Operational Plan

Madsen Drinking Water System

MDWS-OP-3.3

NORTHERN WATERWORKS INC.

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0 DWQMS Matrix

The DWQMS Matrix provided below indicates how the PLAN requirements of Ontario's DWQMS are addressed by Northern Waterworks Incorporated. DWQMS Elements are addressed through a combination of documentation which includes Operational Plans, corporate procedures, and system-specific procedures.

This matrix is intended to facilitate the understanding of the reader with respect to the structure of NWI's QMS. Additionally, this matrix will act to facilitate internal and external auditing processes.

DWQMS Element	Document Title
1 – Quality Management System	Operational Plan [MDWS-OP-3.3]
2 – QMS Policy	Operational Plan [MDWS-OP-3.3]
3 – Commitment and Endorsement	Operational Plan [MDWS-OP-3.3]
4 – QMS Representative	QMS Representative Policy [NWI-QMS-4]
5 – Document & Records Control	Document & Records Control Procedure [NWI-QMS-5]
6 – Drinking-Water System	Operational Plan [MDWS-OP-3.3]
7 – Risk Assessment	Risk Assessment Procedure [NWI-QMS-7]
8 – Risk Assessment Outcomes	Risk Assessment Outcomes [MDWS-QMS-8]
9 – Organizational Structure, Roles, Responsibilities and Authorities	Organizational Policy [NWI-QMS-9]
10 – Competencies	Competencies Policy [NWI-QMS-10]
11 – Personnel Coverage	Personnel Coverage Policy [NWI-QMS-11]
12 – Communications	QMS Communication Procedure [NWI-QMS-12]
13 – Essential Supplies and Services	Essential Supplies and Services Procedure [NWI-QMS-13]
14 – Review and Provision of Infrastructure	Review and Provision of Infrastructure Procedure [NWI-QMS-14]
15 – Infrastructure Maintenance, Rehabilitation and Renewal	Operational Plan [MDWS-OP-3.3]
16 – Sampling, Testing and Monitoring	Sampling, Testing and Monitoring Procedure [MDWS-QMS-16]
17 – Measurement and Recording Equipment Calibration and Maintenance	Measurement and Recording Equipment Calibration and Maintenance Procedure [MDWS-QMS-17]
18 – Emergency Management	Emergency Management Procedure [NWI-QMS-18]
19 – Internal Audits	Internal Audit Procedure [NWI-QMS-19]
20 – Management Review	Management Review Procedure [NWI-QMS-20]
21 – Continual Improvement	Continual Improvement Procedure [NWI-QMS-21]

1 Quality Management System

The Drinking Water Quality Management System (QMS) for the Madsen Drinking Water System is documented in this Operational Plan as part of NWI's efforts to ensure that clean, safe, and reliable drinking water is supplied to all customers served by this system. The development and continual improvement of the Operational Plan will help to ensure that all regulatory requirements are met and that consumers can be confident that their drinking water will be protected through the effective application of the QMS. This Operational Plan was developed to meet the Ministry of the Environment's Drinking Water Quality Management Standard.

2 Quality Management System Policy

The Corporation of the Municipality of Red Lake utilizes the services of Northern Waterworks Incorporated (NWI), an independent contracted operating authority, to operate, maintain, manage and administer the Madsen Drinking Water System (as per agreement). The Municipality of Red Lake and Northern Waterworks Incorporated are committed to the following:

1) Providing the consumer with clean, safe drinking water;

2) Meeting or exceeding all applicable legislative and regulatory requirements; and,

3) Maintaining and continually improving our quality management system.

