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March 21, 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 – Final Report

Dear Ms. McGarrigle:

Please find the attached final report as a follow-up to the preliminary after-incident report submitted to the NSUARB on February 4, 2025. This document outlines the events that led to the issuance of a Boil Water Advisory (BWA) on January 21, 2025. It includes an after-incident review of the causes of the release of unchlorinated filtered water into the Halifax Water distribution system.

As part of the investigation, Halifax Water applied the TapRooT® Root Cause Analysis methodology to identify the Root Causes leading to the interruption in disinfection at the JDKWSP on January 20, 2025.

Nineteen corrective measures were identified in total, with eleven directly related to root causes, and an additional eight identified during the after-incident review process that were not directly associated with a root cause but were identified as important actions for managing risk and resiliency at the JDKWSP and improving customer notification practices.

Some of the longer-term corrective actions and recommendations must be contemplated and aligned with Halifax Water's 5-10-year capital investment strategy. On March 28, Halifax Water committed to filing a report (M11158) on the Water Supply Enhancement Program (WSEP). The WSEP addresses infrastructure requirements at Halifax Water's two large treatment plants, the JDKWSP and Lake Major Water Supply Plants. The drivers for drinking water treatment infrastructure investment requirements are: aging infrastructure, growth, and compliance needs based on both changing regulatory compliance requirements and changing source water quality. This report will provide greater insight into the longer-term approach to the scoping and implementation of this program and consider the significant investment needed to help ensure a highly resilient future water supply system.

Halifax Water is also embarking on the next iteration of its Integrated Resource Plan (M11899), the goal of which is to create a comprehensive, long-term capital plan that integrates various projects, initiatives, and programs with the three drivers of asset renewal, growth and compliance, to ensure the utility can meet its service delivery goals over the next 30 years. The current 5-year capital plan has identified approximately $1.4 billion in infrastructure as outcomes from the 2019 IRP, and identified projects and changes since that time.

Many of the corrective actions in this report are expected to be implemented in the short (<1 year) and medium-term (1-2 years) timeframes. Halifax Water has established a dedicated cross-sectional team to address operational resiliency and to ensure prioritization and timely implementation of corrective measures, focused on these short-term and medium-term measures to ensure service reliability over the next 5-10 years while longer term options for the JDKWSP are carried out through the WSEP.

Halifax Water has also issued a request for proposals for an independent third-party operational resiliency review of the JDKWSP that is expected to provide additional recommendations and required capital investment to ensure service reliability of the existing facility until the long-term plans through the WSEP can be carried out.

Over the coming years, Halifax Water must manage a very extensive portfolio of projects while providing water service to customers. As such, the utility understands that it must account for a high level of service reliability to develop an execution strategy that will prudently and effectively manage these significant capital investments to provide the best long-term value for customers.

Thank you for your attention to this matter. Please contact me if you have any questions or require further information.

Sincerely,

Signed by:
Kenda MacKenzie
0C084AC815794F6...

Kenda MacKenzie, P.Eng.
General Manager/CEO

Attachment

JDK WSP Disinfection Interruption NSUARB Final Report

Attachment A – Updated Corrective Measures from July, 2024 and January, 2025 disinfection interruptions.

Halifax Regional Water Commission

J.D. Kline Water Supply Plant Disinfection Interruption (January 2025)
Final After Incident Review and Root Cause Analysis (M11894)

March 21, 2025

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EXECUTIVE SUMMARY

This final report is a follow-up from the preliminary findings identified and submitted to the NSUARB on Feb 4, 2025. It outlines the sequence of events that ultimately resulted in the issuing of a Boil Water Advisory (BWA) on January 21, 2025, and includes an after-incident review of cause(s) of the release of unchlorinated filtered water into the Halifax Water distribution system.

This report outlines the events at the JDKWSP, identifies the causal factors and root causes of the disinfection interruption, and proposes corrective measures based on the root cause analysis.

On the night of January 20, 2025, a 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 it was airlocked and not feeding chlorine. Once identified, this was corrected immediately.

The reason for the loss of the service water pumps and thus the main chlorination system was discovered to be blown fuses located on the control transformers for both service water pumps. These fuses are standard safeguards designed to prevent damage to additional interconnected infrastructure within the facility. With these fuses replaced, 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 the 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.

The after-incident review from July 1, 2024, identified 16 corrective measures. Eleven of these corrective measures have been implemented to date. This final report identifies 8 causal factors and 12 associated root causes, as well as 19 corrective measures for the January 20 and 21 events, two of these corrective measures have been completed to date.

