2023

CITY OF HAMILTON
CORROSION CONTROL PROGRAM

ANNUAL EVALUATION REPORT ASSESSING THE EFFECTIVENESS OF THE CORROSION CONTROL MEASURES

Hamilton

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1 SUMMARY

This annual evaluation report is provided as per Section 6.6 of Schedule C of the City of Hamilton's (COH's) Municipal Drinking Water Licence (MDWL) Number: 005-101 Issue 10, dated October 6, 2023; as per Part V of the Safe Drinking Water Act, 2002 (SDWA). This report assesses the effectiveness of the Corrosion Control Program (CCP) within the Woodward Drinking Water Subsystem (DWSS). It outlines the activities undertaken by the COH and covers the 2023 calendar year.

This report includes the following:

- Lead results and a summary of any key corrosion control parameters
- A technical evaluation of the effectiveness of corrosion control measures
- A summary of lead levels and other metals monitored since implementation of corrosion control and comparison to pre-implementation levels
- An evaluation of secondary impacts resulting from corrosion control implementation
- Summary of results of all other aspects of the COH's lead mitigation strategy

The COH began the addition of phosphoric acid on November 8, 2018 with 2023 being the fifth year of program operation. Throughout 2023, operating conditions were stable at the Woodward Avenue Water Treatment Plant (WTP) with inhibitor concentrations consistently observed at the ends of the distribution system.

The Schedule 15.1 Community Lead Sampling Program was reinstated in 2018 for the Woodward DWSS under a reduced sampling schedule to monitor the effectiveness of corrosion control measures put in place. Two sampling rounds: Round 31 (Winter) and Round 32 (Summer), were completed in 2023 for a total of 10 rounds completed since CCP implementation in 2018. Result summaries are included in this report.

2 INTRODUCTION

At the November 25, 2015 COH Council Meeting, Report 15-015, the CCP for the Woodward DWSS was approved. The primary recommendation of the report was to implement corrosion control within the Woodward DWSS using a phosphate-based treatment approach, with orthophosphate as the method for corrosion control and phosphoric acid as the treatment additive. On November 8, 2018, the COH began adding phosphoric acid completing the pre-implementation requirements and moving into post-implementation and ongoing activities. This 2023 evaluation report reviews the post-implementation sampling and monitoring activities for the year and illustrates the observed effectiveness of the program.

3 TECHNICAL EVALUATION OF THE EFFECTIVENESS OF CORROSION CONTROL MEASURES INTRODUCTION

3.1 KEY MILESTONES OF POST-IMPLEMENTATION SAMPLING AND MONITORING

With 2023 bringing the City of Hamilton (COH) into the fifth year of the Corrosion Control Program (CCP), post-implementation sampling and monitoring continues to be one of the main ways of evaluating the program's goal of reducing lead concentrations observed at the tap (premise). Post-implementation sampling, as per Schedule C of the Municipal Drinking Water Licence (MDWL), was performed including two rounds of the legislated Community Lead Sampling Program.

Ongoing proactive and reactive flushing of the distribution system took place throughout 2023. This ensured the movement of orthophosphate throughout the distribution system, reduced secondary impacts, and reduced water age.

The Plant Optimization Study commenced in 2019 to study the Woodward Avenue Water Treatment Plant's dosing system for orthophosphate and ammonia. The goal of the study is to ensure the chemicals are delivered effectively and do not create adverse conditions in the distribution system. The study was put on-hold due to the COVID-19 pandemic and subsequent Regulatory Relief from Schedule 15.1 Community Lead premise sampling that took place between Summer 2020 and Summer 2022. The Plant Optimization Study continued in 2023 with recommendations to be presented in 2024.

Secondary impacts stemming from the addition of orthophosphate were observed in the distribution system. Although pre-filter orthophosphate dosing contributed significantly toward reducing treated water aluminum levels, precipitation of orthophosphate with aluminum was observed within the distribution system. This impact was reduced through flushing and did not contribute to aesthetic impairment of drinking water as illustrated through turbidity and colour testing. Other secondary impacts (such as release of bacteria from temporary cast iron scale destabilization) were minor and manageable through flushing.

System-wide sampling continued in 2023 and provided additional monitoring data for the entire distribution system. This branch of the monitoring program allows for surveillance of orthophosphate levels and potential secondary impacts. In the event of an elevated orthophosphate, colour, or turbidity result, further sampling occurs to determine the cause of any anomaly and to ensure appropriate action is taken.

The key post-implementation activities are summarized in Table 1.

TABLE 1: 2023 CCP POST IMPLEMENTATION MONITORING PLAN

Task	Status
Distribution System Flushing	On-going: • 3,620 hydrants flushed in 2023. • Proactive flushing continues in 2024.
Post-Implementation Monitoring	On-going: • Sampling as per Schedule C of the Municipal Drinking Water Licence completed in 2023 and continues in 2024. • Additional System-wide monitoring program and lead pipe loop monitoring. These programs are beyond regulated requirements to help measure corrosion control parameters within the distribution system.
Plant Optimization Study	On-going: • Study to optimize the Woodward Avenue Water Treatment Plant's dosing system for orthophosphate and ammonia, ensuring it is not creating adverse situations in the distribution system and is effectively delivering the chemicals - Commenced Q4 2019 • Study was on hold due to the COVID-19 pandemic and subsequent Regulatory Relief. • Study resumed in 2023. • Study continues with recommendations anticipated in 2024.

3.2 EQUIPMENT MALFUNCTION OR UPSET CONDITIONS

No equipment malfunctions or upset conditions occurred in 2023.