3 Commitment and Endorsement

The Municipality of Red Lake and NWI support the implementation, maintenance, and continual improvement of a drinking water Quality Management System for the Madsen DWS, as documented in this Operational Plan. The Municipality and NWI acknowledge the need for and support the provision of sufficient resources to maintain and continually improve the QMS. All the undersigned persons hereby endorse this Operational Plan:

Name & Title:	Signature:	Date:
Mark Vermette Chief Administrative Officer Municipality of Red Lake	DocuSigned by: Mark Vermette 6554BE11571D436...	April 23, 2018
Todd Olson Infrastructure Development Coordinator Municipality of Red Lake	DocuSigned by: 50DE8218A0A24D8...	April 10, 2018
Jason LeBlanc Chief Administrative Officer Northern Waterworks Incorporated	DocuSigned by: Jason LeBlanc 88889B60117145B...	April 5, 2018
Gilles Vachon Northwest Regional Manager Northern Waterworks Incorporated	DocuSigned by: Gilles Vachon 1C255A37B8324B2...	April 5, 2018

4 QMS Representative

Refer to the *QMS Representative Policy* [NWI-QMS-4].

5 Document & Records Control

Refer to the *Document and Records Control Procedure* [NWI-QMS-5].

6 Drinking-Water System

6.1 General Process Description

The Madsen Drinking Water System provides a potable water supply to the community of Madsen and is composed of a raw water pumping station, the Madsen Water Treatment Plant (MWTP, a Class III chemically-assisted conventional filtration water treatment plant having an approved capacity of 691 m^3/day) and a water distribution system (a Class I system). The system is owned by the Corporation of the Municipality of Red Lake and Northern Waterworks Incorporated serves as the accredited operating authority.

The source water for the treatment process is drawn from a surface water source (Russett Lake) located within the Municipality. Potential pathogenic organisms are removed from the raw water by coagulation, flocculation, sedimentation, dual-media filtration, and disinfection processes. This multiple barrier approach helps to ensure consistently safe and clean drinking water.

6.2 Source Water Characteristics and Event-Driven Fluctuations

General characteristics for the source water supply (Russett Lake) are provided below.

Parameter	Results Range* (2011 - 2017)	Average (2011 - 2017)
Turbidity (NTU)	0.36 - 2.07	0.98
Colour (Pt/Co)	33 - 109	55
Temperature (°C)	2 - 19	9
pH	6.4 - 7.6	7.1
Alkalinity (mg/L as $CaCO_3$)	27 - 33	29
Iron Residual (mg/L)	0.02 - 0.16	0.07
Manganese Residual (mg/L)	0.02 - 0.21	0.06
E. Coli (MPN/100mL)	<1 - 14	---
Total Coliforms (MPN/100mL)	<1 - >2420	---

*The minimum and maximum values for the results range are expressed as minimum and maximum monthly averages. Results in the table were compiled using water quality data collected between January 1, 2011 and December 31, 2017.

Event-driven fluctuations in the source water and subsequent operational challenges are summarized as follows:

(1) Reduced forms of iron and manganese present in the source water have historically been responsible for elevated treated water turbidity and colour, particularly in warmer water temperatures. The operational challenges posed by such fluctuations have been minimized with the introduction of an oxidizing agent chemical feed system at the MWTP. This system effectively oxidizes iron and manganese present in source water, so that the precipitated forms may be removed by remaining conventional treatment processes.

Changes in the concentrations of the reduced forms of iron and manganese in the source water may require slight adjustments to treatment chemical dosages.

(2) Algal blooms in the source water pose a potential concern, whereby such events could interfere with treatment processes and associated toxins may pose a risk of treated water contamination.

Monitoring processes, control measures and response procedures are available to minimize the operational challenges posed by algal blooms.

(3) Seasonal changes in water temperature may impact treatment performance as it concerns chemically-assisted filtration and disinfection processes. Higher water temperatures are also associated with increased biological activity in the source water, resulting in high turbidity, colour, micro-organism counts, and the potential for taste and odour problems.

Generally, seasonal changes pose only minor operational challenges, and these challenges can be anticipated and may require adjustments to treatment processes or chemical dosages.

(4) A limited number of pollution sources are known to affect Russett Lake. The area is influenced by some recreational activities and is susceptible to natural bacteriological contamination by wildlife. Mining and exploration activities adjacent to Russett Lake are also potential pollution sources.

Monitoring processes (i.e. routine or additional regulatory sampling and water quality testing, continuous monitoring), control measures (including normal treatment barriers), and emergency response procedures are available to minimize the operational challenges posed by a source water contamination event.

