** (fodder), industrial, energy and seeded crops, crops used to feed milk- or meat-producing animals.			
	IRRIGATION METHODS: ▪ Open or gravity-flow irrigation systems, flood and furrow irrigation. ▪ Sprinkler irrigation systems ▪ Micro irrigation systems, drip or trickle systems			

Table 1*: Water Reuse Regulation: Treatment level, parameters, crops and irrigation methods allowed for each water class. BOD_5: five-day biochemical oxygen demand; TSS: total suspended solids; NTU: nephelometric turbidity unit. E. coli: Escherichia coli.*

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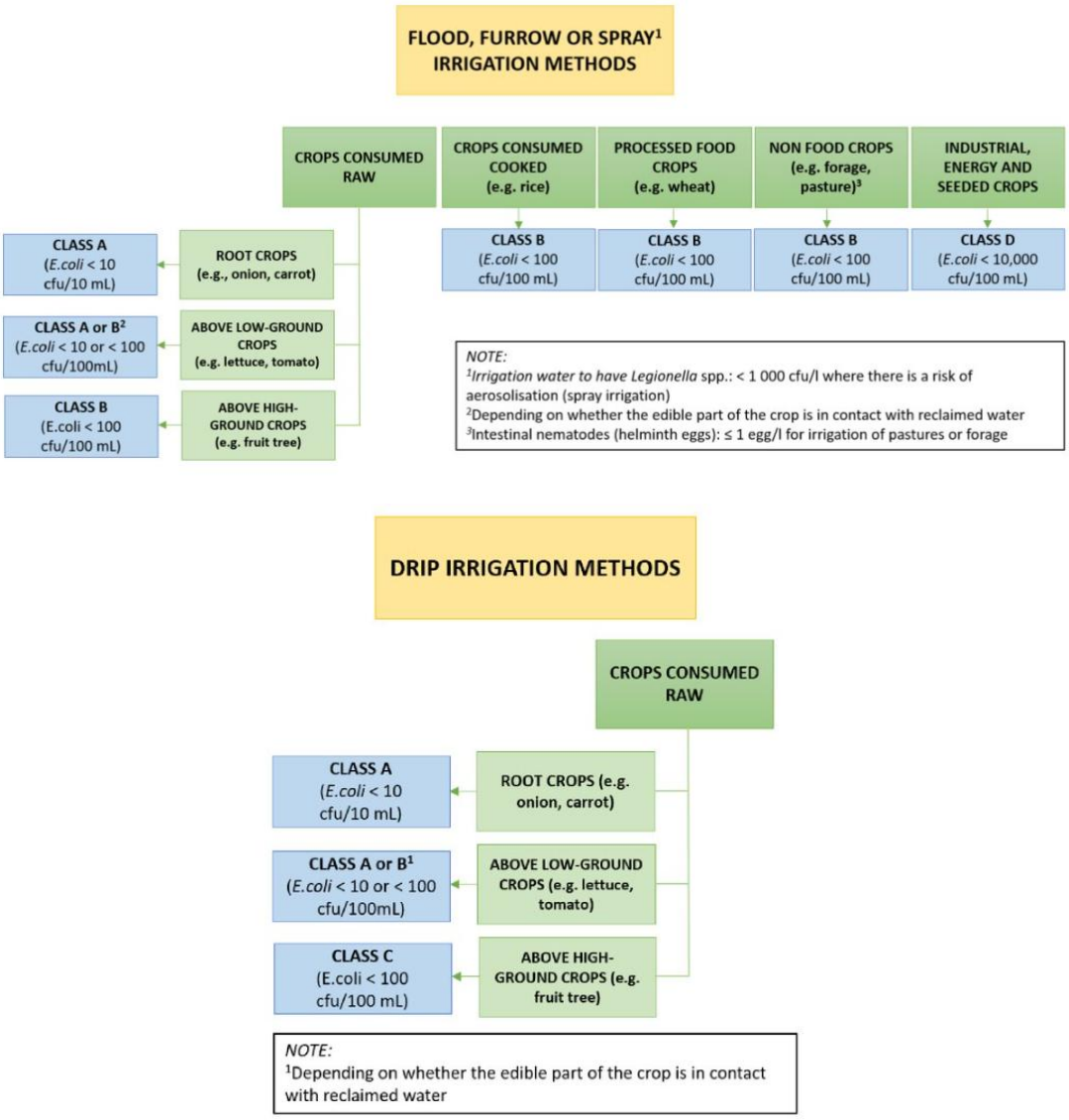

Figure 2: *Top: Irrigation methods and crops allowed in function of the reclaimed water quality. Figures obtained from "Guidelines to support the implementation of the Regulation 2020/741 on minimum requirements for water reuse (2022/C 298/01)". Bottom: Images about drip irrigation*

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2.3. Legal compliance of reclaimed water quality

Reclaimed water shall be in compliance with the legal requirements where the measurements for that reclaimed water meet all the following criteria:

- the indicated values for *E. coli*, *Legionella* spp. and intestinal nematodes are met in 90% or more of the samples;
- none of the values of the samples exceed the maximum deviation limit of 1 log unit from the indicated value for *E. coli* and *Legionella* spp. and 100% of the indicated value for intestinal nematodes.

