

OFFICE OF DRINKING WATER

**TERMS OF REFERENCE
ENGINEERING ASSESSMENT OF A PUBLIC WATER SYSTEM**

Updated: February 2023

1.0 ABBREVIATIONS AND TERMS

Assessment – the process of completing an engineering assessment of a Public Water System to fulfil the requirement for “Assessments of Water System Infrastructure and Water Supply Sources” referenced in Section 9 of The Drinking Water Safety Act.

DWO – the regional Drinking Water Officer with regulatory responsibility for the Public Water System.

The DWSA – The Drinking Water Safety Act.

Engineer – a Professional Engineer as defined in The Engineering and Geoscientific Professions Act and who:

(a) is competent, by virtue of training and experience in engineering relating to drinking water supplies, to engage in practices that fulfil the requirements of these Terms of Reference, and

(b) is not an employee or Operator of the Public Water System being assessed, and

(c) has been engaged by the Owner of the Public Water System to complete an Assessment of a Public Water System in accordance with these Terms of Reference.

GCDWQ – the latest version of the Guidelines for Canadian Drinking Water Quality.

GUDI – Groundwater Under the Direct Influence of surface water.

ODW – Office of Drinking Water.

Owner – the Owner of the Public Water System, which includes Operators.

PWS – Public Water System.

Report – the written report submitted to fulfil the requirement for an Assessment and the deliverable product of these Terms of Reference.

Satellite system – a water system that receives treated water from another water system and that does not have a water treatment plant but does have a reservoir or pumphouse.

System – the Public Water System for which the Assessment is being conducted.

Ten State Standards – the latest version of the Recommended Standards for Water Works issued by the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.

2.0 OBJECTIVES

These Terms of Reference have been prepared to support Section 9, Assessments of Water System Infrastructure and Water Supply Sources, of The DWSA where an engineering assessment is required or being conducted.

An Assessment involves a source-to-tap review of a PWS to assess its general condition and ability to meet provincial standards and industry best practices, and to provide recommendations to improve the safety and reliability of the System.

Owners are notified of their assessment requirements by the DWO. When major upgrades to an existing system are planned for around the time an Assessment is due (i.e., water treatment plant upgrades), the Approvals Unit can be contacted to discuss aligning Assessment timelines.

For regional water systems where a central treatment facility provides treated water to satellite or distribution systems with different Owners, the ODW encourages Owners to collaborate on an Assessment and one combined Report. Similarly, if an Owner has several PWSs with similar sources and treatment systems, a single Report can be prepared. For combined Assessments and Reports, the condition and capabilities of each licensed system must be fully assessed as per these Terms of Reference.

3.0 ASSESSMENT PROCESS

3.1 General Requirements

The Assessment must be completed under the supervision of the Engineer. Other staff may, at the discretion of the Engineer, perform assessment work; however, the Engineer must review and seal the Report.

In performing the Assessment, the Engineer should try, as much as possible, to obtain water system records and information from the Owner. Owners are required under their Operating Licence to maintain water system records. The Owner can contact the DWO for assistance in compiling certain water system data (i.e., bacterial summaries).

The level of effort for the Assessment and level of detail of the Report should reflect water system size, complexity, and potential risks. The focus should be on the design, condition, and capabilities of the major water system components. A detailed review of operation and maintenance practices is not required except where these practices are noted as having a direct or significant effect on treated water quality or compliance (i.e., turbidity issues due to inadequate filter-to-waste procedures). The DWO conducts regular reviews of system operation.

Terms of Reference topics should be addressed based on a water system's infrastructure. For example, for satellite systems that rechlorinate and redistribute treated water, only assessment items applicable to their infrastructure need to be assessed. If information is not available for a Terms of Reference item, the reason should be noted. For re-assessments, much of the System description should be available from the last Report.

The Engineer should state findings as succinctly as possible. Extensive explanation of process theory or water quality parameters is not required. Point form notes and tables should be used whenever possible. Data should be in metric (SI) units.

The Owner or Engineer can contact the Approvals Unit at any time for advice or clarification.

