

# Unidirectional Flushing (UDF) Program to Improve Water Quality in Distribution System

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# INTRODUCTION

- **Distribution System Flushing Program is an important component of any water utility's routine distribution system maintenance.**
- **Flushing removes sediments, deposits and biofilm build-up from the water distribution system, improves water quality triggering reductions in customer complaints.**
- **Incorporating unidirectional flushing (UDF) techniques allow utilities to improve degree of watermain cleaning, reduce total water consumption per flush and decrease frequency of flushing.**

## Flushing of Distribution System

- Flushing of the distribution system is important to the maintenance and to preservation or improvement of water quality and control of bacterial growth.
- The utility could use a protocol to investigate problems, evaluate the objectives of flushing, to define data collection requirements, to plan and implement flushing program, and to refine or upgrade the existing program.

- **The level of effort associated with a flushing program depends on the significance of water quality deterioration attributable to the distribution system.**
- **Flushing programs can be implemented with few resources assigned to data collection.**
- **Nevertheless, continuing effort in data analysis is required if the program is to evolve into a useful and economical tool for water quality management.**



**Ignored, and not  
maintained  
Distribution System  
could end like that!!**

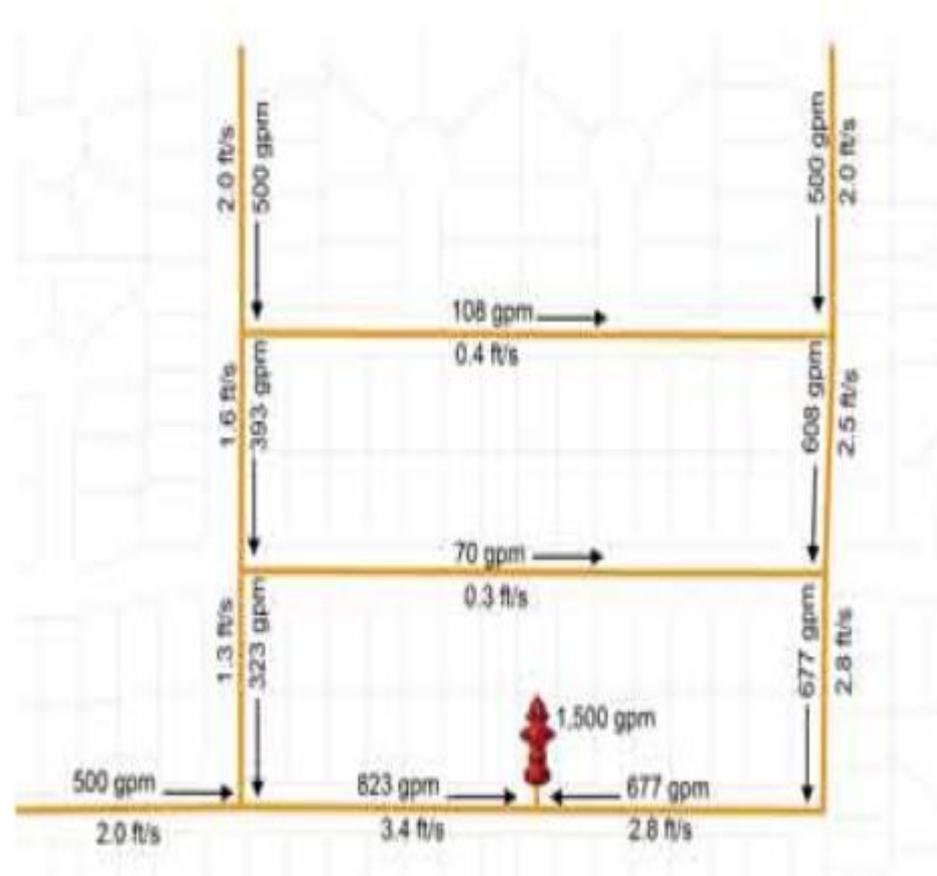
# Unidirectional Water Main Flushing (UDF)

- **Unidirectional Water Main Flushing (UDF) is increasingly used across North America to improve operations, enhance the water system and improve service standards.**
- **Water main flushing has long been considered an effective method to remove unwanted tastes, odours or discolorations of the water, and to improve disinfectant residual.**
- **UDF, a specific type of water main flushing, provides greater cleaning and uses less water than conventional flushing.**

- **Unidirectional Flushing (UDF) of Water mains at the City of White Rock is conducted regularly since 2016 for a variety of reasons: corrosion control; sediment removal; taste and odour control; maintain low turbidity; maintain disinfectant residual; and to prevent the potential of bacterial growths.**
- **UDF is being utilized by a growing number of utilities as a cost-effective way of improving and preserving water quality in the distribution system.**