The indicated values for BOD_5, TSS, and turbidity in Class A water are met in 90% or more of the samples; none of the values of the samples exceed the maximum deviation limit of 100% of the indicated value.

Pathogen monitoring in reclaimed water is a top priority. If the REALM project waters do not contain pathogens or any of these pathogen groups, the monitoring of these parameters can be revised.

2.4 Minimum requirements for monitoring

Reclamation facility operators shall perform routine monitoring to verify that the reclaimed water is in compliance with the minimum water quality requirements (Table 2).

Parameter monitoring is recommended for the follow-up of reclaimed water obtained with the REALM project. It should be included in a good practice manual. The frequency of sampling can be discussed by the whole consortium from the parameters obtained in preliminary sampling.

<table>
<tr><th>Reclaimed water quality class</th><th>E. coli</th><th>BOD_5</th><th>TSS</th><th>Turbidity</th><th>Legionella spp.</th><th>Intestinal nematode</th></tr>
<tr><td>A</td><td>Once a week</td><td>Once a week</td><td>Once a week</td><td>Continuous</td><td rowspan="4">When applicable (*)

Twice a month</td><td rowspan="4">When applicable (*)

Twice a month</td></tr>
<tr><td>B</td><td>Once a week</td><td rowspan="3">In accordance with Directive 91/271/EEC (Annex I, Section D)</td><td rowspan="3">In accordance with Directive 91/271/EEC (Annex I, Section D)</td><td>-</td></tr>
<tr><td>C</td><td>Twice a month</td><td>-</td></tr>
<tr><td>D</td><td>Twice a month</td><td>-</td></tr>
</table>

***Table 2**: Water Reuse Regulation: Minimum frequencies for routine monitoring of reclaimed water for agricultural irrigation. E. coli: Escherichia coli; BOD_5: five-day biochemical oxygen demand; TSS: total suspended solids.(*) When there are several cases in the regulation, it is recommended to consult it carefully for a correct application.*

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3. Implementation of consolidated environmental regulations in the REALM project

In the previous sections, a compilation has been made of the European environmental regulations applicable to discharges and reclaimed water and the primary environmental quality directives that may be affected by discharges and reuse. Each country must transpose these regulations and can develop their own.

In this section, a graphic compilation of the parameters and concentrations covered by all the environmental legislations is made for the REALM project. The graphics include all the parameters and criteria, including those of the European countries that have developed their regulations and added new parameters and concentrations. All of them allow for a better protection of the water and the use for both agricultural irrigation and ecosystemic use if the water regenerated with the project is finally returned to the natural environment.

Figure 3 illustrates the process of the REALM project, the activities that may be involved, the locations (points of compliance) where environmental regulations must be applied (particularly regarding parameters and concentrations), monitoring of the activity and its possible impact on the natural environment. Consideration has also been given to the possible discharge routes of reclaimed water into the surrounding environment (surface water and groundwater) and agricultural practices. How activities can affect water quality is shown graphically. The figure includes all activities and all regulations, considering they occur near the greenhouse and its catchment area.

Figure 4 compiles the parameters and concentrations for wastewater discharge or reclaimed water quality monitoring according to the model proposed by the REALM project indicating the location of the water monitoring points.

RECOMMENDATIONS:

Compiling all applicable environmental regulations is complex, and this scheme should be subject to all necessary location-specific modifications when the REALM concept is applied in a certain country.

For a legal application of the reclaimed water in a specific location, it is mandatory to **review the risk assessment process** of the regulations. At the present date of this deliverable, the procedure is detailed in the "**Guidelines to support the implementation of the Regulation 2020/741 on minimum requirements for water reuse (2022/C 298/01)”**. That is a detailed, well-described document and contains information related to all risk assessment levels of enforcement, i.e. applicable barriers according to required pathogen reduction, crops, type of irrigation, water quality criteria applicable in environmental monitoring programmes, etc. The whole document should be considered as a working manual for every reclaimed water facility in general, and for REALM facilities in particular.

