TECHNICAL SPECIFICATIONS
ON
GREY WATER REUSE AND RAINWATER HARVESTING

2nd Edition

Water Supplies Department
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List of Abbreviations

CFU	Colony Forming Unit
NTU	Nephelometric Turbidity Units
TMF	Temporary Mains Water for Flushing
TON	Threshold Odour Number
TRC	Total residual chlorine
WSD	Water Supplies Department

Glossary

Authorized Person	An Authorized Person registered under the Buildings Ordinance
Disinfection	A process capable of removing or inactivating pathogens
Fitting	Any apparatus, cistern, cock, equipment, machinery, material, tank, tap and valve; and any appliance or device other than a meter, which is installed or used in a fire service or inside service
Grey water	Used water collected from baths, lavatory basins, wash basins, sinks or similar fitments
Hazard	[a]A biological, chemical, physical or radiological agent in, or condition of water, with the potential to cause an adverse health effect. Another word for hazard includes "contaminant"
Inside Service	The pipes and fittings in premises, and any pipes and fittings between the premises and a connection to the main (other than the pipes and fittings forming part of a fire service) which are used or are intended to be used for the purposes of a supply
Point of application	Represents the point at which recycled water is reused for a particular activity
Recycled Water	Reclaimed water, treated grey water and harvested rainwater
Water Authority	The Director of Water Supplies
Waterworks	Any property occupied, used or maintained by the Water Authority for the purpose of water supply, including all water gathering grounds

[a] - represents the definition adopted by the World Health Organization (2017).

1. Introduction

1.1 Objectives

1.1.1 This Technical Specifications is intended for water recycling facilities in building projects. It specifies the requirements for the design, installation, commissioning, operation and maintenance (O&M) of grey water reuse and rainwater harvesting systems, the safety precautions, education and training requirements for end users[1] as well as operators and maintenance staff. "Technical Specifications on Grey Water Reuse and Rainwater Harvesting (1st Edition, WSD, 2015)" will be superseded by this Technical Specifications.

1.1.2 This Technical Specifications shall be read in conjunction with recommendations provided by suppliers/manufacturers of the system equipment as well as relevant ordinances and regulations in Hong Kong.

1.1.3 The guidelines provided in this Technical Specifications are for reference only. Users who choose to adopt this Technical Specifications for their works are responsible for making their own assessments and judgement of information contained herein. The Water Supplies Department (WSD) does not accept any liability and responsibility for any special, indirect or consequential loss or damage whatsoever arising out of or in connection with the use of this Technical Specifications or reliance placed on it.

1.2 Water Quality

1.2.1 The recycled water comprises reclaimed water (from the processing of treated sewage effluent (TSE) from sewage treatment works), treated grey water (from the treatment of used water collected from baths, wash basins, kitchen sinks or similar fitments) and harvested rainwater (treated water converted from rainwater not collected through the raw water systems of the WSD). For the purpose of this publication, recycled water systems in the following text refer to grey water reuse and rainwater harvesting systems only.

1.2.2 Recycled water systems shall be designed in a way that ensures the effluent is fit for purpose and presents no undue risk to health. Water quality of the recycled water shall meet the standards stipulated in **Table 1.1.**

1.2.3 Failure to meet the water quality standards, *E. coli* in particular, could pose undue health risks to users. Section 7 shall be referred to for the required action plan should the water quality testing result in non-compliance with the water quality standards.

[1] "end users" refers to where the recycled water applies

Table 1.1 Water Quality Standards for Recycled Water

Parameter	Unit	Recommended water quality standards
E. coli	cfu /100 mL	Non detectable
Total residual chlorine	mg/L	≥ 1 exiting treatment system; ≥ 0.2 at user end
Dissolved oxygen in recycled water	mg/L	≥ 2
Total suspended solids (TSS)	mg/L	≤ 5
Colour	Hazen unit	≤ 20
Turbidity	NTU	≤ 5
pH		6 - 9
Threshold Odour Number (TON)		≤ 100
5-day Biochemical oxygen demand (BOD_5)	mg/L	≤ 10
Ammoniacal nitrogen (NH_3-N)	mg/L as N	≤ 1
Synthetic detergents	mg/L	≤ 5

Notes:
1. Apart from total residual chlorine which has been specified, the water quality standards for all parameters shall be applied at the point-of-use of the system.
2. Where recycled water is treated for immediate usage, the level of total residual chlorine exiting treatment system may be lower than the one specified in this table.
3. Immediate usage means the collected grey water/ rainwater is drawn into the treatment process immediate before a particular round of usage and the treated water will be depleted after that round of usage is completed.

1.2.4 **Table 1.2** summarises the sources of recycled water, as well as their potential uses.

Table 1.2 Recycled Water Sources and End Uses

Grey Water Sources	Rainwater Sources	Potential End Use After Treatment
• Wash basins • Baths • Showers • Dishwashers • Laundry machines • Kitchen sinks [1]	• Roofs • Permeable paving • Non-permeable paving • Surface runoff from grass and landscaped areas • Air conditioning condensate water	• Toilet flushing • Drip irrigation • Sprayed irrigation • Water features • Car washing • External cleaning • Street cleansing • Industrial process (other than food processes)

Note: [1] For the kitchens with food grinder installed, it is not encouraged that food waste grinders connected directly to grey water collection system, as it might induce clogs in local pipes, the downstream grey water treatment plant must capture and treat it.

1.2.5 Recycled water shall be prohibited from the following uses:

(a) Consumed by humans or animals

(b) Used for cleaning of human or animal body such as eye washing, mouth rinsing and wound cleaning

(c) Used to top-up swimming pools or spas

(d) Used for food preparation or washing dishes or kitchen appliances

(e) Used for irrigating in a way that will contact edible parts of herbs, fruit, or vegetables

(f) Piped to hot water services

(g) Air-conditioning system

2. Design and Construction Requirements

2.1 Grey Water Collection

2.1.1 Grey water shall be collected in a drainage pipework separated from the sewer pipes and allowed to flow from collection appliances to the grey water treatment system via gravity or siphonic action. Surplus grey water shall be collected and discharged directly to the sewer. The designers of the new sewerage system for the development and the sewerage master plan for the district should accordingly take into account the abstraction of grey water from the sewerage system and make appropriate adjustments to the design assumptions so as to safeguard the self-cleansing capacity of the sewer and the overall capacity in the new system, especially during the early stage of occupation where the flow rate of sewer is low. In case the self-cleansing capacity cannot be maintained due to low flow rate, grey water collection system may be suspended until the flow rate reaches the designed level for self-cleansing.

2.1.2 The grey water collection pipework shall be dedicated to the following sources:

(a) Bathroom wash basins

(b) Showers and baths

(c) Clothes washing machines / laundry water

(d) Kitchen sinks

(e) Dishwashers

2.1.3 The collection pipework shall be designed to completely separate blackwater (water from toilet flushing) from the grey water system to prevent contamination.

2.1.4 To reduce the generation of foam, the grey water collection pipework should be designed to minimise turbulence and the use of bends. It should be free draining to avoid stagnation and blockage. Suitable non-intrusive ultrasonic type of flow measurement devices could also be used to avoid blockage.

2.1.5 The grey water collection pipework for conveying collected water by gravity should be designed with similar requirement and standards of foul/storm drainage system. Use of bend for the pipework underground should be minimized as much as possible to avoid blockage.

2.1.6 The collection pipework shall be properly identified and labelled in accordance with Section 8.

2.1.7 A bypass shall be installed around the grey water system allowing the collected grey water to flow directly to the sewer during periods of maintenance or system isolation. Gate valve, for example, as of bypass device / fitting could be considered to install before entering buffer storage tank. The bypass shall not tie into the storm drain system.

2.1.8 Flow measuring device(s) shall be provided to measure the quantity of total grey water collected.

2.1.9 Due to water quality concerns from bacterial growth, collection systems should be designed and constructed such that grey water reaches the treatment process as soon as possible. Intermediate storage should be avoided except the grey water / rainwater collection tanks specified in Section 2.3 below.

2.1.10 Designers shall take into account site-specific and application-specific considerations and make necessary adjustment to the design in this Technical Specifications.

2.1.11 Housing and / or commercial developers may be required to construct the dedicated grey water collection pipe network which is mandated and enforced by the relevant land documents of the housing and / or commercial developments areas.

2.2 Rainwater Collection

2.2.1 Rainwater harvesting system collection consists of:

(a) Roof catchment

(b) Gutters

(c) Downpipes

(d) At-grade catchment, e.g. at-grade pavement or planter drain, etc.

(e) Air conditioning condensate water

2.2.2 A grill or coarse mesh should be placed at the mouth of the drainpipe to prevent large debris (e.g. leaves) from entering the collection system. Where gutters are present, a gutter mesh system can be installed across the gutter section, preferably with a gradient to reduce the need of periodic cleaning. The openings of the grill or gutter mesh should have 4 to 6 mm openings.

2.2.3 First-flush diverters, which diverts the first few minutes of rainwater away from the collection tank, should be installed. The first few minutes of rainfall contains particulates, debris, and contaminants such as bird and animal faeces, pesticides, pollution, roofing material, and dissolved gasses.

2.2.4 A bypass shall be installed around the rainwater system allowing the first flush of rainwater from each rainfall event, the collected rainwater during periods of maintenance or system isolation and the surplus rainwater to flow directly to the storm drain system. The bypass shall not tie into the sewer.

2.2.5 Flow measuring device(s) shall be provided to measure the quantity of rainwater collected.

2.2.6 The collection pipework shall be properly identified and labelled in accordance with Section 8.

2.2.7 Due to water quality concerns from bacterial growth, collection systems should be designed and constructed such that rainwater reaches the treatment process as soon as possible. Intermediate storage should be avoided except the grey water / rainwater collection tanks specified in Section 2.3 below.

2.2.8 Designers shall take into account site-specific and application-specific considerations and make necessary adjustment to the design in this Technical Specifications.

2.3 Collection Tank

General

2.3.1 Most collection tanks for grey water and rainwater systems are constructed of plastics, such as glass-reinforced polyester (GRP) or high-density polyethylene (HDPE). Collection tanks may also be constructed of concrete or steel if these are suitably sealed and protected against the corrosive effects of the stored water. Tanks should be lightproof to minimise algae growth.

2.3.2 Where GRP is used for construction of the collection tank, the design shall comply with Buildings Department's Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers – APP-100 "Structural Plans of Glass Reinforced Polyester (GRP) Water Tanks" requirements with structural drawings and calculations providing the structural integrity and safety according to Hong Kong Building (Construction) Regulations.

2.3.3 The owners / property managers should consult the maintenance contractors of the recycled water system to critically review and consider replacing the exposed GRP/ HDPE collection tank when its designed service life will soon end to avoid sudden brittle failure of the material.

2.3.4 Collection tanks should be fitted with a close-fitting, removable cover to allow for periodic inspection and for internal cleaning and maintenance of components, such as sensors and submersible pumps. Providing a lock to the access cover is recommended to avoid accidental entry into the tank.

2.3.5 Collection tanks and also tanks for part of the treatment process shall be waterproof. If buried, they shall be designed to resist likely ground and traffic loadings, floatation due to hydraulic uplift forces, and groundwater ingress when empty or partially full. Ingress may occur due to the permeability of the tank material (e.g. natural permeability of concrete as well as potential cracks in the concrete) or due to deformation of the tank resulting from water, soil, overburden, and traffic loading.

2.3.6 The collection tank should be sited so that the stored water does not attain high temperatures that could encourage microbial growth. Above-ground tanks should be opaque to minimise the potential of warming and algae growth.