6.3 Treatment Processes

6.3.1 Source Water Intake & Pumping

The intake structure is located approximately 30 m from the shoreline adjacent to the raw water pumping station. Water flows from the source and through the intake structure and 300 mm diameter HDPE intake pipe and is pumped directly from the raw water pumping station to the Madsen WTP. Water is transferred using two constant speed centrifugal raw water pumps via a 150 mm diameter HDPE transmission line.

At the MWTP, an oxidizing agent is added to the source water as it enters the dual baffled raw water reservoirs. The reservoirs have a total volume of 99 m^3 and allow for a sufficient detention time for the oxidization of iron and manganese compounds. The transfer of raw water from Russett Lake to the raw water reservoirs at the MWTP occurs in response to the water level in the raw water reservoir, such that the flow of raw water stops when the water level in the reservoir reaches an upper set point.

6.3.2 Coagulation, Flocculation and Sedimentation

Two constant speed centrifugal pumps are used to transfer water from the raw water reservoirs directly to the treatment units at the MWTP. The two package treatment units at the treatment facility operate in parallel and each have a rated capacity of 345.6 m^3/day. Each unit includes a three-chambered flocculation basin, a clarifier (settling tank) equipped with upflow tube settlers, and a dual-media filter. A coagulant (polyaluminum chloride) is added to the incoming raw water upstream from the flocculation basins. Rapid mixing of these chemicals with the raw water occurs as the raw water passes through an in-line static mixer.

The coagulated water solution then enters the flocculation basins of the respective treatment units, where gentle mixing promotes the formation of floc. Polyacrylamide (polymer – a flocculant) is also added to the water at this stage of treatment to form larger and more stable floc aggregates. Process water then enters the clarifier or sedimentation basin, where its velocity is reduced to allow for the separation and settling of floc. Supernatant then overflows into effluent launders and is directed to the filter unit. Settled floc (sludge) is automatically removed from the bottom of the clarifiers.

6.3.3 Filtration

Any suspended particles that did not settle in the clarifier are removed by passing water through a dual media filter composed of anthracite and silica sand on a layer of support gravel. Filtered water passes through the filter under-drain system and is directed to the treated water storage reservoirs. The filters are periodically cleaned by using an air scour to agitate the entire media bed and reversing the flow of water through the filter using dedicated backwash pumps.

6.3.4 Disinfection

Sodium hypochlorite is used to achieve both primary and secondary disinfection at the Madsen Water Treatment Plant. Primary disinfection ensures that any potentially pathogenic organisms that remain after previous treatment processes are destroyed or inactivated. To achieve primary disinfection, sodium hypochlorite solution is applied to the filtrate upstream from the treated water storage reservoirs. Consistent disinfection is ensured by the continuous monitoring of the disinfectant residual in treated water leaving the facility.

Secondary disinfection requirements are achieved by adding a sufficient amount of free chlorine at the water treatment plant to maintain a residual throughout the distribution system. The purpose of this procedure is to prevent the growth of biofilm within the distribution system and to protect the water from re-contamination as it flows through the community.

6.3.5 pH Adjustment

The primary coagulant used at the MWTP reduces the pH of the water, and a pH/alkalinity adjustment chemical (sodium carbonate) is added to the filtrate as it is directed to the treated water storage reservoir. Increasing the pH of finished water at the facility helps to prevent corrosion in the water distribution system.

6.3.6 Treated Water Storage and Delivery

Following the application of disinfectant and pH adjustment chemicals, filtrate is directed to a two-cell underground baffled storage reservoir with a total volume of 190 m^3. Disinfected water is then held in the reservoir for a sufficient amount of time to achieve primary disinfection.

Each cell includes a pump well, and a total of four (4) vertical turbine high lift pumps are available to transfer finished water from the reservoir to the Madsen distribution system. The high lift pumps are equipped with variable frequency drive motor controllers to maintain pressure and supply in the distribution system. Operation of the high lift pumps is controlled by a pressure switch located on the distribution header inside the water treatment plant.