A summary of the continuously monitored parameters at the Point of Entry are included in Table 2. These values are recorded every 15 minutes to ensure prompt intervention when upset conditions are observed. The Municipal Drinking Water Licence also requires additional parameters to be measured at the Point of Entry annually, quarterly and monthly. The results from these grab samples are summarized in Table 3. Pre- and post-implementation comparison of these parameters illustrate minimal change in water quality linked to the addition of phosphoric acid to the drinking water.

TABLE 2: SUMMARY OF CONTINUOUSLY MONITORED PARAMETERS AT THE POINT OF ENTRY

Dates	Point of Entry Continuous Monitoring Values, Result Value Range			
	pH	Temperature Raw Water (^{0}C)	Orthophosphate (mg/L)	Turbidity (NTU)
08-Nov-18 to 31-Dec-18	7.58 - 8.17	1.50 - 6.66	0.02 - 3.39	0.03 - 0.54
01-Jan-19 to 31-Dec-19	6.67 - 7.64	-1.03 - 20.47	0.20 - 7.81	0.02 - 0.33
01-Jan-20 to 31-Dec-20	6.66 - 7.64	0.63 - 23.35	0.84 - 3.46	0.02 - 0.27
01-Jan-21 to 31-Dec-21	6.74 - 7.60	-0.53 - 23.29	0.96 - 5.33	0.02 - 0.86
01-Jan-22 to 31-Dec-22	6.22 - 7.71	-0.48 - 22.5	0.68 - 6.38	0.009 - 0.282
01-Jan-23 to 31-Dec-23	7.06 - 7.56	0.45 - 20.89	0.74 - 2.86	0.03 - 0.71

TABLE 3: SUMMARY OF CORROSION CONTROL RELATED PARAMETERS AT THE POINT OF ENTRY

Dates	Point of Entry Continuous Monitoring Values, Result Value Range								
	Lead (µg/L)	Iron (µg/L)	Copper (µg/L)	Alkalinity (mg/L)	TDS (mg/L)	Colour (apparent) (CU)	Chloride (mg/L)	Sulphate (mg/L)	Ortho-phosphate (mg/L)
Pre-Implementation 04-Feb-08 to 22-May-18	<1	<10 - 59	0.39 - <2	82 - 99	156 - 252	<2 - 4	30.0 - 31.5	24.2 - 28.2	<0.15
Q4 2018 01-Oct-18 to 31-Dec-18	<0.1	<3	0.2	85	178	<2	30.0 - 31.5	23.7 - 24.7	<0.15 - 3.80
2019 01-Jan-19 to 31-Dec-19	<0.1	<3 - 4	0.3 - 0.6	83 - 88	160 - 232	<2	29.1 - 42.6	22.9 - 27.0	<0.15 - 2.69
2020 01-Jan-20 to 31-Dec-20	<0.1	<3	0.2 - 0.4	86 - 88	166 - 228	<2 - 2	29.2 - 40.3	23.3 - 26.1	1.60 - 2.48
2021 01-Jan-21 to 31-Dec-21	<0.1	<3	0.2 - 0.8	86	170 - 248	<2 - 2	29.1 - 43.4	22.6 - 25.7	1.20 - 2.89
2022 01-Jan-22 to 31-Dec-22	<0.1	<3	0.3 - 0.4	80 - 91	162 - 202	<2 - 2	28.4 - 44.0	22.5 - 25.1	1.48 - 2.85
2023 01-Jan-23 to 31-Dec-23	<0.1	<3	0.2 - 0.3	87 - 91	150 - 228	<2 - 2	28.4 - 39.1	22.1 - 25.8	1.34 - 2.58

3.3 ABILITY TO MAINTAIN OPERATING CONDITIONS AND INHIBITOR CONCENTRATIONS, IN THE DISTRIBUTION SYSTEM AND PREMISE PLUMBING (RESIDENTIAL & NON-RESIDENTIAL)

The ability to maintain operating conditions and inhibitor concentrations within the distribution system was monitored as required by the Municipal Drinking Water Licence (MDWL). The regulated sampling program continued in 2023 whereby orthophosphate concentrations and other related parameters were measured at the ends of the distribution system. In addition, these parameters are also measured throughout the Woodward Drinking Water Subsystem (DWSS) through the System-wide corrosion control sampling program that continued in 2023. This branch of the program provides monitoring data beyond the regulatory requirements for the entire Woodward DWSS. It allows for a System-wide surveillance of orthophosphate levels and potential secondary impacts. In the event of an observed anomaly, flushing and enhanced sampling is initiated to determine the cause so that appropriate action is taken.

As illustrated in Table 4, orthophosphate residuals at the ends of the distribution system demonstrate consistent delivery of orthophosphate throughout the system. There were two instances where the orthophosphate residual measured in the distribution system exceeded the desired range of 1.8 to 3.0 mg/L. Flushing was performed in both areas and subsequent repeat sampling showed a return to normalized concentrations of orthophosphate. The recently implemented System-wide corrosion control sampling program provides additional information to better understand the behaviour of orthophosphate throughout the entire distribution system and not just at the ends of the system. In addition, a difference of ≥0.5 mg/L between total and dissolved orthophosphate can be indicative of precipitation in the distribution system and proactive flushing is performed if this occurs. There was one instance in 2023 where this difference exceeded a 0.5 mg/L tolerance. In this case, resampling occurred post-flushing, and results returned to expected values. In the event of an elevated orthophosphate, colour or turbidity result, further sampling (tier 2) occurs to determine the cause of any anomaly and appropriate action is taken.