2.3.7 For buried tanks that are located in areas subject to flooding, access covers should be raised or sealed.

2.3.8 The collection tank shall be fitted with a screened air vent to avoid building up of any noxious gases.

2.3.9 Filter backwash is considered as foul water and should also be discharged to the foul drain or sewer system.

2.3.10 If the collection tank is buried, or partially buried, sewage backflow into the tank can occur in the event that the foul drain is blocked or the area becomes flooded. Therefore, sewage backflow prevention should be included in the installation.

2.3.11 The sewage backflow prevention device should be fitted with a visible indicator which may only be reset by manual intervention. The sewage backflow prevention device can be in the form of a valve and a float-operated backflow detection switch in the vertical connecting pipe to the foul drain or sewer.

2.3.12 In the event of sewage backflow, the control system should prevent the recycled water from being supplied until the system has been inspected, and any necessary remedial measures have been carried out and the recycled water quality has been checked.

Grey Water Collection Tank

2.3.13 Air ejector(s) should be provided in the grey water storage tank to prevent septicity.

2.3.14 Backflow prevention shall be provided to prevent highly contaminated water from re-entering the system in the event of blockage in the foul sewer.

2.3.15 As the generation of grey water is intermittent, a buffered collection storage tank is required to provide a relatively uniform flow through the rest of the treatment process. However, it is advisable to minimise storage of untreated grey water to reduce the adverse effects of stagnation and bacteria proliferation.

2.3.16 The grey water storage tank should be designed to store untreated flow for a period of at least two hours, but no more than twenty-four hours. For most applications, the tank may be sized to provide 8 to 10 hours of storage.

2.3.17 The methodology of calculating grey water supply and demand is presented in Section 3.

2.3.18 Grey water collection tanks shall overflow to the sewer system. In addition, an opening with control valve/device is required at the bottom of the collection tank to allow solids that have settled out of the grey water to be collected into a sludge storage tank.

Rainwater Collection Tank

2.3.19 Backflow prevention shall be provided to prevent highly contaminated water from re-entering the system in the event of blockage in the storm drainage system.

2.3.20 A calming inlet is recommended for rainwater collection tanks. A calming inlet prevents the disturbance and re-suspension of fine sediments that may gather on the tank floor and introduces oxygen to the lower layers of the tank which helps prevent anaerobic conditions.

2.3.21 The rainwater collection tank may be stored for 10 to 20 days of supply. An important consideration is space availability.

2.3.22 The methodology of calculating rainwater supply is presented in Section 3.

2.3.23 Assuming that space availability is not an issue, the following three scenarios should be considered:

(a) Insufficient rainwater collected to meet the demands of the potential applications. This is likely the case for the majority of installations in Hong Kong where there are multi-story buildings with many occupants. Tank sizing will be governed by the rainfall and catchment area. The tank size should be based on an evaluation of the rainwater likely to be collected from statistical rainfall patterns, catchment area, and filtration coefficients minus the average use, and also the amount of grey water that may be available.

(b) Excessive rainwater collected to meet the demands of the potential applications during wet weather months. This may be the case for commercial and industrial installations. Tank sizing should be governed by the rate of use, according to the level of demand and the required number of days of assured supply.

(c) A rough balance between the rainwater collected and the demands of the potential applications during wet weather months. The tank should be sized sufficiently large such that it does not frequently overflow but not so large that it causes stagnation or is unnecessarily expensive.

2.3.24 Rainwater collection tanks shall overflow to a stormwater drain and not to a foul sewer.

2.4 Grey Water Treatment

2.4.1 Collected grey water in a treatment system shall consist of the following components:

(a) Pre-treatment

(b) Biological treatment

(c) Filtration

(d) Disinfection

(e) Biodegradable food grade dye addition (i.e. Acid Blue 9, if for flushing)

2.4.2 Pre-treatment shall include a fine / mesh screen to remove hair, soap, and other particulate matter in the grey water. The screen shall have an opening of 2 mm.

2.4.3 Where grey water is collected from kitchen sinks and dishwashers, pre-treatment shall also include an oil and grease trap. An automatic oil and grease trap, where the oil is skimmed out automatically using a timer or sensor mechanism, shall be used.

2.4.4 The fine / mesh screen shall preferably be of the self-cleaning type to reduce the reliance on the user cleaning the screen to maintain system performance.

2.4.5 Biological treatment shall be included to remove organic matters and other pollutants in the grey water. Various types of biological treatment may be used to treat grey water, including biological aerated filter (BAF), sequencing batch reactors (SBR) and membrane bioreactor (MBR).

2.4.6 Filtration shall be included and shall be able to meet the required effluent turbidity of equal or less than 5 NTU. Many types of filters are commercially available, membrane filtration, such as microfiltration (MF) and ultrafiltration (UF) are most adopted filters with capability of achieving high effluent quality standards on a small footprint.

2.4.7 Disinfection is required as the final treatment step. The recycled water, such as treated grey water, quality criteria stipulate a total chlorine residual (TRC) equal to or greater than 0.2 mg/L at user end.

2.4.8 Disinfection may utilise chlorine disinfection which may be achieved by using a sodium hypochlorite system. Chlorine tablets may be used for smaller systems. A separate disinfection contact chamber of a size to allow a minimum of 30-minute contact time at peak flow for disinfection is required.

2.4.9 Ultraviolet (UV) disinfection may be used. However, as it does not produce any disinfectant residual in the treated effluent, the treated water shall be used immediately, i.e. the collected water shall be drawn into the treatment process immediately before a particular round of usage and such treated water shall be depleted after that round of usage is completed.

2.4.10 Where the treated water by UV disinfection is to be stored for future use, it shall be supplemented with chlorine addition to provide the necessary residual chlorine. Simple metering and control devices dosing chlorine can effectively supplement the adequate amount of residual chlorine to meet the water quality standards.

2.4.11 Alternatively, for small scale systems (daily consumption <5 m^3), the chlorine supplement can be provided by using household bleach. Common household bleach contains about 5.25% sodium hypochlorite solution. Household bleach can be mixed into the treated grey water to supplement the required level of residual chlorine. Field testing shall however be conducted to determine the exact ratio for correct dosage. The commercially available quick test kit for residual chlorine test could be adopted for the field testing. The testing should be repeated after each supplement until the required level of residual chlorine achieved.

2.4.12 Flow measuring device(s) shall be provided to measure the total quantity of all grey water treated.

2.4.13 The system supplier shall select the most appropriate process to meet the required water quality requirements.

2.4.14 The treatment system shall be capable of connecting to the sewer such that:

(a) An overflow to the environment will not occur should there be a failure of the treatment system.

(b) The operator may direct grey water to the sewer during periods of rain or other circumstances adverse to the discharge of treated grey water into the reuse distribution system.

2.4.15 The treatment system shall be designed to perform continuously and without any interventions between specified inspection intervals performed by the maintenance staff.

2.4.16 The treatment system shall be constructed in accordance with the design specifications as well as allowing ease of access for maintenance and with regard to the health and safety of users, operators, and persons maintaining the facility.

2.4.17 The treatment system shall be clearly marked with the brand name, model, and month and year of manufacture which should be clearly visible after installation.

2.4.18 All metal components shall be of stainless steel or other non-corroding material unless adequately protected against corrosion to satisfy the service life of the component.

2.4.19 All plastics and perishable components in the treatment system subject to exposure to UV radiation, or an adverse chemical or biological environment shall be able to retain their integrity under normal operating conditions to satisfy the service life of the component.

2.4.20 All components shall be securely fixed to withstand all loads encountered during transportation, installation, and normal operation.

2.4.21 Unless specifically designed to operate in a submerged condition, all mechanical and electrical equipment when located within the treatment system vessel(s) shall be located above the maximum water level of the treatment system.

2.5 Rainwater Treatment

2.5.1 Harvested rainwater in a treatment system shall consist of the following components:

(a) Pre-treatment

(b) Filtration

(c) Disinfection

(d) Biodegradable food grade dye addition (if for flushing)

2.5.2 Pre-treatment shall include a first-flush removal device and oil trap, if applicable.

2.5.3 The two most common types of first-flush device are of constant volume and mechanical actuated valve.

2.5.4 A constant volume first-flush device uses a containment chamber that fills up during the first few minutes of a rainstorm. The containment chamber is a container / sampler or a standpipe with a constant volume. During the first few minutes of rainfall, the rainwater is diverted to the stand pipe or container. Once the standpipe or container fills up, the rainwater is transferred into the cistern. At the bottom of the stand pipe is a valve that is slightly opened. The valve drains the water from the standpipe so it will be empty for the next rain.

2.5.5 A mechanical actuated valve first-flush device measures the amount of rainwater to divert by a mechanical method. Once the measured amount of rainwater to divert is detected, a valve is triggered to transfer the remaining rainwater to the rainwater storage tank.

2.5.6 An automatic oil trap, where the oil is skimmed out automatically using a timer or sensor mechanism, shall be used for rainwater collected from driveways, car parks, etc, if applicable.

2.5.7 Coarse filtration followed by sand filtration (or cartridge filtration) and granular activated carbon (GAC) filtration or the like shall be used as follows:

(a) The coarse filter shall be rated at 250 micron or smaller to remove large particulate matter.

(b) The sand filter or cartridge filter shall be rated at 50 micron or smaller.

(c) GAC filtration or the like shall be used to remove smaller particulate matter and hydrocarbons.

2.5.8 An option for coarse filtration is available where the filter is installed inside the rainwater collection pipe prior to entering the storage tank.

2.5.9 Disinfection is required as the final treatment step. The recycled water, such as treated rainwater, quality criteria stipulate a total residual chlorine equal to or greater than 0.2 mg/L at user end.

2.5.10 Disinfection may utilise chlorine disinfection which may be achieved by using a sodium hypochlorite system. Chlorine tablets may be used for smaller systems. A separate disinfection contact chamber of a size to allow a minimum of 30-minute contact time at peak flow for disinfection is required.

2.5.11 UV disinfection may be used. However, as it does not produce any disinfectant residual in the treated effluent, the treated water shall be used immediately, i.e. the collected water shall be drawn into the treatment process immediately before a particular round of usage and such treated water shall be depleted after that round of usage is completed.

2.5.12 Where the treated water by UV disinfection is to be stored for future use, it shall be supplemented with chlorine addition to provide the necessary residual chlorine. Simple metering and control devices dosing chlorine can effectively supplement the adequate amount of residual chlorine to meet the water quality standards.

2.5.13 Alternatively, for small scale systems (daily consumption <5 m^3), the chlorine supplement can be provided by using household bleach. Common household bleach contains about 5.25% sodium hypochlorite solution. Household bleach can be mixed into the treated rainwater to supplement the required level of residual chlorine. Field testing shall however be conducted to determine the exact ratio for correct dosage. The commercially available quick test kit for residual chlorine test could be adopted for the field testing. The testing should be repeated after each supplement until the required level of residual chlorine achieved.

2.5.14 Flow measuring device(s) shall be provided to measure the total quantity of all rainwater treated.

2.5.15 The designer shall select the most appropriate process to meet the required water quality requirements.

2.5.16 The treatment system shall be designed to perform continuously and without any interventions between specified inspection intervals performed by the maintenance staff.

2.5.17 The treatment system shall be constructed in accordance with the design specifications as well as allowing ease of access for maintenance and with regard to the health and safety of users, operators, and persons maintaining the facility.

2.5.18 The treatment system shall be clearly marked with the brand name, model, and month and year of manufacture which should be clearly visible after installation.

2.5.19 All metal components shall be of stainless steel or other non-corroding material unless adequately protected against corrosion to satisfy the service life of the component.

2.5.20 All plastics and perishable components in the treatment system subject to exposure to UV radiation, or an adverse chemical or biological environment shall be able to retain their integrity under normal operating conditions to satisfy the service life of the component.

