Selection Criteria and Guidelines for the Design, Construction and Operation of Potable Water Dispensing Units

1.0 Purpose

Potable Water Dispensing Units (PWDUs) are small scale water treatment systems intended to treat only the consumable portion of total water demand (water used for drinking and food preparation). PWDUs have no distribution system and water is typically stored on site for manual collection by users. PWDUs are intended for communities with drinking water quality issues where full scale water treatment plants may not be feasible due to lack of resources– technical, human, financial. PWDUs are a more economical and sustainable solution, that provide small rural communities with advanced treatment technology on a scale that is affordable.

The following outlines selection criteria and guidelines for the design, construction and operation of PWDUs. These guidelines are intended to ensure that planning results in facilities that are appropriate for each community, that are properly and efficiently constructed, and to provide best management practices for the proper operation and maintenance of systems.

2.0 Design Objectives

2.1 Capacity

The World Health Organization (WHO) recommends 5.5 litres of water per person per day (L/p/d) to meet the need for drinking water for most people under most conditions (2003, WHO). In emergency or disaster situations the WHO also recommends 3 L/p/d for food preparation and cleanup, and 7 L/p/d for personal hygiene as a minimum survival allocation (WHO, 2005). Standard WHO water requirements for domestic use in emergencies are outlined in Table 1.

Table 1: Standard water requirements for an individual

Basic Need for Water	Litres of Water Per Person Per Day
Drinking Water	3-5.5
Food Preparation	2-3
Personal Hygiene	6-7
Total	11-15.5

A PWDU should be designed to meet consumptive needs– drinking water and food preparation. The PWDU must be sized to treat a water demand of at least 5.5 L/p/d based on the population of the town(s) designated as users.

Depending on the population to be serviced by the PWDU, NSF certified treatment equipment at design flow rates may not be available. NSF certified treatment equipment should be sized as closely as possible to design flows.

2.2 Water Quality

A PWDU must be designed to produce drinking water that meets the Guidelines for Canadian Drinking Water Quality (GCDWQ). ENVC may approve the exemption of the pH GCDWQ as the PWDU does not have an associated distribution system. A PWDU must also be able to produce drinking water with DOC of less than 2.0 mg/L.

3.0 Design Considerations

PWDUs are normally comprised of modular process units, which are pre-designed for specific process applications and flow rates, and can be purchased as a package. Packaged PWDUs that are skid mounted and preassembled are preferred. Multiple units may be installed in parallel to accommodate larger flows.

The proposed treatment process of the PWDU must fit the community situation and ensure a continuous supply of safe drinking water for water consumers.

Factors to be considered include:

a. Raw water quality characteristics under normal and worst case conditions including seasonal fluctuations must be evaluated and considered in the design;

b. Demonstration of treatment effectiveness under all raw water conditions at pre-selected flows. This demonstration may be on-site pilot or full scale testing. On-site testing is required at sites having questionable water quality or applicability of the treatment process. The proposed demonstration project must be approved by the DMA and ENVC prior to commencement;

c. The reliability and experience record of the proposed treatment equipment and controls must be evaluated;

d. Unit process flexibility which allows for optimization of treatment;

e. All new waterlines and appurtenances are to be hydrostatically tested in accordance with the Municipal Water, Sewer and Roads Specification;

f. National Sanitation Foundation (NSF) standard, American National Standards Institute (ANSI) or other applicable standards that conform to meet NSF certification is required for treatment equipment and materials that will be in contact with the water;

g. Factory testing of controls and process equipment prior to shipment;

h. Automated troubleshooting capability built into the control system;

i. Start-up and follow-up training and troubleshooting to be provided by the manufacturer or contractor;

j. Provision of an Operation and Maintenance Manual;

k. All equipment must be under manufacturers warranty and replacement guarantee for a period of at least 1 year. The warranty period is to commence upon the date of commissioning of the system. Appropriate safeguards for the water supplier must be included in contract documents. ENVC may consider interim or conditional project approvals for innovative technology where there is sufficient demonstration of treatment effectiveness and contract provisions to protect the water supplier should the treatment not perform as claimed;

l. Provision of 2 year supply of consumables including filters, UV lamps, batteries, etc.; and,

m. The ease of operation and maintenance of the system.

As built drawings must be provided to ENVC and MA upon commissioning of the PWDU system.

3.1 Source Water

Source water for the PWDU can be either be raw water, disinfected water, or treated and disinfected water originating either from a surface or groundwater source, or the distribution system.