Chapter 1 INTRODUCTION

1.1 Objectives and Scope

This report provides a final 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 from January 20 to 21, 2025, up to the issuance of the BWA and will:

- Outline the events that occurred on January 20 to 21, 2025, resulting in a BWA.
- Provide a full root cause analysis for the disinfection interruption at the JDKWSP.
- Identify corrective measures that will be undertaken to prevent recurrence based on information collected during the after-incident review and root cause analysis.
- 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 Nova Scotia Power (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.

1.2 Background

Halifax Water provides 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 the 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 disinfection process used to inactivate bacteria, viruses, and other

microorganisms in drinking water. This is in keeping with Health Canada's Drinking Water Guidelines.

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 taken when an identified issue with the treatment process can result in microbial contamination. While both BWAs 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. Electrical safety systems are designed to protect equipment from high currents 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 BWA issued on July 1, 2024, a total of 16 short—, medium—, and long-term corrective measures were recommended to manage risk and improve resiliency at the JDKWSP. Eleven of these measures have already been implemented, and others are near completion or ongoing. An updated table of corrective measures with status is provided as Attachment A.

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 power transfer 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 have not occurred before at the JDKWSP due to loss of utility power. Service water pumps are required to provide the water used to make chemicals for the

treatment process and to operate the primary chlorination disinfection chemical delivery system. Without them, the primary 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

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 on-site 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 M11894 – Halifax Regional Water Commission – J.D. Kline Water Supply Plant Disinfection Interruption – After Incident Review.

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 control transformers.

2.1.2 Main chlorination system

The JDKWSP uses chlorine gas for the main chlorination system and there are redundant chlorinators. Based on its design, this system requires water to create a vacuum to draw the chlorine gas into the 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.

As chlorine is injected at the outlet of the JDKWSP, a chlorine analyzer monitors the chlorine residual in finished water as it leaves the facility. Due to the location of the chlorine analyzer inside the facility relative to the injection point, there is approximately a 10-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 from 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 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.

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). 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, 2025 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. As of March 21, 2025, the Process Control Narrative (PCN) is underway to finalize the implementation.

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 interpreted by staff to be 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, 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, two staff (one Operator and one Operator-in-Training) were 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 primary 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 transformer fuses were blown 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, 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 to 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 removed the airlock and confirmed 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 participate in 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 AM	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 an 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 call 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 Halifax Water that they are still working on the situation and will provide directions 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 Public 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	Twice daily	January 20, 2025
	Generator test	Monthly	December 16, 2024
	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.

Chapter 4 CAUSAL FACTORS AND ROOT CAUSES OF BOIL WATER ADVISORY ON JANUARY 21, 2025

4.1 Root cause approach

The TapRooT® methodology is a systematic approach designed to identify the root causes of incidents and develop effective corrective actions to prevent recurrence. The TapRooT® methodology was applied to diagnose root causes behind the loss of chlorination at JDKWSP which led to the issuance of a BWA on January 21, 2025.

To begin the TapRooT® Root Cause Analysis, the incident must first be defined in order to focus the analysis. In this case, the incident is defined as the loss of chlorination at the JDKWSP. Following incident definition, a SnapCharT® is generated to sequence the timeline of events. Conditions are then developed for each event, where conditions can include:

- Description of the event
- Actions not performed
- Mistakes or errors
- Different than expected
- Facts, not opinions
- How/What/When/Where/Why/Under what conditions

Causal Factors are then identified and defined through a review of the event conditions, where Causal Factors are defined as “a mistake, error, or failure that directly leads to or causes an incident or fails to mitigate the consequences of the original error.” When a Causal Factor is identified, a failed safeguard to prevent that Causal Factor from occurring has been discovered.

Each Causal Factor is subsequently analyzed individually using the TapRooT® Root Cause Tree® to determine its Root Cause(s). A Causal Factor is initially categorized into one of the following four categories:

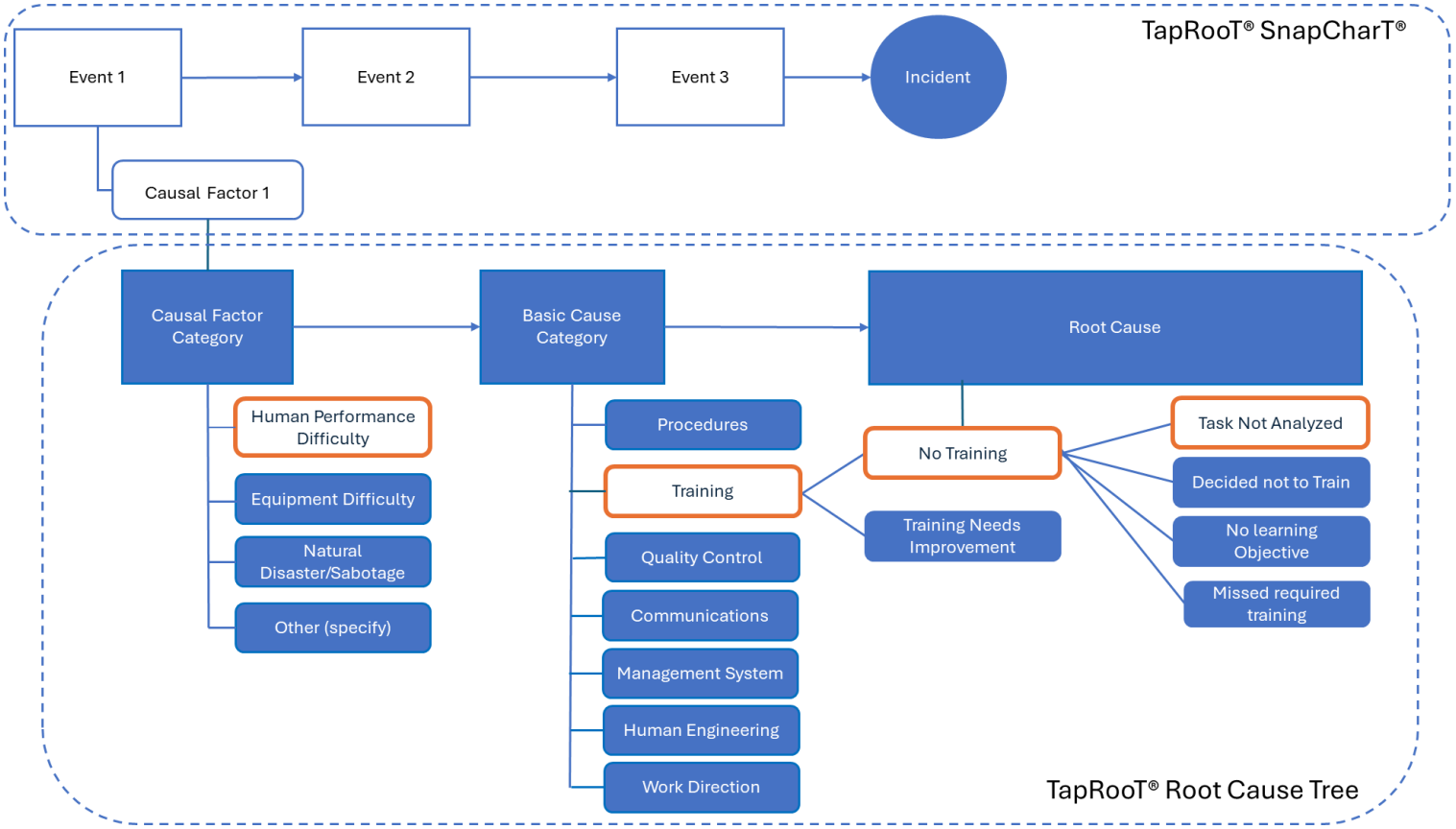
- Human Performance Difficulty
- Equipment Difficulty
- Natural Disaster/Sabotage
- Other (Specify)

Following initial categorization, for Causal Factors identified as a Human Performance Difficulty, a series of 15 yes/no questions are posed (eg. was a mistake made while using a procedure?). When a question is determined to be applicable, one or more of the following Basic Cause Categories may apply:

- Procedures
- Training

- Quality Control
- Communications
- Management System
- Human Engineering
- Work Direction

Subsequent analysis using the methodology leads to diagnosing at least one corresponding Root Cause. Figure 4-1 provides an overview of the TapRooT® Root Cause Analysis methodology used to determine the Root Causes associated with the Boil Water Advisory issued on January 21, 2025.



*Orange shows example path to identifying a Root Cause of “No Training. Task Not Analyzed”.

Figure 4-1: Basic Overview of TapRooT® Root Cause Analysis Methodology

4.2 Identified causal factors and associated root causes

A TapRooT® SnapCharT® (Figure 4-2A and 4-2B) was prepared to outline the sequence of events and Causal Factors that led to the loss of chlorination on January 20th, 2025 and subsequent BWA on January 21, 2025. Overall, 8 Causal Factors leading to the loss of chlorination at JDKWSP were identified. Each of the Causal Factors were then analyzed individually using the TapRooT® Root Cause Tree® to determine their associated Root Causes, which are summarized in Table 4-1.