2.5.21 All components shall be securely fixed to withstand all loads encountered during transportation, installation, and normal operation.

2.5.22 Unless specifically designed to operate in a submerged condition, all mechanical and electrical equipment when located within the treatment system vessel(s) shall be located above the maximum water level of the treatment system.

2.6 Combined Treatment for Grey Water and Rainwater

2.6.1 For installations with both grey water and rainwater, the two streams may be combined such that they produce a single supply of treated water. The rainwater stream may be sent to the grey water treatment system for combined treatment via conveyance from the rainwater storage tank to the grey water collection tank. This is illustrated in the schematic diagram in **Figure 14.1**.

2.6.2 During the dry season from October to March, the rainwater system may be shut down. During these months, any rainfall collected from the rainwater collection system may be bypassed directly to the head of the grey water treatment system. The collected rainwater should be metered.

2.6.3 Particular attention should be paid to the dilution effect induced from the rainwater for design of the combined treatment process.

2.7 Storage

2.7.1 For recycled water systems in Hong Kong, where the point of use is for landscape irrigation, water features, car washing, etc., storage tanks for the recycled water are usually located near the ground floor.

2.7.2 For applications where the recycled water needs to be supplied to higher elevations, e.g., toilet flushing, high level tanks are utilised.

2.7.3 The tank should be sited so that the stored water does not attain high temperatures that could encourage microbial growth. Above-ground tanks should be opaque to minimise the potential of warming and algae growth.

2.7.4 Below ground tanks should be sufficiently rigid to resist likely ground and traffic loadings and floatation.

2.7.5 A back-up water supply, such as potable water, is required to supplement the recycled water as specified in Section 2.14. Backflow prevention device shall be provided as specified in Section 2.15.

2.7.6 The impact of a sudden demand from the back-up water supply should be considered. It is essential that the potable water supply infrastructure is capable of meeting this increase in water demand.

2.7.7 To avoid microbiological growth and bacteria proliferation in the recycled water storage tank, the storage time should be limited. This is especially important in Hong Kong's high temperature climates. As there is generally a steady supply of untreated grey water, storage equal to a single day's use (24 hours) or less is recommended.

2.8 Pumps

2.8.1 Most of the collection tanks of grey water and rainwater systems are located at or below ground level. Pumping of treated grey water and harvested rainwater into a building or elsewhere is required.

2.8.2 Some grey water and rainwater systems omit the cistern component and provide a pressurised recycled water supply directly from the pump to point of use. In the event of pump or power failure, such direct supply systems will not supply recycled water to points of use. Mains make-up water pipework to the direct supply system should be installed with backflow prevention in conformance with the Waterworks Ordinance and Regulations. This is required at each application point served with both recycled water and mains water.

2.8.3 The pumps should be corrosion resistant and properly selected to pump to the required head to fill the cistern or supply adequate flow if pumped directly to the point of use. Submersible pumps and external self-priming pumps are typical.

2.8.4 Pumps should be protected from dry running. A low-level switch in the collection tank should be used. To prevent overheating or burn out of the pump, the level should be set such that the pump does not continually switch on and off due to small and infrequent inflow of source water.

2.8.5 Pumps should be sized so that each pump is capable of overcoming static lift plus friction losses in the pipework and valves.

2.8.6 Pumps should be selected and arranged such as energy use and noise are minimised, cavitation and undue vibration are avoided, and air is not introduced into the recycled water system.

2.8.7 Pumps for untreated grey water should be able to accommodate any solid matter likely to be contained in the grey water.

2.8.8 For recycled water pumping systems that are installed outside the storage tank, the pump should have its own self-priming mechanism or a control system that ensures a constant fully primed condition. The suction line to the pump should be laid with a steady gradient upwards towards the pump. The pump should be placed in a well-ventilated location and protected from extremes of temperature, with sound-free and vibration-free mountings.

2.8.9 A non-return valve should be provided in the suction line to the pump to prevent the water column from draining down. The pump discharge should be supplied with an isolation valve.

2.8.10 For submersible pumping systems, the immersion depth should be in accordance with the pump manufacturer's requirements. The pump should be removable for maintenance. A non-return valve should be provided, with an isolation valve to enable the non-return valve to be serviced.

2.8.11 The pump control unit should operate the pump(s) to match demand; protect the pumps from running dry; protect the motor from over-heating and electric overload; and permit manual override.

2.9 Mechanical Equipment

2.9.1 All mechanical equipment shall be suitable for continuous and intermittent operation.

2.9.2 Bearings shall be of a type able to provide long life, minimal maintenance, and corrosion protection from the aggressive environment.

2.10 Electrical Equipment

2.10.1 All electrical equipment shall be suitable for continuous and intermittent operation.

2.10.2 Electric motors shall comply with the relevant electrical standards and be fitted with thermal overload devices. The motor shall be located free from explosive gas mixture that may be developed. If the explosive gas environment is unavoidable, explosion-proof electric motor shall be applied and complied with relevant international standards. The motor should be suitable for variable speed pumping if variable speed control is adopted.

2.10.3 The treatment system shall be provided with a control panel that indicates the following as a minimum:

(a) indication that system is operating correctly
(b) alarms indicating failure of components including identification of component (e.g. pump, level control, chemicals, UV)
(c) levels in all tanks
(d) power meter shall be installed to monitor the power consumption and show power supply status
(e) flows with accumulated total amount
(f) operating hours
(g) chemical usage
(h) automatic control of the alternative water supply to meet variations in supply and demand
(i) water quality parameters that can be detected on a continuous basis e.g. pH, total residual chlorine, temperature, turbidity, dissolved oxygen and possibly ammonia
(j) supply delivery pressure where a pumped system is used
(k) on-line monitoring results for surveillance on the quality of treated effluent (if on-line monitors are available).

2.10.4 The treatment system shall be fail-safe such that untreated water cannot be supplied to points of use in the event of system failure, including loss of power and loss of disinfection. A fail-safe condition should occur if any essential part of the system ceases to operate.

2.11 Noise

2.11.1 The maximum permissible noise level with all operating equipment shall comply with relevant noise criteria.

2.12 Materials and Fittings

2.12.1 Collection and distribution pipework and fittings should be constructed from corrosion resistant components such as high density polyethylene (HDPE), poly-vinyl chloride (PVC), or acrylonitrile butadiene styrene (ABS) plastic. Black steel, ductile iron pipe may be considered for larger diameter pipe. Copper and galvanised steel pipes are not recommended, although cast iron or ductile iron may be considered for buried piping if ground conditions do not suit the use of plastics.

2.12.2 The materials selected for the recycled water systems shall be suitable for the location and anticipated temperature ranges. All components of the recycled water system shall be capable of withstanding pH levels as low as 5 for the lifetime of the components.

2.13 Power Supply

2.13.1 The power supply shall be readily accessible but also guarded to ensure against inadvertent isolation or disconnection of electricity. Any back-up power supply might be provided, if deemed necessary.

2.14 Back-up Water Supply

2.14.1 An alternative water supply, such as potable mains water supply, is required as a back-up water supply to supplement the recycled water. The back-up water supply may be introduced into the following:

(a) The recycled water storage tank

(b) An intermediate storage tank prior to pumping to the recycled water distribution system

2.14.2 A ballcock valve/float switch or equivalent located inside the storage tank shall be used to activate the back-up water supply when the water level in the storage tank reaches a low level. The ballcock/float switch shall turn off the back-up water supply at a pre-set level to leave space for incoming recycled water. An example is shown in **Figure 2.1**.

2.14.3 The back-up water supply shall be fitted with a control mechanism which ensures that the amount of water supplied is minimised. It shall be fitted with a warning mechanism that alerts the user to the failure of the inlet control valve to close correctly. This warning shall be in the form of a warning pipe that can be seen readily or an audio and visual alarm.

2.14.4 The warning device shall activate before the water level overflows. For underground storage tanks, an alternative to a warning pipe shall be used as it cannot be seen readily.

2.14.5 The back-up water supply shall be sized to meet the full demand requirements.

2.14.6 Flow measuring devices(s) shall be provided to measure the total quantity of all back-up water supplied.

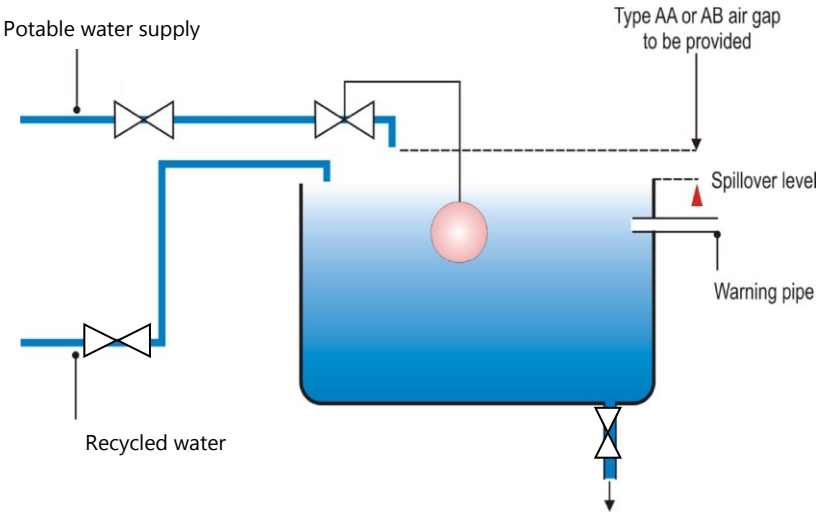

Figure 2.1 Example of Storage Tank Configuration with Ballcock and Air Gap

2.15 Backflow Prevention

2.15.1 To prevent recycled water from entering the potable mains water supply, the back-up water supply shall be fitted with a backflow prevention device, such as:

(a) Type AA air gap

(b) Type AB air gap

2.15.2 Type AA air gap (air gap with unrestricted discharge) means a non-mechanical backflow prevention arrangement of water fittings where water is discharged through an air gap into a storage tank which has at all times an unrestricted spillover to the atmosphere. The air gap is measured vertically downwards from the lowest point of the inlet discharge orifice to the spillover level.

2.15.3 Type AB air gap (air gap with weir overflow) means a non-mechanical backflow prevention arrangement of water fittings complying with Type AA air gap requirements, except that the air gap is the vertical distance from the lowest point of the discharge orifice which discharges into the storage tank to the critical water level of the rectangular weir overflow.

2.15.4 The air gap shall be greater than, or equal to two times the sum of all inlet pipe diameters, or at least 25 mm, whichever is greater.

2.15.5 In addition to the air gap, anti-back flow contamination devices such as backflow preventer / double non-return valves should be installed in inlet pipe for preventing back-contamination.

2.15.6 The potable mains water should be supplied via a make-up tank (intermediate storage tank, such as break pressure tank) before entering the storage tank of recycled water.

2.15.7 Flow rates, head loss, and installation requirements shall be taken into account when selecting the backflow prevention device.

2.15.8 The backflow prevention device shall be located upstream, or at the point of delivery where the two supplies come into contact with each other.

2.16 Overflow, Bypass, and Drainage

2.16.1 An overflow shall be fitted to all tanks or cisterns to allow excess water to be discharged. The overflow shall incorporate backflow prevention. An overflow fitted to aboveground tanks or cisterns shall be screened to prevent the ingress of insects and rodents.

2.16.2 The capacity of the overflow outlet pipe shall be capable of draining the maximum inflow without compromising the inlet air gap.

2.16.3 Where appropriate, the overflow and bypass shall be fitted with an anti-surcharge valve.

2.16.4 The overflow and any bypass of the untreated grey water shall be connected to the foul sewer.

2.16.5 The overflow and any bypass of the rainwater shall be connected to the storm drain system.

2.16.6 The overflow and any bypass of the recycled water shall be connected to the sewerage / storm drain system whichever is appropriate if non-compliance.