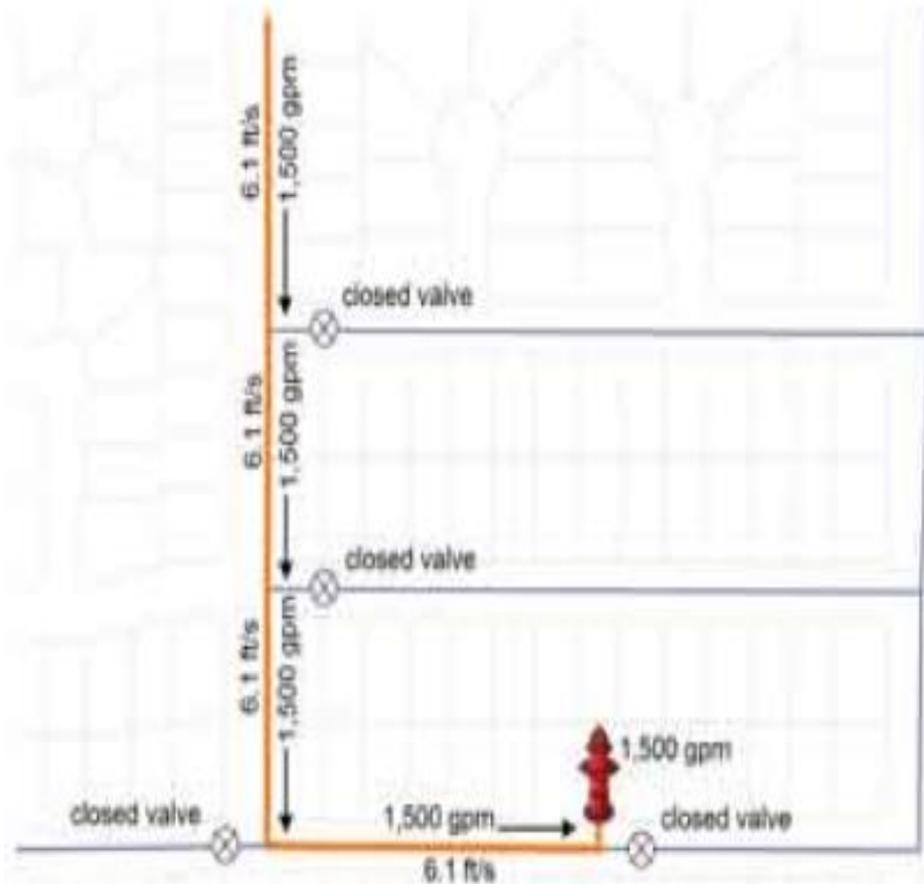
## Conventional Flushing

- The conventional flushing method consists of opening hydrants in the different targeted areas and discharging the water until the accumulations are removed and the water becomes clear.
- This method of flushing is easy to conduct by maintenance and operations crews but requires a large amount of water and may not completely clean the pipe network.
- The diagram shows how the water flows to an open hydrant, using the conventional flushing method. The water moves freely from all directions to an open hydrant. Since there is less flow in a given pipe, velocities may be too low to adequately clean, or scour, the pipes.



## Unidirectional Flushing

- **UDF isolates each pipeline to create flow in a single direction to quickly and efficiently clean the pipe. By concentrating flow, UDF creates higher velocities that are better able to clean the pipe. The cleaned mains may have improved water clarity or color, reduced turbidity and improved chlorine residual.**
- **The diagram shows how the water flows through an isolated pipeline in a single direction, by closing valves and using specific hydrants. The major advantages of this method are; improved cleaning of accumulated deposits on pipes, less required water than conventional flushing, and an impact reduction for customers.**



# Frequently Asked Questions (FAQ)

## What is flushing?

- Flushing is a method of cleaning the water main pipes by forcing water through them at high speed and discharging it through hydrants, which are left open until the water runs clear. This fast-moving water flow scours and cleans out mineral deposits and sediment that have built up over time and settled at the bottom of the pipes.

## Why are residents notified by the City of their flushing program?

- Residents are notified during water main flushing because some may experience a temporary discolouration of water while the water main is being flushed. Any disruption should be short-lived. Residents and businesses along areas where flushing is scheduled to take place will be notified prior to flushing via letters delivered to local businesses and residents, along with signs that will be placed on the road side. So, please keep an eye out for those signs.

## Can you provide me with an exact date and time of the flushing?

- Unfortunately, we cannot. The water main flushing for each section of the pipeline can vary from five minutes to an hour and a half.
- When one section of the pipeline is completed, they will move on to the next section. City staff are working hard to minimize the disruption caused in your area, and due to the varied timeline of the work, it is difficult to schedule a specific time.

## What do I do and what do I not do during water main flushing?

- **Do not:** turn on your taps or flush your toilets when crews are working in your area. This could draw sediment into the water pipes on your property, water meter, hot water tank, and into water filters.
- **Do:** Turn off all time-delayed water-line appliances.
- **Do:** watch for City signage on your street as that will indicate flushing is taking place in your immediate area. The procedure takes 30 minutes to 1 hour for each street.

## What happens when water main flushing is completed?

- After flushing is complete, remove the aerator (a fine mesh grid) on your tap. Then, turn on a cold water tap, preferably the laundry tap, and let the water run for a few minutes.
- Catch some water in a light coloured cup or container to see if it is clear. You can use your water if it is clear.
- Do not choose a tap that has a water filter connected to it; otherwise, the sediment may clog your filter.
- Do not use a hot water tap because it could draw sediment into your hot water tank. Once the water runs clear place back the aerator.
- If the water does not clear within 5 to 10 minutes, wait two hours and try again.

## What do I to do if I experience a loss of water for a long period of time (after two or three hours)?

- If you experience a loss of water (over after two or three hours), please call 604-541-2181.

### Optional Precautionary Measure

- Check the water supply before doing laundry
- Store a sufficient reserve of drinking water for use on the day of water main flushing

# THE CITY OF WHITE ROCK

- Water services and infrastructure in White Rock was owned and operated by private operators for decades.
- EPCOR was the last private operator served the entire City of White Rock as well as certain adjacent properties in the City of Surrey as well as Semiahmoo First Nation.
- The water supply comes from the Sunnyside Uplands Aquifer.
- Total population served is approximately 20,000.
- The City of White Rock purchased the Water Department in October 2015.

# CITY OF WHITE ROCK WATER SYSTEM

- **The City's water supplied from 7 groundwater wells within Sunnyside Aquifer**
- **Long Term Maximum Day Demand is 15 ML/d (174 L/s)**
- **Average Day Demand is 7 ML/d (81 L/s)**