The addition of the inhibitor did not negatively impact the aesthetic appearance of the water in the distribution system. Pre- and post-implementation turbidity values are summarized in Table 4.

Although operating conditions and inhibitor concentrations are not measured in premise plumbing, Section 4 discusses the levels of lead and other metals as seen in premise plumbing because of orthophosphate use.

3.4 ABILITY TO ACHIEVE REDUCTION IN LEAD LEVELS AND OTHER CORROSION RELATED PARAMETERS IN THE DISTRIBUTION SYSTEM AND PREMISE PLUMBING (RESIDENTIAL & NON-RESIDENTIAL)

Lead levels and other corrosion control related parameters are monitored primarily through the Schedule 15.1 Community Lead Sampling Program, under O. Reg. 170/03 of the Safe Drinking Water Act. Prior to the inhibitor addition in the Woodward DWSS, the MDWL contained a Condition of Lead Regulatory Relief - Schedule D.

Upon addition of the inhibitor, the Schedule 15.1 Community Lead Sampling Program was resumed under a reduced sampling plan as specified in the MDWL. Round 31 (Winter) and Round 32 (Summer) took place in 2023 with a summary of the results found in Section 4 of this report.

As summarized in Chart 1, an overall decline in lead levels at the tap and the percentage of samples with results above the Maximum Acceptable Concentration (MAC) for lead (10ug/L) has been observed.

TABLE 4: COMPARISON OF PRE-IMPLEMENTATION AND POST IMPLEMENTATION ORTHOPHOSPHATE RESIDUALS AND TURBIDITY IN THE DISTRIBUTION SYSTEM

Period	Dates	Number of Samples	Distribution Results	
			Orthophosphate (mg/L) Average (Range)	Field Turbidity (NTU) Average (Range)
Pre-Implementation				
1	01-Jul-16 to 30-Sept-16	98	<0.15	0.25 (0.05 - 3.49)
2	01-Nov-16 to 30-Jan-17	79	<0.15	0.29 (0.09 - 3.10)
3	01-Mar-17 to 30-Jun-17	82	<0.15	0.23 (0.07 - 0.71)
Post-Implementation				
1	05-Nov-18 to 27-Dec-18	80	1.57 (<0.15 - 2.55)	0.16 (0.06 - 1.10)
2	01-Jan-19 to 31-Dec-19	524	1.88 (0.22 - 2.42)	0.14 (0.05 - 1.16)
3	01-Jan-20 to 31-Dec-20	531	1.98 (1.72 - 3.53)	0.15 (<0.05 - 1.67)
4	01-Jan-21 to 31-Dec-21	522	2.01 (1.43 - 6.54)	0.20 (<0.05 - 5.04)
5	01-Jan-22 to 31-Dec-22	759	2.07 (1.76 - 10.0)	0.24 (0.05 - 9.87)
6	01-Jan-23 to 31-Dec-23	916*	1.97 (1.48 - 7.80**)	0.26 (0.05 - 4.2)

*Number of samples for 2023 includes 520 regulated weekly end of distribution samples and 396 System-wide samples.

**Orthophosphate result of 7.80 mg/L was resampled after flushing and 2.02 mg/L was obtained.

4 SUMMARY OF LEAD LEVELS AND OTHER METALS

4.1 SCHEDULE 15.1 COMMUNITY LEAD SAMPLING PROGRAM UNDER ONTARIO REGULATION 170/03

Tables 5, 6 and 7 illustrate the pre- and post-implementation results from the Schedule 15.1 sampling rounds for the Woodward Drinking Water Subsystem as seen at premise plumbing (residential and non-residential) and in the distribution system.

TABLE 5: PRE- AND POST-IMPLEMENTATION RESULTS FROM THE SCHEDULE 15.1 COMMUNITY LEAD SAMPLING PROGRAM FOR THE WOODWARD DRINKING WATER SUBSYSTEM – PREMISE (RESIDENTIAL)

Round	Dates	Number of Samples		Results		Percent (%) of Samples with Lead >10ug/L
		Total	Lead >10ug/L	Lead (µg/L) (Range)	Field pH Average (Range)	
1	20-Feb-08 to 2-Apr-08	105	18	<1 - 56	7.19 (6.17 - 7.80)	17%
2	2-Sep-08 to 9-Oct-08	106	36	<1 - 239	7.50 (7.12 - 7.92)	34%
3	26-Feb-09 to 21-Mar-09	100	10	<1 - 11.8	7.17 (6.94 - 7.41)	10%
4	26-Sept-09 to 15-Oct-09	103	35	<1 - 33.9	7.50 (6.97 - 8.01)	35%
5	15-Dec-09 to 15-Apr-10	110	28	<0.5 - 35.3	7.59 (7.25 - 8.00)	26%
6 - 22	Regulatory Relief					
23	15-Dec-18 to 15-Apr-19	50	5	<0.1 - 22.6	7.52 (7.34 - 7.65)	10%
24	15-June-19 to 15-Oct-19	53	5	<0.1 - 33.1	7.52 (6.77 - 7.81)	9%
25	15-Dec-19 to 15-Apr-20	50	4	<0.1 - 18.9	7.58 (7.25 - 7.89)	8%
26 - 29	COVID Regulatory Relief for Lead Sampling (Premise)					
30	15-Jun-22 to 15-Oct-22	51	2	<0.1 - 15.2	7.52 (7.38 - 7.64)	4%
31	15-Dec-22 to 15-Apr-23	50	0	<0.1 - 7.0	7.45 (7.22 - 7.73)	0%
32	15-Jun-23 to 15-Oct-23	50	1	<0.1 - 15.2	7.38 (7.14 - 7.63)	2%

