COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE AND THE FLOODS DIRECTIVE

Guidelines on Integrating Water Reuse into Water Planning and Management in the context of the WFD

Document endorsed by EU Water Directors at their meeting in Amsterdam on 10th June 2016

Disclaimer:

This document has been developed through a collaborative programme involving the European Commission, all the Member States, the Accession Countries, Norway and other stakeholders and Non-Governmental Organisations. The document should be regarded as presenting an informal consensus position on best practice agreed by all partners. However, the document does not necessarily represent the official, formal position of any of the partners. Hence, the views expressed in the document do not necessarily represent the views of the European Commission.

Foreword

Article 5 of the Water Framework Directive requires an analysis of pressures on water bodies. Over-abstraction of water from surface and groundwater bodies is a significant pressure in some areas of Europe and may be driven by wider problems of scarce water resources and increased by climate change. When, based on the Article 5 analysis, over-abstraction is identified as being a significant pressure, Member States should adopt appropriate measures to reduce the existing pressures and to prevent predicted pressures (as a means of climate change adaptation) in order to achieve a good status of surface and groundwater bodies as required by the WFD. Appropriate measures may include improved water efficiency, reducing leaks in water distribution networks, etc. One possible measure is water reuse. Water reuse can also be a tool for management of water quality by limiting the discharge of waste water into sensitive water bodies.

The 2007 Communication on Water Scarcity and Droughts[1] stresses that appropriate measures should take account of a 'water hierarchy', which emphasises the need to address water saving and efficiency as a priority. However, where this is not sufficient, additional water sources might be needed. Reuse of treated waste water is one such possible source.

Water reuse was highlighted as an important possible measure for further EU action in the 2012 Water Blueprint[2]. The 2015 Communication "Closing the loop - An EU action plan for the Circular Economy"[3] took this further, stating that the Commission will take a series of actions to promote the reuse of treated wastewater. One such action has led to these CIS Guidelines on Integrating Water Reuse into Water Planning and Management in the Context of the WFD. Another is the development of a legislative proposal on minimum quality standards for reuse in agricultural irrigation and aquifer recharge, subject to an impact assessment.

It is important to emphasise that there is no 'one size fits all' solution to water scarcity and over-abstraction across the EU. Reuse of treated wastewater is one of the measures which can be used when deemed appropriate by individual Member States following a thorough assessment in the context of the WFD. When it is deemed to be the most appropriate measure, an analysis of risks and benefits to health and the environment needs to be performed.

The intended audience for this document is policy makers, water resource planners, river basin managers and those in the water industry, irrigation associations, etc. The document explores the policy and planning context of reuse of treated wastewater. Since it neither explores nor recommends particular treatment standards or particular technologies for treatment, readers should currently refer to other sources for such information. Also, while the document emphasises the importance of engagement with the public, it is not intended as a tool for such engagement.

[1] COM (2007)414
[2] COM(2012)673
[3] COM (2015)614

The guidelines note that water can be reused for a variety of purposes (agriculture, landscape, urban, environmental, industry, etc.) and the document outlines the range of potential economic and environmental benefits. In all cases the quality of the water (and hence the treatment necessary) would need to be appropriate to the specific end use as well as ensure wider health and environmental protection. Risks to all aspects of health and environment need to be considered, including potential hazardous substances and exposure routes and taking the precautionary principle into account. The document also provides guidelines on the interpretation of EU law as it applies to water reuse and emphasises the need to ensure relevant EU environmental law is fully complied with. Furthermore, it stresses the importance of complying with national legislation on the quality of reused water where this is in place.

The second action under the Circular Economy action plan is for the Commission to develop a legislative instrument on minimum quality requirements for specific uses of reused water. It is important to note that the present document covers more uses than are likely to be covered by that instrument. If EU standards were to be adopted, the assessment and planning steps set out in this document could readily incorporate them. As a result, and recognising the fact that adequate quality standards are a key issue in the planning process, this document is considered as CIS Guidelines and not as a CIS Guidance document for the implementation of the WFD. However, it is agreed that this document would be reviewed and possibly expanded if/when a legislative instrument is adopted in order to ensure consistency and integration between the standards and assessment and planning.

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Acronyms

BOD	Biological oxygen demand
CAP	Common Agricultural Policy
CF	Cohesion Fund
CIS	Common Implementation Strategy
COD	Chemical oxygen demand
DMP	Drought Management Plan
EAFRD	European Agricultural Fund for Rural Development
ERDF	European Regional Development Fund
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EIP	European Innovation Partnership
ESIF	European Structural and Investment Funds
EU	European Union
FP7	Seventh Framework Programme
GDP	Gross domestic product
GWD	Groundwater Directive
ISO	International Standards Organisation
NCFF	Natural Capital Financing Facility
NGO	Non-governmental organisation
NVZ	Nitrate Vulnerable Zone
RBD	River Basin District
RBMP	River Basin Management Plan
RDP	Rural Development Plan
RTWQM	Real Time Water Quality Monitoring
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SME	Small and medium-sized enterprise
SSP	Sanitation Safety Planning
USA	United States of America
USEPA	United States Environmental Protection Agency
UWWTD	Urban Waste Water Treatment Directive
UWWTP	Urban wastewater treatment plant
WFD	Water Framework Directive
WHO	World Health Organisation
WIRE	Water & Irrigated agriculture Resilient Europe
WISE	Water Information System for Europe
WSD	Water scarcity and droughts
WssTP	Water Supply and Sanitation Technology Platform
WWTP	Wastewater treatment plant

Executive summary

Purpose

These guidelines provide information and assistance to relevant Member State authorities to support planning for the reuse of treated wastewater, where appropriate, such as following the Art. 5 analysis in RBMPs and its inclusion as a supplementary measure in Programmes of Measures in cases where water scarcity is identified as a significant pressure. The reuse of treated wastewater can be an important tool to contribute as a local solution to achieving the objectives of the Water Framework Directive (WFD) and to contribute to a more resource efficient economy as well as to adapt to climate change. It is designed to help Member States in improving such consideration in the implementation of the WFD.

Background

The reuse of treated wastewater has been highlighted within EU water policy as one possible alternative water source in water-scarce regions which may be appropriate to consider within water-scarcity planning[4]. It was also identified as a priority in the 2012 Water Blueprint[5] and it is also a supplementary measure which Member States can adopt as part of the Programme of Measures required under Article 11(4) of the WFD. Reuse of treated wastewater is further emphasised in EU policy on resource efficiency, most notably in the 2015 Communication on the Circular Economy[6] which states "in addition to water-efficiency measures, the reuse of treated wastewater in safe and cost-effective conditions is a valuable but under-used means of increasing water supply and alleviating pressure on over-exploited water resources in the EU". The Communication stated that the Commission will take a series of actions to promote the reuse of treated wastewater. These guidelines take forward one action considering the wide context of potential uses of reused water at Member State level and how this could be examined in appropriate planning (including planning under the WFD).

Water reuse should contribute to the UN 2030 Sustainable Development Agenda and especially its target to "substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity" and the sub-target to "By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally".

Audience and scope

The intended audience for these guidelines is policy makers, water resource planners, river basin managers and those in the water industry, irrigation associations, etc. These

[4] Communication from the Commission to the European Parliament and the Council - Addressing the challenge of water scarcity and droughts in the European Union COM (2007)414.
5 Commission Communication: Blueprint to Safeguard Europe's Water Resources COM (2012)673.
6 Commission Communication: Closing the loop - An EU action plan for the Circular Economy. COM (2015)614.

guidelines illustrate the policy and planning context of the reuse of treated wastewater. As no common EU standards are yet in place, this document does not recommend particular treatment standards or particular technologies for treatment, but refers readers to other sources for such information. Recognising this is an important issue in the planning process and a review of this document will be considered if minimum EU-standards are established in the future. Also, while the guidelines strongly recognise the importance of engagement with the public, they are not themselves intended as a tool for such engagement (see CIS Guidance No 8).

These guidelines focus on the reuse of collected wastewater that achieves, after treatment as necessary, a quality standard that is appropriate for its intended use (taking account of the health and environmental[7] risks and local and EU legislation). The present guidelines focus on urban waste water. Reuse of industrial wastewater is included in relation to planning as it is important to understand the potential for reuse by industry within water management planning. The reuse of rainwater and of greywater (e.g. for domestic purposes such as toilet flushing) is not within the scope of the guidelines.

The need for appropriate planning

The guidelines stress the importance of integrated planning for water reuse and the need to include it in RBMPs, RDPs, spatial plans, etc. They guide the reader by elaborating nine key steps for planning for water reuse:

1. Determine the overall pressure and impact on water bodies from water scarcity and over-abstraction and the quantitative needs of water users, based on the WFD Art. 5 review of the impact of human activity on water bodies and results from Art. 8 monitoring. The needs may be for irrigation, urban use, environmental purposes, etc., including downstream users. It also important to identify how these needs might change or fluctuate and options to address this (see also CIS Guidance 34 on water balances) and whether all potentials for water saving according to the hierarchy been fully used. This will determine whether a scarcity issue exists that is significant enough to warrant the use of treated wastewater, such as for aquifer recharge to manage seawater intrusion, etc.. If there is no issue, the following steps are not required.
2. Identify the appropriate measures or water sources to meet the changing needs, identifying clearly how each option will address specific quantitative needs. Include the measures within the Programmes of Measures required by Art. 11 of the WFD.
3. Identify the available quantities of wastewater that could be recycled and how these are placed to address individual needs.
4. Determine the necessary treatment requirements and other requirements ensuring safe use and protection of the environment, taking account of EU and national legislation.
5. Identify the different costs (and energy requirements, externalities) associated with treatment of the different wastewater sources and with the delivery of treated wastewater to the different identified users.

[7] Environment refers in this context especially to surface and groundwater bodies, soil, and related ecosystems.

6. Compare these costs (including externalities), with the other alternatives identified (including "no action") and, how these compare with the benefits (including externalities) to be delivered and, where appropriate, undertake further comparative analysis of alternative options.
7. Determine the funding sources for the development and operation of the reuse scheme(s) and adequate water pricing – is the project viable, who pays and who benefits?
8. Ensure that details of agreements/contracts are signed by the treatment plant manager and users regulating the relationships between the parties and defining their respective duties and responsibilities.
9. Establish systems for control and monitoring to ensure safe use of the treated wastewater for people and the environment and compliance by the operator with necessary legal obligations.

The role of water reuse in meeting water needs

Water reuse can contribute to meeting a number of water needs for the environment and different business sectors:

- **Contributing to environmental objectives/making water available for future uses** such as avoiding input of waste water to sensitive water bodies, creating new aquatic environments, stream augmentation, aquifer recharge (e.g. for saline intrusion control or later abstraction for use).
- **Agricultural/horticulture uses** such as irrigation of crops (food and non-food), orchards and pastures or aquaculture including algal farming.
- **Industrial uses** such as cooling water, process water, aggregate washing, concrete making, soil compaction, dust control.
- **Municipal/landscape uses** such as irrigation of public parks, recreational and sporting facilities, private gardens, road sides, street cleaning, fire protection systems, vehicle washing, toilet flushing, dust control.

There is a range of potential economic benefits from water reuse. Economic sectors that are highly dependent on water supply (availability and quality), such as agriculture, the food industry and the tourism and recreational industry could increase their water supply security with water reuse. The expansion of water reuse has provided employment benefits in the water industry sector. Employment benefits also extend to suppliers of systems, equipment and chemicals for additional wastewater treatment and reuse.

The need for treatment and practice appropriate to protect health and environment

The appropriate use of treated wastewater depends upon its quality and, therefore, the treatment to which it has been subjected. Thus in order to ensure safe water reuse, it is important not only to apply water quality standards appropriate to the specific use, but also to ensure adequate and reliable operation of water reuse systems and appropriate regulatory enforcement.

These guidelines do not recommend any particular standard (chemical, microbiological, physical, etc.). However, legally binding standards for water reuse have been developed by several Member States and some third countries and international organisations have also developed specific standards which they recommend. For Member States where legally binding standards have been adopted, it is necessary to ensure they are complied with. EU-standards are currently being developed for agricultural irrigation and aquifer recharge. To feed into this political process, a technical proposal is under development in the Joint Research Centre. The intention is to seek an opinion on this from the independent Scientific Committee on Health, Environmental and Emerging Risks (SCHEER). The present guidelines would be reviewed if/when a legislative instrument were to be adopted in order to ensure consistency and integration between the standards and assessment and planning.

It is important for competent authorities to ensure that information about relevant standards is communicated to those to whom they apply. Where standards for the reuse of treated wastewater are included in a permit, it is essential that the holder of the permit is fully informed as to what legal obligations they are under and how they have to ensure that these legal obligations are to be fulfilled.

The protection of human health and the environment should be undertaken in the context of a risk management approach. In considering the introduction of a water reuse scheme, it is important to examine the full range of benefits and drawbacks/risks that might result. Risk assessment is a prerequisite for the management of water reuse. A risk management approach can be used at various stages of water reuse activity to ensure environmental and public health protection. While aspects of risk analysis will variously focus on specific health and environmental issues, a good risk assessment will integrate these to provide a clear, holistic conclusion to guide management decisions.

The importance of ensuring participation of stakeholders

It is best practice to have as wide an engagement with the public as possible, as well as with the relevant stakeholders (water industry, farmers, etc.), from the earliest stages of planning. This should include all of those potentially affected (positively or negatively). This helps to create transparency and allows for useful information to be gathered from stakeholders which can be important in informing planning. The precise techniques and processes to use for communication and participation will vary according to circumstances and local traditions.

It is recommended to follow practices of active engagement as promoted by the WFD and explored by CIS Guidance on this issue. Indeed, some Member States have included information campaigns concerning reuse as measures within their Programmes of Measures within RBMPs. Active engagement and adequate treatment standards raise the public's understanding of an issue and are particularly helpful at overcoming misperceptions of an issue.

1 Introduction

1.1 Policy background and purpose of these guidelines

These guidelines provide information and assistance to relevant Member State authorities to support planning for the reuse of treated wastewater, where appropriate, such as within the Art. 5 analysis in RBMPs and its inclusion as a supplementary measure in Programmes of Measures. Where appropriate, it can help in the implementation of RBMPs. The reuse of treated wastewater can be an important tool to contribute to achieving the objectives of the Water Framework Directive (WFD), especially in water-scarce regions, and to contribute to a more resource efficient economy.

In December 2015 the European Commission published a Communication "Closing the loop - An EU action plan for the Circular Economy" (COM(2015)0614) which states "in addition to water-efficiency measures, the reuse of treated wastewater in safe and cost-effective conditions is a valuable but under-used means of increasing water supply and alleviating pressure on over-exploited water resources in the EU". It further stated that the Commission will take a series of actions to promote the reuse of treated wastewater. These are:

1. Proposed legislation setting minimum quality requirements for reused water for irrigation and groundwater recharge (subject to a positive impact assessment)

Promotion of safe and cost-effective water reuse, including:

2. guidance on the integration of water reuse in water planning and management;
3. inclusion of best practices in relevant BREFs,
4. support to innovation (through the European Innovation Partnership and Horizon 2020), and
5. support to investments.

These guidelines take forward action 2. It is important to note the relationship between the actions in the action plan. Actions on minimum quality requirements (1) and these guidelines (2) are taken forward in the context of the WFD and CIS. The action on BREFs is to be taken forward in the existing Comitology processes under the Industrial Emissions Directive. Support to innovation and investments also each have their own decision support processes.

With regard to the two actions relevant to the CIS, it is also important to note that they are very different in the scope of reuse of treated waste water to which they apply. The action on minimum requirements is focused on two areas where there is possible justification for EU level intervention (due to the single market for agricultural products and due to the existing EU legal framework for groundwater protection). In contrast, these guidelines consider the much wider context of potential uses of reused water at Member State level and how this should be examined in appropriate planning (including planning under the WFD).

Water reuse should contribute to the UN 2030 Sustainable Development Agenda and especially its target to "substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity" and the sub-target to "by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, having the proportion of untreated wastewater **and substantially increasing recycling and safe reuse globally"**. Reuse should also be a tool contributing to adaptation to climate change as currently or in the near future many EU Member States might face water scarcity at least seasonally.

As no common EU requirements are yet in place these guidelines do not recommend any particular standards (but note that where these apply in law, they should be followed). The document addresses uses that would not be included in the other Circular Economy action, such as irrigation of landscapes, urban uses, etc. Thus the two actions are complimentary.

The reuse of treated wastewater has also been highlighted previously within EU water policy as one possible alternative water source in water-scarce regions which may be appropriate to consider within water scarcity planning[8]. The reuse of treated wastewater was also identified as a priority in the 2012 Water Blueprint[9]. It is also a supplementary measure which Member States can adopt as part of the Programme of Measures required under Article 11(4) of the WFD.

The 2007 Communication on Water Scarcity and Droughts set out a **water hierarchy** to guide actions to tackle water scarcity (see Box 1). Given the huge potential for water savings in the EU, the Communication laid down a water hierarchy under which water demand management should come first, and alternative supply options such as water reuse should only be considered once the potential for water savings and efficiency has been exhausted. It is also important to note that in some cases water reuse can help address local water quality issues.

Box 1 The Water Hierarchy in the EU Water Scarcity and Droughts Policy[10]

The EU policy on water scarcity and droughts was published in 2007. It includes many aspects, such as integration of water scarcity planning into RBMPs, putting the right price on water, understanding ecological requirements for river flows, etc. For the purposes of these guidelines, it is important as it spells out the hierarchy of measures Member States should consider in managing water scarcity and droughts:

- "Water saving must become the priority and all possibilities to improve water efficiency must therefore be explored. Policy making should be based on a clear water hierarchy. Additional water supply infrastructures should be considered as an option when other options have been exhausted, including effective water pricing policy and cost-effective alternatives. Water uses should also be prioritised: it is clear that public water supply should always be the overriding priority to ensure access to adequate water provision."

[8] Communication from the Commission to the European Parliament and the Council - Addressing the challenge of water scarcity and droughts in the European Union COM (2007)414.

[9] Commission Communication: Blueprint to Safeguard Europe's Water Resources COM (2012)673.

[10] COM(2007)414

As a result, it states:

- "In regions where all prevention measures have been implemented according to the water hierarchy (from water saving to water pricing policy and alternative solutions) and taking due account of the cost-benefit dimension, and where demand still exceeds water availability, additional water supply infrastructure can in some circumstances be identified as a possible other way of mitigating the impacts of severe drought."

In 2012 the WSD Policy was reviewed[11]: This found:

- "In some Member States, additional water supply infrastructures have been developed before exploring the full potential of water saving measures, thus in spite of the water hierarchy. The potential environmental impacts of new water supply infrastructure plans have not been systematically considered by Member States."
- "Wastewater re-use is included in 50%" [of RBMPs]
- "The analysis of water quantity aspects lacks adequate foundation in many RBMPs: quantity data are insufficient and water scarcity is often not clearly distinguished from droughts and vice versa."
- "The understanding of the causal relationships between drivers, pressures, states and impacts that would help identifying the most cost-effective measures for addressing WS&D is still not sufficient."

This demonstrates that there is a need better to consider water reuse as a measure within the context of the water hierarchy and that there is a major challenge for Member States to understand the issues affecting water scarcity and droughts leading to the choice of measures to help manage this.

The reuse of treated wastewater may be used for a wide variety of purposes. However, the appropriate use of treated wastewater depends upon its quality and, therefore, the treatment to which it has been subjected. This is significant in assessing and preventing risks and drawbacks of wastewater reuse for health and the environment[12]. The opportunities and/or limitations to the extent to which water reuse can be taken forward also depends on the availability of infrastructure for treatment and distribution of the water as well as costs and energy requirements. Wastewater reuse requires compliance with different related EU regulations (as will be outlined in chapter 5) and with national laws. International non-binding standards should be used as a reference to ensure water reuse that is safe for environment and health (see Chapter 7). Further, the reuse of treated wastewater may encounter resistance from the public, so its use requires adequate public engagement (see Chapter 8).

These guidelines begin by outlining how water reuse can contribute to WFD and other EU policy objectives. They then set out some definitions to aid the interpretation of this document. They go on to explore the potential environmental, economic and social benefits

[11] COM(2012)672

[12] Environment refers in this context especially to surface and groundwater bodies, soil, and related ecosystems.

and drawbacks of water reuse. The guidelines continue with a detailed examination of the requirements of EU law to ensure water reuse schemes are compliant with that law. Steps for the planning of water reuse are described and, in particular, how protection of public health is to be ensured. The guidelines end with sections on communication and engagement of the public and other stakeholders and on the funding of water reuse schemes.

Throughout these guidelines examples are provided of practical application of water reuse to illustrate particular points. It is important to note that these examples are sometimes pilot projects provided for information and based on input from several sources, but it is not possible to state whether they are, or are not, good practice and fully compliant with the WFD, GWD and other relevant EU law. In most cases it has not been possible to assess long-term impacts as the projects are recent. Moreover, the examples are not necessarily provided by the Member State concerned, but, in several cases, they are taken from the existing literature or illustrate the outputs of research and demonstration projects and pilot experiences.

It is important to stress at the outset that the contexts and the **necessity for the reuse of treated wastewater vary significantly across** the EU – both between and within Member States (and also within individual river basins). Therefore, there is no **'one size fits all' approach** which would be appropriate in the EU. Indeed, reuse is usually a local solution to a local problem. Rather, these guidelines set out the issues to consider and aspects of a planning process, so that appropriate policy makers, water authorities, etc., can consider if the reuse of treated waste water would be appropriate within their particular water management circumstances and, if so, in what way. They are designed to help Member States in improving such consideration in the implementation of the WFD.

The **intended audience** for these guidelines is policy makers, water resource planners, river basin managers and those in the water industry, irrigation associations, etc. The guidelines explore the policy and planning context of reuse of treated wastewater. They do not explore particular treatment standards or particular technologies for treatment, for which readers should refer to other information sources for such information (see Chapter 7). Also, while the guidelines strongly recognise the importance of engagement with the public, they are not themselves intended as a tool for such engagement.

The guidelines focus on the **reuse of collected wastewater that achieves, after treatment as necessary, a quality standard that is appropriate for its intended use**. Reuse of industrial wastewater is included in relation to planning as it is important to understand the potential for reuse by industry within water management planning. The reuse of rainwater and of greywater[13] (e.g. for domestic purposes such as toilet flushing) is not within the scope of the guidelines.

These guidelines are **intended to be used** in cases where water abstraction is determined as being a significant pressure for meeting the WFD objectives. In these cases further investigation is needed as to what are the most appropriate measures to be addressed.

[13] Greywater is domestic waste water from sinks, washing machines, etc., but not water from toilets.

These could be water saving measures as well as the use or re-infiltration of rainwater, etc. However as stated previously, these are not within the scope of this document.

These guidelines are a **product of the Common Implementation Strategy (CIS) of the WFD**. Following the publication of the Water Blueprint, which highlighted the importance of water reuse, the European Commission commissioned further research to explore options on the issue[14] and held a public consultation[15]. These guidelines were produced under the supervision of a drafting group of selected Member State and stakeholder experts and with wider consultation within the CIS.

1.2 How water reuse may contribute to meeting WFD and other EU policy objectives

The legal framework defined through the WFD aims to deliver good ecological status/ good ecological potential of surface waters and good status of groundwaters and prevent deterioration of status across Europe. It is important to note that the WFD (Recital 1) states that "water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such". In order to achieve its objectives, the WFD requires that surface and groundwaters achieve good status and a specific aspect of good status is the quantitative state of those water bodies. Surface water bodies which are over-abstracted, at low levels or with low flows, are unable to achieve the required biological quality and thus good ecological status. For groundwaters, the WFD has specific quantitative objectives. Over-abstraction of groundwater results in various problems, e.g. saltwater intrusion can lead to a failure to achieve good status. Where such problems occur, the WFD requires Member States to identify the pressures causing these problems and to adopt measures within RBMPs to tackle the pressures. Where abstraction of water is such a pressure, the use of alternative water sources to meet water demands of users is one type of measure which may be adopted and water reuse is a specific expression of such a measure. For example, Annex VI identifies supplementary measures to be used within RBMPs. Annex VI (x), states that these include 'efficiency and reuse measures'. Further, in some situations reuse may also contribute to achieving water quality objectives.

In order to support the achievement of WFD objectives in water-scarce areas, the Commission published its Communication on Water Scarcity and Droughts[16]. This made recommendations on the management and planning of water scarcity. It emphasised the importance of first seeking to reduce water demand and making water use more efficient. Following this, it advised the consideration of alternative water sources. Wastewater treated to a standard appropriate for its use is one such source.

While water reuse is a measure to be used to meeting WFD objectives, it is important that the assessment and planning processes of the WFD (and drought management planning consistent with this as promoted by the Communication on water scarcity and droughts) forms the framework within which water reuse schemes are considered. The WFD Art.5

[14] BIO (2015) Optimising water reuse in the EU. http://ec.europa.eu/environment/water/blueprint/pdf/BIO_IA%20on%20water%20reuse_Final%20Part%20I.pdf

[15] Background to, and results of, the public consultation are available here: http://ec.europa.eu/environment/consultations/water_reuse_en.htm

[16] COM(2007)414

analysis of pressures provides a coherent overview of all pressures on water bodies and how they affect water status. This, therefore, provides the core information on water use and demand. Based on these pressures and how they affect objectives, Programmes of Measures are developed. It is important to consider water reuse as a measure that could alleviate water scarcity in areas where over-abstraction is identified as a significant pressure. By addressing this pressure, water reuse can contribute to achieving WFD objectives. However, it is important to ensure that diversion of treated waste water for reuse does not lead to problems in the flows of water bodies to which the water would otherwise be discharged. It is also possible that diversion of discharges to reuse can alleviate contaminant pressure on some water bodies.

