CITY OF VANCOUVER

WATERWORKS UTILITY

ANNUAL REPORT 2023

The Waterworks Utility Annual Report 2023 cover pages were designed by Mackenzie Bonnell, a Media Arts student at Sir Charles Tupper Secondary School.

Waterworks Utility Annual Report 2023

The City of Vancouver acknowledges that it is situated on
the traditional, ancestral, and unceded territories of
the xʷməθkʷəy̓əm (Musqueum) Indian Band,
the Sḵwx̱wú7mesh (Squamish) Nation, and
the səl̓ilwətaʔɬ / sel̓íl̓witulh (Tsleil-Waututh) Nation,
who continue to steward and protect the lands and waterways
since time immemorial.

Executive Summary

This report summarizes the City of Vancouver Waterworks Utility activities and program outcomes for the year 2023. It includes a financial summary for the year, and provides in-depth information on Waterworks performance in programs for:

- Drinking Water Quality
- Water Conservation
- Capital Asset Management
- Asset Operations and Maintenance

This report is posted on the City's website to assure the public of the excellent quality of Vancouver's drinking water, and to highlight the programs and activities supporting continuous delivery of clean, safe drinking water to Vancouver customers.

In accordance with provincial regulations governing water suppliers in British Columbia, the City of Vancouver is required to conduct routine testing of the drinking water quality and to make these results publicly available within 6 months of year-end. This report fulfills those requirements.

If you have any questions about this report, please contact us at 3-1-1.

Useful Contacts and Websites

City of Vancouver	vancouver.ca	3-1-1 (outside Vancouver: 604-873-7000)
Metro Vancouver Water Services	metrovancouver.org/services/water	604-432-6200
Vancouver Coastal Health	vch.ca	604-675-3800
Health Canada	canada.ca/en/health-canada.html	1-833-784-4397
Waterworks Bylaw 4848	bylaws.vancouver.ca/4848c.PDF	
Drinking Water Sampling Results	vancouver.ca/home-property-development/drinking-water-monitoring-and-results.aspx	
City of Vancouver: Water Quality and Water Pressure	vancouver.ca/home-property-development/problems-with-water-quality-or-pressure.aspx	
How to Check your Toilet for Leaks	youtube.com/watch?v=3TtNRUf7-lg	
The Irrigation Assessment Program	youtube.com/watch?v=SJ4A54jkpMk	
Metro Vancouver's Corrosion Control Program	metrovancouver.org/services/water/corrosion-control-program-copper-pipes-protection	
City of Vancouver: Traffic Impacts and Construction Projects	vancouver.ca/streets-transportation/roadwork.aspx	

Acronyms and Abbreviations

AO	Aesthetic Objective
BCDWPA	*British Columbia Drinking Water Protection Act*
BCDWPR	*British Columbia Drinking Water Protection Regulation*
CFU	Colony Forming Units
Cl_2	Chlorine
DBP	Disinfection By-product
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency (USA)
ERP	Emergency Response Plan
GCDWQ	*Guidelines for Canadian Drinking Water Quality*
HAA	Haloacetic Acid
HPC	Heterotrophic Plate Count
K	Thousands
km	Kilometre
m	Metre
M	Million
MAC	Maximum Acceptable Concentration
mg/L	Milligram per Litre
mL	Millilitre
mm	Millimetre
N/A	Not Available
NTU	Nephelometric Turbidity Unit
Park Board	Vancouver Board of Parks & Recreation
pH	Measure of acidity or basicity; pH 7 is neutral
ppb	Parts per Billion
ppm	Parts per Million
SCFP	Seymour Capilano Filtration Plant
THM	Trihalomethane
TM	Transmission Main
UDCL	Utility Development Cost Levy
µg/L	Micrograms per Litre
µS/cm	Micro-Siemens per centimeter
WDMS	Water Demand Management Strategy
WHO	World Health Organization
WQMRP	*Water Quality Monitoring and Reporting Plan for Metro Vancouver and Local Government Members*

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1 City of Vancouver Waterworks Utility

Drinking Water Utility Mission

Dedicated to the enhancement and protection of public health and safety
by providing a reliable, accessible, and sustainable supply of high-quality drinking water,
through a system well-managed and maintained
by a team of dedicated and committed staff.

The City of Vancouver Waterworks Utility (Waterworks) purchases treated drinking water from Metro Vancouver and operates a City-wide network of transmission and distribution water mains to deliver this water to customers. In 2023, Waterworks delivered 104.9 billion litres of drinking water throughout Vancouver.

Waterworks consists of the Design Branch, which designs and administers the utility, and the Operations Branch, which builds, operates, and maintains the distribution system.

Waterworks operates on a self-funded basis, with revenues from water customers and the water stabilization reserve covering the costs of water procurement, capital and operating expenses, and City debt.

Total actual expenditures amounted to $156M in 2023, with $90M allocated to purchasing bulk water from Metro Vancouver and $66M dedicated to system maintenance, including debt servicing costs for capital borrowing.

2 Source Water

All drinking water in Vancouver is purchased from Metro Vancouver. The drinking water comes from rain and snowmelt captured in the Capilano, Seymour and Coquitlam watersheds. Metro Vancouver manages and protects the watersheds and keeps them closed to the public to prevent contamination. No recreational, agricultural, or industrial activities that may contaminate the water are permitted within watershed boundaries.

Metro Vancouver also owns and operates the region's Seymour-Capilano Filtration Plant and the Coquitlam Water Treatment Plant, where source water undergoes treatment and disinfection before distribution to the municipality.

Metro Vancouver monitors and tests the treated water source to ensure its safety and quality. Results are available on their website at metrovancouver.org.

The Capilano Watershed, managed by Metro Vancouver, offers educational opportunities through guided tours. For information on watershed field trips and upcoming events, please contact Metro Vancouver or visit their website. *Image courtesy of Metro Vancouver.*

3 Drinking Water Quality Monitoring Program

Vancouver maintains high standards of drinking water quality, consistently meeting provincial standards, federal guidelines, and industry practices.

The *British Columbia Drinking Water Protection Act* (BCDWPA) and *British Columbia Drinking Water Protection Regulation* (BCDWPR) govern water suppliers in the province. Each municipal water purveyor, including the City of Vancouver, is mandated to hold an annual operating permit issued by the region's Drinking Water Officer.

To ensure compliance with provincial legislation, the *Water Quality Monitoring and Reporting Plan for Metro Vancouver and Member Municipalities* (WQMRP) was jointly developed by regional Medical Health Officers, Metro Vancouver, and local government members, including the City of Vancouver.

The City's water quality monitoring program operates under the protocols outlined in the WQMRP. Drinking water is routinely collected from 53 sampling stations located throughout the City's distribution system (Appendix A), and analyzed for compliance with the BCDWPR, the WQMRP, and Health Canada's *Guidelines for Canadian Drinking Water Quality* (GCDWQ). To enhance monitoring frequency and consistency, the City shifted from biweekly to weekly sampling at all drinking water sampling stations. Sampling parameters and reference frequencies are shown in Table 1.

In 2023, Waterworks collected 2,118 water samples for analysis of:

- Bacteria - *E. coli,* total coliforms, heterotrophic plate count
- Chemical and physical parameters - chlorine, pH, temperature, turbidity

The City also collected 40 samples for disinfection by-products, and 10 samples for metals.

Samples for bacteria, metals and disinfection by-products are analyzed by Metro Vancouver. Their laboratory is a member of the standards Council of Canada and is an accredited laboratory within the Canadian Association of Environmental Analytical Laboratories.

Sampling results are publicly accessible on the City's website, underscoring commitment to communication and transparency.

In event of deviation from standards and guidelines, an investigation is conducted immediately to identify and correct any possible causes. The City will inform the public immediately of any potential health risks through various communications channels, including radio, newspapers, television, and social media platforms. A summary of the City's Emergency Response and Contingency Plan can be found in section 6 of this report.

Table 1. Water Quality Parameters and Testing Frequency

Category	Parameter	Sample Station Sites	Frequency
Bacteriological	*E. coli*	All[1]	Weekly[2]
	Total coliform		
	HPC		
Chemical	Chlorine – free	All[1]	Weekly[2]
	Chlorine – total		
	pH		
Physical	Temperature	All[1]	Weekly[2]
	Turbidity		
Disinfection By-products	Haloacetic Acids	Representative sites	Quarterly
	Trihalomethanes		
Metals	Copper	Representative sites	Semi-annually
	Iron		
	Lead		
	Zinc		
	Other[3]		
Aesthetic	Odour & Taste	Any Site	Complaint Basis

1. "All" refers to all Vancouver's water sampling stations (53).
2. The BCDWPR requires monthly sampling. The City exceeds this requirement, sampling every station weekly.
3. The methodology for metals analysis produces additional results (Appendix C).

3.1 Drinking Water Quality Data

3.1.1 Bacteriology

BCDWPR - Schedule A: Water Quality Standards for Potable Water

Parameter	Standard
Fecal coliform bacteria	No detectable fecal coliform bacteria per 100 ml
Escherichia coli	No detectable *Escherichia coli* per 100 ml
Total coliform bacteria (a) 1 sample in a 30-day period (b) more than 1 sample in a 30-day period	No detectable total coliform bacteria per 100 ml At least 90% of samples have no detectable total coliform bacteria per 100 ml and no sample has more than 10 total coliform bacteria per 100 ml

E. Coli

Zero (0) of 2,118 samples collected contained *E. coli* in 2023.

The *E. coli* group has a stringent standard of zero maximum acceptable concentration (MAC). If *E. coli* is found in the water, under the BCDWPA, the laboratory conducting the analysis must immediately notify the City and the Medical Health Officer. Together, an assessment will be made to determine the possible health risks and the most effective approach to protecting the public. This assessment will include a review of the bacteriological records, chlorine residuals, pressure levels, and other relevant factors. The water will be resampled immediately.

If the risk assessment indicates the water system is operating within expected parameters, then a decision may be made to wait for confirmation of the follow-up sample results. However, if the assessment identifies a risk to water quality, immediate intervention may be necessary including issuing a boil water notice and corrective action taken in accordance with the City's Waterworks Emergency Response Plan.

Total Coliform

Three (3) of 2,118 samples collected contained total coliform in 2023.

1. Sampling station #7 (8180 Champlain Crescent) on July 27. TC count/100mL was 1.
2. Sampling station #16 (3792 West 4th Av) on August 14. TC count/100mL was 11.
3. Sampling station #44 (Balaclava St and Celtic Av) on August 24. TC count/100mL was 1.

After each result, the sampling station was retested immediately, and no subsequent total coliform was found.

Total coliform is a test of all bacteria within the coliform group. While not directly correlated with human health risk, they are used as indicators of how well the drinking water treatment and distribution systems are operating.

The detection of total coliform may indicate possible conditions for pathogen and/or parasite contamination within the water supply. Alternatively, it can indicate contamination during sample collection or laboratory test analysis.

3.1.2 Sampling Frequency

BCDWPR - Schedule B: Frequency of Monitoring Samples for Prescribed Water Supply Systems

Population Served by the Prescribed Water Supply System	Number of Samples Per Month
less than 5 000	4
5 000 to 90 000	1 per 1 000 of population
more than 90 000	90 plus 1 per 10 000 of population in excess of 90 000

In 2023, Vancouver's drinking water was compliant with potable water quality standards set in Schedule B of the BCDWPR. The City's water sampling program exceeded the minimum number of samples per month required by Schedule B (Table 2).

