MY CITY

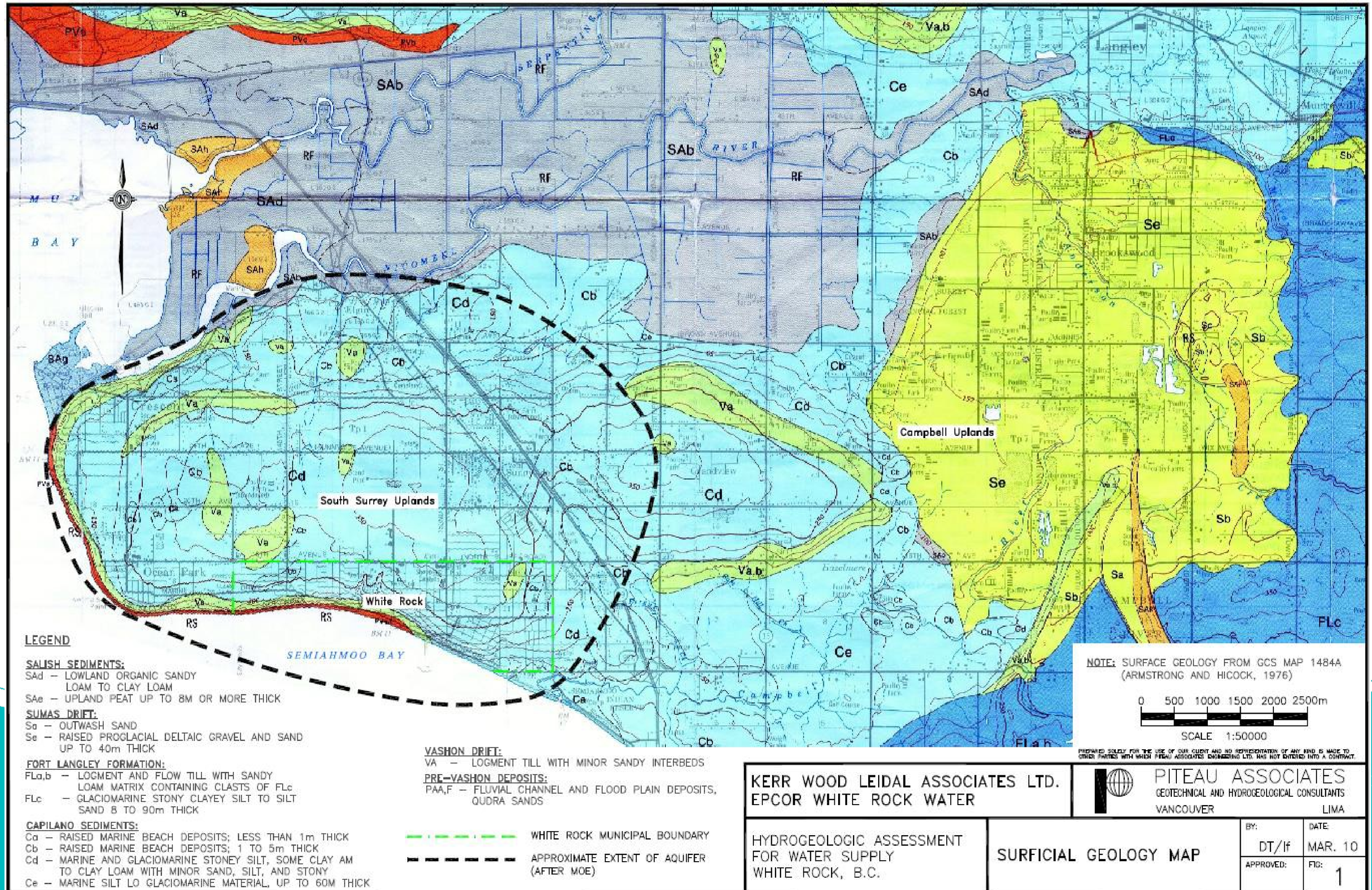
MY WATER

Water Research Open House

Thursday, January 25, 2018

WHITE ROCK
City by the Sea!