Alongside this assessment, the WFD requirements on issues like recovery of costs (Art. 9), such as through pricing, and public participation in water management decisions (Art. 14) are also important in taking forward water reuse schemes to help secure funding and ensure public acceptance (both of these issues are explored further later in these guidelines).

Finally, it is important to note that water reuse schemes need to ensure that they are fully consistent with the requirements of other EU water law – such as the Nitrates and Urban Waste Water Treatment Directives. The relevant legal requirements of these and other directives and their relationship to the water reuse are explored in Chapter 5 of these guidelines. Solving quantitative problems of the WFD should not lead, for example, to producing problems of water quality.

2 Definitions: what is water reuse[17]?

This chapter sets out definitions **only for those which are needed to ensure a common understanding of this document**. It is important to stress that the definitions set out here are included only for the purpose of these guidelines and not for any other purposes. It is important to note that other terms are used in the literature and these may be appropriate in those contexts. These guidelines do not attempt to provide a glossary of technical or legal terms used by other organisations, countries, etc.

Water reuse (in the scope of these guidelines) is the use of water which is generated from wastewater and that achieves, after treatment as necessary, a quality that is appropriate (taking account the health and environment risks and local and EU legislation) for its intended use.

Direct reuse refers to the introduction of treated wastewater via pipelines, storage tanks, and other necessary infrastructure directly from a water treatment plant to a distribution system. An example would be the distribution of treated wastewater to be used directly in agricultural irrigation.

Indirect reuse is the reuse of treated wastewater which is placed into a water body source such as a lake, river, or aquifer and then some of it retrieved for later use.

Urban waste water[18] means domestic waste water or the mixture of domestic waste water with industrial waste water and/or run-off rain water.

Recycling[19]: means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes.

Pollution[20] is the direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems, which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment.

Water scarcity[21] means that water demand exceeds the water resources exploitable under sustainable conditions.

A further distinction also needs to be made between **planned** and **unplanned** use of treated wastewater (or sometimes called intended and unintended use). Planned reuse refers to systems that are developed with the goal of supplying and using treated wastewater. **Unplanned** use refers to uncontrolled reuse of wastewater after discharge, for example

[17] The definitions here draw on those used by WHO (2006). Guidelines for the safe use of wastewater, excreta and greywater.
[18] Source: Directive 91/2781/EEC
[19] Source: slight modification of Directive 2008/98/EC.
[20] Source: Directive 2000/60/EC, Art. 2.34
[21] Source: COM(2007)414.

downstream users using water from a river that has received a discharge of wastewater upstream. **These guidelines only cover planned water reuse** (whether direct or indirect), although water managers should include unplanned use in water balance calculations.

It should be noted that the definition of planned reuse includes reference to treatment of the water appropriate to its intended use. There are different levels of treatment of wastewater. The Urban Waste Water Treatment Directive 91/271/EEC includes the following definitions concerning treatment levels (noting that these are definitions, not treatment levels appropriate for water reuse):

Primary treatment: means treatment of urban wastewater by a physical and/or chemical process involving settlement of suspended solids, or other processes in which the BOD_5 of the incoming wastewater is reduced by at least 20 % before discharge and the total suspended solids of the incoming wastewater are reduced by at least 50 %.

Secondary treatment: means treatment of urban wastewater by a process generally involving biological treatment with a secondary settlement or other process in which the requirements established in Table 1 of Annex I are respected [setting out objectives for BOD, COD and suspended solids].

The directive also sets further treatment requirements concerned with discharges to Sensitive Areas, where nutrient removal is required. This is often referred to as tertiary treatment. This may involve removal of nitrogen, phosphorus or both, depending on the situation. However, other directives such as the Bathing Water Directive may also require additional treatment, but in this case for the removal of pathogens. This is also sometimes referred to as tertiary treatment (as it is additional to secondary treatment). Therefore, 'tertiary treatment' as a term can cover a range of diverse additional treatment techniques, each designed to meet specific objectives. There are also other terms used, such as 'polished' or 'finished', which are used to refer to water treated to a very high quality. Irrespective of compliance with EU law, there is a high level of heterogeneity concerning the treatment levels within the EU; at least in Northern and Central Europe the majority of waste water receives further treatment[22], with some consideration to even extend treatment further, e.g. to reduce micro pollutants.

For the purpose of these guidelines, it is important to note that the definition of reused water refers to a level of treatment appropriate to its use without prejudice to the application of EU or national law. These guidelines do not, therefore, use terms such as 'tertiary treatment', 'polished' or 'finished' as they would not necessarily clarify the level of treatment appropriate to the particular use.

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[22] http://www.eea.europa.eu/data-and-maps/indicators/urban-waste-water-treatment/urban-waste-water-treatment-assessment-3 ("More than 70% of the population in Northern and Central Europe is connected to a wastewater treatment plant that implements tertiary treatment, substantially removing nutrients and organic matter. Wastewater generated by nearly half of the population in Southern and Eastern Europe receives tertiary treatment.")

3 Different potential sources and uses for reuse of treated wastewater

Treated wastewater may be (and is) used for a wide variety of purposes. These guidelines do not suggest any priority between the different possible purposes as this will depend on the particular needs within individual catchments as well as the practicalities of delivering treated wastewater to different possible users. As stated in Chapter 1, while there is a range of different potential sources of water for water reuse (including greywater), these guidelines focus on sources from urban wastewater treatment systems and industrial wastewater reused by those other than the industry generating that water. It should be noted that urban and industrial wastewater will have very different characters (e.g. organic content, pathogens, heavy metals, etc.) and this affects the treatment systems that are necessary to deliver water of a quality appropriate to the particular user. In some cases urban and industrial wastewater may be mixed and this will present further challenges for treatment (which is beyond the scope of this particular document).

There is continuing innovation in potential uses. These include:

- **Contributing to environmental objectives/making water available for future uses** such as aquatic ecosystem restoration or creation of new aquatic environments, stream augmentation, aquifer recharge (e.g. for saline intrusion control or later abstraction for use such as the further uses below).
- **Agricultural/horticulture uses** such as irrigation of crops (food and non-food), orchards and pastures or aquaculture including algal farming.
- **Industrial uses** such as cooling water, process water, aggregate washing, concrete making, soil compaction, dust control.
- **Municipal/landscape uses** such as irrigation of public parks, recreational and sporting facilities, private gardens, road sides, street cleaning, fire protection systems, vehicle washing, toilet flushing, dust control.

It is important to note that new uses might be identified in the future and some sources of treated wastewater might be used for more than one purpose. By considering different uses of treated wastewater, countries are able to reuse significant levels of water (see Box 2).

Box 2 Overview of water reuse in Spain

In Spain[23], about 11% of the total volume of treated wastewater is reused for different uses (this figure varies across the basins). In particular, in the Mediterranean basins, where water is scarcer and there are higher pressures on water resources, this percentage rises up to 24% (Júcar RBD) and to 50-60% (Segura and the Balearic Islands). Irrigation uses about 64% of the total reused water, followed by recreational uses (mainly for golf courses) and then environmental uses.

[23] Source: Spanish Ministry of Agriculture, Food and Environment. Cited in BIO by Deloitte (2015) Optimising water reuse in the EU – Final report prepared for the European Commission (DG ENV), Part I. In collaboration with ICF and Cranfield University.

Overall, water reuse can be for any desired purpose, subject to the following conditions or constraints:

- The quality of the water is fit for the particular purpose, ensuring protection of users and the environment.
- There is sufficient quantity available and it can be delivered (e.g. there is an available distribution system or investment can be made to ensure its delivery).
- The costs (treatment and distribution) of providing the water are acceptable, sustainable and competitive with other available sources, including with possible public support (e.g. financing is covered in Chapter 9).
- The particular use is acceptable to the public and other stakeholders.
- The responsibilities and the liabilities between parties (e.g. farmers, WWTP operator, water distribution systems manager) are defined.
- There is a clear demarcation between reused water distribution systems and drinking water systems so that the two networks do not become inadvertently connected resulting in potential risks to public health.

Determining which uses can and should be provided with treated wastewater is a critical step in the planning process (Chapter 6 of these guidelines).

3.1 Contribute to environmental objectives/make water available for future uses

Treated wastewater can be used to restore and enhance natural habitats such as wetlands or marshes, or maintain flows of small water bodies, which may contribute to maintaining or enhancing biodiversity (see Box 3 for examples). Creation of these types of habitats, for environmental and recreational purposes, can also be supported by water reuse. In coastal areas, water reuse to restore and enhance coastal lagoons and wetlands may be a good alternative to effluent discharge to the sea.

Where treated wastewater is used to contribute to environmental objectives, the priority environmental objectives should be those required by EU law (e.g. objectives of the WFD and/or habitat enhancement under the Habitats Directive).

Water reuse for environmental purposes includes **recharging aquifers**. This technique can also be used to store treated wastewater in the winter months, in order to better address the demand during the summer. Aquifer recharge offers advantages (combating saline intrusion, negligible evaporation, little secondary contamination by animals, no algal blooms and limited pipeline construction) **it may be an alternative to conventional surface water storage**. However, the practice of groundwater recharge may raise concerns depending on the quality of the water entering the groundwater and on the receiving water quality, hydrology and geology. There are strict requirements for the protection of groundwater quality and this is explored in Chapter 5 of these guidelines which describes, inter alia, how to ensure reuse of treated wastewater (including for aquifer recharge) is compliant with the Groundwater Directive 2006/118/EC.

Box 3 Examples of water reuse for environmental objectives/make water available for future uses

In Catalonia, water resources in the *Aiguamolls de l'Empordà* nature reserve (Empuriabrava) are limited, so a reclamation scheme was developed to restore the manmade Cortalet lagoon and recover the area's former wet meadows[24]. The project was based on a constructed wetland system for restoring and/or recreating aquatic ecosystems.

A similar project was carried out in Apulia (Southern Italy), where a large artificial wetland was established and supplied with the effluent of the wastewater treatment plant of Melendugno (Lecce) for environmental restoration and groundwater recharge[25].

An example of aquifer recharge can be found in Cyprus, where treated water recharges the Ezousas aquifer through specially constructed shallow ponds[26]. This water, after natural purification, is pumped again from the aquifer for irrigation. Pumping is carried out strategically so that retention time in the aquifer is maximised.

The Demoware[27] (Demonstration of Water Reuse) FP7 project is testing aquifer recharge to support indirect use for drinking water in El Port de la Selva, Costa Brava, Spain. The main objective is to evaluate if the treatment plant (WWTP regeneration plus infiltration and retention in the aquifer) can generate quality water for municipal supply, as a strategy to increase the volume and the guarantee of available resources in times of low rainfall.

3.2 Agricultural/horticultural uses

Agriculture is the main water user in many Member States, particularly in the south, accounting for around 33 % of total water use[28]. However, this proportion is much higher in certain regions – for example, in parts of Southern Europe (e.g. Spain and Italy), it accounts for up to 80% of all freshwater abstractions, with food crop irrigation being the dominant use. In many parts of Europe irrigation is an essential component of production. Most water used in agriculture for irrigation is abstracted from surface or groundwater and used directly with some on-farm storage (reservoirs), such as in water-scarce Mediterranean areas where large reservoirs are often used to accumulate surface and rainwater for use in drier seasons. Reuse of treated wastewater can be an important reliable source for irrigation for small to medium agricultural areas as flows can be largely guaranteed. For example, in the region of Murcia, Spain, more than 100 Mm^3/yr are reused for agriculture and in Italy, in the rural

[24] Sala, L. (2011) Integration of Water Reuse in the Management of Water Resources in Costa Brava (Presentation at the Hydrogaïa Event, Montpellier).

[25] Semeraro T., Giannuzzi C., Beccarisi L., Aretano R., De Marco A., Pasimeni M.R., Zurlini G., Petrosillo I. (2015) A constructed treatment wetland as an opportunity to enhance biodiversity and ecosystem services. Ecological Engineering, 82, 517-526.

[26] Antoniou, A. Artificial Recharge of Tertiary Treated Sewage to the Ezousas Aquifer in Cyprus. http://nwrm.eu/sites/default/files/regional-workshops/Med/S%204/WG2/NWRMMed_Antoniou.pdf

[27] http://ccbgi.org/demoware. The project is led by Kompetenzzentrum Wasser Berlin and involves Veolia Water Systems Iberica SLU, Amphos 21 Consulting SL, the city council of Port de la Selva, Costa Brava Consortium and joint venture Aguas de la Costa Brava, SA.

[28] EEA (2012) Towards efficient use of water resources in Europe (No 1/2012)

area surrounding the city of Milan, there is an extensive and consolidated use of high quality treated wastewater for agricultural irrigation[29].

It is also important to note that there can be strong links between the agriculture sector and the food processing sector with regard to water reuse. The wastewater, e.g. from vegetable washing, from the food industry can be treated and reused for irrigation (see Box 4).

Box 4 Examining the feasibility of water reuse for irrigation of food crops.

The EU project Demoware[30] project examined the feasibility of food-crops irrigation with the treated effluent from a vegetable transformation and canning factory (agri-food) at a demonstration site in Southern Italy (Capitanata). The wastewater produced in the different industrial processes of washing, steaming, cooking, etc. was treated with conventional activated sludge and tertiary membrane filtration. The produced effluent was used for crop irrigation after storage in closed tanks and on-demand UV disinfection (i.e. in line with the irrigation pumps), in order to counteract possible microbial regrowth.

In several regions, agricultural activity can be at some distance from wastewater sources, presenting problems for its use as the water needs to be transported to the user. Further, agriculture may be seasonal in its need for water, so this presents challenges for storage of water treated for reuse. It is also important to note that reuse of treated wastewater for agriculture is not just an issue for consideration in the Mediterranean. Box 5, Box 6 and Box 7 summarise examples of small scale reuse for agriculture in Italy, a project in the Netherlands which illustrates the interest for water reuse in horticulture and reuse symbiosis by horticulture and agriculture in Portugal.

Box 5 Example of small scale water reuse for agriculture in Italy

In Ferrandina, Southern Italy, municipal waste water (from about 9,500 inhabitants) is treated allowing for the retention of nitrogen as a fertiliser[31]. This has reduced the economic cost of treatment due to the disposal of biological sludge as end-product of standard treatment processes. The treated wastewater is then conveyed through a dedicated pipeline to a nearby olive orchard and supplied by drip irrigation. The distribution of the water is efficient as the olive groves are downhill of the treatment plant, so that gravity is sufficient to move the water. Water reuse is combined with changes to soil management and this has led to improvements in farmers' incomes.

Box 6 Example of water reuse for horticulture in the Netherlands[32]

The Dutch Water Authority 'Schieland en de Krimpenerwaard', together with 'Aqua-Terra Nova' and 'PB Techniek', has successfully operated the innovative AquaReUse facility since 2014. AquaReUse is a water treatment and buffering complex where all horticulture

[29] Mazzini, R. Pedrazzi, L. and Lazarova, V. (2013). Milestones in water reuse - The best success stories (Chapter 15). Eds. V. Lazarova, T. Asano, A. Bahri, and J. Anderson. IWA Publishing

[30] http://www.demoware.eu

[31] Dichio B., Palese AM, Montanaro G., Xylogiannis E., Sofo A., 2014. A Preliminary Assessment of Water Footprint Components in a Mediterranean Olive Grove. Acta Horticulturae, 1038: 671-676

[32] For more information on AquaReUse: www.aquaterranova.nl

wastewater is collected in one central location in a made-to-measure facility. In this facility all the waste and surface water is treated to provide irrigation water, which meets all relevant quality requirements of the horticulture farmers and their clients. This facility enables reuse of wastewater and produces good quality irrigation water for vegetable crops and floricultures. The purified fresh water, on average approximately 123,000 m^3 per year, is made available via a distribution system to the greenhouses (maximum flow rate of 52 m^3/h). Where the purified water cannot be delivered directly, the surplus is injected into the ground to be used as a reserve.

Box 7 Example of agricultural/horticultural symbioses

In Algarve[33], Southern Portugal, several small red fruit hydroponic productions are being developed, usually 1 to 2 ha greenhouses. From the irrigation process, near 300 to 400 m^3 per year of drained water is produced (from which 100 to 200 m^3 is produced in the dry season). These waters are rich in nutrients and, therefore, are combined with other water sources (surface water or groundwater) to irrigate other cultures in the surrounding areas, such as citrus fruit trees, pomegranate trees or hedges. With this symbiosis, nearly 15% of the total irrigation needs, in July, are met by the water reuse. The consumption of chemical fertilizers is also reduced (≈10-12% in P and N).

Water reuse may provide a potential nutrient source for crops. Treated wastewater from urban wastewater treatment plants, for example, will contain nitrogen and phosphorus, among other nutrients in varying amounts depending on the level of treatment. Thus in some cases water reuse could reduce the need for supplemental applications of mineral fertiliser. This was recently demonstrated within the EU project Water4Crops[34] and the Italian national project In.Te.R.R.A.[35] However, this would depend on the particular nutrient needs of a crop (which would also vary across the season) and use of water containing nutrients would also need to take account of soil type and sensitivity of local water bodies (see also Chapter 5, which sets out the need to ensure compliance with the Nitrates Directive). The nutrients contained in the treated waste water should be considered when assessing further fertilising requirements. Supply of reused water containing nutrients would have to ensure that the amount of nutrients is not harmful for the environment and that the water does not contain any other pollutants that put human health and the environment at risk (see Chapter 7).

The social and environmental acceptability of reusing treated wastewater directly for irrigation in agriculture varies significantly between individual Member States. Social acceptance may also differ depending on the crop purpose and how crops are consumed. Such concerns can be addressed through the use of adequate treatment regime and communication and stakeholder involvement in water reuse projects and ensuring reuse schemes are safe for the environment and health. This is explored further in Chapter 8.

[33] Source: Portuguese Environment Agency (APA-ARH Algarve, water reuse permits processes)
[34] www.water4crops.org
[35] Vergine P., Lonigro A., Salerno C., Rubino P., Berardi G., Pollice A. (2016) Nutrient recovery and crop yield enhancement in irrigation with reclaimed wastewater: a case study. *Urban Water Journal*, http://dx.doi.org/10.1080/1573062X.2016.1141224

3.3 Industrial uses

As noted in Chapter 1, it is important to recognise the value of industrial reuse in the wider water management context. Industry may reuse its own treated wastewater or that from another industry. It may also reuse treated wastewater from an urban WWTP. The role of water reuse in delivering water efficiency objectives of the Industrial Emissions Directive will be important in some cases, but is outside the scope of these guidelines (as are any quality criteria for use by industry). Industry may also supply wastewater for use in other sectors (such as agriculture – see Chapter 3.2). Examples are provided in Box 8. It is also important to note that water reuse by industry may be part of wider recycling of resources between industrial and other users in systems known as 'industrial symbiosis' and Box 9 provides an example from Denmark which demonstrates how water reuse within such a context can provide significant savings to water abstracted from natural water bodies.

Industrial water from treated wastewater replaces the use of drinking water or the abstraction of ground or surface water by the industry itself and, therefore, can be part of a water scarcity plan. Industrial water from treated wastewater may also reduce the discharge of treated wastewater into the environment, thereby limiting the introduction of those pollutants, including emerging substances, which are not removed from the wastewater by primary and secondary treatment. Therefore it is important to ensure that these wastewater flows are not emitted to the environment while being reused.

In an industrial context, water use can result in it being part of the product (e.g. in food) and water use is an important element of the processing of materials that result in a product. Uses of appropriately treated wastewater in industry include cleaning, cooling and boiler feed. Despite industrial processes often being complex and quality critical, extensive progress on water reuse in industry has been realised in many industries in recent decades, typically driven by the "Cleaner Production" imperative and the increasing cost of delivered water and of developing new supplies. The degree of water reuse in industry differs significantly across industrial sectors and is strongly dependent on both the nature of the industrial process and local circumstances as well as the proximity of the industry to the water supply.

It is important to note that industrial water reuse is highly determined by the exact quality needs of the individual industrial process and/or product as well as the costs of producing water of the required quality compared to other suitable sources. Industrial water reuse schemes should take into account the overall ecological and economic benefit of different reuse options including those that do not focus on the water itself, but for instance the heat it carries, e.g. in district heating schemes. As a result, while these guidelines emphasise the important role of water reuse by industry within a wider environmental management context, they do not attempt to provide further guidelines on appropriate decision making for this sector.

Box 8 Examples of industrial reuse of treated wastewater

The Tarragona site[36] in the south of Catalonia, Spain, utilises secondary effluent from two municipal wastewater plants, treating it for industrial users. The Tarragona area is highly water stressed and water availability hinders further growth in the region. Water reuse in an industrial park (a petrochemical complex) will free up existing raw water rights to meet future local (municipal and tourism) demand. The final target is to meet 90% of the water demand of the industrial park from water reuse.

Terneuzen[37] is situated in the southwest of the Netherlands. The industrial site of Dow Terneuzen originally planned to use desalinated seawater as a source, but the increasing cost of this proved to be problematic due to quality problems, corrosion, etc. As a result, the nearby municipal WWTP was re-engineered to provide reused water to the industrial complex (10,000 m^3/d). The water is used to generate steam and feed its manufacturing plants. After the steam is used in the production processes, the water is again used in cooling towers until it finally evaporates into the atmosphere (so it is reused a second time). Compared with the energy cost needed for conventional desalination of seawater for the same use, Dow Terneuzen has reduced its energy use by 95 percent by reusing the urban wastewater – the equivalent of reducing its carbon dioxide emissions by 60,000 tonnes each year. Dow is now using this experience gained in Europe at its site in Freeport, Texas, USA.

The LIFE WIRE project is a LIFE12 project being implemented in Barcelona, Spain, that aims to boost industrial reuse of treated wastewater by demonstrating the feasibility of water reuse through the use of satellite treatments able to produce fit-for-use water quality. The project studies the feasibility of technology configurations based on the combination of ultrafiltration, carbon nanostructured material filtration and reverse osmosis to reuse treated urban wastewater in industries. The project technically and economically assesses the benefits of using the proposed treatment scheme over the current conventional treatments in three industrial sectors: electrocoating, chemical and liquid-waste disposal.

Box 9 Kalundborg Symbiosis in Denmark[38]

The Kalundborg Symbiosis is an "industrial ecosystem", where the by-products of one enterprise are used as a resource by other enterprises, in a closed cycle. Kalundborg Symbiosis has developed gradually over several decades, from initiatives of businesses, but with support from the Kalundborg Municipality. The symbiosis involves exchange of all sorts of materials, including water. So, for example, the Asnaes Power Station receives 700,000 m^3 of cooling water from Statoil each year, which it treats to use as boiler feed water. It also uses about 200,000 m^3 of Statoil's treated wastewater for cleaning each year. The cooling water becomes steam which is provided back to Statoil, as well as to other business, such as

[36] See: http://demoware.eu/en/demo-sites/tarragona

[37] See: http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_08d9/0901b803808d92c4.pdf?filepath=liquidseps/pdfs/noreg/609-50111.pdf&fromPage=GetDoc

[38] See: http://www.symbiosis.dk/en

a local fish farm. The savings to local water resources are considerable –nearly 3 million m^3 of groundwater and 1 million m^3 of surface water per year[39].

3.4 Municipal/landscape uses

Water reuse in urban environments is considered to be a component of municipal and landscape water security strategies. Uses of appropriately treated wastewater include irrigation of parks and other urban green spaces, recreational uses such as golf courses, use in fire-fighting, road washing, etc. (see example in Box 10). Reused water, therefore, can in some cases replace the use of drinking water supplies which are often used for these uses. The particular needs vary between different municipal areas and, therefore, the most appropriate uses should be determined on a case by case basis. It is important to note that as well as water quality with regard to contaminant/pathogen levels, reused water in municipal situations also needs to avoid offensive odours.

Due to the potential interaction with the general public, these types of reuse may require special attention in all aspects of communication, awareness and participation, as well as effective water quality monitoring and control. Public and stakeholder communication is explored further in Chapter 8 of these guidelines.

Box 10 Example of reuse of treated waste water for municipal use in Spain

Tres Cantos is a "satellite city" of Madrid, with around 40,000 inhabitants. As it has expanded, the construction of WWTPs has included the provision to treat water for reuse[40]. Currently, the WWTP has a treatment capacity of 37,000 m3 per day. The advanced treatment for reuse supplies 3,000 m^3 per day for the municipal area, where it is used for irrigation of green spaces such as parks. Previously, water from the drinking water supply was used for this purpose.

Box 11 Example of reuse of treated wastewater for indirect drinking water use after retention in an aquifer

The Torreele[41] water plant in Koksijde is on the Belgian North Sea coast. Since 2002 it has treated municipal wastewater from the Wulpen WWTP, which is used for artificial recharge of the dune aquifer of St-André, which is then abstracted for further treatment for drinking water use. Over several years, the groundwater level has lowered and this has led to saline intrusion. The artificial recharge was implemented to prevent this. The plant has a treatment capacity of 6,850 m^3/d and applies a double membrane process: ultrafiltration and reverse osmosis.