Table 2. Population size and water sampling frequency in Vancouver (2019-2023)

Year	City of Vancouver Population (incl. undercount)	Number of samples per month Required[1]	Number of samples per month Collected[2]	Number of samples per year Collected
2023	**722,014**	**154**	**177**	**2,118**
2022	701,100	151	166	1,989[3]
2021	700,280	151	168	2,017
2020	685,410	150	168	2,022
2019	674,600	148	169	2,031

1. Minimum number of samples per month required by Schedule B of the BCDWPR.
2. The number of samples collected per year does not include samples taken for disinfection by-products, metals, or site investigations.
3. In 2023, the population was taken from BC Stats Population Estimates & Projections for British Columbia. Previous years relied on Statistics Canada or population projections from Metro Vancouver to provide a custom report for the population, but these agencies were unable to provide the City with population numbers for 2023 by the report deadline.

3.1.3 Physical and Chemical Parameters

The majority of physical and chemical parameter results were within acceptable ranges. When a sample fell outside the guideline range, it was a temporary occurrence and did not affect water potability.

Table 3. Physical and Chemical Parameters

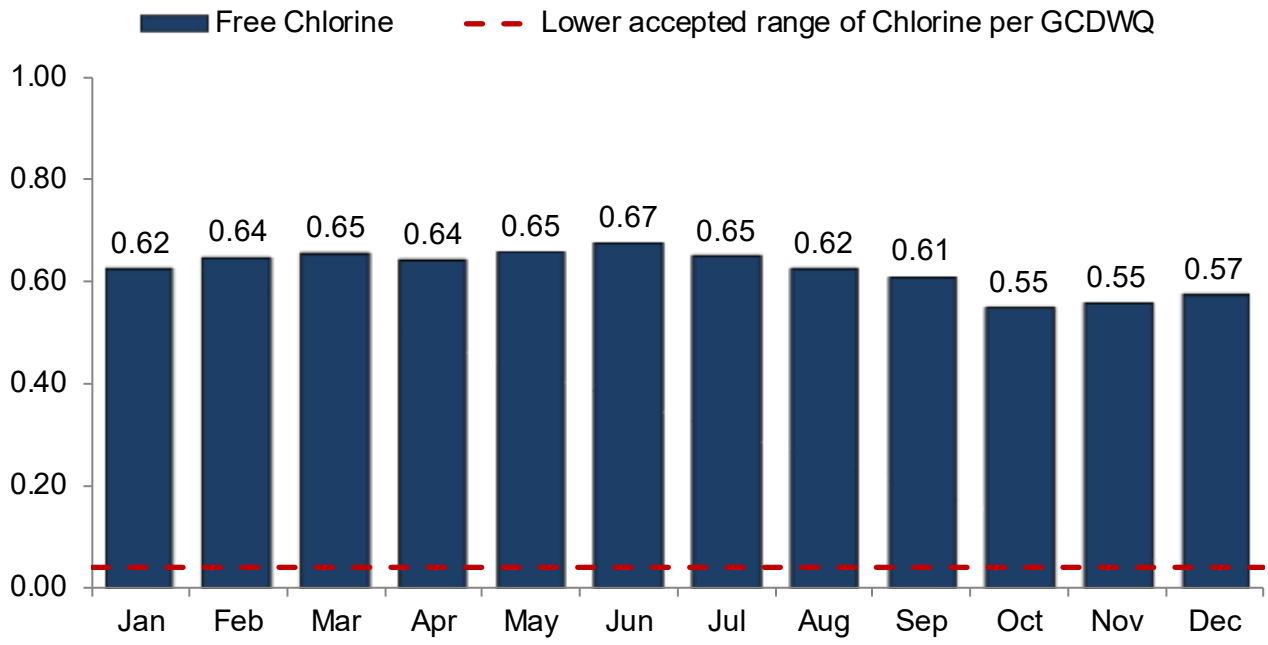
Parameter	Guidelines	Results		
		Av.	Min	Max
Chlorine – free (mg/L Cl_2)	OG: ≥0.04 mg/L Cl_2	0.62	0.08	1.22
Chlorine – total (mg/L Cl_2)	OG: ≤2.0 mg/L Cl_2	0.66	0.10	1.53
pH	7.0 – 10.5	8.49	8.11	8.93
Temperature (°C)	AO: ≤15°C	11.1	4.6	22.9
Turbidity (NTU)	≤1 NTU	0.22	0.09	1.97

Chlorine (Cl_2)

Chlorine is used to disinfect the water and safeguard against microbial re-growth or contamination. Though the GCDWQ does not have a MAC for chlorine, the suggested range is between 0.04 – 2.0 mg/L.

In 2023, chlorine levels in the City's distribution system were within recommended operational guidelines.

Figure 1. Average Monthly Chlorine (free) in 2023

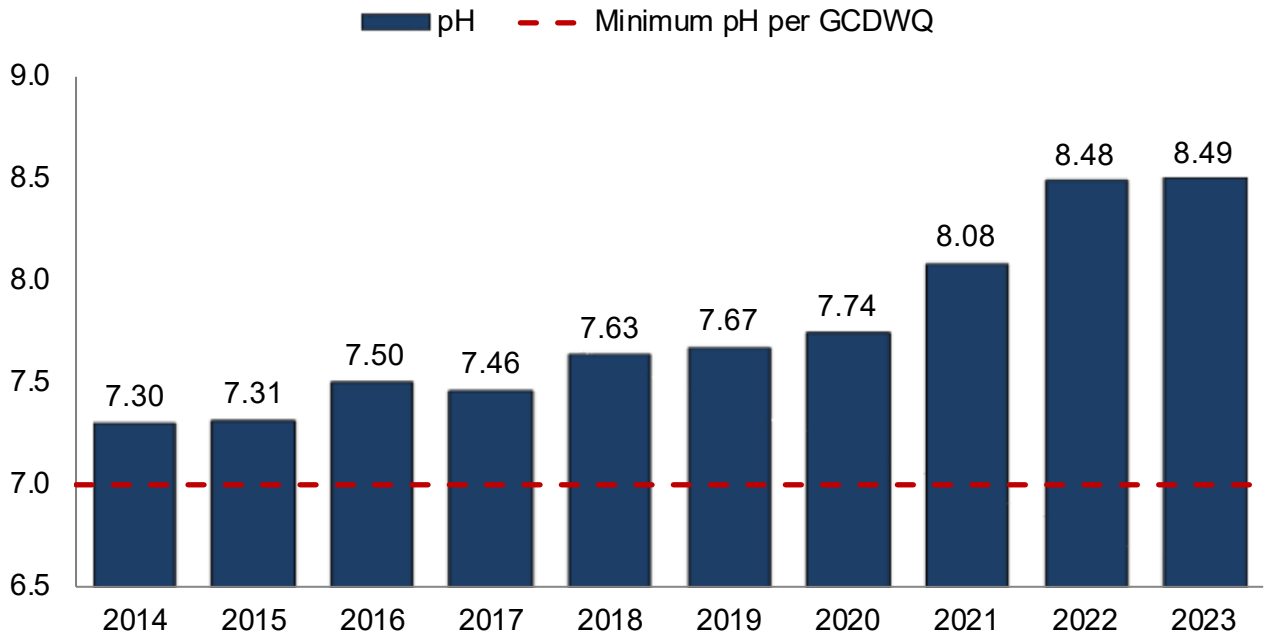


pH

pH is a measure of the acidity/basicity of water. Per the GCDWQ, drinking water should have a pH range of 7 to 10.5.

In 2023, the average pH in Vancouver was 8.49.

Figure 2. Average pH (2014-2023)



The pH of water can determine which chemical reactions will occur in piping infrastructure and possible leaching of metals. Metro Vancouver's corrosion control program treats the region's naturally soft and acidic water by raising the pH and alkalinity so that it is less likely to corrode building pipes made of copper or lead.

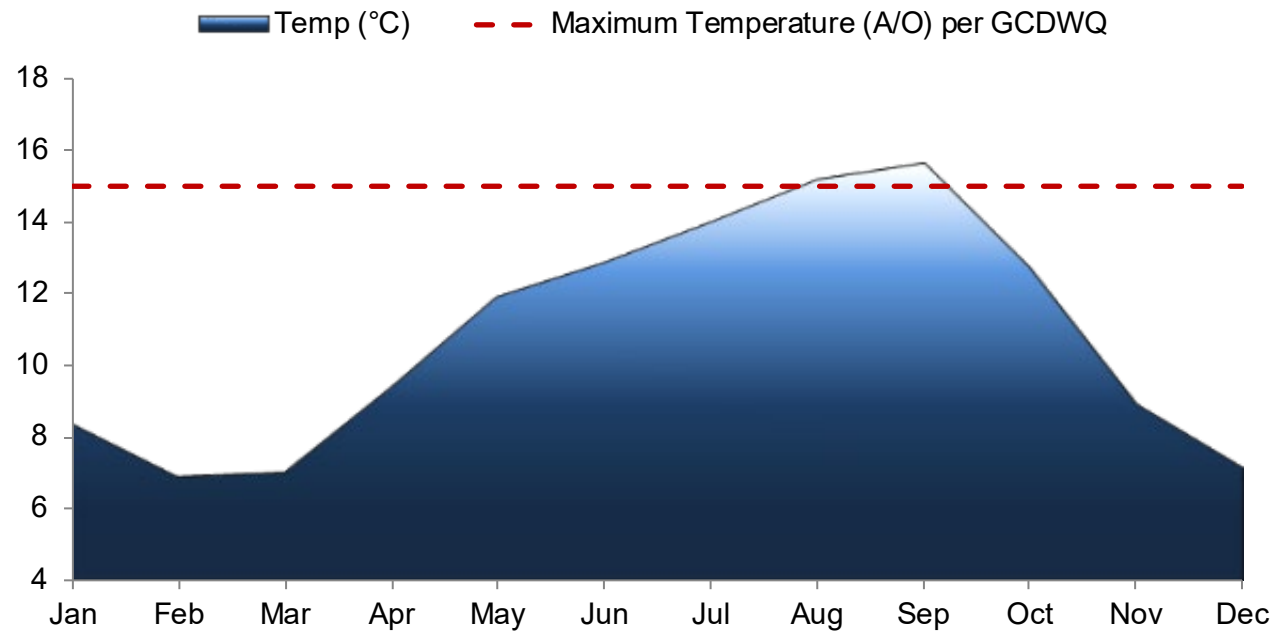
The City of Vancouver primarily consumes water treated by the Seymour-Capilano filtration plant (SCFP). SCFP uses calcium hydroxide (lime) to increase pH and carbon dioxide to increase alkalinity. The water treatment plant on the Coquitlam source uses sodium carbonate to increase pH.

Temperature

The GCDWQ sets an aesthetic objective for drinking water at less than 15°C. Temperatures above 15°C can impact aesthetic qualities and bacterial re-growth.

Vancouver's drinking water temperature is directly related to the source water and seasonal changes. The average drinking water in the distribution system remained below 15°C most of the year, with the exception of summer months.

