Operational Plan

Hudson Drinking Water System

HDWS-OP-3.0

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 Inc. 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 [HDWS-OP-3.0]
2 – QMS Policy	Operational Plan [HDWS-OP-3.0]
3 – Commitment and Endorsement	Operational Plan [HDWS-OP-3.0]
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 [HDWS-OP-3.0]
7 – Risk Assessment	Risk Assessment Procedure [NWI-QMS-7]
8 – Risk Assessment Outcomes	Risk Assessment Outcomes [HDWS-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 [HDWS-OP-3.0]
16 – Sampling, Testing and Monitoring	Sampling, Testing and Monitoring Procedure [HDWS-QMS-16]
17 – Measurement and Recording Equipment Calibration and Maintenance	Measurement and Recording Equipment Calibration and Maintenance Procedure [HDWS-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	Operational Plan [HDWS-OP-3.0]

1 Quality Management System

The Drinking Water Quality Management System (QMS) for the Hudson 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 Sioux Lookout utilizes the services of Northern Waterworks Incorporated (NWI), an independent contracted operating authority, to operate, maintain, manage and administer the Hudson Drinking Water System (as per agreement). The Municipality of Sioux Lookout 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 Sioux Lookout and NWI support the implementation, maintenance, and continual improvement of a drinking water Quality Management System for the Hudson Drinking Water System, 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 of the undersigned persons hereby endorse this Operational Plan:

Name & Title:	Signature:	Date:
Ann Mitchell Chief Administrative Officer Municipality of Sioux Lookout	DocuSigned by: Ann Mitchell 49E1E312CCD14C1...	May 24, 2017
Andrew Jewell Public Works Manager Municipality of Sioux Lookout	DocuSigned by: Andrew Jewell B46F58C49A9E464...	March 23, 2017
Jason LeBlanc Chief Administrative Officer Northern Waterworks Incorporated	DocuSigned by: Jason LeBlanc 88889B60117145B...	March 22, 2017
Gilles Vachon Northwest Regional Manager Northern Waterworks Incorporated	DocuSigned by: Gilles Vachon 1C255A37B8324B2...	March 22, 2017

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 Hudson Drinking Water System provides a potable water supply to the community of Hudson and is composed of the Low Lift (Raw Water) Pumping Station (LLPS), the Hudson Water Treatment Plant (HWTP, a Class II water treatment facility having an approved rated capacity of 726 m^3/day) and the Hudson distribution system (a Class I water distribution system). The Hudson Drinking Water System is owned by the Corporation of the Municipality of Sioux Lookout and Northern Waterworks Incorporated serves as the accredited operating authority.

The source water for the treatment process is drawn from a surface water source (Lost Lake) located within the Municipality. Potential pathogenic organisms are removed from the raw water by coagulation, flocculation, clarification, filtration, and UV (primary) and free chlorine (secondary) 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 (Lost Lake) are provided in the table below.

Parameter	Results Range[1] (2011 - 2015)	Average (2011 - 2015)
Turbidity (NTU)	0.43 – 2.97	1.41
Colour (Pt/Co)	11 – 44	23
Temperature (^oC)	2.6 – 21.8	10.7
pH	7.4 – 8.2	7.8
Alkalinity (mg/L as $CaCO_3$)	34 – 50	44
E. Coli (MPN/100mL)	<1 – 16	---
Total Coliforms (MPN/100mL)	<1 – >2420	---

1. The minimum and maximum values for the results range are expressed as minimum and maximum monthly averages. Results in the table were compiled from water quality data collected between January 1, 2011 and December 31, 2015.

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

(1) Seasonal changes in water temperature may impact treatment performance as it concerns clarification 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 processes or chemical dosages.

(2) Algal blooms in the source water may pose an emerging concern, whereby such events could interfere with filtration 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) Various point and nonpoint sources of pollution exist around Lost Lake. The lake is influenced by recreational activities (boats, float planes), and commercial houseboat operators and fuel storage tanks line the shore of the lake near the water treatment facility. The raw water pumping station and water treatment plant are also situated adjacent to a railway, which presents the potential for derailment and a chemical spill. Hudson does not have a municipal sanitary sewer and treatment system, and leachate from defective private septic systems represents a source of contamination. Finally, Lost Lake is susceptible to natural bacteriological contamination by wildlife.

