POLICY AND PROCEDURES:

1. **TITLE:** **Water Reuse and Conservation Policy**

2. **PURPOSE:**

- The aim of this water reuse policy is to provide a detailed understanding of the entire water reuse system from source to end use. It is necessary to assess the historical water quality data, taking into account the variability, and to construct a flow diagram of the water reuse system from the source to the application or receiving environments.

- Understand the role of water reuse for university including landscape irrigation, industrial uses, toilet and urinal flushing, firefighting and fire suppression, street cleaning, environmental and recreational uses (ornamental water features, water bodies' replenishment, etc.) and car washing.

- Water reuse applications include non-potable urban and recreational reuse, on-site greywater reuse, industrial reuse, agricultural irrigation, rainwater collection and reuse, surface water augmentation and groundwater recharge, and even potable reuse.

- To know 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.
  - 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. The recovery of water channels can create 'ecological corridors' in urban areas and green belts to control soil erosion by wind in arid regions.
  - 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.

3. DEFINITION:

- **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 municipality guidelines) for its intended use.

- **A water reuse system,** as defined in this policy, includes the following:
  - Raw wastewater entering the wastewater treatment plant (WWTP)
  - The wastewater treatment technologies included in the WWTP
  - The additional treatments to produce reclaimed water of the required quality for reuse
  - The storage and distribution systems
  - The irrigation system (in case of agricultural irrigation), or the recharge method (in case of managed aquifer recharge)
  - WWTP Wastewater Treatment Plant

- **A risk management framework** is a systematic management tool that consistently ensures the safety and acceptability of water reuse practices. A central feature is that it is sufficiently flexible to be applied to all types of water reuse systems, irrespective of size and complexity.

  The risk management framework incorporates several interrelated elements, each of which supports the effectiveness of the others. Because most problems associated with reclaimed water schemes are attributable to a combination of factors, these factors need to be addressed together to ensure a safe and sustainable supply of reclaimed water. The elements, based on the recommendations of international guidelines (WHO, 2004, 2009 and 2011) are the following:
  - Assembly of a risk management team.
  - Description of the water reuse system.
  - Identification of hazards and hazardous events, and risk assessment.
  - Determination of preventive measures to limit risks.
  - Development of operational procedures.
  - Verification of the water quality and the receiving environment.
  - Validation of processes and procedures.
  - Management of incidents and emergencies.

4. POLICY:

- The water reuse policy recommends specific minimum requirements for reclaimed water quality taking into consideration of the health and environmental risks related to water reuse practices inside university premises.

- Promotion of reuse of treated wastewater. Treated waste water shall be reused whenever appropriate. Disposal routes shall minimise the adverse effects on the environment.

5. PROCEDURES:

A. The planning steps 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. 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.**
    - 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.
      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.**

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.

3. **Identify the available quantities of wastewater that could be recycled and how these are placed to address individual needs.**
    - Analyse the potentially available treated wastewater than can be reused and how this relates to user needs through a feasibility analysis (including environmental needs). 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.

    - 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 national rules and regulations.**

    - 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 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.

- 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.

- 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. Determining the cost of reused water on a case by case basis as each situation will be different.

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

- 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.

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.

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?

- Need to be funded--the costs are capital and operational expenditures (investments and operational costs). 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.**

- To include in contracts between supplier and user (service duration, costs, pricing level, liability, etc.,) once the service level are determined.
- 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.**

- Need for 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.
- 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 program should be comprehensive enough to include contaminants that pose significant risks in the anticipated reuse applications.

B. Development of operational procedures

- Assure the appropriate performance of the water reuse system to deliver the requested level of reclaimed water quality. It is necessary to develop an operational monitoring protocol to define operational procedures for all activities and process applied within the whole water reuse system to ensure that all preventive measures implemented to control hazards are functioning effectively.

- Develop an operational monitoring protocol to assess and confirm that the performance of preventive measures of the water reuse system ensures reclaimed water of an appropriate quality to be consistently provided. A water reuse system is defined as follows:
    - Raw wastewater entering the wastewater treatment plant (WWTP).
    - The wastewater treatments included in the WWTP.
    - The additional treatments to produce reclaimed water of the required quality for reuse.
    - The storage and distribution systems.
    - The irrigation system.

- Critical control points of the water reuse system have to be determined as they are the focus of the operational monitoring. The identification of critical control points is system specific and it can be done by applying a decision tree shown in Figure 1. (See Figure 1. Decision support tree to identify critical control points in a water reuse system.)

- The operational monitoring protocol has to include parameters that can be readily measured and provide an immediate indication of performance of the preventive measures to enable a rapid response (e.g. disinfectant residuals and other disinfectionrelated parameters). On-line monitoring with real-time data reporting is strongly recommended when technologically feasible.

  - Operational parameters have to be associated with target limits and critical limits to define effectiveness and detect variations in performance.

  - Observational manual checking of preventive measures is also part of the operational monitoring.

  - Operational monitoring protocol has also to include procedures for corrective actions to be implemented when operational parameters are deviated from the critical limit. (See Examples of operational monitoring requirements for the preventive measure of wastewater treatment processes are shown in Table 1.)

C. Verification of water quality and receiving environments.

- This element comprises verification of the overall performance of the water reuse treatment system, the ultimate quality of reclaimed water being supplied, and the quality of the receiving environment.

- Verification monitoring is the use of methods, procedures or tests, in addition to those used in operational monitoring, to assess the overall performance of the treatment system, the compliance with regulatory requirements of the ultimate quality of the reclaimed water being supplied, and the quality of the receiving environment.

- Perform a routine monitoring to verify that the reclaimed water effluent is complying with the requested quality criteria and the additional quality requirements that decide to include as quality criteria derived from r risk assessment outcomes according to site specific conditions.