6.3.7 Instrumentation and Emergency Power

The Madsen WTP includes a PLC complete with a SCADA system for process monitoring and control. Critical process instruments include one raw water flow measuring device, two filtrate turbidity analyzers, one treated water flow measuring device, one treated water turbidity analyzer, and one treated water free chlorine residual analyzer for monitoring primary disinfection.

An 80-kW standby diesel generator is available to supply emergency power.

6.3.8 Process Waste Residuals Management

Process wastewater generated from water treatment processes are also managed at the Madsen WTP. Sludge discharge, backwash wastewater, and rinse-to-waste wastewater are directed to the sludge holding tank (also referred to as the backwash surge tank or surge tank). Using a submersible pump, process wastewater is then transferred from the sludge holding tank to the thickening tank (also referred to as the backwash thickening tank, thickening tank, or decant tank). From the thickening tank, process wastewater is pumped directly to the Madsen sanitary sewer system.

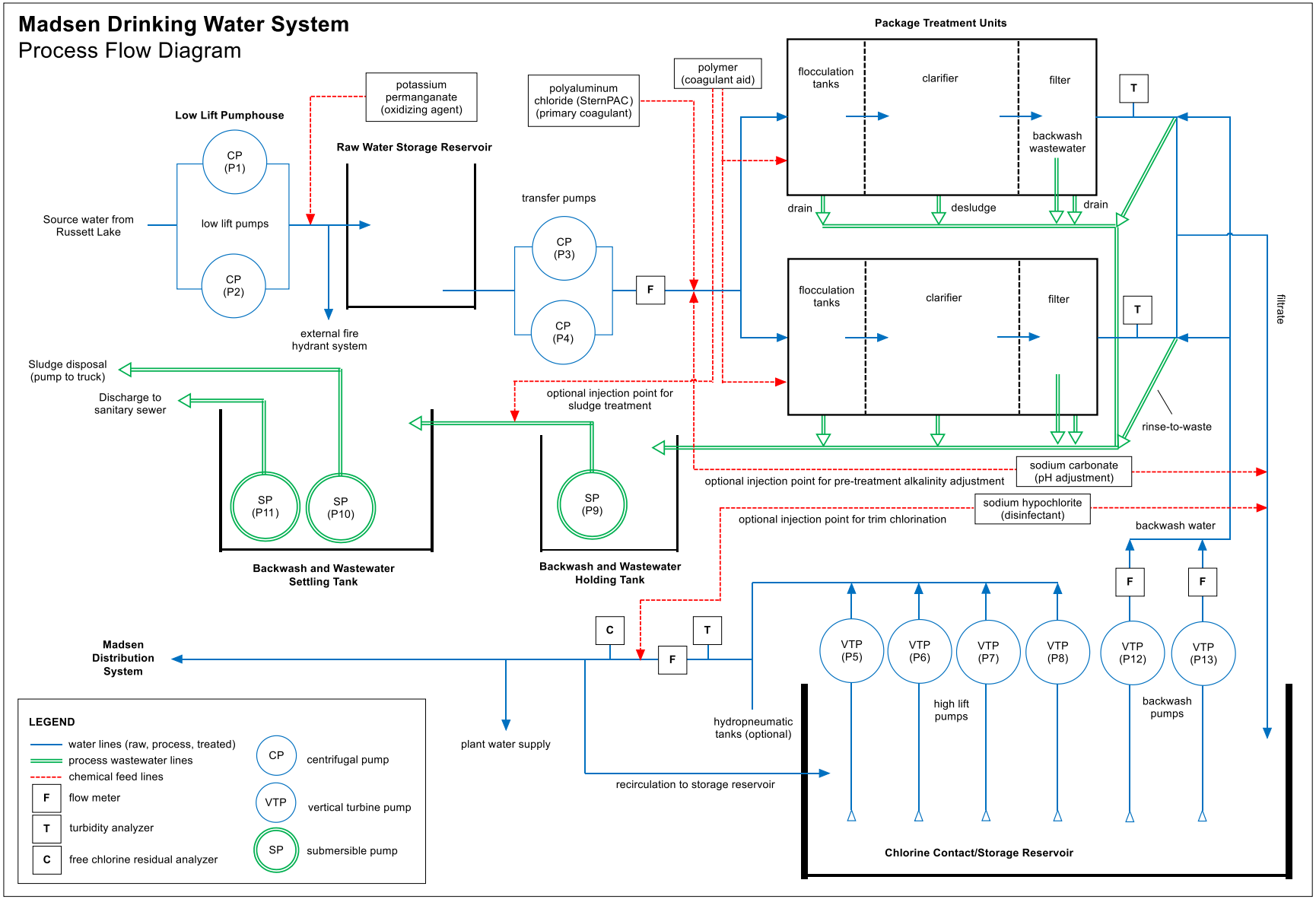
6.4 Distribution System Components

The Madsen distribution system consists of approximately 2.6 km of watermain; the vast majority of watermains are 100 mm diameter HDPE pipes. The system is looped and includes 4 hydrants and associated watermain and hydrant isolation valves.

6.5 Process Flow Diagram

A process flow diagram for the system is provided on the following page.

Madsen Drinking Water System
Process Flow Diagram



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7 Risk Assessment

Refer to the *Risk Assessment Procedure* [NWI-QMS-7].

8 Risk Assessment Outcomes

8.1 Interpretation of the Risk Assessment Outcomes

The risk assessment outcomes were developed using the *Risk Assessment Procedure* [NWI-QMS-7]. This procedure contains all the information necessary to interpret the *Risk Assessment Outcomes* for the Madsen Drinking Water System [MDWS-QMS-8]. The risk assessment outcomes include the following:

(1) Potential hazardous events and associated hazards;

(2) Assessed risks associated with the occurrence of hazardous events, including considering the likelihood, severity, and detectability of the event;

(3) Ranked hazardous events;

(4) Monitoring processes and control measures associated with each hazardous event;

(5) Critical control points and their respective critical control limits; and,