3.2 Records Review

The Owner is expected to provide the Engineer with important water system records including:

- Current Operating Licence.
- Most recent Annual Audit issued by the DWO.
- Most recent Inspection letter/ report issued by the DWO.
- Bacterial summaries for the last three years (available from the DWO by Owner request).
- Water use records for the last three years.
- Laboratory general chemistry analysis reports over the last five years.
- Most recent Assessment Report and ODW response.
- Most recent Annual Report for a System serving 1000 or more persons.
- Applicable water system reports or studies.
- Water system drawings, treatment schematics, and distribution maps.
- Operation and Maintenance (O&M) manuals.

3.3 Interview with the Owner

The Engineer must interview the Owner. The Engineer should focus on clarifying any uncertainties about water system design, operation, and compliance, and identifying Owner concerns with the condition, design or operation of the System. The Engineer should ask about plans for major upgrades or expansion that need to be considered in assessing the safety, capacity, and reliability of the System.

3.4 Interview with the DWO

The Engineer must interview the DWO. The Engineer should discuss concerns raised in Annual Audits and Inspections, and any outstanding action items that may pose a risk to the safety and reliability of the System.

3.5 Site Inspection

An on-site inspection is typically required. The exception may be a distribution-only system where minimal infrastructure is available for inspection or where the Engineer has recently been on-site as part of other work with the System. Considerations include whether any major alterations or expansions have taken place, whether there have been ongoing water quality or compliance issues, and whether significant deterioration in the physical condition, reliability, or ability to meet demands may have occurred since the last Assessment or site visit.

Preparing an inspection checklist may be helpful. Resources include: the Office of Drinking Water assessment checklists, the CCME “Source-to-Tap” technical guidance manual, and US EPA Sanitary Survey and Total Coliform Rule Assessment guidance manuals.

Digital photographs should be taken and included in the Report to supplement discussions of system design, condition, and deficiencies. Photographs should be labelled.

If an issue of significant or immediate concern is identified during a site inspection, the Owner should be advised to notify their DWO as per Operating Licence requirements.

4.0 REPORT CONTENTS

In general, the Report should include the following sections:

1. Water System Description
 2. Water System Records
 3. Owner and DWO Concerns
 4. Site Inspection (if applicable)
 5. Ability to Meet Regulatory Requirements
 6. Ability to Meet Industry Best Practices
 7. Ability to Meet Demands
 8. Recommended Upgrades and Actions
- Submission Form
Appendices

The following items do not have to be included in the Assessment and the Report:

- Detailed review of laboratory bacterial test reports, monthly disinfection and turbidity monitoring reports, and other routine operational records (reviews of these items are completed by the DWO for Annual Audits and Inspections).
- Review of Emergency Response or Advisory Notification Plans.
- Review of Facility Classification and Operator Certification requirements.
- Review of Water Rights, Environment Act, or other regulatory licences.
- Copies of water system records (unless requested by the Owner).

A sample Table of Contents, along with explanatory notes, is provided in the next section. The Engineer is asked to follow this Table of Contents.

The Approvals Unit analyzed feedback provided on Reports. Some of the more common items where information could have been strengthened included:

- Potential contamination sources near a well or intake.
- Description of the raw water line to a water treatment plant or the water supply connection for a satellite or distribution-only system.
- Venting and overflow provisions for a reservoir.
- Normal flow pattern through a multi-cell reservoir and associated baffling factor.
- Set-points for critical alarms such as free chlorine residual, turbidity, and UV dose.
- Likelihood of lead service lines based on system age and Owner observations.
- Typical separation of water and sewer mains.
- Estimated capacities for raw water and distribution pumps.
- Water quality table showing raw and treated water results for key parameters along with any associated provincial standards, and GCDWQ MACs and AOs.
- Summary table of disinfection by-product testing results.
- Comments on emerging issues such as algae, zebra mussels, copper, and lead.
- Comparison of calculated chlorine contact time to the regulatory requirement of 20 minutes.
- Normal low operating volume of a storage system for contact time and CT calculations.
- Comparison of filtration rates and other key design parameters to industry guidelines.
- Effectiveness of phosphate-based and pH-based corrosion control systems.
- Process flow diagrams showing on-line monitoring instruments and sample taps.