TABLE 6: PRE- AND POST-IMPLEMENTATION RESULTS FROM THE SCHEDULE 15.1 COMMUNITY LEAD SAMPLING PROGRAM FOR THE WOODWARD DRINKING WATER SUBSYSTEM – PREMISE (NON-RESIDENTIAL)

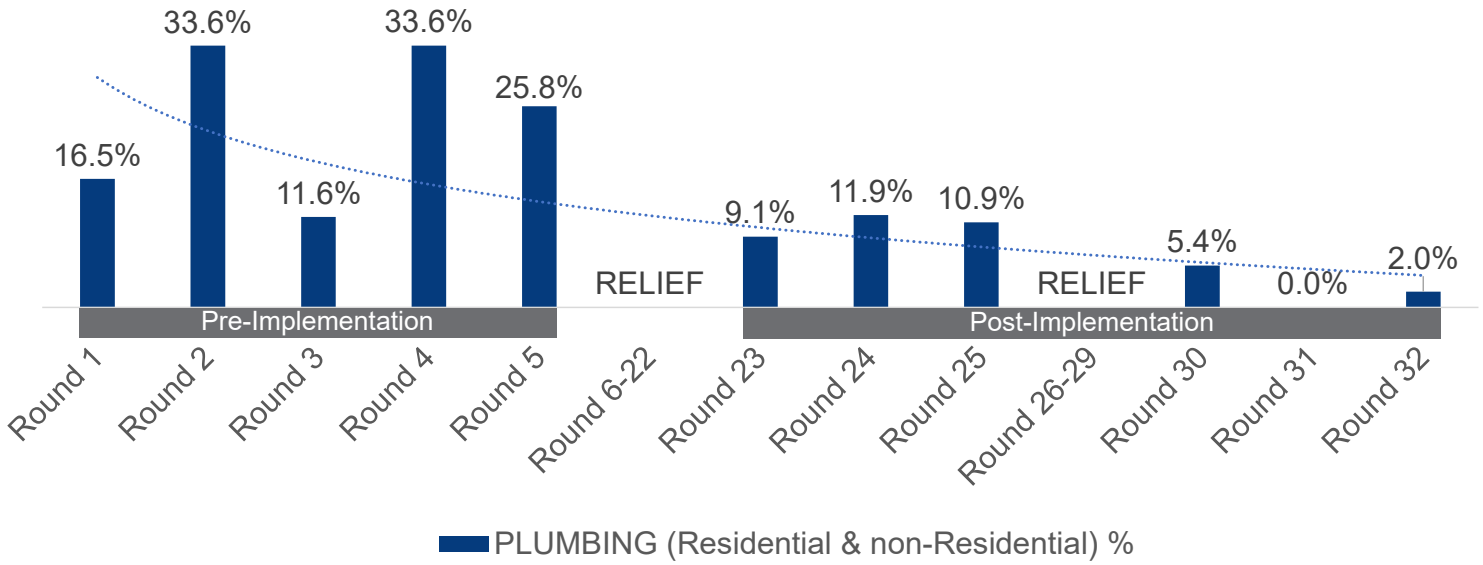
Round	Dates	Number of Samples		Results		Percent (%) of Samples with Lead >10ug/L
		Total	Lead >10ug/L	Lead (µg/L) (Range)	Field pH Average (Range)	
1	20-Feb-08 to 2-Apr-08	10	1	<1-27	7.15 (6.94 - 7.30)	10%
2	2-Sep-08 to 9-Oct-08	10	3	<1-25	7.48 (7.39 - 7.58)	33%
3	26-Feb-09 to 21-Mar-09	12	3	<1-50.2	7.17 (6.82 - 7.72)	25%
4	26-Sept-09 to 15-Oct-09	10	3	<1-48.9	7.56 (7.46 - 7.65)	33%
5	15-Dec-09 to 15-Apr-10	10	3	<0.5-40.7	7.55 (7.35 - 7.76)	33%
6 - 22	Regulatory Relief					
23	15-Dec-18 to 15-Apr-19	5	0	0.4-9.2	7.52 (7.41 - 7.72)	0%
24	15-June-19 to 15-Oct-19	6	2	0.6-20.1	7.53 (7.48 - 7.65)	33%
25	15-Dec-19 to 15-Apr-20	5	2	0.4-29.8	7.68 (7.48 - 7.89)	40%
26 - 29	COVID Regulatory Relief for Lead Sampling (Premise)					
30	15-Jun-22 to 15-Oct-22	5	1	<0.1-33.0	7.55 (7.40-7.63)	20%
31	15-Dec-22 to 15-Apr-23	5	0	<0.1-1.20	7.41 (7.37 - 7.45)	0%
32	15-Jun-23 to 15-Oct-23	5	0	<0.1-2.50	7.32 (7.24 - 7.44)	0%

TABLE 7: PRE- AND POST-IMPLEMENTATION RESULTS FROM THE SCHEDULE 15.1 COMMUNITY LEAD SAMPLING PROGRAM FOR THE WOODWARD DRINKING WATER SUBSYSTEM – DISTRIBUTION SYSTEM

