



City of Prince Rupert

2019 Household Water Sampling Program Report

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BACKGROUND

The City of Prince Rupert has built, maintains, and operates a drinking water system utilized by its 13,000 residents. The City receives its authority to operate the community's drinking water system from the Northern Health Authority, which is charged with ensuring the protection of the public's health in Northern British Columbia. The City and Northern Health have maintained a strong working relationship for many decades, and both organizations are devoted to ensuring that the drinking water for Prince Rupert residents is safe to consume.

The City's water supply and treatment system consists of two surface water sources (Woodworth and Shawatlan Lakes) and a chlorine gas injection facility. Both of these assets are located on the mainland, accessible to City staff only by boat travel across Fern Passage. Following chlorine treatment, drinking water passes through two large diameter submarine lines crossing the seafloor underneath Fern Passage before being distributed throughout the community.

In early 2016, following reports of elevated levels of lead in local schools, Northern Health and the City of Prince Rupert began a series of discussions on the nature of the problem, and potential steps that could be taken to improve the quality of water being consumed by end-users in the community. The City regularly tests the water throughout its distribution system as required by Northern Health, and has never found an exceedance in the concentration of lead anywhere within the system. Nevertheless, the naturally low pH of the City's water was identified by Northern Health as a potentially exacerbating factor in the leaching of lead from pipes within homes, schools, businesses and other institutional users.

In examining the problem, the City and Northern Health are in agreement that the best long term steps that can be taken to address this issue is the upgrading of the City's water treatment system. The current single stage treatment process does not effectively treat all potential biological contaminants that could be present in the City's surface water sources, does not allow for the removal of organic materials and the subsequent formation of disinfection by-products, and does not have the ability to adjust the corrosiveness or hardness of water supplied to residents. Though the City and Northern Health agree that the upgrading of the City's treatment system could substantially reduce the corrosiveness of the City's water and the subsequent risk of lead leaching in individual plumbing systems, this solution will require significant funding and time before it can be implemented.

While the City works to upgrade its water treatment system with the support of Northern Health, Northern Health has placed conditions on the City's operating permit requiring that a community field sampling program be conducted in homes throughout the City. The goals of this program are to assess the susceptibility of homes in the community to lead leaching, and to develop mitigation and communication plans for the community based on those results.

The following report provides a description of the City's 2019 Community Water Sampling program, the results gathered as a result of this program, and any insights that have been gleaned as a result.

SAMPLING PROGRAM DESIGN

The City developed the Community Sampling Program in accordance with the Interim Guidelines on Evaluating and Mitigating Lead in Drinking Water Supplies, Schools, Daycares and Other Buildings. These guidelines, prepared by the Health Protection Branch of the BC Ministry of Health, establish a process for the evaluation of lead and corrosion risk to community water systems.

Following these guidelines, it was determined that a minimum of 60 sample sites would be appropriate for the community, based on its size of 13,000 residents. As the program would require that individual homeowners prepare and provide samples it was decided that 75 sample kits would be offered to community members for testing to ensure that the minimum number of 60 samples could be received. These 75 participants would be chosen randomly in such a manner that testing locations would be distributed evenly throughout the community. Selected participants would be instructed to obtain a free sample kit from City Hall containing a sterile 1L sample bottle and instructions prepared by the local testing lab. Participants would use the sample kit to obtain a stagnant water sample from a faucet in their home and return the sample to either the City or the local lab for testing. If more than 10% of participants exceeded the testing threshold of 15 µg/L concentration of lead, then the City would undertake a secondary sampling program with those participants. In the secondary sampling program, participants would receive three sterile 1L bottles to take three consecutive samples from their stagnant water.

The details of this program were formally supplied to Northern Health on April 8th, 2019, and approved for implementation on April 29th. A copy of this letter is provided in Appendix A of this report.

To solicit participation in the program, the City put a call out for participants using its community engagement platform Rupert Talks. In addition to soliciting signups for participation in the program, residents were asked to provide any details they could regarding the characteristics of their homes and their plumbing. Visitors to the signup page were also provided links to information on the City's water supply including a pamphlet provided to all residents describing the risk of lead leaching in homes produced in 2018. Between May 2nd and May 21st, the City received 168 signups for participation in the program.

From those participants, 75 were divided into their respective sections of the city, and a weighted randomized draw was conducted to select a number of residents from each section representative of that section's proportion of the total community population. Successful participants were then notified by telephone of their inclusion in the program and requested to collect their kits. Kits began to be distributed to participants at the end of May 2019.

Shortly after sample kits began to be distributed, new federal regulations establishing a 2mg/L MAC for copper came into effect, in June of 2019. The City received notice from Northern Health in August of 2019 that the sampling program underway would need to report on copper content as well. As the laboratory test for lead also had the ability to report on copper concentrations, reporting on copper concentrations was incorporated into the sampling program plan beginning on August 15th.

PRIMARY SAMPLE PROGRAM IMPLEMENTATION

Despite the City's best efforts to encourage prompt participation in the sampling program, many residents were slow to collect or return their sampling kits. Six participants were removed from the program for failing to collect their kits in a timely manner and replaced with alternates drawn randomly from their respective sections of the community. 75 kits were ultimately distributed, and 65 returned for testing.

Over the course of the following months, the City received laboratory results as they were completed by the testing lab, and by August 14th, had received more than the 60 samples required to determine initial results. Of the 65 participants from whom the City received samples, 11 (16.9%) contained concentrations of lead greater than the 15 µg/L action threshold.

The sample kits provided to participants also tested for the concentration of copper present. As noted above, during the sampling period, Health Canada instituted a Maximum Acceptable Concentration for Copper of 2 mg/L, so Northern Health requested these results be collected in concert with the results for lead. As the City had access to both lead and copper concentration results for participants, both of these measures were reported to participants. Form letters were drafted which described the concentrations of lead and copper present in their samples, provided context for the testing program and the stagnant sample result, and recommended to all participants that they flush their residential water for several minutes prior to consuming.

Those participants with samples found to be in excess of the 15 µg/L threshold for lead were further encouraged to take part in the City's secondary sampling program. Those residents were also contacted by telephone to invite them to participate in secondary testing and to provide them with instructions on how to take part.