Sunnyside Uplands Aquifer
Where our Water Supply Originates



LEGEND

SALISH SEDIMENTS:
SAd – LOWLAND ORGANIC SANDY LOAM TO CLAY LOAM
SAe – UPLAND PEAT UP TO 8M OR MORE THICK

SUMAS DRIFT:
Sa – OUTWASH SAND
Se – RAISED PROGLACIAL DELTAIC GRAVEL AND SAND UP TO 40m THICK

FORT LANGLEY FORMATION:
FLa,b – LOGMENT AND FLOW TILL WITH SANDY LOAM MATRIX CONTAINING CLASTS OF FLc
FLc – GLACIOMARINE STONY CLAYEY SILT TO SILT SAND 8 TO 90m THICK

CAPILANO SEDIMENTS:
Ca – RAISED MARINE BEACH DEPOSITS; LESS THAN 1m THICK
Cb – RAISED MARINE BEACH DEPOSITS; 1 TO 5m THICK
Cd – MARINE AND GLACIOMARINE STONEY SILT, SOME CLAY AM TO CLAY LOAM WITH MINOR SAND, SILT, AND STONY
Ce – MARINE SILT LO GLACIOMARINE MATERIAL, UP TO 60M THICK

VASHON DRIFT:
VA – LOGMENT TILL WITH MINOR SANDY INTERBEDS

PRE-VASHON DEPOSITS:
PAA,F – FLUVIAL CHANNEL AND FLOOD PLAIN DEPOSITS, QUDRA SANDS

WHITE ROCK MUNICIPAL BOUNDARY

APPROXIMATE EXTENT OF AQUIFER (AFTER MOE)

NOTE: SURFACE GEOLOGY FROM GCS MAP 1484A (ARMSTRONG AND HICOCK, 1976)

0 500 1000 1500 2000 2500m
SCALE 1:50000

KERR WOOD LEIDAL ASSOCIATES LTD.
EPCOR WHITE ROCK WATER

PITEAU ASSOCIATES
GEOTECHNICAL AND HYDROGEOLOGICAL CONSULTANTS
VANCOUVER LIMA

HYDROGEOLOGIC ASSESSMENT FOR WATER SUPPLY WHITE ROCK, B.C.

SURFICIAL GEOLOGY MAP

BY:	DATE:
DT/lf	MAR. 10
APPROVED:	FIG: 1

Water Quality Milestones

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Water Quality Management Initiatives

1. **Disinfection of distribution system**

   ✓ **COMPLETED** - Fraser Health required the City to provide secondary disinfection by February 1, 2017

2. **Increase storage capacity at Oxford and Merklin Sites to over 6 million liters**
   - ✓ **COMPLETED** - The Oxford Site (did not previously exist)
   - ✓ **COMPLETED** - Seismic upgrade at Merklin site/ removal of existing water tower
   - ✓ **COMPLETED** - Construction of Merklin reservoir and pumping stations by April 2017
   - ✓ **COMPLETED** - Additional supply to meet future demand in 2031

3. **Arsenic removal if limit exceeds the Guideline for Canadian Drinking Water Quality (GCDWQ)**
   - Arsenic concentrations are within current limits which is 0.010 mg/L as set by Health Canada
   - By December 31, 2018 Fraser Health requires City to provide treatment, if arsenic levels increase above existing levels

4. **Manganese removal if GCDWQ establishes a limit for health effects in the future**
   - Currently GCDWQ only has an aesthetic limit which is 0.05 mg/L as set by Health Canada

How We Communicate Water Quality

Every month different water quality parameters are tested throughout the City:

- **Weekly laboratory testing**
  - ❖ In-house testing for conductivity, pH, turbidity, free chlorine, total chlorine and temperature
  - ❖ Microbiological testing for Total Coliforms and Escherichia Coli
- **Monthly laboratory testing**
  - ❖ Metal testing for arsenic at the Merklin Site only
- **Quarterly laboratory testing**
  - ❖ Metal testing for arsenic, copper, lead, iron and manganese
  - ❖ Organic testing for Trihalomethane (THM) and Haloacetic Acids (HAA)
- **Yearly laboratory testing**
  - ❖ Inorganics including: antimony, arsenic, barium, boron, bromate, cadmium, chloramines, chromium, cyanide, fluoride, lead, mercury, nitrate, nitrite, selenium, uranium, aluminum, ammonia, calcium, chloride, copper, hardness, iron, magnesium, silver, sodium, sulphate, sulphide, organic carbon, xylenes and zinc