(6) Response procedures for hazardous events.

8.2 Monitoring Critical Control Limits

Various monitoring processes are in place to monitor critical control limits and to identify deviations from those limits. Critical control limits and other parameters associated with critical control limits are monitored by the following processes:

(1) Continuous monitoring and alarm systems (i.e. analyzers and trending associated with filtrate turbidity, free chlorine residual, flow, pressure, etc.). Alarm systems notify operators when critical control limits or other alarm set points have been breached;

(2) Routine regulatory sampling (i.e. weekly microbiological analyses, quarterly chemical analyses, annual chemical analyses, etc.);

(3) Routine water quality tests (i.e. daily tests for free chlorine and turbidity, routine process water quality tests);

(4) Operational checks, where operators collect and interpret data (i.e. pump hours, flows, analyzer readings, compliance data) and inspect facilities on a daily basis;

(5) Additional operational checks associated with planned maintenance, where certified operators conduct more detailed inspections of facilities on a monthly basis; and,

(6) Notification from external parties (i.e. notification that a chemical contamination event has occurred, notification of a large fire in the community, a water quality complaint that results in the identification of a cross-connection, etc.).

8.3 Critical Control Limits Deviations

Procedures outlining how to respond to, report and record deviations from critical control limits exist as a series of *Emergency Response Procedures*. Specifically, *Emergency Response Procedures* contain step-by-step response instructions, including instructions related to communication protocols and recordkeeping requirements.

All critical control limit deviations are recorded in the facility logbook but may also be recorded within Adverse Water Quality Incident documentation, call-out records, customer complaint records, and operational spreadsheets.

9 Organizational Structure, Roles, Responsibilities and Authorities

Refer to the *Organizational Policy* [NWI-QMS-9].

10 Competencies

Refer to the *Competencies Policy* [NWI-QMS-10].

11 Personnel Coverage

Refer to the *Personnel Coverage Policy* [NWI-QMS-11].

12 Communications

Refer to the *QMS Communication Procedure* [NWI-QMS-12].

13 Essential Supplies and Services

Refer to the *Essential Supplies and Services Procedure* [NWI-QMS-13].