PRIMARY SAMPLE PROGRAM RESULTS

Of the 65 samples received from program participants:

- 11 contained a lead concentration higher than the 15 µg/L threshold
- 30 contained a lead concentration between the 5 µg/L and 0.015 mg/L
- 24 contained a lead concentration less than the 5 µg/L Health Canada MAC
- 27 contained a copper concentration higher than the 2 mg/L Health Canada MAC
- 38 contained a copper concentration lower than the 2 mg/L Health Canada MAC

Based on the data collected, the median concentration for lead in stagnant water samples was 7.0 µg/L, with a lower quartile of 4.3 µg/L and an upper quartile of 11.9 µg/L. Given these results, an upper bound for determining outliers would be a concentration of 23.3 µg/L. It is worth noting that of the eleven samples that tested above the 15 µg/L threshold, seven would be considered outlier samples based on this data.

Figure 1 displays the geographic distribution of lead concentration results throughout the community. On initial inspection, there doesn't appear to be a strong association between elevated results and geographic location. Examining the results on a section-by-section basis, some differences between areas do appear to be indicated, though no individual section contains a median concentration above the 15 µg/L threshold. Though sections 2 and 9 both appear to have higher median concentrations than the average, this is in large part due to the low number of samples collected in those sections (6 and 4 respectively) and the presence of a statistical outlier in both. Figure 2 presents the median and quartile boundaries for each section of the community.

The additional data collected during program registration was also used to determine whether a correlation existed between observed lead concentrations and household characteristics, such as the known presence of lead, or the age of the home.