Figure 3. Average Monthly Temperature (°C) in 2023

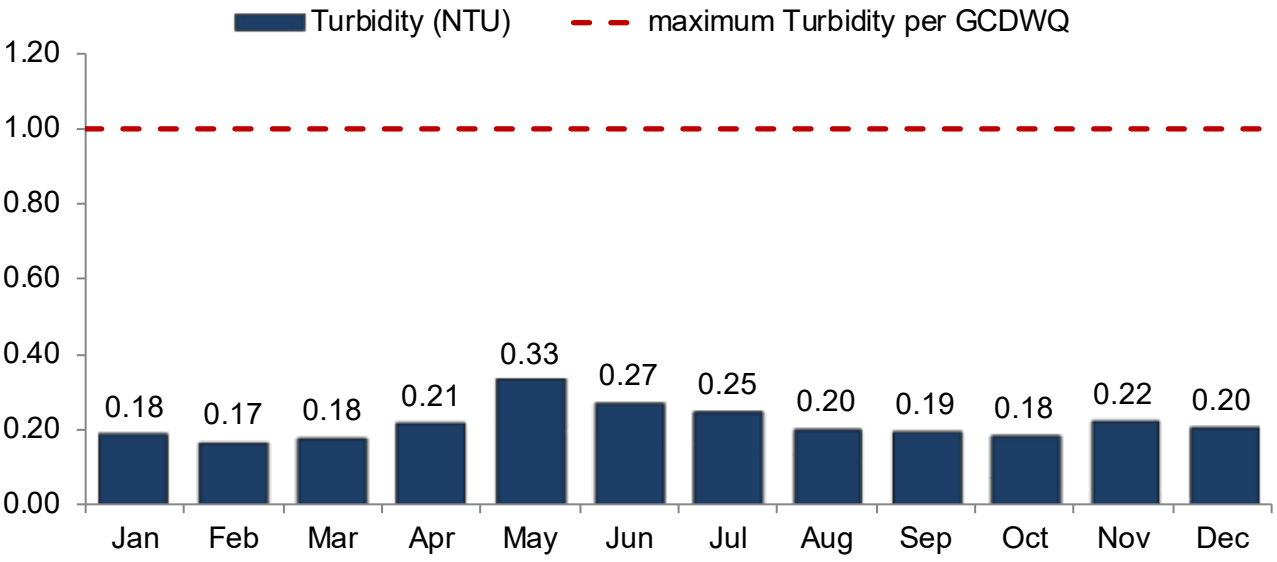


Turbidity

Turbidity is a measure of the clarity or cloudiness of water. The GCDWQ sets an objective of less than or equal to 1.0 NTU for turbidity in drinking water. Elevated turbidity levels can pose an aesthetic concern for customers and limit the effectiveness of disinfection.

The majority (99.6%) of water samples had turbidity results lower than 1.0 NTU. When turbidity above 1.0 NTU was briefly observed, there was no associated bacteriological growth.

Figure 4. Average Monthly Turbidity (NTU)



3.1.4 Disinfection By-products, Metals, Volatile Organic Compounds and Aesthetics

All Disinfection By-Products (DBP) were well below the Maximum Acceptable Concentrations (MAC) as per the GCDWQ. Metals results were below GCDWQ MAC and met aesthetic objectives (AO). DBP results and Metals results are provided in Appendices B and C.

Aesthetic concerns from the public were managed on a case-by-case basis.

Table 4. DBPs, Metals, VOCs, and Aesthetic Concerns

Category	Parameter	Reference	Guideline	Results
Disinfection By-products (DBPs)	Haloacetic Acids, total (HAAs)	GCDWQ	MAC 80 ppb	All sample results were below guideline MAC. (Appendix B)
	Trihalomethanes, total (THMs)	GCDWQ	MAC 100 ppb	
Metals	Copper	GCDWQ	≤ 1.0 mg/L (AO)	All sample results were below guideline MAC or AO. (Appendix C)
	Iron	GCDWQ	≤0.3 mg/L (AO)	
	Lead	GCDWQ	0.010 mg/L (MAC)	
	Zinc	GCDWQ	≤5.0 mg/L (AO)	
	Other	GCDWQ	Parameter specific	
Volatile Organic Compounds	Vinyl Chloride	GCDWQ	MAC 0.002 mg/L	Not applicable.
Aesthetics	Odour & Taste	GCDWQ	Not Specified	Case-by-case assessment.

Disinfection By-products (DBPs)
DBPs are compounds formed by the interaction between chlorine and naturally occurring organic substances in the water, such as breakdown products of decaying leaves and vegetation. Two groups of DBPs are monitored within Vancouver's drinking water four times yearly at 10 locations: Haloacetic acids (HAA) and Trihalomethanes (THM). The MAC listed in the GCDWQ is based on locational running annual averages from quarterly samples.

The running locational averages for THM and HAA in Vancouver's water were below the MAC.

Metals
Metal levels in the water distribution system are monitored twice yearly at 5 locations. Water samples are collected by the City and analysis are performed by the GVWD laboratory.

City water consistently met the GCDWQ guidelines for metal concentrations.

Aesthetics
Waterworks received 227 questions and complaints about the drinking water in 2023 and performed 15 investigations to resolve customers' concerns. The remainder of the investigations were resolved by phone and email. The Utility's jurisdiction over water quality terminates at the property service line; however, we support customers with our expertise and experience.

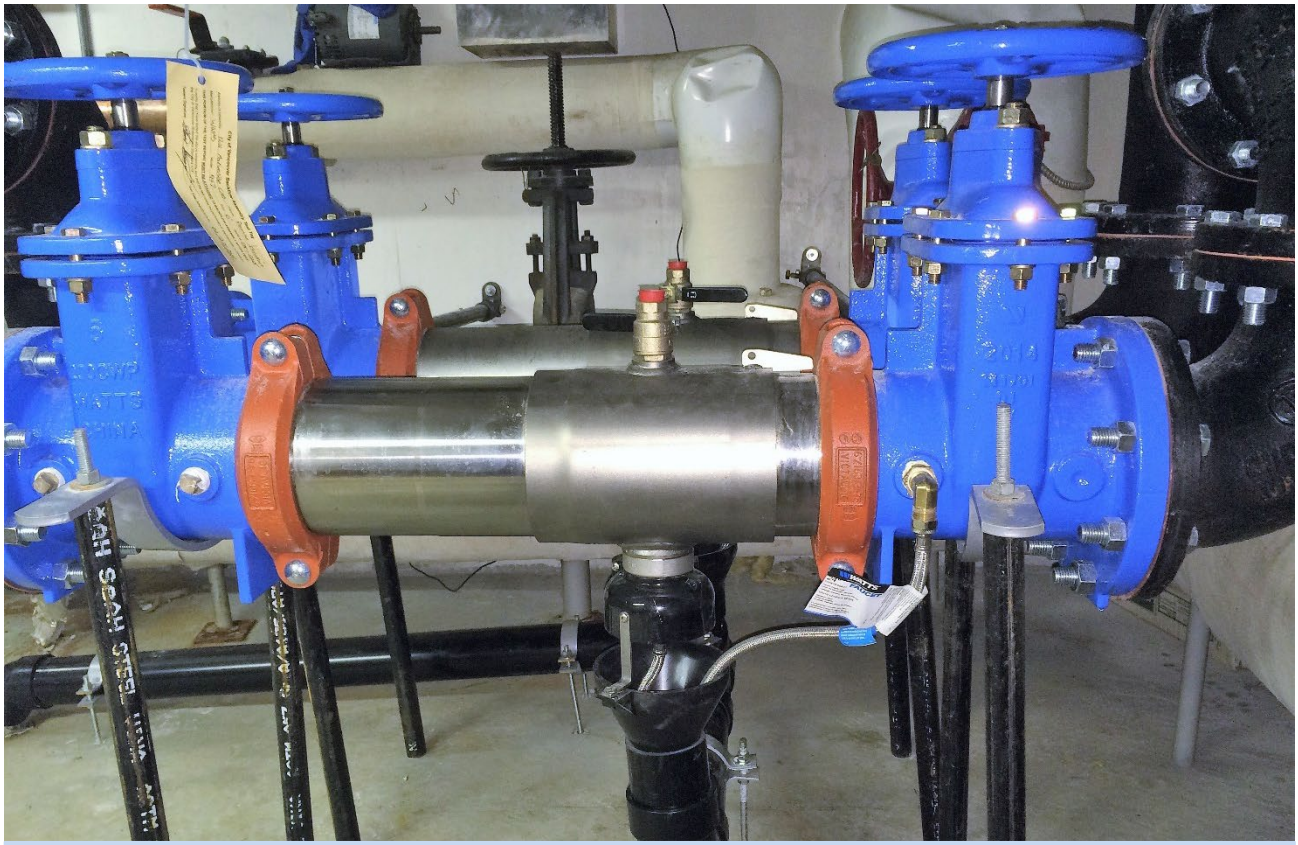
Most complaints were related to localized discolouration due to water main construction and repair work or private-side plumbing activity.

Table 5. Water Quality Complaints in 2023

Category	Total Number of Complaints in 2023
Chemical/Chlorine Odour	12
Looks Dirty/Turbid	175
Milky/Cloudy	9
Miscellaneous	33

Vancouver customers are encouraged to report water quality complaints by calling 3-1-1. Customer feedback supports our ability to promptly address possible issues with our distribution system, or to improve customer experience when the root cause is on the private side. More information on how to resolve water quality complaints is available on the City's website.

3.2 Cross Connection Control Program



Backflow assemblies are vital components in preserving the integrity and safety of the water supply system by preventing the reverse flow of water and potential contamination.

Backflow assemblies protect the water supply from connections to private properties by preventing contamination in the event of back siphonage or back pressure. The Cross Connection Control program works proactively with water customers to ensure appropriate backflow assemblies are

installed, tested annually, and maintained in good working condition, as prescribed by Waterworks Bylaw 4848 Part IV.

The Utility received over 38,000 backflow assembly test reports in 2023, a 202% increase in the number of reports received over the past decade.

3.3 Access to Water

Climate change and extreme weather have highlighted the links between emergency preparedness, equity, and the fundamental human right to clean water. In 2010, the World Health Organization and the United Nations declared access to water a human right while emphasizing the disproportionate challenges faced by vulnerable communities. In response, the City of Vancouver established the Access to Water Program.

There are 3 main functions of the Access to Water program:

1. **Heat Response and Emergency Response:** Addressing the immediate water needs during heatwaves and other emergencies.
2. **Expansion of Permanent Drinking Water Fountains**: Enhancing equitable access to drinking water throughout the city.
3. **Green Events:** Leveraging city events as platforms for outreach and to encourage reduction in waste and bottled water use.

These initiatives are supported through both temporary and permanent assets across the city.

3.31 Temporary Assets

As our climate changes, we are seeing longer and hotter summers more consistently. Since the pilot launched in 2010, our Temporary Asset function has expanded significantly. Currently, the Access to Water Program owns and operates:

- 11 Temporary Hand Washing Stations
- 10 Temporary Drinking Fountains
- 13 Temporary Misting Stations

In 2023, these assets were installed from the beginning of May until mid-November. Locations range all over our city and are confirmed based on the greatest needs of our various communities. The majority of these locations are used as pilot projects to identify whether they are appropriate for a permanent installation, while the remaining locations provide critical supplementary access to water during the warmest months.

During installation, Waterworks staff conduct maintenance on all 34 temporary assets which includes repairs, cleaning, and sanitizing, as well as additional periodic water quality testing directly from the asset taps. The water quality results from these fountains align with the routine water quality samples collected across the city.