[39] Domenech, T. & Davies M. (2011). "Structure and morphology of industrial symbiosis networks: The case of Kalundborg". Procedia Social and Behavioral Sciences 10: 79–89.

[40] http://www.iagua.es/noticias/reutilizacion/14/07/11/tres-cantos-ya-riega-los-parques-de-la-ciudad-con-agua-reciclada-51951

[41] Van Houtte, E., Verbauwhede, J (2013) Torreele: Indirect potable water reuse through dune aquifer recharge. In Lazarova, V., Asano, T., Bahri, A. and Anderson, J. (Eds.) Mi-lestones in Water Reuse – The best success stories. IWA Publishing London, chapter 26, 315-322 and van Houtte, E., Cauwenberghs, J., Weemaes, M., Thoeye, C. (2012) Indirect potable reuse via managed aquifer recharge in the Torreele/St. André project. Chapter 3 in „Water Reclamation Technologies for Safe Managed Aquifer Recharge (Eds.: Christian Kazner, Thomas Wintgens, Peter Dillon), IWA Publishing. 33-4

4 The benefits and risks of reusing treated wastewater

4.1 Introduction

In considering the introduction of a water reuse scheme, it is important to examine the full range of benefits and drawbacks/risks that might result. This chapter summarises the environmental, economic and social benefits that can result from properly designed reuse schemes and the possible drawbacks and risks from its use.

It is important to stress that any scheme must be consistent with achieving objectives set by EU environmental law (see Chapter 5). Further, a preliminary assessment of a scheme, including risk assessment, will help to identify the potential benefits and any potential drawbacks and so help make better decisions on whether to introduce that scheme and, if so, help improve its design (Chapter 6 explores the steps in planning). It is also important to note that many benefits and risks will be specific to local circumstances and, therefore, need to be determined on a case by case basis.

4.2 The environmental benefits of the reuse of treated wastewater

The principle reason for water reuse in Europe is that it is an alternative water source in water-scarce areas and, for this reason, it is already used in several Member States. It, therefore, benefits water users in these areas by providing reliability of water supply. Water reuse may be an effective way of helping to manage some water scarcity issues in the EU. In certain situations, it may also have a lower environmental impact than other alternative water supplies such as water transfers or desalination. Also a large number of wastewater treatment plants in coastal areas of water-scarce regions discharge their effluents to the sea and this implies wastage of limited freshwater resources. Climate change will substantially increase the severity and length of droughts in Europe by the end of the century[42]. Demand for water is likely to exceed available amounts across many river basins throughout Europe. Southern Europe would be most affected by drought, with flow levels of rivers and streams in the Iberian Peninsula, south of France, Italy and the Balkan region reduced by almost 40% due to climate change alone. Water reuse can, therefore, aid in building resilience to climate change for communities and individual users.

Water reuse is first a local solution to a local problem. However, the contribution it can make to addressing water stress needs to be analysed at a national, regional or river basin scale. In summary the possible environmental benefits of a water reuse scheme include:

- Water reuse allows for the conservation of freshwater resources, particularly in areas under water stress, allowing adaptation to future changes in demand and availability in the long term, such as from climate change and population changes.
- Water reuse reduces unplanned reuse and associated health and environmental risks.
- Water reuse can contribute to the reduction in greenhouse gas emissions when using less energy for adequate wastewater treatment and management as compared to importing water, pumping deep groundwater, seawater desalination or

[42] Forzieri G., Feyen L., Rojas R. et al. (2014) Ensemble projections of future streamflow droughts in Europe. Hydrology and Earth System Sciences, 18(1), 85-108.

exporting wastewater, depending on the level of treatment, the source of energy that is used and energy requirements for the conveyance of the water (see the Terneuzen case provided in Box 8).

- Water reuse can in some cases result in net sanitary benefits compared to discharge of treated water to rivers.
- Water reuse can, in some cases, reduce the need for chemical fertilizers providing nutrients for irrigated crops.
- Where water treatment and reuse is optimized to enhance the recycling of nutrients, the energy usage may be lower, although this might be offset by energy use in conveyancing the water as well as higher levels of treatment for removal of contaminants to meet standards for specific water uses.
- Water reuse can be used to enhance the environment through the augmentation of natural/artificial streams, fountains, and ponds by helping to meet quantitative objectives of surface water bodies. The restoration of streams, wetland, and ponds with reused water has contributed to the revival of aquatic life, and created urban spaces and scenery (see example in Box 10). The recovery of water channels can create 'ecological corridors' in urban areas and green belts to control soil erosion by wind in arid regions.
- Appropriately treated wastewater use can be used to recharge aquifers and contribute to the achievement of good quantitative status and avoid deterioration in status of groundwaters, if it can be ensured that the chemical status is not adversely affected. Compared to conventional surface water storage, aquifer recharge has many advantages, such as negligible evaporation, little secondary contamination by animals, and no algal blooming. Recharge of aquifers can also be used to protect groundwater from saline intrusion by barrier formation in coastal regions, and controls or prevents land subsidence.

4.3 Economic benefits of reuse of treated wastewater

It is important to recognise that treated wastewater is a resource, that resource has a value and this value will reflect the price placed upon the resource. Therefore, capturing that resource (i.e. avoiding its loss and adding value by the correct treatment) can deliver economic benefits. As an economic good, appropriately treated wastewater has value to those producing it and to those consuming it. Appreciating this could help in delivering an economically sound management of wastewater collection and treatment services, with consequent advantages in terms of effectiveness and profitability of the whole value chain.

There is a range of potential economic benefits from water reuse (see Box 12 for examples). Economic sectors that are highly dependent on water supply (availability and quality), such as **agriculture**, **food industry** and **tourism and recreational industry** could increase their water supply security with water reuse (depending on the hydrological demands in a basin), decreasing their vulnerability to water scarcity and droughts as well as their vulnerability to longer-term climatic change. This could deliver economic benefits to the businesses concerned. The supply to users of treated wastewater is limited, but is predictable. It, therefore, enables users to plan their business activities. This is not only apparent in high risk areas in southern Europe, but also a driver for supply of reused water to industrial users in Member States not subject to significant water stress, e.g. the energy sector in eastern

England[43] and the food industry in Denmark. Collection, treatment and use in local and decentralised systems can also provide local economic opportunities that did not exit previously. It is important to note that whether there are individual benefits or not (and the scale of any potential benefits), will depend on the particular river basin, individual user and supply of reused water.

Within the **agricultural sector**, although water required for agricultural production has generally declined in most Member States following the reform of the Common Agricultural Policy and adoption of more efficient irrigation methods, recent years have seen an increase in irrigation demand in many southern and eastern Member States[44]. Under a scenario of increasing scarcity, such as due to climate change, as well as regulatory changes under the WFD, the costs of securing freshwater supplies are likely to increase for agricultural businesses. Therefore, alternative sources such as treated wastewater represent an economic opportunity. This is one of the most important economic benefits of water reuse for the agriculture sector, because treated wastewater supplies are reliable, even during some droughts. Therefore, risks to crop production losses can be reduced and the economic standing of individual farms is secured. It is important to note that in non-water-scarce areas water reuse can also be beneficial, for example in greenhouses. Where reused water supplies nutrients, farmers can also benefit financially from lower costs for fertilisers. This water is likely to contain pollutants, so that a thorough assessment is needed. However, water that does not contain a good mineralogical balance may have drawbacks for some types of agricultural production.

The **tourism and recreation sector** may also benefit from water reuse. In some cases, such as golf courses, water reuse may maintain a key tourism asset. In other cases, the 'greener image' associated with water reuse is becoming important. For example, water reuse is a way to counterbalance the environmentally controversial development of golf courses in water-scarce areas[45]. Many tourism operators in water-scarce island areas (for example, many Greek islands and Cyprus) make use of treated wastewater for landscape irrigation.

The **EU water economic sector** could benefit economically with expansion of water reuse, because of business opportunities in this area, with water reuse technologies representing a significant topic for further innovation and there is a growing worldwide market for such technologies (see Chapter 4.4).

Industrial water users are also major users of water for various processes such as process water, cooling, boiler feed and plant wash-down as well as for washrooms and other sanitary uses. Major users of water and producers of wastewater include the chemical sector, paper and pulp production sector, beverage sector, textile sector and aggregates sector. Users may also benefit if water reuse provides water of a guaranteed quality.

Water utilities, through the cost of water supply, wastewater treatment and implementation of the Programmes of Measures under the WFD could take advantage of water reuse opportunities with associated cost savings, e.g. by optimizing nutrient removal

[43] http://www.waternunc.com/gb/angliw08.htm (accessed 18.01.2016)

[44] Arcadis (2012). The role of water pricing and water allocation in agriculture in delivering sustainable water use in Europe (http://www.enorasis.eu/uploads/files/Water%20Governance/role_water_pricin.pdf)

[45] Salgot M and Priestley G K and Folch M (2012). Golf Course Irrigation with Reclaimed Water in the Mediterranean: A Risk Management Matter. Water 2012, 4, 389-429.

processes in urban WWTPs (when such nutrients can be recycled through agricultural irrigation as long as this is compatible with health, water and soil protection requirements). It should be noted that the nature of any savings for utilities will depend heavily on the particular charging, taxation, etc., systems for sewage collection and treatment in each country.

As a means to reduce water scarcity and mitigate effects of droughts, water reuse solutions contribute to reducing the associated costs of damages, reducing the constraints on economic development due to water shortages and the economic consequences of uncertainty about water availability – a potential obstacle to investment decisions. In the absence of policy intervention, these costs can be expected to increase substantially in some regions. Water reuse solutions can also avoid the need for investment in other water supply projects (such as desalination). Box 13 summarises the overall economic impacts of drought in the EU. Reuse of treated wastewater cannot overcome all of these economic impacts, but it can help to reduce them in individual catchments and locations.

While there are economic benefits from water reuse, the precise economic context needs to be considered in each case where water reuse projects are considered. Key economic issues to take into account include:

- **Cost of treated wastewater and cost of reuse solutions**: water reuse schemes remain relatively underdeveloped in the EU owing to a lack of economic attractiveness and perceived low returns on investment. Decisions to invest in such schemes also reflect costs comparisons with other water sources (including costs of abstraction from natural water bodies). Many existing schemes have benefited from direct or indirect subsidy to support both supply and demand, but this may be at odds with the need for cost recovery and financial sustainability in the water sector, although it has to be noted that the cost of conventional water resources is often subsidised or kept low (e.g. for irrigation). Costs of the schemes include ensuring the necessary treatment (for both the user and any subsequent impact on the environment) and the delivery of the treated water to the user. Adequate pricing of fresh water that takes into account, for example, the ecological cost of over-abstraction is an important factor in establishing price equality between fresh and treated wastewater.

- **Financing of reuse projects**: where there are funds available to support treatment works, water distribution systems and some uses, such as irrigation systems (such as EU funds as explored in Chapter 9), these need to be considered in the economic case for reuse in each individual situation.

- **Marginal cost pricing** systems can reduce excessive water use and pollution as well as ensure the sustainability of wastewater treatment programmes. Adequate pricing schemes create incentives to reduce water demand and encourage water reuse schemes. The issue of pricing is considered further in Chapter 9.

  The capital and operational costs of switching from a freshwater water source to a treated wastewater source of water need to be understood and local opportunities to minimise costs and/or boost benefits should be explored and maximised (e.g.

through using a cost-benefit analysis). Furthermore, costs arise where there is a need to switch between different sources, such as due to seasonal variations in use.

- **Impact on land value: water reuse for irrigation** may also influence land property values positively. Positive impacts are reported for arid and semi-arid regions, where urban irrigation is a key factor for landscape greening, erosion and dust control and environmental protection.

- **Long-term economic viability** also represents an important condition in implementing water reuse. Reused water is often priced just below the consumer cost of drinking water to make it more attractive to potential users, but this may also affect the ability to recover costs[46]. Distortion in the market for water supply complicates the pricing of treated wastewater, as does the lack of accounting for externalities, including water scarcity and social, financial, and environmental burdens of effluent disposal in the environment. Long term economic viability of water reuse should be evaluated at the macro-scale, taking into account all non-monetary benefits for sustainable development and integrated water resource management.

Box 12 Examples of the economic benefits of reuse of treated wastewater

Spain's experience in the implementation of the WFD shows that using water reuse as a measure can lower the overall implementation cost of Programme of Measures[47], as it can contribute to achieving good status of water bodies, by reducing point source pollution, promoting the natural recovery of streams and aquifers, preserving the highest quality freshwater for the most sensitive uses, and avoiding conflicts related to water use rights. The reduction of implementation costs has mainly benefited the competent authorities in charge of the implementation of the RBMP.

In Western Australia, water reuse concerned with a co-generation power plant in a highly water stressed area is estimated to deliver $AUS 1.67 million/year in social and economic shared benefits (74% of which benefit the local community of Perth) and for the cogeneration plant it is estimated to save $AUS 2.4 million[48].

Box 13 The economic impacts of drought in the EU

The overall impacts on the economy due to the 2003 drought have been estimated at a minimum of €8.7 billion (mainly concerning Mediterranean countries and the UK), measured as the estimated losses directly resulting from the drought[49]. Direct effects of droughts, such as damage to agriculture and infrastructure, are more obvious, but indirect effects, such as a reluctance to invest in an at-risk area, can also have a serious economic

[46] Jimenez B. and Asano T. (2007). Water Reuse: An International Survey of Current Practice, Issues and Needs (Scientific and Technical Report No. 20). IWA Publishing.
[47] Source: Spanish Ministry of Agriculture, Food and Environment (quoted in Bio (2015))
[48] http://programme.worldwaterweek.org/sites/default/files/engie_20150716-www.pdf
[49] European Commission (EC) (2007). Impact Assessment of the Communication 'Addressing the challenge of water scarcity and droughts in the European Union' (SEC(2007) 993).

impact. A 1% increase in the area of the country affected by drought can slow a country's gross domestic product (GDP) growth by 2.7% per year[50]. Further examples of economic impacts of drought in Europe have been provided by the EEA[51], but not a later overall figure for the EU as a whole.

In Catalonia, Spain, a simulation of the macroeconomic impact of water restrictions to the Catalan economy for 2001 showed that restrictions on non-priority water uses following a drought warning would have led to a loss of gross added-value of about €1.196bn (0.97% of Catalonia's GDP), while extended restrictions in the case of an extreme drought would have caused a loss of €8.079bn, representing 6.52% of the GDP[52].

4.4 Increased business competitiveness through stimulating innovation

A greater emphasis on water reuse is also likely to lead to increased innovation in the development of technologies and techniques for water reuse, thus providing business opportunities for the water industry sector, as well as other relevant businesses such as the agriculture and horticulture sectors. Such technologies include not only new treatment technologies, but those for distribution, monitoring of water quality, etc. Technology providers in this sector range from SMEs to world leaders. Innovation would also likely lead to the development of technologies to reuse water at lower costs. The stimulation of new technologies is encouraged by initiatives such as the European Innovation Partnership on Water (see Box 14).

Water reuse is a growing issue across many parts of the world. Therefore, European businesses offering innovative, cost-effective and more efficient technologies may gain a competitive advantage. There is a rapidly growing world water market, which is estimated to be as large as €1 trillion by 2020. By seizing new and significant market opportunities, Europe can increasingly become a global market leader in water-related innovation and technology[53] and developing technologies further will increase the attractiveness of European industry to global markets. The stimulation of innovation within the European water industry sector on this issue would also contribute to the wider objective of increasing the competitiveness of European industry – an objective of the Europe 2020 Strategy.

[50] Brown, C., Meeks, R., Ghile, Y. et al. (2013). Is water security necessary? An empirical analysis of the effects of climate hazards on national-level economic growth. Philosophical Transactions of the Royal Society A. 371: 20120416. DOI:10.1098/rsta.2012.0416

[51] EEA (2012). Vulnerability to Water Scarcity and Drought in Europe ETC/ICM Technical Report 3/2012. http://icm.eionet.europa.eu/ETC_Reports/VulnerabilityToWaterScarcityAndDroughtInEurope

[52] Gonzalez, J. and Ventosa, I. (2009). Consum d'aigua i anàlisi input-output: simulació de l'impacte macroeconòmic de restriccions sectorials en l'abastament d'aigua. Nota d'economia 93-94. 1r i 2n quadrimestres 2009 (http://economia.gencat.cat/web/.content/documents/articles/arxius/consumd_aiguaianalisiinput-outputsimulaciodel_impactemacroeconomicderestricc.pdf)

[53] European Commission (EC) (2012). Impact Assessment of the Communication: 'A Blueprint to Safeguard Europe's Water Resources' (SWD(2012) 382 final).

According to Global Water Intelligence[54], the global market for water reuse is on the verge of major expansion and, going forward is expected to outpace desalination. Between 2009 and 2016 capital expenditure on advanced water re-use was expected to have grown at a compound annual rate of 19.5% as the global installed capacity of high quality water re-use plants grows from 28 Mm^3/d to 79 Mm^3/d.

The WssTP has also identified a major eco-innovation potential in terms of technologies and services around water recycling in industry, agriculture and urban water systems[55]. Water reuse practice for agriculture and industry is one of the fastest growing applications internationally.

Given the importance of the water industry sector in the EU, the past and current spread of water reuse technologies in the EU and worldwide has been a driver for the competitiveness of this industry sector, and this situation is expected to continue over the next 10 years. In this regard, Water Reuse Europe (www.water-reuse.eu) (WRE) has been established as the trade association for organisations involved in the European water reuse sector. WRE's mission is to create a collective identity for the European water reuse sector and promote an innovative and dynamic water reuse industry.

Water reuse is also a driver of competitiveness for many other EU industries outside the water sector. According to WssTP, a greener image is, for many industries, an important benefit of water reuse. In some sectors however, like the food and beverage sector, water reuse can lead to negative perceptions, e.g. in relation to health, safety and the environment.

These guidelines do not provide an overview of the available technologies, not least because it cannot anticipate what may be available in the near future[56]. However, decision makers should examine the new technologies and techniques that are available (and tested) to determine which can provide treated water to the standards required for the desired purpose(s) and, of these, which can do this in the most cost-effective way.

Box 14 European Innovation Partnership on Water (EIP Water)

To unlock the full potential of the EU water sector, the European Innovation Partnership on Water (EIP Water) was established[57]. Water reuse is one of the top five priorities of this partnership. EIP Water aims at removing barriers to innovation, connecting supply and demand for water-related innovations, creating dissemination strategies for proven solutions and supporting market acceleration of innovations. The Steering Group of EIP Water invited the Action Groups to develop and test the following solutions[58]:

- "Fit for Purpose/Symbiotic approaches based on technical, economic, social and environmental criteria, where cost-effective treatment meets intended use and

[54] Global Water Intelligence (2010). Municipal Water Reuse Markets.
[55] WssTP (2013). Water Reuse: Research and Technology Development Needs.
[56] Information concerning technology innovation for water reuse is being explored by the DEMOWARE FP7 project and it will form a source of information.
[57] COM(2012) 216
[58] See: http://www.eip-water.eu/

quality.

- Innovative solutions and/or treatment options, producing and testing recycled/reclaimed water for residential, urban, industrial and agricultural uses, with consideration of ecosystems and involving multiple stakeholders.
- Systems capable of determining the quality of recycled and reclaimed water to improve management and public acceptance according to health requirements.
- Innovative separation- and extraction technology pilot projects in industrial zones to harvest resources from waste- and re-used water".

Within EIP Water, the 'WIRE Action Group' (Water & Irrigated agriculture Resilient Europe) identified water reuse in irrigation as one of its three priorities[59]. WIRE started its activities in May 2014 and has many partners[60]. The group is involving SMEs and innovators from sectors other than irrigated agriculture. It aims to 'customise existing or upcoming innovation to the farmers' and growers' needs, and to facilitate innovation uptake in the complex, multi-faceted irrigated agriculture reality and market'.

The EIP Water Action Group "Industrial Water Reuse and Recycling", with 49 registered partners, was established in 2013 with a special focus on the issues listed above and specifically oriented towards:

1. "Industrial use of recycled and reclaimed water and the use of treated industrial wastewater for urban and agricultural uses.
2. The assessment of recycled and reclaimed water quality to preserve the product quality and process stability."

The "RTWQM Action Group" (Real Time Water Quality Monitoring) established a working group for water reuse. The main goal of the RTWQM AG is to foster solutions to water challenges based on online water quality monitoring technologies and affordable monitoring strategies.

The SPADIS action group (Smart Pricing and Drought Insurance Schemes in Mediterranean countries) analyses water security pricing schemes in order to make pricing a real mechanism to match water supply and demand, including by assigning each water source a price depending on its role in terms of the supplied quantity and its relative water security in the short and the longer term.

4.5 Social benefits of water reuse

As a means of increasing water availability, water reuse may provide further economic security to a range of sectors (municipal, agricultural, industry, etc), which translates into social benefits[61] (see Box 15), as long as water reuse does not deflect attention of decision makers in water-scarce areas from moving towards more water efficient societies and health and environmental risks are addressed.

[59] See: http://www.eip-water.eu/working-groups/wire-water-irrigated-agriculture-resilient-europe-ag112
[60] http://www.eip-water.eu/WIRE
[61] European Commission (2012). Impact Assessment of the Communication: 'A Blueprint to Safeguard Europe's Water Resources' (SWD(2012) 382 final).

The expansion of water reuse has provided employment benefits in the water industry sector, with qualified jobs in the development, operation and maintenance of additional wastewater treatment and water reuse solutions as well as in research and development, taking into account the innovation potential of this area. Employment benefits also extend to suppliers of systems, equipment and chemicals for additional wastewater treatment and reuse.

In Member States from Southern Europe (e.g. Spain, Italy, Cyprus, Malta, Greece), tourism is a major economic sector, strongly contributing to the economy and to employment. In those water-scarce countries, a reliable supply of water services can support tourism activities[62]. Therefore, water reuse has an indirect influence on the development of tourism, by allowing the development of water-related activities and thus creating jobs.

Other possible social benefits associated with the use of water reuse include:

- Contributing to food security and sustaining agricultural employment for many households.
- Increased quality of life, wellbeing and health as reuse allows the maintenance of attractive landscapes in parks and sports facilities and improvement of urban environment (e.g. urban parks and fountains).
- Supporting the sustainability of rural communities (both with reference to their long-term maintenance and their environmental impact) by providing relatively secure water sources for rural businesses.
- Being a cohesion tool that encourages the drinking water, wastewater and environment agencies and other stakeholders to work closely together using an integrated approach, thereby helping all to recognise the benefits and risks of treated wastewater reuse.
- Helping to achieve Sustainable Development Goals (SDGs) (specifically goal 6) through increased water availability and sanitation, protection of the environment through the use of appropriate technology solutions.

Box 15 Water reuse providing jobs in agriculture

In Clermont-Ferrand (France) and Milan, San Rocco (Italy), 60 and 35 agricultural jobs were secured thanks to water reuse projects respectively. Both projects have enabled a dynamic agricultural activity to be maintained in regions where crops where endangered due to a lack of available water supply (Clermont-Ferrand) or the poor (unsuitable) quality of irrigation canals (San Rocco)[63]. In the Almeria province, Spain, water reuse for farmland irrigation led to increased crop production and thus 1 million working hours are offered during the crop harvesting season[64].

[62] European Commission (2013). Potential for Growth and Job Creation through the Protection of Water Resources.

[63] AFD (2011). La réutilisation des eaux uses traitées (REUT). Eléments de méthodologie pour l'instruction de projets (http://www.afd.fr/webdav/shared/PORTAILS/SECTEURS/EAU_ET_ASSAINISSEMENT/pdf/synth%C3%A8se%20REUT%20AFD%20au%20230911VF.pdf)

[64] Thomas, J.S. and Durham, B. (2003). Integrated Water Resource Management: looking at the whole picture. Desalination 156. 21-28.

4.6 The risks to health and the environment related to the quality of reused water

Raw wastewater contains a multitude of substances and organisms that pose a potential risk for the human health and the environment. Pathogens (bacteria, viruses, parasites), for example, have the potential to cause disease. Secondary treatment significantly reduces these, but additional treatment will nearly always be necessary to provide water which is safe for reuse. Wastewater also contains other pollutants which may pose a risk to health and the environment and some of these are regulated under EU law (e.g. as priority substances – see Chapter 5). Runoff, leaching, or infiltration of treated wastewater into surface water, groundwater bodies or to land has also the potential to conflict with water quality objectives. The degree of impact could depend on several factors, including the quality of the receiving water, the depth of the water table and vadose zone, soil drainage, and the amount and the quality of treated wastewater.

Where water has not been adequately treated, the environment and people can be exposed to pathogens and harmful substances through various routes of exposure, such as by direct contact with the water, including from wells, or from the consumption of unwashed/uncooked crops, on which the pathogens may occur[65]. Further, over time harmful substances can accumulate e.g. in soils which can present problems, e.g. for crops grown at a later date, for groundwater and soil ecology. The composition of treated wastewater depends on the origin of the collected wastewater, season, health status of the population and treatment applied[66]. Many pathogens and harmful substances can survive for long periods of time in water, wastewater, soil or on crop surfaces with the potential to be transmitted to humans or animals. Understanding and assessing such risks is, therefore, very important. However, it is important to stress that the correct treatment and management of waste water can provide water which is safe for health and the environment and, therefore it is important to determine if additional treatment is needed and what type of treatment is necessary and the results should be integrated to provide a clear, holistic conclusion to guide management decisions.