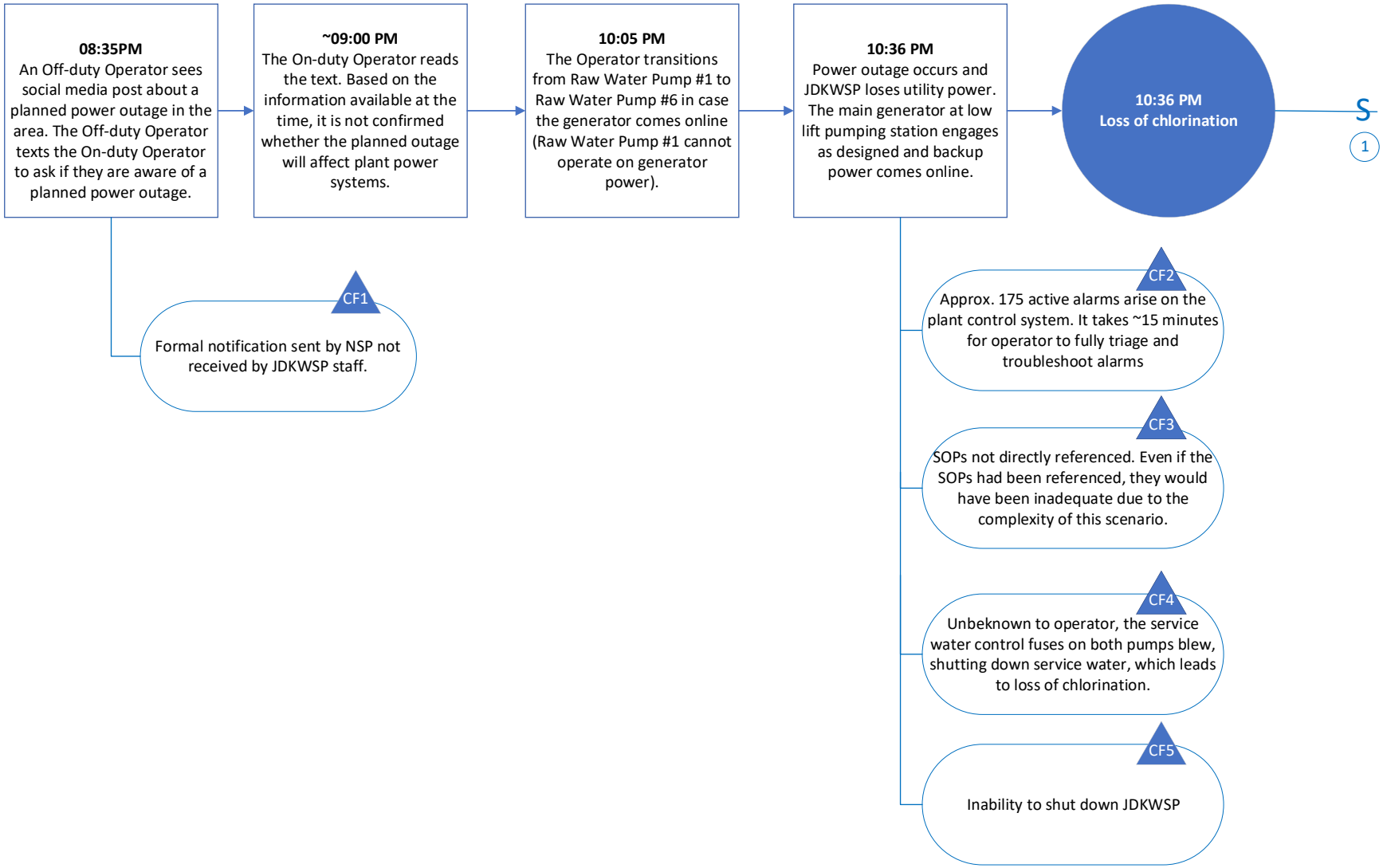


Figure 4-2A: Summary of TapRooT® SnapCharT® for January 21, 2025 BWA.