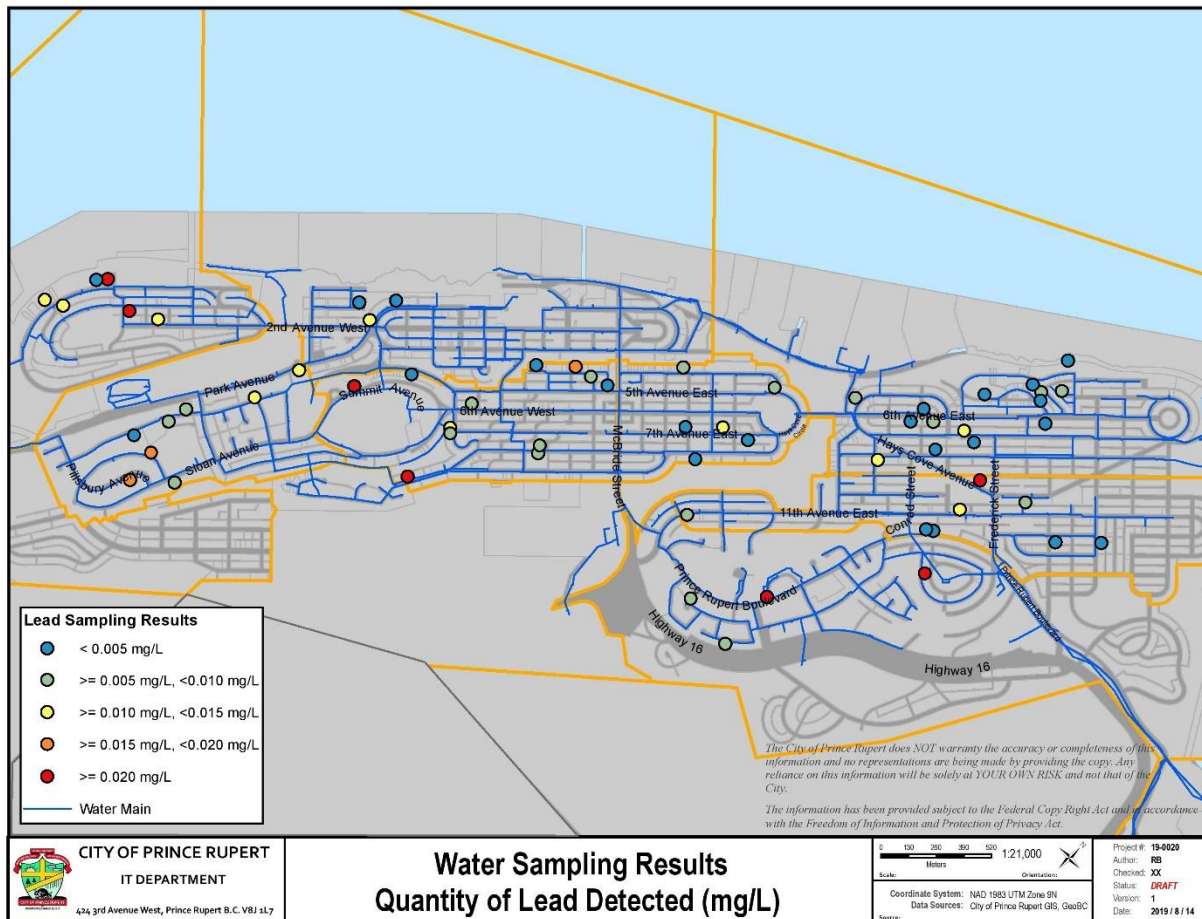


Figure 1 - Geographic Distribution of Lead Concentrations

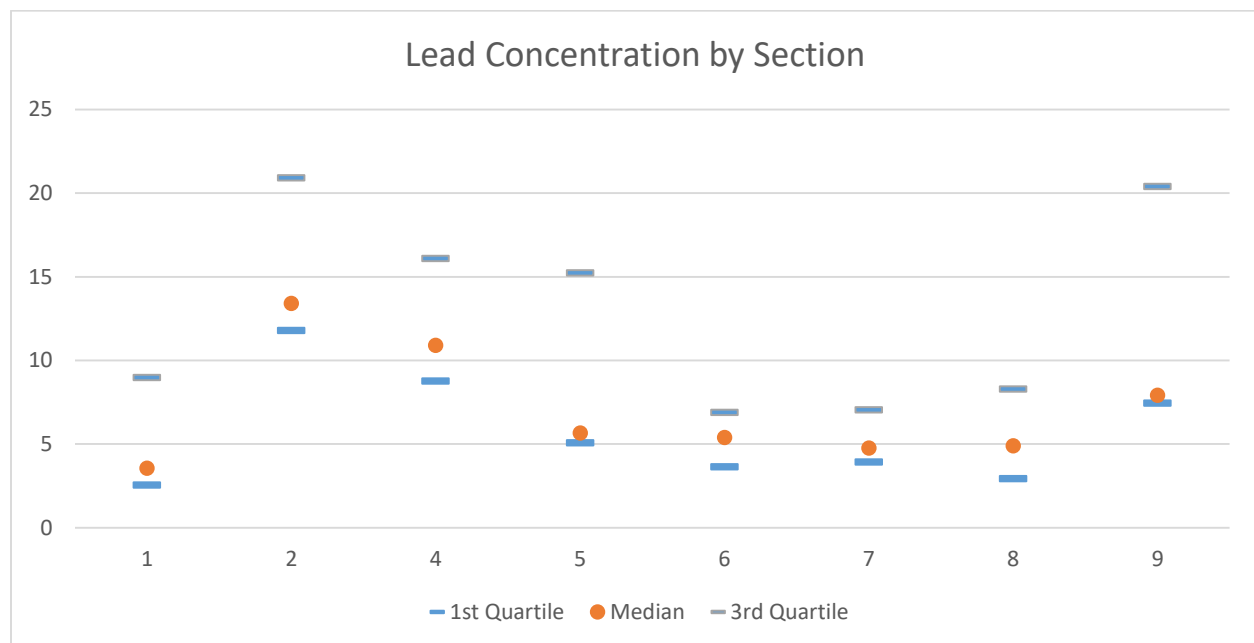


Figure 2 - Lead Concentration by Section

With regards to the presence of lead, participants were asked upon registration whether they were aware of the presence of lead within their home plumbing systems. Participants had the option of responding with “Yes”, “No”, or “Unsure”. Treating those who responded as unsure as intermediaries between known presence or absence of lead, the correlation of lead presence to measured lead concentration was calculated. Surprisingly, this factor showed little to no correlation, with a correlation coefficient of only 0.04 between the variables. The absence of any strong correlation is readily visible in Figure 3 below.

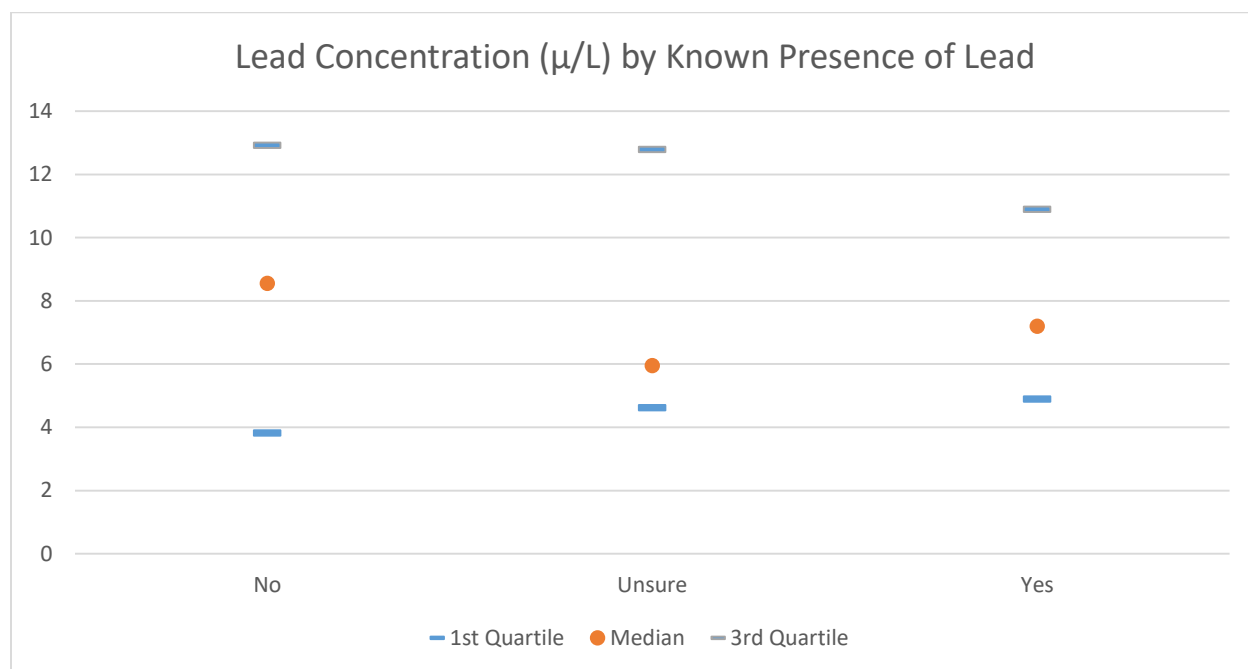


Figure 3 - Lead Concentration by Known Presence of Lead

Lead concentration was also evaluated against the reported age of the home. Participants were offered the ability to provide the construction date of their home within one of several ranges, including 1900-1940, 1941-1960, 1961-1979, and 1980 onwards. Participants who were unsure of the age of their home were excluded from evaluation. Though a negative correlation may have been expected (indicating that older homes contained a higher concentration of lead) in fact, a weak positive correlation seems to be present, with a correlation coefficient of 0.25.

Looking at the data in more detail, we can see that the majority of high results are concentrated in the construction date range of 1961-1979. This range represents nearly a third of all sample participants and so this might be expected, however examining the median and quartile ranges clearly shows that this range of home construction age has the highest lead concentrations of all categories.

Also notable in this data is the unexpectedly high concentrations relative to other categories for homes built after 1980. These homes would have been built after regulations were implemented to reduce lead in plumbing components, and yet their median and upper quartile concentrations are noticeably higher than those of much older homes.

Figure 4 below presents the lead concentration median and quartile range data for all categories of home age.