Once these parameters are tested all of the test results are uploaded to the White Rock website for viewing. Please visit **www.whiterockcity.ca/MyWater**

Unprecedented Communications on Water Related Activities

Since acquiring the water utility from EPCOR, the City has provided an unprecedented level of information to the public through public meetings, marketing and communication campaigns, water quality test results, and FAQs related to water and secondary disinfection on the City's website available at www.whiterockcity.ca/mywater.

Open Houses

The City has held multiple Open Houses and Community Forums on water in White Rock. All of the event materials from these open houses/community forums is on our website under "Event and Communication Material" on the My Water page:

- Public Information Meeting - June 16, 2015
- Community Forum - October 15, 2015
- Open House - March 2, 2016
- Water Quality Open House - December 7, 2016
- Water Quality Open House – January 25, 2018
- (Upcoming) Water System Master Plan Open House – February 21, 2018

Conferences

- Dr. Saad Jasim's Keynote address to the International Ozone Association-Swansea, UK, October 26, 2016
- BCWWA Conference, Victoria, BC, May 29, 2017
- 23rd World Congress International Ozone Association, August 14, 2017, Washington DC, USA

Connect With US!

The City communicates water related matters by advertising in the local newspaper, special brochures sent each quarter with your water utility bill, the City's e-newsletter, and through social media.

whiterockcity

@whiterockcity

cityofwhiterock

Newsletter

www.whiterockcity.ca/newsletter

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The Impact of Manganese

AN AESTHETIC OBJECTIVE ONLY

Manganese is an element that can be found in over 100 common salts, rocks and in the soils found on the floors of lakes and oceans. The aesthetic objective for manganese is 0.05 mg/L in the Guidelines for Canadian Drinking Water Quality set by Health Canada. There is currently no maximum allowable limit.