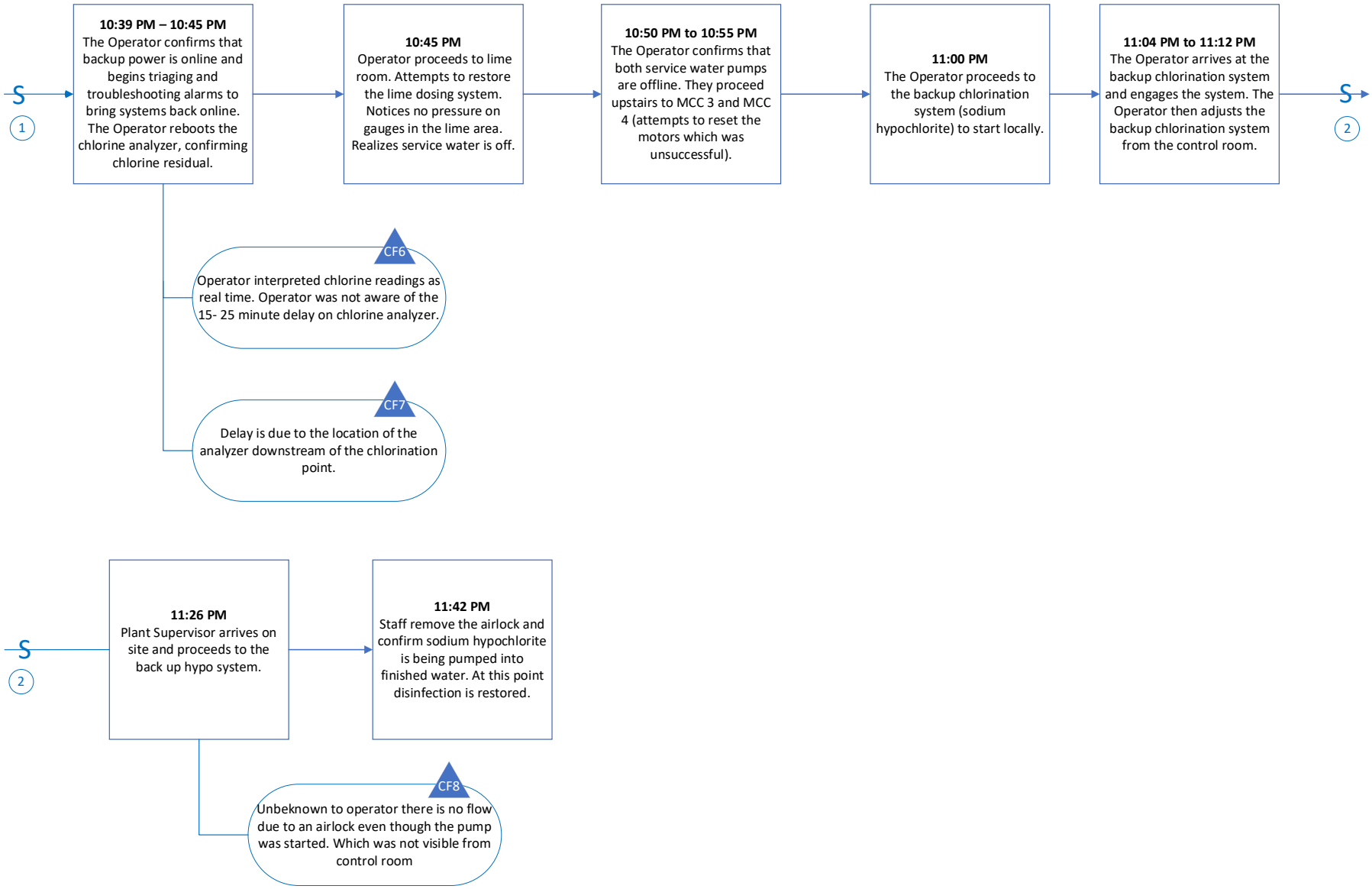


Figure 4-2B: Summary of TapRooT® SnapCharT® for January 21, 2025 BWA.

A summary of the Causal Factors and associated Root Causes leading to the BWA issued on January 21, 2025, as identified through the TapRooT® Root Cause Analysis method is provided in Table 4-1. Overall, a total of 12 root causes were identified.

Table 4-1: TapRooT® Root Cause Analysis summary for January 21, 2025 JDKWSP BWA.

CF #	Causal Factor	Basic Cause Category	RC #	Root Cause(s)*
1	Formal notification sent by NSP was not received by JDKWSP staff. Five phone numbers, none of which were still in use, were robocalled by NSP. Contact numbers had not been updated by Halifax Water. A 3-hour advance notice is needed to make arrangements to preemptively turn on the emergency generator for a planned outage.	Communications	1.1	**Communication system needs improvement.** Halifax Water has no formal arrangement in place to ensure contact information in the NSP alert system is maintained and up to date.
2	Once the utility power outage occurred and the backup power came online, approximately 175 active alarms were received on the HMI in the control room, with each alarm requiring operator acknowledgement. At the time of the power outage, there was no alarm rationalization process in place, and it took approximately 15 minutes for the operator to acknowledge all alarms.	Human Engineering	2.1	**Displays on Human Machine Interface (HMI) need improvement.** The large number of alarms took approximately 15 minutes to troubleshoot, which exceeded the timeframe available for preventing unchlorinated water from entering the distribution system.

CF #	Causal Factor	Basic Cause Category	RC #	Root Cause(s)*
3	SOPs are not normally directly referenced for troubleshooting as they are cumbersome. The operator relied on their experience of plant operations to troubleshoot.	Procedures	3.1	**Procedure not used because too difficult to use.** The format of SOPs is not fully suitable for handling emergency situations where quick decision making is imperative.
		Training	3.2	**Understanding needs improvement through practice/repetition.** For quick and effective response to emergency situations, regular training exercises are needed to ensure personnel are better prepared to encounter different scenarios.
4	Unbeknown to the operator, the service water control fuses on both service water pumps were blown when backup power came online, shutting down service water, leading to the loss of chlorination.	Design	4.1	**Problem not anticipated during design of system.** The service water pump fuses functioned as intended; however, the fuses blowing concurrently was not anticipated in the original design of the system.