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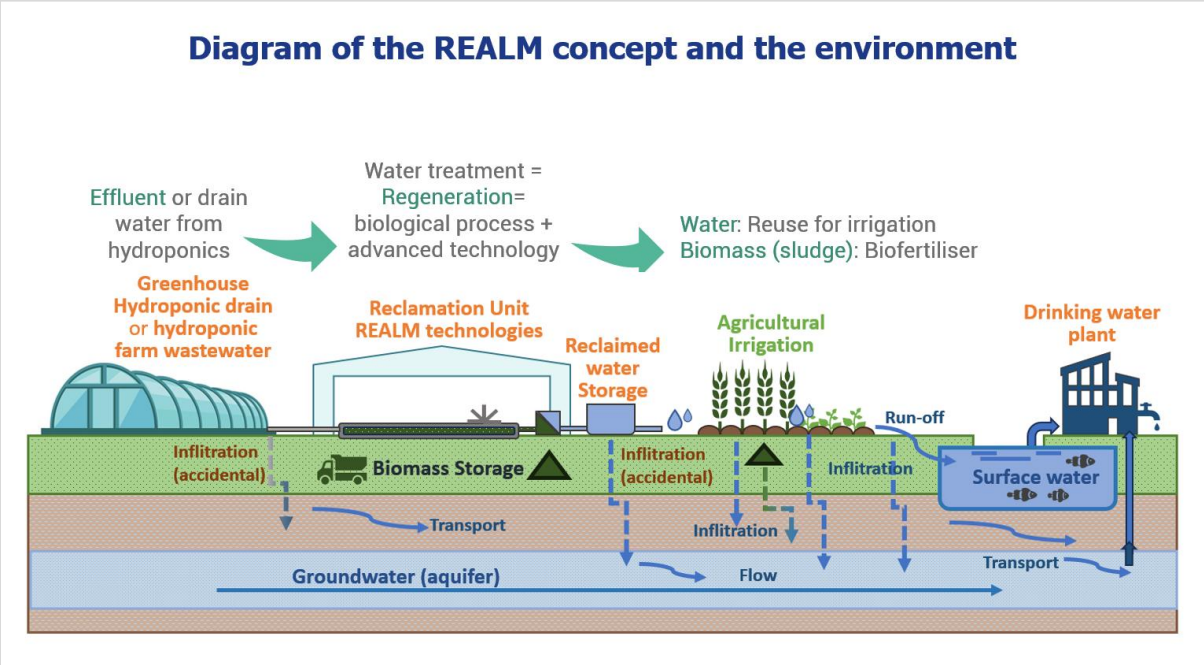

***Figure 3**: Diagram of the REALM concept and the main elements of a water reuse system, identifying potential receptors in the environment.*

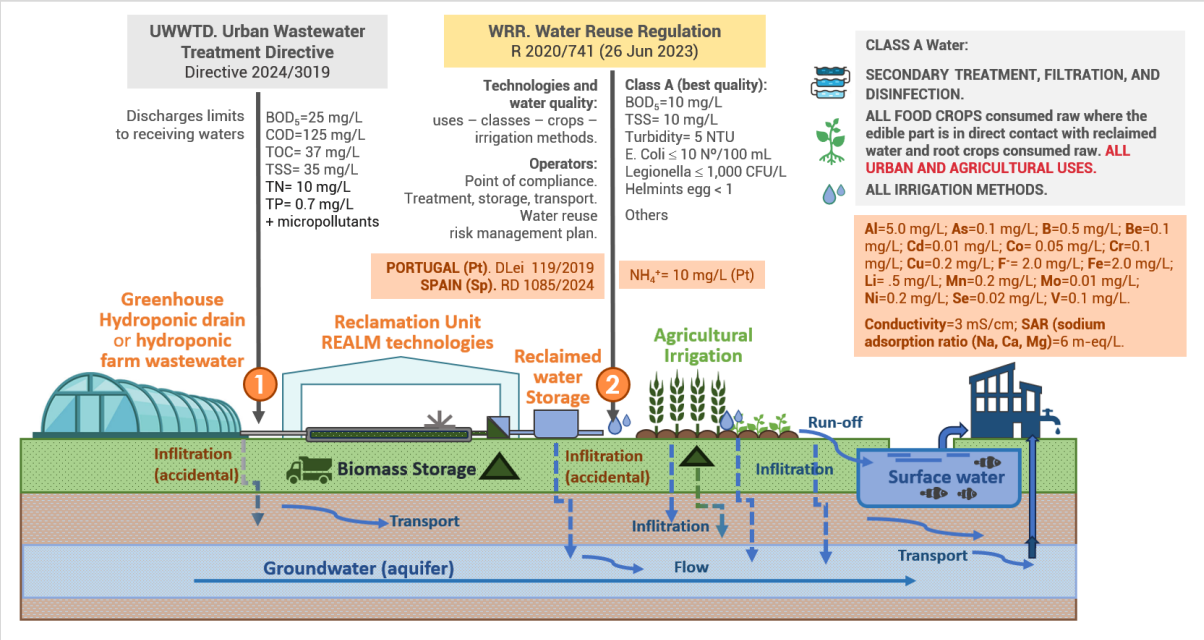

***Figure 4**: Parameters and concentrations for treated water quality monitoring according to the model proposed by the REALM project. Points (1) and (2) are points for water monitoring. Point (2) is a point of compliance of reclaimed water. BOD_5: five-day biochemical oxygen demand; COD: chemical oxygen demand; TOC: total organic carbon; TSS: total suspended solids; TN: total nitrogen; TP: total phosphorous; E. coli: Escherichia coli; NTU: nephelometric turbidity unit; CFU: colony-forming unit.*