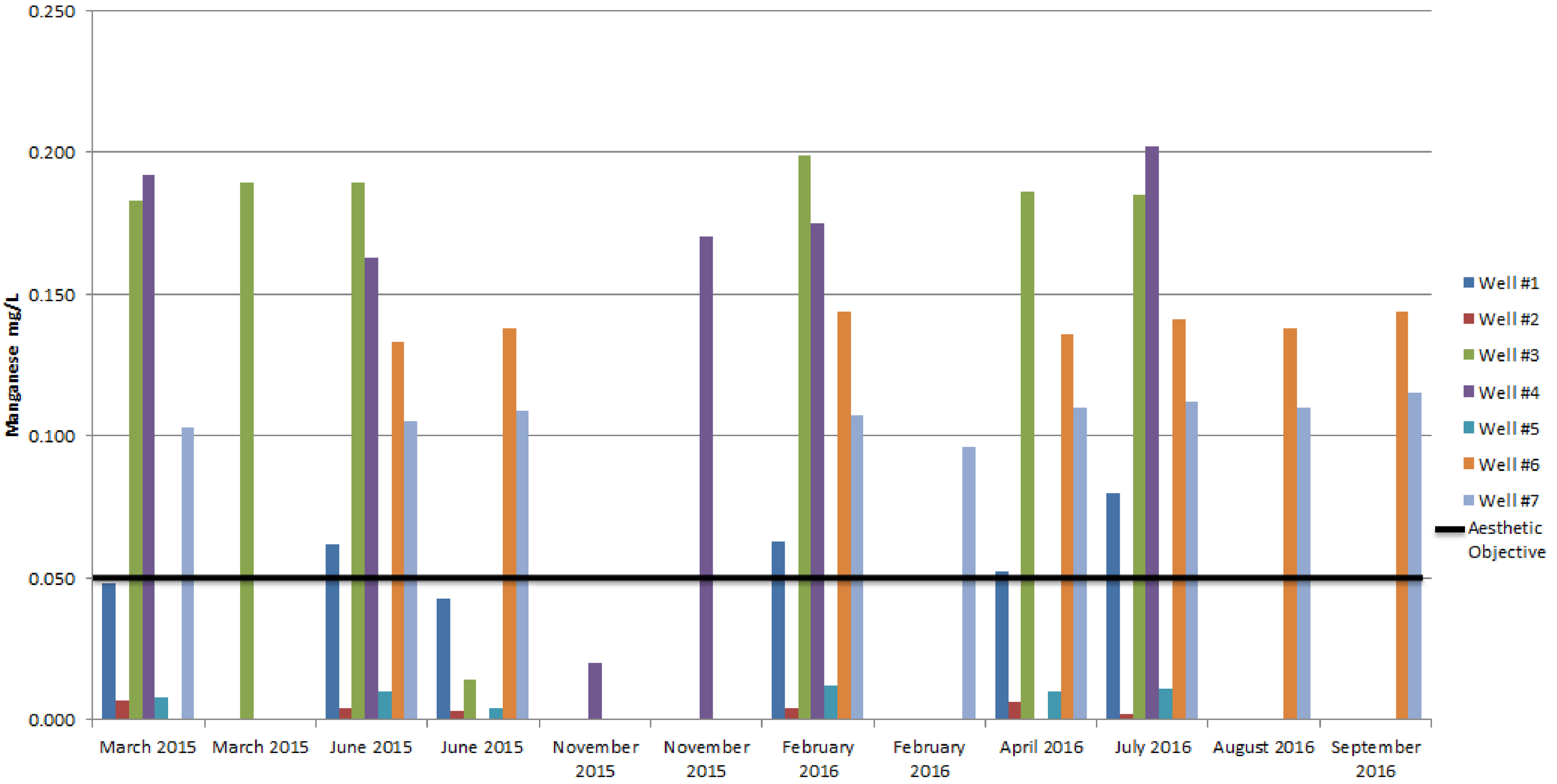
- Manganese is among the least toxic elements; only exposure to extremely high concentrations from human-made sources has resulted in adverse human health effects
- At levels exceeding 0.15 mg/L, manganese can stain plumbing fixtures and laundry and may cause an undesirable taste in beverages
- It is difficult to remove manganese to achieve concentrations below 0.05 mg/L. Therefore, for aesthetic purposes, the aesthetic guideline limit for manganese in drinking water is 0.05 mg/L

Source: Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Manganese

- Should the Guidelines for Canadian Drinking Water Quality deem manganese a health criteria, a treatment system must by operational one year after the date of the changes to the Guideline Limits