Monitoring processes (i.e. routine 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 & Distribution

6.3.1 Source Water Intake & Pumping

Source water is obtained from Lost Lake, a large inland lake forming part of the English River drainage system. Raw water is drawn through flared elbow intake inside a cribbed structure located approximately 43 meters offshore at a depth of 9.45 meters. Water is then gravity fed through a 150 mm diameter intake pipe extending from the intake structure to a wet well with a storage volume of 111.6 m^3 at the Low Lift Pumping Station. Three vertical turbine low lift pumps located at the LLPS are available to transfer source water through a transmission line to the Hudson Water Treatment Plant.

6.3.2 Coagulation, Flocculation, & Clarification

A primary coagulant chemical is added to the incoming raw water prior to the water entering two package treatment units. Rapid mixing of the primary coagulant chemical with the raw water occurs as the raw water passes through an in-line static mixer. Each package treatment unit is rated at 4.2 L/s and includes a three-stage flocculator, a clarifier, and a dual media filter. In the three-stage flocculator, coagulated water is gently mixed to promote the formation of floc masses. The optional application of a coagulant aid at the stage of treatment is intended to form larger floc aggregates. Process water then enters the clarifier, where its velocity is reduced to allow for the separation and settling of floc. Supernatant overflows into the clarifier effluent launders and is directed to the dual media filter.

6.3.3 Filtration

Most of the particulate matter that was present in the raw water will become an insoluble floc and be removed in the clarifiers. During normal operation, however, some floc passes from the clarifiers to the filters. The filters remove any remaining particles that have not settled out by passing the water through layers of anthracite and silica sand, supported by a layer of coarse gravel. Filtrate is directed through an underdrain system and to the UV reactors for disinfection.

The filters are periodically cleaned by using an air scour to agitate the entire media bed and reversing the flow of water (backwashing) through the filter using dedicated pumps. The pumps withdraw water from the storage reservoir, and an optional injection point for a de-chlorinating agent exists on the backwash line upstream from the filters. After the backwash process, filtered water is directed to the backwash equalization chamber (i.e. rinsing-to-waste) until a pre-determined amount of time has passed and the water meets specific water quality objectives.

6.3.4 Disinfection

Disinfection occurs following filtration, immediately upstream from the treated water storage reservoir. Filtrate is passed through one of two available UV reactors, each unit rated at 8.4 L/s and including a UV intensity sensor and shut-off controls. UV disinfection ensures that any potentially pathogenic organisms that remain after previous treatment processes are destroyed or inactivated. Consistent disinfection is ensured by the continuous monitoring of UV disinfection parameters.

A super-chlorinated solution is applied to the filtrate after it passes through the UV reactors upstream from the treated water storage reservoir. Secondary disinfection requirements are achieved by adding a sufficient amount of free chlorine at the water treatment plant in order 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 Treated Water Storage

Following disinfection filtrate is directed to the two celled storage reservoir with a total storage volume of 564 m^3. Treated water is delivered from the reservoir to the distribution system by the use of two variable speed vertical turbine high lift pumps located at the WTP. An optional chlorine injection point exists for trim chlorination purposes at a location downstream from the reservoir but prior to entry to the distribution system.

6.3.6 pH Adjustment

The primary coagulant used at the Hudson Water Treatment Plant reduces the pH of the water. A pH/alkalinity adjustment chemical is added to the filtrate prior to UV disinfection. This ensures that the pH of treated water will be restored to a level that will not cause corrosion in the distribution system.

6.3.7 Instrumentation and Emergency Power

The Hudson WTP includes a PLC complete with a SCADA system for process monitoring and control. Critical process instruments include two raw water flow measuring devices, two filtrate turbidity analyzers, two UV intensity sensors, one treated water flow measuring device, one treated water turbidity analyzer, and two treated water free chlorine residual analyzers (located on either side of the optional trim chlorine injection point).

The system also includes a 150 kW standby diesel generator located at the low lift pumping station for supplying emergency power to both the pumping station and the water treatment facility.

6.3.8 Waste Residuals Management

Clarifier sludge discharge, backwash wastewater and rinse-to-waste water are directed to the backwash equalization chamber at the Hudson WTP. Process wastewater then flows to a concrete sludge/sedimentation chamber with a total capacity of 22,700 L located external to the treatment plant building. Sludge is allowed to settle in the chamber and supernatant is directed to a subsurface disposal system consisting of a proprietary storm water type chamber-based storage and exfiltration field with a total storage capacity of approximately 100 m^3. Accumulated sludge in the sludge/sedimentation chamber is periodically removed using a vacuum truck.