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Key content:

Two implementing regulations:

- Urban Wastewater Treatment Directive, UWWTD.
- Regulation for Water Reuse, WRR.

Two points of compliance and water monitoring:

[1] At the inlet of the reclaimed water treatment unit.

[2] At the outlet of the water reclamation treatment unit, and or, at the outlet of the reclaimed water storage tank, if existing. That is a point of compliance of WRR. The fate could be agricultural irrigation or recirculation to greenhouses.

Water monitoring parameters and concentrations:

- UWWTD mandatory parameters and concentrations: BOD_5, COD, TSS.
- Reference N and P concentrations for equivalent populations of 10,000 to 150,000 p.e.

Additional parameters and concentrations:

- NH_4 (included in the Portuguese regulation as a complementary parameter for the control of possible biofouling or obstructions in the pipelines).
- Anions and cations and other irrigation water control parameters.

Additional information in the figure:

- Indication of the generic water bodies that may be affected by the activity, either in the vicinity of the treatment, storage area, by surface run-off or infiltration into the soil and groundwater.

Discharges from agriculture using hydroponic techniques can be controlled under the new UWWTD, which sets limits for discharges of urban wastewater and wastewater from agri-food industries.

The New Directive sets limits for the overall parameters of organic matter (BOD_5 and COD) and solids concentration, as well as for controlling N and P. For these, the concentrations set by **the Directive are 10 mg/L of Total Nitrogen (TN) and 0.7 mg/L of Total Phosphorous (TP) in discharges to "waters sensitive to eutrophication"**. The EU policy for the coming years is to increase the numbers of "**areas vulnerable to eutrophication**", given the significant improvement in EU water quality observed with the UWWTD and the Nitrates Directive.

The REALM project treats effluent water from hydroponic crops. The treatment with microalgae, the separation by membrane filtration technology of the water-microalgae-biomass and the incorporation of additional treatments, such as ozonation to remove organic compounds and pathogens, are treatments that would allow the reuse of water for agricultural use, which is the most recommended use in WRR.

The treatment diagram proposed by REALM is a complete water reclamation unit. The quality of the water obtained from this sequence of processes must comply with the parameters of the new UWWTD and must also reduce the microbiological load to the levels set by the reclaimed Class A water.

The water quality will indicate which crops can be irrigated and the irrigation technique. For other uses in other countries, or if the reclaimed water does not comply with the best quality irrigation water, legislation should be consulted.

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The WRR is fully operational from 26 June 2023. Depending on the treatment technology and the water quality achieved, this regulation classifies the water-product into A, B, C and D, where the **Class A classification would be the highest quality water for irrigation**. The pathogens concentration conditions the classification level, the main indicator being *E. coli*, because this regulation applies to urban wastewater.

Depending on the concentrations of organic matter (BOD_5, COD and TSS) in the water to be treated and the mode of operation of the microalgae technology in terms of residence time, cell retention time, etc., the treated water will reach a certain quality. When, for whatever reason, it is not possible to obtain reclaimed water of the highest quality, it may be used for other less demanding purposes. Portugal and Spain have additional reuse legislation, which includes more uses than exclusively agricultural, and extend the parameters to include N and P. The combined standards of both countries also include irrigation water quality criteria of some elements to protect crops. Spain also incorporates conductivity values and sodium absorption ratio. All the parameters and concentrations recommended are shown in **Figure 4**.

The water treated in the REALM project can include monitoring the parameters in **Figure 4**. Many of them (nutrients, metals and other elements) should be measured regularly. Once the water has been treated with the regeneration unit, if the quality corresponds to the values in **Figure 4**, it is classified as class-A water, the highest quality for irrigation. It can be applied to all types of crops and with all irrigation techniques. If any parameter (mainly pathogens) results higher than indicated, the water would be classified in another category.

The target water in the REALM project should be free of enteric pathogens and low in organic matter (BOD_5, COD and TSS). In any case, even if the list contains parameters that the waters do not have or are assumed not to have, they are parameters required by regulation. They must be measured.

