RESEARCH HIGHLIGHTS

Technical Series 99-115

WATER QUALITY GUIDELINE AND WATER MONITORING TOOLS FOR RESIDENTIAL WATER REUSE SYSTEMS

Introduction

As part of CMHC's mandate to promote healthy housing, much research has been devoted to reducing water consumption in Canadian households. In addition to the more conventional water management strategies, CMHC has focused on residential water reuse–a concept that is gaining attention throughout the world. At present, CMHC has supported a number of demonstration projects utilizing water reuse technologies in Ottawa, Vancouver, Toronto, and the Far North.

A barrier to the acceptance of reuse technology in Canada has been the lack of data surrounding reused water quality and the lack of regulations for monitoring protocol (Note: British Columbia has been the first province to establish regulations for water reuse). Therefore, there is a need to examine water quality monitoring processes and their applicability for residential on-site water reuse. Moreover, there is a need to ensure occupant safety by monitoring the reliability of the reuse control system itself.

Research Program

This research paper has been commissioned by CMHC to examine monitoring needs for residential water reuse systems to satisfy the safety and health concerns of homeowners, property managers, consulting engineers, and regulatory agencies. It deals specifically with indirect water reuse processes such as reuse for toilet and laundry purposes.

Key components of the study are to examine regulatory, health, and safety concerns, identify concerns of the various responsible authorities, and develop a consensus/protocol for water reuse system monitoring and control. The guideline identifies various monitoring parameters and describes the available control system components; it also reviews their applicability in a residential water reuse system.

Key personnel from health and environmental agencies were invited to participate in a round table in mid-April 1999 to discuss the requirements of a water reuse monitoring and control protocol. That round table discussion was titled: "On-Site Water Reuse in Canada–Ottawa '99 Protocol."

Research Findings

A monitoring program is necessary to address concerns about health and safety issues involving water reuse research, as well as the safe and practical application of reuse systems. The activities conducted to develop this monitoring program are the following:

- Identify monitoring program appropriate for an indirect water reuse classification (toilets);
- Review existing monitoring water reuse programs in Canada and other jurisdictions;
- Examine water quality parameters;
- Conduct a one-day round table discussion with key environmental and health decision-makers (On-Site Water Reuse in Canada–Ottawa '99 Protocol); and
- Survey water monitoring and control equipment.

The following diagram relates different water reuse classifications to required monitoring programs:

This research paper concentrates on the establishment of a monitoring program for the *indirect use* classification (toilet use, clothes washing). As shown in Figure 1, the *indirect use* classification is not very extensive because activities such as toilet flushing do not require as high a standard as potable use since it is not ingested or used for body contact.

Water quality is monitored using physical, chemical, or microbiological parameters. Most of these parameters were discussed at the Ottawa '99 Protocol Round Table.

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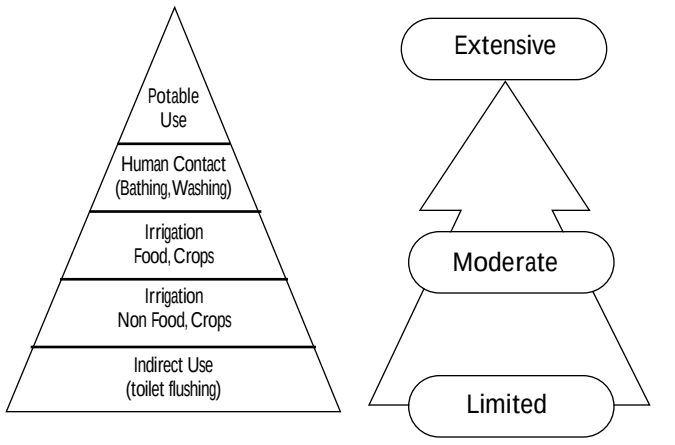
Figure 1:
Hierarchy of Typical Water Reuse Classifications and Monitoring Program Requirements.



One of the key physical parameters is turbidity. Health and aesthetics are considered when establishing acceptable turbidity levels. High levels of turbidity can protect micro-organisms from the effects of disinfection, stimulate the growth of bacteria, and exert a higher chlorine demand for disinfection. Turbidity is measured in Nephelometric Turbidity Units (NTU). The Ottawa '99 Protocol determined that a limit range of 5 to 20 NTU was deemed reasonable.

Colour is an aesthetic objective under the water quality guidelines. The presence of colour in water is not directly linked to health concerns. The target colour level for reuse of grey water in toilets of 30 TCU (True Colour Units) is considered aesthetically acceptable to most consumers. The Ottawa '99 Protocol concluded that, although a limit range of 5 to 20 TCU is advisable, the range should be established based on existing local water conditions.

A third physical property to consider in a monitoring program is odour. The treatment objective is to provide water that has no offensive odour. Odours may indicate the presence of harmful chemical substances or undesirable biological activity in the water.

The Ottawa '99 Protocol also discussed the analyses of suspended solids in the water. It was determined that the measurement of total suspended solids is an important parameter when the treatment facility is being commissioned. However, the measurement was considered unnecessary in long-term testing provided the treatment is being monitored for other key parameters.

The chemical or biochemical parameters to consider in the development of a monitoring program are:

- Biochemical or chemical oxygen demand (BOD/COD);
- Oxidation–reduction potential (ORP);
- Dissolved oxygen (DO);
- Organic compounds; and
- Volatile residues.