It is also important to note that substances do show very hetereogenous behaviour regarding their removal in treatment processes as well as differences in retention, depletion and reduction in soil aquifer passage (one treatment would not equally remove all substances). For example, some substances even persist over several years; e.g. the drugs carbamazepine and primidone “did not show significant reductions even after six years passage through the soil aquifer treatment system.”[67] Further, for many micro-pollutants much remains unknown, so that as information improves, understanding of risks will need to take this new information into account.

Environmental and health risks also differ due to site-specific characteristics, such as geology, topography, hydrology, climate, zoning [68], local soil type, irrigation methods,

[65] Lindesmith, L. et al., Nat. Med., 9:548-553, 2003; Seymour, I. J. and Appleton, H., J. App. Microbiol., 91:759-773, 2001; Gupta, S. K., et al., Epidemiological Infections, 9:1-18, 2007; WHO, Guidelines for the Safe Use of Wastewater, Excreta and Greywater, Vol. 2, 2006

[66] ANSES (2012) Réutilisation des eaux usées traitées pour l’irrigation des cultures, l’arrosage des espaces verts par aspersion et le lavage des voiries (http://www.anses.fr/Documents/EAUX2009sa0329Ra.pdf)

[67] WHO 2006 Guidelines for the safe use of wastewater, excreta and greywater, pg 120

[68] ISO 16075, part 1, pg 13

aquifer vulnerability, method of recharge and groundwater use[69]. For example, there is evidence that the removal efficiencies of substances are higher in soils with higher contents of silt, clay and organic matter[70] and that "pathogen inactivation is much more rapid in hot and/or sunny weather than under cool, cloudy or rainy conditions."[71]. Thus the risks are very case specific. As a result criteria should be identified for individual assessments for each project/ site that feeds into the decision for the appropriate treatment level.

In understanding possible health and environmental risks, it is important to consider all types of risks (not simply those which can be quantified and modelled). It is also important to distinguish the concepts of hazard, exposure and risk. Hazard for human health can be defined as any biological, chemical, etc., agent that can cause harm to humans with sufficient exposure or dose[72]. Risk is the likelihood of identified hazards causing harm in exposed populations in a specified timeframe including the magnitude of that harm and/or the consequences. Therefore, many of the substances and/or pathogens in water could pose a risk to people, depending upon their exposure to them. For reuse of treated wastewater, exposure could arise from direct contact with the water (e.g. spraying during irrigation, recreational use and landscaping, abstraction for drinking water from nearby sources[73], or from its presence in/on products (e.g. crops). A further factor affecting health risks is the susceptibility of particular groups (e.g. the young, the old, the pregnant and the immune compromised). Therefore, the overall risk to health depends on the hazardous properties of substances or pathogens in the water (which can be controlled through treatment), the degree of exposure of individuals to the water (which can be controlled through good practice, such as crop restriction, delays between fertilisation and harvest to allow die-off of remaining pathogens, hygienic food handling and food preparation practices, produce washing, disinfection and cooking) and susceptibility of the population. If no hazards are expected at levels which may compromise human health (because of sufficient treatment), and if no events are expected through which exposure may occur, then the risk to human health is typically rather low.

Addressing health and environmental risks is best done through effective planning (see Chapter 6), such as sanitation safety plans. Analysis to support plans should include examination of hazards and risks, including hazard identification, release assessment (what is actually released into the environment), exposure assessment, risk evaluation, risk estimation, leading to decisions for risk management to be incorporated into the appropriate plans.

Human health and environmental risks associated with water reuse are described in many publications, including Australian regulations[74] and the WHO guidelines[75], with additional

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[69] WHO 2006, pg. 121

[70] WHO 2006, pg. 120

[71] WHO 2006, pg. 42

[72] Sperber, W.H. (2001). Hazard identification: from a quantitative to a qualitative approach. Food Control 12: 223–228.

[73] Note that the WFD includes specific obligations for drinking water protection zones.

[74] NRMMC-EPHC-AHMC (Natural Resource Management Ministerial Council, Environment Protection and Heritage Council, Australian Health Ministers' Conference) (2006) Australian guidelines for water recycling: managing health and environmental risks: Phase 1. National Water Quality Management Strategy. NRMMC-EPHC-AHMC, Canberra, Australia.

examples of exposure pathways for potential chemical and biological contaminants. According to the WHO, for the reuse in agriculture of water containing agents or substances of concern, the greatest health risks are associated with crops that are eaten raw (e.g. salad crops), root crops (e.g. radish, onion) or crops that grow close to the soil (e.g. lettuce and courgettes)[76]. It is important to note that contamination of such crops with pathogens cannot be removed efficiently afterwards by washing even if chlorinated water is used. Further, environmental risks, e.g. from micro-pollutants that are as yet poorly understood, have to be considered on a case by case basis taking into account a precautionary approach while ensuring compliance with EU and national legislation.

There are very few epidemiological studies on water reuse and related health issues[77]. The literature does not report cases of human diseases caused by treated wastewater in the EU and worldwide. This is confirmed by the feedback from reuse schemes in Cyprus, which has a long experience of reusing water for irrigation and groundwater recharge, and where almost all the (appropriately treated) effluents are now being reused, although more research on longer-term impacts would be useful (see Box 16).

In France, several reviews of public health risks have been carried out as part of the development of the national legislation on the reuse of treated urban wastewater. One of these reviews concluded that the health risk associated with water reuse for irrigation was comparable to or lower than the risk associated with sewage sludge spreading in agriculture where such spreading is conducted in compliance with the relevant regulations[78]. In another study a risk assessment was conducted on 10 substances (hexachlorocyclohexane, dieldrin, Di (2-ethylhexyl) phthalate, pentachlorophenol, chromium, nickel, cobalt, arsenic, cadmium, lead) predicting the absence of adverse effects for the population at the concentrations measured in treated wastewater[79].

Emerging pollutants, such as pharmaceutical products and their metabolites, personal care products, household chemicals, food and industrial additives, etc. are a growing environmental and health concern that is also relevant to water reuse. The risks for human health are related to the consumption of potable waters but also to the ingestion of crops which can accumulate some of them. There are also possible impacts on soil and the aquatic environment which need to be taken into account.

NRMMC-EPHC-AHMC (Natural Resource Management Ministerial Council, Environment Protection and Heritage Council, Australian Health Ministers' Conference) (2008) Australian guidelines for water recycling: managing health and environmental risks: Phase 2. Augmentation of water drinking supply. National Water Quality Management Strategy. NRMMC-EPHC-AHMC, Canberra, Australia.

NRMMC-EPHC-AHMC (Natural Resource Management Ministerial Council, Environment Protection and Heritage Council, Australian Health Ministers' Conference) (2009) Australian guidelines for water recycling: managing health and environmental risks: Phase 2c: Managed aquifer recharge. National Water Quality Management Strategy. NRMMC-EPHC-AHMC, Canberra, Australia.

[75] WHO (2006). Guidelines for the safe use of wastewater, excreta and greywater.

[76] WHO (2006).

[77] E.g. Devaux I., Planchon C., Gerbaud L., Bontoux J., Glanddier P.Y. (1999). Evaluation du risque sanitaire associé à la réutilisation agricole des eaux usées traitées de l'agglomération clermontoise.

[78] AFSSA (2008) Réutilisation des eaux usées traitées pour l'arrosage ou l'irrigation (http://www.anses.fr/Documents/EAUX-Ra-EauxUsees.pdf)

[79] Avis ANSES (2012) Réutilisation des eaux usées traitées pour l'irrigation des cultures, l'arrosage des espaces verts par aspersion et le lavage des voiries. 137 p.

At the moment, however, knowledge of the actual level of risk associated with many of these substances is limited as well as on the long-term consequences (if any) of water reuse (e.g. on soils). As further information on pollutants of emerging concerns and their impacts becomes available, water managers will need to take it into account in their decision making and planning for water reuse. This would include the need for further analysis of the nature, extent and possible impacts of emerging pollutants and how these might be addressed in decision making and water planning, including water reuse.

Box 16 Examples of research on health risks due to water reuse in Cyprus

Several studies have been conducted in Cyprus in order to assess the potential impacts of irrigation with treated municipal wastewater on crops[80]. Research results concerning the long-term wastewater irrigation of fodder and citrus crops revealed no impacts on soil physicochemical properties and its heavy metal content, as well as on crop heavy metal content. Research concerning wastewater irrigation of tomato crops showed no accumulation of heavy metals, whereas *E. coli*, *Salmonella* spp and *Listeria* spp were not detected in tomato homogenates. However recent research findings suggest that *E.coli* is not appropriate as an indicator of faecal contamination, due to its rapid decay outside its natural environment[81]. Research on pharmaceutical compounds detected traces of these compounds in treated effluent, but further research is going on to assess whether they are being taken up by plants under field conditions.

Occupational health risks

Different types of workers may be exposed to water during water reuse and to the possible microbiological and chemical contaminants mentioned above: farmers, workers in the water industry, workers in industries where reused water is used, workers involved in urban and recreational applications of water reuse, etc. While workers may be exposed to potential contaminants during longer periods than the public, the risks would not be necessarily higher due to better awareness and the implementation of preventive measures (e.g. protective equipment) by appropriate businesses. The literature does not report cases of occupational diseases caused by exposure to reused water. However, it is important that where treated wastewater is produced/used any potential risks to workers are identified and managed through preventive measures appropriate to the particular situation. Where water is treated to a high standard, risks should not normally be expected.

Risk to soil quality

The composition of treated effluent (e.g. heavy metals, boron, and other toxic constituents) can affect soil productivity and thus the sustainability of land use for agriculture. Some Member States have specific objectives for soil management and quality and, if these apply, it is important that reuse of treated waste water is consistent with these. Salt accumulation

[80] Research works carried out by the University of Cyprus, presented during the CIS PoM working group meeting of 25/03/14

[81] Inter alia: Vergine P., Saliba. R., Salerno C., Laera G., Berardi G., Pollice A. (2015) Fate of the faecal indicator *Escherichia coli* in irrigation with partially treated wastewater. *Water Research*, 85, 66-73.

(salinisation) in the root zone may have harmful impacts on crop yields, but this can be avoided through good water management[82]. Good practices therefore consider both the risks and the opportunities for farmers reusing wastewater but also the responsibility to support compliance with the WFD (see Chapter 5). Therefore, water reuse schemes may require further treatment to remove substances identified as posing a risk to the protection of soils. The effect of the use of other products, such as chemical fertilizers and pesticides, should also be taken into account in the risk assessment regarding soil quality.

Water quantity

Treated wastewater for reuse (diverted from wastewater treatment plant discharge (if it does not replace current direct uptake from the river), and where reused flow is significant compared to the river flow, may have an impact on river flow levels, which could affect both the ecology and water availability for downstream abstraction. In some particular hydrological conditions, such as a very dry season, treatment plants have to discharge in streams with a very limited flow rate. In this particular case, the WWTP discharge can contribute to maintaining an ecological flow. Under these conditions, water managers should take into account this aspect when they evaluate the water balances and distribution, including water reuse[83].

The impact, if any, of a water reuse scheme would be specific to the individual project. Therefore, the impact of the reuse scheme on the local hydrological regime (and therefore on the environment and dependent users) should be assessed on a case-by-case basis in advance of project development. **Water balances** can help to identify the role of water reuse at basin level, which are always computed as a reduction in returned volume to the system (see **CIS Guidance №34**). When water reuse is an alternative source of water for meeting demands, the decrease in returned volume should be compared to the impacts produced by the abstraction from other water sources. If water reuse becomes a significant pressure that impacts the waterbody status, then cost-effective measures need to be taken in order to counterbalance that impact, including rejecting reuse as a source of water.

Inappropriate treatment

One of the key aspects of planning and designing a water reuse scheme (see Chapter 6) is to define the quality needed according to the use planned that will then determine the level of required treatment and the choice of treatment technology. Scheme design needs to take into account the quality (and the variability of the quality) of the influent wastewater (secondary effluents), the quality requirements of the purpose of use and reliability of operation. Design and implementation of an under-performing treatment system could lead to unacceptable or unreliable water quality for water reuse purposes (defeating the object of improved resilience and water security).

[82] David, B., Briol, M. Hercule-Bobroff, S. (2012). Reuse in practice: a review of selected French case studies. Water Practice and Technology. Vol 10 (2). 312-318.

[83] For more information on water balances and their use in implementing the WFD, see CIS Guidance No 34 https://circabc.europa.eu/sd/a/820ec306-62a7-475c-8a98-699e70734223/Guidance%20No%2034%20-%20Water%20Balances%20Guidance%20(final%20version).pdf

Risks from treatment choices

There might be risks posed by the treatment process (e.g. formation of sub products, deficits in the removal of pollutants). In rare cases, an advanced treatment could pose a higher risk than the use of treated wastewater with a lower treatment (e.g. discharge of disinfection by-products such as trihalomethanes). Such risks should be assessed in the planning processes where risks are analysed and the decisions made on the treatment required (see Chapter 6). The choice of appropriate treatment should in any case be based on the best available technology, standards, legislation and sound knowledge.

Risks to species and habitats

Ecosystems, species and habitats have all their needs related to water quality and quantity. When planning water reuse it should be ensured that conservation status of species and habitats, including requirements of the Birds and Habitats Directives, in the area are not compromised by the changes in availability / quality of water resources, e.g. ecological flows are still ensured.

5 Ensuring the reuse of treated wastewater is consistent with EU water law

5.1 Introduction

The reuse of treated waste water, must be undertaken in full compliance with the requirements of relevant EU legislation. This chapter provides guidelines on the interpretation of key EU water directives specifically as regards water reuse in order to ensure reuse systems are compliant with their provisions. It begins with a short consideration of the Water Framework Directive and a more detailed examination of the Groundwater Directive, Urban Waste Water Treatment Directive and Nitrates Directive.

It is important to note that other EU environmental law may also be relevant to water reuse. It is not possible in these guidelines to identify every possible interaction between the reuse of treated wastewater and EU environmental law and provide a detailed interpretation of all of this legislation. If such interactions do arise, then the reader should refer to the guidance documents produced under the relevant legislation. For example, if the treatment plant is part of an industrial installation, provisions of the Industrial Emissions Directive 2010/75/EU may apply (along with its associated BAT reference documents). Depending on the scale, a decision to build a treatment plant may require an Environmental Impact Assessment (EIA) under the EIA Directive 2011/92/EU. For example, the EIA Directive requires an EIA for artificial groundwater recharge schemes where the annual volume of water recharged is equivalent to or exceeds 10 million m^3. If there is a plan which includes treatment plants for reuse of treated wastewater and its distribution, this might be subject to a Strategic Environmental Assessment (SEA) under the SEA Directive 2001/42/EC. A proposal to construct close to a Natura 2000 site might lead to interactions with the provisions of the Birds and Habitats Directives 2009/147/EC and 92/43/EEC and, as noted in Chapter 4, water reuse schemes should be consistent with conservation objectives.

It is also important to highlight other EU water law which will be relevant to specific reuse schemes. In the hypothetical case where reused water could end up in situations where water is eventually used for drinking water, the scheme would need to allow for treatment to standards compliant with at least the Drinking Water Directive 98/83/EC. Further, while this chapter focuses on ensuring compliance with much of the EU law protecting surface and groundwater bodies, it does not cover the obligations arising from Bathing Water Directive 2006/7/EC or the Marine Strategy Framework Directive 2008/56/EC, which could be relevant in some circumstances. Other relevant EU law includes that on food hygiene, such as Regulation (EC) No 852/2004 which, *inter alia*, states that "Food hazards present at the level of primary production should be identified and adequately controlled to ensure the achievement of the objectives of this Regulation" (Recital 10). This emphasises the importance of ensuring that food hygiene is considered from the start of the production process, including as regards the quality of water used in that process.

5.2 Water Framework Directive 2000/60/EC (WFD)

A key purpose of these guidelines is to explore how reuse of treated wastewater may contribute to achieving the objectives of the WFD and how to minimize the risks from water reuse on these objectives. Indeed, it was this role that led to its inclusion in the Water Blueprint. This brief analysis here does not cover the positive interactions with the WFD (see

Chapters 1 and 4). Rather it notes particular elements of the WFD that water planners should be aware of to ensure that reuse schemes do not lead to outcomes which could conflict with WFD requirements.

The WFD sets out objectives for surface water bodies and groundwater bodies, with objectives for both the quality and quantity of water. For all water bodies the requirements are for no deterioration of the existing status and to achieve good status by 2015 (unless an exemption under Art. 4 is applied, and ignoring the later deadlines in the updated Priority Substances Directive 2008/105/EC (as amended by Directive 2013/39/EU) for some elements of the chemical status assessment).

Surface waters

For surface waters the requirements relate to ecological status and chemical status; the normative definition of status classes is described in Annex V of the WFD. The details of the interpretation of these requirements and how they are to be applied have been explored in several previous CIS guidance documents.

With regard to reuse of treated wastewater, it is important to note two elements of the suite of elements that determine the status of surface water bodies – the chemistry of the reused water and the impact of reuse on the quantitative characteristics of the water body. They may in turn affect the ecological and chemical status of the water body.

If the reuse of treated wastewater would be likely to lead to the pollution of surface water (e.g. through its use in irrigation, e.g. via runoff) by any chemical substances that would pose a risk to the achievement of the related environmental objectives (objectives of achieving good status and non-deterioration), either the water should not be used, the practices for using it should be changed, or additional treatment should be undertaken beforehand. Determining the necessary levels of treatment to meet specified environmental objectives implements the ‘combined approach’ principle of Art. 10 of the WFD.

Further, Art. 7 WFD requires that Member States ensure the necessary protection for water bodies which are sources for drinking water with the aim of avoiding deterioration in their quality in order to reduce the level of treatment required in the production of drinking water. Clearly the requirements relating to drinking-water protected areas are far-reaching and entail more stringent levels of protection.

Member States must ensure that the direct or indirect reuse of treated wastewater does not lead to changes in the chemistry of surface water bodies which would compromise the achievement of the ecological and chemical status objectives, including non-deterioration of status, specified by the WFD and the Priority Substances Directive* 2008/105/EC, *including as regards the special protection of water bodies used for the abstraction of drinking water.

As regards the impact of water reuse on quantitative characteristics, this may concern both overall water levels and flow regimes (i.e. ecological flows (Eflows)). Reuse of water from a WWTP could (depending on the situation) result in less water being discharged to a river, thus negatively affecting the flow regime downstream of the discharge (it might however have no effect on the flow) (see Chapter 4). Changes in flow regimes might in some cases directly affect the ecology of a water body and indirectly affect it via changes in the ability of a water body to dilute pollutants discharged into it. The precise determination of quantitative characteristics/flow regimes for individual water bodies is very much a case-by-case issue, as is the impact that any reuse scheme might have on those objectives.

Member States should ensure that the introduction of schemes for the reuse of treated wastewater does not negatively affect the hydrological characteristics of surface water bodies to the extent that they would compromise the objectives specified by the WFD.

Groundwaters

The WFD objectives for groundwaters relate to chemical status and quantitative status, which are required to meet good status and avoid deterioration in status. As with surface waters, the reuse of treated wastewater can potentially affect both the chemistry and quantitative characteristics of groundwater bodies. Further, the requirements of Art. 7 for the protection of water bodies which are sources for drinking water applies to groundwater water bodies which are sources for drinking water. The objectives for groundwater quality have been further elaborated in the Groundwater Directive (GWD) and this is explored in more detail below. Therefore, this short section will focus on the potential interaction with groundwater quantity.

The most likely interaction of reuse with groundwater quantity is in aquifer recharge. However, it is also important to note that groundwater quantitative status may be improved by water reuse schemes that act as alternative sources and so might lead to a reduction in abstraction from natural water bodies. Water may be recharged to aquifers for three reasons:

- To directly improve water levels **of overexploited aquifers** and thus help to **reach good quantitative status** of those water bodies.
- To temporarily store water, e.g. during periods when there is rain or when crops are not growing and irrigation is not needed.
- To counter groundwater salinization due to seawater intrusion as a result of overexploitation of coastal aquifers.

The WFD (Art. 11.4) lists artificial recharge of aquifers (Annex VI, Part B) as a supplementary measure which Member States may choose to adopt as part of a Programme of Measures to achieve the objectives of the WFD in a river basin.

In any event, the WFD requires as a basic measure (Art. 11.3.f) that **artificial recharge or augmentation** of groundwater bodies be **subject to prior authorisation** and that such actions do **not compromise the achievement of objectives for the groundwater body**. Art. 11.3.f mentions that water may be derived from any surface water or groundwater, which includes treated urban waste water. The objectives concerned would be quality objectives and this point is explored in the section on the GWD.

It should also be noted that Art. 11.3.j includes a 'prohibition of direct discharges of pollutants into groundwater' as a basic measure. Water reuse schemes, therefore, should be designed so as not to allow direct discharges of pollutants into groundwater. This prohibition should be seen as complementary to controls imposed by Art 11.3.f and requirements of Art.6 of the Groundwater Directive (see below).

It follows that reuse of treated wastewater for recharge of aquifers can contribute to WFD objectives, as long as the water is of sufficient quality.

Member States may reuse treated wastewater in aquifer recharge as a supplementary measure to contribute to WFD objectives for groundwater providing:

- ***Such recharge is subject to prior authorisation.***
- ***The quality of the reused water does not compromise the quality objectives for groundwaters specified by the WFD and GWD.***
- ***Associated controls should be periodically reviewed and where necessary updated, e.g. so as to reflect progress in knowledge about pollutants and their impacts.***

Finally, it should be noted that, with regard to basic measures that should be applied, Art. 11.3.g requires appropriate controls on point source discharges of pollutants (e.g. prior regulation) and Art. 11.3.h. requires measures to prevent or limit diffuse pollution sources liable to affect the objectives of the WFD. If reuse schemes are liable to result in such discharges (point or diffuse from direct or indirect use), which could compromise the achievement of WFD objectives, then the WFD requires that appropriate controls be applied.

5.3 Groundwater Directive 2006/118/EC (GWD)

Introduction

The framework for the protection of groundwater in the EU is set out in the WFD. This includes the definition of groundwater bodies, requirements for assessment of status, obligations for measures, planning within RBMPs, integration with protected areas, drinking water protection, etc. The GWD establishes further provisions for the protection of groundwater against pollution, including more detailed criteria to assess the chemical status of groundwater bodies and identification of significant and sustained upward trends, along with specific measures to prevent or limit inputs of pollutants to groundwater.

The interaction between these directives and reuse of treated wastewater concerns two main issues:

1. a possible positive impact on the quantitative status of groundwater bodies (e.g. in managed aquifer recharge).
2. a possible negative impact on the qualitative status of groundwater bodies.

Definitions and assessment of groundwater chemical status

Articles 1-5 of the GWD provide some additional definitions (to those of the WFD). They also indicate that the criteria for determining groundwater status should be based on groundwater quality standards set out in Annex I and threshold values to be determined by Member States. These provisions interact with the reuse of treated wastewater in so far as the treated wastewater may contain substances included in Annex I or subject to threshold values determined at Member State level.

It should be noted that where treated wastewater reuse is planned, the quality of that water has to ensure that its use would not cause a breach of GWD quality standards or threshold values for groundwater. The quality of the wastewater treated will determine the level of treatment needed. In which case, the Annex I quality standards and threshold values established in accordance with Annex II will guide this, subject to the provisions of the GWD mentioned below.

Measures to prevent or limit inputs of pollutants to groundwater (Art. 6)

The GWD has the objective to prevent or limit inputs of pollutants to groundwater. Art. 6 of the GWD states that, in order to achieve this objective, "*Member States shall ensure that the programme of measures … includes:*

- *all measures necessary to prevent inputs into groundwater of any hazardous substances…;*
- *for pollutants listed in Annex VIII to WFD … which are not considered hazardous, … all measures necessary to limit inputs into groundwater so as to ensure that such inputs do not cause deterioration or significant and sustained upward trends in the concentration of pollutants in groundwater*."

Water reuse schemes, therefore, should be designed to prevent or limit the introduction of pollutants to groundwater[84]. This includes preventing/limiting any direct introduction of pollutants, and their introduction via diffuse pathways, e.g. as a result of use in agricultural irrigation, etc. Ensuring this requires an understanding of which substances are present, how they might enter a groundwater body and what might be done to prevent or limit this.

Art. 6.3.d of the GWD also provides that "*without prejudice to any more stringent requirements in other Community legislation, Member States may exempt from the measures required by paragraph 1 inputs of pollutants that are: (d) The result of artificial recharge or augmentation of bodies of groundwater authorised in accordance with Article 11(3)(f) of Directive 2000/60/EC.*"

This means that aquifer recharge schemes must be subject to prior authorisation (WFD Art. 11.3.f (i.e. including assessment to ensure that the achievement of WFD/GWD objectives is not compromised). It also means that the requirements to take measures to prevent inputs of hazardous substances and limit inputs of other pollutants can be exempted if it is ensured that the achievement of good status will not be compromised. The GWD (Art. 6.3 2nd subparagraph) requires that there be efficient monitoring in place, either in accordance with point 2.4.2 of WFD Annex V, or otherwise appropriate, to ensure the conditions are met.

[84] See also: CIS Guidance Document No 17: Guidance on Preventing or Limiting Direct and Indirect Inputs in the Context of the Groundwater Directive, including the interpretation of 'prevent and limit' approach.

Therefore, any water reuse schemes that involve aquifer recharge should ensure that there is adequate assessment and that the appropriate permitting and control measures are in place.