3.32 Permanent Infrastructure

The City of Vancouver has over 280 permanent drinking fountains managed by the Park Board and Engineering Department. The Park Board is responsible for the majority of the infrastructure, with over 200 seasonally operational assets. Engineering owns 70 permanent fountains, 40 of which are freeze-proof and operational all year.

In 2023, the Access to Water program focused on creating more equitable access to water in the Downtown Eastside, leading to the installation of 9 new freeze proof drinking fountains. They are located at:

1. 390 Main Street
2. 211 Gore Avenue
3. 255 Dunlevy Avenue
4. 111 Princess Avenue
5. 1671 East Hastings Street
6. 117 East Hastings Street
7. East Hastings Street & Hawks Avenue
8. West 10th Avenue & Sasamat Street
9. Nelson Street & Gilford Street

To provide more equitable water access the underserved Downtown Eastside, 390 Main Street and 255 Dunlevy Avenue received 2 permanent freeze-proof assets equipped with bottle fillers, accessible drinking fountains, and hand washing basins.

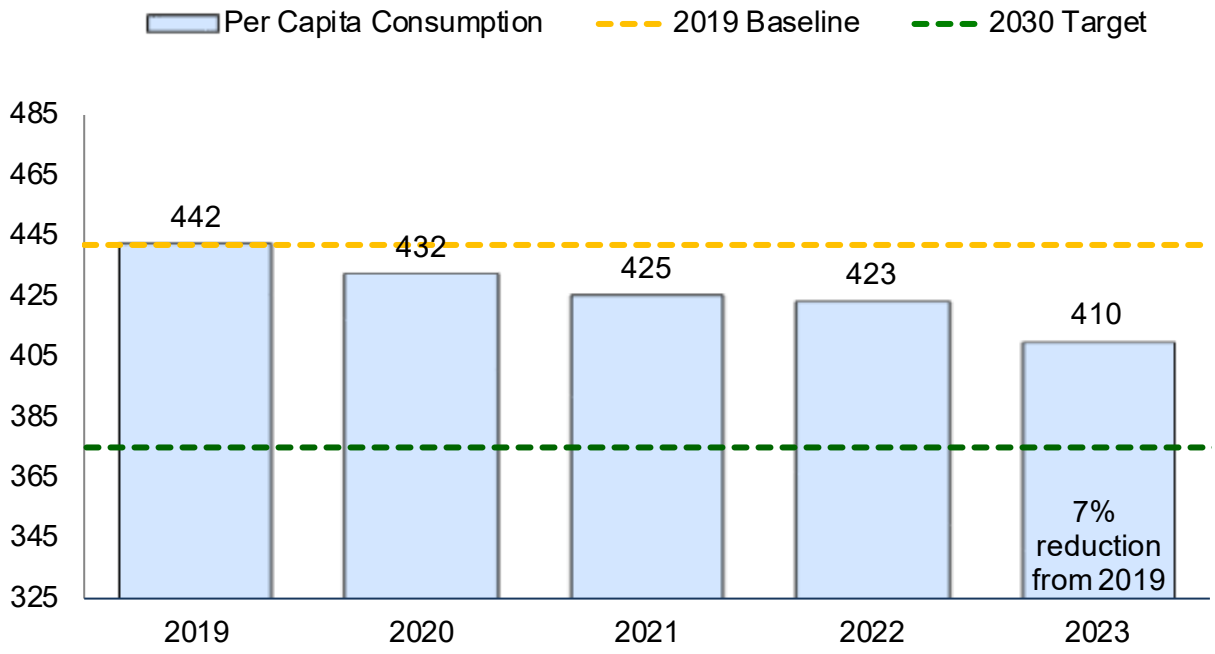
This new drinking fountain, installed at the intersection of East Hastings Street and Hawks Avenue, provides water in a previously underserved area. For more information about Vancouver's public drinking fountains, please visit the City's website.

4 Water Conservation

Water conservation is a key component of drinking water demand management, protecting our drinking water supply now and into the future. A growing population with densified development, and the effects of climate change on source waters, put increasing pressure on Vancouver's drinking water supply. The Water Demand Management Strategy (WDMS, 2021) implements operational and policy requirements to offset the growing demand on our drinking water system, modeling sustainable use for future generations. Expanding regional drinking water supply has high financial, social, and environmental costs; reducing demand delays future needs for costly source expansion.

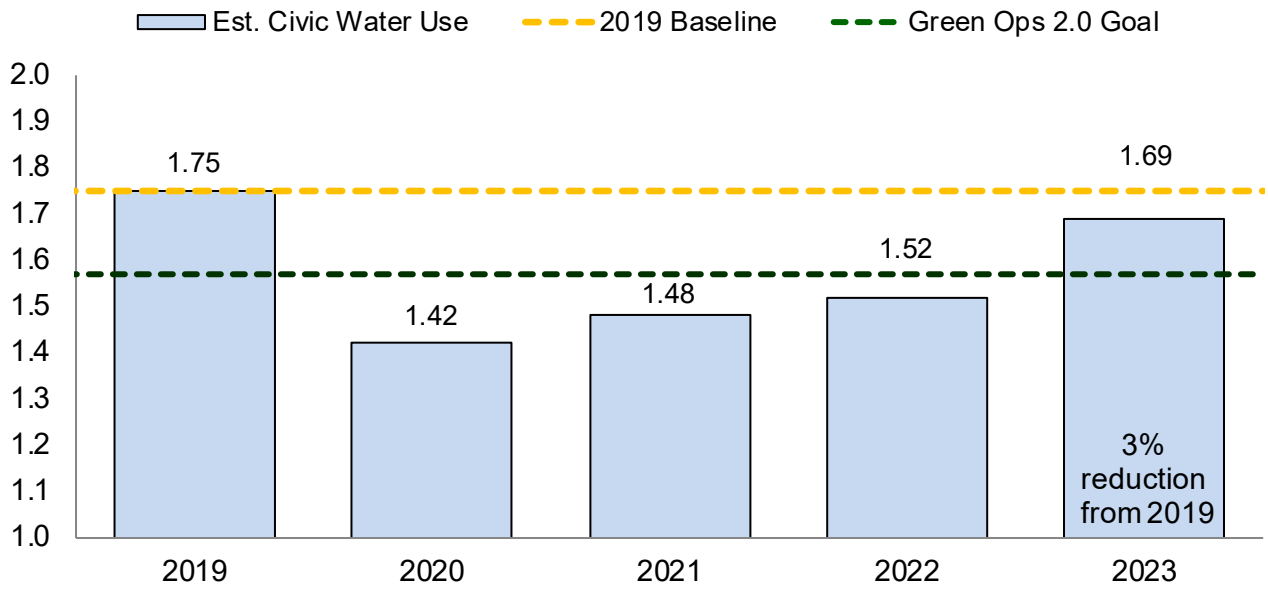
The WDMS builds on previous conservation success to support further reductions via accelerated residential water metering, improved meter reading technology, and equitable water rates. The strategy targets a 15% reduction in drinking water consumption per capita by 2030, in addition to recognizing the need to offset drinking water use where feasible in future development. At the end of 2023, consumption was at 410 L/cap/day; a 7% drop from 2019 (Figure 5: Per Capita Water Consumption).

Figure 5: Per Capita Water Consumption (litres/capita/day)



Civic drinking water use is further targeted through the Green Operations 2.0 Plan (2020), to reduce consumption by 10% from 2019 levels, by 2030. In 2020, the 10% reduction goal was surpassed, associated primarily with pandemic-related facility closures (Figure 6: Civic Facilities and Operations Water Consumption). The City is working towards pre-pandemic operation levels; as such, the targets of the Green Operations 2.0 remain in place anticipating a return to expected operational consumption in the near future. Civic water use in 2023 was 3% below the 2019 baseline.

Figure 6: Civic Facilities and Operations Water Consumption



Operational highlights in 2023 include:

- Installation of 27 new water meters in existing civic facilities.
- Resolution of 389 new high water consumption cases, involving 150 site visits by Water Conservation Plumbers. Mailing out of roughly 1,900 notification letters to customers regarding high water consumption.
- COOP students carried out Residential Leak Detection program from May – August.
- Completed installation of 464 water meters at Single Family Homes with Laneways.
- Drinking Water Regulations Enforcement Program issued 512 tickets and 805 warnings.

5 Asset Management

The Waterworks Utility is responsible for the installation, operation, and maintenance of the City's water distribution system. This includes 1,474 km of water mains, 100,286 service connections, 27,127 meters, 6,581 hydrants, 25,000 valves, and 28 pressure reducing valve (PRV) stations. Additionally, the Utility also operates and maintains the Dedicated Fire Protection System comprised of 12 km of 600 mm diameter steel pipe, designed to withstand the maximum credible earthquake for Vancouver. Detailed information about the system inventory is available in Appendix D.

Funding for Waterworks is allocated through capital and operating program. The capital program funds the installation, replacement, and upgrading of infrastructure. The operating program covers the purchase of bulk water from Metro Vancouver and all costs associated with the maintenance and operation of the municipal water system.

5.1 Capital Program

In 2023, capital investments in the water system totaled approximately $30.3M. This funding was allocated across twenty-five sub-programs, which supported the installation of new infrastructure that primarily replaced aged water mains, service connections, hydrants, and meters. Major capital programs are highlighted in the following sections.

5.1.1 Distribution Main Construction

Distribution main construction, funded through the Distribution Main Replacement and Utility Development Cost Levy (UDCL) programs, represents the largest component of the Waterworks capital budget. In 2023, 13.3 km of distribution main were constructed at a cost of $22.7M.

The Waterworks asset management team ensures the water system remains reliable by identifying replacement candidates and setting a target replacement rate for each capital planning cycle. The target rate is determined by reviewing the distribution system's overall condition, specifically considering main age, material, and the leak or break history. The goal is to find a replacement rate that minimizes the risk of water main failure while maximizing the service life of system assets. The target rate has evolved over time: In 2011, the target rate was set at 0.8% system per year; from 2012-2018 it was adjusted to 1.0% however due to funding constraints a reduced target of 0.5% system per year was adopted, and from 2019-2023 the target rate was increased to 0.5% to 0.9% system per year to better align with deterioration rates of the system assets. The replacement rate trend is shown in Figure 7.

The water main renewal rate will continue to increase to 1.2% per year over the next decade. This adjustment is in anticipation of a large portion of the water system nearing the end of its service life.

Waterworks completes many distribution main replacement projects throughout the year to ensure our water supply is reliable and resilient. Customers that might be affected by upcoming work will receive advance notification by mail. Additionally, any projects causing road closures are announced on the City's website.