Source water for the PWDU from the distribution system that has already been treated or disinfected must take into consideration removal of Disinfection By-Products (DBPs) that may have already formed in the feed water and the affect chlorinated water may have on the PWDU process components.

The PWDU must be able to treat water to the same standard regardless of whether the source water's treatment system is functional or not.

3.2 Selection of Best Available Technology

Climate, physical conditions, population, community water system operator capacity, capital costs, operation and maintenance costs, and regulations are the factors that must be considered in determining the type of PWDU system best suited to a particular community.

a. Finished water quality must meet the Guidelines for Canadian Drinking Water Quality;

b. Based on the design flow, source water quality, GCDWQ and design considerations, the most appropriate treatment process must be objectively chosen from available technologies;

c. Long term affordability including operation, maintenance and life cycle cost must be considered in the determination of the best available technology.

Available water treatment technologies can include: multi-media filtration, ultra-filtration, nanofiltration, activated carbon filtration, reverse osmosis, ozonation, UV disinfection, chlorine disinfection, water softening, iron and manganese removal, pH adjustment, arsenic removal, etc.

3.3 Pilot Studies

All PWDU treatment trains must be piloted to prove the effectiveness of the proposed treatment process. Once proven the PWDU treatment process can be considered standardized and will not require further piloting. If the treatment system cannot meet the design objectives of the PWDU, then changes and/or additions to the process must be carried out to bring the PWDU into compliance.

3.4 PWDU Housing

The PWDU facility may be housed in an existing building or a newly constructed building.

The PWDU unit must be located in a separate room from other water treatment equipment or other uses which the building may house. The PWDU unit must not be located in the same building as active chlorination equipment or chlorine storage.

The housing for the PWDU facility must be appropriately sized for access by the operator to undertake required maintenance and to store supplies.

The PWDU building must be adequately heated, lit and ventilated and allow sufficient space for the operator to maintain the various process components. Climate control and adequate insulation must regulate condensation or frost build-up on the outside of pipes and other PWDU components or in the housing building.

If a skid mounted PWDU unit is selected, the building must accommodate the easy installation and removal of the unit.

The PWDU facility must be located in a centralized location that is easily accessible to the public with adequate parking for at least two (2) vehicles. A timed locking mechanism may be used to regulate access to the PWDU facility.

The dispensing area must be well lit and have sufficient windows and/or glass doors to see the interior from outside for security purposes. The parking lot and area outside of the public access door to the PWDU dispensing area must be well lit if access is provided during non-daylight hours.

The potable water dispensing area must be located in a separate room from the treatment equipment with its own entrance. The public must not have access to the treatment equipment. The treatment equipment must only be accessible by town staff.

The PWDU facility must be fully accessible to persons with disabilities or in compliance with the *Buildings Accessibility Act*.

3.5 Storage

At least 5.5 L/p/d of finished, partially finished or raw water storage must be provided for all PWDU systems.

The purpose of a storage tank in the PWDU system is to provide for emergency storage of drinking water, to equalize demand, and to reduce the capacity and size of the treatment units by providing storage.

As long as the disinfection unit prior to the dispensing tap is functioning, drawdown of treated or partially treated from the water storage tank may be permitted.

Residence time in the water storage tank must be limited to a maximum of 48 hours in order to obtain optimal water quality and minimize water quality deterioration in the tank.

A minimum of 50 percent of the total volume of the water storage tank must be active volume.

Re-circulation of water from the tank to different treatment units via a re-circulation pump must be employed to maintain water quality in the tank.

The tank must be designed to permit complete drainage for maintenance and cleaning purposes, or any adverse water quality event.

Volume levels must be indicated on the storage tank including maximum and minimum design storage levels.

If there is more than one storage tank, the emptying/filling cycle must alternate between tanks.

Storage tanks should be made of polyethylene. Other materials (fibreglass, concrete, metal) may be acceptable.

3.6 Alarms and Automated/Unattended Operation

All PWDU systems must be equipped with alarms that indicate whether or not the system is operational.

The PWDU control system should have at least 3 status conditions that are indicated on a control panel:

- Operational
- Not operational
- Standby/ checking operational status

Multiple automated system checks should be performed on the PWDU system prior to a change of status to operational. System checks can include:

- UV transmittance
- Storage tank level
- Water pressure
- Ozone level
- Water quality parameter level (eg. colour)

A failure can include loss of power, loss of communications, violation of operation conditions, failure of equipment (motors, generators, sensors, switches, etc.), maintenance required on equipment, replacement of consumables required, vandalism, deliberate or unintentional contamination, violation of drinking water quality guidelines, etc.