Source: Permit to Operate from Fraser Health Authority

2015 - 2016 Manganese Levels for Wells 1 - 7



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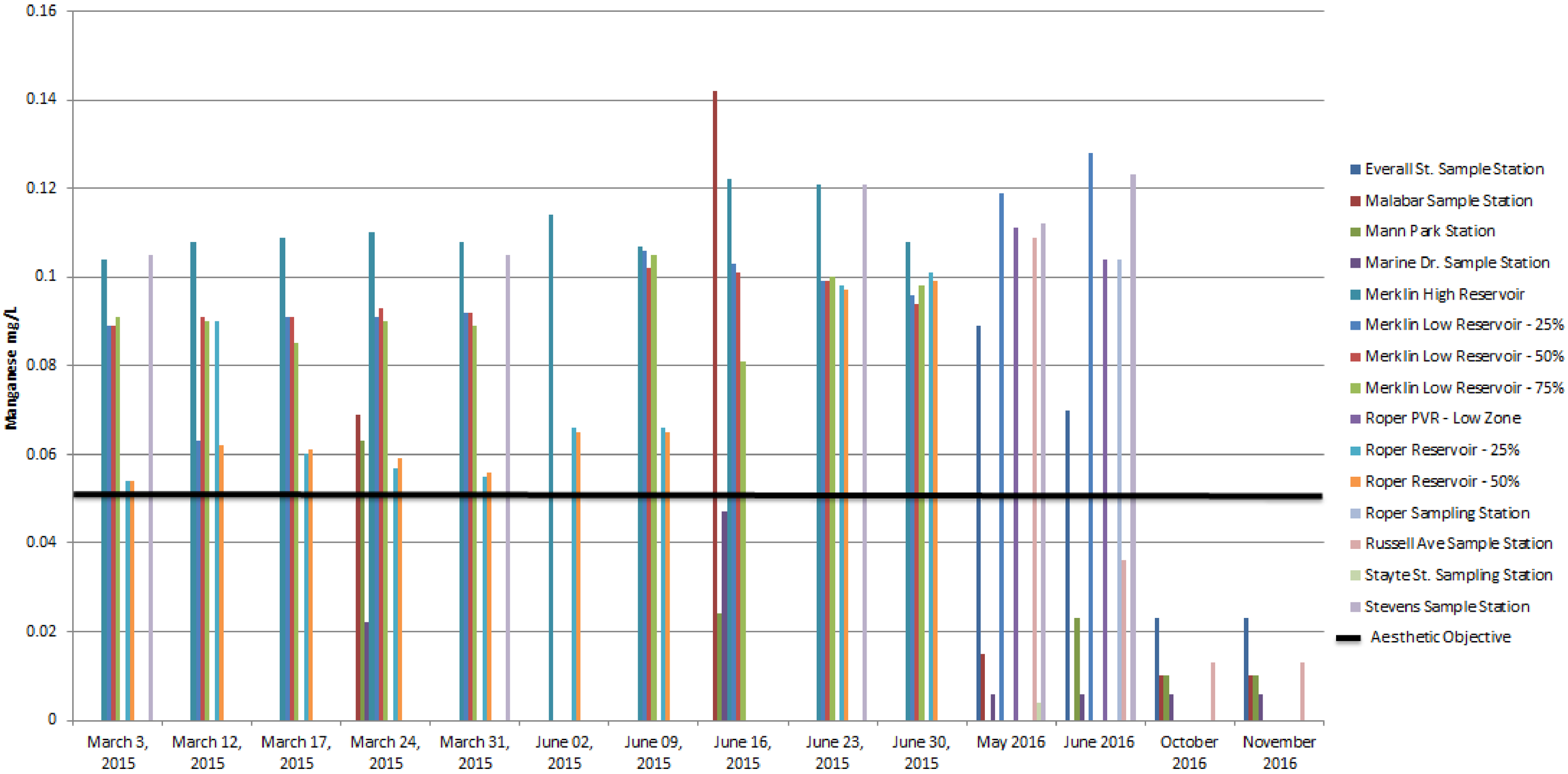
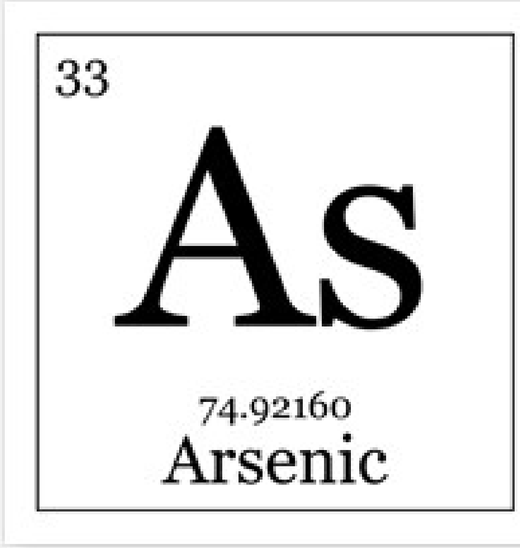
2015 & 2016 Manganese Levels for Reservoirs and Stations