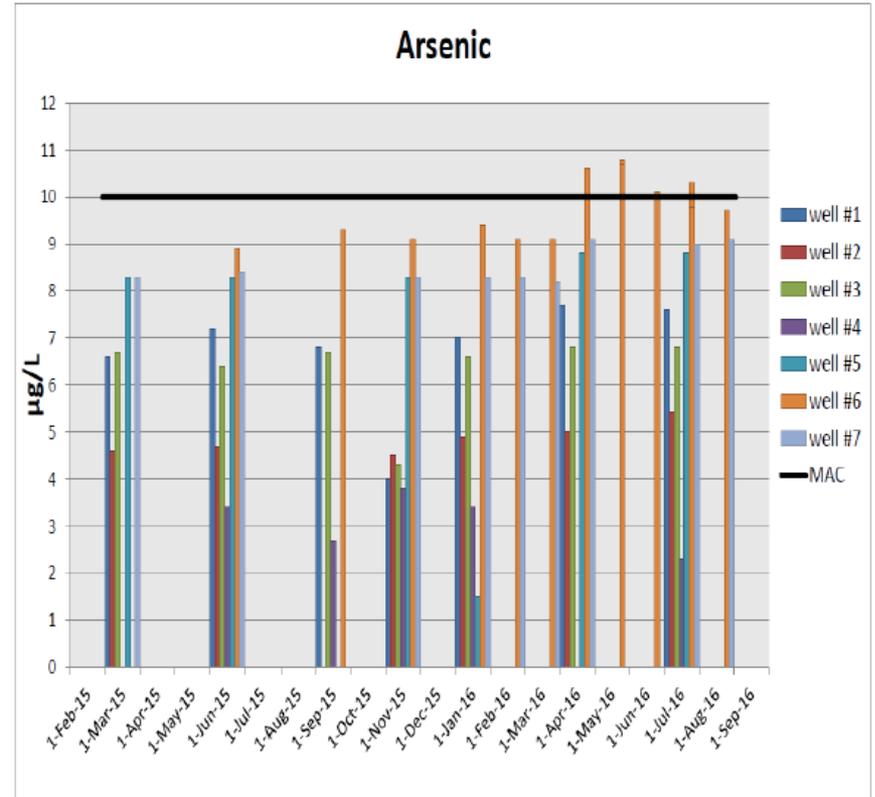
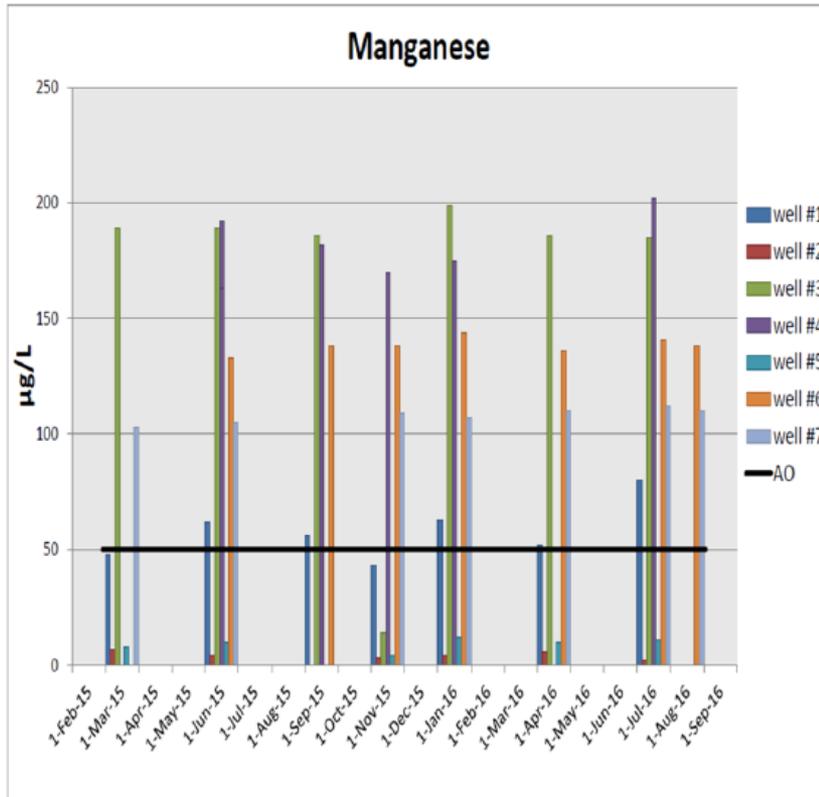
## **Parameters of concern:**

- **Manganese above AO of 0.05 mg/L (AO Changed to 0.02 mg/L, and new MAC at 0.12 mg/L in May 2019)**
- **Arsenic above MAC of 0.010 mg/L**

# City of White Rock Water System



# ARSENIC & MANGANESE IN WATER SUPPLY



CBC News · Posted: Nov 14, 2016 9:05 AM PT | Last Updated: November 15, 2016



White Rock resident Beverly McLaughlin says the water from her taps, shown here in her washing machine, stayed this dark brown colour for about 10 hours. (Beverly McLaughlin)

## HEALTH CANADA NEW GUIDELINES

- The new guidelines incorporates new studies and approaches and takes into consideration the availability of appropriate treatment technology.
- Based on this review, the drinking water guideline for manganese is a maximum acceptable concentration (MAC) of 0.12 mg/L (120 µg/L), based on infants, the most sensitive population.
- Although the MAC established in this document is based on infants, this value is intended to protect all Canadians.
- The new AO is 0.02 mg/L

- **Manganese is an essential element for humans. Deficiency is considered unlikely in Canada, as adequate amounts are obtained from food.**
- **A non-cancer endpoint was chosen for this assessment as available studies are not adequate to support a link between manganese and cancer.**
- **Some studies in humans suggest an association between manganese in drinking water and neurological effects in children; however, they can only be used to support the choice of the key health effect. The effects observed in children are consistent with the neurological effects reported in the key animal studies used to establish the MAC.**

# Project to build New Water Treatment Plant

- To ensure water supplied is of the highest quality, the City of White Rock submitted a grant application to the “Clean Water and Wastewater Fund” (CWWF) to construct a water treatment plant for Arsenic and Manganese treatment.
- On March 17, 2017, the announcement was made by the Government of Canada and the Government of British Columbia that the City of White Rock would receive a historic \$11.79 million in grant funding to construct a water treatment plant to remove Arsenic and Manganese.

## Operation of New Water Treatment Plant in the City of White Rock

- Since end of March 2019, the new White Rock Water Treatment Plant started operating for the first time, delivering a significantly improved water quality with Manganese concentration brought to below detection limit, while raw water supplied prior to the plant operation contained an average of 120-150  $\mu\text{g/L}$  of Manganese.
- Therefore, no more additional Manganese to be deposited in the water mains

## WTP DESIGN BUILD PROJECT

The design of the Water Treatment Plant included the following key treatment processes:

Pre-Oxidation with ozone for arsenic and manganese in the raw water supply.

Removal of manganese using Greensand Plus media filters.