6.3.9 Distribution System Components

The Hudson distribution system was installed exclusively in 1990 and includes approximately 6 km of water mains, 46 water main gate valves, and 7 hydrants. Watermain materials consist of HDPE and PVC, ranging in size from 50 to 150 mm in diameter.

6.4 Critical Upstream and Downstream Processes

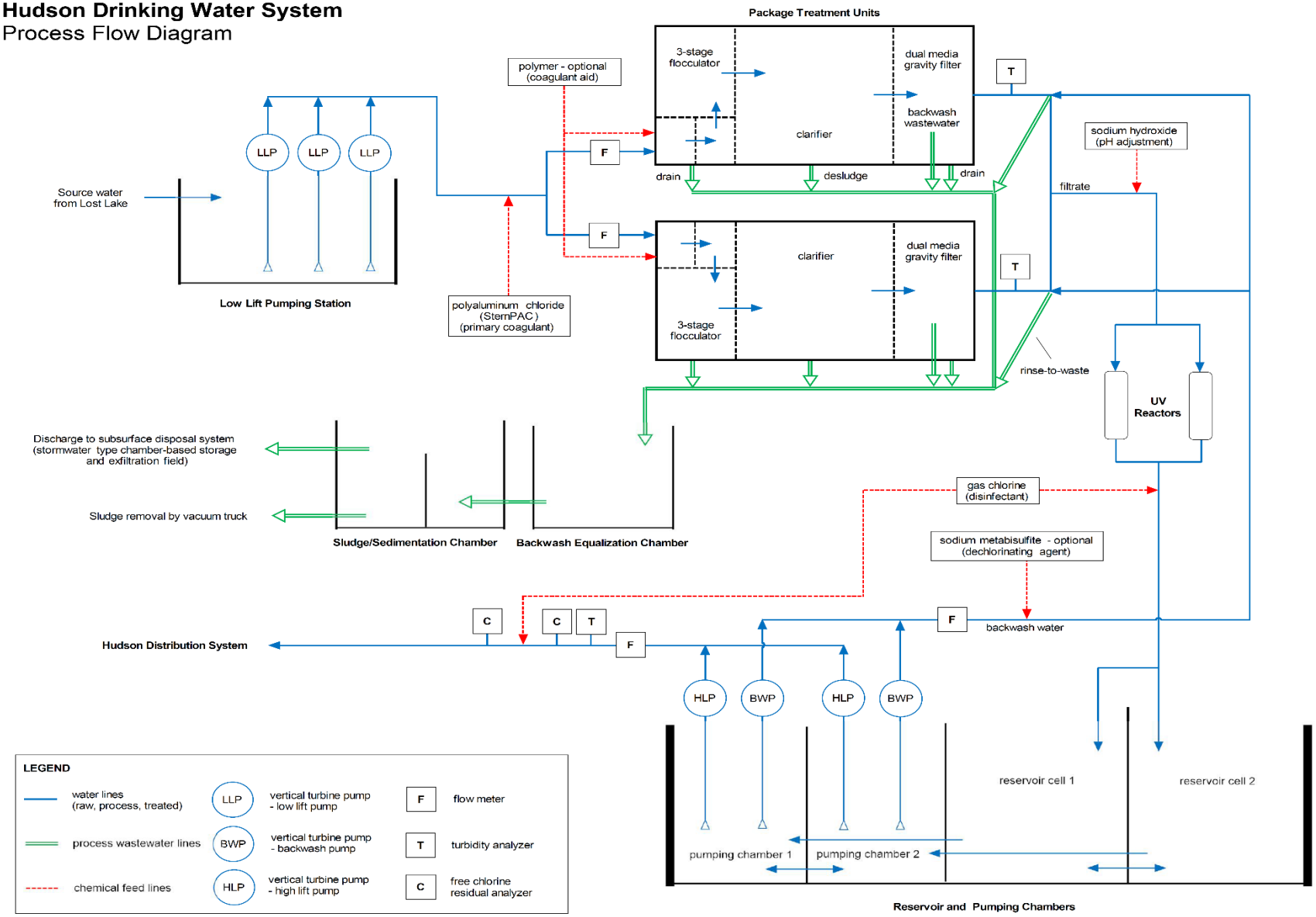
Source water integrity monitoring is considered an upstream process which is relied upon to ensure the provision of safe drinking water. Emergency response procedures exist for situations involving source water contamination.