Round	Dates	Number of Samples		Results			Percent (%) of Samples with Lead >10ug/L
		Total	Lead >10ug/L	Lead (µg/L) (Range)	Field pH Average (Range)	Alkalinity (mg/L) Average (Range)	
1	20-Feb-08 to 2-Apr-08	20	0	<1 - 1	7.20 (6.10 - 8.00)	85 (82 - 87)	0%
2	2-Sep-08 to 9-Oct-08	21	0	<1 - 2	7.40 (7.20 - 7.60)	82 (80 - 85)	0%
3	26-Feb-09 to 21-Mar-09	20	0	<1 - 4	7.00 (6.10 - 7.60)	86 (84 - 88)	0%
4	26-Sept-09 to 15-Oct-09	20	0	<1 - 2	7.50 (7.20 - 7.70)	84 (77 - 90)	0%
5	15-Dec-09 to 15-Apr-10	23	0	<0.5 - 2.7	7.75 (7.57 - 8.03)	85 (83 - 88)	0%
6 - 22	Regulatory Relief						
23	15-Dec-18 to 15-Apr-19	10	0	0.1 - 2.5	7.47 (7.36 - 7.66)	86 (82 - 89)	0%
24	15-June-19 to 15-Oct-19	11	1*	<0.1 - 44.4	7.50 (7.35 - 7.87)	87 (82 - 90)	9%
25	15-Dec-19 to 15-Apr-20	10	0	<0.1 - 1.2	7.60 (7.40 - 8.01)	85 (84 - 87)	0%
26	15-June-20 to 15-Oct-20	10	0	<0.1 - 0.3	7.51 (7.42 - 7.65)	87 (85 - 88)	0%
27	15-Dec-20 to 15-Apr-21	10	0	<0.1 - 1.8	7.48 (7.39 - 7.60)	87 (86 - 88)	0%
28	15-June-21 to 15-Oct-21	10	0	<0.1 - 0.3	7.36 (7.23 - 7.45)	85 (83 - 86)	0%
29	15-Dec-21 to 15-Apr-22	10	0	<0.1 - 0.6	7.68 (7.47 - 7.87)	88 (87 - 90)	0%
30	15-Jun-22 to 15-Oct-22	10	0	<0.1 - 0.3	7.31 (7.47 - 7.59)	89 (86 - 93)	0%
31	15-Dec-22 to 15-Apr-23	10	0	<0.1 - 0.2	7.44 (7.21 - 7.59)	89 (89 - 90)	0%
32	15-Jun-23 to 15-Oct-23	10	0	<0.1 - 0.5	7.35 (7.24 - 7.53)	86 (85 - 88)	0%

*Hydrant was found to contain a lead port. Resampling and analysis at the same hydrant had a lead result of <0.1ug/L

CHART 1: PERCENT (%) OF PREMISE SAMPLES WITH LEAD ABOVE THE MAC (10mg/L)



As required by the Municipal Drinking Water Licence, copper is monitored at residential and non-residential premise plumbing through the Schedule 15.1 Community Lead Sampling Program. Copper was not measured prior to the implementation of the Corrosion Control Program; however, it was measured throughout the distribution system over three sampling periods as part of the City of Hamilton's corrosion control baseline study.

The Ontario Drinking Water Standards, Objectives and Guidelines have an Aesthetic Objective (AO) guideline of 1,000 µg/L for copper. Pre- and post-implementation sampling results are illustrated in Table 8 and show copper results remaining well below the AO guideline.

TABLE 8: PRE- AND POST-IMPLEMENTATION RESULTS OF COPPER IN THE SYSTEM

Dates	Number of Samples	Copper Results (ug/L) (Range)
Distribution		
Pre-Implementation 01-Jul-16 to 30-Sept-16	98	<2 - 62
Pre-Implementation 01-Nov-16 to 30-Jan-17	79	<2 - 90
Pre-Implementation 01-Mar-17 to 30-Jun-17	82	<2 - 42
Residential and Non-Residential Premise		
Post-Implementation 01-Jan-19 to 31-Dec-19	114	2.0 - 93.1
Post-Implementation 01-Jan-20 to 31-Dec-20	55	1.7 - 63.3
Post-Implementation 01-Jan-21 to 31-Dec-21	COVID Regulatory Relief for Sampling (Premise)	
Post-Implementation 01-Jan-22 to 31-Dec-22	56	1.2 - 90.6
Post-Implementation 01-Jan-23 to 31-Dec-23	110	1.4 - 239

5 EVALUATION OF SECONDARY IMPACTS

5.1 CUSTOMER FEEDBACK OR WATER QUALITY COMPLAINTS, SINCE IMPLEMENTATION OF CORROSION CONTROL, WITH ANALYSIS OF REASONS

The City of Hamilton (COH) collects and reviews customer feedback and water quality complaints to ensure customer safety and satisfaction. In 2023, five general inquiries on the COH's programs were received as follows:

- Restoration timelines after Water Service Line Replacements (two inquiries)
- COH's timeline for replacing the public portion of the Water Service Line (two inquiries)
- General information request for the Lead Water Service Pipe Replacement Loan Program (one inquiry)

In all the above cases, the information requested was promptly provided through the Customer Service and Community Outreach team.

One specific customer inquired if the COH was aware of an increase of phosphorus in the drinking water and its potential to cause various health issues. The customer observed the increase after privately testing the water in their swimming pool. Through speaking with the Project Manager, Regulatory Monitoring, they were advised of the following:

- The Corrosion Control Program (CCP) and the purpose of the added orthophosphate
- The extensive program development phase that took place prior to implementation on use of orthophosphate and its safety including consultation with various stakeholders (Public Health Services, regulatory bodies, technical experts including a peer review, municipalities, industries, and residents)
- Use of food grade phosphoric acid and the dosing concentrations that are used
- Referred to the COH website where they could find more information on the program including the Annual Report of the program

Section 6b summarizes the outreach and education performed by the COH in relation to the CCP and lead awareness.