Figure 7: Annual Distribution Main Replacement Rate (2014-2023)

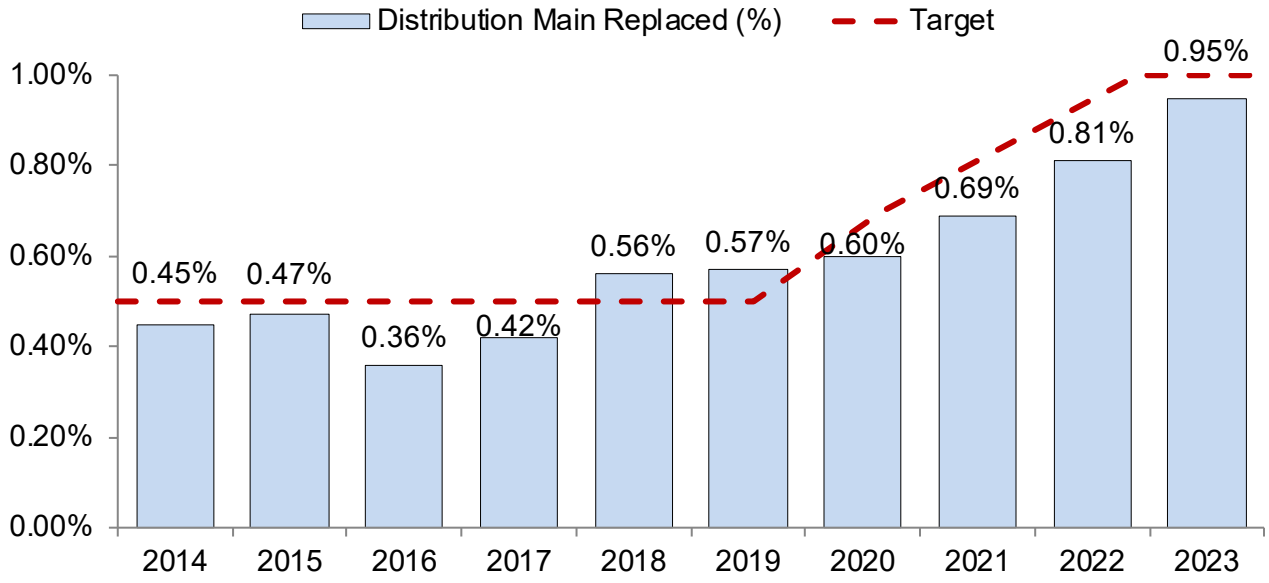


Table 6. Completed Distribution Main Program Funded Projects

Package Name (if applicable)	Street Segment	Pipe Diameter (mm)	Length of Project (m)
Marpole East (2023)	West 64th Avenue, Columbia Street to Manitoba Street	200	205
	Gladstone Street, East 37th Avenue to East 41st Avenue	200	467
Shaughnessy East	Nanton Avenue, Selkirk Street to Osler Street	200	171
	West 29th Avenue, Selkirk Street to Oak Street	200	367
	Devonshire Crescent, Cartier Street to Oak Street	200	814
	Osler Street, West 29th Avenue to Connaught Drive	200	180
	Lane West of Oak Street, West 29th Avenue to Connaught Drive	100	199
	Osler Street, Balfour Avenue to West King Edward Avenue	200	285
	Laurier Avenue, Granville Street to Oak Street	200	817
Kerrisdale South (2023)	West 62nd Avenue, East Boulevard to Granville Street – 2023	200	288
	West King Edward Avenue, Alamein Avenue to Arbutus Street (2023)	200	319
Paton Street and Haggart Street	Haggart Street, Eddington Drive to Paton Street	200	257
	Paton Street, Eddington Drive to Haggart Street	200	281
Hastings Sunrise South (2023)	East 4th Avenue, Slocan Street to Renfrew Street	200	399
	East 6th Avenue, Windermere Street to Rupert Street	200	202
	Windermere Street, East 5th Avenue to East 6th Avenue	200	108

	East 6th Avenue, Penticton Street to Windermere Street	200	1128
	Cypress Street, West 52nd Avenue to West 57th Avenue (2023)	200	231
Wall Street and Eton Street	Wall Street, North Kaslo Street to North Renfrew Street	200	221
	Wall Street, West Trinity Street to North Slocan Street	200	865
	Eton Street, Wall Street to North Nanaimo Street	200	301
East 14th Avenue and Clark Drive	Clark Drive, East 14th Avenue to East 15th Avenue	200	127
	East 14th Avenue, Glen Drive to Clark Drive	200	281
Burnaby Street and Bidwell Street (2023)	Bidwell Street, Comox Street to Davie Street	200	270
	Bidwell Street, Barclay Street to Comox Street	200	235
	Nelson Street, Lane West of Chilco Street to Cardero Street	200	762
East 54th Avenue and Kerr Street (2023)	East 54th Avenue, Wales Street to Kerr Street (2023)	200	692
	Homer Street, West Pender Street to West Cordova Street	200	185
Kitsilano Centre	West 8th Avenue, Stephens Street to Larch Street	200	321
	West 8th Avenue, Balaclava Street to Bayswater Street	200	201
	Balaclava Street, West 6th Avenue to West 8th Avenue	200	191
	West 7th Avenue, Balaclava Street to Bayswater Street	200	208
	West 6th Avenue, Balaclava Street to Bayswater Street	200	218
	Bayswater Street, West 4th Avenue to West 8th Avenue	200	388
	West 30th Avenue, Heather Street to Cambie Street	200	249
Renfrew Heights (2023)	Dieppe Drive, Malta Avenue to Normandy Drive	200	630
		Total	**13.1 km**

Table 7. Completed UDCL Program Funded Distribution Main Projects

Project Name	Street Segments	Pipe Diameter (mm)	Length of Project (m)
	Lord Street, West 65th Avenue to Southwest Marine Drive	300	198
		Total	**0.198 km**

Table 8. Completed Developer Funded Distribution Main Projects

Project Name	Street Segments	Pipe Diameter (mm)	Length of Project (m)
	Hull Street, Victoria Drive to Lane North of Victoria Drive	200	43
		Total	**0.043 km**

Table 9. Completed Sewers Funded Distribution Main Projects

Project Name	Street Segments	Pipe Diameter (mm)	Length of Project (m)
Shaughnessy East	Lane West of Oak Street, West King Edward Avenue to West 26th Avenue	100	115
		Total	**0.115 km**

Major Waterworks Construction Projects

In 2023, the City of Vancouver continued to coordinate work closely with other utilities and public right-of-way projects to minimize impact to the public during essential water main replacements.

- **Hastings Sunrise South**
  The Hastings Sunrise South project consists of replacing 3.5 km of aging water main along E 4th Avenue, E 6th Avenue, E 7th Avenue and E 8th Avenue, roughly between Penticton Street and Cassiar Street. Approximately 1.8 km of the total 3.5km was replaced in 2023, with the remaining 1.7 km scheduled to be built in 2024.

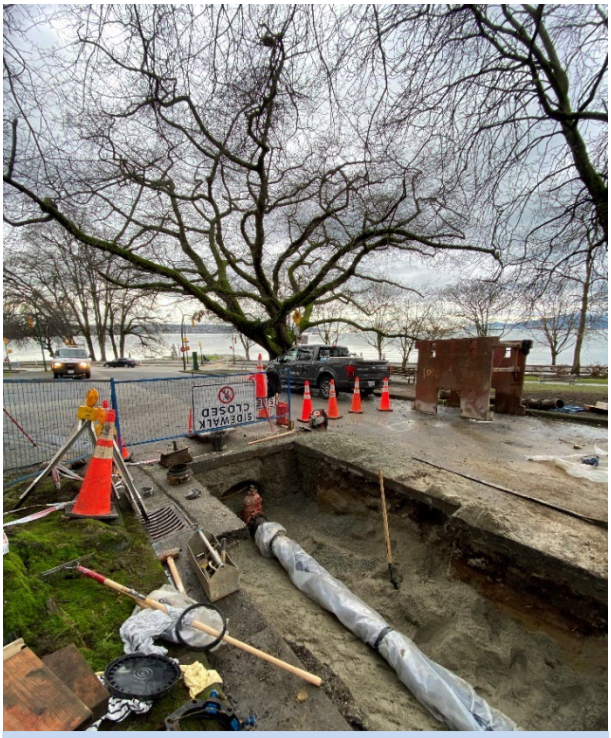
- **Shaughnessy East**
  Shaughnessy East project consisted of replacing 2.8 km of aging water main. These water main replacement candidates were grouped together to minimize mobilization costs and increase crew productivity. This project was carefully coordinated with the City of Vancouver Sewers and Drainage Design Branch, which had an on-going project in the area to minimize construction impacts to the public.

- **Burnaby Street and Bidwell Street; Nelson Street, Lane West of Chilco Street to Cardero Street**
  These two projects in the West End consist of replacing 1.9 km of aging water main. The projects were grouped together to minimize mobilization costs, increase crew productivity, and minimize impact to the West End neighborhood. The project teams engaged with residents through bi-monthly neighborhood-wide project update letters and engaged with Business Improvement Associations to ensure businesses were well-informed of the work and impacts were minimized.

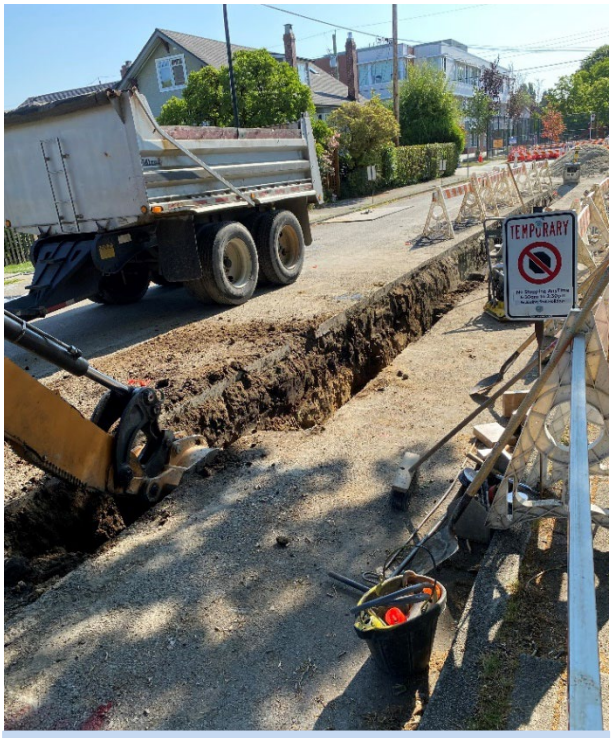
- **Kitsilano Centre**
  The Kitsilano Centre project consisted of replacing a 1.5 km grid network of aging water mains generally from West 6th Avenue to West 8th Avenue between Balaclava Street and Bayswater Avenue; including Bayswater Avenue from W 4th Avenue to W 8th Avenue; and West 8th Avenue, from Stephens Street to Larch Street. Waterworks engaged with the General Gordon Elementary School to minimize disturbance to school operations. These water main replacement candidates were grouped together to minimize mobilization costs and increase crew productivity.

Hastings Sunrise South: Water main construction along East 8th Avenue.

Shaughnessy East: Installing water main “arch” under 1800 mm Metro Vancouver water main.



Burnaby Street and Bidwell Street: New water main laid on the south end of Burnaby Street.



Kitsilano Centre: Backhoe excavating trench for new water main along West 7th Avenue.

5.1.2 Transmission Main Replacement Program

Like the distribution main replacement program, the transmission main replacement program supports water system reliability by replacing aging infrastructure. Transmission mains, defined as larger than 300 mm in diameter, are essential to convey large volumes of water throughout the City. They represent approximately 5% of the City's 1,474 km of water main network. The City earmarks funding for one or two transmission replacement projects in each capital plan (every 4 years).

No transmission main replacement projects occurred in 2023, however considerable progress was made on the design on the upcoming West Pender Street transmission main project. This project will be completed in 2024 and 2025 in two phases. The first phase, beginning in May 2024, will replace 490 m of 600 mm transmission main stretching from Bute Street to Burrard Street. The second phase, set to commence in the second quarter of 2025, will replace 685 m of 450 mm transmission main.

5.1.3 Service Installations

The City of Vancouver owns more than 100,000 water service lines which connect commercial and residential properties to the water system.