The normal operation of water distribution mains is also a critical downstream process, whereby compromises to distribution system integrity represent possible threats of contamination. Emergency response procedures exist for such situations.

6.5 Process Flow Diagram

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

Hudson 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

Risk assessment outcomes are developed using the *Risk Assessment Procedure* [NWI-QMS-7]. This procedure contains all the information necessary to interpret the *Risk Assessment Outcomes* for the Hudson Drinking Water System [HDWS-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 taking into account 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, UV intensity, 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 Hudson Drinking Water System include the following:

(1) The *Planned Maintenance Activities* Standard Operating Procedure [HDWS-SOP-1] documents a comprehensive planned maintenance program that is carried out by Operators at the Hudson Drinking Water System on a monthly basis. This procedure dictates planned 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 available at the Hudson Water Treatment Plant.

(2) The *Measurement and Recording Equipment Calibration and Maintenance Procedure* [HDWS-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 Hudson WTP on a monthly basis.

(3) The distribution system is flushed and hydrants are operated and inspected on an annual basis for the Hudson DWS. Major distribution system and hydrant deficiencies identified during this program are used to plan for future maintenance activities.

(4) The *Review and Provision of Infrastructure Procedure* [NWI-QMS-14) and annual budgeting procedures conducted by NWI 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 Sioux Lookout. 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.

(5) 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 (annually), b) hoist inspections (annually), c) fire extinguisher inspections (annually), d) backflow prevention device testing (biannually), e) thermal imaging inspections (every 3 years), f) emergency generator servicing (every 3 years), g) generator battery replacement (every 3 years), h) UPS battery replacement (every 5 years), i) reservoir cleaning and inspections (every 5 years), and j) the inspection of intake structures and pipes (every 10 years).

15.2 Unplanned Maintenance

Unplanned maintenance tasks related to the treatment component of the Hudson Drinking Water System result from equipment malfunction or breakage. 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 Hudson Drinking Water System are typically performed by the Municipality of Sioux Lookout, 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.

16 Sampling, Testing, & Monitoring

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

17 Measurement and Recording Equipment Calibration and Maintenance

Refer to the *Measurement and Recording Equipment Calibration and Maintenance Procedure* for the Hudson Drinking Water System [HDWS-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, infrastructure review, and internal auditing processes, which include the identification of QMS deficiencies and the assignment of corrective actions.

22 Revision History

Date	Version	Comments
01-Mar-2011	1.0	Initial publication of Operational Plan.
24-Aug-2012	2.0	Publication of new version of Operational Plan following QMS re-structuring.
28-Oct-2013	2.1	Section 3 (Commitment and Endorsement) was amended to include the appropriate municipal representative and NWI's Top Management with respect to the Standard. Minor formatting changes were applied to the cover page, footers, and tables.
14-Jan-2014	2.2	Section 15 (Infrastructure Maintenance, Rehabilitation, and Renewal) was amended to clarify infrastructure maintenance, rehabilitation, and renewal programs for the subject system.
01-Mar-2017	3.0	Updates to sections 2 (QMS Policy), 3 (Commitment and Endorsement), 6 (DWS Description) and 15 (Infrastructure Maintenance, Rehabilitation and Renewal); section 13 (Essential Supplies and Services) removed following replacement with corporate procedure; formatting changes to entire document.

Schedule "C"

Subject System Description Form
Municipal Residential Drinking Water System

Owner of Municipal Residential Drinking Water System[1]	**The Corporation of the Municipality of Sioux Lookout**
Name of Municipal Residential Drinking Water System:[2]	**Hudson Drinking Water System**

Subject Systems			
	Name of Operational Subsystems [3]	Name of Operating Authority [5]	DWS Number(s)[6]
☒ Check here if the Municipal Residential Drinking Water System is operated by one operating authority. Enter the name of the operating authority in adjacent column[4]		**Northern Waterworks Incorporated**	**220005385**
Operational Subsystem 1:			
Operational Subsystem 2:			
Operational Subsystem 3:			
Operational Subsystem 4:			

Add attachments if there are additional 'Operational Subsystems'

Contact Information [7]			
Name	Title	Phone Number	e-mail address
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