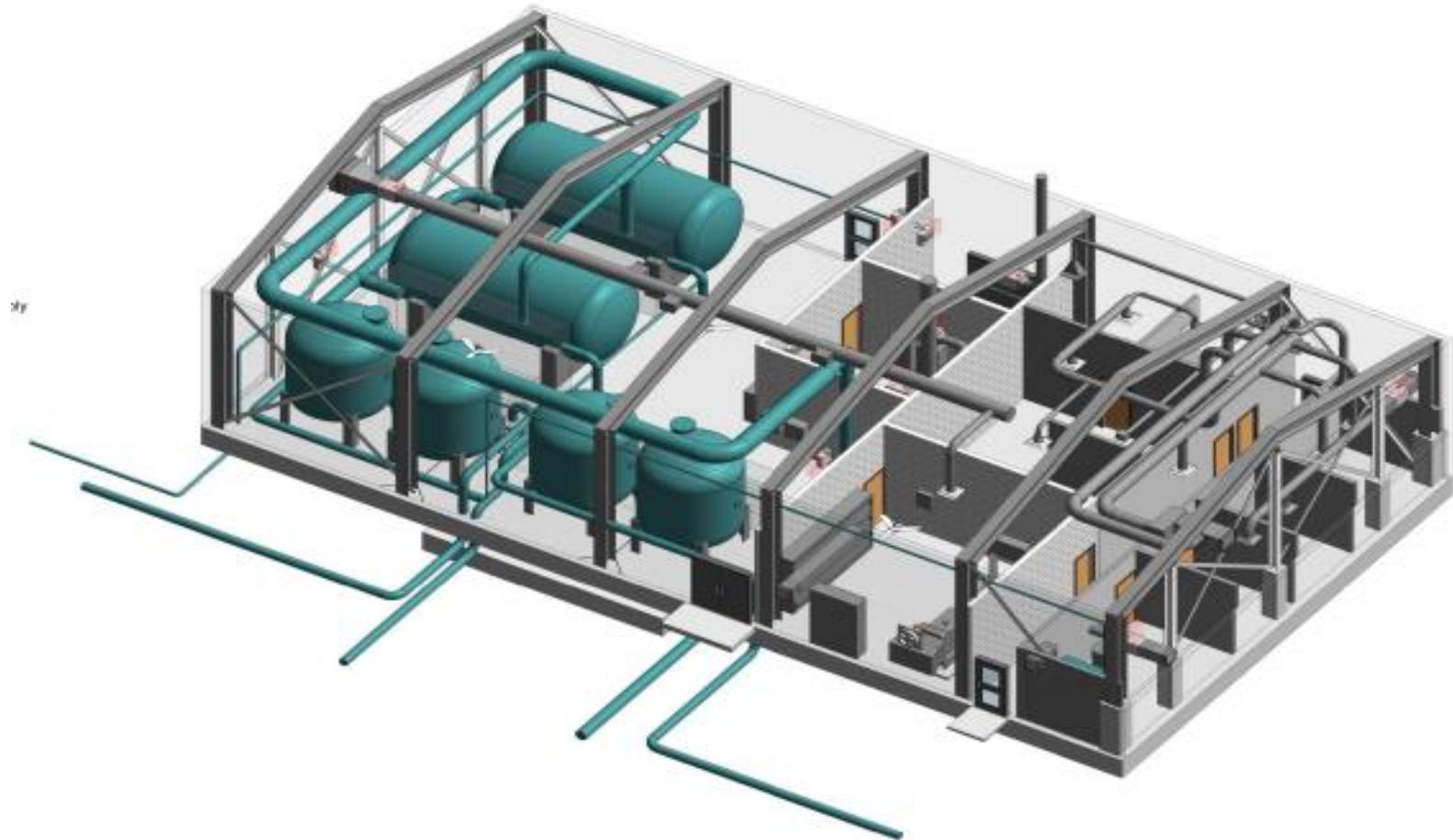
Removal of arsenic using Bayoxide E33 media filters.

The treatment objectives of the White Rock WTP are to deliver drinking water meeting the following operational targets:

- Mn < 0.02 mg/L
- As < 0.002 mg/L (95% of time, 0.005 mg/L for 5% of operation)

All other water quality parameters shall meet the objectives of the Guidelines for Canadian Drinking Water Quality (GCDWQ).

# White Rock WTP









To develop an effective program, and to be able to operate successfully based on the size of the distribution system, The City was divided into 3 Areas