5.2 IMPACTS ON SECONDARY DISINFECTION, INCLUDING BIOFILM FORMATION

The COH monitors secondary disinfection through measuring chlorine residuals throughout the distribution system. Biofilm formation is monitored through the Heterotrophic Plate Count (HPC) test. Table 9 summarizes both chlorine residuals and HPC as seen before and after orthophosphate addition.

In 2019 and 2021, an increase in the HPC was observed at specific locations. The COH investigated locations with elevated HPC as part of their due diligence HPC resampling program. It was discovered that internal building plumbing was the cause of the increase, as these locations had very little or no water use. By increasing water use at these locations, the HPC count returned to baseline levels.

5.2 IMPACTS ON SECONDARY DISINFECTION, INCLUDING BIOFILM FORMATION (CONTINUED)

Due diligence Heterotrophic Plate Count (HPC) resampling continued in 2023 as a proactive means of acting on water quality indicators. Locations that returned elevated HPC counts were identified as either dead-end areas or locations with very little water use. Flushing these areas of concern and resampling returned expected HPC results.

There were no significant changes observed with the chlorine residuals observed within the distribution system.

TABLE 9: SUMMARY OF CHLORINE RESIDUALS AND HPC VALUES PRE- AND POST-IMPLEMENTATION

Dates	Distribution Results	
	Combined Chlorine Average (mg/L) (Range)	HPC Average (Range)
Pre-Implementation 01-Jan-18 to 07-Nov-18	1.92 (0.64 - 2.8)	1 (0 - 98)
Post-Implementation 08-Nov-18 to 31-Dec-18	1.85 (0.93 - 2.8)	2 (0 - 64)
Post-Implementation 01-Jan-19 to 31-Dec-19	1.79 (0.51 - 3.06)	29 (0 - 1,010)
Post-Implementation 01-Jan-20 to 31-Dec-20	1.74 (0.11 - 2.81)	13 (0 - 2,200)
Post-Implementation 01-Jan-21 to 31-Dec-21	1.73 (0.19 - 2.85)	3 (0 - 1,720)
Post-Implementation 01-Jan-22 to 31-Dec-22	1.68 (0.51 - 2.95)	3 (0 - 810)
Post Implementation 01-Jan-23 to 31-Dec-23	1.72 (0.04 - 2.90)	5 (0 - 1,700)

5.3 IMPACTS ON WASTEWATER TREATMENT PLANTS RECEIVING TREATED WATER FROM THE OWNER, INCLUDING ESTIMATES OF INCREASES IN PHOSPHOROUS LOADINGS TO THE RECEIVER, AND COMPARISON TO EFFLUENT LIMITS

The City of Hamilton operates both the Woodward Avenue and Dundas Wastewater Treatment Plants (WWTPs). In 2023, the annual average of the raw influent total phosphorus concentrations and loadings were observed to increase in both WWTPs. This increase did not cause significant impact to the wastewater treatment process as was observed in the final effluent concentrations summaries illustrated in Tables 10 and 11. The values remain below the effluent limits set by the Environmental Compliance Approvals (ECA)/Certificate of Approval; Woodward Avenue WWTP ECA Number 9410-B65QRT, dated May 14, 2019, and Dundas WWTP Certificate of Approval Number 3101-89PNRC, dated October 6, 2010.

TABLE 10: SUMMARY OF RAW INFLUENT CONCENTRATIONS AND LOADINGS PRE- AND POST-IMPLEMENTATION

Dates	Average Results					
	Woodward Avenue Wastewater Treatment Plant			Dundas Wastewater Treatment Plant		
	TP (mg/L)	Lab pH	TP Daily Loadings (Kg/day)	TP (mg/L)	Lab pH	TP Daily Loadings (Kg/day)
Pre-Implementation Jan to Oct 2018	4.83	7.74	1,484	3.24	7.66	40
Post-Implementation Nov to Dec 2018	5.55	7.72	1,897	3.29	7.71	44
Post-Implementation Jan to Dec 2019	4.25	7.69	1,560	3.22	7.67	42
Post-Implementation Jan to Dec 2020	5.49	7.61*	1,611	3.39	7.65*	40
Post-Implementation Jan to Dec 2021	4.87	7.59	1,344	3.41	7.62	37
Post-Implementation Jan to Dec 2022	5.23	7.58	1,332	3.76	7.61	38
Post-Implementation Jan to Dec 2023	8.21	7.57	2,664	4.36	7.56	52

Note: TP - Total Phosphorus as P

*For samples collected from May 29, 2020 to December 31, 2020, use lab pH results with caution as an electrode malfunction may have impacted the results.