5.4 Directive 91/271/EEC concerning urban waste water treatment (UWWTD)

This directive, *inter alia*, sets out obligations concerning the collection of wastewater from urban and certain industrial sources and obligations concerning its treatment. It is, therefore, highly relevant to the reuse of treated wastewater.

Wastewater covered by the UWWTD is not normally subject to the provisions of the Waste Framework Directive 2008/98/EC. However, the waste legislation does apply where the waste waters fall outside the strict controls of the UWWT Directive as the exclusion from the waste legislation in Article 2(a) of Directive 2008/98/EC is not absolute[85]. It is therefore important that any discharges from UWWT plants which are destined for reuse are appropriately provided for in a regulatory regime of prior authorisation.

Furthermore, the Industrial Emissions Directive provides its own regime for wastewater treatment plans falling under its direct scope setting out the requirement to apply the Best Available Techniques. Where an IED installation does not discharge to an UWWT plant controlled under the UWWTD, discharge limits will be established in accordance with the provisions of IED.

Promotion of reuse of treated wastewater

It is firstly important to note that Art. 12.1 states that "Treated waste water shall be reused whenever appropriate. Disposal routes shall minimise the adverse effects on the environment". Therefore, the UWWTD makes two direct statements regarding reused treated wastewater:

Wastewater shall be reused whenever appropriate.

Member States shall minimise any adverse effects on the environment from reuse of wastewater.

It should be noted that while many of the direct obligations in EU law described in these guidelines concern EU water objectives, the latter point in Art. 12.1 concerns all adverse environmental effects. For example, if reuse of wastewater were to be a significant risk to soil or surface- and groundwater, such risks should be minimised.

Collection of wastewater

The UWWTD sets out obligations to Member States for collection of wastewater (Art. 3) based on the size of agglomerations. It should be noted that the wastewater collection

[85] See Case C-252/05 Thames Water Utilities Ltd where the waste framework directive in its previous form was deemed applicable to waste waters which had escaped from the collecting system before treatment and resulted in pollution.

requirements are minimum requirements. If Member States decide to collect wastewater from agglomerations smaller than those covered by the UWWTD, they are fully free to do so. Such collection might, for example, be undertaken to collect water for reuse in water-scarce areas. Therefore:

The UWWTD requirements on wastewater collection do not constrain or direct decisions relating to reuse of wastewater.

Wastewater treatment requirements - overview

The UWWTD sets out obligations for treatment of wastewater prior to discharge. It is important to note that the term 'discharge' is not defined in the directive. However, it is not limited to discharge of treated wastewater into a water body as e.g. Art.11 addresses discharge of industrial waste water into collecting systems. Thus it should be assumed that 'discharge' includes treated water leaving a wastewater treatment plant to be used for another purpose.

Water from wastewater treatment plants destined for reuse is considered a discharge under the UWWTD at the point where it leaves the water treatment plant (after treatment).

The UWWTD establishes several requirements relating to discharge. Of relevance to these guidelines are those relating to secondary treatment, more stringent treatment (nutrient removal) and an obligation with respect to meeting requirements of other directives.

Secondary treatment

Art. 4 states that wastewater entering collection systems should be subject to a secondary or equivalent treatment for discharges from agglomerations above 10,000 p.e. and of 2,000 p.e. and more if the discharge is to freshwaters (including groundwaters) and estuaries. Therefore:

Wastewater from a treatment plant serving 10,000 p.e. or more discharged for reuse must be subject to secondary or equivalent treatment. Water that is discharged to freshwaters (including aquifers) or estuaries from agglomerations between 2,000 and 10,000 p.e. must be subject to secondary or equivalent treatment.

More stringent treatment (nutrient removal)

Art. 5 sets out additional treatment requirements for discharges to Sensitive Areas. Annex II details Sensitive Areas as water bodies subject to eutrophication, and areas where further treatment is necessary to fulfil other Directives. The treatment requirements apply to discharges from agglomerations above 10,000 p.e. (except when Art 5(4) is used, see further in the text). The directive sets out levels of treatment for such discharges (for nitrogen and/or phosphorus as appropriate).

However, Art. 5(5) states that "Discharges from urban wastewater treatment plants which are situated in the relevant catchment areas of sensitive areas and which contribute to the pollution of these areas shall be subject to [the relevant treatment provisions]". Therefore, discharges that are not directly into a water body are still subject to provisions of Art. 5. However, the requirement for such discharges to have in place nutrient removal can be suspended from the obligation of nutrient removal, where it is demonstrated that the removal will have no effect on the level of eutrophication of the sensitive area.

As noted earlier, reuse of treated wastewater is a discharge, so the application of Art. 5(5) requires an evaluation of whether the reuse of treated wastewater affects the contribution made by the treatment plan to pollution of the sensitive areas into which its discharges feeds. The requirement to have in place nutrient removal can only be suspended on a case by case basis and must be thoroughly justified. Where nitrogen and/or phosphorus in the water is applied in irrigation, the nutrient load in reused water should be accurately assessed and accounted for in a nutrient balance. Further, the nature of the receiving soils, rate of uptake by the crop (and how this varies across a season) and other factors all affect whether the nitrogen and/or phosphorus applied in the irrigation water is ultimately removed or is likely to continue to contribute to pollution in the Sensitive Area. **If there is a likelihood that nutrients in reused water could still contribute to pollution in Sensitive Areas, there are two options available:**

- ***Continue to require more stringent treatment before discharge (as specified in the UWWTD).***
- ***To alter the use of the irrigation water so that this risk is removed (e.g. to make use of advanced fertilisation and irrigation decision support and adequate technologies).***

Finally, Art. 5.4 provides for an alternative approach by Member States, whereby instead of applying the specified treatment requirements for the treatment plants above 10,000 p.e., a Member State ensures that the percentage reduction of the overall load entering all urban wastewater treatment plants in a Sensitive Area is at least 75% for N and 75% for P. As this requirement is for urban waste water entering all treatment plants, the nature and purpose of any discharges, including for reuse, is unaffected by the obligation. It is also important to note that, if a Member State adopts this approach, the load reduction can be achieved through any appropriate combination of treatment levels (secondary, advanced, etc.) across the wastewater treatment plants.

Meeting requirements of other directives

Annex I.B.4 of the directive states that 'more stringent requirements than [those in the directive] shall be applied where required to ensure that receiving waters satisfy any other relevant directives'. Other treatments such as UV disinfection may be relevant where required because the waters are designated as sensitive for reasons such as bathing water quality or shellfish water quality to reduce faecal contamination.

It must be noted that Annex I.B applies to discharge from UWWTPs to receiving waters. With regard to reuse of treated wastewater, this would, therefore, not apply to issues such as recycling within an industrial complex. Therefore, the UWWTD requires that (direct and indirect) discharge to waters must meet the objectives of relevant directives, such as the WFD and GWD. Of course, these directives already apply, but it is important to note the synergy and mutual reinforcement of the provisions.

In conclusion:

The nutrient removal requirements of Art. 5 apply, in principle, in Sensitive Area and catchment areas of Sensitive Areas. If wastewater is reused in catchments that do not contribute to pollution of Sensitive Areas, this article is not relevant.

In the catchment of Sensitive Areas, when Member States use Art. 5(2) and 5(3) they must apply the more stringent Art. 5 treatment requirements to wastewater treatment plants above 10,000 p.e., unless it is demonstrated that the discharge will not contribute to the pollution of the Sensitive Area.

When Member States use the alternative of Art. 5(4) of removal of 75% of N and P for the overall load entering treatment plants in a catchment of a Sensitive Area, they have to continue to apply this level of reduction at the Sensitive Area level even if the treated water is reused.

Where reuse of treated wastewater results in discharge to waters, the UWWTD requires that this satisfies the requirements of other directives, such as the WFD and GWD.

Industrial wastewater (as covered by the UWWTD)

Industrial wastewater is addressed under Art. 11 and Art. 13. Art. 11 requires that industrial wastewater discharged into collecting systems that lead to a UWWTP is subject to prior authorisation and that the conditions impose satisfy the requirements of Annex IC. A critical issue for such prior authorisation is that the water discharged by industrial sources allows the adequate function of the WWTP. If it is decided that water from the WWTP should be reused, conditions may need to be imposed on the quality of the industrial discharges to ensure that this is possible.

Art. 13 concerns certain industrial activities (mainly food and beverage industries) listed in Annex III of that Directive which have their own wastewater treatment systems and which do not discharge to UWWTPs. Art. 13 requires that such discharges are also subject to prior authorisation before discharge. If such water were to be considered for reuse, then the prior authorisation would likely require amendment to ensure that the level of treatment meets the quality objectives for the particular use of the reuse water.

Enforcement and planning

Art. 12 requires that Member States' competent authorities ensure that disposal of water from urban wastewater treatment plants is subject to prior regulations and/or specific authorisation. This regulatory requirement still applies if the treated water is destined for reuse. The authorisation should include specific requirements linked with this reuse and be periodically reviewed and where necessary updated, e.g. to reflect progress in knowledge about impacts of water reuse.

Art. 15.1 requires competent authorities to monitor discharges of UWWTPs to ensure compliance with the requirements for discharge (domestic and industrial). Any specific treatment levels necessary for reuse of wastewater would be taken into account in such compliance monitoring.

Art. 15.4 requires information on discharges from WWTPs to be collected by competent authorities and for this to be made available to the Commission. This has since been elaborated and Member States and the Commission have jointly developed technical specifications for such reporting within WISE[86]. Included within this is reporting under an agreed format on reuse of water from the WWTPs.

Art. 17 requires Member States to establish a programme for implementing the directive and to update it regularly. If there are changes in treatment due to reuse of wastewater, this should be included in an updated programme. An implementing Decision was adopted in 2014 (Decision 2014/431/EU) concerning the formats for national programmes. Table 5 of this decision asks 'Is any action foreseen to promote the reuse of treated wastewater (Article 12.1)?' Therefore, Member States are to report on the reuse of treated wastewater in their plans to the Commission. It should be noted that the degree of detail and structure of reporting on reuse of treated wastewater is not defined as the Decision allows Member States to provide this a 'free text'.

In conclusion:

The prior authorisation and monitoring requirements of the directive apply where wastewater is discharged for reuse.

The reporting through WISE under Art. 15.4 requires Member States to provide information on the reuse of treated wastewater from WWTPs.

The programme for implementing the directive should include information on reuse of wastewater as also required to be reported under the implementing Decision.

Conclusion

Water discharged from wastewater treatment plants destined for reuse may be subject to different treatment requirements under the UWWTD than that discharged directly to receiving waters. However, as detailed above, such differences are restricted to specific circumstances and limitations.

Also, it is very important to note that reuse covers a wide range of possible uses. One category of reuse is to recharge natural water bodies. These are more commonly

[86] See: http://rod.eionet.europa.eu/obligations/613/overview

groundwater aquifers, but could also be surface waters to regulate flow, etc. In such cases, any of the possible departures from the UWWTD described above would not apply:

Where reuse of treated wastewater involves discharge into a groundwater aquifer (e.g. for recharge) or a surface water body, all of the requirements of the UWWTD apply and the UWWTD requires that the discharges satisfy the requirements of 'other relevant directives' also.

5.5 Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources (Nitrates Directive)

Introduction

The Nitrates Directive aims to protect waters which are or may become subject to nitrogen pollution from agricultural activities (i.e. not other potential users of reused water). Its specific objective (Art. 1) is: reducing water pollution caused or induced by nitrates from agricultural sources and preventing further such pollution.

It is, therefore, relevant to the reuse of treated wastewater as such water may be used in agriculture and it may contain nutrients (including nitrogen) contributing to the problem the directive seeks to address.

The provisions of the Nitrates Directive only potentially apply to water reuse in agriculture and its nitrogen content. It does not apply for other purposes of reused water.

Designation of areas to be subject to provisions of the directive

Art. 3 sets out obligations to designate Nitrate Vulnerable Zones (NVZs) according to criteria in Annex I, which concern surface water bodies which are eutrophic or at risk of eutrophication or which exceed or are at risk of exceeding the Drinking Water Directive limit for the concentration of nitrates, or groundwater bodies which exceed or are at risk of exceeding 50 mg/l nitrates. Member States may either designate specific areas as vulnerable or decide to apply mandatory measures on the whole territory. The designation criteria are determined by the quality of the receiving water bodies, which is pollution is caused – at least partly – by agriculture. Therefore:

The reuse of treated wastewater in agriculture would have implications for the designation of NVZs by Member States only if the use of such water would present an additional risk of nitrate pollution to waters not previously considered to be at risk (and therefore ought to be designated as NVZs).

Definitions

Before examining the provisions of the directive as it applies to agricultural practice, it is important to clarify terms used by the directive and how these relate to reused water as these affect the precise requirements of the directive. The directive contains the following relevant definitions (Art.2):

‘”nitrogen compound”: means any nitrogen-containing substance except for gaseous molecular nitrogen’. From this it is clear that ‘substance’ includes liquid and the definition includes nitrogen in treated wastewater.

‘”fertilizer” means any substance containing a nitrogen compound or nitrogen compounds utilised on land to enhance growth of vegetation’. The definition gives examples which do not include treated wastewater, but it is evident that treated wastewater containing nitrogen used with the purpose to enhance vegetation growth is included.

‘”chemical fertilizer’: means any fertiliser which is manufactured by an industrial process’. Treated wastewater cannot be considered as manufactured and is not, therefore, a ‘chemical fertilizer’ under the directive.

‘”livestock manure”: means waste products excreted by livestock or a mixture of litter and waste products excreted by livestock, even in processed form’. Treated wastewater from urban or industrial sources is not, therefore, ‘livestock manure’ under the directive. However, treated wastewater from animal housing, etc., is ‘livestock manure’ (but is not addressed in these guidelines).

Codes of good agricultural practice

Under Article 4 of the directive, Member States must develop codes of good agricultural practices. The codes apply to all waters, but are implemented by farmers on a voluntary basis. They become mandatory in nitrate vulnerable zones, unless superseded by other measures in Annex III. Annex II lists items to be included in the codes ‘in so far as they are relevant’.

The items include periods when the land application of fertilizer is inappropriate, the application of fertilizers to steeply sloping ground and to water-saturated, flooding, frozen or snow-covered ground and conditions for application of fertilisers near water courses. It may be relevant that treated wastewater containing nitrogen as a fertiliser is considered in the above measures. It is important to note that the code envisages the establishment of fertilizer plans for each farm and the keeping of records of fertiliser use. The amount of nitrogen applied to land through wastewater would have to be included in the fertiliser plan and records of fertiliser use. Other items refer to chemical fertilizers and livestock manure, which do not apply to reused wastewater.

Provisions on application processes and fertilizer planning in the voluntary codes of good agricultural practice should, where appropriate, include reused water containing nitrogen as a fertiliser used on farms.

Action Programmes

Art. 5 requires Member States to establish action programmes for vulnerable zones. These contain requirements, detailed in Annex III, that farmers must apply. They also include the measures Member States have prescribed in the codes of good agricultural practice (unless these measures have been superseded by measures in Annex III), which become mandatory in NVZs. Therefore:

Provisions of Annex III relating to periods when the land application of fertilizer is prohibited or limitation of the land application of fertilizers would apply to wastewater, as well as provisions of Annex II specified above, relating to the application of fertilizers to steeply sloping ground and to water-saturated, flooding, frozen or snow-covered ground and conditions for application of fertilisers near water courses. Similarly, the use of wastewater containing nitrogen would have to be included in fertilizer plans and in the records of fertiliser use.

Other rules in Annex III (including the quantitative limits on nitrogen application) apply to livestock manure and, therefore, would not apply to treated wastewater containing nitrogen.

Action programmes set out rules that farmers must follow in NVZs and should include specific requirements if farmers use treated wastewater containing nitrogen.

Other requirements

The Nitrates Directive contains further requirements for monitoring, assessing effectiveness, etc. These are not materially affected by the use of treated wastewater containing nitrogen, except that its use would need to be taken into account where relevant.

Conclusion

For farmers, treated wastewater containing nitrogen to be used for plant growth can be defined as a fertilizer under the Nitrates Directive and, therefore, restrictions on its use may apply as set out above. In particular, balanced fertilisation must take account of all sources of nitrogen and the nitrogen originating from reused waters must be taken into account in the methodologies for defining the fertiliser quantities. This is the case whether the farmer is simply using the water for irrigation or seeking to utilize the nitrogen it contains.

If treated wastewater containing nitrogen is used on agricultural land, it falls under the definition of fertiliser under the Nitrates Directive and all relevant provisions setting out specific conditions of its land application apply – obligatorily in nitrate vulnerable zones and as voluntary measures outside.

5.6 Conclusions

Treated wastewater has to be compliant with EU and national water law. When treated wastewater is to be used for, e.g. irrigation and/or aquifer recharge instead of discharge to the river, compliance with several EU directives will need to be ensured.

The development of schemes for the reuse of treated wastewater may have very different characteristics depending on the sources of the water, its intended use, the quality standards established for each use and the appropriate levels of treatment to achieve these quality standards on the most cost efficient and effective way. The range of potential issues arising include the quality of water directly introduced to a receiving water body (e.g. in aquifer recharge), indirectly introduced (e.g. run-off in irrigation), impacts on flow regimes, etc. Each of these interactions with the environment may be regulated under EU law, including controls on specific types of activities or binding objectives for environmental quality.

It is, therefore, important that any scheme for the reuse of treated wastewater considers the objectives arising from the EU water law set out in this chapter (as well as any other relevant EU law) to ensure that such schemes are fully compliant. This requires co-ordination between those seeking to develop such schemes and water managers who understand the implications of EU water law, as transposed into national laws. It is also important to note that compliance with these EU directives does not mean that the available water from a WWTP for reuse is necessarily safe for a specific use – this needs to be determined on a case by case basis. The objective of soil conservation and emerging pollutants, in particular, may require further attention.

Water reuse schemes may require significant investment for treatment and distribution of water and commitments by associated businesses. Ensuring such investments are compliant with the law is a critical part of the business decision.

6 Planning for the reuse of treated wastewater

6.1 Introduction: the planning context

It has become important to promote integrated water resources, based primarily on sustainable water demands, ensuring availability and quality, protection and regeneration of the water environment, and the use of instruments that encourage efficient water use. These objectives can only be defined if traditional supply approaches are replaced by strategies for "demand management" and "conservation" and "restoration" of water resources and their associated ecosystems, looking for more environmental sustainability, more economic rationality and public participation around water management, with appropriate mechanisms for information and consultation.

Planning in its widest sense takes a number of different forms. Planning for spatially defined areas is most relevant in the context of these guidelines. This would include:

- River Basin Management Plans and drinking water protection areas.
- Drought management plans (DMPs) and other planning for water scarcity and droughts (which might be included in RBMPs).
- Land-use planning (urban, rural, etc.).
- Irrigation Plans.
- Water supply and sanitation plans.
- Other relevant plans (Rural Development Plans (RDPs) and investment/ infrastructure plans for utilities).

Across these plans are assessments of the problems facing water bodies and decisions for investment in measures to address those problems and to meet needs for the environment, citizens and businesses. The structure and approach of some of the planning is driven by EU law and in other areas by Member State law. Box 17 provides two examples of assessment and planning in Spain.

Planning for the reuse of treated wastewater should not be separated from these different planning processes. RBMPs and, if any, DMPs[87] identify the problems facing water bodies and the pressures on them, together with opportunities for measures to tackle those pressures. Reuse of treated wastewater may be one of those measures if water scarcity is an issue (as noted earlier, it is a supplementary measure under the WFD) and should be planned within this wider context, ensuring that reuse does not have any adverse impacts on WFD objectives (and those of other EU law) (as explored in Chapter 5).

The planning processes across Member States vary (even with the framing of planning provided by the WFD). Therefore, it is not possible to state which organisations should be responsible for planning for reuse. However, the analysis and planning should be integrated into the planning of those primarily responsible for water management, management of utilities, urban planning, etc. Further, as Chapter 8 makes clear, it is important to ensure full engagement of utilities, users and other stakeholders in that planning process.

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[87] See the CIS 2008 Technical Report on Drought Management Plans http://ec.europa.eu/environment/water/quantity/pdf/dmp_report.pdf

In most cases water reuse is an auxiliary water source and, therefore, planning needs to be undertaken alongside consideration of use of other sources for particular water demands. Water demands reflect changing population patterns, influenced by land use planning which also identifies opportunities and constraints for infrastructure (including for water treatment and distribution). Demand changes over time. Therefore, in considering reuse schemes it may be appropriate to adopt a modular approach, whereby additional capacity can be added to a scheme if demand were to change. RDPs may identify opportunities for rural communities to invest in use of treated wastewater and, furthermore, investment plans (or similar) for utilities will set out future infrastructure needs, of which the treatment and distribution systems for reuse of treated wastewater may be part.

It is not possible to provide guidance on exactly how reuse of treated wastewater should be addressed in each of these planning contexts as they are structured and developed differently across the Member States. However, it is important to ensure that planning for reuse of treated wastewater is properly integrated into these planning processes. While planning for water reuse does need to be integrated into other relevant planning processes, specific plans for reuse may be appropriate. For example, Spain drafted a National Plan for Water Reuse with specific objectives on a range of issues, including promotion of reused water, public awareness, etc.

Planning involves consideration of problems, challenges and solutions to these. In beginning this process and throughout its implementation, it is important to identify the key stakeholders that need to be engaged with and when this needs to happen. This is explored further in Chapter 8.

It is also important to note that some planning processes and decisions will be subject to different forms of impact assessment and analysis (Box 18). Plans may be subject to Strategic Environmental Assessment and individual development decisions may be subject to Environmental Impact Assessment. Both issues are covered by respective EU directives, but Member States may also have additional provisions (e.g. on what is to be subject to EIA). Where reuse of treated wastewater is included, SEA and/or EIA assessments may be required. Extensive guidance (including at Member State level) is available on the application of both SEA and EIA.

Box 17 Examples of strategic planning and analysis in Spain[88] and Italy

Assessment of water reuse potential in the Júcar River Basin District, Spain

In the Júcar River Basin District, according to the RBMP, a total of 120 hm^3/year of water is directly reused mainly in lower basins with the metropolitan area of Valencia in the Turia, mostly for irrigation, accounting for about 25% of the total treated wastewater. An analysis was undertaken of the WWTPs of Pinedo I and Pinedo II that treat the urban waste water of Valencia and of many of the municipalities of its metropolitan area. It was concluded that these two plants can produce more water in the summer period than is currently used for irrigation, which could be reused in other irrigation areas while increasing their guaranteed supply, in particular in periods of scarcity of resources and/or reducing groundwater abstraction.

Consolider Tragua Programme (2006-2012), Spain

The national research programme "Consolider Tragua" examined the application of different treatments of water coming from the WWTPs based on advanced technologies, establishing water chemical and biological quality standards and determining the impact on the natural environment for different uses. The programme produced an inventory of wastewaters for potential reuse, treatment protocols according to their characteristics, a methodology to evaluate the water impact on the environment, criteria to select the available economically improved technologies for the various wastewater effluents from the conventional WWTPs, standard methods of chemical, microbiological and toxicological analysis, and the respective socio-economic analysis.

In.Te.R.R.A. project (2011-2015) Apulia, Italy.

The national research project In.Te.R.R.A. (PON R&C 01_01480) evaluated the reuse potential of treated wastewater from several municipal and agro industrial treatment plants for irrigation of food and non-food crops[89]. Different treatment technologies (including non-conventional ones) were evaluated and compared in terms of effluent quality and their effects on cultivated crops. Toxicological testing on the different water sources used for irrigation, soils, and crops was also carried out. Moreover, a socio-economic investigation explored the acceptance of these practices by stakeholders and the general public. Among the outcomes of the project, a book of guidelines on safe and effective use of treated wastewater in irrigation was produced[90].

[88] Further information can be found in Spanish RBMPs and in: Funcionalidad de las cuencas como clave para la sostenibilidad: algunos casos piloto. 2008. http://www.magrama.gob.es/ca/ceneam/formacion-ambiental/agua_cuencas.aspx

[89] Lonigro A., Montemurro N., Rubino P., Vergine P., Pollice A. (2015) Reuse of treated municipal wastewater for irrigation in Apulia region: the "IN.TE.R.R.A." Project. *Envir. Engin. and Manag. Jour.*, 14, 7, 1665-1674.

[90] Rubino P., Lonigro A. (Eds.) (2015) "Progetto PON In.Te.R.R.A. – Linee guida per il riuso irriguo delle acque reflue depurate" ISBN 978-88-7470-405-7. In Italian.

