902-420-9287
450 Cowie Hill Road
P.O. Box 8388 RPO CSC
Halifax, Nova Scotia
Canada B3K 5M1

February 4, 2025

VIA EMAIL (Pamela.McGarrigle@novascotia.ca)
Ms. Pamela McGarrigle, Clerk of the Board
N.S. Utility and Review Board
3rd Floor, Summit Place, 1601 Lower Water Street
P. O. Box 1692, Postal Unit M
Halifax, NS B3J 3S3

RE: M11894 – J.D. Kline Water Supply Plant Disinfection Interruption – January 21, 2025 After Incident Review

Dear Ms. McGarrigle:

Halifax Water has experienced two interruptions to primary chlorine disinfection at the J.D. Kline Water Supply Plant (JDKWSP) within the past year. On the afternoon of July 1st, 2024, an issue occurred at the JDKWSP causing a power failure and loss of the chlorination system. There was a 16-minute period when water did not have the final disinfection (chlorination) treatment before leaving the facility.

On the night of January 20, 2025, a planned Nova Scotia Power outage resulted in the main generator at the low lift pump station engaging as designed. This restored power to both the low lift and main facility buildings but triggered approximately 175 alarms, which the Operator immediately began triaging and troubleshooting to bring the facility back to normal operation. During the troubleshooting, it was discovered that the service water pumps were offline and without power, which meant the main chlorination system was offline. The backup sodium hypochlorite chlorination system was then engaged, but it was later discovered that the system was airlocked and not feeding chlorine. Once identified, this was corrected immediately.

As a result, for 66-minutes the water leaving the facility was fully treated, except it did not have final disinfection treatment with chlorine. Where disinfection was not provided, Halifax Water issued a BWA in the early morning of January 21, 2025. The BWA was issued and communicated to customers through multiple pathways before the unchlorinated water reached the first customer in the distribution system. While the outcome of these events both resulted in boil water advisories (BWAs), the causes of the interruptions were different. This report provides a preliminary after-incident review of the events that occurred from January 20 to 21, 2025, and the circumstances that led to the release of unchlorinated filtered water from the JDKWSP into the distribution system and the subsequent BWA. Specifically, this report covers the incident on January 20 to 21, 2025, up to the issuance of the BWA and will:

- Outline the sequence of events that occurred on January 20 to 21, 2025, resulting in a BWA.
- Identify and explain the currently identified root causes of the disinfection interruption on January 20, 2025. This preliminary report focuses on facts and contributing factors, with a full root cause analysis to be provided in the final report.
- Identify corrective measures that will be undertaken to prevent reoccurrence based on information collected during the preliminary after-incident review.
- Include a review of the steps taken by Halifax Water to ensure the disinfection and related backup power supply systems were working correctly in anticipation of the planned NSP outage.
- Include a description of the communications plan that Halifax Water undertook to inform customers of the risks associated with the interruption in disinfection services on January 21, 2025.

A final after incident report containing a comprehensive root cause analysis for the January 20 to 21, 2025 incident will be completed and submitted to the Utility and Review Board by March 21, 2025. This report has been reviewed by the Halifax Water Board.

Should you have any questions, please do not hesitate to contact me.

Sincerely,

Signed by:
Kenda MacKenzie
0C084AC815794F6...

Kenda MacKenzie, P.Eng.
General Manager/CEO

Attachment
M11894 JDK WSP Disinfection Interruption January 2025 Preliminary After Incident Review
Attachment A – Halifax Regional Water Commission – J.D. Kline Water Supply Plant Disinfection Interruption (January 2025) Preliminary After Incident Review (M11894)
Attachment B – Updated Corrective Measures from July 1, 2024 disinfection interruption.

Halifax Regional Water Commission –

J.D. Kline Water Supply Plant Disinfection Interruption (January 2025)
Preliminary After Incident Review (M11894)

February 4, 2025

CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

Halifax Water has experienced two interruptions to primary chlorine disinfection at the J.D. Kline Water Supply Plant (JDKWSP) within the past year. While the outcome of these events both resulted in boil water advisories (BWAs), the causes of the interruptions were different.

The following report is a preliminary after-incident review of the January 20 and 21, 2025 event, which resulted in the release of unchlorinated filtered water into the Halifax Water distribution system and issuance of a BWA. The report outlines the sequence of events at the JDKWSP, identifies preliminary root causes of the disinfection interruption, and proposes corrective measures based on the preliminary after-incident review.

On the night of January 20, 2025, a Nova Scotia Power (NSP) outage resulted in the main generator at the low lift pump station engaging as designed. This restored power to both the low lift and main facility buildings but triggered approximately 175 alarms, which the Operator immediately began triaging and troubleshooting to bring the facility back to normal operation. During the troubleshooting, it was discovered that the service water pumps were offline and without power, which meant the main chlorination system was offline. The backup sodium hypochlorite chlorination system was then engaged, but it was later discovered that the system was airlocked and not feeding chlorine. Once identified, this was corrected immediately.

The source of the loss of service water pumps, and thus the main chlorination system, was found to be blown control fuses located on the transformers for both service water pumps. The fuses are there and designed to blow to prevent damage to infrastructure downstream. These fuses were replaced, and the main chlorination system was brought back online.

Public Health and the provision of safe drinking water is of utmost concern to Halifax Water. Overall, the JDKWSP facility did not have final disinfection with chlorine for 66 minutes. As a result, a BWA was issued with direction from Nova Scotia Environment and Climate Change (NSECC) to ensure protection of public health. The BWA was issued and communicated to customers through multiple pathways before the unchlorinated water reached the first customer in the distribution system.

There were 16 corrective measures that were identified in the after-incident review from July 1, 2024. Nine of these corrective measures have been implemented to date. This preliminary report identifies 14 initial corrective measures for the January 20 and 21 event.

At this time, the only identified common root cause between the two disinfection interruption incidents and subsequent BWAs relates to the original design of the plant, as it does not allow Halifax Water to stop the gravity flow of water from the plant to the distribution system. The timeline for implementation of adequate treated water storage and ability to shutdown the plant is a long-term corrective measure for both incidents and could not have been implemented ahead of the January 20 to 21, 2025 incident. A final after-incident report containing a comprehensive root cause analysis for this incident will be completed and submitted to the Utility and Review Board by March 21, 2025.

Chapter 1 INTRODUCTION

1.1 Objectives and Scope

This report provides a preliminary after-incident review of the events that occurred from January 20 to 21, 2025, and the circumstances that led to the release of unchlorinated filtered water from the JDKWSP into the distribution system and the subsequent BWA. Specifically, this report covers the incident on January 20 to 21, 2025, up to the issuance of the BWA and will:

- Outline the sequence of events that occurred on January 20 to 21, 2025, resulting in a BWA.
- Identify and explain the currently identified root causes of the disinfection interruption on January 20, 2025. This preliminary report focuses on facts and contributing factors, with a full root cause analysis to be provided in the final report.
- Identify corrective measures that will be undertaken to prevent reoccurrence based on information collected during the preliminary after-incident review.
- Include a review of the steps taken by Halifax Water to ensure the disinfection and related backup power supply systems were working correctly in anticipation of the planned NSP outage.
- Include a description of the communications plan that Halifax Water undertook to inform customers of the risks associated with the interruption in disinfection services on January 21, 2025.

A final after-incident report will be submitted to the Utility and Review Board by March 21, 2025.

1.2 Background

Halifax Water is responsible for providing safe, high-quality water, wastewater, and stormwater services to customers throughout the Halifax Regional Municipality. The utility operates three large and six smaller community water supply plants to serve 360,000 customers.

Each water supply plant has varying types of treatment systems in place based on source water quality and other factors. Operators at all of Halifax Water's supply plants continuously monitor and adjust the treatment processes. The various treatment processes at the plants include:

- Direct multi-media filtration
- Sedimentation with multi-media filtration
- Disinfection
- Ultrafiltration
- Nanofiltration
- Iron and manganese removal/green sand filtration

Through a multi barrier approach and to ensure protection of public health, NSECC requires Halifax Water to provide primary disinfection at the facilities as well as to maintain a chlorine residual of at least 0.2 mg/L (milligrams per litre or parts per million) for secondary disinfection in all parts of the distribution system to protect against microbial contamination. Chlorine is the most common type of drinking water disinfection process used to inactivate bacteria, viruses, and other microorganisms. This is in keeping with Drinking Water Quality Guidelines set by Health Canada.

Halifax Water has experienced two interruptions to primary chlorine disinfection at the JDKWSP within the past year. Both incidents resulted in BWAs, which are a public health protection measure that is taken when there is an identified issue with the treatment process that can result in microbial contamination. While both BWA were due to interruptions in primary chlorine disinfection, the causes of the interruptions were different. The section below provides the background for these two disinfection interruptions.

July 2024 BWA

On the afternoon of July 1, 2024, an internal electrical issue occurred at the JDKWSP. As a result, electrical safety systems at the low lift pump station were engaged. The electrical safety systems are designed to protect equipment from high current and excessive heat. These safety systems isolated power at the facility during this electrical failure and prevented the main emergency generator from engaging. Additionally, the secondary (auxiliary) generator in the main treatment facility building, designed to bridge the time between an external power (utility) outage and the main emergency generator, was engaged as designed but shut off from high engine temperature shortly thereafter. This then caused a loss of power to the main treatment facility building and the chlorination system.

As a result, for a sixteen (16) minute period, treated water entering the distribution system did not have final disinfection treatment with chlorine before leaving the JDKWSP. While all other treatment requirements were being met at the time, based on regulatory requirements and direction from NSECC, Halifax Water issued a BWA. Based on the after-incident review of the July 1, 2024, BWA, a total of 16 short—, medium—and long-term corrective measures were recommended to manage risk and improve resiliency at the JDKWSP (The full report is provided as Attachment A, and updated table of corrective measures with status is provided as Attachment B). Nine of these measures have already been completed, and others are near completion or ongoing.

January 2025 BWA

A second BWA was issued on January 21, 2025. While the BWA was issued due to an interruption in chlorine disinfection, like on July 1, 2024, the events that caused the disinfection interruption were independent of the BWA on July 1, 2024.