5.0 SUBMISSION OF THE REPORT

The Owner is responsible for ensuring that an Assessment is performed and that a copy of the Report is submitted to the ODW by the deadline provided by the DWO. Once the Report has been finalized and accepted by the Owner:

- The Owner and the Engineer complete their sections of the Submission Form.
- The Owner or Engineer submits one (1) paper copy of the Report including the Submission Form, and an electronic copy (pdf) by email or on a storage device (i.e., USB drive) to their DWO or to the Approvals Unit.

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6.0 FOLLOW-UP ACTIONS

The Owner should develop and implement an action plan for addressing Report recommendations to improve the overall safety and reliability of the System. The Approvals Unit can be contacted to discuss upgrading plans and approval requirements.

SAMPLE TABLE OF CONTENTS

1.0 WATER SYSTEM DESCRIPTION

1.1 GENERAL CHARACTERISTICS

Summarize **basic System characteristics** including:

- Name, location, and basic description.
- Year began operating and dates of major upgrades.
- Source type (groundwater, potential GUDI, GUDI, surface water) and name if applicable (i.e., Lake Winnipeg, Winkler Aquifer).
- Operating season if applicable.
- Population served, for seasonal systems provide average and peak day populations.
- Number of service connections/ sites/ standpipes and general types (i.e., residential, commercial, industrial, institutional, cottage, RV, standpipes, central washrooms).
- Current average day demand (ADD), maximum day demand (MDD), peak hourly demand (PHD), and per capita/ site water use (apply industry water consumption and peaking factors if water use records are not available).
- Whether the system is operating under a long-term Boil Water Advisory (BWA) or Boil Water Quality Advisory.

1.2 WATER SOURCE

For **groundwater or GUDI** provide: number and location of wells relative to the water treatment plant; general well characteristics including size, cased depth, and overburden.

For **surface water** describe: intake location and depth; any raw water ponds including storage volume; whether algal blooms or zebra mussels are an issue for the source.

For **all water sources** describe: how water is transferred to the water treatment plant (i.e., raw water piping and pumping provisions); raw water supply capacity; basic source water protection provisions (i.e., intake screen, fencing, sealed well cap).

For a **satellite or distribution-only system** provide: the PWS that supplies the treated water; location and description of the water supply connection to that PWS.

1.3 WATER TREATMENT SYSTEM

Provide a basic process flow diagram showing pumps, treatment units, chemical injection points, sample taps and on-line monitoring instruments, and a description of the process flow. Provide water treatment capacity as a flow rate and as a percentage of MDD, and typical hours per day the treatment process operates.

Describe treatment objectives including any specific performance targets such as removal rates (%), treated water quality (mg/L), residual levels (mg/L), or UV set-points/ parameters.

For **each major unit process**, provide the purpose/ target water quality parameter(s), treatment capacity, level of redundancy, and important design and operating parameters:

- Coagulation: coagulants/ polymers; rapid mix provisions; feed control including triggers for adjusting chemicals or dosage (i.e., turbidity, temperature).
- Flocculation: stages; flocculant aids; whether mixer speeds are adjustable.
- Clarification: type; retention time at MDD; settling enhancements (i.e., tube settlers, sludge blanket).
- Media filter: type (i.e., pressure, slow sand, rapid multi-media); media types; filtration rate; backwash rate; backwash control (i.e., manual, timed, volume, pressure, NTU)

- and set-points; source of backwash water; filter-to-waste control and set-points; alarm set-points for any on-line analyzers (i.e., filter effluent turbidimeters).
- GAC adsorption filter: type of GAC; date last replaced; empty bed contact time at MDD; backwash control (i.e., manual, timed, volume, pressure); backwash frequency; source of backwash water.
 - Cartridge filter: micron rating; trigger for change-out; change-out frequency.
 - Membrane: type (MF/ UF/ NF/ RO); model; recovery rate (%); for MF/ UF, rated pathogen log removal and direct integrity test frequency, control limits and response to failed test; if blending, bypass rate/ ratio; ability to filter-to-waste.
 - Air stripper: type (i.e., packed tower, mixer/ aerator); off-gas venting provisions.
 - Ion exchange: type of resin (i.e., cation, strong base anion); regenerant; regeneration control and frequency; if blending, bypass rate/ ratio.
 - Chemical feed: chemical; feed control (i.e., manual, flow-paced, feedback); trigger for initiating feed if intermittent; alarm set-points for any on-line analyzers (i.e., pH sensor, chlorine analyzer).
 - UV unit: model; minimum dose and UVT for target pathogen log reduction; NSF certification or EPA validation; method of monitoring operation within validated conditions (i.e., flow, UVT, UV intensity); dosage control if applicable; alarm set-points.