14 Review and Provision of Infrastructure

Refer to the *Review and Provision of Infrastructure Procedure* [NWI-QMS-14].

15 Infrastructure Maintenance, Rehabilitation, & Renewal

15.1 Planned Maintenance, Rehabilitation, & Renewal

Major components of the infrastructure maintenance, rehabilitation and renewal programs in place for the Madsen Drinking Water System include the following:

(1) The *Planned Maintenance Activities* Standard Operating Procedure [MDWS-SOP-1] documents a comprehensive planned maintenance program that is carried out by Operators at the Madsen Drinking Water System on a monthly or less frequent basis. This procedure dictates planned inspection and maintenance activities associated with infrastructure components including pumps, valves, chemical feed systems, treatment equipment, emergency response equipment, standby power systems, heating systems, lighting, and other components necessary to ensure a safe and reliable supply of drinking-water.

This procedure also facilitates infrastructure rehabilitation and renewal, as it requires the identification and reporting of deficiencies. Identified deficiencies may be addressed through operational budgets, particularly as it concerns the rehabilitation and renewal of smaller infrastructure components such as chemical feed systems and valves. Records of planned maintenance activities are controlled in accordance with NWI's *Document and Records Control Procedure* [NWI-QMS-5].

(2) The *Measurement and Recording Equipment Calibration and Maintenance Procedure* [MDWS-QMS-17] documents certain planned calibration and maintenance activities that are specific to instrumentation. The associated *Calibration and Maintenance Records* are used to indicate a variety of maintenance activities, such as instrument inspection, cleaning, and quality assurance. Generally, such activities are carried out by Operators at the Madsen DWS on a monthly or quarterly basis. Calibration and maintenance records are controlled in accordance with NWI's *Document and Records Control Procedure* [NWI-QMS-5].

(3) The Madsen distribution system is flushed, and hydrants are operated and inspected on an annual basis. Major distribution system and hydrant deficiencies identified during this program are used to plan for future maintenance activities. Records of such distribution maintenance activities are controlled in accordance with NWI's *Document and Records Control Procedure* [NWI-QMS-5].

(4) NWI tracks and oversees additional maintenance activities that include infrastructure inspection, maintenance or servicing that occur on a less frequent basis. These activities may be performed by third parties and may include a) flow meter verifications, b) hoist inspections, c) fire extinguisher inspections, d) backflow prevention device testing, e) thermal imaging inspections, f) emergency generator inspection and servicing, g) generator battery replacement, h) UPS and UPS component replacement, i) reservoir cleaning and inspections, and j) the inspection of intake structures and standpipes.

(5) The *Review and Provision of Infrastructure Procedure* [NWI-QMS-14] and annual budgeting procedures are the main methods through which infrastructure rehabilitation and renewal occurs. Specifically, the annual infrastructure review process evaluates overall infrastructure adequacy and provision. This process also requires the identification of deficiencies and the application of recommendations to address those deficiencies. The outcomes of the infrastructure review represent the main inputs into annual capital budgets prepared by NWI for consideration and approval by the Municipality of Red Lake. The integration of annual budgeting and infrastructure review processes represents a continuous and cohesive effort to identify deficiencies and plan for infrastructure rehabilitation and renewal.

15.2 Unplanned Maintenance

Unplanned maintenance tasks related to the treatment component of the Madsen Drinking Water System result from equipment or infrastructure failures. Unplanned maintenance is authorized by the Operations Manager, Northwestern Regional Manager, or the Overall Responsible Operator. Documentation of these unplanned maintenance tasks are recorded in the facility logbooks. Measures to prepare for and expedite unplanned maintenance tasks in these scenarios include equipment interchangeability and redundancy, spare parts inventories, and the availability of relevant operations and maintenance manuals.

Unplanned maintenance tasks, infrastructure repair, and infrastructure renewal related to distribution system components of the Madsen Drinking Water System are typically performed by the Municipality of Red Lake, in conjunction with representation from Northern Waterworks Inc. Measures to prepare for and expedite unplanned maintenance tasks include the cataloguing of the distribution system, maintaining a parts inventory, and having access to repair procedures.