Late evening on January 20, 2025, a planned NSP outage resulted in a loss of utility power at the JDKWSP. The backup generator engaged as expected upon the loss of utility power. As with any unanticipated power outage where the backup generator cannot be brought online ahead of time, the resulting transfer of power was reactionary and not seamless, causing a brief blackout. This specific transfer resulted in blown fuses of the control circuits for both service water pumps, functioning as designed to protect downstream infrastructure. Blown fuses on the control circuits for both service water pumps has not occurred before at the JDKWSP due to loss of utility power. Service water pumps are required for process chemical makeup and the chlorination disinfection chemical delivery system. Without them, the main chlorination unit cannot operate. As a result, for sixty-six (66) minutes, the water leaving the facility was fully treated, except it did not have final disinfection treatment with chlorine before leaving the JDKWSP. All other treatment requirements were being met based on regulatory requirements; however, where primary disinfection was not provided, Halifax Water, in consultation with NSECC, issued a BWA in the early morning of January 21, 2025.

Chapter 2 OVERVIEW OF RELEVANT SYSTEMS AT THE JDKWSP

2.1 Process Overview and Relevant Systems

At the JDKWSP, raw water from Pockwock Lake is pumped from the low lift pump station to the main treatment facility building, consisting of a direct filtration treatment process to remove pathogens, turbidity, metals, and organic matter. Treated water is stored in clearwell and reservoir storage tanks before being released to the distribution system. Due to the original design and configuration of the plant, which was based on requirements at the time, chlorine addition occurs immediately before it enters the transmission main, and chlorine contact for pathogen inactivation (i.e., primary disinfection) occurs within the transmission main itself. There is no onsite water storage after chlorine is added, and there is currently no ability to stop the flow from the plant to the distribution system without causing significant operational risks downstream. Additional details on the process at the JDKWSP are outlined in the previous report (Attachment A).

The key aspects of the treatment process at the JDKWSP that pertain to the incident on January 20 to 21, 2025, are the service water, main chlorination, and backup chlorination systems, as described below.

2.1.1 Service Water

The treatment process at the JDKWSP relies on service water, which is water that is used within the plant for various operational needs like mixing and delivering chemicals, including the main chlorination system, and backwashing filters. At the JDKWSP, service water for the process is pumped from the clearwell. There are two service water pumps, one in service and one backup at any time. Each service water pump has a dedicated control circuit. These circuits are powered by separate fused transformers.

2.1.2 Main chlorination system

The JDKWSP uses chlorine gas for the main chlorination system. There are redundant chlorinators. This system requires water to generate a vacuum to draw the chlorine gas into water. In the case of the JDKWSP, the water used for the chlorine gas system is service water, which is pumped from the clearwell as described above.

Chlorine is injected at the outlet of the JDKWSP. There is a chlorine analyzer that continuously monitors the chlorine residual in finished water leaving the facility. Due to the location of the chlorine analyzer inside the facility relative to the injection point, there is approximately a 15-to-25-minute delay in chlorine residual readings on this analyzer from the location of the chlorine injection, depending on plant flow rates. This means the chlorine residual reading on the analyzer is not a real-time indicator of chlorination status.

2.1.3 Backup chlorination system

The primary backup chlorination system is a pumped sodium hypochlorite system. It does not require service water for operation and is directly injected into finished water. The system is comprised of redundant pumps, which can be turned on in the control room or locally at the pumps.

If the main chlorination system fails, the operator is to start the backup sodium hypochlorite chlorination system immediately. At the time of the incident, the pumps for backup chlorination with sodium hypochlorite were powered from electrical outlets at the plant that receive power when on utility power or if either of the facility generators are running. At the time of the incident, had there been no power to the outlets, a portable battery generator was available and located beside the sodium hypochlorite pumps. In the case of a power outage, Operators would need to go to the pumps, unplug them from the wall, and plug them into the portable battery generator. Implementation of the portable battery generator was a corrective measure in M11894 – Halifax Regional Water Commission – J.D. Kline Water Supply Plant Disinfection Interruption – After Incident Review (Attachment A) that was implemented since the BWA on July 1, 2024, to reduce time to initiate the system and remove the immediate need for a portable gas-powered generator that was located away from the backup hypochlorite system (Attachment B).

As part of ongoing work to improve the resiliency of the backup hypochlorite system, on January 27, 2025, the backup hypochlorite system pumps were moved to be powered by uninterrupted power supply (UPS) units to eliminate the need for a portable battery generator (also a corrective measure within M11894 – Halifax Regional Water Commission – J.D. Kline Water Supply Plant Disinfection Interruption – After Incident Review, Attachment A). The main generator at the low lift pump station engaged as designed on January 20, restoring power to both the low lift and main facility buildings, which meant an alternative power source was not required for the backup system. However, in the event of a power failure, with the UPS in place, the pumps can run on battery power for an extended period, and the UPS units allow for system automation. Prior to the January 20 to 21 incident, precursor work to automate the backup hypochlorite system was ongoing. The final stages of implementation continued Monday, January 27, 2025, to automate the operation of the backup hypochlorite system (Attachment B).

Chapter 3 REVIEW OF JANUARY 21 BWA

3.1 Incident description

A planned NSP outage on the night of January 20, 2025, resulted in the loss of utility power at the JDKWSP. NSP notified Halifax Water of the planned outage through their auto dialer system. Contact was not made directly with the JDKWSP staff ahead of the event, as the phone numbers on file for the autodial notification process for the facility were not active. With adequate notice of known events that can cause disruption in power, the common precautionary practice is for Halifax Water staff to transition to emergency backup power in a planned manner resulting in a seamless transition and minimizing risk to electrical infrastructure at the facility. Planned transition to backup power requires adequate advance notice to call and bring in additional staff to complete and monitor the transition to backup power. The loss of utility power this night at the facility was no different than any unplanned loss of power that occurs from time to time for various reasons.

While the direct notification from NSP did not reach JDKWSP staff directly, an off-duty Operator became aware of a planned outage in the area and notified the Operator on duty approximately 2 hours ahead of the planned outage. It was not clear to the on-duty Operator from the information available whether the planned outage would impact the facility. Once aware, as a precaution, the Operator took steps that were feasible within the time before the planned outage to prepare the plant to ensure continuity of service, which included transferring between raw water pumps. After the July 1, 2024, incident, additional staff were hired to provide two operators on shift through nights, weekends, and holidays at the JDKWSP. At the time of the incident there were two Operators on shift.

During the power outage on January 20, 2025, the main generator at the low lift pump station was engaged as designed, and power was restored to both the low lift and main facility buildings. When power was restored, approximately 175 alarms were present that required Operator acknowledgment. Increased incidence of alarms happens when there is a loss of utility power without prior transition to the backup power system. The Operator began troubleshooting steps to clear alarms and bring the facility to normal operation. During this troubleshooting process, staff became aware that service water pumps were not working. The main chlorination system could not function without service water and went offline during the incident, resulting in a lack of chlorination for primary disinfection. After confirming that the service water pumps could not quickly be restarted, staff engaged the backup sodium hypochlorite chlorination system from the control room. After approximately 15 minutes, a routine monitoring check of the backup chlorination system indicated that the pump was airlocked and not feeding chlorine, which compounded the time without chlorination. Upon detection, the operator immediately removed the airlock and confirmed that the sodium hypochlorite system was functioning properly.

It was later determined on-site during the incident that control fuses were blown on the transformers for both service water pumps, preventing them from receiving run commands locally or remotely. Fuses are part of the electrical protection system designed to blow during high current events to avoid damage to the associated circuit. The fuses were replaced, and the main chlorination system was brought back online. JDKWSP Operators then shut off the backup sodium hypochlorite chlorination system and got the treatment process online once it was confirmed that the main chlorination system was working.

Overall, the facility did not have final disinfection with chlorine before leaving the JDKWSP for 66 minutes. All other treatment requirements at the time were met, and the water entering the distribution system was fully treated except for primary disinfection. Staff also implemented operational adjustments to the distribution system to minimize the amount of water leaving the facility.

A BWA was issued with direction by NSECC and as outlined in the Approval to Operate for the JDKWSP and Section 5.1 (4) of the Guidelines for Monitoring Public Drinking Water Supplies Part I – Municipal Public Drinking Water Supplies (Nova Scotia Environment and Climate Change, October 2021):

> *Section 5.1 Deficiencies that require a boil water advisory include.*
>
> > *(4) lack of disinfection (i.e., all systems) or failure of a key water treatment process (e.g. filtration process for systems relying on surface water or GUDI sources).*

Based on the interruption in primary disinfection on January 20, 2025, the scenario described in Section 5.1 (4) applied, which required the issuance of a BWA to protect public health early in the morning on January 21, 2025.

The BWA was issued before the unchlorinated water reached the first customer in the distribution system. A detailed account of the events that led to the issuance of the BWA on January 21, 2025, is provided below in Table 3-1.

Table 3-1: Detailed event timelines on January 20 to 21, 2025.

Date	Time	Description
January 20, 2025	08:35 PM	An Off-duty Operator sees a social media post about a planned power outage in the area. The Off-duty Operator texts the On-duty Operator to ask if they are aware of a planned power outage.
	~9:00 PM	The On-duty Operator at the plant reads the text. Based on the information available at the time, it is not confirmed whether the planned outage will affect plant power systems.
	10:05 PM	The Operator transitions from Raw Water Pump #1 to Raw Water Pump #6 in case the generator comes online (Raw Water Pump #1 cannot operate on generator power).
	10:36 PM	The power outage occurs and the JDKWSP loses utility power. The main diesel generator at the low lift pumping station engages as designed, and backup power comes online. Approximately 175 active alarms arise on the plant control system and require Operator acknowledgement.
	10:39 PM	The Operator confirms that backup power is online and begins triaging and troubleshooting alarms to bring systems back online. The Operator reboots the chlorine analyzer, confirming chlorine residual.
	10:45 PM	The Operator continues triaging and troubleshooting alarms, and attempts to restore the lime dosing system, and notices no pressure on gauges in the lime area (indicating no service water flow).
	10:50 PM	The Operator confirms that both service water pumps are offline and goes to the motor control center to reset the motors.