Failure of any part of the PWDU treatment system must trigger automatic shut-off devices to prevent dispensing of untreated water. Manual shut-off of the PWDU system must also be provided. As long as the disinfection unit prior to the dispensing tap is functioning, drawdown of treated or partially treated from the tank may be permitted.

The dispensing unit faucets must have an automatic shut off after no more than 5 minutes if left open. This is a precaution to shut off taps if left unattended.

Faucets must be such that no hoses can be connected.

A SCADA or automatic dial up system may be installed to send out alarms/messages to the water system operator or town officials that the PWDU system is not operational. This is not a requirement. If a SCADA system is installed, additional operational equipment to allow for a SCADA system is required.

All aspects of PWDU automation systems must be submitted to the ENVC including the following information:

a. Identify all critical features in the PWDU that will be electronically monitored, have alarms and can be operated automatically or off-site via the control system.

Include a description of automatic plant shutdown controls with alarms and conditions which should trigger shutdowns.

b. Automated PWDU shutdown is required on all alarms. Automated start-up of the PWDU is prohibited after shutdown due to an alarm. Built in control system challenge test capability must be provided to verify operational status of alarms.

c. The plant control system must have the capability for manual operation of all PWDU equipment process functions.

d. A process flow diagram showing the location of all critical features, alarms and automated controls must be provided.

e. An operator shall be on "standby duty" status at all times and located within a reasonable response time of the PWDU.

f. An operator shall do an on-site check at a frequency recommended by the manufacturer to verify proper operation and PWDU security.

g. Description of operator staffing and training, planned and completed, in both process control and the automation system.

h. Operations manual that gives operators step by step procedures for understanding and using the automated control system under all water quality conditions. Emergency operations during power or communications failures or other emergencies must be included.

i. A plan for at least a 1 year demonstration period to prove the reliability of procedures, equipment and surveillance system. Challenge testing of each critical component of the overall system must be included as part of the demonstration project.

j. Schedule for maintenance of equipment and all parts replacement.

k. Sufficient staffing must be provided to carry out daily on-site evaluations, operational functions and needed maintenance and calibration of all critical treatment components and monitoring equipment to ensure reliability of operations.

l. Staff must perform at least weekly checks on the communication and control systems to ensure reliability of operations.

m. Provisions must be made to ensure security of the PWDU facility at all times. Incorporation of appropriate intrusion alarms can be provided which are effectively communicated to the operator or municipal authority.

3.7 PWDU and Process Equipment

The PWDU must have a first flush or by-pass mechanism that diverts water upon start-up or cleaning of the unit away from the storage tank. Flushed water should be discharged to a sump drain or open ditch.

Backwash from filters must go the sanitary sewer, retention pond or chamber, or to a dry pit. It must not be discharged directly to a water body.

The PWDU may be fitted with a chlorine injection site for routine (at least quarterly) maintenance and disinfection of system components.

PWDU systems may be designed with intentional duplication of treatment processes. Duplication of treatment process allows for alternating use of equipment, reduced wear and tear on equipment, and planned redundancy in the case of breakdown of one of the treatment units.

Refer to the Government of Newfoundland and Labrador's *Guidelines for the Design, Construction and Operation of Water and Sewage Systems* for the requirements of specific treatment processes for Ozone, Reverse Osmosis, UV Disinfection, etc.

The PWDU must have pre and post treatment sampling ports available for the collection of monitoring samples.

Finished water must be continuously disinfected immediately before being dispensed to the public using UV or any other approved method for that unit.

For PWDU systems using ozone, all parts including pipes, valves, and storage tanks coming into contact with ozone in air must be made of 316L stainless steel. All components coming into contact with ozone in water must be made of 304L or 316L stainless steel.

pH adjustment may be required for treatment process optimization. pH adjustment filters are the recommended technology over chemical addition for pH neutralization in PWDU systems.

All PWDU systems must have calculated a design process flow and a maximum expected dispensing flow.

Treatment units must be designed for the flow they are likely to receive, either the process flow or the dispensing flow. For treatment units that are likely to experience both flow regimes, the unit must be designed for whichever flow is greater.

The PWDU system must be constructed in accordance with the terms and conditions of the Permit to Construct.

The PWDU must be able to treat source water quality typical during extreme rainfall events to levels required by the *GCDWQ*.

The PWDU may be equipped with an automatic shut-off when the quality of the treated water does not meet specifications.