CF #	Causal Factor	Basic Cause Category	RC #	Root Cause(s)*
5	Inability to shut down JDKWSP. All treated water at the JDKWSP is unchlorinated until it reaches the mixing chamber, where chlorination occurs before the water leaves the plant. Interrupting the flow at this stage is not possible without causing significant water quality or quantity issues. There is currently a very short window for responding to interruptions because there is no chlorinated water storage on site.	Other	5.1	**Fundamental design constraint.** The point of chlorination at the JDKWSP 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. 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. It was also originally intended that if JDKWSP required a shutdown for maintenance or encountered a failure, it could be shut down by closing the outlet sluice gate. 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 JDKWSP. As a result, the facility has an extremely limited shutdown or disruption window, which has now become a significant constraint for maintenance and emergency response.
6	Operator interpreted the chlorine readings as real time. Operator was not aware of the 10-to-25-minute time delay on the chlorine analyzer.	Training	6.1	**Understanding and instruction need improvement.** Improved training and instruction are needed for all operators to understand that chlorine residual readings are delayed and how this impacts troubleshooting.

CF #	Causal Factor	Basic Cause Category	RC #	Root Cause(s)*
		Human Engineering	6.2	**HMI labels need improvement.** Labelling on the HMI is needed to clearly indicate that chlorine residual readings have a time delay of 10 to 25 minutes.
7	The delay in chlorine readings is due to the location of the analyzer downstream of the chlorination point.	Human Engineering	7.1	**Equipment arrangement/placement needs improvement.** Placement of the chlorine analyzer in the JDKWSP should be located closer to the injection point to reduce delay in chlorine residual readings.
		Design Specs	7.2	**Problem not anticipated.** The delay in chlorine readings due to the location of the analyzer downstream from the chlorination point was not anticipated to be an issue during design/installation.
8	Unbeknown to the operator, an airlock had formed in the sodium hypochlorite feed line and chlorine was not being delivered through the backup system. This was not visible from the control room.	Design	8.1	**Design specs need improvement.** Design of backup hypo system needs improvement to stop the foot valve from coming above the liquid level.
		Human Engineering	8.2	**HMI display needs improvement.** The setup as of January 20, 2025, had no reliable indication of chlorine feed rate. Only pump status (on/off) was available therefore the presence of an airlock was not visible on the HMI.

*Bold text denotes TapRooT® terminology

Chapter 5 CORRECTIVE MEASURES

Based on the facts collected from this after-incident review, several short—, medium—, and long-term corrective measures have been recommended to address root causes and to manage risk and improve resiliency at the JDKWSP. Table 5-1 summarizes corrective measures associated directly with the root causes from Table 4-1, while Table 5-2 provides additional corrective measures identified during the after-incident review process. Some of these corrective measures were identified previously in the preliminary after incident review report submitted on February 4th, 2025. 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. A scoping exercise is currently underway to define specific timelines for each of the ongoing corrective measures. The status of corrective measures for both BWA incidents is provided in Attachment A.

Table 5-1: Summary of recommended corrective measures based on TapRooT® Root Cause Analysis.

Item #	RC #	Root Cause(s)	Corrective Measure	Timeline
1	1.1	**Communication system needs improvement.** No formal arrangement in place to ensure contact information in NSP alert system is maintained and up to date. Additionally, notifications received by NSP would not always meet 3-hour timeframe required to adequately prepare for an outage.	Formalize a procedure for communications with NSP. Update and regularly review 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
2	2.1	**Displays on HMI need improvement.** The large number of alarms took approximately 15 minutes to troubleshoot, which exceeded the timeframe available for preventing unchlorinated water from entering the distribution system.	Review alarms from the incident. Conduct a holistic review of alarm philosophy and prioritization to assist operators in emergencies. Implement alarm rationalization and prioritization process based on review, train staff on alarm rationalization and prioritization process.	Medium-term
3	3.1	**Procedure not used because too difficult to use.** The format of SOPs is not fully suitable for handling emergency situations where quick decision making is imperative.	Develop checklists based on SOPs that can be referenced quickly during emergency situations.	Short-term
4	3.2	**Understanding needs improvement through practice/repetition.** For quick and effective response to emergency situations, regular training exercises are needed to ensure personnel are better prepared to encounter different scenarios.	Develop a schedule of drills and tabletop exercises (at least quarterly). Conduct these emergency exercises to enhance emergency preparedness as part of an improved comprehensive operator training plan.	Short-term
5	4.1	**Problem not anticipated during design of system.** The service water pump fuses functioned as intended to protect downstream equipment from a surge in electrical current; however, the fuses blowing concurrently was not anticipated in the original design of the system.	Complete electrical review to inform electrical risk as part of the Operational Resiliency Review.*	Medium-term

*The Operational Resiliency Review is a corrective measure (Item #20) listed in Table 5-2, described further on page 29.