		Utility power becomes available at the low lift pumping station. The generator remains on, and power is monitored for 30 minutes to ensure stable voltage while staff troubleshoot the facility's ongoing situation.
	10:55 PM	Attempts by the Operator to restart either service water pump are unsuccessful.
	11:00 PM	The Operator calls the Supervisor to inform them of the situation. The Supervisor begins traveling to the JDKWSP. The Operator proceeds to start the backup chlorination system (sodium hypochlorite).
	11:04 PM to 11:12 PM	The Operator arrives at the backup chlorination system and prepares it to run from the control room. The Operator then engages the backup chlorination system from the control room.
	11:12 PM to 12:53 AM	The backup chlorination system (sodium hypochlorite) is online.
	11:15 PM	The On-Call Electrician is contacted by plant staff and begins travel to the JDKWSP.
	11:20 PM	The main diesel generator at the low lift pumping station is turned off, and utility power is restored to the low lift pumping station and the facility.
	11:26 PM to 11:42 PM	The plant Supervisor arrives on site, reviews the situation with the Operator and confirms that neither service water pump will operate. Staff perform routine monitoring on the backup chlorination system to ensure it is working correctly and detect that lines are airlocked and not delivering sodium hypochlorite. Staff remove the airlock and confirm sodium hypochlorite is being pumped into finished water.
January 21, 2025	12:01 AM	The Manager of Water Supply Plants is notified that the facility had an interruption in chlorination.
	12:11 AM	The Acting Senior Manager of Water and Wastewater Treatment is notified of the situation.
	12:21 AM to 12:40 AM	The Director of Operations, Acting Director of Environment Health and Safety, Acting Water Quality Manager, and General Manager are notified of the situation.
	12:21 AM to 12:44 AM	The On-Call Electrician arrives on site and assesses the service water pump panels and breaker. The Electrician determines that control fuses are blown on the transformers for the service water pumps, preventing them from receiving a run command. The On-Call Electrician restores power to the service water pump control circuits by replacing fuses.
	12:44 AM	The plant staff turn on the service water pumps and ensure the operation of the service water system.
	12:53 AM	The main chlorination system is put back online. Staff confirm chlorine gas flow on the main chlorination system. The backup chlorination system (sodium hypochlorite) is removed from service.
	12:41 AM to 5:25 AM	The General Manager, Acting Senior Manager of Water and Wastewater Treatment, Manager of Water Supply Plants, Director of

		Operations, Acting Director of Environment Health and Safety, Acting Water Quality Manager, Manager of Water Distribution West Region, Regular Communications Associate and Senior Manager of Communications have a video call to discuss the situation.
	12:51 AM to 1:30 AM	One raw water pump and chemical feeds are started. Staff check all chemical pumps and associated systems and then bring the second raw water pump online, restoring the plant to normal operation.
	12:54	A call is made to the NSECC Regional Director of the Central Region. The call goes to voicemail.
	1:01 AM	A call is made to NSECC through after-hours protocol to the On-Call Inspector. NSECC informs that they will call back with a determination of the requirement to issue a boil water advisory.
	1:17 AM	A call is made to the On-Call Medical Officer of Health to notify them of the situation.
	1:17 AM to 2:15 AM	Halifax Water staff continue video calls to discuss the situation and plan for operational changes in the distribution system to minimize flow to the city. Staff begin filling out the NSEMO alert-ready request forms and preparing communications materials.
	1:24 AM to 2:25 AM	Distribution operations staff prepare and execute operational adjustments to slow flow leaving the JDKWSP.
	2:42 to 2:53 AM	Calls are made to NSECC for direction on the situation. The calls go to voicemail. NSECC calls back and informs that they are still working on the situation and will provide direction soon.
	3:23 AM	Halifax Water receives a phone call from NSECC with verbal confirmation to issue a BWA.
	3:27 AM	Halifax Water Board of Commissioners Chair is called to notify of the BWA – message left.
	3:29 AM	HRM CAO is called to advise of BWA and to confirm contact with HRM EM to assist with alerts (hfxALERT & Non-Intrusive Alert through NS EMO).
	3:35 AM to 4:29 AM	Halifax Water staff continue the video call to discuss the situation and finalize the Pupblic Service Announcement (PSA) for the BWA.
	3:37 AM	The Halifax Regional Fire and Emergency Deputy Chief is contacted to initiate an alert message.
	4:07 AM	An email is sent to Halifax Water Board of Commissioners to notify them of the situation.
	4:25 AM	NSECC provides BWA issuance paperwork.
	4:42 AM	Halifax Mayor and Council are advised of the situation via email.
	4:45 AM	The Halifax Regional Fire and Emergency Deputy Chief provided with email messaging for alerts, both hfxALERT and Provincial Alert.
	4:46 AM	A PSA is added to Halifax Water website and emailed to staff. The PSA is pushed to news media outlets and social media channels.
	4:48 AM	NSP is advised of the situation, and conversations begin to review protocols.
	4:54 AM	Nova Scotia Health Authority and Halifax Regional Centre of Education are notified of the BWA.

	5:50 AM	A non-intrusive provincial alert posted on The Weather Network (Halifax).
	6:45 AM	hfxALERT issued.

3.2 Steps taken to ensure the disinfection and related backup power supply systems were working properly in anticipation of planned NSP outage

During the planned NSP outage on the night of January 20, 2025, the main diesel generator engaged as designed to restore power to the low lift station and the main plant. Routine procedures to maintain operational readiness were followed. The table below describes routine checks and preventative maintenance activities.

Table 3-2: Routine checks and preventative maintenance on relevant systems at the JDKWSP.

System	Item	Frequency	Date last completed before power interruption
Low lift generator	Operator check	Once daily	January 20, 2025
	Generator test	Monthly	December 16, 2025
	Inspection, service, maintenance	Annual	October – November 2024
Auxiliary generator (interim rental unit installed July 2024)	Operator check	Twice daily	January 20, 2025
	Inspection, service, maintenance	Annual	July 2024
Main chlorination system (chlorine gas)	Operator check	Every 4 hours	January 20, 2025
	Pigtail inspection	Monthly	January 3, 2025
Backup chlorination system (sodium hypochlorite)	System test	Monthly	January 19, 2025

3.3 Halifax Water communications plan to notify customers of the risks associated with the interruption of disinfection services

Elements of the communication plan for issuing the BWA and notifying customers are listed below in the communications playbook. The timing of the execution of the communications plan elements is provided within the report's timeline section. The messaging around risks associated with the interruption of disinfection services needs to be consistent for all customers, and this is addressed through the BWA fact sheet that was released with the public service announcement and posted to the website.

Halifax Water Communications Playbook

If an issue requires public notification, such as a BWA, a communications playbook is followed to ensure accurate and timely information is distributed publicly. Depending on the magnitude of the impact on Halifax Water's systems and customers, the tactics used may vary. Still, the objective remains the same—to be our customers' first and most accurate source of information. The following sections highlight aspects of Halifax Water's general communications playbook that are relevant to this event.

Information Gathering

Timeline and Service Impacts

- Gather information to provide estimates on service restoration time to customers. Indicate impacts to water, wastewater, and stormwater service. Provide time estimates for when service will be interrupted and restored, if available, and if any additional service interruptions are expected.

Distribution

Halifax Water Website

- The PSA is added to the website, including maps and frequently asked questions.

Email

- PSAs are sent to the news media outlets, staff, and area Councillors. This includes relevant maps or graphics and website links as attachments.
- General Manager to notify Halifax Water Board Chair and Commissioners for Boil Water Advisories, Do Not Consume Notices and/or significant system failures that impact customers/environment.

Social Media

Facebook

- Post to Facebook with the full PSA included.

X/ Twitter

- Tweets are posted using the PSA title and a condensed version of key information; this includes a link to the full PSA in the tweet.

Amplification of Notification

- Based on news media interest, conduct in-person, video, or phone interviews with local media outlets as required.

Additional outreach

- Nova Scotia Health Authority
- Halifax Regional Centre for Education

Municipal Alert System

- To maximize reach and amplify Halifax Water's communications, Halifax Water will coordinate with HALIFAX and arrange to use the hfxALERT system. While this is a subscription-based system, it is widely used and supports getting the message out.

Provincial Alert System

- Based on the magnitude of the event and the risk to public health and safety, Halifax Water can use the provincial alert system in coordination with HALIFAX.

3.4 Preliminary causes of boil water advisory on January 21, 2025

To date, Halifax Water has been focused on collecting facts to develop an accurate timeline of events and to better understand what happened during the incident and the contributing factors. The final report due on March 21, 2025, will include a comprehensive root cause analysis through an industry standard incident investigation process. One root cause has been identified and is the same as one of the root causes for the July 1, 2024 BWA, and this is discussed below.

3.4.1 Fundamental Design Constraints

As a result of the BWA issued on July 1, 2024, fundamental design constraints were identified as a root cause. These fundamental design constraints remain the primary root cause of the incident from January 20 to 21 since flow cannot be isolated from the facility when there are disinfection interruptions and there is no chlorinated water storage at the facility. Therefore, chlorination at the outlet mixing chamber is always required to achieve primary disinfection and disinfection interruptions can result in BWAs.

During the incidents on July 1, 2024, and January 20, 2025, flow from the JDKWSP could not shut down to prevent unchlorinated water from entering the distribution system. As currently designed, the JDKWSP has constraints that prevent adequate treated water storage at the facility, directly impacting the ability to shut down without significant interruption to water quantity or quality. As a result, staff could not prevent unchlorinated water from entering the distribution system. However, staff implemented operational adjustments to the distribution system to minimize the amount of water leaving the facility.

All treated water in storage at the JDKWSP is unchlorinated. The finished water chlorine application only occurs when all filtered water is consolidated into a mixing chamber before leaving the plant through a finished water conduit. At this point in the process, it is not possible to interrupt the flow from the finished water conduit, and chlorination at the outlet mixing chamber is required at all times to achieve primary disinfection and to meet regulatory requirements. Chlorination and flow cannot be interrupted without incurring a significant water quantity or quality event.

Halifax Water's design records indicate that the point of chlorination has not changed since the facility was constructed in the 1970s. The criticality of the location at that time was offset by the fact that flow from the facility was capable of being interrupted at the time if needed through an installed outlet sluice gate, as described in the previous report (Attachment A).