Compressor units for ozone generation should be installed with a fan that operates automatically when the compressor is operating to prevent overheating.

Action should be taken to prevent excessive condensation from interfering with PWDU system treatment processes.

Pipes in the PWDU system may be marked with the direction of flow.

All PWDU systems must be equipped with a flow meter with a totalizer feature.

All meters, valves, or monitoring devices may be labelled indicating what they are monitoring or controlling.

Electrical surge protection devices are recommended as part of the PWDU system.

At least one disinfection unit (eg. UV) must be located downpipe of the storage tank.

3.8 Dispensing Unit

The potable water dispensing area must be separated from the treatment equipment. The public must not have access to the treatment equipment.

There may be signage in the potable water dispensing area explaining the following if applicable:

a. The meaning of alarm lights or non-access to water
b. Use of sanitary/clean water containers
c. Times of access
d. Cost of water by volume
e. Warnings not to access treatment equipment area
f. Warnings not to contaminate dispensing mechanism
g. This water is meant for use by the citizens of town X
h. Collect drinking water here
i. How to properly store collected drinking water
j. If there are problems, please call town/operator
k. This building is being monitored
l. No smoking
m. Vandals will be prosecuted

There must be a location in the dispensing area in which to post basic instructions on usage and the data containing water quality test results.

Access to the potable water dispensing area may be allowed through use of a timed locking mechanism.

The dispensing unit must be able to accommodate variable size containers.

The dispensing area may have a maximum of 3 dispensing taps.

Tap heights must be fixed and not adjustable.

The dispensing area must be equipped with a bottle washing station.

The dispensing unit must be configured in such a way as to prevent backflow/back-siphonage of water from a collection container to the dispenser and PWDU system. There must be an air gap between the dispensing unit and the collection container of at least 2.5 cm (or 2 times the pipe diameter) measured vertically.

Air gap devices (eg. cage) may be used on the dispensing unit to physically prevent the container from contacting the dispenser.

The dispensing unit must be configured in such a way as to minimize either deliberate or inadvertent contamination of the dispenser. A dispensing unit that prevents physical contact with the actual dispenser is recommended. Use of a control button to operate the dispenser is recommended.

Any countertops, cabinets, splash guards, frames, sinks, shelves, the floor and other fixtures in the dispensing area should not be of wood. Preferably such fixtures should be made of stainless steel, plastic, ceramic, concrete or some combination thereof.

A hose dispenser must not be used to fill containers with water and hoses must not be connected.

There must be adequate drainage in the dispensing unit area including both a sink beneath dispensing taps and a floor drain.

The dispenser for drinking water must not be located outside of the facility building.

Adjustable level taps and flexible piping are not recommended in the dispensing area as adjustable taps present opportunities for contact and potential contamination of the tap and needless wear and tear on the flexible piping.

Spring loaded taps that shut off when not manually held open may be used.

Removable rubber mats may be installed on the floor in the dispensing area to minimize danger of someone slipping and falling, and to help keep the dispensing area clean.

3.9 Process Flow Diagram

The consultant must prepare a Process Flow Diagram (PFD) of the PWDU system that indicates the flow of water through the different treatment processes. The PFD should display relationships between *major* equipment making up the PWDU. The PFD must include but is not limited to:

- Process piping
- Major equipment symbols, names and identification numbers
- Control valves and other major valves that affect operation of the system
- Interconnection with other systems
- Major bypass and recirculation lines
- Alarms and automated controls
- Operational data such as temperature, pressure, volumetric flow rate, etc.

A copy of the PFD must be included in the Operation and Maintenance Manual.

4.0 Operation

The town is responsible for the operation and maintenance of the PWDU.

Operation of the PWDU must be in accordance with the Operation and Maintenance Manual provided and the terms and conditions of the Permit to Operate.

Filters must be backwashed at a frequency deemed necessary or as outlined in the Operation and Maintenance Manual.

All parts and consumables used in the operation and maintenance of the PWDU, including chemicals, must be NSF certified and as recommended by the manufacture. Inferior substitutes should be avoided.

The PWDU system (pipes, treatment units, tank, dispensing units) must be flushed, cleaned and disinfected at least once every three months.

The potable water dispensing area must be cleaned as required to maintain sanitary conditions. Unsanitary conditions include build up of dirt, bio-films, mold, algae, garbage, or other conditions likely to be unhealthy or potentially cause disease. Full cleaning and sanitization of the dispensing area must be carried out at least once per week.