Box 18 Examples of impact assessment and analysis tools appropriate to planning for water reuse

- Strategic Environmental Assessment
- Environmental Impact Assessment
- Cost Benefit Assessment
- Life Cycle Analysis
- Water balance analysis
- Water footprint analysis
- Health and environmental risk assessment

6.2 Steps in planning for reuse of treated wastewater

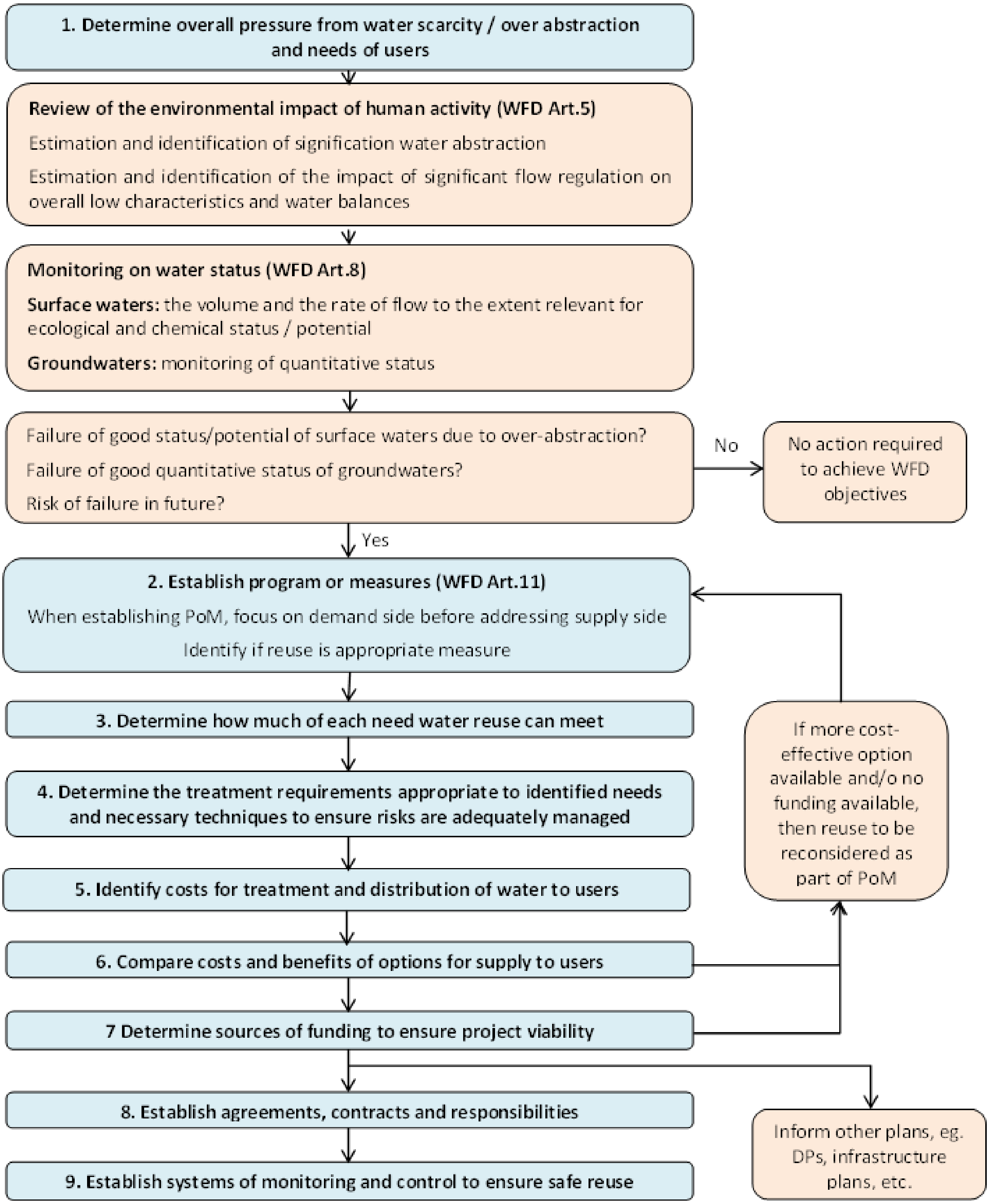
It is important to have a coherent planning approach to taking forward the reuse of treated wastewater, if there is a need, e.g. for an additional water resource in water-scarce regions. Therefore, while it is important to ensure that the issue is properly integrated into different planning processes (as noted above), simply leaving it within those processes might result in a fragmented and incoherent outcome. Pieces of decisions might arise within RBMPs, RDPs, land-use plans, etc., with no overall framework. Of course this depends on the situation in each Member State – for example a water scarcity plan might provide the opportunity for coherent and integrated planning on water reuse.

Planning for reuse (and much water management) needs to be able to adapt to circumstances. Prior assessment to develop plans will identify problems, solutions and ways forward. However, these do change – users change their needs, costs change, etc. Therefore, it is important to allow for adaptation in planning and flexibility in implementation.

A coherent approach requires the decision maker(s) to consider a series of steps in the planning for the reuse of treated wastewater. These are elaborated below and summarised in Figure 1 below. The first steps are based around the key steps in the implementation of the WFD, which starts with an analysis of pressures and water status, leading to the adoption of programmes of measures. If appropriate, reuse may be a measure to consider in the Programme of Measures. It is important to recognise that the relationship with planning processes such as RBMPs, DMPs, RDPs, spatial plans, etc., is more complex than is possible to show in the Figure. Information from these planning processes feeds into the analytical steps for water reuse planning, but analysis focused on reuse would feed back into those planning processes. Further, analysis of costs and options within reuse planning would feed back and forth with WFD Art. 5 analysis and the determination of appropriate measures within PoMs. The specific interactions between the steps and different planning frameworks would vary depending on individual circumstances.

Figure 1 Summary of the steps in planning for reuse of treated wastewater set out in these guidelines.

The approach is a stepwise approach. The necessity to proceed or detail of the next step(s) is dependent on the outcome of the previous step.



The Figure also presents the steps as a largely linear representation. Of course planning frameworks such as those under the WFD are circular in nature. The Figure is linear in the sense that the steps begin by examination of the context of water needs and end with detailed decisions on individual reuse projects. Of course, as projects are implemented, the analysis of the early steps on water needs, etc., would be updated. Thus the circularity and iterative nature of planning should be recognised (including that 'feed-back' between steps may take place at several different stages in the planning process. It is important to note that the issue of public participation is not placed in a specific step. As Chapter 8 explores, early engagement of the public (e.g. in helping to reach consensus on problems and solutions) is preferred, but further engagement in later stages of planning is also needed.

The planning steps

1. Determine the overall pressure and impact on water bodies from water scarcity and over-abstraction and the quantitative needs of water users. Identify whether you have a significant water scarcity issue or any other reason to use treated wastewater, such as aquifer recharge to manage seawater intrusion. Needs may be for irrigation, urban use, environmental purposes, aquifer recharge needs etc. and may change over time. Future needs should take account of all potentials for water saving according to the water hierarchy.

The first step is to identify whether there is a significant water scarcity issue causing a pressure on water bodies – is there a problem or need? The most likely contexts are (i) to avoid over-abstraction of water bodies and so helping to achieve environmental objectives, (ii) to meet user needs in situations of water scarcity and (iii) dealing with extensive seawater intrusion issues and aquifer recharge needs.

The analysis should follow the key analytical steps in the implementation of the WFD. This includes the Art. 5 review of the impacts of human activity on water bodies and information from monitoring required by Art. 8.

DMPs should include an examination of the needs of different water users and/or uses (in a quantitative assessment) and decisions relating to which should receive water as a priority. They might, for example, prioritise activities which have a higher importance to local communities and to ecosystems or importance in meeting WFD and GWD objectives.

There are a number of potential drivers for water reuse and it is important to ensure that these drivers are analysed with regard to overall water need. Drivers include those directly related to water demand (e.g. to avoid overexploitation of aquifers or deterioration of surface water quality), waste water discharges (e.g. nutrient recycling), environmental needs (e.g. pressure of wetlands), agriculture, municipal and industry needs, etc[91]. It is important that downstream uses of water are included in this analysis.

[91] Drivers are explored further in: Plan Bleu – UNEP (2012). Treated wastewater reuse in the Mediterranean: lessons learnt and tools for project development (http://planbleu.org/sites/default/files/publications/cahier11_reut_en.pdf)

In areas affected by water scarcity and drought where there are many potential competing demands and/or uses for water, it is important to identify which users and/or uses are more critical than others. For example, in the Netherlands the "verdringingsreeks" prioritizes fresh water distribution over four categories of application (safety and preventing irreversible damage (also taking into account irreversible damage to habitats, flora and fauna); utilities; small scale, high quality users; others, such as agriculture and industry). This prioritization is laid down in the Dutch Water Act. In France the law[92] requires balanced water management, prioritizing the requirements of health, public safety and civil security as well as the supply of drinking water. It should also meet or reconcile the uses of 1) biological requirements of water ecosystems; 2) management of water for natural water flow and flood protection; 3) agricultural, industrial, tourism, transport and other uses.

The needs of many users will show seasonal variations, including the environmental needs (see also CIS Guidance 34 on water balances). This will, in particular, reflect differences between users which may meet their water needs through rainfall and those which do not. For example, water needs for urban parks can be met through rainfall, but not most water needs for industry. The most obvious seasonal effect is seen in the agriculture sector, which not only directly relates to the availability of precipitation as a water source, but also to the seasonality of the need, as water is only required during particular periods of crop growth, etc.

Developing a detailed profile of different user needs is important as it provides an understanding of the diversity of users, extent of need and priorities for which reuse of treated wastewater might be an option. The practical options for storage of treated wastewater should include consideration of seasonable variation in demand. Further, where options include aquifer recharge, it is important to determine the viability of that option with respect to ensuring compliances with the quality objectives of EU water law (see Chapter 5).

There will be situations where reuse of treated wastewater is not driven by water scarcity or quality, but where it might increase water efficiency and water saving and provide a reliable or cheaper source. In this situation it is necessary to identify if there are such user needs. In planning for reuse of treated wastewater in non-water-scarce situations, some or all of the steps below may not be needed.

2. Identify the appropriate measures or alternative water sources to meet the needs, identifying clearly how each option will address specific quantitative needs. Include these within the Programmes of Measures.

Before deciding on the reuse of treated wastewater as an option for the different users identified, it is important to determine if there are other more appropriate measures that can be taken to meet those needs. Applying the water hierarchy, in particular, should include an examination of whether the efficiency of water use can be improved to help meet individual needs.

[92] Article L211-1 of the Environment Code

The measures should be set out in the Programmes of Measures required by Art. 11 of the WFD. Water reuse may be one supplementary measure. It is important to note that later steps in this planning sequence examine costs and benefits, including for alternative options. The results of this analysis might lead to changes in decisions on appropriate measures to address the identified pressures and, therefore, to improvements in the final Programmes of Measures.

3. Identify the available quantities of wastewater that could be recycled and how these are placed to address individual needs.

The next step is to analyse the potentially available treated wastewater than can be reused and how this relates to user needs through a feasibility analysis (including environmental needs as set out in the RBMP). The starting point is the quantities of water in wastewater treatment plants which could be adapted to treat wastewater to the standard appropriate to the required use (see Chapter 7). If the planning is taking place at the scale of an individual treatment facility (e.g. when a new facility is being installed or due to individual operator decisions), then the assessment is straightforward. However, if the planning is catchment-wide, then it is important to include not only municipal wastewater sources, but industrial sources also, if these can be treated to a quality appropriate to the use, so that a complete picture is developed.

The quantitative needs of different users can then be mapped out alongside the potentially available sources from different wastewater treatment plants. Putting the information together spatially allows for an assessment of how far priority users are from potential water reuse sources. This is critically important in assessing the costs of water reuse schemes.

4. Determine the necessary treatment requirements and other requirements ensuring safe use and protection of the environment, taking account of EU and national legislation.

Once the likely main users of treated wastewater have been identified, it is important to determine the necessary treatment design to deliver that water, based on an assessment of potential risks from the specific use(s) of the reused water (see Chapter 7). An assessment is needed of the quality of the water entering a wastewater treatment plant (e.g. it may contain industrial effluents and specific contaminants), the quality requirements for users and environmental protection, the requirements to meet EU level obligations, the requirements to meet national or regional legal obligations and, therefore, the specific treatment processes, if any, to be undertaken to meet those requirements and any specific practices that would need to be taken to ensure safe use of the water. Where relevant this should assess any and all risks identified to health and the environment, as described in Chapter 4.

If there are different options to deliver water of a similar usable quality, the choice of treatment approach might be determined by the practicalities of the individual treatment plant (e.g. the ease of introducing particular techniques to an existing layout) and the costs of different options. Cost issues are explored further in the next step.

Further issues to ensure safe use, include decisions on how the water is to be used, such as irrigation practices, in aquifer recharge, etc. There is, of course, a strong interaction with the appropriate standards for treatment. However, it is critical to examine not only the treatment levels, but practical use of the water to ensure its safety and so ensure all risks are managed.

5. Identify the different costs (and energy requirements, externalities) associated with treatment of the different wastewater sources and with the delivery of treated wastewater to the different identified users.

The costs for treatment and supply of treated wastewater need to be determined. Treatment costs will depend upon a number of factors such as the scale of the treatment plant, the quality of the water prior to treatment (which would differ, for example, between industrial treatment plants and municipal treatment plants) and the particular quality requirements of the user(s).

Further sources of costs are the distribution system and eventual costs for storage if needed for balancing continuous supply of treated wastewater and fluctuating or seasonal demand. Construction of the distribution system is a potentially significant cost and, therefore, different costs can be determined based on the proximity of different users as determined in Step 3.

Finally, it is also important to determine ongoing operational costs, including for water treatment, maintenance of the treatment plant and distribution system and for monitoring of the water to ensure it is supplied at the correct quality for the user.

There are published studies of the costs of reused water and comparisons with other sources[93]. However, it is important to determine costs on a case by case basis as each situation will be different.

6. Compare these costs (including externalities), with the other alternatives identified (including "no action") and, how these compare with the benefits (including externalities) to be delivered and, where appropriate, undertake further comparative analysis of alternative options.

The analysis of costs and benefits is likely to result in different costs for supply of treated wastewater to different users based on their proximity, noting that the costs and benefits are not only monetary in nature. Thus the users to receive water will not simply be those of highest priority as the costs for distribution need to be taken into account. Also, the costs and benefits of alternative options may be included in the assessment, so that lower cost choices can be identified to deliver the required benefit.

[93] See for example: WateReuse Research Foundation (2015). Framework for Direct Potable Reuse.

7. Determine the funding sources for the development and operation of the reuse scheme(s) and adequate water pricing – is the project viable, who pays and who benefits?

As noted above, the costs are capital and operational expenditures (investments and operational costs). Both need to be funded (see Chapter 9). If the provision of treated wastewater to a user is a purely commercial undertaking, then the operator of the treatment facility needs to determine the time period over which they expect to recover the start-up costs and determine the price of water accordingly. In some cases some start-up costs might receive support from public funds. The prices for the water are likely largely to reflect the ongoing costs of supply, year on year. The exact nature of the economic relationship will vary depending on individual circumstances. The water provided may be a private water company or a public utility. The users may be private companies or public bodies (including municipalities both owning the utility and using the water). It is not possible here to set out every possible permutation of economic relationship, but it is important that this is full clarified in each case.

8. Ensured that details of agreements/contracts are signed by the treatment plant manager and users regulating the relationships between the parties and defining their respective duties and responsibilities.

Once the service level, service duration, costs, pricing level, liability, etc., are determined, these should be included in contracts between supplier and user. However, it is important to ensure that all responsibilities are clearly identified in any contract. This includes obligations for quality control of the water and any limitations on the use of the water by the user, such as through a monitoring plan. The latter is important as the supplier is providing a product 'safe' for a particular use and it is important that they are not held liable for consequences of its use in situations for which it was not produced.

9. Establish systems for control and monitoring to ensure safe use of the treated wastewater for people and the environment and compliance by the operator with necessary legal obligations.

Finally, it is important that public authorities identify the appropriate systems of inspection and control of the treatment, supply and use of the treated wastewater, based on robust, scientific determination of risks. This will depend on the particular uses, the level of risk to the public and the environment if something in the system were to go wrong and history of compliance with environmental obligations by the parties concerned. This is explored further in Chapter 7. The potential impacts of water reuse (e.g. accumulation of pollutants in soils, ground- or surface water) should be monitored allowing to track long-term impacts and to adjust the system accordingly.

Monitoring of reused water quality has a crucial role. When reused water is stored for longer time before its reuse, its quality can change. Therefore the timing and location of monitoring is crucial and should be properly planned. Monitoring programmes should be comprehensive enough to include contaminants that pose significant risks in the anticipated reuse applications.

6.3 Final points

This stepwise process should lead to the identification of important water needs where water reuse is an appropriate cost effective solution. It is important to note that the process will be likely to identify more complex interactions, such as water reuse being able to address multiple needs, but this can be built into the planning process.

Further, water reuse may not only substitute existing sources (and thereby reduce over-abstraction of surface or groundwaters), but it can be a source for new consumptive uses. For example, instead of discharging wastewater to the sea, reusing the water may allow for urban and industrial uses or local horticulture that was not previously possible with other available sources.

There is limited information available on overall planning in which reuse of treated wastewater is assessed and planned. Much of the literature and is focused on the planning of individual projects (including financial planning of treatment works). While this is at a more detailed level than to be included in these guidelines, the reader is referred to literature which contains good examples of project planning for development of such treatment works[94].

[94] See: Water Reclamation and Reuse http://www.webpages.uidaho.edu/ce432/WA%20DOE%20Water%20Reclamation%20and%20Reuse%20Stds.pdf and also: Condom N., Lefebvre M., Vandome L. (2012). Treated Wastewater Reuse in the Mediterranean: Lessons Learned and Tools for Project Development. Plan Bleu, Valbonne. (Blue Plan Papers 11). http://planbleu.org/sites/default/files/publications/cahier11_reut_en.pdf

7 Protecting public health and the environment

7.1 Introduction

In order to ensure the safe water reuse, it is important not only to apply water quality standards appropriate to the specific use, but also to ensure adequate and reliable operation of water reuse systems and appropriate regulatory enforcement.

As noted in Chapter 1, the European Commission, in consultation with stakeholders, is currently examining quality standards for reuse of treated wastewater for two uses as one action arising from the Circular Economy action plan. Therefore, these guidelines do not recommend any particular standard. However, this document does provide information on the nature of standards, references to standards that have already been developed and how they may be applied, including in the wider context of risk management.

7.2 Standards for the quality of reused treated wastewater

As stated above, these guidelines do not recommend any particular standard (chemical, microbiological, physical, etc.). However, legally binding standards for water reuse have been developed by several Member States and some third countries and international organisations have also developed specific standards which they recommend. Most of the standards that have been developed at Member State level derive from the WHO and USEPA Guidelines[95,96]. These standards usually focused on human health aspects and thus microbiological parameters. In order to ensure that water reuse is safe and compliant with EU legislation both environmental and health aspects have to be sufficiently considered in the development of standards. For Member States where legally binding standards have been adopted, it is obviously necessary to ensure they are complied with (just as it is important to comply with any other relevant national legal obligations, e.g. quality standards for irrigation waters, etc.).

Examples of standards and their use are set out in Table 1 and Table 2. The reader is directed to work supporting the development of possible standards at EU level which has explored the standards that apply in Member States (and at international level) and which would be too detailed to include here[97], [98], [99]. It is important that policy makers examine how standards that might apply in specific national, regional or river basin contexts accommodate different types of use of reused water and ensure that such standards are fit for purpose and do not jeopardize waterbody status.

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[95] EUWI-MED (2007). Mediterranean wastewater reuse report (http://ec.europa.eu/environment/water/water-urbanwaste/info/pdf/final_report.pdf)

[96] See also: Paranychianakis, N. V., Salgot, M., S. A. Snyder, and Angelakis, A. N., (2015). Quality Criteria for Recycled Wastewater Effluent in EU-Countries: Need for a Uniform Approach. Critical Reviews in Envir. Sci. and Techn. 45:1409–1468.

[97] BIO by Deloitte (2015) Optimising water reuse in the EU – Final report prepared for the European Commission (DG ENV), Part I. In collaboration with ICF and Cranfield University.

[98] Alcalde Sanz, L., & Gawlik, B.M. (2014). Water Reuse in Europe Relevant guidelines, needs for and barriers to innovation. JRC Science and Policy Report.

[99] Alcalde Sanz, L., Tavazzi S. & Gawlik, B.M. (2016). Development of minimum quality requirements at EU level for water reuse in agricultural irrigation and aquifer recharge. JRC Technical Report.

It is worth noting that legally defined standards usually are developed to protect human health. These standards may follow different approaches and cover different uses. Many standards distinguish thresholds and requirements depending on the intended use and follow a multi-barrier-concept, e.g. ISO standards. Where Member States are not listed they may, or may not, have standards for practical guidance for ensuring correct application of reused water. For uses such as reuse in industry, the required quality is determined by the particular industrial use and is, therefore, usually an internal matter for the industries concerned (while also ensuring the safety of the workforce).

Table 1 Water reuse standards in selected EU Countries

Note that the standards are legally binding in each of the respective Member States, except in Portugal[100].

Country	Standards reference	Issuing Institution
Cyprus	Law 106 (I) 2002 Water and Soil pollution control and associated regulations KDP 772/2003, KDP 269/2005	Ministry of Agriculture, Rural Development and Environment Department of Environment
France	JORF n°0201 du 31 août 2010 page 15828 texte n° 34 JORF num. 0153, 4th July 2014 Order of 2014, related to the use of water from treated urban wastewater for irrigation of crops and green areas.	Ministry of Public Health Ministry of Public Health Ministry of Agriculture, Food and Fisheries Ministry of Ecology, Energy and Sustainability
Greece	CMD N0 145116 Measures, limits and procedures for reuse of treated wastewater	Ministry of Environment Energy and Climate Change
Italy	DM 185.2003 Technical measures for reuse of wastewater	Ministry of Environment Ministry of Agriculture, Ministry of Public Health
Portugal	NP 4434 2005 Reuse of reclaimed urban water for irrigation	Portuguese Institute for Quality
Spain	RD 1620/2007 The legal framework for the reuse of treated wastewater	Ministry of Agriculture, Food and Environment, Ministry of Health

[100] Source: European Commission (2014). Water Reuse in Europe. Relevant guidelines, needs for and barriers to innovation. A synoptic overview.

Table 2 Examples of standards developed by third countries and/or international organisations

Organisation or country	Comment
World Health Organisation (WHO)	Guidelines for the safe use of wastewater, excreta and greywater were first published by the WHO in 1973; a second version was issued in 1989 and a third version in 2006. A revision process of the WHO guidelines started in 2014, with the aim to publish a revised version of the series of technical documents, along with implementation-oriented documents. In addition, the WHO plans to develop specific water reuse guidelines for drinking water production purposes; these guidelines are expected to be published by 2019 and would include limit values for chemicals, while the existing guidelines mainly cover microbiological parameters.
International Standards Organisation (ISO)	In 2015, ISO 16075 standards parts 1 to 3 were published on water reused for irrigation[101]. These documents cover both agricultural and landscape irrigation and provide guidance on planning, operation, water quality and good practices to avoid potential adverse impacts of water reuse on public health, crops, soil and water resources. The last part 4 with guidance on monitoring will be published soon. ISO standards for urban use, performance evaluation and health risks management are under development.
Australia	Natural Resource Management Ministerial Council, Environment Protection and Heritage Council, Australian Health Ministers' Conference (2006). Australian guidelines for water recycling: managing health and environmental risks[102].
United States	Guidelines for standards have been produced by the EPA (2012)[103] and introduced in California (Title 22).

Standards to ensure water is of sufficient quality for particular uses may be established for different aspects of production of that water and its use. They may:

- Define particular wastewater treatment requirements.
- Set quality criteria for individual contaminants.
- Apply to the quality of water collected at the outlet of the wastewater treatment plant or at the point of use.
- Be specific for each particular type of use.

[101] ISO 16075 Guidelines for treated wastewater use for irrigation projects, http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=5148678

[102] NRMMC-EPHC-AHMC (2006). Australian guidelines for water recycling: managing health and environmental risks: Phase 1. National Water Quality Management Strategy. NRMMC-EPHC-AHMC, Canberra, Australia

[103] EPA (2012). Guidelines for Water Reuse. EPA/600/R-12/618, United States Environmental Protection Agency

It is, therefore, important to be clear as to what standards apply, where they apply and how they are to be applied, to ensure that health and the environment are protected.

7.3 Practical application of quality standards

Establishing quality standards for the reuse of treated wastewater in law is only the start. These then need to be applied in practice. A key issue is how the law defines the responsibility for applying the standards. The law might state that:

- All reused treated wastewater (for a stated purpose) must meet specified standards (responsibility on the users/producers).
- Alternatively, it might state that authorities (e.g. a regulator) should ensure that those standards are met (responsibility on public bodies).

In either case it is important for competent authorities to ensure that information about relevant standards is communicated to those to whom they apply. Where relevant this also needs to include information on the context for their application (e.g. applying to particular uses of reused treated wastewater). The mechanisms to provide such information will vary according to the type of recipient, but are likely to include:

- Clear, simple information provided online (ideally structured according to user needs).
- Information leaflets.
- Discussions during site visits (e.g. during permit visits or inspections).
- Advice from farm advisory services.
- Communication via professional associations (e.g. water utilities, farmers' unions).

In many cases standards may be set out in permits or licenses. It is very likely that inclusion of requirements to meet such standards will form part of a wider permit (e.g. for the operation of a wastewater treatment plant). Where standards for the reuse of treated wastewater are included in a permit, it is essential that the holder of the permit is fully informed as to what legal obligations they are under and how they have to ensure that these legal obligations are to be fulfilled. To achieve this, standards for the reuse of treated wastewater included in a permit should be set out as follows:

- It must be clear for which parameter each standard applies.
- It must be clear where the standard applies (e.g. at the point of leaving a treatment plant, in the distribution system, etc.).
- It must be clear if any deviation from the standards is allowed (e.g. 99% of samples must meet the standard).
- The permit should state what monitoring is required to assess water quality compliance (noting that monitoring requirements do create costs, so it is important to determine precisely what monitoring is needed to ensure safe operation of a reuse system).
- The permit should require that all monitoring undertaken (e.g. online, continuous monitoring) is recorded and that this is made available to inspection/control authorities.