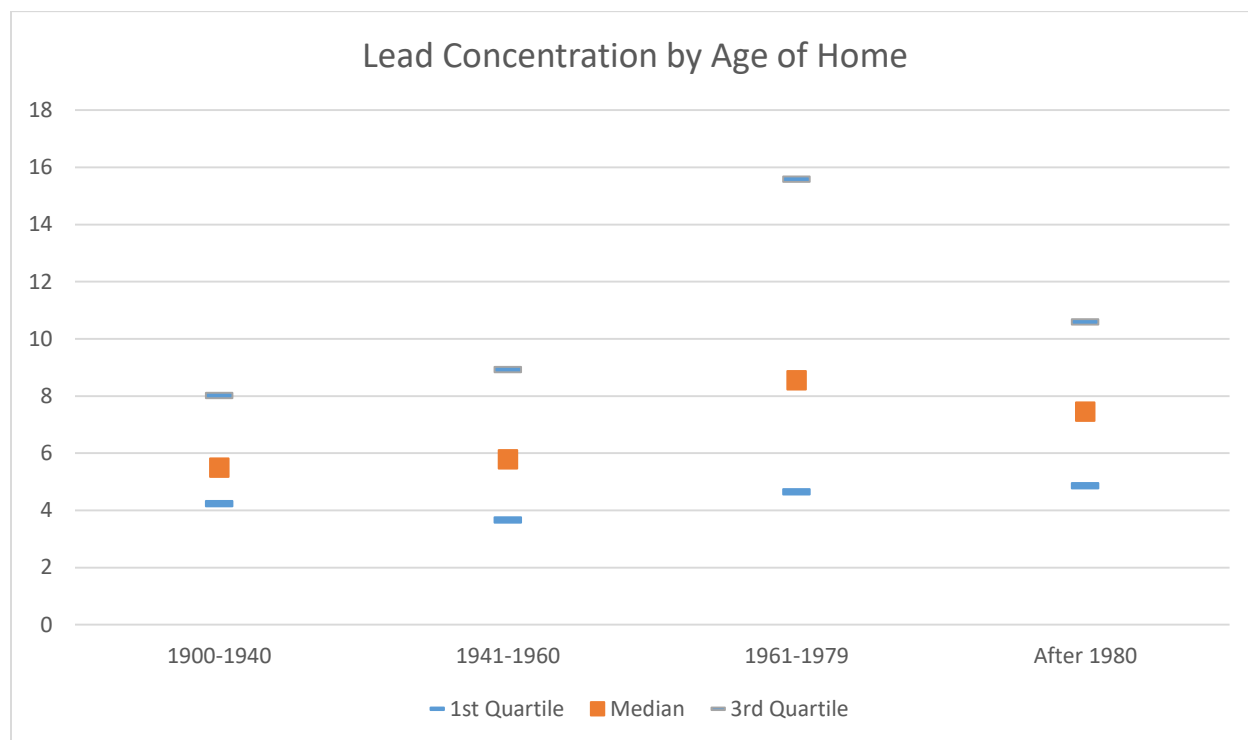


Figure 4 - Lead Concentration by Construction Date

SECONDARY SAMPLE PROGRAM IMPLEMENTATION

The receipt of primary test results yielded eleven households above the 15 µg/L testing threshold for lead, prompting the requirement for secondary testing of those households. As previously noted, those households were contacted by telephone to invite them to participate in secondary testing and to provide them with instructions on how to take part. Respondents were directed to fill three 1 L bottles after the water had not been used for 6 hours, and return them to the testing lab or City Hall. (See Appendix B for details). These same samples were also tested for copper in the same manner as for lead.

During the process of distributing the secondary test kits, it was identified by Northern Health that the previously-approved 3-bottle test regime that had been initiated was not in line with most recent regulatory standards, so a third, tertiary sample program was initiated to a 4-bottle testing standard. In total, 8 households completed secondary testing with a 3-bottle test, as they had begun prior to the identification of the need for 4-bottle testing.

SECONDARY SAMPLE PROGRAM RESULTS

Of the eight samples received from secondary sampling program participants in the secondary (3-bottle) testing program:

- All but one of eight samples measured significantly reduced concentrations of lead between the first and third bottle tests
- The mean sample concentration dropped from 32.3 µg/L to 13.8 µg/L over the course of the three bottle test
- One sample dropped below 5 µg/L for lead (the current MAC) by the third bottle
- Four samples dropped below 10 µg/L for lead (the MAC prior to 2019) by the third bottle
- Of the remaining three samples, two saw lead concentration reductions between the first and third litres tested, indicating that additional flushing would likely reduce the concentration further
- The final sample, which saw the highest concentration in lead in the third bottle test, is considered an outlier
 - Additional testing would be required to understand whether this was an issue of bottle mis-labelling, or some other unknown factor
- In the secondary tests for copper concentration, all measures of copper concentrations dropped substantially between the first and third bottle drawn
- The mean sample concentration for copper dropped from 3.48 mg/L to 2.09 mg/L over the course of the three bottle test
- Four of the eight households dropped below the 2 mg/L threshold (MAC) for copper by the third bottle test
- All test results showed copper concentrations below 3 mg/L following the third bottle test.

See Figure 5 and Figure 6 for additional detail on lead and copper concentrations throughout testing for individual respondents.