2.16.7 Any discharge to sewer / storm drain from the recycled water system shall minimise the volume of foam introduced to the sewerage / storm drain system and shall be properly dechlorinated and decolorized, if necessary.

2.16.8 Flow measuring devices(s) shall be provided to measure the total quantity of all collected but not treated / supplied grey water, rainwater and recycled water down the overflow, bypass and storm drain system.

2.16.9 The discharge of any surplus grey water, rainwater or recycled water as well as backwash water shall be made at a location that would not overload the downstream carrying capacity of their respective receiving sewerage or storm drain systems.

2.17 Controls

2.17.1 A control unit shall be incorporated in the recycled water systems to ensure that users are aware of whether the systems are operating effectively.

2.17.2 The control unit shall:

(a) Make the user aware when any consumable items need replenishment or replacement

(b) In the event of any system failure:

(i) Alert the user by a visible or audible warning

(ii) Ensure that the bypass directs untreated grey water to the foul sewer, and untreated rainwater to the storm drain

(iii) Ensure that grey water and/or rainwater treatment continues or the recycled water is not stored for a period that would allow water quality to deteriorate

(c) In the event of a treatment failure, ensure that the recycled water applications are fed from the back-up water supply

(d) Control pumps and minimise operational wear and energy use

(e) Activate the back-up water supply automatically when required by the control unit

(f) Provide a volt-free output to enable the recycled water systems to be linked to a building management system, where appropriate

2.17.3 To prevent waste, storage tanks or cisterns with valve-controlled water inputs shall have a warning system so that any failure is readily noticeable.

2.18 Sludge Holding Tank

2.18.1 A sludge holding tank is necessary to provide temporary storage of sludge produced by the biological treatment component of the recycled water treatment system.

2.18.2 Wet sludge could be hauled off to the local municipal sewage treatment works on a periodic basis, if applicable, or on-site de-watering of the wet sludge should be considered.

2.18.3 The sizing of the sludge holding tank depends on the biological process and influent characteristics of the grey water. Without any specific information, the tank can be sized based on 7 hours of hydraulic residence time of the grey water design flow. For example, if the design flow is 100 m^3/day, the volume of the tank can be calculated as shown below:

$$7 \text{ hours} \times 1 \text{ day}/24 \text{ hours} \times 100 \text{ m}^3/\text{day} = 29 \text{ m}^3$$

2.18.4 An aerator /ejector or the like should be provided for the sludge holding tank to prevent septicity.

2.18.5 Vehicular access should be maintained for desludging tankers.

2.19 Location and Access of Treatment Systems

2.19.1 Recycled water treatment systems are likely to be located at ground level or below.

2.19.2 Proper access for maintenance will ensure safe and efficient operation of the system. The treatment system will need periodic access to maintain pumps, change filters, and cleaning. Easy access around collection and treatment tanks

should be provided, including sealed but not airtight man-sized access ports for all but the smallest tanks (e.g. 1 m^3 or smaller).

2.19.3 Access to the treatment room(s) should be restricted and secured from public access for safety reasons.

2.19.4 Regarding the location of the grey water collection tank, the prevention of sewer backflow should be taken into consideration, including the minimum vertical separation between the overflow and sewer pipe. The tank should not be located directly above drainage pipes or other buried services. The tank should be vented to the atmosphere, either via the grey water drain and stack, or with a stub-vent from the tank.

2.20 Distribution

2.20.1 Recycled water shall be distributed as follows:

(a) Pump from the storage tank directly to the point of use

(b) Pump from the storage tank to intermediate storage tanks or cisterns near the point(s) of use

(c) Supplying by a gravity storage tank, cistern, where feasible

2.20.2 Technical requirements and practical guidelines to be adopted in the design and construction of inside service in local buildings have been stipulated in "Technical Requirements for Plumbing Works in Buildings" (December 2021). Existing guidelines for saltwater for flushing regulated in the "Technical Requirements" are also applicable to recycled water system when it is used for flushing purpose.

2.20.3 Distribution systems should be designed and constructed such that the overall storage time of recycled water does not result in unacceptable deterioration in water quality through the network to the point of application. Header tanks for toilet flushing should not be oversized. Dead zones in the distribution piping should be avoided to prevent bacteria proliferation. For lengthy distribution systems, consideration should be given to recirculation of a small flow of the treated effluent to the treatment process to avoid stagnation.

2.20.4 There are no fundamental differences between the design of recycled water and mains water distribution systems, though the pipework and materials for the recycled water system should be chosen for resistance to corrosion.

2.20.5 Care should be taken not to cross connect recycled water and mains water pipework during installation or subsequent work on the system. Pipe marking is essential to help avoid accidental cross-connection. Where necessary, designer may consider using pipe size and material different from potable water system.

2.20.6 All pipework and fittings shall be marked and / or labelled in accordance with Section 8.

2.20.7 To avoid accidental cross contamination, the recycled water system should operate at a lower pressure than the potable water mains supply, if possible.

2.20.8 Consideration should be given to minimising the energy used to distribute the recycled water.

2.20.9 Surges and water hammer should be absorbed and prevented from causing undue high pressures by the incorporation of pressure controls or expansion vessels, such as a set of surge vessels.

2.20.10 Pipework should be sized to provide adequate flow and pressure.

2.20.11 Pipework and fittings should be arranged as follows:

(a) To be sufficiently strong to resist bursting from the subjected pressure in operation

(b) To prevent cross-connections with potable mains water supply

(c) To prevent the trapping of air during filling, and the formation of air locks during operation

2.20.12 For multiple building scale schemes and larger configurations, disconnection from the system should be considered. This may be required where a building opts out of a communal grey water reuse scheme, or persistently provides grey water of a quality which would be detrimental to the overall performance of the system, such as highly contaminated or strongly coloured grey water.

2.20.13 Disconnection of grey water collection should be as close as possible to the source and the downstream pipework should be drained. Retention of stagnant grey water in any part of the system should be avoided. Temporary disconnection of collection may be provided by a lockable valve or a plug. Permanent disconnection should include physically removing a pipe section and sealing the open ends.

3. Methodology in Assessing Quantity of Supply and Demand

3.1 Introduction

3.1.1 This section presents the methodology for estimating the quantity of recycled water supply and demand.

3.2 Recycled Water Supply from Rainwater Yield

3.2.1 The recycled water systems should be planned to ensure adequate rainwater collected for recycled water production and avoid surplus capacity standing idle.

3.2.2 The amount of rainwater retrieved can be estimated from the following equation:

$$Y_r = A_c \times R_m \times C_r$$

where:
Y_r is the weekly average rainwater yield (litre/week)
A_c is the collection area (m^2)
R_m is the average weekly rainfall (mm)
C_r is the run-off coefficient

If an in-line filter is installed to the rainwater collection system, a filter efficiency, N_f, should be incorporated into the above equation. Typically, a vertical inline filter has a value of 0.9.

3.2.3 The collection area is the plan area (rather than the slope area) available for rainwater collection. Possible collection areas include roofs of buildings, open spaces such as playgrounds, or sky gardens at midlevel of buildings. Car parking lots and roads within the development may also serve as part of the collection area.

3.2.4 Average weekly rainfall of 80 mm may be used, as derived from rainfall record of the Hong Kong Observatory.

3.2.5 Run-off coefficient is a multiplication factor used to establish the proportion of the volume of rainwater that can be collected relative to the volume that falls on the surface. It accounts for losses of rainwater due to evaporation and absorption by the construction materials. Typical values are shown in **Table 3.1**.

Table 3.1 Typical Run-off Coefficient for Different Types of Catchment Area

Surface Type	Run-off Coefficient
Pitched roof tiles	0.75 – 0.9
Flat roof smooth surface	0.50
Flat roof with gravel or turf (less than 150mm thick)	0.40 to 0.50
Gravel roads	0.15 to 0.30
Asphalt surfaced areas (roads, car parks, etc)	0.85 to 0.90
Block pavement with wide joints	0.50 to 0.70

3.3 Recycled Water Supply from Grey Water Yield – Simplified Approach

3.3.1 The recycled water systems should be planned based on recycled water demand from developments, to ensure adequate grey water collected for recycled water production and avoid surplus capacity standing idle.

3.3.2 If there is a lack of readily available data, the values in **Table 3.2** can be used as a preliminary step to estimate the grey water yield from developments.

Table 3.2 Estimated Grey Water Yield of Selected Venues

Type of Development	Estimated Grey Water Yield (litres/person/day)
Residential R1 [1]	90 [5]
Residential R2 [2]	111 [5]
Residential R3 [3]	138 [5]
Residential R4 [3]	138 [5]
Modern Village Housing [4]	90 [5]
Schools (not including canteen)	6.9 [6]
Offices (not including canteen)	16.5 [6]
Services (shops, etc.)	21 [6]
Restaurants/canteens	0.5 m^3/m^2 kitchen area/day [7]

Notes:

1. Private housing blocks in R1 zones: Private Sector Participation Schemes and Housing Authority Home Ownership Schemes. Residential One (R1) is the highest density residential planned use. Population densities may be around 1,740 persons per hectare, with a maximum plot ratio of 8.0.
2. Private housing blocks in R2 zones: Residential Two (R2) is a medium density residential planned use. Population densities may be around 1,050 persons per hectare, with a maximum plot ratio of 5.0.
3. Private housing in R3 and R4 zones, villas, and bungalows: Residential Three (R3) is a medium to low density residential planned use. Population densities may be around 470 persons per hectare, with a maximum plot ratio of 3.0. Residential Four (R4) is a low density residential planned use. Building height is restricted to no more than 2 storeys with a maximum plot ratio of 0.4.
4. Modern Village Housing: These are limited to a site area of approximately 65 square metres and to a height of 3 storeys, and which are in the New Territories Small House Category.
5. From EPD's values for flow for different types of development in Appendix 2 of Guidelines for the Design of Small Sewage Treatment Plants. 30% of the value is used to correlate to the grey water yield (Level I and Level II).
6. Assume 30% of sewage design flow rate from EPD's values for flow for different types of development in Appendix 2 of Guidelines for the Design of Small Sewage Treatment Plants.
7. From EPD's values for flow for different types of development in Appendix 2 of Guidelines for the Design of Small Sewage Treatment Plants. 100% of the value is applied since the source is directly from kitchen areas.

3.4 Recycled Water Supply from Grey Water Yield – Detailed Approach

3.4.1 To refine the grey water yield estimate **Table 3.3** should be used to estimate the grey water yield from developments. The developments may not contain all the features shown in **Table 3.3**. Designers may decide which features to consider as sources for grey water.

Table 3.3 Calculation Table for Estimating Grey Water Yield

Installation Type	Unit of Measurement	Capacity/ Flow Rate	Use Factor	Estimated Grey Water Yield (Litres/ person/day)	
				Fixed Use	Subtotal [(1)x(2)]+(3)
		(1)	(2)	(3)	(4)
Wash-hand basin taps	Flow rate (litres/min)		1.58	1.58	
Bath (where shower also present)	Capacity to overflow (litres)		0.11	0	
Shower (where bath also present)	Flow rate (litres/min)		4.37	0	
Bath only	Capacity to overflow (litres)		0.50	0	
Shower only	Flow rate (litres/min)		5.60	0	
Kitchen/utility room sink taps	Flow rate (litres/min)		0.44	10.36	
Washing machine	Litres/kg dry load *		2.1	0	
Dishwasher	Litres/place setting		3.6	0	
Waste disposal unit	Litres/use	If present = 1 If absent = 0	3.08	0	
(5) Total calculated demand per person (litres/person/day) = (Sum of column 4)					
Total calculated demand (litres/day) = number of persons x (5)					

Notes:
For estimation purposes, typical values are shown in the table (as highlight in the grey cells) and can be used where more precise values are not known. (Source of use factors: The Water Efficiency Calculator for New Dwellings, Department of Communities and Local Government, UK, 2009.)
* Litres/kg dry load = [washing machine water consumption per wash cycle in litres]/[maximum dry wash load recommended by manufacturers in kilograms]

3.5 Estimating Recycled Water Demand

3.5.1 The most common usage of recycled water in Hong Kong is for toilet flushing, landscape irrigation and street cleansing. Other uses include car washing, external cleaning, and other industrial use.