The volatile residues may include the disinfectant residuals used in the water reuse treatment system.

The Ottawa '99 Protocol determined that a monitoring program need not include BOD because of the difficulties and length of time to conduct the analysis. The round table came to the same conclusion about chemical compounds such as copper, iron, and manganese, provided that the treatment facility is operating in a satisfactory manner.

To minimize health hazards and risks associated with exposure to microbiological contamination, the treated water should be microbiologically safe. Many tests are used to confirm safe water. The tests rely mainly on the presence of specific organisms that best indicate the presence of pathogens. Indicator organisms when absent tend to indicate that disease-producing organisms are probably also absent. One of these indicator micro-organisms is fecal coliform bacterium. Fecal coliform bacteria are found in warm-blooded animal intestines and feces. Escherichia-coli (E-coli) is the strain of coliform specific to mammal fecal contamination and is thus the most used contamination indicator.

There exists a wide variation in existing regulations for water reuse quality requirements. The three existing monitoring guidelines for treated reused water for toilet flushing are criteria developed by the following:

- The United States Environmental Protection Agency (USEPA);
- CMHC in consultation with the Ontario Ministry of the Environment and the Regional Municipality of Ottawa-Carleton Health Department for the Light Grey Water Reuse Pilot Plant Project in Ottawa; and
- Townshend, for the CMHC report "Advancing the Light Grey Option."

All three criteria are presented in the following tables:

Table 1:
USEPA Unrestricted Urban Reuse Criteria (Toilet Flushing)

Parameter	Range Expected	Comments
BOD	5-30 mg/l	Normally monthly average
Total Suspended Solids	5-30 mg/l	Lower limit for most states
Coliform	0-200 per 100 ml	Most states require no single fecal coliform count to exceed 75/100 ml; or 75% of samples over month must be below detectable limits.
Turbidity	2-5 NTU	

Table 2:
CMHC Toilet Reuse Pilot Project Ottawa Water Reuse Criteria

Parameters	Light Grey Water Criteria For Toilet Flushing
Total Suspended Solids	10 mg/l
Coliform	Conform to drinking water standards
Turbidity	20 NTU
Colour	30 TCU
Iron	1.0 mg/l
Manganese	0.5 mg/l

Table 3:
Toilet Flushing Water Standards – Townshend

Parameters	Criteria
Turbidity	20 NTU
Colour	30 TCU
Odour	6 units
Manganese	0.5 mg/l
Copper	1.0 mg/l
Iron	1.0 mg/l

Monitoring programs should also include the monitoring of the instruments and test procedures used in the water treatment process. Monitoring requirements should not be expected to remain the same over the treatment facility's life cycle. Start-up concerns are expected to be different from the long-term system treatment performance considerations.

The guideline reports a number of monitoring instruments and test procedures. Equipment findings and strategies for incorporation into monitoring programs in residential water reuse systems are presented below.

- For microbiological testing and/or verification purposes, the use of a private laboratory or a simple Presence/Absence tube tester is recommended;
- In chlorine residuals testing, the use of test kits is recommended, which can be cost-effective.
- The use of specific testing equipment such as conductivity meters, colorimeters, and spectrophotometers for continuous monitoring or in-house testing purposes is considered to be too costly for a residential application. When specific organic or inorganic chemical tests are required, the use of a laboratory to perform such testing should be considered.
- Measurements for turbidity are recommended as part of any monitoring program. Should the number of samples be sufficient to warrant the purchase of an instrument, then a portable turbidometer should be considered; otherwise, it is recommended that laboratory services be used to conduct turbidity tests.
- There are a number of new emerging instruments and techniques, such as particle counters and gene probe technologies, that hold considerable promise as monitoring tools. It is expected these technologies may provide the water industry with reliable and inexpensive methods to conduct parameter testing. Future research and/or lower instrument costs will be required before such technologies become widely available.
- The use and incorporation of automation controllers into small water reuse systems are recommended.

Results

The findings in this water quality guideline provide the basis for an interim monitoring tool for indirect water reuse systems (toilet flushing). The key parameters identified in this guideline are colour, turbidity, odour, coliform, and total suspended solids. Suggestions on the use of control equipment and test procedures for residential water reuse monitoring program are also described.

Establishing a monitoring guideline for water reuse systems is the first step in gaining its acceptance. The research conducted by CMHC has led to funding for a number of water reuse demonstration projects.

This initiative, along with other similar projects, will help further the understanding of water reuse systems.

It is important to emphasize that the findings and recommendations in this report do not constitute a definitive criterion or risk assessment but rather provide guidelines for consideration in a monitoring program. Each regulatory agency is expected to have specific concerns, which may have to be addressed separately on a case-by-case basis. It is expected that the information in this paper will provide a good reference and starting point, one that which can be cited by regulatory agencies, designers, and homeowners in deciding the various monitoring parameters and control system components for a residential water reuse monitoring program.

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Research Report: Water Quality Guideline and Water Monitoring Tools for Residential Water Reuse Systems, 1999

Research Consultant: totten sims hubicki associates

A full report on this project is available from the Canadian Housing Information Centre at the address below.

Housing Research at CMHC

Under Part IX of the National Housing Act, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

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