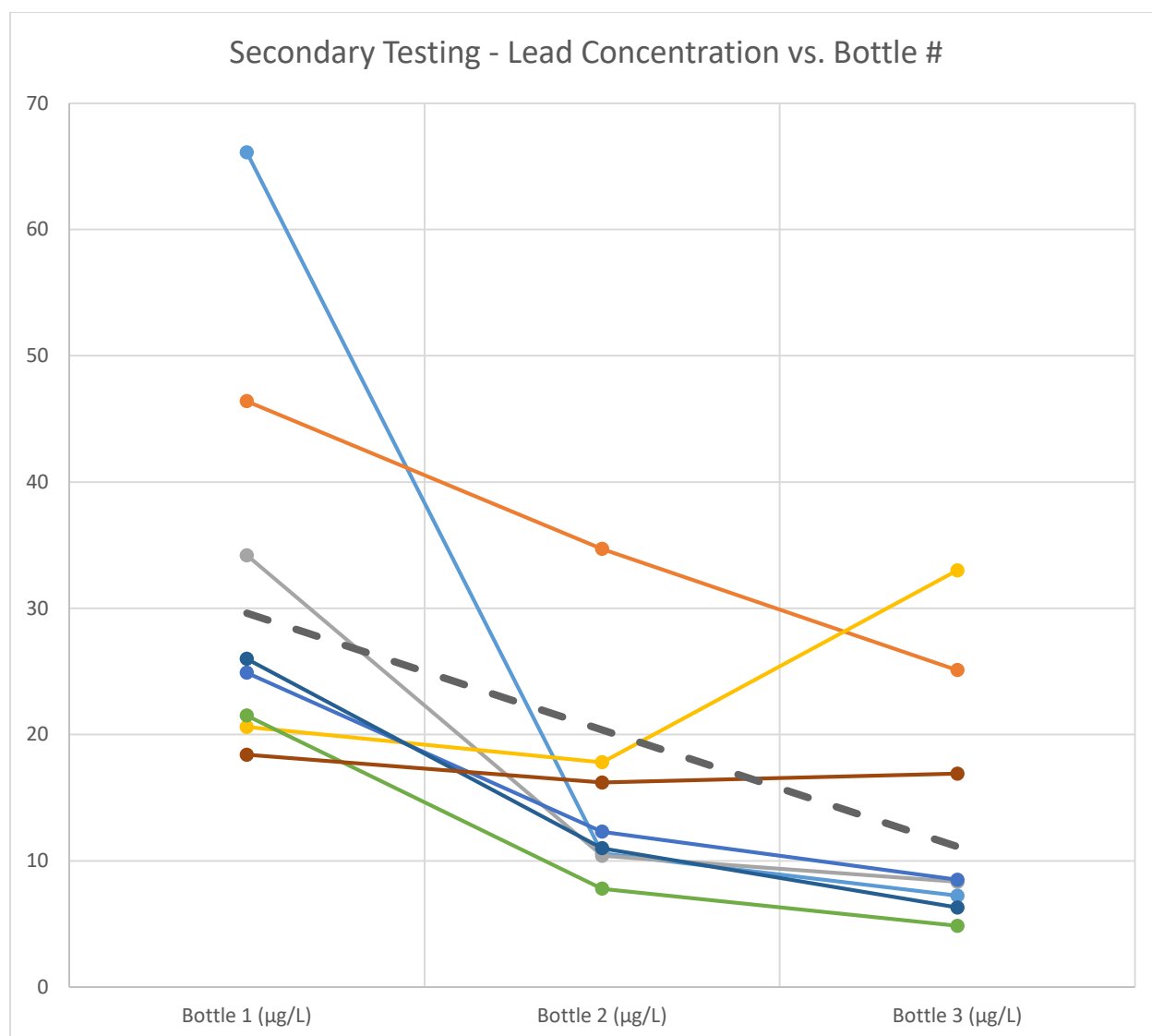


Figure 5 – Secondary Testing Lead Concentration Versus Bottle # (Three Bottle Test)

The Figure above displays each participant's sample concentrations vs. the bottle number of their samples, along with a trendline for the data set. Though not all sample sites dropped below the 5 µg/L MAC for lead following three litres of flushing, the sample set as a whole trends downward quite quickly. This suggests that as water is sampled from points upstream of the sample point of withdrawal, lead concentrations are reduced. This result would seem to confirm that the presence of lead in these samples is not related to distribution lines or City-side service lines, but rather a function of lead content in copper pipes, joints or fixtures within the home's plumbing.

Based on the data collected, the median concentration for lead for the 8 samples collected following the third bottle test was 13.78 µg/L, below the original threshold for secondary testing. It should be noted, however, that two of these samples are outliers, with one flagged as potentially requiring retesting.

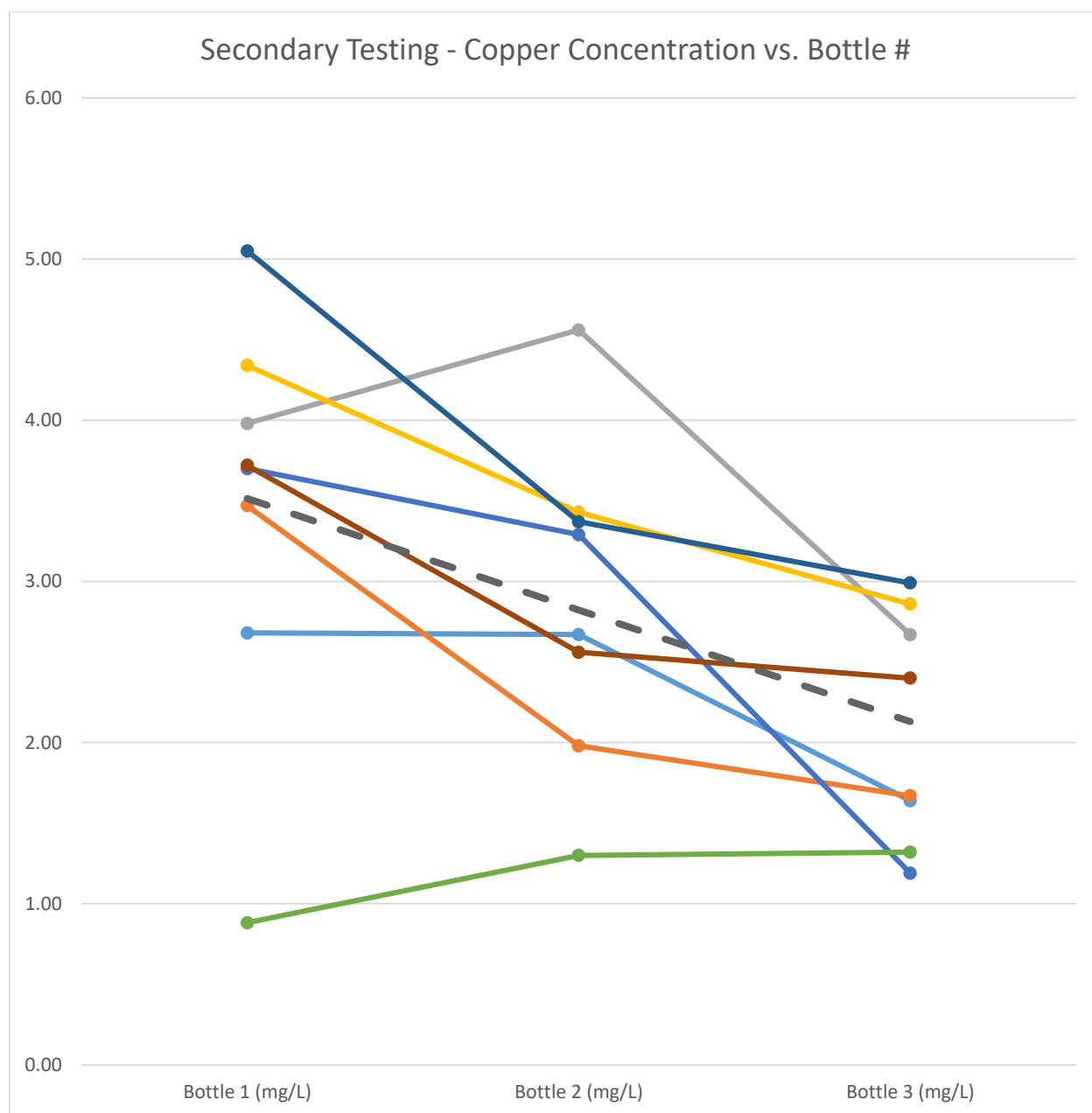


Figure 6 – Secondary Testing Copper Concentration Versus Bottle # (Three Bottle Test)

As with the Figure for lead, the Figure above displays each participant's sample concentrations for copper vs. the bottle number of their samples, along with a trendline for the data set. Over the course of the three-bottle test, all samples above the 2mg/L MAC in the first bottle sampled dropped in copper concentrations substantially by the third. The median sample concentration at the third bottle test for copper concentration is 2.0925 mg/L.