3.5.2 **Table 3.4** presents a calculation table for estimating recycled water demand. Based on the estimated yield and demand figures, the designer of the recycled water system can then provide the relevant information to the recycled water system supplier.

Table 3.4 Calculation Table for Estimating Recycled Water Demand

Toilet Flushing			
Usage type	**Volume per use(litres)**	**Use factor**	**Litres/person/day =[(1)x(2)]**
	(1)	**(2)**	**(3)**
Single-flush WC		4.42	
Dual flush WC, full flush		1.46	
Dual flush WC, part flush		2.96	
(4) Total calculated demand per person (litres/person/day) = (Sum of column 3)			

Total calculated demand (litres/day) = number of persons x (4)	

Landscaping Irrigation		
Volume per use per day (litres/day/m²)	**Area of irrigation (m²)**	**Litres/day = [(1)x(2)]**
(1)	**(2)**	**(3)**
7 [1]		

Car Washing		
Volume per car per day (litres/car/day)	**Number of cars in development**	**Litres/day = [(1)x(2)]**
(1)	**(2)**	**(3)**
6 [2]		

External Cleaning		
Volume per square metre per day (litres/m²/day)	**Area of cleaning (m²)**	**Litres/day = [(1)x(2)]**
(1)	**(2)**	**(3)**
1 [3]		

Notes:
For estimation purposes, typical values are shown in the table (as highlight in the grey cells) and can be used where more precise values are not known. (Source of use factors: The Water Efficiency Calculator for New Dwellings, Department of Communities and Local Government, 2009.)
1. Based on the assumption of water consumption of 7 litres/day per square meter of irrigation area.
2. Based on 2 litres/person /day and assuming 3 people per vehicle.
3. Based on using a high pressure sprayer and assuming street washing frequency of once per day.

4. Installation

4.1 General

4.1.1 Installation should be carried out in accordance with instructions given by the manufacturer or supplier.

4.1.2 Consideration should be given to the following:

(a) Access to the recycled water treatment equipment

(b) Access to underground and above-ground tanks

(c) Location of access covers

(d) Vehicular access to the treatment systems

4.2 Tank Installation

4.2.1 All tanks should be fitted with lids / covers that protect the water from contamination and prevent inadvertent human entry, and avoid ingress of insect and leak of odour.

4.2.2 Any openings to be cut in a tank, other than those provided by the manufacturer, should be round, so as not to cause any additional stress on the tank that might result in a split. Where non-circular openings are unavoidable, stress relief should be applied to the cut to minimise any risk of splitting.

4.2.3 Above-ground tanks should not be supported by pipework but should be securely mounted and supported on a stable base.

4.2.4 Above-ground tanks to be installed within a building should be able to withstand any temporary deformation that is required during installation.

4.2.5 Underground or partially buried tanks should be so installed that they are not deformed or damaged.

4.2.6 Measures should be taken to ensure the structural stability of underground tanks. Examples of measures include concrete surrounds, backfilling, and / or controlled filling with water.

4.2.7 The area around the access covers of any underground tanks should be impervious and free draining away from the covers to avoid contamination during maintenance and inspections.

4.2.8 When installed and correctly supported, tanks should not deform as the water level in the tank changes.

4.3 Cistern Installation

4.3.1 Where recycled water storage cisterns are used within buildings, they should be installed with appropriate support, insulation, and means to prevent contamination. The cistern should be supported on a firm level base capable of

withstanding the weight of the cistern when completely filled with water. Plastic cisterns should be supported on a flat rigid platform fully supporting the bottom of the cistern over the whole of its area.

4.3.2 An automatic supply cut-off device activated by an overflow may be installed to minimise water wastage.

5. Testing, Commissioning and Decommissioning

5.1 Commissioning Procedures

5.1.1 For all schemes, the manufacturer or system supplier shall provide detailed guidance on commissioning procedures. Commissioning will typically be carried out by the manufacturer, system supplier or its representative, who has received appropriate training and has the necessary sampling and testing equipment to verify correct operation of the system.

5.1.2 Commissioning procedures should be system specific. The procedures generally include the following steps:

(a) Visual check of the pipework systems. Verify that actual equipment and pipe layout matches the schematic and that all pipes are properly identified and labelled.

(b) Verify overall system integrity and hydraulic operation using clean water for strength and leak testing.

(c) Verify operation of control strategy, fail-safe features and indicators using clean water.

(d) Initial operation of the collection treatment / system with recycled water being discharged to sewer / storm drain until tests confirm acceptable quality of recycled water.

(e) Full operation with checks on filters, disinfectant and colourant dosing, and operation of level controls.

5.1.3 All pipework shall be tested following construction to ensure that the materials are free of defects and have been installed correctly. The following tests, where applicable, shall be performed by a licensed plumber prior to handover of the system to the user:

(a) The pipework of the domestic wastewater (blackwater) system shall be tested to ensure that there are no cross-connections with the grey water and rainwater collection pipework as specified in Section 5.2.

(b) The recycled water distribution system shall be flushed and tested to ensure that pipework and tanks are watertight and that there are no cross-connections with any potable mains water supply.

(c) The pipework and fittings of the recycled water distribution system shall be tested in accordance with all relevant WSD requirements and at a minimum of 1.5 times the normal operating pressure.

(d) The recycled water system shall be tested to ensure that wiring is electrically safe and that there is no interference to or from other electrical or electronic equipment, or wiring in the vicinity.

5.1.4 Upon completion of commissioning, a handover / commission certificate should be provided to the contractor / operator / owner detailing the results of tests carried out.

5.1.5 Upon handover of the recycled water system, the contractor / operator / owner shall be provided with sufficient information by the system supplier to enable them to operate the system satisfactorily. The user shall be advised of any procedures or precautions which need to be followed. The information shall cover aspects that will ensure the reliable operation of the recycled water systems, and any routines that could reduce maintenance requirements.

5.2 Cross Connection Test for Recycled Water Distribution System

5.2.1 Before the development is occupied, a licensed plumber shall perform an initial cross-connection test for the recycled water pipes distribution system in a private premise, where applicable, in accordance with the procedures stipulated by the designer. Such distribution system is regarded as Inside Service in the context of Waterworks Ordinance. The current "Technical Requirement for Plumbing Works in Building" published by WSD applies. The following basic procedures are suggested as a reference for the designer's consideration.

(a) The potable water system shall be activated and pressurised. The recycled water system shall be shut down and completely depressurised.

(b) The potable water system shall remain pressurised while the recycled water system is depressurised. The minimum period which the recycled water system is to remain depressurised shall be determined on a case-by-case basis, taking into account the size and complexity of the potable and recycled water distribution systems.

(c) All fixtures, potable and recycled, shall be tested and inspected for flow. Flow from any recycled water system outlet shall indicate a cross-connection. No flow from a potable water outlet would indicate that it may be connected to the recycled water system.

(d) The drain on the recycled water system shall be checked for flow during the test and at the end of the period.

(e) The potable water system shall then be completely depressurised.

(f) The recycled water system shall then be activated and pressurised. For the initial test, a temporary connection to a potable water supply will be required to test the recycled water system plumbing.

(g) The recycled water system shall remain pressurised while the potable water system is depressurised. The minimum period the potable water system is to remain depressurised shall be determined on a case-by-case basis.

(h) All fixtures, potable and recycled, shall be tested and inspected for flow. Flow from any potable water system outlet shall indicate a cross-connection. No flow from a recycled water outlet would indicate that it may be connected to the potable water system.

(i) The drain on the potable water system shall be checked for flow during the test and at the end of the period.

(j) If there is no flow detected in any of the fixtures that would have indicated a cross-connection, the potable water system shall be re-pressurised.

5.2.2 In the event that a cross connection is discovered, a licensed plumber, if applicable, shall take immediate actions in accordance with the procedures stipulated by the designer. The following procedures are suggested as a reference for the designer's consideration.

(a) Notify all affected occupiers to stop using water from tap for drinking, cooking and other potable uses before completion of the rectification work.

(b) Recycled water piping to the building shall be shut down at the meter, and the recycled water riser shall be drained.

(c) Potable water piping to the building shall be shut down at the meter.

(d) The cross-connection shall be uncovered and disconnected.

(e) The building shall be re-tested following procedures listed in the above section.

(f) The potable water system shall be disinfected according to WSD's disinfection procedure with fifty (50) mg/L chlorine for twenty-four (24) hours.

(g) The potable water system shall be flushed after twenty-four (24) hours, and a standard bacteriological test shall be performed. If test results are acceptable, the potable water system shall be permitted to be recharged.

5.2.3 A visual system inspection of the recycled water system shall be conducted annually, or more frequently if necessary, by a licensed plumber, if applicable. The results of the inspection shall be recorded in a standard form (Sample found in **Annex 1**) and kept by the property manager for inspection by appropriate authorities:

(a) Meter locations of the recycled water and potable water lines shall be checked to verify that no modifications were made, and that no cross-connections are visible.

(b) All pumps and equipment, equipment room signs, and exposed piping in the equipment room shall be checked.

(c) All valves shall be checked to ensure that valve lock seals are still in place and intact. All valve control door signs shall be checked to verify that no signs have been removed.

(d) If the visual test indicates that the recycled water plumbing has been modified, a cross-connection test is required.

5.2.4 Colour testing shall be conducted annually, or more frequently if necessary, by a licensed plumber, if applicable:

(a) The recycled water supplied to the development for flushing purpose shall be colour labelled with a biodegradable food grade dye.

(b) To reduce chlorine consumption, the colorant should be designed to be dosed at outlet of the disinfection facilities. The ideal concentration / amount for the colourant can be determined empirically through storage experiments with the actual recycled water and based on the dye manufacturer's recommendations.

(c) In the event that a cross connection is discovered, a licensed plumber, if applicable, shall take immediate actions in accordance with the procedures stipulated by the designer. The procedures described in Section 5.2.2 are suggested as a reference for the designer's consideration.

(d) The results of the colour testing shall be kept by the property manager for inspection by appropriate authorities.

(e) In addition to conducting the colour testing annually, it is recommended that the colour test also be performed whenever there is any alternation or repair of the plumbing facilities.

5.3 Decommissioning Procedures

5.3.1 When an installed system is taken out of service for an extended period, it should be made safe. Detailed recommendations should be included with the O&M procedures provided by the system supplier. In general, the following steps should be carried out:

(a) The entire system should be disinfected.

(b) Electrical connection to the system should be isolated.

(c) Surplus chemicals should be properly disposed of with due regard to safety and the environment.

(d) The collection / treatment tanks and recycled water pipework should be drained.

(e) Grey water collection pipeline should be diverted directly to the sewerage system. Pipework should be modified to ensure that wastewater can only enter the sewerage system, and that there are no dead zones where grey water could collect and stagnate.

(f) Inlets and outlets to the collection and treatment tanks should be plugged.

(g) If possible, pumps should be removed and stored properly.

(h) Parts of the system or pipework which are to remain in use should be thoroughly cleaned, disinfected, and flushed.

(i) Where recycled water was used for toilet flushing, the header tank may be retained as the means of providing mains water for toilet flushing, depending on the design of the system. Any mains water in a tank or pipe which has previously contained recycled water should be considered as contaminated until it is thoroughly cleaned and disinfected.