# FLUSHING IN PROGRESS





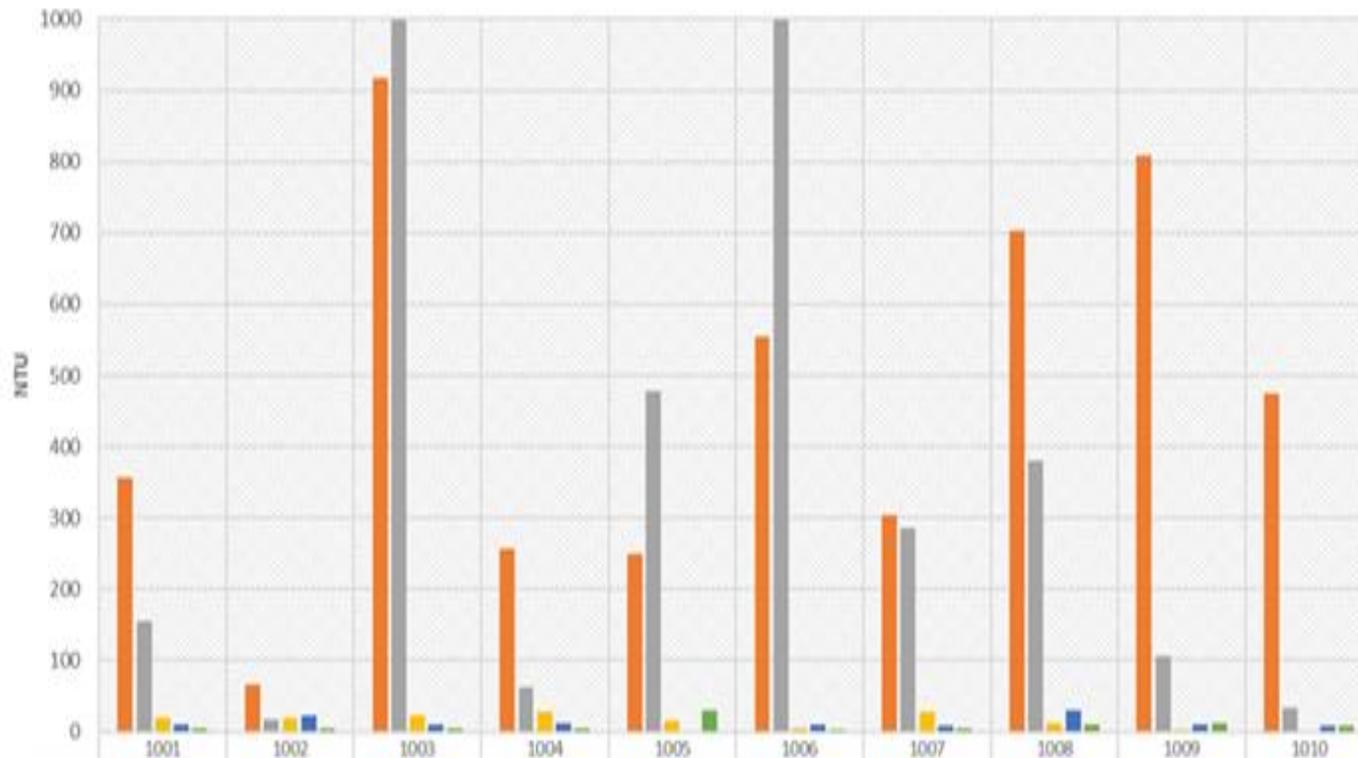
MATHS SUMMER MATH PROGRAMS 804-385-3100

WATER MAIN FLUSHING IN AREA  
WHITE ROCK City by the Sea

- **Significant improvements were noticed during the operation of the UDF program in the City of White Rock Distribution System. The program was implemented every year, starting in 2016 in the months of October-December.**
- **The program was implemented twice in 2017 in order to have a higher improvement after noticing the results of 2016. After 3 years of conducting the UDF program a significant improvement are noticed.**

## Area 1 Turbidities

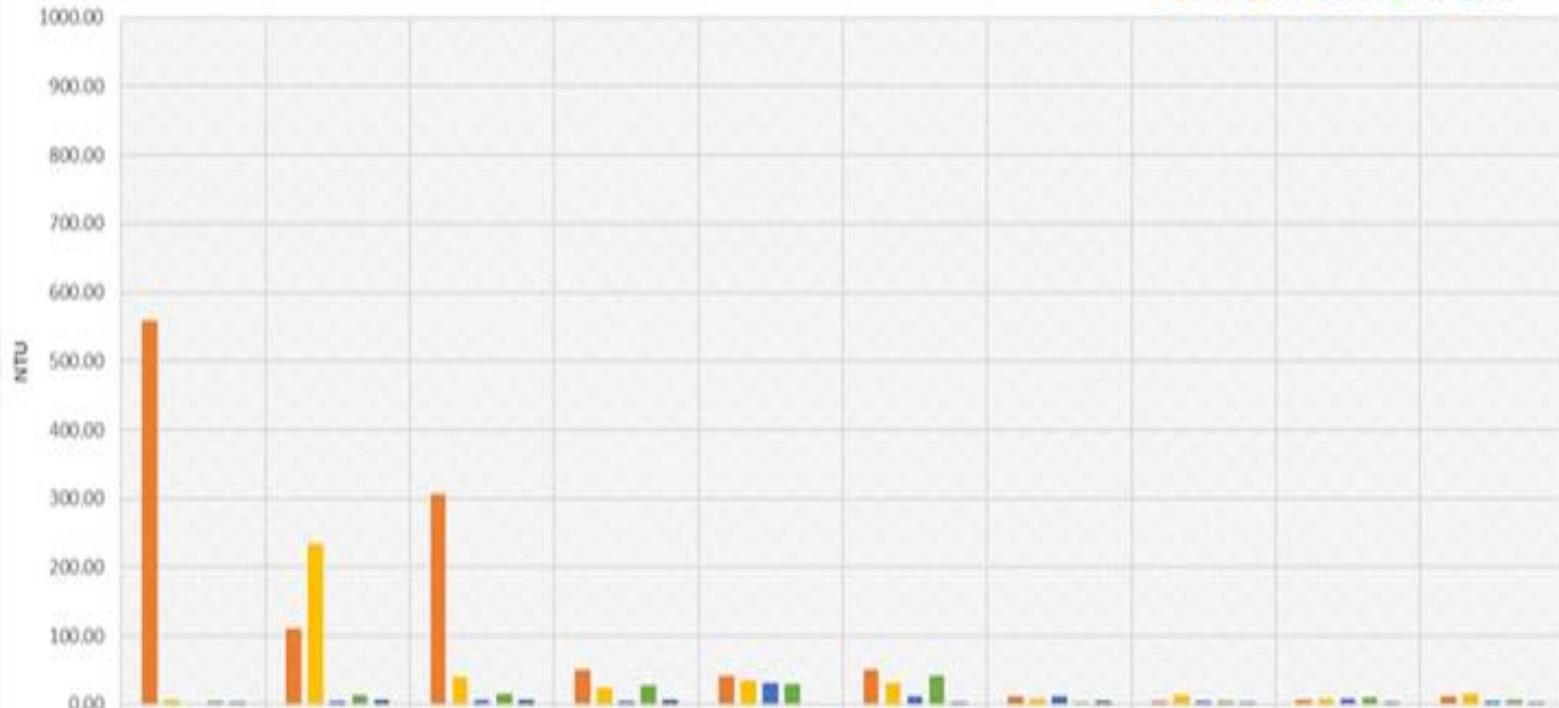
■ 2016 
 ■ 2017 
 ■ 2017 
 ■ 2018 
 ■ 2019