- Implement monitoring programs of the environmental matrices at risk to control the effect of reclaimed water irrigation as part of the verification monitoring.

- A monitoring program for soils, crops, groundwater and surface water, and dependent ecosystems has to be established, on a case-by-case basis, according to the identified risks.

- Analytical methods used for monitoring shall comply with the requirements to conform to the quality control principles, including, if relevant, ISO or national standardized methods, to ensure the provision of data of an equivalent scientific quality and comparability.

D. Validation of processes and procedures

- Ensure that processes and procedures control hazards effectively and that the water reuse system is capable of meeting its design requirements.

- Validation monitoring is to prove that the water reuse system can deliver the expected water quality specified for the intended use.
- Validation monitoring has to be conducted when a reclamation system is established (commissioned) and put in operation, when equipment is upgraded or new equipment or processes are added.
- Once the setup of the whole water reuse system has been validated, it is generally sufficient with the operational and verification monitoring.
- Perform, as part of the validation monitoring; have a performance targets.

E. Management of incidents and emergencies

- This element deals with responses to incidents or emergencies that can compromise the quality of reclaimed water.
- The institution have to establish incident and emergency protocols, and to develop and document response plans. Such responses protect public and environmental health, and help to maintain user confidence in reclaimed water.

F. Treatment Efficiency and Quality Assurance

- Develop a better understanding of contaminant attenuation in environmental buffers.
- Develop a better understanding of the formation of hazardous transformation products during water treatment for reuse and ways to minimize or remove them.
- Develop a better understanding of pathogen removal efficiencies and the variability of performance in various unit processes and multibarrier treatment and develop ways to optimize these processes.
- Quantify the relationships between organisms detected (using the polymerase chain reaction (PCR)) and viable organisms in samples at intermediate and final stages of treatment.
- Develop improved techniques and data to consider hazardous events or system failures in risk assessment of water reuse.
- Identify better indicators and surrogates that can be used to monitor process performance and develop online real-time or near real-time analytical monitoring techniques for their measurement.
- Analyze the need for new reuse approaches and technology in future water management.

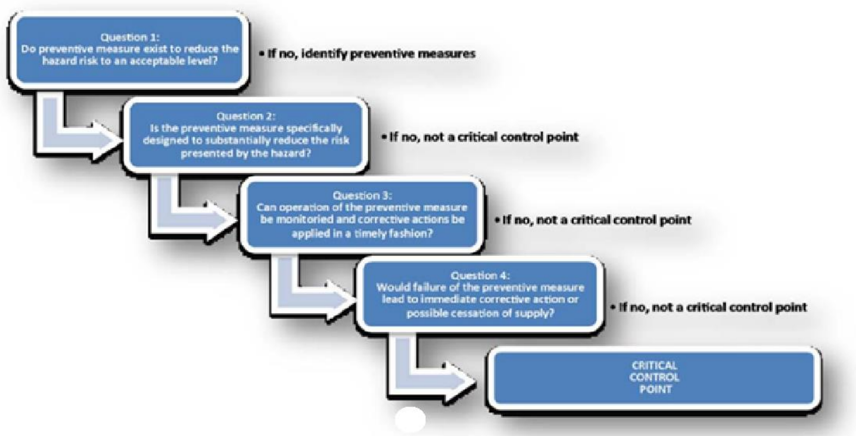
6. RESPONSIBILITIES:

- Maintenance-Water Treatment
- University Administration; Finance & Support Services

7. ATTACHMENT:

Figure 1. Decision support tree to identify critical control points in a water reuse system.

Figure 1. Decision support tree to identify critical control points in a water reuse system.



Examples of operational monitoring requirements for the preventive measure of wastewater treatment processes are shown in Table 1.

Table 1. Examples of operational monitoring for several treatment processes.

Treatment process	Operational monitoring	Indicative frequency
Secondary treatment (activated sludge)	Flow rate Nitrate, nitrites BOD_5 Suspended solids, solids retention time Dissolved oxygen Hydraulic retention time	Continuous (on-line) for flow rate, dissolved oxygen Weekly for other parameters
Low-rate biological systems (stabilization ponds)	Flow rate BOD_5, (facultative and maturation ponds) Algal levels	Continuous (on-line) for flow rate Weekly for other parameters
Soil-aquifer treatment	Flow rate Total Organic Carbon (TOC) Total Nitrogen, nitrates, nitrites	Continuous (on-line) Weekly for other parameters
Media filtration system	Flow rate Turbidity	Continuous (on-line)
Membrane bioreactor (MBR)	pH Turbidity Suspended solids, solids retention time Dissolved oxygen Hydraulic retention time Transmembrane pressure	Continuous (on-line) for parameters such as pH, turbidity, dissolved oxygen, transmembrane pressure Weekly for other parameters
Membrane filtration technology	Transmembrane pressure Turbidity Electrical conductivity	Continuous (on-line)
Ultraviolet light disinfection (UV)	Flow rate Turbidity upstream UV intensity and/or calculated dose UV transmissivity	Continuous (on-line)
Ozone/Biological Activated Carbon	Ozone dose Temperature	Continuous (on-line)
Chlorination	Free chlorine residual, Ct* pH Temperature	Continuous (on-line)

(*) Ct means the product of residual disinfectant content (mg/l) and disinfectant contact time (min).

Source: WHO, 2006; NRMMC-EPHC-AHMC, 2006; USEPA, 2012.

8. DISTRIBUTION:

This policy will be distributed annually to students, parents/guardians, and staff, and it will also be included in any student codes of conduct, disciplinary policies, student handbooks, and university websites.