TABLE 11: SUMMARY OF FINAL EFFLUENT CONCENTRATIONS AND LOADINGS PRE- AND POST-IMPLEMENTATION

Dates	Average Results					
	Woodward Avenue Wastewater Treatment Plant*			Dundas Wastewater Treatment Plant		
	TP (mg/L)	Lab pH	TP Daily Loadings (Kg/day)	TP (mg/L)	Lab pH	TP Daily Loadings (Kg/day)
Pre-Implementation Jan-Oct 2018	0.443	7.85	138	0.052	7.70	0.65
Post-Implementation Nov-Dec 2018	0.341	7.77	116	0.054	7.75	0.72
Post-Implementation Jan-Dec 2019	0.504	7.76	194	0.083	7.76	1.07
Post-Implementation Jan-Dec 2020	0.572	7.62**	171	0.108	7.45**	1.27
Post-Implementation Jan-Dec 2021	0.573	7.54	162	0.131	7.52	1.45
Post-Implementation Jan-Dec 2022	0.437	7.54	116	0.129	7.51	1.25
Post-Implementation Jan-Dec 2023	0.200	7.06	63	0.089	7.59	1.05

Note 1: TP - Total Phosphorus as P
Note 2: Woodward Avenue Wastewater Treatment Plant (WWTP) ECA Limits for TP = 0.80mg/L; TP Loadings = 327Kg/day; pH = 6.0 to 9.5, inclusive.
Note 3: Dundas WWTP ECA Limits for TP = 0.50mg/L; TP Loadings = 9.1Kg/day; pH = 6.0 to 9.5, inclusive.

*Woodward Avenue WWTP Data is an average of Final Effluent North and South. Beginning October 2022, the data is an average of Final Effluent 1 and 2, where the final treatment process moved from secondary to tertiary (third) level treatment as a result of the Woodward Wastewater Treatment Plant Upgrades.
**For samples collected from May 29, 2020 to December 31, 2020, use lab pH results with caution as an electrode malfunction may have impacted the results.

6 OWNER LED MITIGATION STRATEGIES

6.1 LEAD SERVICE LINE REPLACEMENT ON PUBLIC AND PRIVATE PROPERTY

The City of Hamilton (COH) has estimated that there was a total of 19,200 sub-standard/lead water service lines (LWSLs) remaining within the Woodward Drinking Water Subsystem at the end of 2023. This number is an approximation due to various uncertainties and variables that make it difficult to track.

The COH's Sub-Standard Water Service Line Replacement Program has been in place for over 30 years to address customer requests related to pressure or other concerns (such as undersized services or leaks). Over the last 10 to 15 years, as the public has been made more aware of the risk associated with lead, the focus of the program has shifted from poor pressure to sub-standard/LWSL replacements.

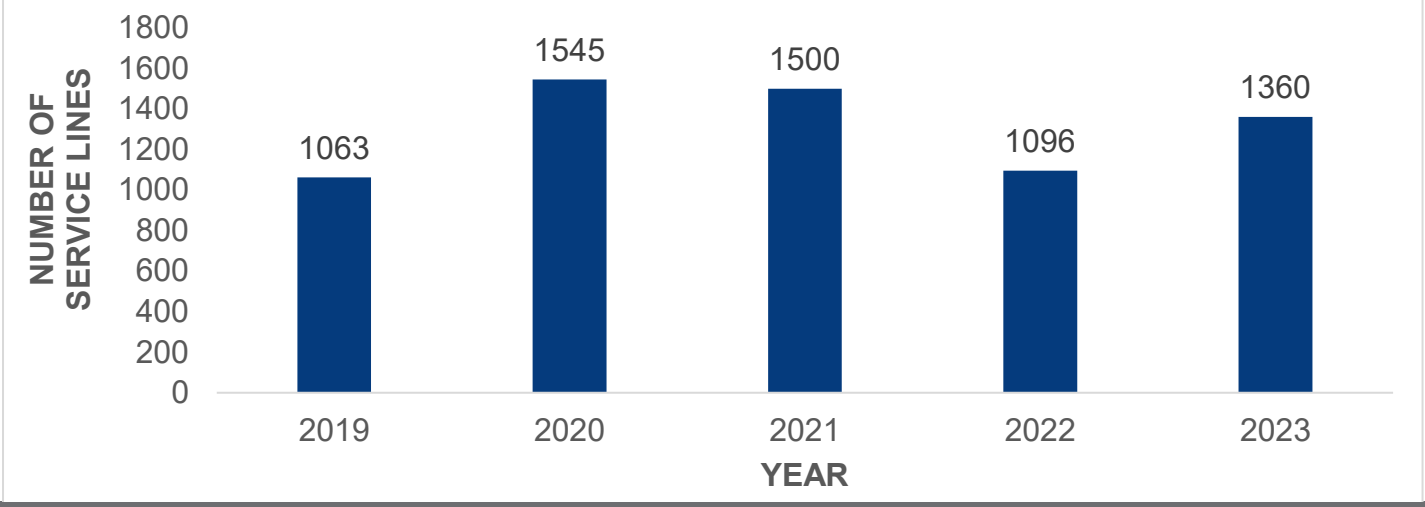
In this program, the COH replaces the sub-standard material up to the property line (public portion) when the homeowner replaces the privately-owned portion. In addition, the COH has a loan program available to assist homeowners with the replacement of their privately-owned portion.

Under this program in 2023, 827 sub-standard/LWSLs replacements were completed by the COH on the public portion, 1,070 replacements were performed on the private portion, and 290 replacements were completed as part of routine watermain maintenance/rehabilitation work. It is important to note that only the public portion is replaced as part of routine watermain work as performed by capital construction. This summary is illustrated in Table 12. A summary of the number of sub-standard service line replacements over the last five years is illustrated in Chart 2.