■	2016	357	67	918	256	249	555.00	304.00	703.00	809.00	474.00
■	2017	156	17	999	63	479	999.00	285.00	380.00	107.00	34.50
■	2017	19	20	22	29	15	4.01	28.40	11.80	2.03	1.70
■	2018	10	22	11	11	0	9.20	8.17	29.10	9.89	7.73
■	2019	5	5	5	5	30	3.40	4.50	9.90	11.00	7.70

### Area 2 Turbidities

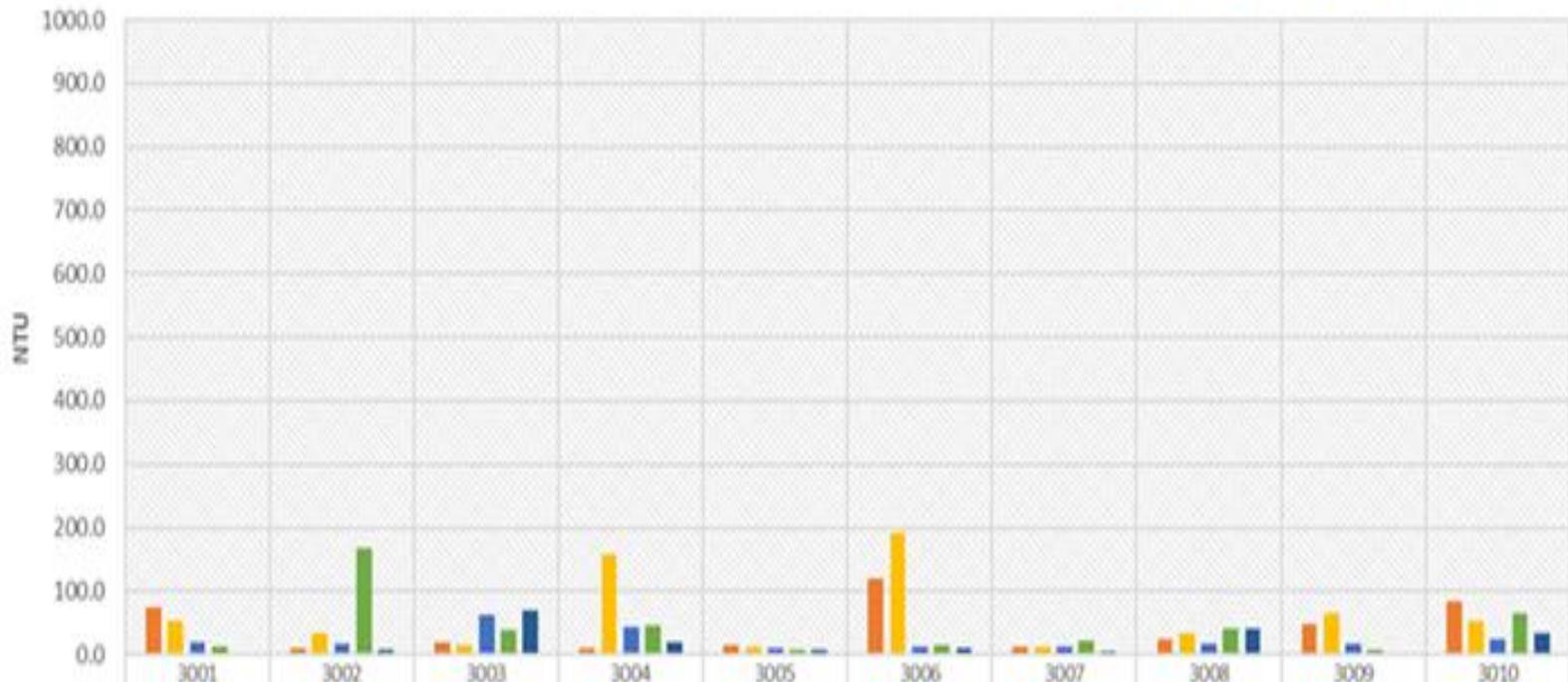
2016 2017 2017 2018 2019



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
2016	559.00	111.00	307.00	50.80	42.30	50.30	11.30	4.67	6.43	11.80
2017	7.20	234.00	40.60	25.10	35.90	31.00	9.46	14.10	8.53	16.30
2017	1.90	5.95	7.18	5.44	32.20	11.40	11.50	4.90	8.95	4.83
2018	4.4	14.4	16.1	27.8	29.6	41.8	3.5	5.6	10.1	6.2
2019	2.9	7.2	6.6	6.1	2.2	3.5	5.5	3.2	3.3	3.8

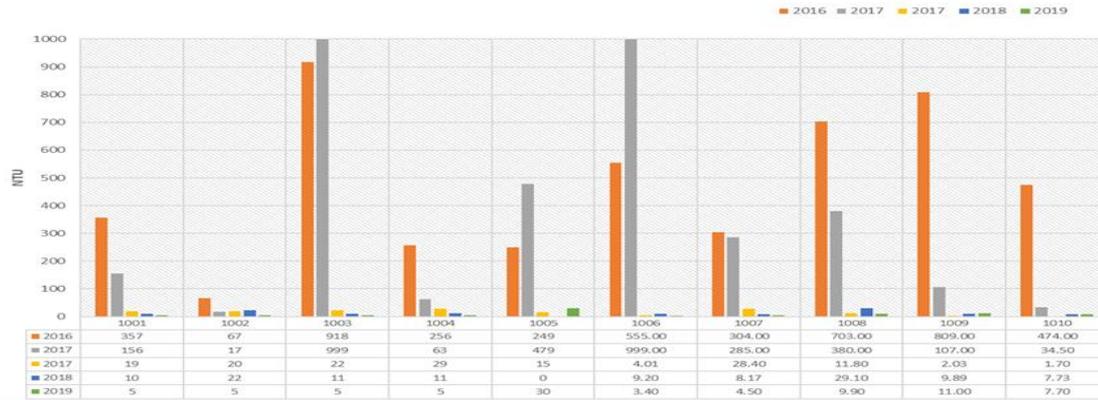
## Area 3 Turbidities

■ 2016 
 ■ 2017 
 ■ 2017 
 ■ 2018 
 ■ 2019



■ 2016	74.6	10.1	20.3	10.5	13.7	119.0	11.4	24.3	48.7	85.0
■ 2017	53.4	33.9	15.8	158.0	11.5	192.0	12.7	34.4	64.7	52.8
■ 2017	20.4	17.6	62.9	43.2	10.8	11.2	11.6	17.7	16.8	23.5
■ 2018	11.4	169.0	37.5	44.9	6.8	13.8	22.3	39.9	8.0	64.5
■ 2019	3.6	8.7	69.8	20.7	6.7	9.2	5.1	42.0	3.9	32.7

Area 1 Turbidities



Area 2 Turbidities



Area 3 Turbidities



- The data shows clearly the reduction in turbidity due to the removal of Manganese deposits in the Distribution System after the UDF program initiation.