The specifications made by the reuse regulations regarding the operator(s) involved in the process are necessary because they are responsible for the quality of the water. Suppose there is only one responsible operator, i.e. the operator for the purification process. In that case, this operator is responsible for the water quality up to the point of compliance and for the end-user, the farmer. If the responsibility for transport or storage is transferred to another operator, there would be several points of compliance, and the new operator would be responsible for the water quality. The point of compliance is the point where a reclamation facility operator delivers reclaimed water to the next actor. **Every transfer must ensure the water quality**.

The WRR indicates a minimum set of water treatments for a reclamation unit. As more treatments are applied, better-quality water is obtained. The most intensive treatment includes secondary treatment, filtration and disinfection; the product water should have Class A quality and a low pathogen load. This water is suitable for all types of crops, and all irrigation methods can be applied. If the treatments are less stringent, or the pathogen load is higher, the reclaimed water will be classified into other classes, changing the crops and the irrigation method allowed.

The REALM project establishes a sequence of treatments that can be considered rigorous. The drainage water of hydroponics crops will be filtered to remove debris and treated by ozonation or chlorination to reduce pathogens. Then, the water is treated in the microalgae reactor to reduce nutrients (and other organic pollutants) from the water. The culture would then be tangentially filtered to separate the water and algal biomass. The water can then go back to the algae demo, go back to the greenhouse for irrigation or be discharged.

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4. Policy brief

The REALM project aims to establish a model facility for treating surplus water from hydroponic-based agriculture. The proposed facility includes a microalgae-based technology complemented with additional treatments to condition the effluent and use it as reclaimed water for agricultural use or as tertiary wastewater treatment, reducing the concentration of nutrients to meet discharge requirements.

The timing of the REALM project coincides with significant revisions of EU environmental policy, resulting from the implementation of essential strategies to tackle the climate crisis and to safeguard ecosystems and natural resources from environmental pollution. These strategies are led by the '*European Green Deal*' and include the '*Zero Pollution Strategy*' (reducing pesticides and fertilisers in agriculture to reduce water pollution), the '*Farm to Fork Strategy*' (promoting sustainable agricultural practices and reducing the input of nutrients and pesticides of agricultural origin into surface and groundwater) and the '*Biodiversity strategy 2030*' (promoting greater protection and restoration of aquatic ecosystems).

These strategies set out a roadmap for updating the EU's two critical pieces of legislation to control pollution and protect water:

- The Urban Wastewater Treatment Directive (UWWTD), which regulates pollutant concentrations in urban, some industrial and agri-food industry discharges;
- The Water Framework Directive (FWD), which is the main legal instrument for water protection.

The new UWWTD 2024/3019 has been approved during the REALM project, while the amendment of the WFD is ongoing.

The revision of both legal frameworks aims to provide better water protection. The key aspects of the revision are:

- Increasing the number of areas identified as sensitive or vulnerable to eutrophication.
- Greater coordination between Member States to declare these sensitive areas.
- Mandatory secondary treatment for agglomerations above 2,000 p.e.
- Mandatory tertiary nutrient removal treatments for agglomerations of 10,000 p.e. and above.
- Mandatory quaternary treatments to remove micropollutants, including pesticides for agglomerations above 150,000 p.e.
- More stringent allowable discharge concentrations for nutrients: nitrogen (N) and phosphorus (P).
- New standards for micropollutants in discharges.
- Promoting water reuse and the application of sludge in agriculture.
- New substances and environmental quality standards in waters.
- Increased monitoring of surface water and groundwater.
- Increased monitoring of pesticides and nitrate concentrations in surface water and groundwater.
- More coordinated monitoring programmes.

In addition to these key aspects of the revision of both regulations, the Water Reuse Regulation (WRR) has been implemented and has been in full compliance since June 2023. This Regulation defines different classes of reclaimed water depending on the intensity of treatments applied and the water quality achieved. Water class determines which crops can be irrigated and the irrigation technique. The

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parameters in reclaimed water include those regulated in the UWWTD, plus an exhaustive control of pathogens characteristic of wastewater, mainly of urban origin.

The WFD is the primary water protection legislation in the EU. All environmental legislation, both previously and subsequently adopted, is legislated under the principles of the WFD with the ultimate aim of achieving 'good status' in all the waters throughout the EU. The WFD states that water protection against pollution from any source (point or diffuse) should be based on the 'combined approach' principle. The '**combined approach**' refers to the coordinated application of environmental regulations to control discharges and water quality regulations for specific substances. Monitoring programmes should integrate both the polluting activity (wastewater discharges or run-off from agriculture zones) and the monitoring of the environmental quality of the receiving environment.