TABLE 12: SUMMARY OF SUB-STANDARD SERVICE LINE REPLACEMENTS PERFORMED IN 2023

Year	Public	Private	Watermain Maintenance/ Rehabilitation Work (Public)	Remaining LWSL
2023	827	1,070	290	Approximately 19,200

CHART 2: NUMBER OF SUB-STANDARD SERVICE LINE REPLACEMENTS (2019 - 2023)



6.2 OUTREACH AND EDUCATION, ESPECIALLY TO POPULATIONS VULNERABLE TO LEAD IN DRINKING WATER

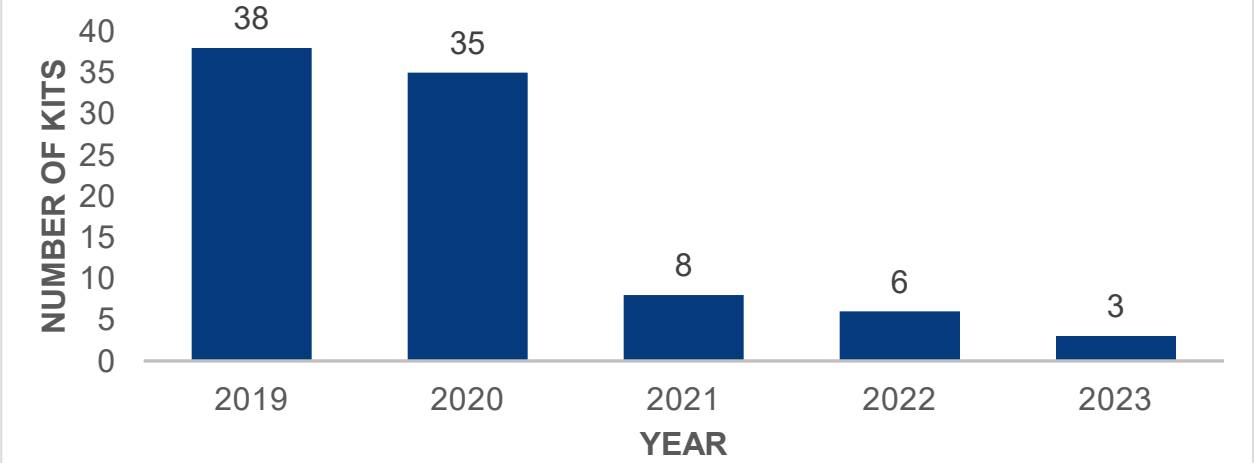
In 2023, the following outreach/education on lead awareness and the Corrosion Control Program was completed:

- The City of Hamilton (COH) maintained the Lead Awareness (www.hamilton.ca/LeadPipes) and Corrosion Control (www.hamilton.ca/CorrosionControl) websites.
- Lead Awareness advertising: (September 1-30, 2023):
  Digital: The Weather Network & Junction
  Social Media: Instagram – Target wards 1, 2, 3, 4, 7
  Print: Hamilton Spectator
- 26,525 properties mailed Lead Awareness packages. These are sent to homes built before 1955 and have an unknown service type, and properties with known lead water service lines.
- 879 Coordinated Roads Program information packages mailed out including Public Health lead inserts and the Lead Pipe Replacement Program details to property owners that were going to be affected by road cuts at their properties due work such as watermain replacement or road resurfacing.
- 159,000 properties within the Woodward Drinking Water Subsystem received the Fall Newsletter via the Alectra Bill Insert. This insert included lead pipe awareness messaging. Alectra Utilities is an electricity utility and distributor that invoices water, wastewater and stormwater charges on behalf of the COH.

6.3 FILTER KIT PROGRAM

The COH provides filter kits certified by the National Sanitation Foundation (NSF/ANSI-53). The kit consists of a Brita jug and three filters. They are provided to homeowners when requested or to contractors when a permit to replace a lead water service line is obtained. In 2023, a total of three lead filter kits were provided to residents by the COH. The decline in the number of kits provided since 2020 is due to the Hamilton Water Storefront closure as a result of the COVID-19 pandemic. Permit sales pivoted to a virtual platform and contractors were no longer obtaining kits. During this time, coupons were handed out instead of kits and coupon redemption was minimal. Although the Hamilton Water Storefront has since re-opened, the uptake on filter kits has remained low and the majority of permit sales remains virtual. A summary of the number of kits provided to residents over the last five years is illustrated in Chart 3.

CHART 3: NUMBER OF LEAD FILTER KITS HANDED OUT (2019 - 2023)



6.4 INVOLVEMENT OF PUBLIC HEALTH AUTHORITIES

The City of Hamilton (COH) Public Health Services (PHS) has worked in conjunction with the Hamilton Water division of the Public Works Department, from the development of the Corrosion Control Program (CCP) to the implementation of activities related to the program.

COH PHS educates the public on the risks associated with lead exposure by maintaining a link on their website of the various sources of lead in the environment, the health risks and how the public can take steps to protect themselves from lead exposure.

The COH PHS was also involved in all Adverse Water Quality Incidents (AWQIs) that were initiated in 2023. Semi-annual liaison meetings between the COH PHS and Hamilton Water continued in 2023 keeping both units informed on related activities. These semi-annual meetings and the involvement of PHS during AWQIs continues in 2024.

7 CONCLUSION

The COH began the addition of phosphoric acid in the Woodward Drinking Water Subsystem on November 8, 2018, and in conformance with the requirements of Schedule C of the Municipal Drinking Water Licence, continues to sample and monitor to evaluate the effectiveness of the program for lead control.

The post-implementation sampling and monitoring plan shows the orthophosphate inhibitor is working as expected with minimal secondary effects observed. The Schedule 15.1 Community Lead Sampling Program results demonstrate a reduction in lead concentrations and a decreasing trend in the percentage of samples above the Maximum Acceptable Concentration (MAC) of 10 ug/L set by Ontario Regulation 169/03.

Sampling and monitoring, including the Schedule 15.1 Community Lead Sampling Program will continue in 2024.