Item #	RC #	Root Cause(s)	Corrective Measure	Timeline
6	5.1	**Fundamental design constraint.** The point of chlorination at the JDKWSP 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. 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. It was also originally intended that if JDKWSP required a shutdown for maintenance or encountered a failure, it could be shutdown by closing the outlet sluice gate. 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 JDKWSP. As a result, the facility has an extremely limited shutdown or disruption window, which has now become a significant constraint for maintenance and emergency response.	Address fundamental design constraints by providing adequate treated and chlorinated water storage and the ability to shut down for maintenance or failure conditions without interruption to water quantity or quality.	Long-term
7	6.1	**Understanding and instruction need improvement.** Improved training and instruction are needed for all operators to understand that chlorine residual readings are delayed and how this impacts troubleshooting.	Review and update SOPs for clarity. Create new SOPs as appropriate. Ensure staff understand through training as part of an improved comprehensive operator training plan.	Short, medium, and long-term
8	6.2	**HMI labels need improvement.** Labelling on the HMI is needed to clearly indicate that chlorine residual readings have a time delay of 10 to 25 minutes.	Install labels on chlorine analyzer and on the HMI to indicate 10-to-25-minute delay in readings.	Short-term

Item #	RC #	Root Cause(s)	Corrective Measure	Timeline
9	7.1	**Equipment arrangement/placement needs improvement.** Placement of the chlorine analyzer in the JDKWSP should be located closer to the injection point to reduce delay in chlorine residual readings.	Install a second chlorine analyzer in a location closer to the chlorine injection point to mitigate delay in chlorine residual readings.	Short-term
	7.2	**Problem not anticipated.** The delay in chlorine readings due to the location of the analyzer downstream from the chlorination point was not anticipated to be an issue during design/installation.		
10	8.1	**Design specs need improvement.** Design of backup hypo system needs improvement to stop the foot valve from coming above the liquid level.	Improve the design and operation of the backup hypo system to prevent the formation of airlocks.	Short-term
11	8.2	**HMI display needs improvement.** The setup as of January 20th, 2025, had no reliable indication of chlorine feed rate. Only pump status (on/off) was available therefore the presence of an airlock was not visible on the HMI.	Install flow meters on the backup hypo system to improve monitoring to ensure that the system is feeding chlorine.	Short-term

Table 5-2: Summary of additional recommended corrective measures identified based on after-incident review.

Item #	Corrective Measures	Timeline
12	Complete formal incident debriefs with various levels of staff.	Short-term
13	Evaluate and develop an improved comprehensive operator training plan with defined key performance measures of competency and operator success.	Short-term
14	Investigate the feasibility of chlorine analyzer monitoring earlier in the distribution system to better assess the impact of events.	Short-term
15	Investigate the feasibility of additional rechlorination locations within the distribution system to minimize impacts of chlorine disinfection interruptions.	Medium-term
16	Clarify protocols for issuing municipal and provincial alerts for advisories with HRM and the Province	Short-term
17	Explore additional options for notifying customers beyond PSAs and social media.	Medium-term
18	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
19	Complete an Operational Resiliency Review for the JDKWSP.	Short, medium-term

As part of Corrective Measure 19 (Table 5-2), Halifax Water has established a dedicated cross-sectional team to focus on operational resiliency. Further, a request for proposals has been issued for an independent third-party Operational Resiliency Review at the JDKWSP. The JDKWSP Operational Resiliency Review will complete a comprehensive risk-based evaluation to identify single-points-of-failure and other potential risks at the water supply plant. Proposed strategies to control and mitigate the identified risks will help inform projects over the short-, medium-, and long-term to improve operational resiliency at the JDKWSP. This independent third-party review of the JDKWSP is expected to provide additional recommendations and required capital investment to ensure service reliability of the existing facility until long-term plans for the facility can be carried out.

Attachment A provides a summary of the status of the 16 corrective measures identified as a result of the July 1, 2024 BWA, as well as the 19 identified in the after incident review of the January 20 to 21, 2025 incident presented in this report. As noted in Attachment A, 11 of the 16 corrective measures identified in the after-incident review from July 1, 2024 have been implemented to date, many of which relate to the specific root causes identified for that incident and are independent of the January 20 to 21, 2025 incident. Additionally, 2 of the 19 corrective measures from the January 20 to 21, 2025 have been completed to date.