The other important factors noticed were the reduction of Backwash Volume of Water used and the time needed for backwash

Area 1

Total Backwash Water Volume, 2016	2854 m <sup>3</sup>	Total Backwash Water Volume, 2019	1151 m <sup>3</sup>
Time	1211 min.	Time	481 min.

⊕ Area 2

Total Backwash Water Volume, 2016	6385 m <sup>3</sup>	Total Backwash Water Volume, 2019	2194 m <sup>3</sup>
Time	2263 min.	Time	1088 min.

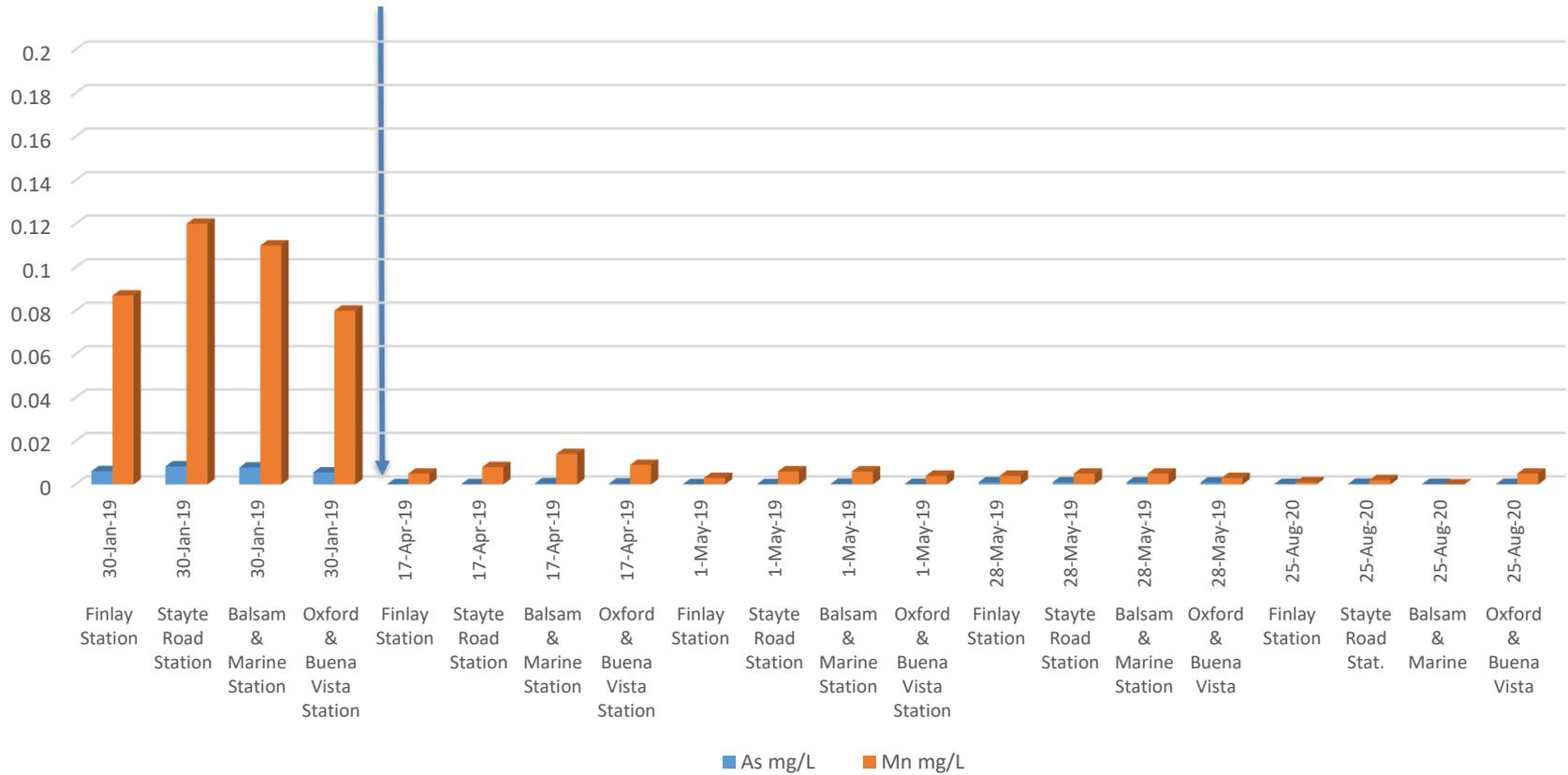
Area 3

Total Backwash Water Volume, 2016	2133 m <sup>3</sup>	Total Backwash Water Volume, 2019	1348 m <sup>3</sup>
Time	1114 min.	Time	636 min.