5.4 Switch-off during Extended Service Suspension

5.4.1 As generally 14 days chemical storage capacity will be reserved for normal operation of recycled water system, it is recommended that when an unstable supply condition or an extended period of more than 14 days service suspension is expected, e.g., Chinese New Year for schools, commercial and industrial buildings, etc, recycled water systems be switched off and the storage tanks flushed through with mains water prior to the suspension of service. This helps ensure that biological activity is minimised and proliferation of organisms

avoided. The recommendations of manufacturer or system supplier to resume service should be followed.

6. Operation and Maintenance

6.1 System Management

6.1.1 Due to the specialised nature of the treatment process and associated plant, consideration should be given to employing an appropriate contractor to operate and maintain the scheme. The skills and expertise of a typical building management and services teams / organisations without special training are unlikely to include those required for a recycled water treatment facility. The need to protect public health should be paramount when deciding on which management model would be adopted.

6.1.2 The organisations responsible for operation, maintenance and monitoring need to ensure that they are aware of any changes to regulations and legislation covering recycled water, water quality, electrical installations, etc., such that they can upgrade the schemes as and when appropriate accordingly.

6.2 Operation and Maintenance

6.2.1 Before maintenance, the recycled water systems shall be drained and flushed with clean water to reduce the risk of contamination to maintenance personnel, people in the vicinity and the physical surroundings.

6.2.2 Electricity and all water supplies shall be isolated before opening any sealed lids or covers of tanks.

6.2.3 Human entry into tanks shall be avoided wherever possible. Where entry is essential, it shall only be undertaken by trained personnel with personal protection equipment suitable and provision of adequate on-site supervision according to relevant statutory requirements for confined spaces.

6.2.4 Maintenance procedures shall be in accordance with the manufacturer's or system supplier's recommendations.

6.2.5 In accordance with manufacturer's or system supplier's recommendations, flow measuring devices shall be calibrated on a periodic basis.

6.2.6 The recycled water storage tank and buffer / storage tanks for untreated grey water and rainwater shall be cleaned and disinfected twice yearly in accordance with tank manufacturer's or system supplier's recommendations.

6.2.7 All labelling and marking of the recycled water pipework and fittings should be checked to ensure that they are in good condition and remain suitable to make all users aware that the water in the supply system is recycled water and is not potable.

6.2.8 For all schemes (grey water, rainwater and combined systems), an O&M manual should be obtained from the manufacturer or system supplier and from the contractor and be validated and kept by owner of the recycling system. All elements of the scheme should be covered in a unified manner. Separate

manuals covering all components should be avoided unless there is a comprehensive summary manual covering all components in a coherent manner.

6.2.9 The O&M manual should include a simple fault-finding chart explaining how the system should be put back into operation from a fail-safe condition. It should clearly differentiate between those conditions which can be rectified by the user and those which may require external assistance.

6.2.10 In the absence of any manufacturer's or system supplier's recommendations, the maintenance schedule in **Table 6.1** should be used as a reference. A log of inspections and maintenance should be kept.

Table 6.1 Maintenance Schedule for Recycled Water Systems

System Component	Frequency	Action
Gutters/downpipes (for rainwater system)	Every six months	Check to ensure there are no leaks or blockages due to buildup of debris; clean gutters if necessary
Manual cleaning filters	Monthly	Check condition of filter and clean if necessary
Self-cleaning or coarse filters	Every three months	Check condition of filter and clean if necessary
Cartridge, GAC filters	Every three months (depending on suspended solids content in the source water)	Replacement
Membranes, biological support media, and strainers	Annually	Check condition and clean or replace if necessary
Storage tanks/cisterns	Annually	Check to ensure there are no leaks, no build up of debris, and that all tanks and cisterns are stable and the covers are correctly fitted
	Every six months	Drain down, clean and disinfect with sodium hypochlorite
Backwash	Annually	Check functionality
Pumps and pump controls	Annually	Check to ensure there are no leaks and corrosion; carry out a test run
Back-up water supply	Annually	Check that the supply is functioning correctly and that the air gaps are maintained
Control unit	Annually	Check that the unit is operating properly, including alarm functions where applicable
Water level gauge	Annually	Check to ensure that any gauge indication responds correctly to the water level in the storage tanks/cisterns
Wiring	Annually	Visually check that the wiring is electrically safe
Pipework, valves and fittings	Annually	Check to ensure there are no leaks, pipes are watertight, no misconnection
Markings	Annually	Check that warning notices and pipework and valve identification are correct, visible and in place
Support and fixings	Annually	Adjust and tighten, where applicable
UV disinfection	Every six months	Clean and replace lamps, if necessary
Chemical disinfection	Monthly	Check that any dispensing unit is operating properly; replace chemical supply if needed
Biodegradable food grade dye storage and dosing system	Annually	Check to ensure that food dye colourant storage and dosing unit are operating properly
On-line water quality monitors, water metering	As recommended by manufacturer	Regular calibration

6.3 Warranty and Guaranteed Service Life

6.3.1 All metal fittings, fasteners and components of the treatment system, other than pumps and motors, shall be of non-corroding material and should have a service life of at least 15 years, if applicable.

6.3.2 All mechanical and electrical parts installed within the treatment system should have a minimum service life of 15 years, if applicable.

6.3.3 Providing the treatment system has been installed, used, and maintained in accordance with the documentation supplied upon delivery, all labour and materials shall be supplied free of charge by the system supplier or manufacturer during the warranty period for the purposes of repairing any equipment or component failures. Servicing of the treatment system is the responsibility of the owner; it is not provided free by the system supplier or manufacturer and shall be conducted in accordance with the documentation supplied upon delivery.

6.4 Manuals

6.4.1 The following manuals and documents shall be provided:

(a) A comprehensive operations and maintenance manual, for use by service technicians, which incorporates a detailed routine evaluation and maintenance schedule based on appropriate and defined service intervals. The maintenance schedule shall specify the work to be carried out by a service contractor as part of the continuous maintenance, and any required work to be conducted by the owner of the system.

(b) A service report form which is suitable for use by service technicians.

(c) A user instruction manual which includes the following:

(i) Overview of the treatment system and intended use

(ii) Warranty and service life

(iii) Servicing requirements

(iv) Frequency of calibration of on-line water quality monitors

(v) Trouble shooting and signs of failures

(vi) A list of toxic substances / loads to be avoided

(vii) Desludging requirements (if any)

(viii) Safety information

(ix) Spreading of hydraulic loads

(x) Use of treated effluent – fit for purpose

(xi) Influent sources to be connected to the treatment system

(xii) Alarm information and use restrictions

(xiii) Manufacturers name and contact details

(xiv) Procedures to be taken when cross connection occurs (Section 5.2.2)

6.4.2 The instruction manual should include a simple fault-finding chart explaining how the treatment system should be put back into operation from a fail-safe condition. Differentiation should be clearly made between those conditions which can be rectified by the user and those which may require external assistance by service technicians.

6.5 Submittals

6.5.1 The following information shall be provided by the manufacturers:

(a) Statement of warranty and service life containing the following:

(i) Equipment components under the warranty

(ii) Warranty terms, including service life period under the warranty

(iii) Warranty limitations

(iv) Warranty claims and procedures

(b) Installation manual and O&M manuals

(c) User instruction manual

(d) Service report form

(e) Certified engineering drawings, dimensioned and accompanied by a schedule of all components with name, model, size, description, function, material of manufacture and location in the treatment system. All components that are to be shown include the following:

(i) Electric motor(s)

(ii) Gearbox

(iii) Compressor

(iv) Pump(s)

(v) Valves

(vi) Diffusers

(vii) Flow meter

(viii) Media

(ix) Media fixings

(x) Chlorinator

(xi) Pipework

(xii) Sludge collection and pumping equipment

(xiii) Baffles

(xiv) Partitions

(xv) Brackets

(xvi) Fastenings

(xvii) Electrodes

(xviii) Float switches

(xix) Control panel

(xx) Arrangement of the alarms

(f) Key plan showing location of treatment system within the development

(g) Plan and section showing location of the treatment system within the development and surrounding facilities

(h) Process and instrumentation diagrams

(i) Hydraulic profile with supporting calculations

(j) Detailed process design calculations

(k) Detailed drawings with plan and elevation showing treatment plant room layout, including pipework and equipment

(l) Route of access to the treatment plant room

(m) Ventilation and lighting details

6.5.2 Any dangerous goods (DG) storage required submission to Fire Services Department (FSD), shall be provided by the authorised person on behalf of the owner.

7. Requirements on Sampling, Monitoring, Flow Measurement and Record Keeping

7.1 Sampling and Monitoring

7.1.1 Regular monitoring of recycled water quality is required to ensure that the public health and safety of end users are protected. The treatment system requires particular attention during commissioning and early phases of operation.

7.1.2 To ensure that monitoring and associated testing takes place and that it is carried out in a consistent and competent manner, an appropriate independent organisation shall be appointed to fulfil this role.

7.1.3 The water sampling and laboratory testing shall be preferably conducted by an organisation accredited for providing laboratory testing services for monitoring parameters under the Hong Kong Laboratory Accreditation Scheme or its partners under the Mutual Recognition Agreement signed with the Hong Kong Accreditation Service.

7.1.4 **Table 7.1** presents the required water quality monitoring schedule.

Table 7.1 Water Sampling and Testing Plan

Water Quality Parameters	Sampling Frequency	Reference Analytical Method(s)
E. coli	Monthly	DoE 7.8&7.9, APHA 9222K
Total Residual Chlorine (TRC)		APHA 4500-Cl G DPD colorimetric or equivalent
pH		APHA 4500-H+ B
5-d Biochemical Oxygen Demand (BOD_5)		APHA 5210 B
Total Suspended Solids (TSS)		APHA 2540 D
Turbidity		APHA 2130 B
Dissolved Oxygen (DO)		APHA 4500-O G
Threshold Odour Number (TON)		APHA 2150 B
Colour (in Hazen Unit)		APHA 2120 E
Ammoniacal-nitrogen (NH_3-N)		BS6068 Section 2.11:1989 or equivalent
Synthetic detergents		APHA 5540-C

Notes:

1. The analytical method(s) are for reference for grab sample laboratory test. The analyses shall follow the Standard Methods for Examination of Water and Wastewater, American Public Health Association, 20th Edition, or higher.
2. Dissolved oxygen and total residual chlorine are measured in-situ.
3. The table indicated the minimum manual sampling frequency. The water sampling should be stepped up if abnormalities are identified. The sampling frequency of individual parameters should be increased based on the output of the recycled water.
4. Colour needs to present noticeable blue to the naked eye.

7.1.5 Samples for the routine monitoring shall be collected from locations that best represent the whole system status, i.e., the points of use furthest from the treatment system. Additional samples shall be taken from effluent storage tanks or equivalent if routine sampling from points of use or other observations indicate a problem.

7.1.6 Installation of online water quality sensors for chlorine and turbidity measurements at the outlet of the treatment system is recommended.

7.1.7 Should testing results of water parameters exceed the water quality standards in **Table 1.1**, re-sampling and testing shall be performed immediately to confirm the results. System operation shall also be investigated.

7.1.8 Should testing results of water parameters continue to exceed (such as at least two consecutive testing results) the water quality standards, the following remedial measures shall be followed:

(a) Contact system supplier for recommendations and employ a treatment specialist to resolve the problem.

(b) Suspend the use of recycled water. Back-up water supply shall be used instead.

(c) Recycled water distribution system shall be flushed and disinfected, water sampling and testing could be conducted on site with quick test kit for instant notice, prior to introducing potable water supply to supplement the recycled water supply.

(d) The treatment system shall remain operational while conducting system operation investigation. The treated effluent shall be diverted to discharge.