These Figures summarize the Secondary Testing Program, conducted prior to notice that a 4-bottle test would be required. The Tertiary Sample Program described below addresses the results from the 4-bottle test.

TERTIARY SAMPLE PROGRAM IMPLEMENTATION

The final Tertiary Sample Program attempted to gather and analyze 4-bottle samples from the top 10% (six sites) of all households tested in the initial Primary Sample Program. All six kits were distributed to the selected households by the end of 2019. However despite the city's best efforts, only 5 households returned their samples. Repeated attempts to contact the final participant have been unsuccessful, and our current understanding is that this participant may no longer reside at their original sampling address.

TERTIARY SAMPLE PROGRAM RESULTS

Of the five samples received from the tertiary sample program participants:

- All five samples measured significantly reduced concentrations of lead between the first and fourth bottle tests
- The mean sample concentrations from all five participants were an initial concentration of 31.47 µg/L reducing to a concentration of 7.67 µg/L by the third bottle
- One sample dropped below 5 µg/L for lead (the current MAC) by the fourth bottle
- Three of the five samples dropped below 10 µg/L for lead (the MAC prior to 2019) by the fourth bottle
- The remaining sample was measured at 30.4 µg/L, but had decreased to a concentration of 12.3 µg/L by the fourth bottle
 - It is worth noting that this sample site was the only one of the five to be located in an apartment building as opposed to a detached home
- Of tertiary tests for copper concentration, all but two samples dropped below the 2 mg/L threshold (MAC) for copper in the fourth bottle test
- The remaining two samples displayed concentrations of 2.2 mg/L, and 3.06 mg/L in the fourth bottle tested
- The mean sample concentrations for copper began at 3.55 mg/L in the first bottle tested, reducing to 1.86 mg/L by the fourth bottle sampled

See Figure 7 and Figure 8 for additional detail on lead and copper concentrations throughout testing for individual respondents.

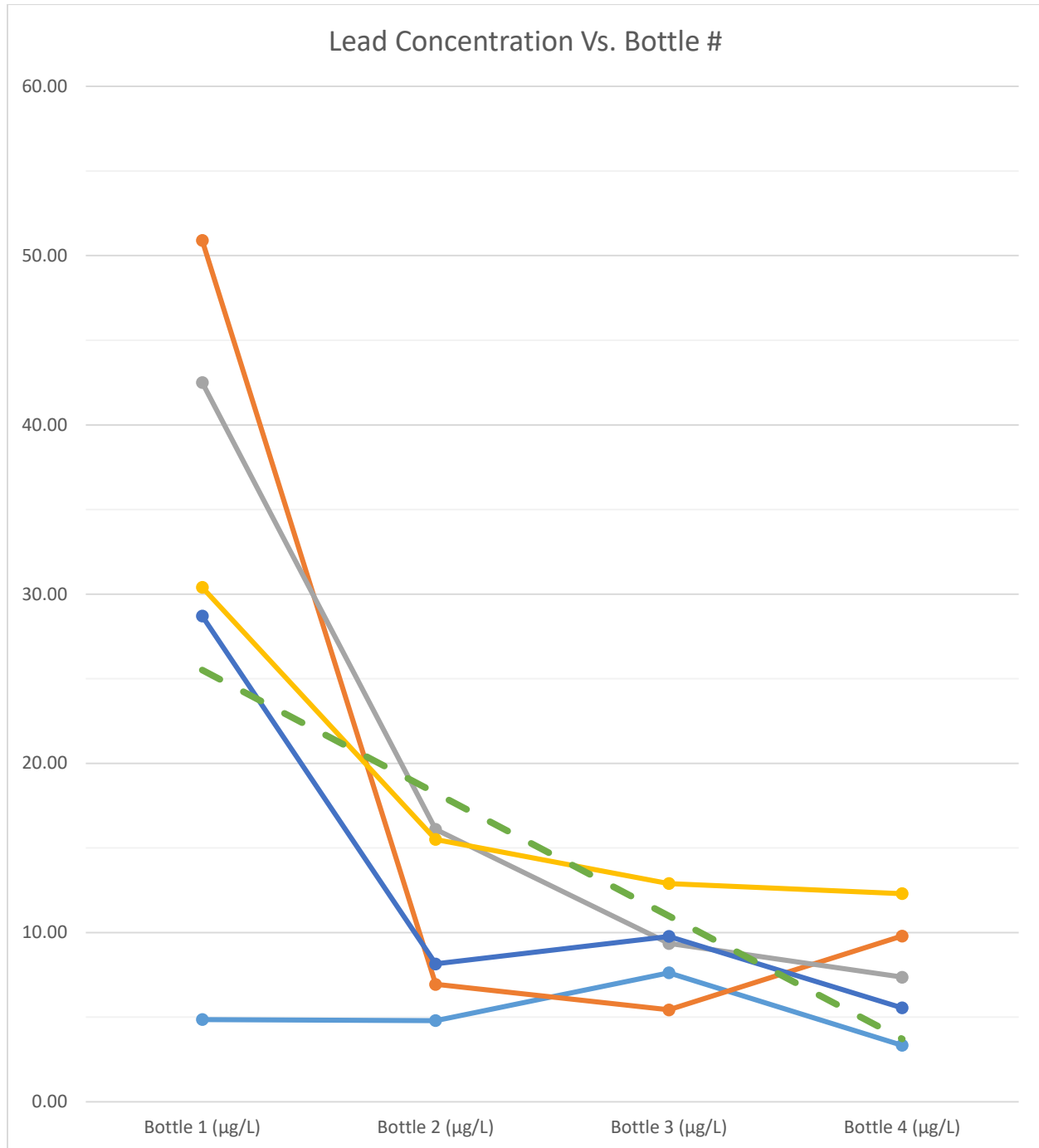


Figure 7 - Lead Concentration Versus Bottle # (Four Bottle Test)

As with the 3-bottle tests, the Figure above displays each participants sample concentrations for lead vs. the bottle number of their samples, along with a trendline for the whole data set. Based on the data collected, the mean concentration for lead for the final five samples collected following the fourth bottle test was 7.67 µg/L, below the MAC for lead prior to 2019. Based on the trendline generated from the data, it is anticipated that further flushing (for the full suggested 2-3 minute range) would reduce lead concentrations to below the MAC in this cohort of households.