- The permit should indicate who is in charge of monitoring: the water provider, the final user, the public authority (depending on Member State practice). Different parameters and/or frequencies can be attributed to the different actors within a monitoring scheme (e.g. monthly monitoring by water distributor and annual check by public authority)[104].
- Permits could, depending on the legal framework in a country, include additional elements such as public communication.
- Where non-compliance of standards is detected, the permit may state if these are to be immediately notified to the relevant authority. The permit may also state action to be taken if there is non-compliance (e.g. for the operator of a wastewater treatment plant to inform users of the water).

Permits should be made public (as should results of compliance monitoring). Doing this helps to enhance public confidence as it is clear that those responsible for reuse of treated wastewater have to meet specified standards and it is clear how this is to be achieved in practical terms.

Inspection and control are important tools to ensure regulated entities comply with their legal obligations (whether directly set out in law or prescribed in permits and licenses). It is, therefore, important to ensure that the following are taken forward:

- All competent authorities relevant to the particular water reuse scheme should be identified (e.g. there may be different authorities checking compliance for the water industry and the agriculture sector).
- Each inspection authority should be clearly informed about the particular standards that apply to the respective regulated entity. This is straightforward if these objectives have been clearly set out in a permit.
- Inspections should ensure that standards are being complied with, including through the examination of records, etc.

It is good practice for inspectorates to develop inspection plans and programmes[105]. It is also good practice that inspectorates target their resources and individual inspection activities towards those activities which present the greatest risk to health and the environment and/or the greatest risk of non-compliance. Any likelihood of failure to meet quality standards for reuse of treated wastewater would constitute a potential risk to health and/or the environment. Therefore, it is also important for relevant inspectorates to understand both the potential consequences of non-compliance with quality standards and the potential for regulated entities to be non-compliant in order to inform the risk analyses which inform the development of their inspection programmes.

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[104] See for example: SWRCB (2010). Final Report: Monitoring Strategies for Chemicals of Emerging Concern (CECs) in Recycled Water—Recommendations of a Science Advisory Panel. California State Water Resources Control Board: Sacramento, CA, 2010.
http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/docs/cec_monitoring_rpt.pdf

[105] For more information about inspection plans and programmes see Recommendation 2001/331/EC on Minimum Criteria for Environmental Inspections.

The institutional structures for setting standards, issuing permits and undertaking inspections vary significantly across the Member States. There may be several different institutions, or functions may be combined within single institutions. In such cases it is important for clear communication between the institutions to ensure standards are fully complied with.

7.4 Risk assessment and management

The protection of human health and the environment should be undertaken in the context of the precautionary principle and a hazard and risk management approach. Risk assessment is a prerequisite for the management of water reuse. A risk management approach can be used at various stages of water reuse activity to ensure environmental and public health protection. Such an approach should guide the development of specific standards for the quality of reused water, as well as guide the use of that water. While aspects of risk analysis will variously focus on specific health and environmental issues, a good risk assessment will integrate these to provide a clear, holistic conclusion to guide management decisions.

For the purposes of these guidelines, the most appropriate risk management framework is that supported by the WHO[106] and Australia[107]. These risk management frameworks set out an approach to identify specific hazards and critical preventative measures to ensure that reused water is fit for purpose[108]. However, in looking to manage risks to health and environment, it is important to frame any approach in a precautionary manner and also to ensure that water reuse does not lead to any adverse changes in the environment (e.g. introduction of substances to soils and/or water).

In 2015, WHO published[109] its approach to Sanitation Safety Planning (SSP), as a step-by-step risk-based approach to implementing its 2006 guidelines. In summary, SSP aims to:

- Systematically identify and manage health risks.
- Guide investment based on actual risks, to promote health benefits and minimise adverse health impacts.
- Provide assurance to authorities and the public on the safety of sanitation-related products and services.

In applying the SSP concept to water reuse, it is important to take account of the issues raised throughout these guidelines, from the initial step of priority setting within RBMPs, etc. (as outlined in Chapters 1 and 6), hazard identification and control (Chapters 4 and 7),

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[106] WHO (2006). Guidelines for the safe use of wastewater, excreta and greywater.

[107] NRMMC-EPHC-AHMC (Natural Resource Management Ministerial Council, Environment Protection and Heritage Council, Australian Health Ministers' Conference) (2006) Australian guidelines for water recycling: managing health and environmental risks: Phase 1. National Water Quality Management Strategy. NRMMC-EPHC-AHMC, Canberra, Australia.

[108] De Keuckelaere, A., et al. (2015). Zero Risk Does Not Exist: Lessons Learned from Microbial Risk Assessment Related to Use of Water and Safety of Fresh Produce. Comprehensive Reviews in Food Science and Food Safety, 14: 387-410.

[109] WHO (2015). Sanitation Safety Planning: Manual for Safe Use and Disposal of Wastewater, Greywater and Excreta. http://apps.who.int/iris/bitstream/10665/171753/1/9789241549240_eng.pdf?ua=1

operational monitoring and quality control (Chapter 7.3). Further details are not elaborated here to avoid unnecessary duplication.

It is not possible in these guidelines to set out the detail of risk management of the use of treated wastewater, not least because the step-by-step guide produced by the WHO serves this purpose well. However, these guidelines do stress the importance of good risk assessment and management. This should include risks to those working in wastewater treatment facilities and using treated wastewater and the general public. Work is currently ongoing[110] to develop the water reuse safety plan approach and this should be taken into account where possible. A multiple barrier treatment scheme helps to reduce risks and good quality data, using on-line water quality monitoring, also reduces the likelihood of failure. Decision support tools for a quick response in case of failure should also be developed. Reducing risk is not only about standards and treatment levels (i.e. technologies deployed), but about ensuring good practice as reused water is used.

Box 19 Study of risk assessment and management in Spain

In Spain a study was carried out regarding risk assessment and risk management in managed aquifer recharge and water reuse in Sabadell[111]. The increasing practice of water reuse, including or not managed aquifer recharge (MAR), requires a thorough assessment of the risks posed by it in real systems.

The treated effluent of the Ripoll River WWTP is discharged into the Ripoll River, thus enhancing the natural infiltration to the alluvial aquifer. Pumping of the groundwater induces a riverbed filtration process (RBF), which is one type of MAR. The recovered water undergoes further post-treatments, including UV, chlorination and sand filtration. After the post-treatments, the water is used for park irrigation and street cleaning. This site was part of the RECLAIM WATER research project, supported by the EU (FP6) and devoted to studying MAR and the use of treated wastewater for it in different locations in Europe, as well as in other countries outside Europe. For the Sabadell case study, a risk assessment and a risk management plan have been developed. In addition, a quantitative microbial risk assessment (QMRA) has been developed.

[110] Goodwin, D., Raffin, M., Jeffrey, P and Smith, H. (2015). Applying the water safety plan to water reuse: towards a conceptual risk management framework. Environ. Sci.: Water Res. Technol., 2015, 709-722

[111] Environmental Science and Technology (H0701: Ciències I Tecnologies del Medi Ambient). Risk and Risk Assessment in Managed Aquifer Recharge and Recycled Water Reuse: The Case of Sabadell. Thesis submitted to the University of Barcelona in fulfilment of the requirements for the degree of Doctor by María Neus Ayuso Gabella. Director: Professor Miquel Salgot de Marçay. Tutor: Professor Joan Mata Álvarez.

8 Public participation and engagement with stakeholders

8.1 Introduction

The reuse of treated water can raise public concerns. They may be concerned over risks of direct or indirect exposure to that water (whether this is a risk or not). Proper planning and decision making on the use of treatment to the required standards will help address these concerns. However, there may still be a perception by the public of risks to health and the environment. Therefore, it is important to engage with the public and other stakeholders in the planning and introduction of systems for water reuse.

It is also important to note that the general public and other stakeholders could have legitimate views on the priorities for water reuse and other practical decisions. This includes all of those potentially affected (positively or negatively). It is, therefore, important that these are captured in the planning and decision making processes described in Chapter 6 from an early stage. This chapter explores the importance of engagement with the public and other stakeholders and how to do this. It is important to stress, however, that these guidelines are not written as a tool for public communication itself.

It is best practice to have as wide as possible engagement with the public, as well as with the relevant stakeholders on an equal footing (water industry, farmers, etc.), from the earliest stages of planning. The precise techniques and processes to use for communication and participation will vary according to circumstances and local traditions. Not least the size of the public to be engaged with will affect the appropriate engagement processes.

It is also important to engage with the public and other stakeholders at an early stage as possible. This helps to create transparency and allows for useful information to be gathered from stakeholders which can be important in informing planning, etc.

It is recommended to follow practices of active engagement as promoted by the WFD and explored by CIS Guidance on this issue[112] as well as other relevant sources[113]. Indeed, Member States such as Malta and Spain have included information campaigns concerning reuse as measures within their Programmes of Measures within RBMPs. Active engagement is very important as it brings the public into the decision making process rather than them feeling they are the recipients of information for which they are simply being asked an opinion. Active engagement raises the public's understanding of an issue and is particularly helpful at overcoming misperceptions of an issue. The CIS Guidance No 8 emphasised that public participation is NOT necessarily about:

"*Everybody joining:* be selective with actors, do a stakeholder analysis;
Everybody deciding: make clear what everybody's responsibilities are;

[112] CIS Guidance No. 8. Public Participation in relation to the Water Framework Directive. https://circabc.europa.eu/sd/a/0fc804ff-5fe6-4874-8e0d-de3e47637a63/Guidance%20No%208%20-%20Public%20participation%20(WG%202.9).pdf%20b

[113] Such as guidance on participative planning developed by the EU-funded AQUAREC project and studies under the DEMOWARE Project: Brouwer, S., Maas, T., Smith, H., Frijns, J. (2014). D5.2 Trust in Water Reuse: Review report on international experiences in public involvement and stakeholder collaboration. DEMOWARE Project.

Losing control: participation cannot work if the outcome is completely predetermined, yet organise it well;
Achieving consensus at all expense: make clear that it will be impossible to satisfy all wishes hundred percent. Participation will help to explain decisions as they occur and promote ownership of the outcome arrived at."

Therefore, it is important to be clear (for both the public and for authorities) of the expectations and limitations of public participation. However, good public communication and participation can lead to:

- Increasing awareness of the issues, benefits, risks, etc.
- Obtaining knowledge from the public for decision makers to improve decisions for reuse schemes.
- Public acceptance, commitment and support to the decisions.
- Creation of communication channels for future communication needs.

It is also important to note that engagement with the public on the issue of water reuse may arise in formal consultation situations. For example, water reuse might be highlighted as one solution to water scarcity problems within a RBMP. If so, the formal consultation process on that RBMP would raise the issue with the public. At a different scale, construction of treatment facilities or distribution systems might trigger consultation under EIA or local laws on construction permits. Again this would raise the issue of water reuse with the public.

In many cases, active engagement with the public on the issue of water reuse would be best undertaken within the wider context of water scarcity management (or even river basin management), looking at the needs of different users, the stresses caused and the options for water sources, etc.. This places water reuse in its context – addressing a problem and for it to be considered alongside other potential solutions.

8.2 How to engage with the public and stakeholders?

Many authorities are aware that stakeholder participation is a key success factor for the development and efficient operation of water reuse schemes (Box 20 and Box 21 explore examples of engagement with the public). In order to build trust and get support, authorities therefore have to initiate stakeholder awareness raising actions, consultation and collaboration activities during the development of new water reuse schemes. In most cases, the development of water reuse projects is thus an opportunity to enhance good governance practices and public participation. However, the examples show that once reuse schemes are in place, they can be used as ongoing awareness raising opportunities.

It is important to perform some prior analysis of the stakeholder/public that needs to be consulted. The analysis should identify:

- The relationship between the stakeholder/public and the particular water reuse issue/scheme.
- The scale of the scheme and the context of the stakeholder/public.
- The capacity of the stakeholder/public to engage in communication.

- Any relevant political, social, etc., contexts that might affect the means of communication or its effectiveness.

The analysis also needs to identify who is to undertake the engagement with stakeholders. This will include stakeholders working with other stakeholders. For example, in early stages of problem analysis at river basin level, the water industry will be a stakeholder for the river basin authority to engage with. However, later as reuse schemes are constructed and become operational, the water industry may become active in engaging with other stakeholders. Thus who does the engagement may vary at different stages and for different purposes.

It is important to note that different stakeholders will require different types of communication and the language used is critical (hence Chapter 2 of these guidelines notes that the terminology used here is not designed for wider public communication). Some stakeholders need simple clear messages which they can react to, while others will wish to engage with more detailed technical discussions. Use of novel techniques and technologies can also help to engage with some sections of the public. Different types of stakeholders include:

- **Professionals** – public and private sector organisations, professional voluntary groups and professional NGOs (social, economic and environmental). This also includes statutory agencies, conservation groups, business, industry, and academia. It will include major sources of reused water (utilities) and users (such as farmers' associations).
- **Authorities, elected representatives** - government departments, environmental authorities, statutory agencies, municipalities, local authorities
- **Local Groups- non-professional organised entities** operating at a local level.
- **Individual citizens, farmers and companies** representing themselves.

In all cases it is important not only to determine who needs to be communicated with and by what method, but also who is to do the communicating and whether they are able to do this. For public authorities, if a communication strategy is being developed, it is important to ensure that the capacity is available to deliver it. It may be useful, for example, to draw on expertise from others (water industry, health professionals, etc.). However, if there are situations where there are significant concerns from reuse of treated wastewater, it will be important to ensure that those undertaking the communication are perceived to be as trustworthy was possible.

It is also important to gather sufficient information before communication begins. This includes information on:

- The justification of the need for water re use, e.g. the context of water scarcity, including under future climate conditions.
- The costs of installing treatment and distribution systems.
- The environmental benefits and drawbacks/risks.
- The social and economic benefits and drawbacks/risks.

- All of these should be analysed within the planning process in order to provide a clear justification for the introduction of the water reuse scheme.
- Transparency on exposure risks to the public, how these will be addressed and the treatment levels to appropriate standards.

The public participation process can involve different types of activity, such as:

- Provision of information online (this can be constructed so as to be easily understandable to lay readers, but also allow access to more technical information).
- Public meetings, workshops, seminars, etc.
- Development of tailored literature.
- Provision of information, speakers, etc., for others to use (e.g. farmers' unions or advisors).
- Preparing public awareness plans on wastewater treatment management (e.g. visits to WWTPs, use of the media, etc.), to be implemented as necessary to encourage public confidence in the operation of local WWTPs.

It is important to ensure that all information is available as far as is possible. Further, before engaging directly with the public, it may be good practice to discuss water reuse issues with relevant NGOs. This will ensure that they understand the context of any water reuse proposals and potentially obtain support during the communication process. Box 22 and Box 23 provide examples of gaining social acceptance of reuse schemes in Italy.

Experience of water reuse points to the importance of establishing effective channels of communication between government departments or regulatory bodies responsible for different parts of the water reuse cycle, with regulators pointing to coordination between environmental and public health authorities as the key factor to effective water reuse policy and communication. Therefore, communication should include water managers, local government, health authorities, etc.

Awareness raising campaigns, development of awareness raising tools and dissemination of information on the various benefits of water reuse among all key stakeholders have two main objectives: to build trust, credibility and confidence in water reuse (addressing health risks-related concerns of the general public and workers potentially exposed to the water); and raise awareness on the benefits of reuse for the various stakeholders involved in the development of water reuse schemes.

In communicating with the public it is important to clarify the communication context. It may be that the context is a particular consultation on a specific water reuse scheme. However, the role of water reuse may be addressed with the public in wider contexts, such as in developing RBMPs or in plans for addressing water scarcity and droughts. These wider planning contexts should be preferred as these are able to set out all of the problems facing a catchment and the water users within it and the potential role of water reuse alongside other possible solutions.

Box 20 Examples of where communication with the public builds trust for reusing water

A study carried out in the Segura River Basin, Spain, showed that the acceptability of reusing water for agricultural purposes increases when the population is informed about the cost of traditional supplies and the cost savings that can result from reusing water[114].

A study was conducted[115] to evaluate the customer perception of the "Watercycle" recycling scheme of the London Millennium Dome (now called the O2 Arena). The reuse of water was explained in the venue using signage in the washrooms and a Watercycle exhibit. The study showed that the acceptability of water reuse systems was significantly enhanced for the individuals who had seen the signage or the exhibit.

Box 21 Engaging with stakeholders in Milan

Since its operations began[116], the Nosedo and San Rocco WWTPs have been open to scheduled visits, particularly for schools or educational institutions and citizens from various local or non-local associations. Environmental awareness from citizens and schools is fostered through guided visits of the treatment plants. In particular, local non-profit associations have developed, in cooperation with staff of the purification plant of Nosedo, an educational pathway related to the agricultural and food environment with visits to the plant. Occasionally, farmers hold their meetings at the plant's conference room.

Several local politicians, representing the Milan town administration, province or the Lombardy regional administration, hold meetings with enterprise unions, citizens, farmers or environmental associations, in order to discuss environmental requalification, agriculture development, food safety or energy reuse. Environmental associations also organise their meetings in the plant's conference room to address issues regarding water and its reuse, as well as different environmental matters related to the research sector.

Box 22 Social acceptance of treated wastewater reuse in Apulia (southern Italy)

In Italy, within the framework of the national project entitled PON-In.Te.R.R.A. (2011-2015, www.pon-interra.it) an analysis of the social acceptance of water reuse was performed in order to understand the drivers and factors influencing public acceptance for agricultural irrigation in the Apulia region, and identify the actions required. Surveys were prepared and distributed across the regional territory targeting consumers and farmers, resulting in around 500 replies. Both farmers and consumers have a high degree of awareness about water scarcity in Apulia and suggest the use of treated wastewater as one of the solutions. In this case, the majority of farmers and consumers are in favour of water reuse, with respectively 59% and 87% of acceptance, although they do not know the water quality limits set by the legislation. Nevertheless, the various advantages of water reuse have been well

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[114] Alcon F, Pedrero F, Martin-Ortega J, Arcas N, Alarcon JJ, de Miguel M (2010). The non-market value of reclaimed waste-water for use in agriculture. Span J Agric Res 8

[115] Hills, S., R. Birks, and B. McKenzie (2002). "The Millennium Dome" Watercycle" experiment: to evaluate water efficiency and customer perception at a recycling scheme for 6 million visitors." Water Science & Technology 46: 233-240.

[116] Mazzini, R. Pedrazzi, L. and Lazarova, V. (2013). Milestones in water reuse - The best success stories (Chapter 15). Eds. V. Lazarova, T. Asano, A. Bahri, and J. Anderson. IWA Publishing

recognised. Farmers have less trust (26% opposed) than consumers (4% opposed) in the public and private control on the reuse process. These results were used to conduct a series of meetings, involving the different stakeholders around consultation roundtables aimed at defining the actions required to enhance the social acceptance. Stakeholders reported the need to revise the existing legislation by enforcing controls and setting sanctions, adopting the latest treatment technologies, involving the users in the decision making process, disseminating information and results concerning the environmental benefits and improving the overall management of the treatment-reuse system.

Box 23 Using a demonstration site for communication with stakeholders in Sicily

In Eastern Sicily[117] a permanent exhibition on natural wastewater treatment systems aims to provide technicians, students and farmers with up to date information unconventional water sources for reuse in irrigation. This includes a full-scale natural wastewater treatment system for tertiary treatment of secondary effluent from a conventional wastewater treatment plant. Treated wastewater is used for irrigation of energy (*Arundo donax*) and food crops using micro irrigation techniques. Since 2001 an average of 100 persons per year (students, scientists, politicians, technicians) have visited the site.

8.3 Issues affecting public acceptability

The type of application for which water is reused, as well as the quality of water reused, are important factors for public acceptance. Public acceptance decreases when public health and/or the environment are perceived to be at risk. For instance, public acceptance for reusing water to irrigate crops that are intended to be eaten or to wash clothes is likely to be lower than reusing water for bioenergy cropping. As noted earlier, language is also important. When communicating with the public it may be important, therefore, to avoid referring to 'wastewater' (as it reused treated wastewater), as this can affect the perception of the quality of the water (even if it is of drinking water standard).

According to the WHO[118] the following variables will determine the acceptability of wastewater reuse projects:

- The degree of public awareness (for example, the number of people informed about the procedure).
- The average understanding of sanitation issues.
- The average knowledge of water stress issues.
- Existing alternatives to wastewater reuse.
- The degree of confidence in the wastewater treatment technology.
- The degree of confidence in the sanitary regulations established by the government.

[117] Aiello R., Cirelli G.L., Consoli S., Licciardello F., Toscano A. (2013). Risk assessment of treated municipal wastewater reuse in Sicily. Water Science & Technology, 67(1), pp. 89-98

[118] WHO (2006)

Hartley[119] identified ten factors contributing to increasing public acceptance of water reuse:

- Degree of human contact is minimal.
- Protection of public health is clear.
- Protection of the environment is a clear benefit of the reuse.
- Promotion of water conservation is a clear benefit of the reuse.
- Cost of treatment and distribution technologies and systems is reasonable.
- Understanding of wastewater as the source of reclaimed water is minimal.
- Awareness of water supply problems in the community is high.
- Role of reclaimed water in overall water supply scheme is clear.
- Perception of the quality of reclaimed water is high.
- Confidence in local management of public utilities and technologies is high.

A survey conducted as part of the AQUAREC project revealed that, in the view of some public administrations and of the population, treated wastewater still remains basically wastewater. Furthermore, it is not widely known that in many urban and semi-urban areas in Europe surface or groundwaters (still) have bacterial quality worse than that of wastewater after appropriate secondary-treatment, and that some agricultural areas are irrigated with self-abstracted water whose quality is lower than secondary-treated water. It is not widely known either that, in many urbanized catchments, the water cycles actually include indirect, unplanned and uncontrolled reuse of - sometimes even untreated - wastewater[120].

The first stage of acceptance of water reuse is the acceptance by the community of the need. In this case, water reuse becomes a solution to a problem and this, in turn, is an important driver of public perception[121]. Concerns about risks may also be reduced by the public gaining confidence in the technologies available for water treatment[122].

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[119] Hartley, T.W. (2006). Public perception and participation in water reuse, Desalination, 187, pp. 115-126.
[120] Melin, T. (2006). Wastewater reuse in Europe. Desalination, 187, 89-101.
[121] UK Water Industry Research (2005). Framework for developing water reuse criteria with reference to drinking water supplies.
[122] WssTP (2013). Water Reuse: Research and Technology Development Needs.

Public acceptance also strongly relies on the understanding of the local water cycle (see Box 24, Box 25, Box 26). An important consideration is the question of when does wastewater cease to become wastewater and become just another water resource. In this respect, separating the reclamation phase and the application phase by dilution and storage either in a reservoir or in groundwater may be an important step in achieving acceptance, particularly when retention can be measured in weeks or months rather than days[123]. This approach has been used with considerable success in a number of circumstances where water reuse has been used to directly supplement drinking water sources in Singapore and the UK[124].

Box 24 Public perceptions are affected by the level of information provision

A US-based study aimed to assess whether prior knowledge of unplanned drinking water reuse affects acceptance of planned drinking water reuse[125]. It revealed that users' perception of water reuse can improve significantly once they receive information about the holistic water cycle and the existence of unplanned drinking water reuse. It also revealed that the terminology continues to have a strong influence on the level of acceptability (e.g. 'purified water' much better perceived than 'treated wastewater') and that more information on monitoring and testing is needed to increase trust.

Box 25 Public perceptions of water reuse can be positive

In France, a good level of acceptability with regard to water reuse was found during a survey[126]: a majority of the French population (68%) agreed to consume fruits and vegetables irrigated with reused water. However, the survey showed that less than half of the population (45%) would accept domestic supply of drinking water produced from treated wastewater water. A perception survey was also conducted in the context of the Clermont reuse scheme (crops irrigation), showing high acceptability by the nearby inhabitants.

Box 26 Non-European examples of increasing public acceptance

Experience from major reuse projects in Australia with a focus on irrigation of products consumed raw points to major early investments in marketing and awareness-raising campaigns as key success factors. In Adelaide, for example, the Virginia Pipeline project was supported by an extensive (3 year) education programme including a market study, display of water reuse at public meetings and ongoing support of the local health authority, resulting in a clear change of public perceptions over the period. In this case, upfront capital investment was high, over €16m, but this investment was rapidly recovered by the

[123] Strang, V (2004). The meaning of water. Berg Publishers Limited.

[124] Walker D. (2001). The Promotion of a Planned Indirect Wastewater Re-use Scheme in Essex. J.Ch.Instn. Wat. & Envir.Mangt.. 15, (4), 271-278.

[125] McPherson and Snyder (2011). Effect of Prior Knowledge of Unplanned Potable Reuse on the Acceptance of Planned Potable Reuse. Presentation at the 15th Annual Water Reuse & Desalination Research Conference, May 16-17 (https://www.watereuse.org/sites/default/files/u3/Linda%20Macpherson.pdf)

[126] MEDDE/CGDD, March 2014, Études & documents n°106 – Ressources en eau : perception et consommation des Français - Résultats d'enquête (Studies & documents no. 106 – Water resources: perceptions and consumption of French people – Survey results).

economic benefits from the production of vegetables, fruits and nuts for local and interstate markets [127]. The availability of additional water not only enabled an increase in agricultural production, but also a doubling of the land value from 12,000 €/ha to 24,000 €/ha [128]. This suggests that even relatively extensive educational programmes can be commercially viable, if these result in increased demand or willingness to reuse water.