Based on the expected life and current age of service assets, there is a goal to replace 1,100 to 1,300 services each year, achieved through:

1. 150-200 reactive renewals (leaking services replaced instead of repaired)
2. Approximately 900 services upgraded through redevelopment (though not all will be "old" services due for renewal), and
3. 200-300 service renewals through the distribution main replacement program.

The asset management team monitors the number of service leaks and failures and the replacement levels achieved year-to-year to ensure that funding levels continue to support the required renewal rates for the service network. Table 10 illustrates the number of services that were installed and/or replaced in 2023.

Table 10. Service Installations

Program	Installations
Reactive replacement of leaking services	103
Proactive replacement of aging services	147
New commercial services	153
New residential services	837
Total	**1,240**

The number of leaking services were lower than forecast, which resulted in fewer reactive replacements.

5.2 Operations and Maintenance Program

Operating and maintenance expenditures in 2023 were approximately $6.9M, under the program budget of $7.5M. The annual maintenance budget supports reactive maintenance to complete emergency repairs and ongoing corrective and preventative maintenance programs designed to:

- Ensure that water system components are reliable and in good working order.
- Maximize service life of components to realize the initial capital investment benefit.
- Promote efficient operation of the water system, resulting in a higher level of customer service.

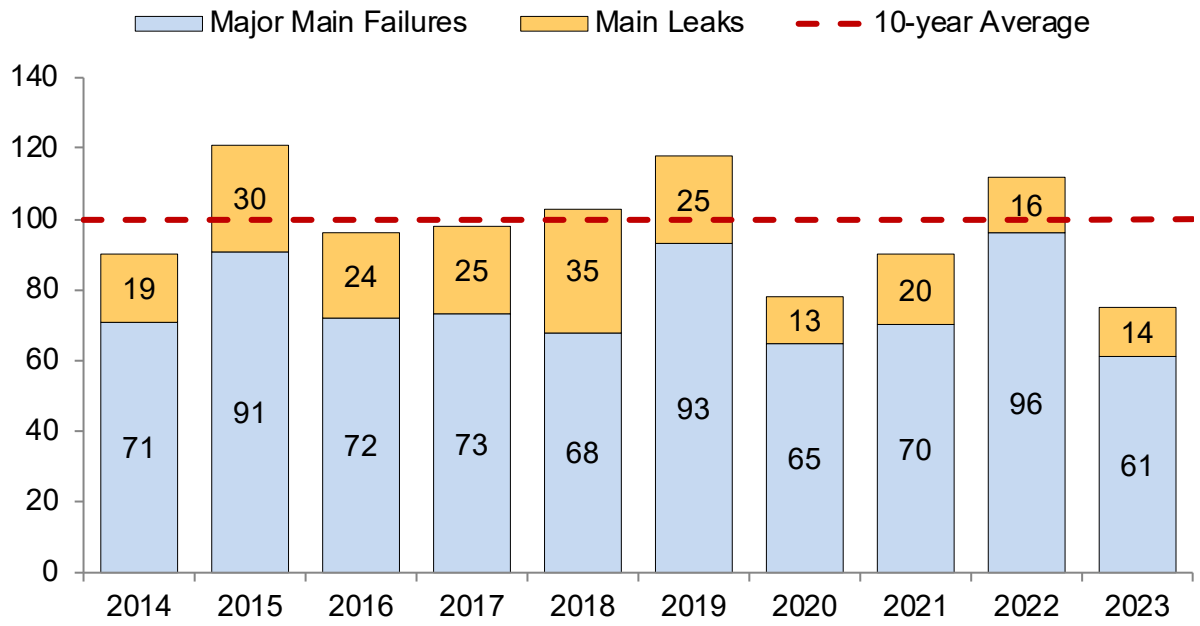
5.2.1 Main Breaks

Promptly responding to water main breaks is critical to prevent possible property damage, safeguard drinking water quality, and minimize service disruptions for customers. In 2023, crews responded to 75 water main failures. The majority of the water main breaks and leaks occurred during the winter months from October to January.

Waterworks collects data to track and report on program and system performance. The number of main breaks per 100 km of pipe is typically used as an indicator of the overall condition of a water distribution system.

In 2023, the City of Vancouver ranked well relative to Canadian municipal water systems despite having one of the oldest systems, with 5.1 breaks per 100 km of pipe, compared to the national median of 6.5 breaks per 100 km. When compared to other systems with a similar system age (40-50 years), Vancouver has a below average main break rate.

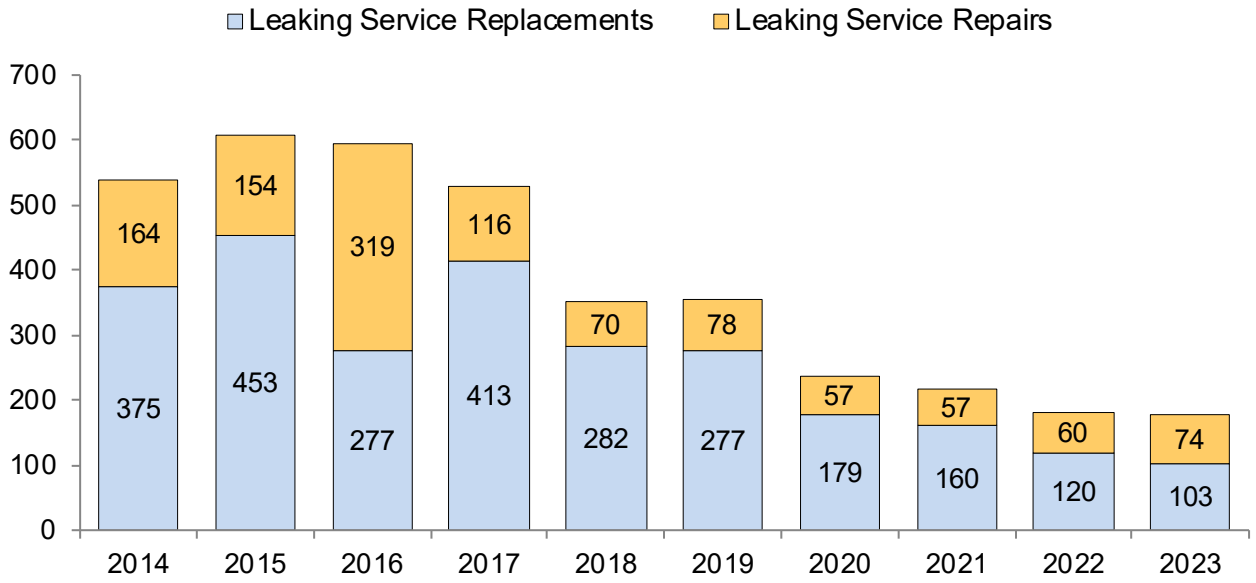
Figure 8. Main Break/Leak History (2014-2023)



5.2.2 Service Leak Repairs

In 2023, 177 leaking services were repaired (74) or replaced (103). The number of leaking services in 2023 was a significant drop compared to six years previous. The decrease in leaks is a result of targeted proactive replacements during construction projects, improved renewal funding starting in 2017, and decreased corrosivity of the drinking water.

Figure 9. Service Leak History (2014-2023)



5.2.3 Proactive Leak Detection

In 2023, 100% of the City's water mains were proactively inspected for leaks. The Proactive Leak Detection program uses acoustic equipment to detect leaks that would otherwise go undetected.

Identifying and repairing leaking services helps reduce system water losses and reduce operating costs. Throughout the year, the leak detectors identified 313 leaks. The leak detection summary is provided in Table 11.

Table 11. Proactive Leak Detection Results

Main leaks	City side service leaks	Hydrant leaks	Valve leaks	Private side leaks	Total
3	27	185	55	43	313
		86%		14%	

5.2.4 Water Meters

In 2023, the aging meter replacement capital funding was used to replace 355 water meters. Waterworks replaced 34 large meters (>50 mm), with a focus on some of the older, more costly meters. Waterworks tests large meters, which comprise 10% of the total meter inventory, every 1-3

years for safety, operability, and accuracy of readings. Large meters are repaired or replaced as required based on the results.

The remaining meters replaced were aging small meters (≤50 mm). In 2023, 289 small meters were replaced. Small meters make up 90% of the meter inventory and are expected to last 20-25 years depending on their level of consumption. As small meters age, they gradually lose accuracy, and it becomes economical to replace them once they exceed their estimated service life. These replacement life cycles were verified through consumption analysis and testing to ensure accurate readings and equitable billing to our customers. A large portion of our small meter inventory is approaching the end of its expected life and will require replacement over the next 10 years.

5.2.5 Hydrants

As part of the annual fire hydrant inspection program, 100% of the hydrants in the system were inspected in 2023 to ensure proper operation. Through the preventative maintenance program and construction projects, 49 hydrants were replaced in 2023.

6 Emergency Response and Contingency Plan Summary

The City's Waterworks Emergency Response and Contingency Plan (ERP) plays a vital role in ensuring the safety and reliability of the water distribution system. In the event of an emergency, this plan provides a structured approach to safeguarding the drinking water supply and protecting public health.

The ERP is designed to meet the requirements set forth in the Drinking Water Protection Act and Regulation, serving as a comprehensive Emergency Response and Contingency Plan. Additionally, in accordance with Section 15 (a) of the Drinking Water Protection Regulation, this summary of the ERP aims to inform water users about the plan's key elements and objectives.

The ERP operates in conjunction with current corporate-level emergency plans and business continuity plans within the City of Vancouver. Together, these plans ensure a coordinated and effective response to emergencies that may impact the City of Vancouver's water supply.

The Waterworks Emergency Response objectives are as follows (in priority order):

1. Provide water for firefighting, including the Dedicated Fire Protection System.
2. Repair and restore the water system on a priority basis.
3. Ensure an adequate supply of potable water, with a focus on high priority facilities.
4. Maintain high standards of water quality to protect public safety.

The ERP defines clear roles and responsibilities for staff during emergencies, ensuring a coordinated and efficient response.

During the implementation of the ERP, staff will adhere to safety protocols, communicate with relevant agencies, and minimize further damage to the water system.

Following an emergency event, staff will document actions taken, evaluate the effectiveness of the emergency response, and revise the ERP as necessary to enhance preparedness and resilience.

7 Financial Review

The Water Utility is self-funded. Water purchases, capital and operating expenses, and City debt are paid by revenues collected from water users each year. Total actual expenditures for 2023 were $156M. Of this amount, $90M was used to purchase bulk potable water from Metro Vancouver and the remaining $66M was spent rebuilding and maintaining the water system, including servicing debt costs from past capital borrowing. A breakdown of budgeted versus actual expenditures and revenues is provided in Table 12.

Waterworks carries a "Water Rate Stabilization Reserve" to provide a funding buffer for year-over-year variations in demand and forecasted increases of bulk water rates from Metro Vancouver. In 2023, total revenues exceeded total expenditures, so the surplus of $11.6M was transferred to the reserve.