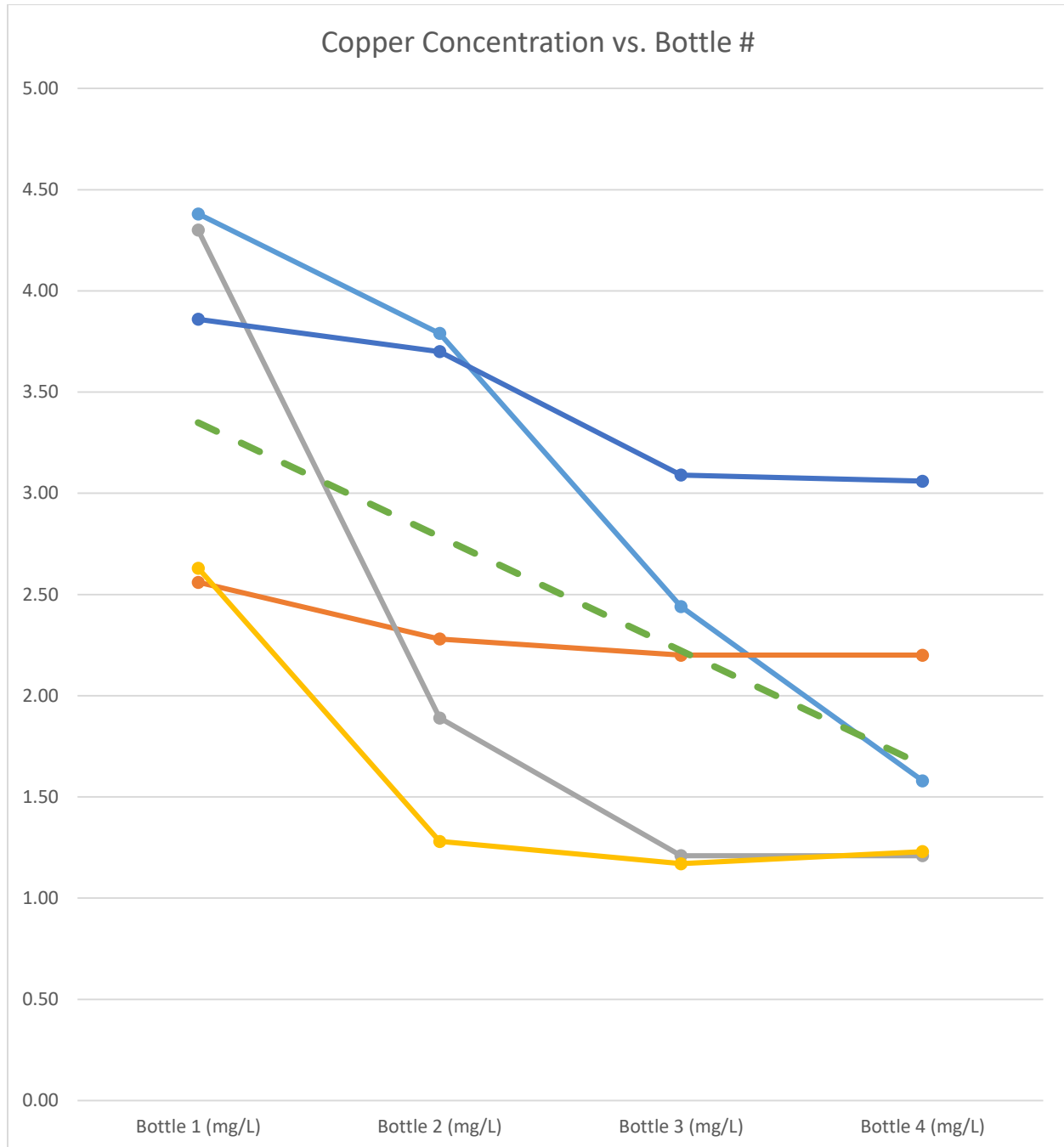


Figure 8 - Copper Concentration Versus Bottle # (Four Bottle Test)

As with the figure for lead, the figure above displays each participant's sample concentrations for copper vs. the bottle number of their samples, along with a trendline for the whole data set. Following the fourth bottle test, all samples dropped in copper concentrations substantially, which only two samples remaining above the 2 mg/L MAC. The mean sample concentration at the fourth bottle test for copper concentration was 1.86 mg/L, below the newly instituted MAC. Based on trendline generated from the data, it is anticipated that further flushing (for the full suggested 2-3 minute range) would reduce copper concentrations to below the MAC in this cohort of households.

CONCLUSIONS

Based on the results obtained from the sampling program, there do not appear to be any defined areas within the city that are more at risk of increased concentrations of lead or copper due to contributions from installed infrastructure. The lack of any clear problem areas means that targeted interventions such as localized treatment or replacement of installed infrastructure are not available to the City to reduce the risk of lead leaching in homes due to corrosion.

The data gathered by the City on other relevant household parameters (building age, type of dwelling, and known presence of lead plumbing) unfortunately also did not demonstrate any strong correlations that could be readily acted on in a targeted manner. However, the data gathered regarding home construction dates did validate the City's existing approach of recommending that all homeowners with home plumbing installed or replaced before 2013 flush their pipes before consuming water.

At this time, the City intends to continue informing residents of the risk of lead and copper leaching in their homes as it works towards the development of a comprehensive water treatment plant. Thankfully, in August of 2019, the City was awarded a significant grant for the implementation of water treatment, with \$22 million being contributed by both federal and provincial governments. With this grant funding in hand, the City is working towards completing the construction of this upgraded water treatment facility within the next 5 years. The construction of this facility should result in the improvement of multiple measures of water quality, including a reduction in the corrosiveness of the water entering homes.