# What was the Impact of the new Water Treatment Plant??

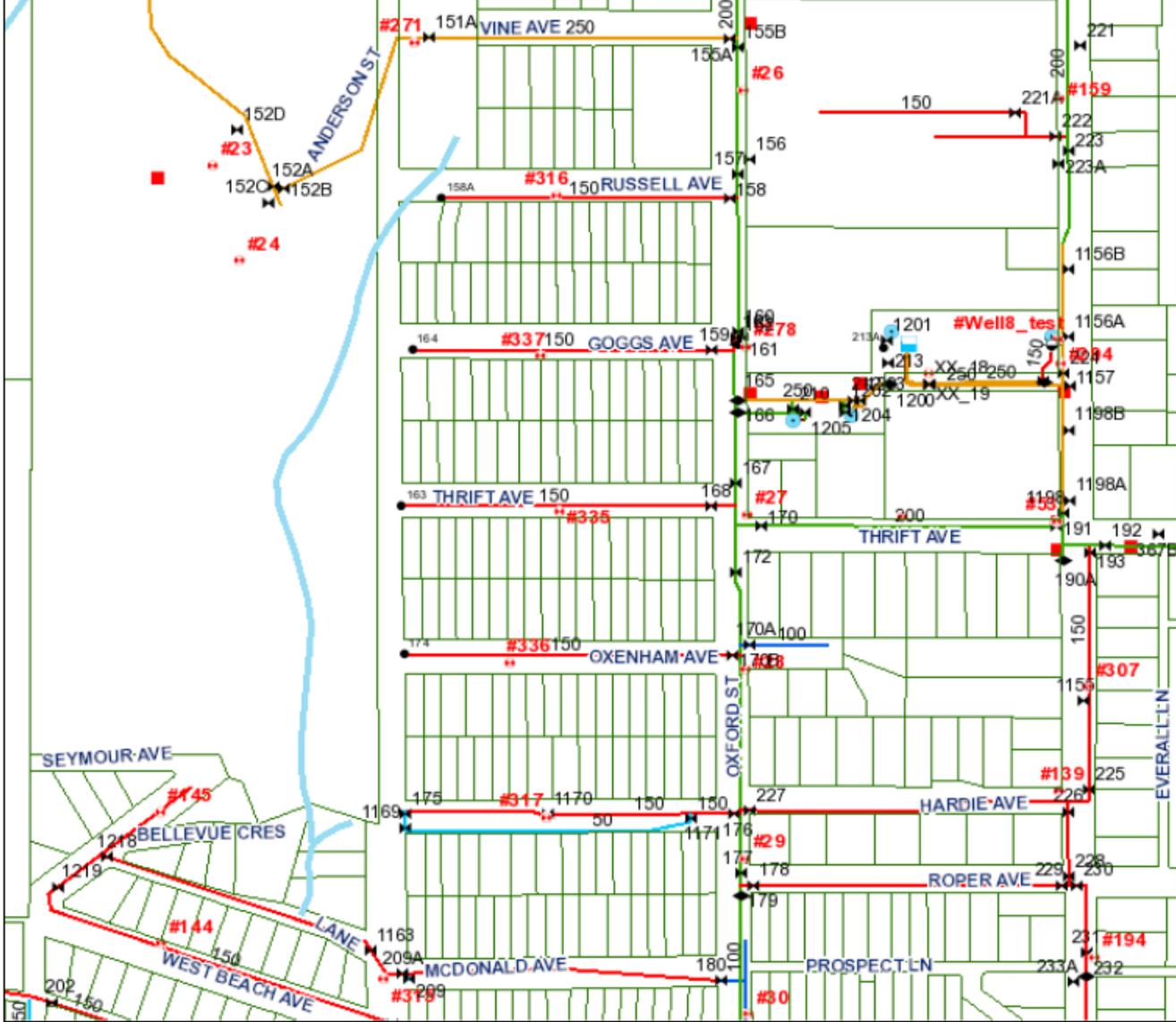
# Arsenic and Manganese in the Distribution System

## Start of the New Water Treatment Plant



# DEAD-ENDS

- **The installation of mains that are not looped is strongly discouraged because stagnation can occur in a dead-end line.**
- **Dead ends are not considered to be best practice and should be avoided because they reduce fire flows, lead to the deterioration of water quality, and can cause corrosion.**
- **Dead ends can also affect water pressure, flushing operations, and water service during main repair and maintenance.**



### Legend

- Street Names
- Streams
- Railway
- Ocean
- Lots Boundaries
- Air Valve
- Blow Off
- Valve with Label
- Hydrant with Label
- PRV
- Reservoir

- 150 mm (6 inch)
- 200 mm (8 inch)
- 250 mm (10 inch)
- 300 mm (12 inch)

### Fiber Optic Service Boxes

- Indoor
- Outdoor

### Valves

- Closed
- Open
- Abandoned
- Well

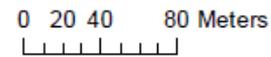
### Water Main (Diameter)

- 25 mm (1 inch)
- 50 mm (2 inch)
- 100 mm (4 inch)



## Dead End Watermains

Scale: 1:3,676



The data provided is compiled from various sources and IS NOT warranted as to its accuracy or sufficiency by the City of White Rock. This information is provided for information and convenience purposes only. Lot sizes and legal descriptions must be confirmed at the Land Title Office.

## DEAD ENDS & WATER QUALITY

- **AWWA Policy Statement, Water Quality Control in Distribution Systems, recommends the “design and operation of the distribution system to preclude dead ends and excessive detention times,” as a standard water quality maintenance practice.**
- **The policy cites health regulations that have placed increasing emphasis on monitoring and maintaining quality in the distribution and storage systems through customers’ taps.**

# DEAD ENDS WATER QUALITY CONCERNS

- **Falling Disinfectant Residuals**
- **Increase the potential of microbiological activities**
- **Increase the Disinfectant by Products (DBPs)**
- **Impact on the system pressure**

# CONCLUSIONS

- **The UDF Program improves the condition of Distribution System, by removing sediment, biofilm, which reduce potential impacts on water quality delivered to the public, and reduce the potential of having negative aesthetical impact on the water delivered.**
- **Reducing discharged water used in the UDF, is a significant reduction of the volume withdrawn from the Sunnyside Aquifer, which is an important step in Water Conservation and in management of water resources and reduction of energy use, considering the relationship between Climate Change, Energy and Water.**

# ACKNOWLEDGEMENT

The author would like to acknowledge the support from the City of White Rock.

The author would like to acknowledge the funding support provided by Government of Canada and the Government of British Columbia for providing funding for the project from the Clean Water and Wastewater Fund (CWWF). The Design Build of the Water Treatment Plant to remove arsenic and manganese to  $<2 \mu\text{g/L}$  and  $<20 \mu\text{g/L}$ , respectively, provides a significant improvement for the water quality provided to the public.

**THANK YOU!!!**

**Questions???**