If the PWDU system undergoes automatic shut down due to poor source water quality caused by an extreme event (heavy rainfall, spring melt, thermal inversion), the system must be flushed, cleaned and disinfected before being put back into service.

There must be adequate snow clearing provided for the PWDU building to allow for building access and parking.

All PWDUs should be supplied with a field test kit for colour, especially when UV disinfection is being used as part of the treatment process.

An owner's maintenance log must be prepared and made available to ENVC and must include manufacturer's information on all components of the system.

5.0 Monitoring

Regulatory inspection of PWDUs will be undertaken by staff of ENVC to assess compliance with Permits to Operate.

Drinking water quality monitoring will be undertaken by staff of ENVC to assess compliance with GCDWQ. The Department of Government Services will monitor for bacteriological parameters.

Consultants and/or equipment manufactures will be required to conduct performance monitoring of the PWDU during the warranty period (1 year) to be submitted to the town and staff of ENVC. Performance monitoring requirements will be determined on a site by site basis by the ENVC and may include:

- Monthly sampling
- Sampling during varying water quality scenarios

Operators must maintain daily records to include the following parameters:

- Water usage (total flow in/out)
- Water quality (turbidity, color, TDS)
- Chlorine residual
- UV Transmittence
- All maintenance activities performed

Reverse osmosis systems must also include daily monitoring of:

- Feed flow, pressure
- Product flow
- Reject flow, pressure; and
- Recirculating flow

Ozone systems must also include daily monitoring of:

- % Ozone

- Atmospheric ozone
- Ozone leak detection system functioning

Completion of daily records will allow personnel to quickly and accurately assess the operation of the PWDU equipment. This will improve troubleshooting during equipment shut-downs.

5.1 Operation and Maintenance Manual

Two hardcopies and one digital copy of a PWDU Operation and Maintenance Manual must be provided to the town. A digital copy of the Manual must be provided to ENVC and MA. The Operation and Maintenance Manual must include:

- a description of the treatment, control and other component equipment including function, normal operation characteristics and limiting conditions
- a process flow diagram of the PWDU
- a control diagram of the PWDU
- equipment model and serial numbers
- equipment supplier contact information
- consultant contact information
- contact information for suppliers of consumable parts
- start-up, break-in, and routine normal operating instructions and sequences including regulation, control, stopping, shut-down and emergency instructions
- seasonal or any special operating instructions
- logical sequence of instructions for routine procedures including installation, disassembly, repair, reassembly instructions
- troubleshooting guide for typical problems
- necessary maintenance schedules including servicing lubrication schedule, and list of lubricants required
- safety instructions for the unit
- electrical service characteristics, controls and communications
- wiring diagrams including all power and control circuits
- sequence of operation by controls manufacturer
- manufacturer's product data including printed operation and maintenance instructions, parts list, illustrations, assembly drawings and maintenance diagrams
- list of original manufacturers spare parts, current prices and recommended quantities to be maintained in storage
- instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance
- warranty information including date of beginning of time of warranty
- additional information as specified
- step by step procedures for understanding and using the automated control system under all water quality conditions including emergency operations during power or communications failures or other emergencies

The Operation and Maintenance Manual must be prepared by personnel experienced in maintenance and operation of described products as per Section 01720 of the *Government of Newfoundland and Labrador Municipal Water, Sewer and Roads Master Construction Specifications*. Contents should be arranged by systems under Section numbers and in sequence according to a Table of Contents.

The Operation and Maintenance Manual must be a user friendly document that is simple and easy to understand for local operators.

6.0 Safety

All operations must be conducted in accordance with current Newfoundland and Labrador Occupational Health and Safety Act regulations for the safety of employees and the general public.

7.0 Accountability

All equipment will be under warranty with a replacement guarantee for a period of at least 1 year from the date the PWDU system is commissioned.

All PWDUs will be provided with a minimum of 2 years worth of consumables.

All PWDUs installed under publicly funded proposal will require Permits to Construct and Permits to Operate. Any violation of the terms and conditions of these permits is a violation of the *Water Resources Act*.

8.0 References

CBCL Ltd., May 2010, *Evaluation of Existing Potable Water Dispensing Units and Recommendations for Design and Operational Guidelines*.

World Health Organization, 2003, *Domestic Water Quantity, Service, Level and Health*, WHO, Geneva, Switzerland.

World Health Organization, 7/01/2005, *Minimum Water Quantity Needed for Domestic Use in Emergencies*, Technical Notes for Engineers, Technical Note No. 9, WEDC, UK.