Regarding the management and control of eutrophication of superficial and subterranean water mass by nutrients (mainly nitrates), the trend in many Member States is to consider their water bodies as **nitrate vulnerable zones, NVZ** (Directive of Ground Water) or **sensitive water subject to eutrophication, SW** (UWWTD). These classifications allow stricter control of nutrient concentrations in discharges and intensified environmental monitoring programmes. The new UWWTD intensifies the monitoring of N and P in treated water discharges and calls for more water bodies to be classified as sensitive to eutrophication.

EU Member States incorporate European directives into their environmental legislative hierarchy and develop additional legislation or national or regional implementation and monitoring plans according to their geographic characteristics or environmental interests. In the regulatory review for REALM, two trends have been identified in the application or approach to some of the aspects regulated. Concerning areas vulnerable to eutrophication, some EU countries (e.g., the Netherlands and Finland) have declared all their water bodies as NVZ or SW, which implies the control of nutrients in discharges and receiving waters. Regarding water reuse, countries at risk of drought, such as Spain and Portugal, have anticipated European regulations by developing their regulations and increasing the use of reclaimed water.

The REALM model is intended to be extrapolated to any EU country, so the legislation applied to the REALM wastewater treatment technology must ensure compliance in all countries. Therefore, the most restrictive criteria or decisions taken by EU countries should be considered for the application of the REALM model.

Recommendations based on Policy Brief:

- The hydroponic water outlet (drainage) should be considered a "point source" of contamination – this is the water used in the REALM facilities.
- The set of treatments of the REALM facilities is considered tertiary water treatments according to the UWWTD or a reclamation unit according to the WRR if the water is destined for agriculture.
- The REALM project should be ambitious in removing N and P in water from hydroponic agriculture. All waters affected by direct or indirect discharges related to these installations should be considered vulnerable or sensitive to eutrophication.
- If the destination of the water treated by REALM is discharged, it must meet the maximum allowable concentrations of the new UWWTD, including those for N and P.
- **The allowable concentrations for discharge at the point of compliance will be 25 mg/L BOD_5 (or 37 mg/L TOC); 125 mg/L COD, 35 mg/L TSS; 10 mg/L TN; 0.7 mg/L TP.**
- If the fate of the treated water is for agricultural irrigation, it must meet the concentrations set by the WRR.

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- The REALM facilities must be ambitious in obtaining higher-quality reclaimed water.
- It is recommended that REALM facilities include treatments that reduce the number of pathogens in the water if the water contains pathogens.
- When used for irrigation in agriculture, reclaimed water by REALM facilities should comply with the parameters for Class A water of the WRR, which allows irrigation for any crop and any irrigation.
- **The recommended concentrations for reclaimed water at the point of compliance will be (Class A): *E. coli* ≤ 10 Nº/100 mL; BOD_5 ≤ 10 mg/L; TSS ≤ 10 mg/L; Turbidity < 5 NTU; other pathogens (see WRR).**
- If the reclaimed water does not meet these parameters, its classification and the types of cultivation and irrigation must be determined.
- It is recommended that the REALM facility has a "Risk Management Plan" (RMP) if the water to be treated contains pathogens. It is recommended that the WRR be consulted to develop an RMP under the terms of the Regulation.
- Suppose that after an initial assessment, it is determined that no pathogens could pose a risk to human health and ecosystems. In that case, the plan can be reduced to some essential elements, e.g., a description of the reclamation system and technology, identification of the actors in each specific project, identification of compliance points, and a manual of good practice for the storage, transport and application of reclaimed water in the different forms of irrigation.
- A surface and groundwater quality monitoring plan must be designed to assemble the combined approach. This plan must cover all surface waters affected by discharges or runoff from the agricultural application area. The monitoring plan must include monitoring of N in both surface water and groundwater, plus parameters to be established by the competent environmental authority.

The treatment installation model proposed by the REALM project represents an improvement in water treatment with a high nutrient load and low organic matter content, such as the effluents from hydroponic agriculture installations. The sequence of treatments proposed is rigorous and should allow a high-quality effluent for direct discharge and water reuse in agriculture.

The recommendations in this Policy Brief should guide the technology and the efficiency of the treatments.

For the actual implementation of this model, a thorough analysis of the applicable legislation is recommended.

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4.1. Pertinent regulations for REALM

The main regulations considered for the policy brief for the REALM model are the following:

A. WASTEWATER TREATMENT AND REUSE:

1. **Urban Wastewater Treatment Directive 91/271/ECC [UWWTD]**. Provides minimum standards for wastewater treatment throughout the European Union.
2. **Urban Wastewater Treatment Directive 2024/3019 (recast) [UWWTD]**. Updates the directive with stricter standards and more control of N and P discharges.
3. **Regulation for Water Reuse 2020/741 [WRR]**. Establishes minimum requirements for the safe reuse of treated wastewater, promoting its use in agricultural irrigation.