Attachment A: Summary of recommended corrective measures from July 1, 2024 and January 21, 2025 BWA after incident reviews with status updates.

Item #	Root Cause	Corrective Measure	Timeline*	Status as of March 21, 2025
July 1, 2024 BWA				
1	Electrical and mechanical failures	Assess and conduct repairs as required on raw water pumps and components.	Short-term	Complete
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	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	Complete
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	Complete
9	Other compounding factors	Complete formal incident debrief with various levels of staff.	Short-term	Complete
10	Other compounding factors	Increase operator staffing on shift to minimize response time to emergency incidents.	Short/medium-term	Complete
11	Other compounding factors	Review and update SOPs for clarity. Ensure staff understanding through training.	Short/medium-term	Implemented (Ongoing program)
12	Other compounding factors	Conduct emergency exercises to enhance knowledge on response to varying incidents.	Short, medium, and long-term	Implemented (Ongoing program)
13	Other compounding factors	Improve emergency lighting throughout the facility.	Short/medium-term	Complete
14	Electrical and mechanical failures	Install a permanent generator to replace the auxiliary generator.	Medium-term	Ongoing (Interim solution implemented)

Item #	Root Cause	Corrective Measure	Timeline*	Status as of March 21, 2025
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 providing adequate treated and chlorinated water storage and the ability to shut down for maintenance or failure conditions without interruption to water quantity or quality.	Long-term	Ongoing
January 21, 2025 BWA				
1	Communication system needs improvement	Formalize a procedure for communications with NSP. Develop SOP to update and regularly review 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	Ongoing (Interim solution implemented; permanent solution underway)
2	Displays on HMI need improvement	Review alarms from the incident. Conduct a holistic review of alarm philosophy and prioritization to assist operators in emergencies. Implement alarm rationalization and prioritization process based on review, train staff on alarm rationalization and prioritization process.	Medium-term	Ongoing
3	Procedure not used because too difficult to use	Develop checklists based on SOPs that can be referenced quickly during emergency situations.	Short-term	Ongoing
4	Understanding needs improvement through practice/repetition	Develop a schedule of drills and tabletop exercises (at least quarterly). Conduct these emergency exercises to enhance emergency preparedness as part of an improved comprehensive operator training program.	Short-term	Ongoing
5	Problem not anticipated during design of system	Complete electrical review to inform electrical risk as part of the Operational Resiliency Review.	Medium-term	Ongoing
6	Fundamental design constraint	Address fundamental design constraints by providing adequate treated and chlorinated water storage and the ability to shut down for maintenance or failure conditions without interruption to water quantity or quality.	Long-term	Ongoing
7	Understanding and instruction need improvement	Review and update SOPs for clarity. Create new SOPs as appropriate. Ensure staff understanding through training	Short, medium, and long-term	Ongoing

Item #	Root Cause	Corrective Measure	Timeline*	Status as of March 21, 2025
		as part of an improved comprehensive operator training program.		
8	HMI labels need improvement	Install labels on chlorine analyzer and on the HMI to indicate 10-to-25-minute delay in readings.	Short-term	Complete
9	Equipment arrangement/placement needs improvement Problem not anticipated	Install a second chlorine analyzer in a location closer to the chlorine injection point to mitigate delay in chlorine residual readings.	Short-term	Ongoing
11	Design specs need improvement	Improve the design and operation of the backup hypo system to prevent the formation of airlocks.	Short-term	Complete
11	HMI display needs improvement	Install flow meters on the backup hypo system to improve monitoring to ensure that the system is feeding chlorine.	Short-term	Ongoing
12	None – identified during after incident review independent of root cause analysis	Complete formal incident debriefs with various levels of staff.	Short-term	Ongoing
13		Evaluate and develop an improved comprehensive operator training plan with defined key performance measures of competency and operator success.	Short-term	Ongoing
14		Investigate the feasibility of chlorine analyzer monitoring earlier in the distribution system to better assess the impact of events.	Short-term	Ongoing (Interim solution implemented; permanent solution underway)
15		Investigate the feasibility of additional rechlorination locations within the distribution system to minimize impacts of chlorine disinfection interruptions.	Medium-term	Ongoing
16		Clarify protocols for issuing municipal and provincial alerts for advisories with HRM and the Province.	Short-term	Ongoing
17		Explore additional options for notifying customers beyond PSAs and social media.	Medium-term	Ongoing
18		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
19		Complete an Operational Resiliency Review for the JDKWSP.	Short, medium-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. A scoping exercise is currently underway to define specific timelines for each of the ongoing corrective measures.