Briefly describe how sanitary and process wastewater are managed for water treatment plants or pumphouses.

1.4 TREATED WATER STORAGE (including satellite reservoirs)

Describe treated water storage units including: location; material; whether above/ below ground; total volume; effective volume at normal low operating level; flow path if multiple tanks/ cells; baffling; level control, access/ inspection, vent, overflow, drain and isolation provisions; whether sized for fire protection (i.e., MOE sizing equation).

Estimate hydraulic residence time under ADD and storage volume as a percentage of ADD.

For underground reservoirs, indicate whether any raw water, drain, or wastewater piping passes above (i.e., in top slab) or through the reservoir, and containment provisions.

1.5 DISTRIBUTION

Describe distribution pumping components including: type and location of distribution and standby pumps; pump capacities; pump control; distribution pressure set-point. For fuel-driven pumps, note spill containment measures if located above a reservoir.

Describe backflow prevention for any bulk fill (i.e., truck fill, pail fill, wall hydrant).

Summarize general distribution network characteristics including: watermain and service line materials; isolation and flushing provisions; extent of looping; degree of metering; presence of potential high hazard connections for backflow risk (i.e., livestock operation, wastewater facility); presence of lead service lines.

Identify flood protection and drainage provisions for any meter/ valve chambers.

If system includes satellite reservoirs or pumping stations, describe these components as noted above for treated water storage and distribution components.

1.6 OPERATION AND CONTROL

Describe the general method of controlling operation of water system components, level of automation, major/ critical alarms and associated set-points, and alarm methods (i.e., local, dial-out).

Note whether up-to-date water system drawings and O&M manuals are available.

Note the location of any standby generators and ability to run equipment, along with spill containment provisions if located above a reservoir.

Describe any bypass that could allow untreated or partially treated water to enter the distribution system. Identify any piping cross connections within the water treatment plant and the method of backflow prevention.

2.0 WATER SYSTEM RECORDS

The review of water system records should focus on identifying infrastructure, process, or equipment related deficiencies as opposed to basic operational tasks.

2.1 OPERATING LICENCE STANDARDS

Briefly summarize key water quality and treatment standards, and any on-line (continuous) monitoring requirements.

2.2 PREVIOUS ASSESSMENT AND FOLLOW-UP ACTIONS

Summarize and provide a status update on key recommendations.

2.3 ANNUAL AUDITS AND INSPECTIONS, AND FOLLOW-UP ACTIONS

Summarize and provide a status update for any required or recommended items from the most recent DWO Annual Audit and the most recent DWO Inspection.

2.4 WATER QUALITY DATA

Provide a table summarizing the most recent chemistry analysis reports for the raw water, if applicable, and the treated water. Note any exceedances of provincial standards, and of any other Maximum Acceptable Concentration (MAC), Aesthetic Objective (AO), or Operational Guidance Value (OG) from the GCDWQ. A separate table should be provided for disinfection by-products, if applicable, due to sampling frequencies and locations.

Note water quality conditions that affect treatment processes, process control or compliance (i.e., seasonal turbidity spikes, high organic content, patterns or trends in bacterial positives, elevated ammonia, corrosivity).

3.0 OWNER AND DWO CONCERNS

Summarize any concerns noted during interviews with the Owner and the DWO. Describe major changes, upgrades or expansions since the last assessment (if applicable) and any planned for the System over the next five years. Describe any major incidents or emergencies.

4.0 SITE INSPECTION

Summarize observations of the general condition of major water system components. Identify deficiencies that could compromise water safety or reliability. A structural condition survey and detailed plumbing, mechanical, and electrical system surveys are not required.