A successful public awareness campaign is the NEWater programme in Singapore, which has resulted in a 98% acceptance rate for water reuse schemes amongst the public[129]. A comprehensive public education campaign was directed towards a wide range of stakeholders – including politicians, opinion leaders, water experts, grassroots leaders, students and the general public – to win confidence by explaining the advanced technology, showcasing its proven quality and addressing the misconceptions around water reuse.

[127] Lazarova, V. (2013). Global milestones in water reuse: keys to success and trends in development, *Water 21*, August, pp. 12-22.
[128] Stevens and Anderson (2013). Irrigation of crops in Australia. In: Milestones of Water Reuse: the Best Success Stories, ed. by Lazarova et al., IWA Publishing, London
[129] *http://unesdoc.unesco.org/images/0023/002321/232179E.pdf*

9 Funding Water Reuse Schemes

9.1 Introduction

Delivering water reuse schemes has costs, particularly with regard to the construction of treatment works and distribution systems of the water to users, as well as their operating and maintenance costs. However, it is important to stress that a secure water supply of high quality is a product of considerable value to users and in water-scarce regions, for example; reuse schemes are, therefore, valuable to their users[130]. It is important to note that, as with other water sources, costs are borne by one part of society or another and, therefore, determining the costs and who should pay with regard to water reuse is part of a wider consideration of payment for all water services. It is also crucial that funding schemes do not contribute to putting additional pressures on water bodies and ecosystems that are already in poor status / condition.

9.2 Investments and operational costs of treated wastewater reuse

In planning a water reuse scheme, the funding must be budgeted and the sources of those funds identified and decisions for a water supplier will, in many cases, reflect the extent of expected financial returns. There may be options similar to existing WWTP infrastructure developments, or funding options linked to uses of the water, such as support for sustainable irrigation. The types of funding will be case specific, so cannot be detailed in these guidelines. They could include a range of public and private sources, including EU funds where appropriate (see section 9.3). The contexts for raising finance vary across Europe, with public and private utilities and different arrangements for payment for services such as sewage. This means that some opportunities to raise funds in some countries will not exist in others. This needs to be carefully taken into account in planning investment.

Investment costs as a percentage of the total cost of a water reuse projects depend on a number of factors, such as existing water treatment infrastructure, treatment costs, payment regimes, etc.. These costs depend on a number of factors, such as existing water treatment infrastructure. It is important that investment needs for water reuse are considered alongside wider investment needs for the collection and treatment of wastewater. This allows for the investment decisions to be more coherent with wider water management decisions and the spending associated with them.

Timing is also an important consideration for determining costs. When urban or industrial treatment plants need to be renewed, including treatment facilities for reuse may be more easily included at lower costs than if they are retrofitted to an existing system.

Major investments may be needed to link treatment plants to users. For water reuse suppliers, the benefits of reused water are largely limited to financial returns (if any), and reducing demand for freshwater may impact on overall investment in water infrastructure131. An example of an analysis of investment costs for reuse in Italy is given in Box 27.

[130] Winpenny, J., Heinz, I., Koo-Oshima, S. (2013). The wealth of waste. The economics of wastewater use in agriculture.

[131] Fatta et al. (2005). Wastewater reuse: problems and challenges in Cyprus, Turkey, Jordan and Morocco. *European Water*, Vol. 11, No. 12, pp. 63-69.

Box 27 Assessing the costs of treatment upgrading in Italy

A techno-economical assessment of additional costs involved in effluent upgrading for water reuse in irrigation to comply with national regulation was proposed in the case of Apulia (Southern Italy)[132]. The additional actions to comply with the Italian reuse standards were evaluated in two cases according to the effluent quality of existing treatment facilities. The analysis of wastewater treatment facilities concerned:

a. The identification and estimation of additional costs required to adapt treatment facilities to reuse standards, depending on the effluent quality (Type A facilities of 2,000 PE and reuse for irrigation and Type B facilities of 500,000 PE for industrial reuse);
b. Aspects related to the organization and management of the system and to methodological and technical aspects of water pricing policies. This concerned the different management levels involved in the reuse cycle: wastewater treatment plant, reuse facilities, and distribution network.

The analytical evaluation resulted in the assessment of costs which vary according to the plant size and type of reuse, ranging between 0.07 €/m^3 (Type B) and 1.14 €/m^3 (Type A).

Note that in costing a water reuse scheme, it is important to take into account appropriate externalities, e.g. identifying avoided costs from the introduction of such schemes. These should be compared to investment costs and so help decision makers make appropriate investment choices. Of course, avoided costs may fall to different actors than investment costs and understanding who pays and who gains requires a broad overview from relevant authorities. The main externalities from water reuse are presented in Table 3. A water reuse scheme should not be considered if there are any significant negative externalities (e.g. to the environment or health) (see Chapter 6).

Table 3 Identification of positive externalities from water reuse[133]

Type of issue	Externality
Water infrastructure	Avoid construction and/or treatment costs for water that would have been treated and discharged through different routes.
Reuse of nutrients	Reuse of nitrogen and/or phosphorus in agriculture.
Use of the resource	Increases water supply and makes supplies more secure.
Environment	Can reduce abstraction from surface and groundwaters. If used for environmental purposes it will deliver specific benefits. Reduction of contaminant loads to water.
Education	Can raise awareness of water cycle and wider environmental issues.

[132] Fresa et al. (2007). Planning for Wastewater Reuse. Options Méditerranéennes, Series B: Studies and Research, N. 56, vol. II, 129-147

[133] Based on: Hernandez et al. (2006). Feasibility studies for water reuse projects: an economical approach, Desalination, Vol. 187, pp.253-261.

Evidence suggests the economic returns on water reuse can significantly outweigh costs, when such externalities and public goods are accounted for[134]. Quantifying these benefits can strengthen the case for reuse schemes and public support.

9.3 Water pricing as a source of funding

Paying the right price for water is one way to raise the funds for the development and/or operation of water reuse schemes. Adequate water pricing is important for the sustainable, long term financing of high quality drinking water and sewerage services. There are often insufficient price differentials between treated wastewater and freshwater, which is made worse by a lack of sufficient cost recovery and the existence of public subsidies to conventional water resources in many areas of the EU. This leads to the consequence that the prices of conventional resources and reused water may not reflect their actual cost. This situation may affect the economic attractiveness of water reuse projects and affect decisions by water users and decision makers. The development of water reuse schemes, therefore, needs to be done in the wider economic context of user-, polluter- and beneficiary-pays principles.

Recovery of costs for water services in the EU is defined within Article 9 of the Water Framework Directive including environmental and resource costs, having regard to the economic analysis conducted according to Annex III, and in accordance in particular with the polluter pays principle.

Low levels of cost recovery would discourage both water efficiency and reused water by failing to account for the full external costs of freshwater abstraction and wastewater discharge. Because these external costs are typically borne by taxpayers, price support measures for water reuse may be justified, to enhance its competitiveness. This is the case in two Member States where water reuse schemes have significant uptake (Spain and Cyprus) partly through the use of subsidies, together with an integrated supportive regulatory regime. However these cases remain highly atypical for the EU overall, and concerns over their financial sustainability still persist. Box 28 provides examples of tariffs in Cyprus and pricing in Spain.

Box 28 Examples of tariffs in Cyprus and pricing in Spain

Reused water tariffs in Cyprus range from 33 to 44% of freshwater (water from dams) rates, ratios which appear typical for the Mediterranean region[135]. Although such subsidised price structures have been in place for many years, these ratios are often based on perceptions of willingness to pay (WTP) within different user groups rather than empirical evidence of substitution rates.

[134] Molinos-Senante M., Hernández-Sanchoa F. and Sala-Garridob R. (2011) Assessing disproportionate costs to achieve good ecological status of water bodies in a Mediterranean river basin. J. Environ. Monit., 2011,13, 2091-2101.

[135] Hidalgo and Irusta (2005) The cost of wastewater reclamation and reuse in agricultural production in the Mediterranean countries. Proceedings of the IWA International Conference on Water, Economics, Statistics and Finance-Rethymno, Greece, July 2005.

Strong pollution abatement regulations have also increased the overall capacity of treated effluent supplies. Comparison with uptake levels in 2005 indicates a relatively inelastic demand within the agricultural sector, attributed to distribution and infrastructure constraints, but noticeable elasticity of demand for uses in landscape irrigation (sports, hotels and gardens).

Treated wastewater in Spain's Segura river basin is sold to irrigators at around 0.12 €/m^3. This represents a fraction of the estimated 0.40 €/m^2 cost including capital, operational and environmental expenditures. Overall, 99% of available wastewater resources are currently reused, 60% being directly reused, mostly in irrigation[136].

Water reuse may be economically favourable compared to other unconventional sources[137] and it is important that pricing for reused water is integrated with pricing in the context of wider water supply. However, competitive tariffs for water reuse (at or below those of fresh water) have been seen as essential to drive uptake[138].

In considering pricing for water reuse (noting that any option that does not result in full cost recovery has some form of subsidy), the following options exist:

- *No charging* – treated wastewater may be charged at a zero tariff so as to increase its demand and therefore reduce or avoid effluent discharge into sensitive aquatic environments. Some schemes in Australia, that aim to reduce effluent discharge into sensitive aquatic environments, do not charge at all for treated wastewater reuse[139].

- *Price based on cost of supply* – the cost of the reused water supply is determined simply by the cost of treatment and distribution of that product to the user.

- *Defined percentage of the price for drinking water* - treated wastewater is often offered for a lower price than drinking water. This price signal highlights the advantages of treated wastewater for the customers and increases its acceptance. Examples are given in Box 29.

- *Defined percentage of the price for fresh irrigation water (untreated surface or groundwater)* - treated wastewater is often offered for a lower price than irrigation water, giving a strong incentive to use. This price signal highlights the advantages of treated wastewater for the customers and increases its acceptance. Examples are given in Box 29.

136 Global Water Intelligence (2012). Paying the Price for Reuse in Spain.
137 Plan Bleu – UNEP (2012). Treated wastewater reuse in the Mediterranean: lessons learnt and tools for project development (http://planbleu.org/sites/default/files/publications/cahier11_reut_en.pdf)
138 Hidalgo and Irusta (2005) The cost of wastewater reclamation and reuse in agricultural production in the Mediterranean countries. Proceedings of the IWA International Conference on Water, Economics, Statistics and Finance-Rethymno, Greece, July 2005
139 WSAA (2005) Australia's water, sharing our future prosperity, Water Services Association of Australia, Melbourne.

- *Price adjusted to the willingness to pay of users* - from a demand viewpoint, knowing how much different users would be willing to pay for the reused water is important. Rates for water reuse would be based on what the market could uphold, without taking into account the costs required, so users are charged the value of the water to them. An increased awareness of the benefits of reuse amongst users can lead to increased demand and also induce users to state a higher willingness to use and willingness to pay.

- *Same prices for conventional and reused water* - in this case there is no difference in prices between conventional and reused water.

- *Prices based on the recovery of environmental and resource cost*, as required by the WFD.

Box 29 Examples of charging a percentage of price for drinking water

In Cyprus, reused (tertiary) treated water is supplied for irrigation and landscape uses, with a price that is only 33% - 40% of the price of fresh water supplied for the same users, in the same areas (fresh water price was €0.17/m3 for agriculture and €0.34/m3 for landscape, while the reused water price was €0.07/m3 and €0.15 respectively). This was one strong incentive for the users to accept it as a new reliable water resource.

A survey of 11 southern Californian water reuse projects mostly supplying irrigation water showed water price as a percentage of drinking water prices ranging from 45 to 100% with an average of 77%[140]. Sydney Water in Australia provides reused water for domestic uses in the Rouse Hill residential area for only 30% of the drinking water price. Also in Sydney Olympic Park the price is fixed at AUS$ 0.15 below the drinking water price[141].

It is important though, to ensure a suitable relationship between the rates for conventional water resources and those for reused water. Setting an excessively low price for treated wastewater in relation to existing alternatives could over-encourage the use of this water, provoking unsuitable uses and even external costs and possibly damage the image of treated waste water seen as “less good” than existing alternatives. A solution to this is the use of an increasing block tariff - stepped increases in tariffs as usage increments. In essence, fixing the price for reused water is always a trade-off of cost distribution between the beneficiaries, the operators and the tax payer in general. The complexities of determining a price for water reuse are explored in the case of Madrid in Box 30.

[140] APWA (2005). Good until the last Drop: A practitioner’s guide to waste-water reuses, American Public Works Association.
[141] AATSE (2004). Water Recycling in Australia, Australian Academy of Technological Sciences and Engineering; SOPA (2006). Sydney Olympic Park - Urban water reuse & integrated water management. Ed. Sydney Olympic Park Authority.

Box 30 Pricing of water reuse in Madrid by the Canal de Isabel II

In 2006, a new system of charging for water services, provided by the public entity in Madrid Region, Canal de Isabel II (CYII), was justified by the strong support that the region of Madrid is giving to water reuse[142]. The Madrid “Plan Dpura”, aims to supply 30 to 40 Mm^3 per year of reused water for irrigation of public green areas, golf courses, industrial uses and street cleaning. The view is taken that by targeting higher value added activities, higher prices and rates may be applied. The service for reused water supply comprises two services:

- Reclamation service, which includes preparatory works and necessary treatment (tertiary, auxiliary, conditioning and refining) applied to previously treated wastewater, to produce flows with suitable physicochemical and microbiological characteristics for its reuse.
- Transport service: The service driving reusable water from the treatment plant to the point of supply that connects with the users´ distribution system.

For the application of rates the contracted capacity and its use by the user is taken into account. The traditional structure has two parts: a service fee and a consumption fee; the consumption fee includes different prices if at least 75% of the contracted volume has not been used. On the fixed part or service fee, both treatment and transport, is applied to a fixed amount a correction factor "iR" and "iT" and is multiplied by the daily cubic meters of contracted capacity. The factor "iR" is the percentage of the investment made by the CYII, compared to the total investment made in reclamation infrastructure, from which the user is provided with reusable water. The "iT" factor of the transport service is the percentage of investment made by the CYII compared to total investment required for the implementation of transport infrastructure.

Rates of water reuse of the Canal de Isabel II for the years 2006 to 2012. Consumption of less than 150,000 m^3 per year

Concept			2006	2007	2008	2009	2010	2011	2012
Service fee (fixed amount, in €/m^3 of contracted capacity)	Reclamation		5,270300	5,1468	5,1468	4,7987	5,2703	5,3915	5,5532
	Transport		4,887391	5,2419	5,2419	5,3677	5,3677	5,4912	5,6559
Consumption fee (€/m^3)	Reclamation	<25% volume	0,252821	0,2711	0,2711	0,2776	0,2776	0,2840	0,2925
		<75% volume	0,184559	0,1979	0,1979	0,2026	0,2026	0,2073	0,2135
		>75% volume	0,116297	0,1247	0,1247	0,1277	0,1277	0,1306	0,1345
	Transport	<25% volume	0,048303	0,0517	0,0517	0,0529	0,0529	0,0541	0,0557
		<75% volume	0,035261	0,0378	0,0378	0,0387	0,0387	0,0396	0,0408
		>75% volume	0,022219	0,0237	0,0237	0,0243	0,0243	0,0249	0,0256

142 Análisis de fórmulas de recuperación de coste de tratamiento de las aguas residuales y de su distribución para reutilización. Alberto del Villar García. Grupo E1 de Economía Ambiental de la Universidad de Alcalá de Henares

The design of these fees allows full recovery of the costs of investment and maintenance and conservation applied by the CYII for the provision of these services. It is possible to alter with the correction factors ("iR" and "iT") to apply exceptions criteria (grants) to cost recovery.

Since 2006, the rates for this service have had a cumulative growth up to 2012 of almost 16%. Although rates were frozen in two years (2008 and 2010), for comparison, the consumer price index (CPI) for that period in the Region of Madrid, barely exceeded a cumulative 12%.

9.4 The use of EU level funds

There are many different EU level funding sources which may be used to support financing of water reuse schemes. These include: the ERDF and Cohesion Fund, EAFRD, Horizon 2020, LIFE, Natural Capital Financial Facility, EIB Grants and the European Fund for Strategic Investments (ESFI). Some are grants, some loans. Some are 100% funded, some require co-funding. Some apply to eligible areas/situations, others are universal. Some apply to particular types of recipients. All have different planning and application processes which need to be taken account of in developing and implementing water reuse schemes. A summary of the relevance of each of these EU level funding sources is provided below.

Cohesion Policy funds

The European Regional Development Fund (ERDF) and the Cohesion Fund (CF)[143] are part of the European Structural and Investment Funds (ESIF), which invest around €450 billion in European regions and Member States along 11 thematic areas in line with the Europe 2020 Strategy for smart, sustainable and inclusive growth.[144] Thematic Objective 6 (protecting the environment and promotion resource efficiency), which has about €35 billion from the ERDF and CF, includes:

- Investing in the water sector to meet the EU requirements and to address needs, identified by Member States, for investment going beyond those requirements.
- Promoting ecosystem services, green infrastructure, innovative technologies, resource efficiency in water sector, etc.

In line with the priorities set by Member States and the Commission in the various programmes, the ERDF and CF can be used for funding water reuse schemes, based on their contribution to water efficiency and, more generally, on delivering objectives in the water sector where these meet EU needs. Additional funding might come from the €41 billion allocated to Thematic Objective 1 (research and innovation), which supports innovative solutions for all areas including water management. An example of the use of Cohesion Policy Funds is given in Box 31.

[143] The Cohesion Fund helps Member States with a GNI per inhabitant of less than 90% of the EU-27 average to invest in, inter alia, the environment.

[144] https://cohesiondata.ec.europa.eu/

Box 31 Example from Spain of the use of Cohesion Policy Funds

In Spain's Segura River Basin District, 99% of all treated effluent is currently reused for agricultural irrigation or environmental allocations by 96 plants. This scheme has been made possible through a large capital investment of €630m sourced from Cohesion Policy funds.

Rural Development Funds (EAFRD)

The funding through Pillar II of the CAP is for funding in rural areas. Rural Development Plans have been adopted. However, the most relevant rural development priorities/focus areas are:

- (5) (a) increasing efficiency in water use by agriculture.
- Art. 18: Investments in physical assets.
- Art. 19: Restoring agricultural production potential, "preventing" natural disasters.

Water reuse schemes for irrigation increase water efficiency use by agriculture, they are an investment in a physical asset, help mitigate drought problems, etc. Therefore, appropriate water reuse schemes could be eligible for support.

Horizon 2020

H2020 funds projects addressing "societal challenges", including "Climate Action, Environment, Resource Efficiency and Raw Materials". Water is a main focus and this includes the Innovation Partnerships, including EIP Water. Calls have been published and one focus area is on 'water innovation'. Further calls will arise and it is likely that some aspects of water reuse schemes may be eligible, especially if there are innovative elements. H2020 is not appropriate for major infrastructure investment. The EIP Water website gives more information[145].

LIFE Projects: 2014-2020

LIFE projects include different types of project support with different levels of funding support. These include:

- Interventions – traditional projects, NGO support, technical assistance (60% co-financing).
- Integrated projects (IPs)(60% co-financing).
- Capacity building (100% financing).

Of these different types, Integrated Projects have particular potential. These are aimed at implementing plans/strategies (e.g. RBMPs) at large scale. Proposed actions should target significant pressures affecting the environment's capacity for water retention and the use of low impact measures identified in RBMPs, etc. There is a maximum of €855 million for 7 years (of which around €637million in the sub-programme for Environment), with 3 IPs per Member State over 7 years. Therefore, if water reuse schemes are part of the integrated approach to water management within RBMPs, IPs might form a funding source.

[145] http://www.eip-water.eu/horizon-2020-launched-%E2%82%AC15-billion-over-first-two-years

European Investment Bank
The EIB provides loans for investment. In its stated priorities on the environment, types of projects eligible include water supply and wastewater treatment and disposal. Therefore, construction of treatment facilities for water reuse and distribution systems may be eligible for loans. Information is available at the EIB website[146]. The EIB is also administering the European Fund for Strategic Investments (ESFI), which allows for specific investment in water infrastructure.

Natural Capital Financing Facility (NCFF)
The NCFF is an EU financial instrument funded by the EIB and the European Commission, but managed by EIB. The NCFF will provide debt and equity finance for a range of different types of projects. These include projects relating to water reuse. A pilot phase was established 2014-2017 with a total amount of €100m for financing of operations, with additional grant support facility of €10m for technical assistance. Information is available at the EIB website[147].

Box 32 Examples of EU-funded research projects aiming to promote water reuse

FRAME (2015-18) "A novel Framework to Assess and Manage contaminants of Emerging concern in indirect potable reuse"[148]. The project focus is to develop new strategies to minimize the impacts of a broad range of chemical and biological contaminants when reusing treated municipal wastewater via subsurface treatment to augment drinking water resources. FRAME is testing several treatment combinations including ozonation and advanced oxidation processes coupled with a new process of sequential biologically active filtration. Modelling transport and fate of emerging contaminants and their transformation products through various treatment combinations will provide guidance in assessing the efficiency of mitigation strategies. The FRAME concept will influence European and national regulations related to wastewater and indirect drinking water reuse. It will be primarily validated at water reclamation facilities in Germany and Spain.

R3Water project (2014-2017) on 'Reuse of water, Recovery of valuables and Resource efficiency in urban wastewater treatment'[149]. The main objective of the project is to demonstrate solutions that support the transition from a treatment plant for urban wastewater to a production unit of different valuables. Regarding water reuse, the project aims to demonstrate the benefits of introducing on-line microorganism monitoring technologies in order to increase the efficiency of the water reclamation plants, while guaranteeing the sanitary safety of the 'fit-for-purpose' of reused water.

DEMOWARE project (2014-2016) on Innovation Demonstration for a Competitive and Innovative European Water Reuse Sector'[150] This project will execute 'a highly c*ollaborative programme of demonstration and exploitation, using nine existing and one greenfield site to stimulate innovation and improve cohesion within the evolving European*

[146] http://www.eib.org/projects/cycle/applying_loan/index.htm
[147] http://www.eib.org/products/blending/ncff/index.htm
[148] http://www.frame-project.eu/
[149] http://r3water.eu/
[150] http://demoware.eu/en

water reuse sector'. The project is guided by SME and industry priorities and has two central ambitions: to enhance the availability and reliability of innovative water reuse solutions, and to create a unified professional identity for the European Water Reuse sector. The project ultimately aims to improve both operator and public confidence in reuse schemes.

Water4Crops project (2012-2016) "Integrating biotreated wastewater reuse and valorization with enhanced water use efficiency (WEF) to support the Green Economy in EU and India"[151]. This is one of the largest Euro-India collaborative projects co-funded by the Department of Biotechnology, Government of India and the European Commission that will address the emerging and worldwide increasingly important issue of water and wastewater reuse and management.

SAFIR project (2006-2010) on 'Safe and high quality food production using low quality waters and improved irrigation systems and management'[152]. This project addressed two problems: the safety and quality of food products, and the increasing competition for clean fresh water around the globe. One of the objectives was to test new technology for water recycling and use in agriculture in southern Europe and other areas with insufficient drinking water. The project assessed the impact of the new technology on product quality and safety, production system, and the environment as well as risks from farm to fork.

AQUASTRESS project (2006-2009) "Mitigation of water stress through new approaches integrating management, technical economic and institutional instruments"[153]. AquaStress is an EU funded integrated project (IP) delivering interdisciplinary methodologies enabling actors at different levels of involvement and at different stages of the planning process to mitigate water stress problems. The project draws on both academic and practitioner skills to generate knowledge in technological, operational management, policy, socio-economic, and environmental domains. Contributions come from 35 renowned organizations, including SMEs, from 17 Countries.

RECLAIM WATER project (2005-2008) "Water reclamation technologies for safe artificial groundwater recharge". The strategic objective of the RECLAIM WATER project was to develop hazard mitigation technologies for water reclamation providing safe and cost effective routes for managed aquifer recharge. The work assessed different treatment applications in terms of behaviour of key microbial and chemical contaminants. RECLAIM WATER integrated technological water reclamation solutions with natural attenuation processes occurring in the subsurface to achieve upgraded water quality assessed on the basis of key contaminants.

[151] http://water4crops.org
[152] http://www.safir4eu.org/
[153] http://aquastress.net

AQUAREC project (2002-2006) on 'Integrated Concepts for Reuse of Upgraded Wastewater'[154]. This project aimed to provide knowledge to support rational strategies for municipal wastewater reclamation and reuse as a major component of sustainable water management practices. It produced several deliverables of relevance for policy makers and reuse project developers, including:

- A 'Guideline for quality standards for water reuse in Europe' with proposed limits for water reuse.
- A 'Water Reuse System Management Manual' including proposed water quality criteria for different end-uses (agriculture, urban uses, industrial uses and groundwater recharge).
- A 'Handbook on Feasibility Studies for Water Reuse Systems', primarily intended for reuse project developers.
- A guideline on 'Participative Planning for Water Reuse Projects', dealing with public acceptance issues.

[154] http://cordis.europa.eu/projects/rcn/69076_en.html