According to planning and design documents, the Pockwock transmission system was configured to connect the JDKWSP primarily to other reservoirs and not directly to customers. Using reservoirs, the utility could store chlorinated water downstream to provide water service to customers and isolate flow leaving the plant at any time.

Accordingly, it was also originally intended that if JDKWSP required a shutdown for maintenance or encountered a failure, it could be simply shutdown by closing the outlet sluice gate and thereby isolating the plant from the city as described in Attachment A. While this may have been the original intention, this gate valve is no longer operational and closing it poses significant risks to the entire system. In the decades since the JDKWSP was constructed, several developments have been serviced directly from the transmission main and introduced the functional requirement to have no isolation of flow from the plant. As a result, the facility has an extremely limited shutdown or disruption window, which has now become a significant constraint.

As a result, isolating the JDKWSP from the city during the events that occurred from January 20 to 21, 2025, as well as on July 1, 2024, was not a viable option to minimize the release of unchlorinated water from entering the Pockwock distribution system.

Addressing these fundamental design constraints was a corrective measure identified in the after-incident report from the July 1, 2024, BWA. The Water Supply Enhancement Program (WSEP) is a long-term program to address asset renewal, growth and evolving regulatory requirements for water supply plants, including the JDKWSP. Components of this program include evaluation of treatment requirements and plant upgrades as well as adding on-site storage infrastructure, allowing the facility to meet disinfection requirements before water enters the distribution system. The on-site storage project for JDKWSP is currently in the concept design phase.

Chapter 4 CORRECTIVE MEASURES

Based on the facts collected from this preliminary after-incident review, several short—, medium—, and long-term corrective measures have been recommended to manage risk and improve resiliency at the JDKWSP. These measures are provided below in Table 4-1.

Table 4-1: Summary of recommended corrective measures based on preliminary after-incident review.

Item #	Corrective Measures	Timeline*	Status
1	Complete formal incident debriefs with various levels of staff.	Short-term	Ongoing
2	Review and update SOPs for clarity. Create new SOPs as appropriate, including a process for transferring to backup power prior to known potential disruptions. Ensure staff understanding through training.	Short-term/medium-term	Ongoing (Resources have been allocated for SOP review)
3	Conduct emergency exercises to enhance knowledge on response to varying incidents.	Short, medium, and long-term	Ongoing
4	Address fundamental design constraints by providing adequate treated water storage and the ability to shut down for maintenance or failure conditions without interruption to water quantity or quality.	Long-term	Ongoing (In concept design phase)
5	Create a process control narrative with alarms for fully automated chlorination redundancy, update relevant SOPs to reflect changes, commission the system, train staff, and conduct emergency exercises on new procedures.	Short-term	Ongoing (Started January 27)
6	Develop an improved operator training plan with defined key performance measures of competency and operator success.	Short-term	Ongoing (Resources have been allocated to training plan review and improvements)
7	Review alarms from the incident. Conduct a holistic review of alarm philosophy and prioritization to assist operators in emergencies.	Medium-term	Ongoing
8	Investigate the feasibility of chlorine analyzer monitoring earlier in the	Short-term	Ongoing

	distribution system to better assess the impact of events.		
9	Investigate the feasibility of additional rechlorination locations within the distribution system to minimize impacts of chlorine disinfection interruptions.	Medium-term	Ongoing
10	Investigate the feasibility of installing a plant chlorine analyzer in a location closer to the chlorine injection point.	Short-term	Ongoing
11	Improved/enhanced communications with NSP. Update phone numbers on file with NSP, clarify communication protocols for various types of power events and improve internal communications for power outages (emergency and non-emergency).	Short-term	Interim measures are in place, and long-term solution ongoing
12	Clarify protocols for issuing municipal and provincial alerts for advisories with HRM and the Province.	Short-term	Ongoing
13	Engage with NSECC and MOH to clarify language in the Approval to Operate and Guidelines for Monitoring Public Drinking Water Supplies regarding loss of disinfection and discuss a public health risk-based approach.	Medium-term	Ongoing
14	Complete an operational resiliency review for the JDKWSP.	Medium-term/long-term	Ongoing

* Short term refers to measures that can be implemented in less than one year. Medium term is estimated to take 1-2 years and long-term is estimated at 5-10 years.

There were 16 corrective measures that were identified in the after-incident review form July 1, 2024. Nine of these corrective measures have been implemented to date (Attachment B), many of which relate to the specific root causes identified for that incident and are independent of the January 20 to 21, 2025 incident.

At this time, the only identified common root cause between the two disinfection interruption incidents relates to the original design of the plant and is captured by Item #4 in Table 4-1. The timeline for implementation of adequate treated water storage and ability to shutdown the plant is a long-term corrective measure and could not have been implemented ahead of this incident.

The corrective measures identified in Table 4-1 are those that have become apparent through the preliminary after-incident review. The next step is to complete the comprehensive root cause analysis and prepare a final report with updated corrective measures for this incident. The final report will be provided to the Utility and Review Board by March 21, 2025.

J.D. KLINE WATER SUPPLY PLANT DISINFECTION INTERRUPTION – AFTER INCIDENT REPORT

September 19, 2024

Contents

LIST OF TABLES

LIST OF FIGURES

Chapter 1 INTRODUCTION

1.1 Background

On the afternoon of July 1st, 2024, an internal electrical issue occurred at the J.D. Kline Water Supply Plant (JDKWSP). As a result, backup safety systems at the low lift pump station were engaged that are designed to prevent damage to equipment and/or ensure fire suppression. These safety systems isolated power at the facility and during this electrical failure, prevented the main emergency generator from engaging. Additionally, the secondary, (auxiliary) generator located in the main treatment facility building, and that is designed to bridge the time between an external power (utility) outage and the primary emergency generator, failed. This then caused a loss of power to the main treatment facility building and the chlorination system.

As a result, for a sixteen (16) minute period, water did not have the final disinfection treatment with chlorine before leaving the JDKWSP. While all other treatment requirements were being met at the time, based on regulatory requirements and discussions and direction from NSECC, Halifax Water issued a boil water advisory.

1.2 Objectives and Scope

This report provides a post-incident review of what occurred on July 1st, 2024, and looks at the circumstances that lead to the release of unchlorinated filtered water from the JDKWSP into the Halifax Water distribution system and the subsequent boil water advisory. Specifically, this report will:

- Provide background information pertinent to the disinfection interruption incident review.
- Discuss regulatory framework requirements related to disinfection.
- Outline the sequence of events that occurred on July 1st, 2024, resulting in a boil water advisory.
- Identify underlying causes leading to the disinfection interruption.
- Provide recommendations for corrective measures.

This report covers the incident on July 1st, 2024, up to the issuance of the boil water advisory.

1.3 Sources of Information

The following sources of information were used in the preparation of this report:

- Nova Scotia Environment - Approval for Operation – Water Treatment Facility Approval No 2008-061444-09 PID # 00330985
- Nova Scotia Treatment Standards for Municipal Drinking Water Systems
- Operational plant logs
- Real time operational data from the JDKWSP
- Discussions with Halifax Water staff
- Standard operating procedures for the JDKWSP
- Technical reports:
    - Report on Halifax-Dartmouth Regional Water Supply – Canadian-British Engineering Consultants Limited (1970)
    - Chain Lake Emergency Source of Supply, Pre-Design Engineering Report, Pockwock Regional Water Supply – CBCL Limited (1979)

Chapter 2 J.D. KLINE WATER SUPPLY PLANT

2.1 Process Overview and Service Area

The JDKWSP serves approximately 201,000 customers in the communities of Beaver Bank, Middle and Lower Sackville, Hammonds Plains, Bedford, Halifax, Timberlea, Spryfield, Portions of Fall River, Windsor Junction and Herring Cove (Figure 2-1). Commissioned in 1977, the plant produces an average daily flow of approximately 85 ML/D (22.5 MGD) with a design capacity of 220 ML/D (58 MGD) and is the largest water supply plant in Atlantic Canada. Based on the source water quality at the time of design, the facility was designed as a direct filtration plant with raw water sourced from Pockwock Lake. The JDKWSP has two main buildings – the low lift pump station, and the main treatment facility building (Figure 2-2).