(e) Once the problem is isolated and resolved, take samples from the system for testing to confirm its compliance with the water quality standard before resuming usage of recycled water.

(f) Should the problem persist, the recycled water system should be shut down until the problem is solved.

7.2 Flow Measurement

7.2.1 The total volume of all grey water, rainwater collected shall be fully measured.

7.2.2 The total volume of the recycled water produced and delivered to end users shall be fully measured.

7.2.3 Flow measuring device(s), such as water meter, shall be provided to measure the total quantity of all potable mains water supply used as backup water supply.

7.2.4 Flow measuring device(s), such as water meter, shall be provided to measure the total quantity of all grey water and/or rainwater collected but not processed to produce recycled water (i.e. overflowed or diverted to bypass and drainage systems).

7.3 Record Keeping

7.3.1 The property manager or operator shall maintain the proper records for a proper period of at least one year using a standard record form (Sample found in **Annex 2**).

7.3.2 Records shall be readily available for WSD to check upon request.

7.3.3 Records to be maintained might include the following:

(a) Water sampling and testing analyses

(b) Records of volume of grey water collected

(c) Records of volume of rainwater collected (whenever rainwater is collected)

(d) Records of volume of recycled water produced

(e) Records of volume of potable mains water supply supplied as back-up water with reason for its use

(f) Records of volume of grey water and rainwater collected but not treated, e.g., overflowed, bypassed or drained

(g) Records of volume of recycled water delivered to end users

(h) Operating hours (preferably records of on / off cycles combined with flows)

(i) Records from visual system inspection of recycled water system conducted annually by licensed plumber

(j) Logs of inspections and maintenance work carried out by maintenance staff

(k) Records of chemical consumption

7.3.4 The property manager or operator shall ensure that all system documentation, including installation drawings, as-built records, amendment records, manuals, warranties, certificates and maintenance records are passed on to future owners when the property is sold.

7.3.5 System suppliers and delegated maintenance companies shall maintain a database of installed systems and inform property managers shall their contact details change. It is recommended that a label describing the revised contact details be affixed to the control cabinet at the next service visit.

8. Marking and Labelling of Piping and Fittings

8.1 Identification of Pipelines and Services

8.1.1 Pipework for rainwater collection, grey water collection and recycled water shall be clearly distinguishable from the potable, salt water and wastewater pipework on a development. This practice prevents inadvertent cross-connection between water of different qualities, particularly drinking water.

8.1.2 The methods for identification are adapted from commonly accepted international standards or relevant Government departments' guidelines.

8.1.3 The pipe colour of recycled water pipes to be adopted may refer to the colour code of underground facilities[2] and be agreed with relevant authorities and maintenance agents as appropriate.

8.2 Labelling of Rainwater Collection Pipework

8.2.1 Pipework for rainwater collection could be labelled with "RAINWATER" in order to prevent cross connection between the rainwater and mains water supplies. **Figure 8.1** illustrates an example of the label for reference.

Figure 8.1 Example of Labelling for Rainwater Collection Pipes

8.3 Labelling of Grey Water Collection Pipework

8.3.1 Grey water collection pipework could be labelled with "GREY WATER". Markings shall be made at time of piping manufacture, or labelling shall be attached during installation. An example is shown on **Figure 8.2** for reference.

8.3.2 Pipework for collection could be labelled along their length with marker tape as appropriate in order to prevent cross connection between the source water and potable water supplies. Colour codes of "grey" colour and "black" background could refer to 10 A 03 from BS 1710 and 00 E 53 from BS 1710, respectively.

Figure 8.2 Example of Labelling for Grey Water Collection Pipes

8.4 Labelling of Recycled Water Distribution Pipework

8.4.1 Grey water and rainwater after treatment is defined as recycled water.

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[2] https://www.hyd.gov.hk/en/technical_references/technical_document/xppm/related_documents/doc/Colour_Code_of_Underground_Facilities-1.pdf

8.4.2 The basic identification for recycled water pipes inside/outside buildings shall be coloured, e.g. green colour (12 D 45 from BS 1710), stripes on background of black with green labels. An example is shown in **Figure 8.3** for reference.

Figure 8.3 Example of Labelling for Recycled Water Pipes

8.4.3 The requirement and details of identification tape for source water collection pipework and recycled water pipework ahead may refer to relevant WSD Standard Drawing and be agreed with relevant authorities and maintenance agents as appropriate.

8.5 Identification at Points of Use

8.5.1 To minimise the risk of misuse of recycled water, in addition to display of sufficient signage at the point of use, the installation of accessible taps at the point of use of recycled water should be avoided as far as possible. If the installation of taps is unavoidable, the tap should be properly locked as far as possible.

8.5.2 All outlets supplying recycled water shall be clearly labelled with the words "Non-potable water" or a prohibition sign (**Figure 8.4**) so that users and maintenance personnel are aware of the non-potable water supply.

8.5.3 For landscape areas, general signs should be provided to indicate that the water used for irrigation uses recycled water.

8.5.4 Where the majority of points of use on a premise are for non-potable water, the point of use for potable water may be identified with the words "Potable water" or by the potable water sign shown on **Figure 8.5**.

Figure 8.4 Example of Prohibition Sign

Figure 8.5 Example of Potable Water Sign

8.5.5 It is recommended that tags identifying each end user application and its water supply be secured using flexible fasteners or the like to avoid being detached. The lettering shall be no less than 5 mm in height. Examples for recycled water are shown on **Figure 8.6**.

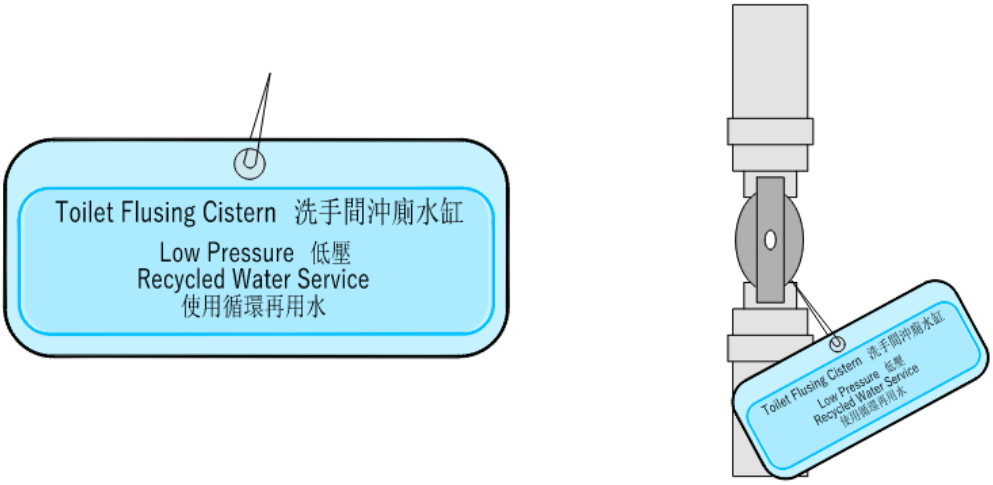


Figure 8.6 Example of Identification Tags and Positioning for Recycled Water

9. Special Considerations for New Developments

9.1 General

9.1.1 Developments which contain facilities producing clinical or chemical wastes shall not set up grey water systems. If such facilities are set up in commercial building, and such facilities should be known to the new development.

9.1.2 Examples of producers are:

(a) Hospitals

(b) Government clinics

(c) Dental hospital

(d) Nursing homes

(e) Day procedure centres

(f) Private medical clinics (including Chinese medicine practitioners)

(g) Dental clinics

(h) Medical laboratories

(i) Residential care homes including those for the elderly

(j) Universities with medical teaching or research

(k) Industrial facilities producing chemical waste

10. Safety Precautions

10.1 Safety Precautions for Operation / Maintenance Staff

10.1.1 Training in safe work procedure, including the use and maintenance of protective equipment shall be provided to the personnel carrying out the recycled water system commissioning.

10.1.2 Recycled water treatment may involve application of chemicals classified as dangerous goods by FSD, which is a major concern. All personnel involved shall be fully conversant with the safe handling of the products.

10.1.3 Chemicals used for disinfection may be hazardous in undiluted form through contact, ingestion or inhalation. Containers should be properly labelled and kept in a secure place away from residents. Chemical suppliers must provide guidance on handling precautions and response procedures in case of accidental contact or ingestion. Chemicals shall be stored at an appropriate location to facilitate chemical handling. Chemicals shall be stored in accordance to FSD's requirements for bulk storage. Storage quantities shall not exceed the exempted quantity under the Dangerous Goods Ordinance (Cap. 295) and its subsidiary regulations.

10.1.4 Sodium hypochlorite solution is a corrosive substance classified as Class 8 dangerous goods item. The solution should be stored in tanks fabricated from fibreglass or rubber lined steel. Under the existing Dangerous Goods Regulations, storage of sodium hypochlorite in quantities exceeding 250 litres requires a license.

10.1.5 Material safety data sheet (MSDS) and relevant recognised data sheet for chemicals used in recycled water treatment processes shall be provided by the system supplier or manufacturer and included in the operation and maintenance manual.

10.1.6 MSDS and relevant warning / safety label shall be provided on the surface of chemical buckets. The MSDS and labels shall be properly protected against water and chemical damage.

10.1.7 Eye wash bottles or washing basin with fresh water tap shall be provided adjacent to the recycled water treatment chemicals tanks or any appropriate location for emergency use. The water contained in the eye wash bottle shall be replaced periodically.

10.1.8 Mechanical or natural ventilation shall be provided to the room entirely or partially used for chemical storage.

10.1.9 Electrical work must only be undertaken by a competent electrician. Unless specifically designed to operate under submerged conditions, all electrical devices and connections should be made above the maximum flood level of the system under fault conditions. An electrical safety certificate (the Form WR1 or WR2 under Cap 406) should be issued upon completion of electrical installation or maintenance work.

10.1.10 Electrical fittings and luminaries serving the chemical storage area shall be weather-proof and corrosion resistant type.

10.1.11 Warning signs shall also be erected to restrict the unauthorised access to recycled water treatment systems.

10.1.12 Any part of the water recycling system may be contaminated with pathogenic bacteria. Plumbers, maintenance personnel and any others who come into contact with the water recycling system should wash their hands thereafter.

10.1.13 Grey water /rainwater collection pipework and tanks should be handled as if contaminated with faecal material. Gloves and overalls should be worn during routine cleaning and maintenance activities, and when cutting into the system.

10.1.14 Sufficient personal protective equipment shall be provided to protect workers during plant activities, such as sampling, from exposure to potential hazards such as aerosols.

10.2 Colour-Labelling of Recycled Water

10.2.1 Purple / lavender colour coded pipework (if practicable) and label identifications on pipe surface (section 8.4) could be adopted to clearly distinguish different types of supply to avoid contamination due to cross-connection of pipes or misuse.

10.2.2 As an additional preventive measure for toilet flushing, colour-labelling of recycled water (i.e. addition of biodegradable food-grade dye i.e. Acid Blue 9 to recycled water at outlet of the water recycling system) is required to make recycled water discernible to fresh water and give an immediate visual warning to customers in case of the fresh water supply system being contaminated by recycled water.

10.3 Safety Precautions for End Users

10.3.1 Due to the non-potable nature of recycled water, safety precautions associated with the use of recycled water can be managed by minimising direct contact with human and avoiding potable consumption. If splashed in the eyes, wash immediately with clean water.

10.3.2 End users shall wash hands after being in contact with recycled water. If splashed in the eyes, wash immediately with clean water. Avoid any unnecessary contact with recycled water.

10.3.3 End users shall not consume food or drink while working with recycled water. Wash hands and face with fresh water before eating and finishing work.