Though any home containing lead and copper in their plumbing will always have some risk of metals leaching, reducing the corrosiveness of the City's water in the long term should substantially reduce this risk. In the meantime, a consistent communications campaign informing residents of the risk and educating them on the steps they can take to reduce that risk is likely to be the most effective means of ensuring the public's health.

Until such time as the new water treatment plant is in operation, the following mitigations have been suggested, and will continue to be shared via the City's communication channels, as per the direction of Northern Health:

- Continue communicating the risks of lead in household drinking water to the public
- Recommend that all users flush their water for 2-3 minutes prior to use, to ensure that they are drawing water that has not been stagnant in the home's plumbing system for an extended period of time
- Recommend that any household with increased sensitivity to lead (pregnant or nursing mothers or those with small children) have their home's water tested to confirm that flushing in this manner will be effective
- For any households with abnormally high initial concentrations of lead (greater than the outlier value of 23 µg/L), recommend the installation of lead-specific under sink filters for drinking water until the new treatment system is in operation
- Recommend that all households with copper pipes or fittings or fixtures that have the potential to contain lead replace those components with modern lead-free alternatives as they're able

APPENDIX A – PROGRAM DESCRIPTION LETTER



CITY OF PRINCE RUPERT

424 - 3rd Avenue West, Prince Rupert, B.C. V8J 1L7

www.princerupert.ca

April 8, 2019

DELIVERED VIA EMAIL

Attention: Vu Nguyen
Environmental Health Officer, Prince Rupert and Haida Gwaii
Northern Health

Dear Mr. Nguyen,

RE: City of Prince Rupert Corrosion Field Sampling Program

As you are aware, the City of Prince Rupert's Operating Permit for the City's drinking water system includes a requirement that the City "develop a monitoring program for assessing corrosion of materials in residential distribution system. The City has reviewed the Interim Guidelines on Evaluating and Mitigating Lead in Drinking Water Supplies, Schools, Daycares and Other Buildings, and in coordination with Northern Health has developed the following plan for testing to be implemented by July 31, 2019.

The City will begin by developing a publicity campaign to enroll community members into the testing program. The publicity campaign will make use of the City's digital engagement platform Rupert Talks to provide homeowners with information about potential sources of lead in their drinking water, to gather information about their home's plumbing and other building characteristics, and to encourage them to take part in the testing program. The program will be advertised initially through postings on the City's website, with a goal of attracting a minimum of 75 participants. Should it be necessary, the City will consider advertising through the local newspaper or by direct mail until the required number of registrants has been achieved. Once the minimum number of registrants have been obtained, 75 of them will be selected randomly to provide testing locations distributed throughout all areas of the community, and will be requested to take part.

Selected participants will be instructed to obtain a free sample kit from the front desk at City Hall during regular business hours, and to return their kit to Norlab (the City's testing lab) for testing by no later than June 1, 2019. The sample kit will contain a sterile one liter sample bottle with a unique ID sticker affixed, a page of testing instructions produced by Norlab (attached), and a copy of the City's information pamphlet on potential sources of lead in drinking water (also attached). As participants obtain their kit, City staff will record which kit was provided to the participant and when that kit was obtained. Norlab will provide the City with test results as they are received, and staff will update the program tracking table to allow for follow-up with those participants whose samples are not returned promptly.

If by June 1st the City has not received the results from at least 60 participants, staff will follow up with participants until the minimum number has been received. Following June 1st, once

OPERATIONS DEPARTMENT

Email: richard.pucci@princerupert.ca

Phone: 250.627.0950

Fax: 250.627.0999

at minimum 60 samples are returned, the City will evaluate those results to determine whether more than 10% of samples contained concentrations of lead greater than 0.015 mg / L. If more than 10% of households exceed the initial screening limit, then the City will follow up with those participants who exceeded the limit to take part in a secondary 3-bottle test, to be completed by July 31st, 2019.

The sampling plan above was developed following the protocol for evaluating if corrosion control is appropriate, described in section 2.1 of Appendix C in the guidelines provided by Northern Health. Following completion of the sampling program, the City will work with Northern Health to evaluate all results and determine if any additional mitigations are warranted. All individual testing results will be provided to the participants, and additional mitigations communicated to participants and the public as appropriate.

We trust that this plan as described will fulfill the City's immediate obligations under our operating permit. If you require any further information or clarifications, please inform us and we will provide a prompt response.

Sincerely,

A handwritten signature in black ink, appearing to be 'RP' followed by a horizontal line.

Richard Pucci
Director of Operations
City of Prince Rupert

/hs

cc: Robert Long, City Manager

Encl: Water Quality Mailout
Norlabs Lead & Copper Sampling Instructions

APPENDIX B – PROGRAM INSTRUCTIONS

Lead & Copper Secondary Sampling Instructions

Preparation for Sampling

- Do not use any water in the water system **for at least six hours** before collecting water samples. The period of no water use should be no longer than 24 hours.
- **No Water Use Includes:** NO running taps, flushing toilets, showering, dishwashing, laundry or any other household water use. Be sure appliances, such as icemakers, lawn sprinkler systems and HVAC humidifiers are shut off.
- Since 6 hours of no water use is required, the best time for collecting water samples is either first thing in the morning or upon returning home at the end of the work day.
- Identify a **COLD** water tap that does not have a water treatment unit or filter attached to it.

Sampling Steps

1. **Start with the bottle labeled “Secondary Sample Kit #1”**
2. Open the bottle and hold it under the faucet.
3. Turn the water on to a low flow and collect the first 1 liter of water that comes out of the faucet.
(DO NOT RUN THE WATER FROM THE TAP BEFORE FILLING THE BOTTLE)
4. Fill the bottle and turn off the tap as soon as the bottle is filled.
5. Place the lid on the bottle and tighten the cap securely.
6. **Repeat steps 1-5 above for Secondary Sample Kits #2, #3 and #4, in order.**
7. Complete the Sample Submission Form on the opposite side of this page.
8. Return the sample bottles along with the Sample Submission Form to Northern Laboratories or Prince Rupert City Hall:

Northern Laboratories (2010) Ltd.
530 3rd Avenue West
Prince Rupert BC V8J 1L8
250-627-1906

City of Prince Rupert
424 3rd Avenue West
Prince Rupert BC V8J 1L7
250-627-1781