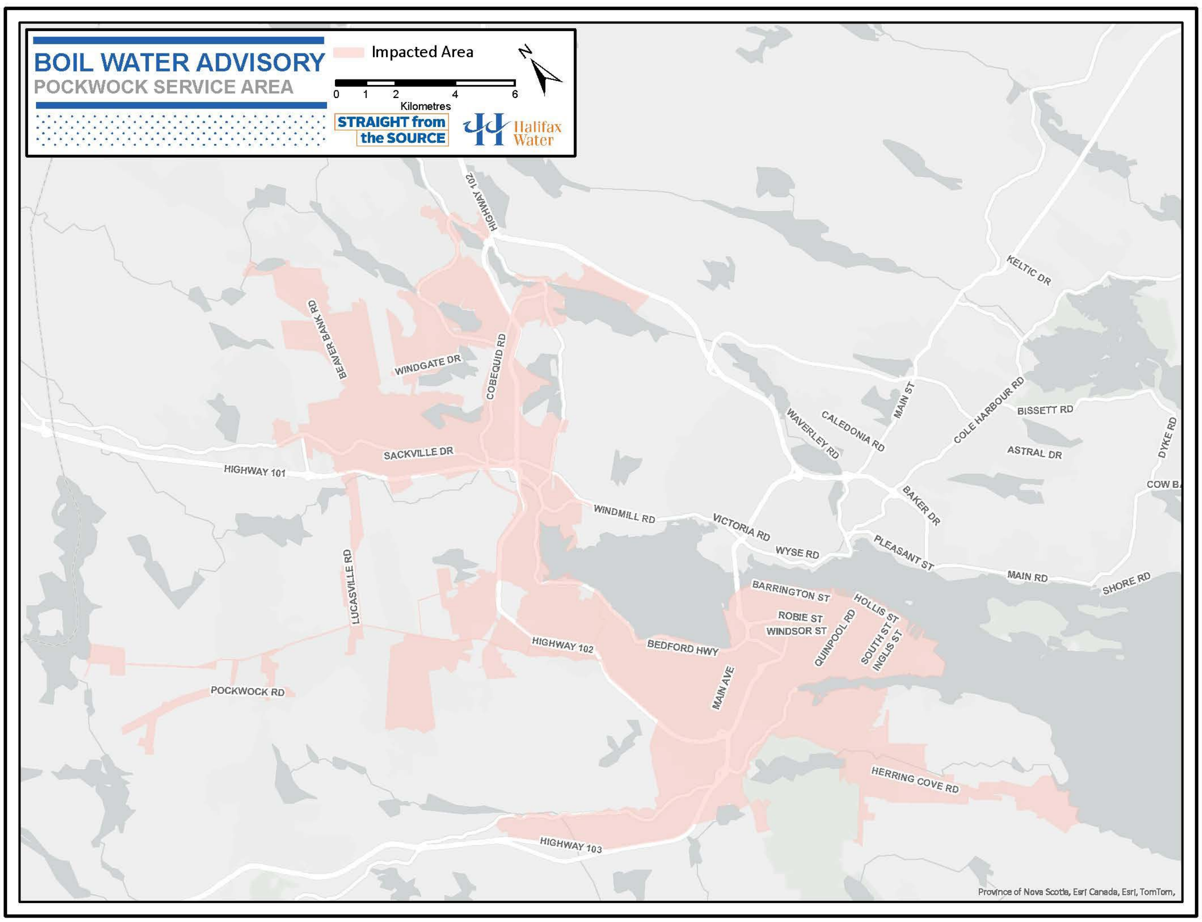

Figure 2-1: A map of the area served by the JDKWSP indicated in red. This area was impacted by the boil water advisory on July 1st, 2024.

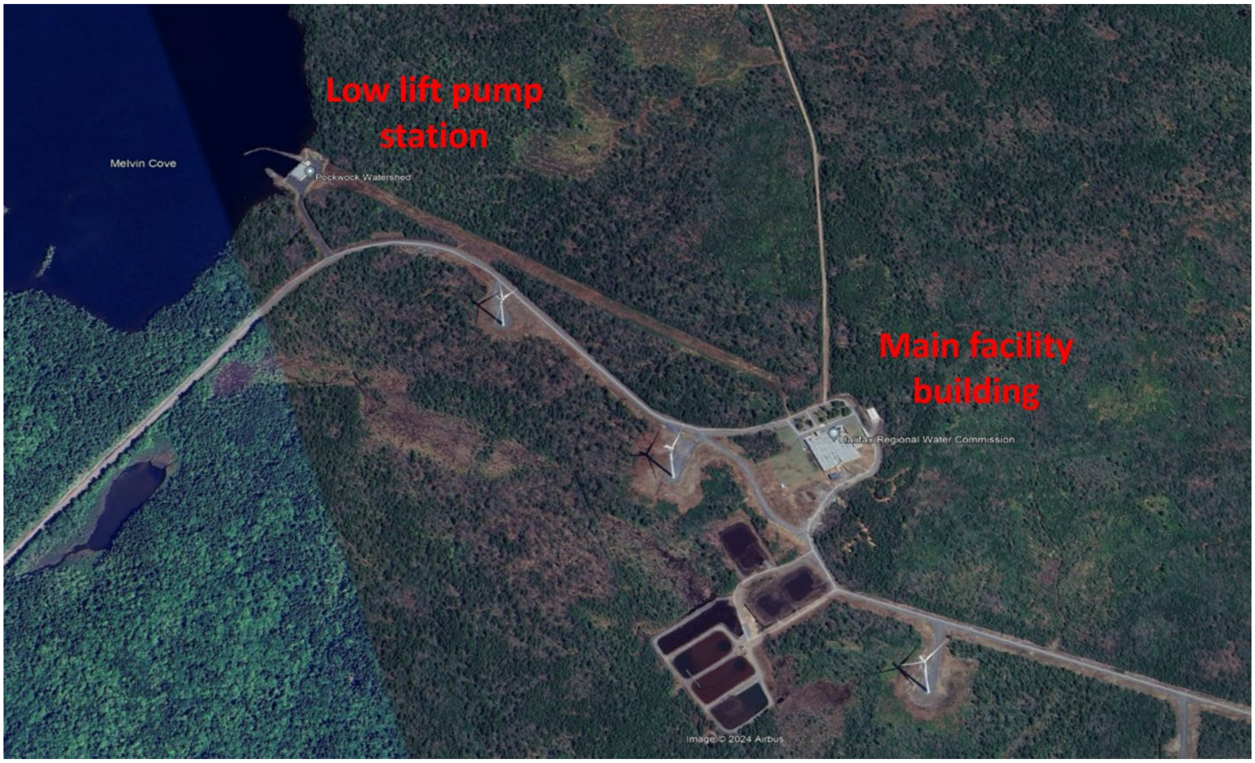

Figure 2-2: Aerial Photograph of the JDKWSP indicating the low lift pump station and the main treatment facility building.

The low lift pump station is equipped with intake and screening equipment, six (6) vertical raw water turbines and an electrical room. Raw water is pumped from the low lift pump station to the main treatment facility building which consists of direct filtration (coagulation, hydraulic flocculation, granular media filtration) followed by chlorination for primary disinfection (Figure 2-3).

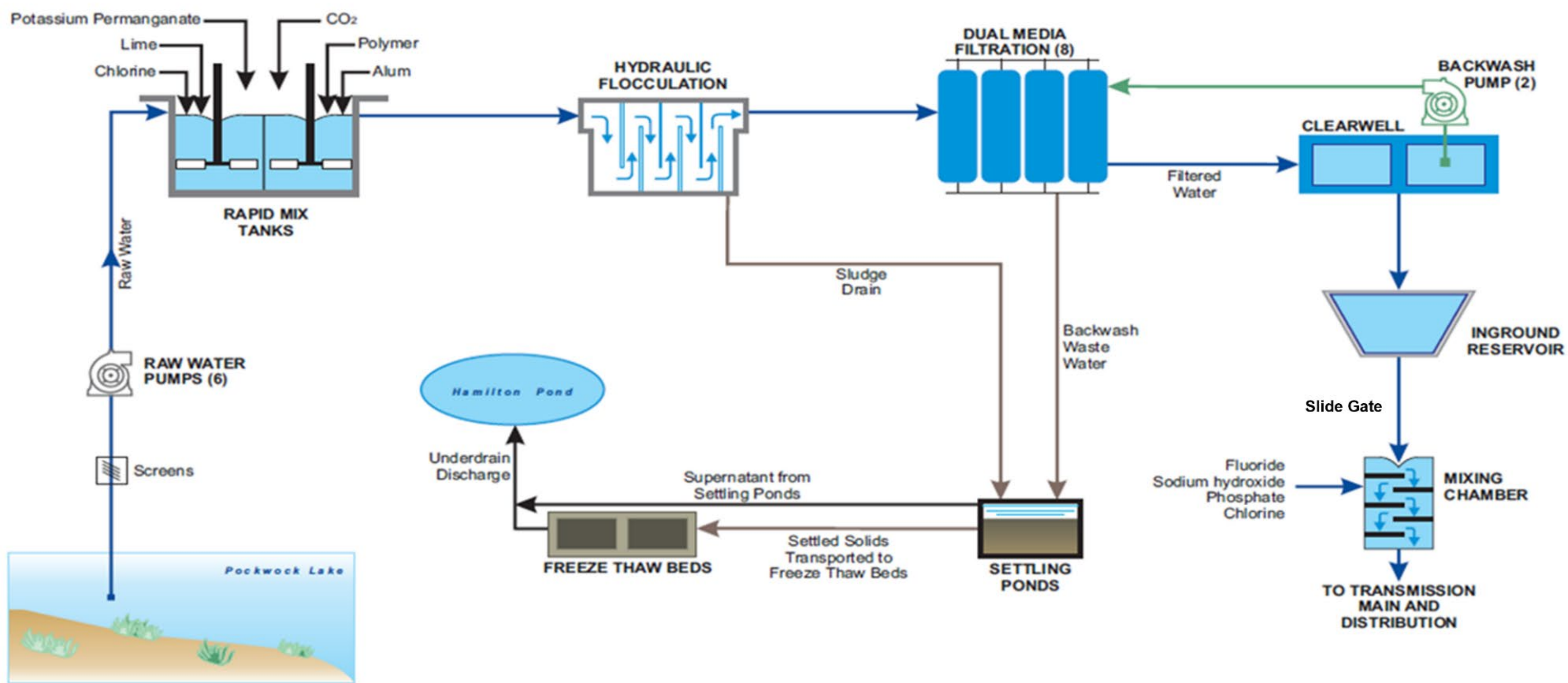

Figure 2-3: Treatment schematic of the JDKWSP.

2.2 Minimum Treatment Requirements

The minimum treatment requirements for an Approval Holder of a Municipal Drinking Water Supply in Nova Scotia are described in *Nova Scotia Treatment Standards for Municipal Drinking Water Systems (June 2022), Nova Scotia Environment and Climate Change.* These minimum standards must be met to achieve compliance with the health-based treatment guidelines in accordance with Health Canada's Guidelines for Canadian Drinking Water Quality, as amended from time to time.

These requirements are described based on the type of source water and type of treatment technology. The JDKWSP is a direct filtration plant using a surface water source (Pockwock Lake). The facility uses free chlorine for primary disinfection. As such, the following overall general treatment is required per the Treatment Standards:

- Through both engineered filtration and disinfection, a minimum treatment efficiency:
    a. 3.0-log reduction for protozoa (Giardia and Cryptosporidium), and
    b. 4.0-log reduction for viruses,

At the JDKWSP, primary disinfection, through the use of chlorine, shall achieve a minimum of 0.5-log inactivation for Giardia when used in conjunction with filtration. The JDKWSP also requires a minimum 3.0-log inactivation for viruses to be achieved by disinfection with chlorine.