5.0 ABILITY TO MEET REGULATORY REQUIREMENTS

5.1 DISINFECTION CONTACT TIME REQUIREMENTS

Provide **contact time calculations**, where a chemical disinfectant is used for primary disinfection, to confirm compliance. Use calculation procedures and tables from the ODW Filtration and Disinfection Log Reduction Credits guideline. Compare this value to the System's regulatory requirement. Clearly state the assumed peak hourly flow, effective volume, and baffling factor. Consider the location of inlets and outlets including distribution pump intakes in selecting a baffling factor.

Identify any deficiencies in process design or operation that may compromise the ability to provide this contact time at all times (i.e., raw water bypass, reservoir cells must be bypassed during cleaning).

5.2 LOG REDUCTION CREDITS

For **all water sources** where a chemical disinfectant is used for primary disinfection: complete CT calculations to determine log inactivation for viruses.

For **surface water and GUDI sources**: determine filtration credits, and complete CT calculations or UV dosage reviews to determine log removal and log inactivation credits for *Cryptosporidium* and *Giardia*.

Use CT calculation and log credit procedures and tables from the ODW Filtration and Disinfection Log Reduction Credits guideline.

Identify any deficiencies in process design or operation that may compromise the ability to claim full credits (i.e., unresolved UV alarms, no filter-to-waste, not consistently meeting turbidity standards, SCADA programming does not allow reporting per continuous monitoring requirements, not conducting or reporting daily direct integrity or LRV results).

5.3 TURBIDITY STANDARDS (if applicable)

Comment on compliance with turbidity standards and performance of the filtration system. Identify any deficiencies in design or operation that compromise the ability to meet turbidity standards on a continuous basis (i.e., lack of continuous monitoring or alarm provisions, inadequate control limits for backwashing, lack of filter-to-waste).

5.4 CHEMICAL STANDARDS (if applicable)

Comment on compliance with chemical water quality standards in the Operating Licence or GCDWQ MACs, and performance of the treatment process. Comment on System or water quality characteristics that may contribute to lead or copper corrosion. Comment on the effectiveness of any corrosion control measures including pH adjustment and inhibitors.

For surface water sources, comment on the effectiveness of any algae or zebra mussel control efforts, and the general capabilities of the treatment process to remove algae and their toxins (i.e., microcystins). Include comments on any other emerging issues, such as new drinking water quality standards or MACs that may affect the System.

6.0 ABILITY TO MEET INDUSTRY BEST PRACTICES

6.1 DESIGN AND OPERATION

Identify significant deviations from industry best practice (i.e., Ten State Standards, Ontario Design Guidelines for Drinking Water Systems) in the water supply, the treatment, the storage, the distribution, and the control systems. Focus on major deviations that could negatively affect drinking water supply reliability, successful or optimal operation of a treatment process, or treated water quality.

Examples include: critical treatment process not sized to meet MDD; untreated bypass; filtration rate higher than recommended; drain or overflow connected to sewer; inadequate water-sewer main separation; lack of redundancy; lack of alarm system; filter-to-waste not based on turbidity; reservoir hatch not watertight; GAC media not regularly replaced; no bypass around anion exchange to allow blending to reduce corrosivity; lack of standard operating procedures for critical tasks; reservoir overflow not screened; inadequate flood protection for facilities or equipment; no contingency plan if source impacted by drought.

6.2 AESTHETIC OBJECTIVES

Discuss the ability of the treatment process to address aesthetic water quality issues including the effectiveness of any pH adjustment or sequestering agents.

7.0 ABILITY TO MEET DEMANDS

7.1 CAPACITY

Evaluate the ability of the water supply, the treatment, the storage, and the pumping systems to meet peak demands. Identify any capacity limitations that could affect growth or expansion of the water system over the next five years.

7.2 RELIABILITY

Evaluate the ability of the water supply, the treatment, the storage, the pumping, and the distribution components to reliably produce and distribute safe drinking water through a discussion of age or physical condition, redundancy (i.e., backup or standby equipment), multiple treatment barriers, level of automation, back-up power, on-line monitoring and sensors, and alarm provisions.

8.0 RECOMMENDED UPGRADES AND ACTIONS

Provide a prioritized list or table of infrastructure, process, treatment, and equipment related deficiencies, and recommendations for addressing these deficiencies. This list or table only has to appear once in the Report.

SUBMISSION FORM

APPENDIX A - PROCESS SCHEMATIC

APPENDIX B - INSPECTION PHOTOS