Table 12. 2023 Financial Summary

2023 Revenue	Budget	Actual
Flat Rate	$60,754,565	$60,878,000
Metered Rate	$84,070,79	$84,508,422
Meter Service Charge	$4,887,104	$5,811,095
Fire Line Flat Rate	$3,622,224	$3,885,434
Other Revenues	$836,474	$1,034,190
Total Revenues	$154,170,446	$156,117,160

2023 Expenditures	Budget	Actual
City Debt	$35,897,525	$35,901,301
Water Purchases (Metro Vancouver)	$95,752,696	$90,098,523
Operating & Maintenance	$18,239,504	$18,479,503
Total Expenditures	$149,889,725	$144,479,503
Transfer (from)/to Stabilization Reserve	$4,280,721	$11,637,657
Total Expenditures (incl. Transfer)	$154,170,446	$156,117,160

Appendix A

Map of Drinking Water Sample Stations

CITY OF VANCOUVER

DRINKING WATER SAMPLE STATIONS

Appendix B

Disinfection By-products Results

Disinfection By-products Results[1]

Station	Date Sampled	THM (ppb)						HAA (ppb)						
		Bromodichloromethane	Bromoform	Chlorodibromomethane	Chloroform	Total Trihalomethanes	**Total THM Quarterly Average** ***(Guideline Limit 100 ppb)***	Dibromoacetic Acid	Dichloroacetic Acid	Monobromoacetic Acid	Monochloroacetic Acid	Trichloroacetic Acid	Total Haloacetic Acid	**Total HAA Quarterly Average** ***(Guideline Limit 80 ppb)***
COV Sampling Station 3 Porter & Victoria	2022-May-09	<1	<1	<1	20	21	**27**	<0.5	11	<0.5	0.6	8	19	**19**
	2022-Aug-22	<1	<1	<1	24	24	**25**	<0.5	8.5	<0.5	<5.0	7	15	**18**
	2022-Nov-15	<1	<1	<1	23	24	**23**	<0.5	11	<0.5	<5.0	8	18	**17**
	2023-Feb-02	<1	<1	<1	48	48	**29**	<0.5	10	<0.5	<0.5	8	18	**18**
	2023-May-29	<1	<1	<1	22	24	**30**	<0.5	9.3	<0.5	0.8	6	16	**17**
	2023-Sep-23	1	<1	<1	25	27	**32**	<0.5	8.2	<0.5	0.5	7.2	16	**17**
	2023-Dec-04	<1	<1	<1	25	26	**36**	<0.5	12	<0.5	0.8	8.7	22	**17**
COV Sampling Station 7 8100 Champlain	2022-May-09	<1	<1	<1	21	22	**29**	<0.5	11	<0.5	1	7	20	**21**
	2022-Aug-22	<1	<1	<1	37	37	**25**	<0.5	12	<0.5	<5.0	14	28	**19**
	2022-Nov-15	1	<1	<1	27	28	**27**	<0.5	10	<0.5	0.9	8	19	**22**
	2023-Feb-02	<1	<1	<1	40	40	**32**	<0.5	10	<0.5	0.6	9	19	**22**
	2023-May-29	<1	<1	<1	21	23	**32**	<0.5	8.4	<0.5	<0.5	5	13	**20**
	2023-Sep-23	1	<1	<1	24	26	**30**	<0.5	11	<0.5	3.6	13	28	**17**
	2023-Dec-04	<1	<1	<1	27	29	**32**	<0.5	9.3	<0.5	<0.5	8.9	18	**16**
COV Sampling Station 24 Champlain & Arlington	2022-May-09	<1	<1	<1	18	19	**26**	<0.5	9.6	<0.5	0.9	6	16	**16**
	2022-Aug-22	<1	<1	<1	23	23	**25**	<0.5	7.4	<0.5	<5.0	5	12	**17**
	2022-Nov-15	<1	<1	<1	22	23	**22**	<0.5	9.1	<0.5	<5.0	6	17	**15**
	2023-Feb-02	<1	<1	<1	49	50	**29**	<0.5	9.7	<0.5	<0.5	7	16	**15**
	2023-May-29	<1	<1	<1	22	24	**30**	<0.5	8.5	<0.5	<0.5	5	13	**15**
	2023-Sep-23	1	<1	<1	27	29	**32**	<0.5	5.8	<0.5	4.7	11	21	**15**
	2023-Dec-04	<1	<1	<1	27	28	**37**	<0.5	8.8	<0.5	<0.5	7.2	16	**15**
COV Sampling Station 28 10th & Woodland	2022-May-09	<1	<1	<1	21	22	**26**	<0.5	12	<0.5	0.6	8	20	**19**
	2022-Aug-22	<1	<1	<1	24	24	**26**	<0.5	8.4	<0.5	<5.0	6	15	**21**
	2022-Nov-15	<1	<1	<1	22	23	**23**	<0.5	9.7	<0.5	0.8	7	17	**17**
	2023-Feb-02	<1	<1	<1	52	53	**31**	<0.5	11	<0.5	0.7	10	22	**19**
	2023-May-29	<1	<1	<1	25	27	**32**	<0.5	9.5	<0.5	0.9	7	17	**18**
	2023-Sep-23	1	<1	<1	27	29	**34**	<0.5	8.3	<0.5	<0.5	5.3	14	**19**
	2023-Dec-04	<1	<1	<1	28	30	**40**	<0.5	13	<0.5	1.3	9.6	24	**20**
COV Sampling Station 30 1100 Foundry Quay	2022-May-09	<1	<1	<1	16	17	**22**	<0.5	8.9	<0.5	<0.5	5	14	**14**
	2022-Aug-22	<1	<1	<1	18	18	**21**	<0.5	7.3	<0.5	<5.0	4	11	**15**
	2022-Nov-15	<1	<1	<1	19	20	**19**	<0.5	8.3	<0.5	0.7	5.1	14	**13**
	2023-Feb-02	<1	<1	<1	33	34	**22**	<0.5	8.5	<0.5	<0.5	5.9	14	**13**
	2023-May-29	<1	<1	<1	21	23	**24**	<0.5	8.5	<0.5	<0.5	4	13	**13**
	2023-Sep-23	1	<1	<1	21	23	**26**	<0.5	8.8	<0.5	<0.5	5	14	**14**
	2023-Dec-04	<1	<1	<1	24	25	**29**	<0.5	11	<0.5	<0.5	6	17	**14**

1. Disinfection By-product analysis performed by Metro Vancouver Laboratory.
2. COV Sampling Station 70 replaced COV Sampling Station 46 on Nov 14, 2022.

Disinfection By-products Results[1]

Station	Date Sampled	THM (ppb)						HAA (ppb)						
		Bromodichloromethane	Bromoform	Chlorodibromomethane	Chloroform	Total Trihalomethanes	**Total THM Quarterly Average** ***(Guideline Limit 100 ppb)***	Dibromoacetic Acid	Dichloroacetic Acid	Monobromoacetic Acid	Monochloroacetic Acid	Trichloroacetic Acid	Total Haloacetic Acid	**Total HAA Quarterly Average** ***(Guideline Limit 80 ppb)***
COV Sampling Station 54 Salish & Sennok	2022-May-09	<1	<1	<1	18	20	**26**	<0.5	9.8	<0.5	0.7	6	17	**16**
	2022-Aug-22	<1	<1	<1	22	22	**25**	<0.5	7	<0.5	0.6	4	12	**18**
	2022-Nov-15	1	<1	<1	25	26	**23**	<0.5	9	<0.5	1	7.2	17	**16**
	2023-Feb-02	<1	<1	<1	49	49	**29**	<0.5	9	<0.5	1	8.2	18	**16**
	2023-May-29	<1	<1	<1	21	23	**30**	<0.5	7.7	<0.5	<0.5	5	12	**15**
	2023-Sep-12	1	<1	<1	23	25	**33**	<0.5	8.1	<0.5	<0.5	5	13	**16**
	2023-Dec-04	<1	<1	<1	26	28	**36**	<0.5	8.5	<0.5	<0.5	8	16	**15**
COV Sampling Station 55 23rd & Balaclava	2022-May-09	<1	<1	<1	26	26	**24**	<0.5	9.1	<0.5	0.5	5	15	**15**
	2022-Aug-22	<1	<1	<1	21	21	**23**	<0.5	7.7	<0.5	<5.0	4	13	**16**
	2022-Nov-15	<1	<1	<1	23	25	**23**	<0.5	9.6	<0.5	0.6	6.1	16	**14**
	2023-Feb-02	<1	<1	<1	39	39	**28**	<0.5	8.8	<0.5	1.2	6.1	16	**15**
	2023-May-29	<1	<1	<1	20	22	**27**	<0.5	8.3	<0.5	<0.5	4	12	**14**
	2023-Sep-12	1	<1	<1	23	24	**29**	<0.5	8.1	<0.5	<0.5	4	12	**15**
	2023-Dec-04	<1	<1	<1	23	25	**31**	<0.5	11	<0.5	0.8	7	18	**14**
COV Sampling Station 58 Euclid & Chatham	2022-May-09	<1	<1	<1	25	26	**25**	<0.5	8.4	<0.5	1	4	13	**14**
	2022-Aug-22	<1	<1	<1	22	22	**23**	<0.5	7.4	<0.5	<5.0	4	12	**14**
	2022-Nov-15	<1	<1	<1	22	23	**22**	<0.5	8.5	<0.5	0.8	5	14	**13**
	2023-Feb-02	<1	<1	<1	37	37	**27**	<0.5	8.5	<0.5	<0.5	6	14	**13**
	2023-May-29	<1	<1	<1	18	20	**26**	<0.5	7.5	<0.5	1	3	11	**13**
	2023-Sep-12	1	<1	<1	24	26	**27**	<0.5	8.5	<0.5	<0.5	7	15	**13**
	2023-Dec-04	<1	<1	<1	22	23	**29**	<0.5	10	<0.5	<0.5	6	16	**13**
COV Sampling Station 62 Belmont & Tolmie	2022-May-09	<1	<1	<1	21	23	**27**	<0.5	4.8	<0.5	0.5	7	13	**13**
	2022-Aug-22	<1	<1	<1	25	25	**27**	<0.5	5.4	<0.5	<5.0	5	11	**15**
	2022-Nov-15	<1	<1	<1	21	23	**24**	<0.5	9.2	<0.5	0.6	6.8	17	**14**
	2023-Feb-02	<1	<1	<1	57	57	**32**	<0.5	6.5	<0.5	0.7	8	15	**14**
	2023-May-30	<1	<1	<1	21	23	**32**	<0.5	7.5	<0.5	0.9	5	14	**14**
	2023-Sep-12	1	<1	<1	27	29	**34**	<0.5	5.1	<0.5	<0.5	5	10	**15**
	2023-Dec-04	<1	<1	<1	28	30	**40**	<0.5	5.2	<0.5	0.9	9	15	**15**
COV Sampling Station 70[2] 723 SE Marine	2022-May-09	<1	<1	<1	17	17	**24**	<0.5	9.5	<0.5	<0.5	5	15	**18**
	2022-Aug-22	<1	<1	<1	31	31	**22**	<0.5	13	<0.5	<5.0	12	26	**16**
	2022-Nov-15	1	<1	<1	23	25	**24**	<0.5	11	<0.5	0.9	7	19	**19**
	2023-Feb-02	<1	<1	<1	39	39	**N/A**	<0.5	9.9	<0.5	<0.5	6.9	17	**N/A**
	2023-May-30	<1	<1	<1	22	24	**N/A**	<0.5	7.7	<0.5	<0.5	5	12	**N/A**
	2023-Sep-12	1	<1	<1	22	24	**N/A**	<0.5	11	<0.5	<0.5	10	21	**N/A**
	2023-Dec-04	<1	<1	<1	23	25	**32**	<0.5	11	<0.5	<0.5	7	18	**15**

1. Disinfection By-product analysis performed by Metro Vancouver Laboratory.
2. COV Sampling Station 70 replaced COV Sampling Station 46 on Nov 14, 2022.