15.3 Long Term Forecast

A long term forecast of major infrastructure maintenance, rehabilitation and renewal activities is included in the *Infrastructure Asset Management System* [RLDWS-QMS-14-1] for the Red Lake project. In accordance with the *Review and Provision of Infrastructure Procedure* [NWI-QMS-14], the forecast is reviewed and updated once per calendar year coincident with the completion of the infrastructure asset condition assessments.

15.4 Program Monitoring

To ensure that the planned maintenance program remains effective, the *Planned Maintenance Activities* SOP and the *Measurement and Recording Equipment Calibration and Maintenance Procedure* are reviewed and updated annually. This review is facilitated by Compliance Coordinators and includes Operations Managers and Operators. The review accounts for changes to infrastructure and allows an opportunity to refine and continually improve the maintenance program, particularly as it involves incorporating new best practices.

15.5 Program Communication

NWI's infrastructure maintenance, rehabilitation and renewal programs for the Madsen DWS are communicated to the Municipality of Red Lake on annual basis as a component of the *Management Review Report*. Significant planned and unplanned infrastructure maintenance, rehabilitation and renewal activities are also described in monthly operational reports submitted to the Municipality by the Operations Manager.

16 Sampling, Testing, & Monitoring

Refer to the *Sampling, Testing, & Monitoring Procedure* for the Madsen Drinking Water System [MDWS-QMS-16].

17 Measurement and Recording Equipment Calibration and Maintenance

Refer to the *Measurement and Recording Equipment Calibration and Maintenance Procedure* for the Madsen Drinking Water System [MDWS-QMS-17].

18 Emergency Management

Refer to the *Emergency Management Procedure* [NWI-QMS-18].

19 Internal Audits

Refer to the *Internal Audit Procedure* [NWI-QMS-19].

20 Management Review

Refer to the *Management Review Procedure* [NWI-QMS-20].

21 Continual Improvement

Northern Waterworks Incorporated is committed to continually improving the effectiveness of its Quality Management System. Continual improvement is facilitated by the management review and internal auditing processes, which include the identification of QMS deficiencies and the assignment of preventive and corrective actions.

Refer to the *Continual Improvement Procedure* [NWI-QMS-21].

22 Revision History

Date	Version	Comments
1-Dec-2009	1.0	Initial publication of Operational Plan
1-Jul-2011	2.0	Revisions to address external audit results.
25-Jul-2012	3.0	Publication of new version following QMS restructuring.
25-Oct-2013	3.1	Section 3 (Commitment and Endorsement) was amended to include NWI's current Top Management with respect to the Standard.
29-Apr-2014	3.2	Updates to section 15 (Infrastructure Maintenance, Rehabilitation, and Renewal); section 13 (Essential Supplies and Services) removed following replacement with corporate procedure.
2-Apr-2018	3.3	Updates to sections 2 (QMS Policy), 3 (Commitment and Endorsement), 6 (Drinking-Water System), 8 (Risk Assessment Outcomes), 15 (Infrastructure Maintenance, Rehabilitation, and Renewal) and 21 (Continual Improvement).

Ontario

Ministry of the Environment and Climate Change

Schedule C – Director's Directions for Operational Plans (Subject System Description Form)

Municipal Residential Drinking Water System

Fields marked with an asterisk (*) are mandatory.

Owner of Municipal Residential Drinking Water System *
The Corporation of the Municipality of Red Lake

Name of Municipal Residential Drinking Water System *
Madsen Drinking Water System

Subject Systems

☑ Check here if the Municipal Residential Drinking Water System is operated by one operating authority. Enter the name of the operating authority in the below table.

	Name of Operational Subsystems(if Applicable)	Name of Operating Authority *	DWS Number(s) *
1		Northern Waterworks Incorporated	210001479

Provide the information outlined in the 'Contact Information' section for **each** Operational Subsystem.

Contact Information 1

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Title *	Phone Number *
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Last Name *	First Name *	Middle Initial
LeBlanc	Jason	

Title *	Phone Number *
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