The effectiveness of a chemical disinfectant is based on the residual concentration, water temperature, pH and contact time (the time that the given disinfectant residual is held before the first service connection). This relationship is commonly referred to as CT Disinfection. CT is simply the product of the residual concentration of the disinfectant (C) measured in mg/L and the disinfectant contact time (T) measured in minutes. CT Disinfection is the water treatment industry standard for disinfection and is a requirement of Nova Scotia's Treatment Standards to ensure water provided to customers is safe. Failure to provide either adequate disinfectant concentration or contract time may result in the failure to achieve minimum treatment requirements to achieve primary disinfection.

2.2.1 Achieving Primary Disinfection at the JDKWSP

The JDKWSP was constructed in the 1970's to allow gravity flow through the treatment facility via the multimedia filters into the hydraulically connected clear wells and facility reservoir, and then consolidated into the treated water mixing chamber where chlorination occurs prior to leaving the plant through the finished water conduit into the transmission main (1500mm) to Halifax. There is no storage of chlorinated water onsite, and therefore chlorination at the outlet mixing chamber is always required to achieve primary disinfection. Primary disinfection is achieved in the finished water conduit at the treatment plant and in the transmission main between the facility and the first customer (Figure 2-4).

The original design narrative from the 1970's for the JDKWSP indicated that in the event a shutdown was required, a 1500mm cast iron slide gate located prior to the treated water mixing chamber could isolate treated water in the clear wells and prevent water flow to the city, and that water would be provided to customers from distribution system storage in the event of a shutdown. This gate is not operational and using it would impose significant risk as there are now several developments serviced directly from the transmission main. These developments introduced the functional requirement to have no isolation of flow from the plant.

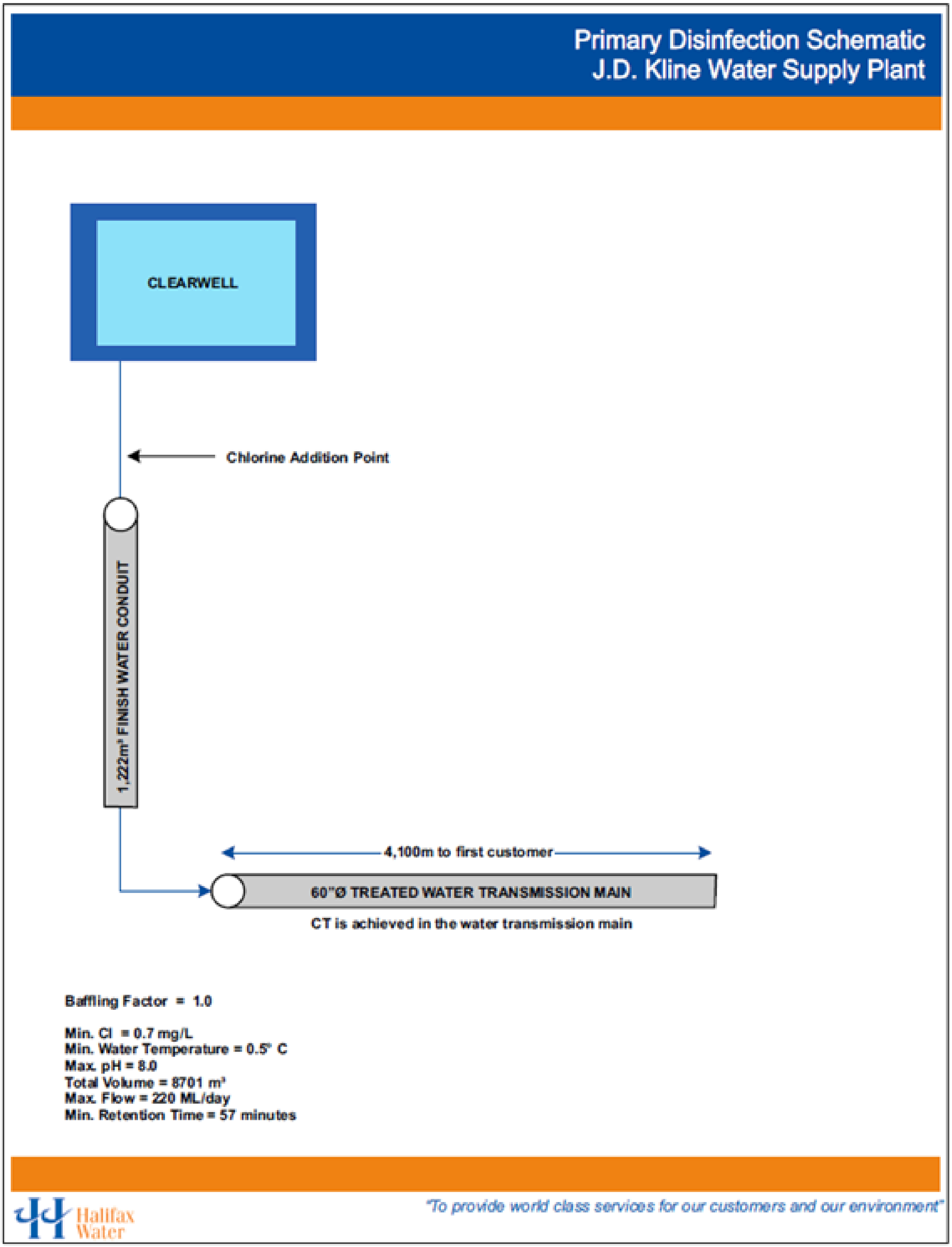

Figure 2-4: Simplified diagram showing primary disinfection process schematic and CT for the JDKWSP.

2.3 Electrical Service Overview

The JDKWSP receives electricity from Nova Scotia Power through high voltage overhead lines to a pad-mounted transformer and an eight-cell medium voltage distribution switchgear system. This switchgear system is composed of electrical disconnect switches, fuses or circuit breakers, and generator panels, that are designed to protect and isolate electrical equipment to the low lift pump station and the main power feed to the treatment facility.

The external Nova Scotia Power feed enters the low lift pump station and power is subsequently routed from the low lift pump station to the main treatment facility through switchgear via an overhead distribution line where the voltage is stepped down feeding a motor control center (MCC) located at the main treatment facility. A diesel standby generator located at the low lift pump station provides standby power in the event of loss of utility power to the switchgear. The main treatment facility is equipped with a diesel standby generator (referred to as "auxiliary generator") in the event there is an interruption of the power feed from the low lift switchgear. The auxiliary generator is designed to provide temporary power in the event of a power interruption as all plant power, including the main generator, is routed through the low lift pump station. Figure 2-5 provides a simplified schematic of the power flow to both buildings.

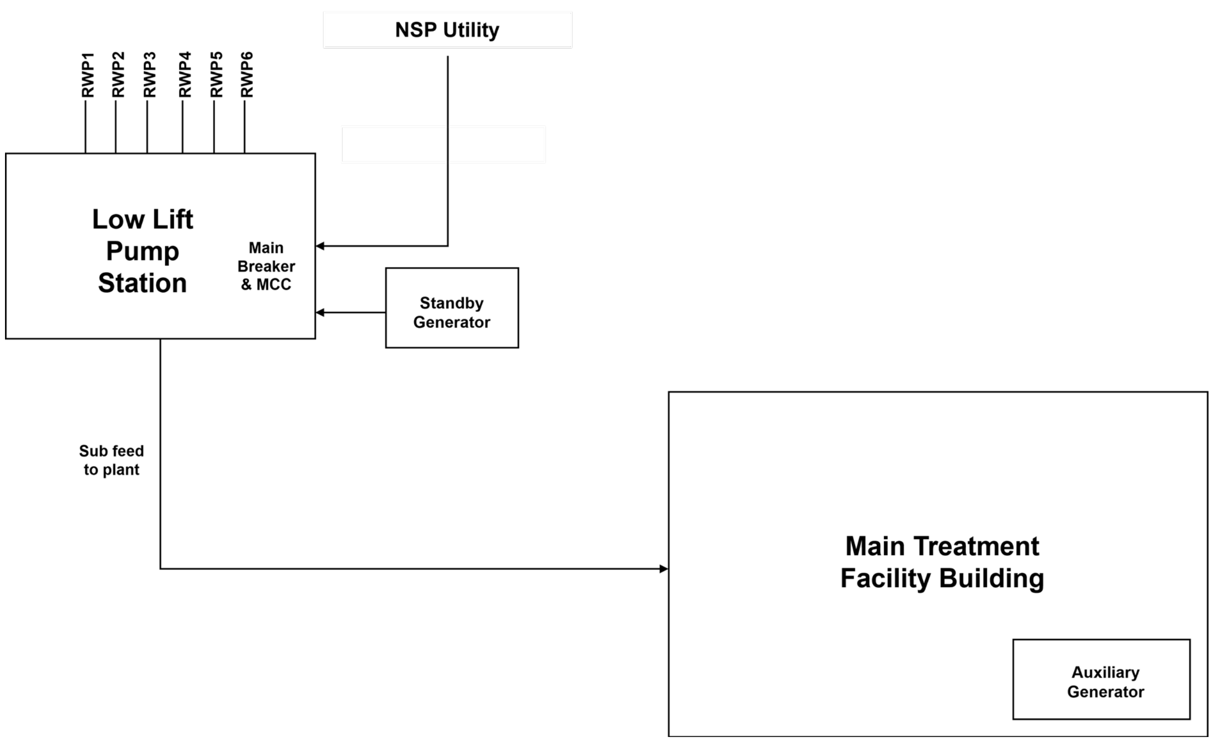

Figure 2-5: Simplified overview of power flow and relevant electrical components at the JDKWSP.

Chapter 3 AFTER INCIDENT INVESTIGATION

3.1 Incident Description

Midday of July 1st, 2024, operations staff were conducting routine work, managing water plant flow demands through the industrial control system to conduct a routine switch from the operation of raw water pump #2 (RWP2) to raw water pump # 1 (RWP1). During this switch, RWP1 faulted during start-up, which resulted in an immediate loss of power at both the low lift pump station and the main treatment facility building.

Under the normal operation sequence during a power failure of the Nova Scotia Power feed, the standby generator located at the low lift pump station would come online and restore power to both locations. However, power remained offline at the low lift pump station and the immediate cause of the outage was not known at the time. When this occurred, staff attempted to manually engage the standby generator at the low lift pump station, however it did not come online because there was no disruption to the Nova Scotia Power feed.