B. WATER FRAMEWORK AND ENVIRONMENTAL QUALITY STANDARD:

4. **Nitrates Directive 91/676/EEC**. It protects waters against nitrate pollution from agricultural sources and promote the sustainable use of fertilisers.
5. **Water Framework Directive 60/2000/CE [WFD]**. To establish a framework for the protection and sustainable management of water in the European Union, with the aim of ensuring its quality and availability in the long term.
6. **Groundwater Directive 2006/118/EC**. It sets out criteria for assessing the chemical status of groundwater and measures to prevent or limit the introduction of pollutants.
7. **Environmental quality standards in the field of water policy Directive 2008/105/EC [EQSD]**. It sets maximum allowable concentrations in surface water for certain priority substances that pose a significant risk to the aquatic environment.
8. **Environmental quality standards Directive 2013/39/EU [EQSD]**. Amends the previous directives on priority substances in the field of water policy, updating the list of pollutants and their permitted concentrations.
9. **Directive 2014/101/EU**, introduces specific amendments to Directive 2000/60/EC to improve its implementation and consistency with other water management legislation.
10. **Update of WFD**, Directive 2006/118/EC and Directive 2008/105/EC. Proposal COM/2022/540 final.

C. OTHER DIRECTIVES:

11. **Drinking Water Directive 2020/2184/EC**. Quality standards for human consumption. Water use that may be directly or indirectly affected by a water reclamation facility.
12. **Bathing Water Directive 2006/7/EC**. Quality standards to protect human health in bathing waters and recreational activities. Water use that may be directly or indirectly affected by a water reclamation facility.

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Annex: risk management according to the legislation for water reuse

The European Union Water Reuse Regulation (WRR; and specific legislation in Member Countries) is very demanding in terms of risk assessment associated with water treatment and the application of water in agriculture or other uses. It should be noted that the main objective of the regulation is to reclaim water from urban wastewater treatment plants whose pathogen load represents a high risk to human health and ecosystems. That is not the case for the REALM project using drainage water from hydroponic agriculture; however, it is important to address that water **reclamation projects must have a risk assessment plan, so** it is recommendable **to adapt the requirements of the WRR Risk Plan to the REALM project at the final stage of the research project and with the aim of its future and real implementation.**

As set out in Article 5(1) of the Regulation, the competent authority is ultimately responsible for ensuring that a risk management plan is in place that addresses all possible aspects of a water reuse project, including the production, supply and use of reclaimed water, and assigns responsibilities for each aspect of the management of a reuse project. While the competent authority is the responsible party, the parties who should develop the plan are the operator of the reclamation facility, other responsible parties who may be involved and should be consulted (e.g. the competent authority) and end-users, as appropriate.

The REALM project could develop a "Risk Management Plan" (RMP) or a "Code of Good Practice" with several basic elements, e.g. description of the reclamation system and technology, identification of the actors in each specific project, identification of compliance points, and a manual of good practice for the storage, transport and application of reclaimed water in the different forms of irrigation. For the area of water application, adapt the document to the most common agricultural practices and crops in the area. If a specific end-user is identified, clearly specify the crops and irrigation practice to be used in the document.

In the technical report "Technical Guidance – Water Reuse Risk Management for Agricultural Irrigation Schemes in Europe" a modular procedure is proposed whereby each module addresses a specific aspect of a risk management plan and includes 11 key elements (KRMs). Figure representing the scheme and the list includes a brief description of each one.