10.3.4 End users shall cover any wounds, after washing with soap and fresh water, with a waterproof dressing to prevent contact with recycled water.

10.3.5 All workers or persons likely to be using recycled water are required to attend briefing session to understand that recycled water is being used, that recycled

water is not to be used for drinking, handwashing or other similar uses, and that they shall wash their hands and face with fresh water before eating or finishing work.

10.4 Safety Precautions for Spray Irrigation and Street Cleansing Using High Pressure Sprayer with Recycled Water

10.4.1 Recycled water is treated and disinfected according to the required water quality standards. It is safe for non-potable uses including toilet flushing, landscape irrigation and street cleansing, etc.

10.4.2 Due to the non-potable nature of recycled water, suitable precautionary measures shall be applied to prevent the public from making direct contact with recycled water from spray irrigation or street cleansing using high pressure sprayer as far as practicable. For example, portable barriers, cones and warning notices or the like may be placed around the affected areas to avoid approaching of the public. Operation should be avoided to clean busy roads and main traffic thoroughfares during peak hours.

10.4.3 Only freshly prepared recycled water shall be used for irrigation and street cleansing. Each batch of freshly prepared recycled water shall be consumed within 24 hours.

10.4.4 Spray irrigation or street cleansing using high pressure sprayer shall be located away from areas where food or drink is processed for consumption.

10.4.5 Signage of "Recycled Water – Do Not Drink", or prohibition sign as shown in **Figure 8.4** shall be provided in appropriate locations.

11. Recommended Practice for Occupants of Developments with Recycled Water Systems

11.1 General

11.1.1 Occupants of the development shall be educated not to pour excessive amounts of disinfectants or other household cleaning agents into basins and sinks connected to the grey water collection system.

11.1.2 The addition of grease, oil, and solid material to kitchen shall be kept to a minimum, by disposing of these wastes as kitchen refuse rather than down the drain.

11.1.3 Avoid pouring waste cooking oil down a drain collecting grey water for reuse. They should be disposed of at the cisterns instead.

11.1.4 Blackwater shall not be poured into basins and sinks connected to the grey water collection system.

12. Recommended Education and Training on the Proper Use of Recycled Water

12.1 General

12.1.1 Education and training shall be provided to staff and residents of developments using recycled water.

12.1.2 Training for staff specifically involved with the operations and maintenance of the grey water and/or rainwater treatment system shall be separately provided and incorporate safety precautions for operations and maintenance staff as discussed in Section 10.1.

12.2 Recommended Education and Training Content for Residents

12.2.1 Education and training for residents shall incorporate, but not limited to, the following:

(a) Overview of the treatment technology used within the development for supply of recycled water, including the sources of the grey water and/or rainwater collected

(b) Prohibited uses as discussed in Section 1.2.5

(c) Safety precautions for end users as discussed in Section 10.3

(d) Proper practices within household as discussed in Section 11.1

12.2.2 Posters and pamphlets may be used to reinforce the education and training.

12.3 Recommended Education and Training Content for Staff

12.3.1 Education and training for staff within developments shall incorporate, but not limited to, the following:

(a) Overview of the treatment technology used within the development for recycled water production

(b) Prohibited uses as discussed in Section 1.2.5

(c) Safety precautions for end users, irrigation, and street cleansing using high pressure sprayer as discussed in Sections 10.3 and 10.4 respectively

(d) Proper practices within household as discussed in Section 11.1

(e) Induction training for new employees

(f) Training on emergency situation

12.3.2 Posters and pamphlets may be used to reinforce the education and training.

13. Compliance with Water Pollution Control Ordinance (Cap. 358), Waterworks Ordinance (Cap. 102) and associated Environmental Ordinances and Regulations

13.1 General

13.1.1 The design, operation and maintenance of the recycled water systems shall comply with environmental ordinances and regulations, including but not limited to the Building (Standards of Sanitary Fitments, Plumbing, Drainage Works and Latrines) Regulations (Cap. 123I), Water Pollution Control Ordinance (Cap. 358) (WPCO), Noise Control Ordinance (Cap. 400), Air Pollution Control Ordinance (Cap. 311), Waste Disposal Ordinance (Cap. 354), Country Parks Ordinance (Cap. 208), Waterworks Ordinance (Cap. 102)[3], Public Health and Municipal Services Ordinance (Cap. 132), and if applicable Environmental Impact Assessment Ordinance (Cap. 499), and associated Regulations. Such compliance shall include but not limited to the attainment of relevant discharge licenses, if applicable.

13.1.2 Any discharges from the recycled water treatment systems, disposals of used recycled water for various uses to sewers, storm drains or other environmental waters are subject to licensing control under the WPCO. The discharges are required to comply with the licence standard to be specified according to the WPCO Technical Memorandum – "Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters".

[3] https://www.elegislation.gov.hk/hk/cap102

14. Reference Design

14.1 Combined Grey Water and Rainwater System

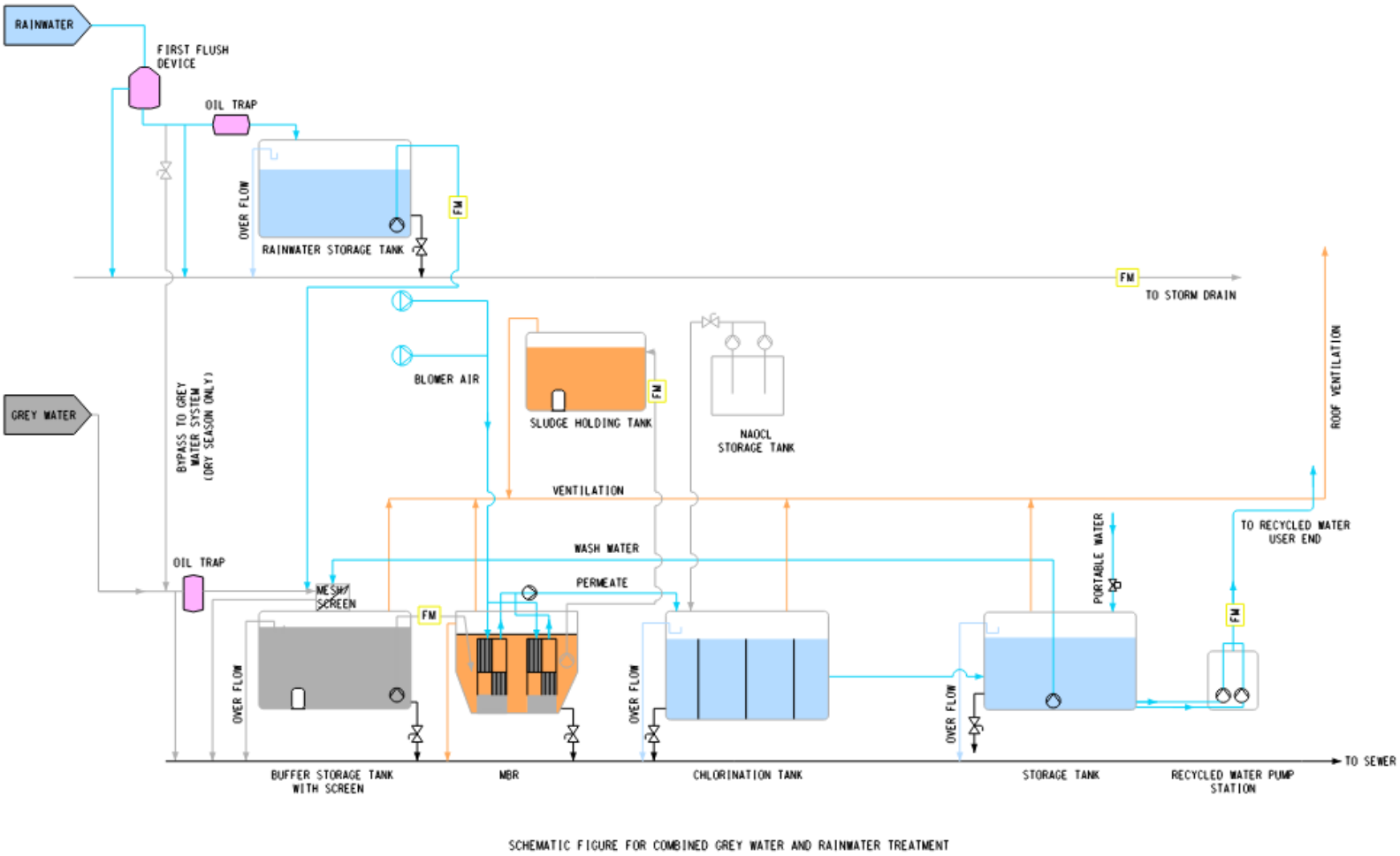
14.1.1 This section presents an example schematic design for a combined grey water and rainwater system.

14.1.2 Typical influent characteristics of grey water, without rainwater combined, are shown in **Table 14.1**. The expected effluent characteristics are shown in **Table 1.1**.

Table 14.1 Typical Influent Characteristics of Grey Water

Parameter	Unit	Grey Water Influent
E. coli	cfu/100 mL	10^4 - 10^8
Total suspended solids (TSS)	mg/L	30 - 200
Turbidity	NTU	30 - 400
pH	--	6 - 9
Chemical oxygen demand (COD)	mg/L	100 - 700
5-day Biochemical oxygen demand (BOD_5)	mg/L	50 - 500
Ammoniacal nitrogen (NH_3-N)	mg/L	2 - 15

14.1.3 An indicative schematic figure of the combined grey water and rainwater treatment systems are shown on **Figure 14.1** for indicative purpose. In this example, MBR is the main treatment component for the combined grey water rainwater system.



SCHEMATIC FIGURE FOR COMBINED GREY WATER AND RAINWATER TREATMENT

Figure 14.1 Schematic Figure for Combined Grey Water and Rainwater Treatment

Annex 1 –
Sample Standard Form for Recording Visual Inspection Results by Licensed Plumber

Standard Form for Recording Visual Inspection Results by Licensed Plumber

Date of Inspection: _____ **Ref. No.** _____

Name of Inspector: _____

Plumber License No.: _____

Location of Inspection: _____
_____

Purpose/ Usage Areas of Recycled Water: _____

Time of Inspection: _____ **Room Temperature:** _____

Physical Observations (water):

Odor:	none	sewage	sulfide	oil	gas	sour	other:_____
Colour:	none	yellow	brown	green	gray	milky	other:_____
Turbidity:	none	cloudy	opaque				

Floatables: none particulates oil sewage other:_____

Deposits: none sediments oily describe: _____

Physical Observations (facilities):
Meters: in place and intact other:

Recycled water lines: in place and intact other:

Pumps and equipment: in place and intact other:

Equipment room/door signs: in place and intact other:

Exposed piping in the equipment room: in place and intact other:

Valve (lock seals): in place and intact other:

Colour labelled for recycled water: in place and intact other:

Cross-connection test: required, not required

Photos:

Annex 2 –
Sample Record Form for Recycled Water Systems

Record Form for Recycled Water Systems

Date: _____ **Ref. No. _____**

Name of Operator: _____

Location of the Plant: _____
_____

Purpose/ Usage Areas of Recycled Water: _____

Volume of Grey Water Collected: _____m^3

Volume of Rainwater Collected: _____ m^3

Volume of Potable Mains Water Supply supplied as back-up water: _____ m^3

Reason for using Potable Mains Water as back-up water:

_____

Volume of Recycled Water delivered to end users: _____ m^3

Operation Hours: From _____ to _____

Amount of Chemicals Consumption:
Chemical 1: _____ Amount: _____
Chemical 2: _____ Amount: _____
Chemical 3: _____ Amount: _____

Remarks:

_____

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Prepared by: _____ **Checked by: _____**