During the power disruption at the low lift pump station, the auxiliary generator located at the main treatment facility building immediately restored power per its design, and allowed controls, operational, and treatment requirements to be maintained.

However, after approximately 30 minutes, this generator triggered its overtemperature alarm and shut down. Power was subsequently lost at the main treatment facility building and all associated systems including the primary chlorination equipment were without power.

Staff immediately began to initiate the standard operating procedures for the emergency chlorination process. Throughout this period, filtered unchlorinated water from the plant entered the distribution system. This is because water from the clear well cannot be operationally isolated from the distribution system, as described in Section 2.2.1. This resulted in a failure to achieve primary disinfection.

Staff connected the portable gas generator used to power emergency chlorination equipment, already located onsite, to restore chlorination to the finished water. It should be noted that all other treatment requirements at the time were met, and the water was fully treated aside from primary disinfection. Staff also implemented operational adjustments to the distribution system to minimize the amount of water leaving the facility.

As outlined in Section 5.1 (4) of the Guidelines for Monitoring Public Drinking Water Supplies Part I – Municipal Public Drinking Water Supplies (October 2021), Nova Scotia Environment and Climate Change:

> *Section 5.1 Deficiencies that require a boil water advisory include*
>
> > *(4) lack of disinfection (i.e., all systems) or failure of a key water treatment process (e.g. filtration process for systems relying on surface water or GUDI sources).*

Based on the loss of primary disinfection on July 1st, 2024, the scenario described in Section 5.1 (4) required the issuance of a boil water advisory.

The advisory was issued before the unchlorinated water reached the first customer in the distribution system. A detailed account of the events that led to the issuance of the boil water advisory on July 1st, 2024, is provided below in Table 3-1.

Table 3-1: Detailed event timelines on July 1st, 2024.

Time	Description
12:28 to 13:04	The Duty Operator used the industrial control system to start raw water pump #1. The pump immediately failed to start and power to the low lift pump station and the main treatment facility building was interrupted. The Duty Operator immediately called the Facility Supervisor, who instructed them to call both the On-Call Operator and the On-Call Electrician for assistance on-site. The Supervisor proceeded to the treatment facility to assist. The auxiliary generator immediately started and restored power to the main treatment facility building but the low lift pump station was still without power. The primary chlorination system was still operational at this time.
13:04	The Duty Operator reported to the Facility Supervisor that the auxiliary generator stopped working and all associated systems were without power. Primary disinfection of treated water goes offline. The Facility Supervisor instructed the Duty Operator to engage the emergency chlorination equipment immediately.
13:05 to 13:20	The Duty Operator and the On-Call Operator activate the portable gas generator located onsite and engage the emergency backup chlorination system as per the Standard Operating Procedure.
13:20	Primary disinfection of treated water is restored using the emergency backup chlorination system.
13:30 to 13:35	The Facility Supervisor informs the Director of Operations of the situation. Manager of Distribution (West) is contacted to aid in limiting flow from the plant to the city and to help manage the distribution system.
13:35 to 13:52	Facility staff work with electricians to restore power to the facility. The On-Call Electrician in consultation with the facility's regularly assigned Electrician restored utility power to the low lift pump station and main facility by resetting the main utility breaker following facility safety protocols. On-Call Electrician then investigates the auxiliary generator failure at the main treatment facility building and discovered a water coolant alarm which indicated that the generator faulted out on high coolant water temperature due to a failed solenoid valve. The cooling water by-pass valve was opened by the Facility Supervisor to restore the auxiliary generator to standby status.
13:52	The Facility Supervisor was informed that power had been restored to the main treatment facility building and that the auxiliary generator was back to standby status.
13:55 to 14:00	Raw water pump #5 was started and water flow was restored to the treatment process. The primary disinfection chlorination system was verified for correct operation and was restored. The emergency chlorination system remained operational at this time to provide continuity of chlorination in case of further unforeseen complications.

	Raw water flow was rotated to pump #4 as part of routine operations.
14:21 to 15:33	Raw water flow was rotated to pump #2 to manage water demands. Facility staff continued to assess cause of outage at the low lift pumping station.
15:33 to 15:35	At this point, the root cause of the initial outage was still unknown. With both electricians on site, raw water pump #1 was started to test whether it was operational or the root cause of the outage. When raw water pump #1 was given a start command, the main power feed was once again interrupted to the pumping station and treatment facility. The auxiliary generator at the main facility ran normally and primary chlorination system remained operational.
15:40	Facility Supervisor updated the Director of Operations.
15:43	Staff electricians restored utility power by resetting the main breaker at the pumping station. It was theorized that raw water pump #1 was the cause of the outage.
15:45	Lack of primary disinfection occurrence was reported by the Facility Supervisor to Halifax Water's Regulatory Compliance Department through the reporting process as outlined in standard operating procedures.
15:45 to 15:55	Water Quality Program Supervisor who was on call, reported the lack of primary disinfection to the Acting Director of Regulatory Services. Water Quality Program Supervisor also reported the situation to NSECC through the after-hours protocols.
15:49 to 16:25	Acting Director of Regulatory Services, Acting General Manager, Director of Operations and Acting West Water Operations Manager commence a call to assess the situation and discuss ways to mitigate the impact of unchlorinated water in the system (e.g., flushing, isolating areas of the system). It was determined that no type of operational intervention could occur that would ensure the unchlorinated water would not reach customers.
16:25	Halifax Water Communications are notified, and communications materials and alerts are developed for a Boil Water Advisory.
16:40 to 16:52	Due to failure to achieve primary disinfection, and the requirements outlined in the *Guidelines for Monitoring Public Drinking Water Supplies* to issue a boil water advisory under these circumstances, further attempts are made to contact NSECC directly. The NSECC Duty Inspector was reached and took the information. After discussion, it was determined they would try to get someone to respond to us quickly.
16:57	Attempts to reach senior staff within NSECC continue due to the nature of the event. The Interim Director of the Water Branch of Applied Science Division of NSECC is reached by phone and given information to determine course of action.
17:21	Interim Director of Water Branch NSECC calls to confirm that a Boil Water Advisory needs to be issued for the entire Pockwock System.
18:00	A Public Service Announcement (PSA) announcing the boil water advisory was distributed to news media outlets and other key stakeholders via email and on social media. Additionally, HRM redistributed the PSA on its HFXAlerts system and used its social media channels to amplify the message.

	Note: At this time, the unchlorinated water had moved approximately 5 km down the transmission main and not yet reached the first service connection.
18:02	Small Systems Supervisor is contacted to increase dose in re-chlorination stations in the Pockwock system by 0.2 mg/l as a precaution. The doses were changed remotely.
19:30	Halifax Water was notified that the provincial alert system was available for this type of event. Staff learned the parameters and approvals process for this system and began developing an effective alert based on the delivery platform (mobile text alerts).
20:49	Nova Scotia alert issued for the boil water advisory via the Provincial Emergency Management Office.

3.2 Underlying Causes Leading to Boil Water Advisory

3.2.1 Cause #1: Mechanical and Electrial Failures

In response to the electrical problems, a contractor was dispatched to identify any potential issues with motors and/or wiring. It was during this initial inspection that the contractor identified that the electrical insulation on the RWP1 motor failed, causing a ground fault. The RWP1 motor was tested to confirm that the pump insulation was the cause and was removed for repairs.

As a result of the insulation failure, there was a surge in current that then caused the safety systems to be triggered (as designed) to prevent further damage. Each pump has two integrated safety mechanisms, including digital motor protection relays and fuses, and a third layer of protection through the main utility breaker.

However, during this event, the electrical protection coordination failed when the digital motor protection relay and the fuses for RWP1 were not triggered. As designed, the digital motor protection relay is connected to a temperature sensor embedded in the RWP1 motor, but during this incident, there were no temperature alarms generated by the protective relay. The fuses for RWP1 did not detect the surge (e.g., were not blown).

Based on the post-incident inspection, it has been determined that instead of the fuses and digital motor protection relay safety systems engaging, the main utility breaker tripped and isolated the power supply to both the low lift pump station and the main treatment facility building. When this occurred, it took both the low lift pump station and main treatment facility building offline because the power feed for both is located at the low lift pump station, and both loads are downstream of the breaker.

When the ground fault occurred on RWP1 it was significant enough that it tripped the main utility breaker before the other layers of protection could react. The sequence of trip alarms/signals between the digital motor protection relay, fuses and main utility breaker is complex and dated due to varying vintages of equipment technology. As a result, it can have an impact on switching speed and sensitivity, which may have had a role in why the main utility breaker detected the ground fault and tripped before the other layers of protection.

Through a visual inspection, the On-Call Electrician determined that there were no alarms on the standby generator at the low lift pump station. Staff then briefly and unsuccessfully attempted to manually engage this generator. However, even if the generator had started, the power would still have been isolated, as the main utility breaker was open and functioning as designed to prevent the power supply from being restored without a reset. When the On-Call Electrician observed that the lockout safety relay for the station had not tripped, they were able to determine that there was utility power from the Nova Scotia Power grid and that the generator did not engage, because that is how the safety mechanism was designed.

While the standby generator at the low lift pump station did not engage, the auxiliary generator located at the main treatment facility building did start and immediately restored power to that building. However, after running for approximately 30 minutes, the auxiliary generator failed. When the On-Call Electrician visually inspected the automatic transfer switch for the auxiliary generator it appeared to be normal. Further inspection of the auxiliary generator control panel found a water coolant alarm, and it was then determined that the generator faulted out on high coolant water temperature. It was then established that that the cooling water was not circulating because a solenoid valve had failed. While there was a by-pass valve on the auxiliary generator that allows for circulation of cooling water, it was closed, as per routine operation. Upon this observation, staff opened the by-pass valve to allow for coolant water circulation, as per the standard operating procedure.

The main utility breaker was reset by the On-Call Electrician once it was safe to do so. With power restored, operators attempted to start RWP1 remotely to confirm that it was the underlying cause of the power failure. However, this interrupted the power at the low lift pump station once again, but with the by-pass for the cooling water now open the auxiliary generator at the main treatment facility building ran normally.