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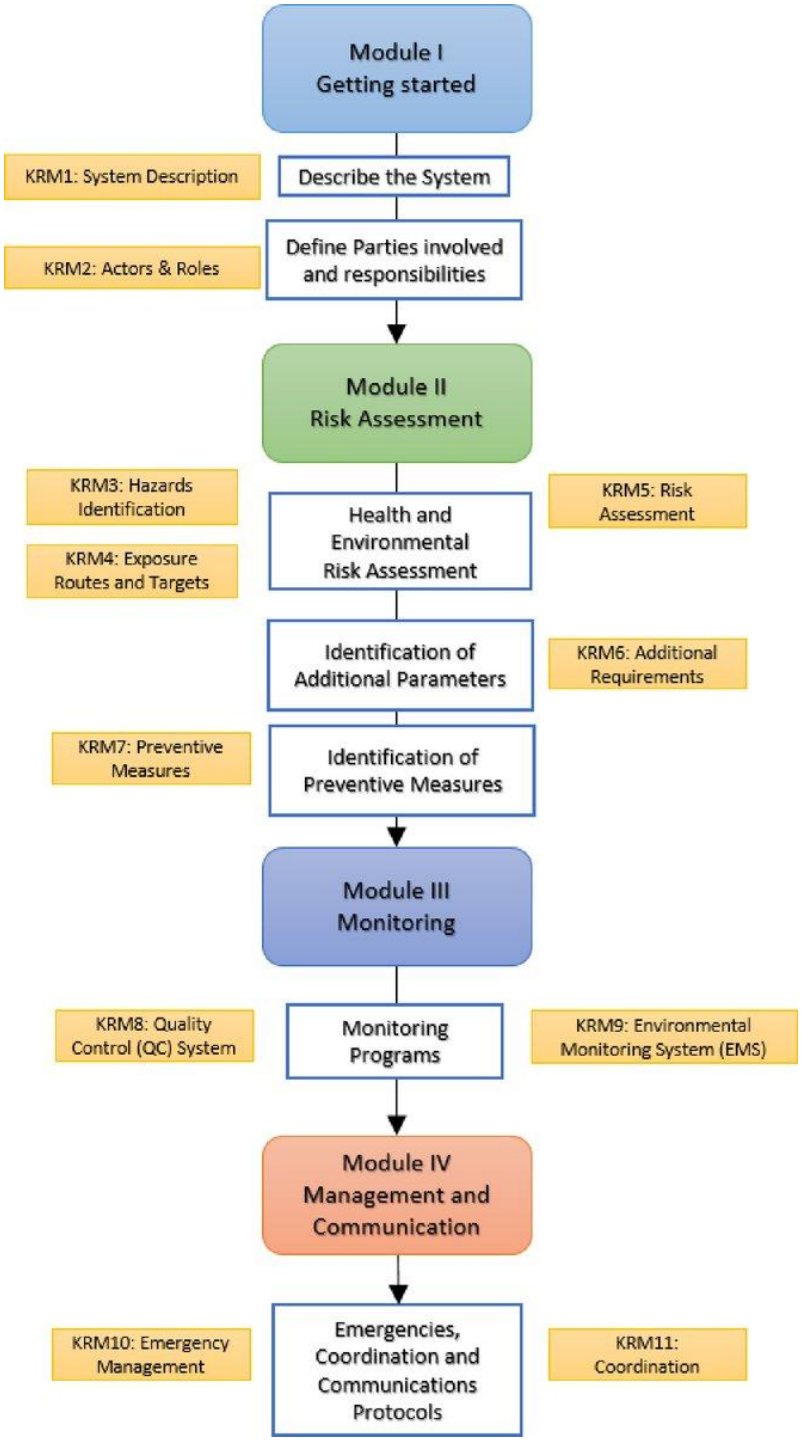

***Figure 5**: Water reuse key risk management elements (KRMs) organised into four modules to aid the formulation of a Risk Management Plan. Figures obtained from "Guidelines to support the implementation of the Regulation 2020/741 on minimum requirements for water reuse (2022/C 298/01)".*

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KRM1: Describe the system. Describe the entire water reuse system, from the entry point to the regeneration unit, to the point of use.

KRM2: Actors and roles. Identify all the parties involved in the water reuse system, along with their roles and responsibilities.

KRM3: Hazard identification. Identify potential hazards (pathogens and pollutants) and hazardous events (e.g. treatment failures) associated with the water reuse system.

KRM4: Environments and populations at risk and exposure routes. Identify populations and environments potentially exposed to each identified hazard.

KRM5: Environmental and health risk assessments. For each previously identified hazard, identify potential associated risks for each receptor (people, animals, crops or plants, other terrestrial biota, aquatic biota, soils or the environment in general), for each exposure route.

KRM6: Additional requirements. The outcomes of the risk assessment might identify additional or stricter water quality and monitoring requirements than those from the Regulation. If additional parameters or limits are included, this should be based on the outcomes of the risk assessment and supported by scientific evidence that they originate from the water reuse system and not from other sources. These additional parameters may also include the following pollutants: heavy metals, pesticides, disinfection by-products, pharmaceuticals, substances of emerging concern, bacteria that exhibit anti-microbial resistance.

KRM7: Preventive measures. Identify preventive measures or barriers (additional or already in place) that should be applied to parts of the water reuse system, to limit or mitigate any identified risk. For example, access control methods, additional water treatments or specific irrigation technologies or barriers.

KRM8: Quality control systems. Determine quality control measures, including protocols for monitoring the reclaimed water for the relevant parameters and maintenance programmes for the equipment, to ensure the effectiveness of the treatment chain and the preventive measures adopted.

KRM9: Environmental monitoring system. Set up an environmental monitoring system to control the release of the identified pollutants in the exposed environmental receptors (e.g. freshwater, groundwater, soil). The monitoring system could include documented procedures already in place to ensure ongoing environmental protection, where appropriate, or these could be further developed or tailored, depending on the results of the environmental risk assessment.

KRM10. Set up protocols to manage incidents and emergencies.

KRM11: Coordination. Determine coordination and communication mechanisms between the different actors involved in the water reuse system.

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