Appendix C

Metals Results

Metals Results[1]

Metals	Units	*Canadian Guideline (MAC)*[2]	COV Sampling Station 9 Harrison & Rosedale		COV Sampling Station 19 38th & Camosun		COV Sampling Station 26 Franklin & Kootenay		COV Sampling Station 34 10th & Willow (Drinking Fountain)		COV Sampling Station 39 37th & Hudson	
			Feb 15 2023	Sep 12 2023	Feb 15 2023	Sep 12 2023	Feb 15 2023	Sep 12 2023	Feb 15 2023	Sep 12 2023	Feb 15 2023	Sep 12 2023
Aluminum Total	µg/L	*<1003 (AO)*	39	42	40	34	40	28	41	35	38	36
Antimony Total	µg/L	*6*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arsenic Total	µg/L	*10*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Barium Total	µg/L	*1000*	2.4	2.6	2.5	2.9	2.8	3.3	2.5	3.0	2.7	3.0
Boron Total	µg/L	*5000*	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium Total	µg/L	*5*	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium Total	µg/L	*n/a*[4]	8270	4640	8400	8180	9230	8020	8580	6880	8090	6050
Chromium Total	µg/L	*50*	0.07	<0.05	0.07	<0.05	0.11	<0.05	0.07	<0.05	0.08	<0.05
Cobalt Total	µg/L	*n/a*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper[5] Total	**µg/L**	***≤1000(AO)***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2.8	3.0	<0.5	<0.5
Iron Total	**µg/L**	***≤300 (AO)***	30	26	16	9	29	11	16	16	5	19
Lead Total	**µg/L**	***5***	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Magnesium Total	µg/L	*n/a*	199	163	201	232	213	227	207	202	210	192
Manganese Total	µg/L	*≤50 (AO)*	3.4	5.7	2.8	7.4	3.9	8.6	2.2	7.2	2.7	6.5
Mercury Total	µg/L	*1*	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum Total	µg/L	*n/a*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel Total	µg/L	*n/a*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Potassium Total	µg/L	*n/a*	175	171	174	215	182	213	180	196	177	191
Selenium Total	µg/L	*50*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver Total	µg/L	*n/a*	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sodium Total	µg/L	*≤200000 (AO)*	1600	5950	1630	1920	1580	1760	1610	3460	1580	4260
Zinc Total	**µg/L**	***≤5000 (AO)***	<3.0	<3.0	9.1	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

1. Metals analysis performed by Metro Vancouver Laboratory.

2. MAC = Maximum Acceptable Concentration.

3. AO = Aesthetic Objective. AO for conventional treatment; 200 mg/L for nonconventional treatment types.

4. n/a = MAC or AO not available.

5. Copper, Iron, Lead and Zinc require semi-annual testing as per the Water Quality Monitoring and Reporting Plan for the GVRD and Member Municipalities. Since the method produces other metal results, these values are also provided.

Appendix D

System Inventory

Diameter	Asbestos Cement	Concrete	HDPE[1]	Steel	DICL[2]	Cast Iron	Other[3]	PVC	Unknown[4]	Total (m)
Pre-1920										**Total**
20 mm							38			38
25 mm							4			4
50 mm							37		1	38
75 mm						279				279
100 mm						582				582
150 mm				47		7,869			2	7,921
200 mm				63		5,242				5,314
300 mm						2,311			13	2,324
400 mm				24					61	84
450 mm				235						235
600 mm					141					141
625 mm				6						6
650 mm										0
800 mm				3,258						3,258
Total (m)	**0**	**0**	**0**	**3,633**	**153**	**16,283**	**79**	**0**	**77**	**20,224**
Years: 1920-1929										**Total**
25 mm							5			5
100 mm						578				578
150 mm						14,679				14,679
200 mm						3,313				3,313
300 mm						330				330
450 mm				29						29
500 mm				11						11
600 mm				1,430						1,430
Total (m)	**0**	**0**	**0**	**1,470**	**0**	**18,899**	**5**	**0**	**0**	**20,374**
Years: 1930-1939										**Total**
20 mm						1	21			22
25 mm							2			2
50 mm							36			36
100 mm				150		331				481
150 mm				35		32,781				32,816
200 mm						10,017			1	10,018
300 mm				60		7,099				7,159
350 mm				10						10
450 mm				3,385						3,385
500 mm				1,236						1,236
600 mm				968						968
625 mm				690						690
750 mm				1,737						1,737
800 mm				3						3
Total (m)	**0**	**0**	**0**	**8,274**	**0**	**50,229**	**59**	**0**	**1**	**58,563**
Years: 1940-1949										**Total**
25 mm							10			10
40 mm						15				15
100 mm						532				532
150 mm				5	1	80,260				80,265
200 mm					13	34,324			23	34,361
300 mm				29		10,915				10,944
450 mm						266				266
800 mm				426						426
Total (m)	**0**	**0**	**0**	**460**	**14**	**126,312**	**10**	**0**	**23**	**126,819**

1. HDPE - High-Density Polyethylene
2. DICL - Cement Lined Ductile Iron
3. Other - Combined Data for Copper Galvanized Pipe
4. Unknown - Data missing regarding material

Appendix D - System Inventory

Diameter	Asbestos Cement	Concrete	HDPE[1]	Steel	DICL[2]	Cast Iron	Other[3]	PVC	Unknown[4]	Total (m)
Years: 1950-1959										**Total**
25 mm							79			79
50 mm						12	584			596
100 mm						470				470
150 mm				6	45	103,676				103,727
200 mm				12	1	54,659				54,672
250 mm				24						24
300 mm				93	99	35,132			30	35,357
450 mm				40		29				69
600 mm				491						491
750 mm				952						952
Total (m)	**0**	**0**	**0**	**1,617**	**145**	**193,977**	**663**	**3**	**30**	**196,436**
Years: 1960-1969										**Total**
20 mm						8	136			144
25 mm							553			553
40 mm							334			334
50 mm							1,260			1,260
100 mm				6	537	2,198				2,741
150 mm				39	491	156,980			29	157,539
200 mm	60			81	769	111,972				112,882
300 mm				1,016	6,600	27,497			1	35,114
350 mm				1						1
450 mm				420	1,828	8,626				10,875
500 mm				114	2					116
600 mm				325						325
650 mm				509						509
675 mm				1,507						1,507
750 mm				877						877
900 mm				7						7
Total (m)	**60**	**0**	**0**	**4,902**	**10,228**	**307,281**	**2,284**	**0**	**30**	**324,786**
Years: 1970-1979										**Total**
20 mm							108			108
25 mm							105	32		137
40 mm							110			110
50 mm						1	127	60		188
100 mm					2,088					2,088
150 mm					44,701	5,388				50,089
200 mm				14	52,256	4,846		2	5	57,123
250 mm					10					10
300 mm				58	51,098	312				51,469
400 mm					4,462					4,462
450 mm				1,145	707					1,852
500 mm					1,642					1,642
600 mm				24	1,275				2	1,301
625 mm				5						5
750 mm		154		16						170
800 mm				264						264
Total (m)		**154**		**1,527**	**158,239**	**10,547**	**451**	**94**	**8**	**171,020**

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Appendix D - System Inventory

Diameter	Asbestos Cement	Concrete	HDPE[1]	Steel	DICL[2]	Cast Iron	Other[3]	PVC	Unknown[4]	Total (m)
Years: 1980-1989										**Total**
20 mm							58			58
25 mm							1	37		38
40 mm							255			255
50 mm							502	12		513
100 mm					989					989
150 mm				41	33,970	299				34,310
200 mm				70	27,286	143		4	5	27,508
250 mm					6					6
300 mm			37	40	37,702	82		1	10	37,872
400 mm				14	473					488
450 mm		53		29	3,159					3,241
550 mm					49					49
650 mm		1								1
750 mm		6,324		1,165						7,489
900 mm		1,599								1,599
1000 mm				172						172
Total (m)		**7,978**	**37**	**1,530**	**103,633**	**524**	**816**	**54**	**15**	**114,588**
Years: 1990-1999										**Total**
20 mm							38			38
25 mm							102			102
40 mm							31			31
50 mm					3		354			357
100 mm					1,021			9		1,030
150 mm					10,527			192		10,719
200 mm					69,538	4		186		69,728
250 mm					34					34
300 mm					55,509			4		55,513
400 mm				5	2,359					2,364
450 mm				14	1,084					1,097
500 mm				8						8
600 mm				5,705	5,380					11,085
750 mm				101						101
900 mm					3,689					3,689
1000 mm				10						10
Total				**5,843**	**149,143**	**4**	**526**	**392**		**155,907**
Years: 2000-2009										**Total**
20 mm							17			17
25 mm					29		69			97
40 mm							1			1
50 mm					31		155			186
100 mm			298		2,791					3,089
150 mm			148	3	6,429	14				6,593
200 mm					85,817	103	1		6	85,927
250 mm					3					3
300 mm				6	36,020			11	5	36,042
400 mm				40	55					95
450 mm					557					557
500 mm				2						2
600 mm				5,861	4,528					10,389
650 mm										0
750 mm				4	210					214
900 mm					1					1
Total (m)			**446**	**5,917**	**136,470**	**117**	**242**	**11**	**11**	**143,215**

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Appendix D - System Inventory

Diameter	Asbestos Cement	Concrete	HDPE[1]	Steel	DICL[2]	Cast Iron	Other[3]	PVC	Unknown[4]	Total (m)
Years: 2010-2019										**Total**
25 mm							23			24
40 mm							43			43
50 mm			79				93			171
100 mm			590		567	1				1,157
150 mm			131		4,033	198		1		4,364
200 mm			32		72,231	107		142	5	72,517
300 mm					17,195	11		38		17,245
400 mm				9	25					34
450 mm					30					30
500 mm					20					20
600 mm				2	5,737			1		5,740
750 mm					51					51
Total (m)	**0**	**0**	**832**	**11**	**99,890**	**316**	**160**	**183**	**5**	**101,396**
Years: 2020-2023										**Total**
25 mm							40			40
40 mm							1			1
50 mm							13			13
100 mm					17					17
150 mm			3		916	8				926
200 mm			88		8,864	8		3		8,964
300 mm			35		5,802	1				5,838
400 mm			1,408							1,408
450 mm				2	36					37
600 mm				1	489					491
750 mm					839			2		841
900 mm					730					730
Total (m)	**0**	**0**	**1,534**	**3**	**17,692**	**17**	**53**	**6**		**19,305**
Years: Unknown										**Total**
20 mm						20	68			88
25 mm							328			328
40 mm							66			66
50 mm						5	655	57	31	748
75 mm						28				28
100 mm					21	1,173				1,194
150 mm				209	2	11,148			173	11,532
200 mm				99	271	3,986			433	4,789
250 mm						1,076				1,076
300 mm				13	103	1,341			8	1,466
350 mm				1						1
400 mm									2	2
450 mm				9	58	154			10	232
500 mm				2						2
600 mm				591						591
800 mm				23						23
1000 mm				8						8
Total (m)				**955**	**455**	**18,931**	**1,117**	**57**	**658**	**22,172**
Total for All Years	**60**	**8,132**	**2,849**	**36,142**	**676,063**	**743,437**	**6,465**	**799**	**858**	**1,474,804**

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