Based on the issues identified and the solutions used to address them, staff confirmed that the main cause of the incident was the switch over from RWP2 to RWP1 and subsequent insulation failure on RWP1 which led to the main utility breaker for the low lift pump station to trip. With the breaker tripped, the standby generator did not power up the low lift pump station and main treatment facility. This resulted in the auxiliary generator coming online briefly, but quickly overheating and failing due to lack of coolant water from a failed solenoid valve. The combined insulation and solenoid valve failures were a root cause of loss of primary disinfection with chlorine.

3.3 Cause #2: Fundamental Design Constraints

During the incident on July 1st, 2024, flow from the JDKWSP could not shut down to prevent unchlorinated water from entering the distribution system. As currently designed, the JDKWSP has constraints that prevent adequate treated water storage at the facility which directly impacts the ability to shut down without significant interruption to water quantity or quality. As a result, during the incident on July 1st, 2024, staff could not prevent unchlorinated water from entering the distribution system. Staff did however implement operational adjustments to the distribution system to minimize the amount of water leaving the facility.

All treated water in storage at the JDKWSP is unchlorinated. The additional finished water chlorine application only occurs when all filtered water is consolidated into a single mixing chamber before leaving the plant through a finished water conduit. At this point in the process, it is not possible to interrupt flow from the finished water conduit, and chlorination at the outlet mixing chamber is required at all times to achieve primary disinfection and to meet regulatory requirements. Both chlorination and flow, therefore, cannot be interrupted without incurring a significant water quantity or quality event.

Halifax Water's design records indicate that the point of chlorination has not changed since the facility was constructed in the 1970's. The criticality of the location at that time was offset by the fact that flow from the facility was capable of being interrupted at the time if needed through an installed outlet sluice gate.

According to planning and design documents, the Pockwock transmission system was configured with intention of having the JDKWSP connected by transmission primarily to other reservoirs and not directly to customers. By using reservoirs, the utility could store chlorinated water downstream to provide water service to customers and would allow flow leaving the plant to be isolated at any time.

Accordingly, it was also originally intended that if JDKWSP required a shutdown for maintenance, or encountered a failure, that it could be simply shutdown by closing the outlet sluice gate and thereby isolating the plant from city. While this may have been the original intention, this gate valve is no longer operational and closing poses significant risks to the entire system. In the decades since the JDKWSP was constructed, several developments have been serviced directly from the transmission main and introduced the functional requirement to have no isolation of flow from the plant. As a result, the facility has very limited shutdown or disruption window, which has now become a significant constraint.

As a result, isolating the JDKWSP from the city during the event that occurred on July 1st, 2024, was not a viable option to minimize the release of unchlorinated water from entering the Pockwock distribution system.

3.3.1 Other Compounding Factors

In addition to the electrical failures and the fundamental design constraints outlined above, the following factors may have had a compounding effect on the incident response time on July 1st, 2024:

- **Resource Capacity:** The JDKWSP has experienced staff shortages in recent years, resulting in hiring new personnel at the facility. At the time of the event, there were a total of seven (7) water treatment plant operators who work at this facility and one vacant day operator position, with one operator on shift during the incident. There is only one operator onsite at the JDKWSP per shift on evenings, weekends, and holidays, with an additional day operator on-call, which makes response in a complex situation such as this incident a challenge to manage the multiple priorities. The new personnel working at the JDKWSP may not have been exposed to emergency response through experience with past incidents. Exposure to tabletop emergency response exercises happen once per year through Environmental Management System (EMS) requirements. Resource capacity challenges are compounded by the age of the facility and limited historical facility specific knowledge.
- **Standard Operating Procedures (SOP):** Multiple SOPs were needed during the July 1st events; thus, staff were required to consult a number of documents that created an added layer of complexity during critical moments in response. As standalone SOPs, they did not provide sufficient details when several failures occurred simultaneously, and subjective language in certain documents may have compounded the impacts or contributed to delay in response.
- **Communications:** Halifax Water issued the boil water advisory notice prior to the volume of non-disinfected water reaching customers. However, during the incident there were limited staff on site, and those at the facility were focused on stabilizing the incident, which led to a delay in reporting. Communications between the various groups/departments and the regulator (NSECC) could have been more efficient to decrease response timelines.
- **Other:** The emergency lighting at the JDKWSP is designed to facilitate safe exit from the facility during emergencies. During the July 1 events, these lights could not provide sufficient visibility to address issues and added to the challenges in engaging the backup chlorination system and further response to the incident.

Chapter 4 RECOMMENDED CORRECTIVE MEASURES AND PROGRESS STATUS

Based on the after-incident review described in this report, several short, medium and long term corrective measures have been recommended to manage risk and improve resiliency at the JDKWSP. Table 4-1 below provides a summary of recommended corrective measures as well as the status at the time this report was prepared.

Table 4-1: Summary of recommended corrective measures.

#	Cause	Corrective Measure	Timeline	Status*
1	Electrical and Mechanical Failures	Assess and conduct repairs as required on raw water pumps and components.	Short term	Raw water pump 1 complete, other pumps ongoing
2	Electrical and Mechanical Failures	Assess the emergency generators.	Short term	Complete
3	Electrical and Mechanical Failures	Install a temporary generator to power the main plant building, replacing the auxiliary generator.	Short term	Complete
4	Electrical and Mechanical Failures	Install standby electrical system to power emergency chlorination equipment, in the event of a complete power failure, to reduce time to initiate the system and remove immediate need for portable gas-powered generator.	Short term	Temporary solution complete, permanent solution ongoing
5	Electrical and Mechanical Failures	Install an uninterrupted power supply (UPS) that will be able to supply power to necessary instrumentation in the event of a power failure.	Short term	Temporary solution complete, permanent solution ongoing
6	Electrical and Mechanical Failures	Conduct thermal scanning of electrical equipment at the low-lift pump station.	Short term	Ongoing
7	Electrical and Mechanical Failures	Assess main incoming power bus and associated utility, emergency breakers, as well as transfer controls. Assess the sequence settings that control the safety systems at the pump station. Re-program the sequence as necessary based on the assessment.	Short term	Ongoing
8	Electrical and Mechanical Failures	Assess layers of engineered protection on raw water pumps and install additional layers as needed.	Short term	Ongoing
9	Other Compounding Factors	Complete formal incident debrief with various levels of staff.	Short term	Ongoing
10	Other Compounding Factors	Increase operator staffing on shift to minimize response time to emergency incidents.	Short/medium term	Ongoing
11	Other Compounding Factors	Review and update SOPs for clarity. Ensure staff understanding through training.	Short/medium term	Ongoing
12	Other Compounding Factors	Conduct emergency exercises to enhance knowledge on response to varying incidents.	Short, medium, and long term	Ongoing

13	Other Compounding Factors	Improve emergency lighting throughout the facility.	Short/medium term	Ongoing
14	Electrical and Mechanical Failures	Install a permanent generator to replace the auxiliary generator.	Medium term	Ongoing
15	Fundamental Design Constraints	Upgrade and increase resiliency of incoming power feed. Consider adding a new, dedicated utility service to the main water supply plant building.	Long term	Ongoing
16	Fundamental Design Constraints	Address fundamental design constraints by provision for adequate treated water storage, and ability to shut down for maintenance or failure conditions, without interruption to water quantity or quality.	Long term	Ongoing

*Ongoing status indicates that corrective measures will be implemented within the short term (6-months), medium term (1-year), and long term (5 to 10 years).

Attachment B: Summary of recommended corrective measures from July 1, 2024 BWA after incident review with status updates.

#	Cause	Corrective Measure	Timeline	Past Status	Status as of February 4th, 2025
1	Electrical and Mechanical Failures	Assess and conduct repairs as required on raw water pumps and components.	Short term	Raw water pump 1 complete, other pumps ongoing	Complete
2	Electrical and Mechanical Failures	Assess the emergency generators.	Short term	Complete	Complete
3	Electrical and Mechanical Failures	Install a temporary generator to power the main plant building, replacing the auxiliary generator.	Short term	Complete	Complete
4	Electrical and Mechanical Failures	Install standby electrical system to power emergency chlorination equipment, in the event of a complete power failure, to reduce time to initiate the system and remove immediate need for portable gas-powered generator.	Short term	Temporary solution complete, permanent solution ongoing	Complete
5	Electrical and Mechanical Failures	Install an uninterrupted power supply (UPS) that will be able to supply power to necessary instrumentation in the event of a power failure.	Short term	Temporary solution complete, permanent solution ongoing	Complete
6	Electrical and Mechanical Failures	Conduct thermal scanning of electrical equipment at the low-lift pump station.	Short term	Ongoing	Ongoing
7	Electrical and Mechanical Failures	Assess main incoming power bus and associated utility, emergency breakers, as well as transfer controls. Assess the sequence settings that control the safety systems at the pump station. Re-program the sequence as necessary based on the assessment.	Short term	Ongoing	Ongoing
8	Electrical and Mechanical Failures	Assess layers of engineered protection on raw water pumps and install additional layers as needed.	Short term	Ongoing	Complete
9	Other Compounding Factors	Complete formal incident debrief with various levels of staff.	Short term	Ongoing	Complete
10	Other Compounding Factors	Increase operator staffing on shift to minimize response time to emergency incidents.	Short/medium term	Ongoing	Complete
11	Other Compounding Factors	Review and update SOPs for clarity. Ensure staff understanding through training.	Short/medium term	Ongoing	Ongoing program
12	Other Compounding Factors	Conduct emergency exercises to enhance knowledge on response to varying incidents.	Short, medium, and long term	Ongoing	Complete

13	Other Compounding Factors	Improve emergency lighting throughout the facility.	Short/medium term	Ongoing	Ongoing
14	Electrical and Mechanical Failures	Install a permanent generator to replace the auxiliary generator.	Medium term	Ongoing	Ongoing
15	Fundamental Design Constraints	Upgrade and increase resiliency of incoming power feed. Consider adding a new, dedicated utility service to the main water supply plant building.	Long term	Ongoing	Ongoing
16	Fundamental Design Constraints	Address fundamental design constraints by provision for adequate treated water storage, and ability to shut down for maintenance or failure conditions, without interruption to water quantity or quality.	Long term	Ongoing	Ongoing

*Ongoing status indicates that corrective measures will be implemented within the short term (6-months), medium term (1-year), and long term (5 to 10 years).