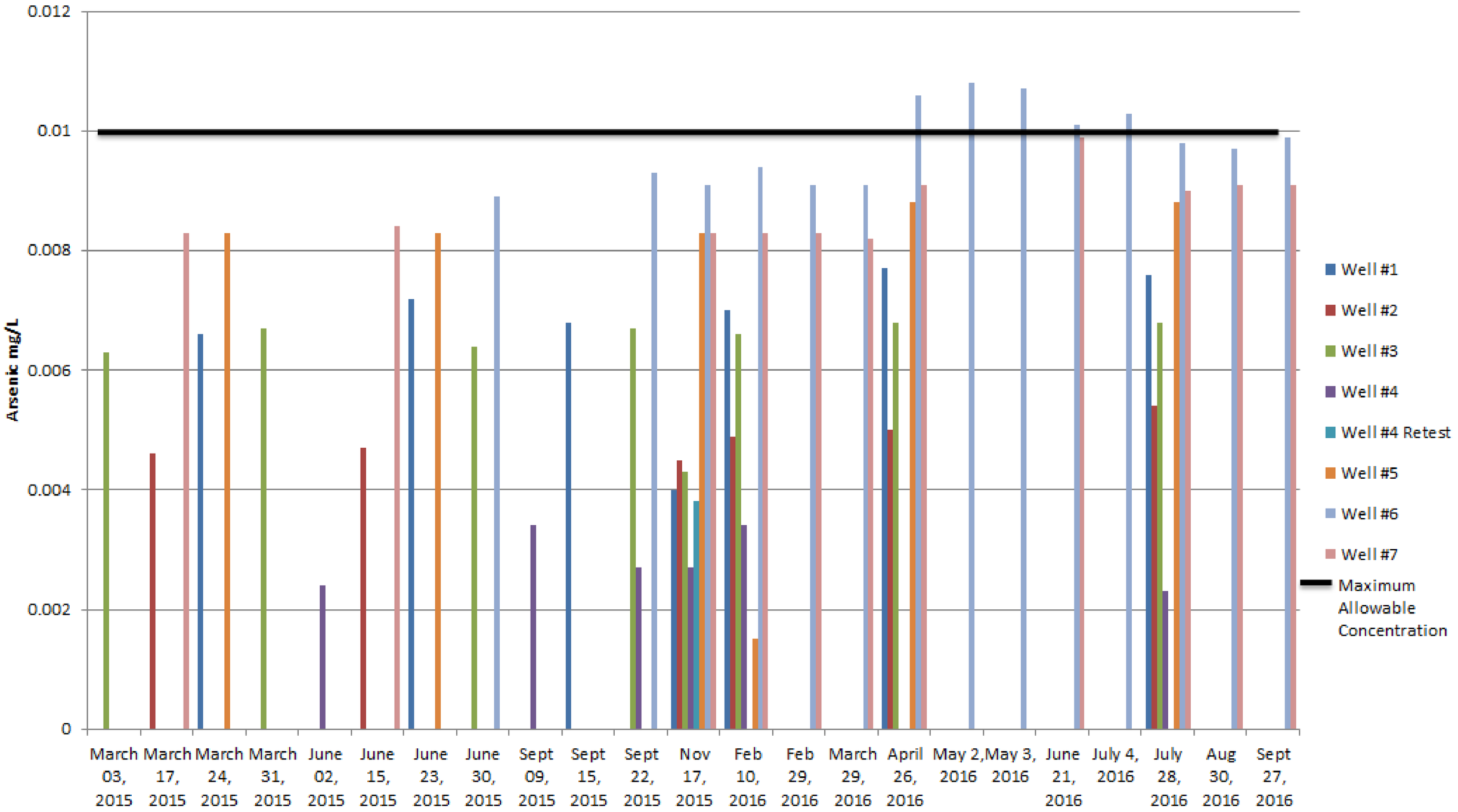


Impact of Naturally Occurring Arsenic



- Arsenic is a naturally occurring metal found in mineral deposits or rocks throughout the Earth's crust. Arsenic may enter lakes, rivers or underground water sources when the mineral deposits containing arsenic dissolve
- In 2007, the GCDWQ lowered the maximum allowable concentration (MAC) from 0.025 mg/L to 0.010 mg/L
- Although the MAC (Maximum Allowable Concentration) for arsenic is set at 0.010 mg/L, levels should be kept as low as reasonably achievable

2015 & 2016 Arsenic Levels for Wells 1 - 7



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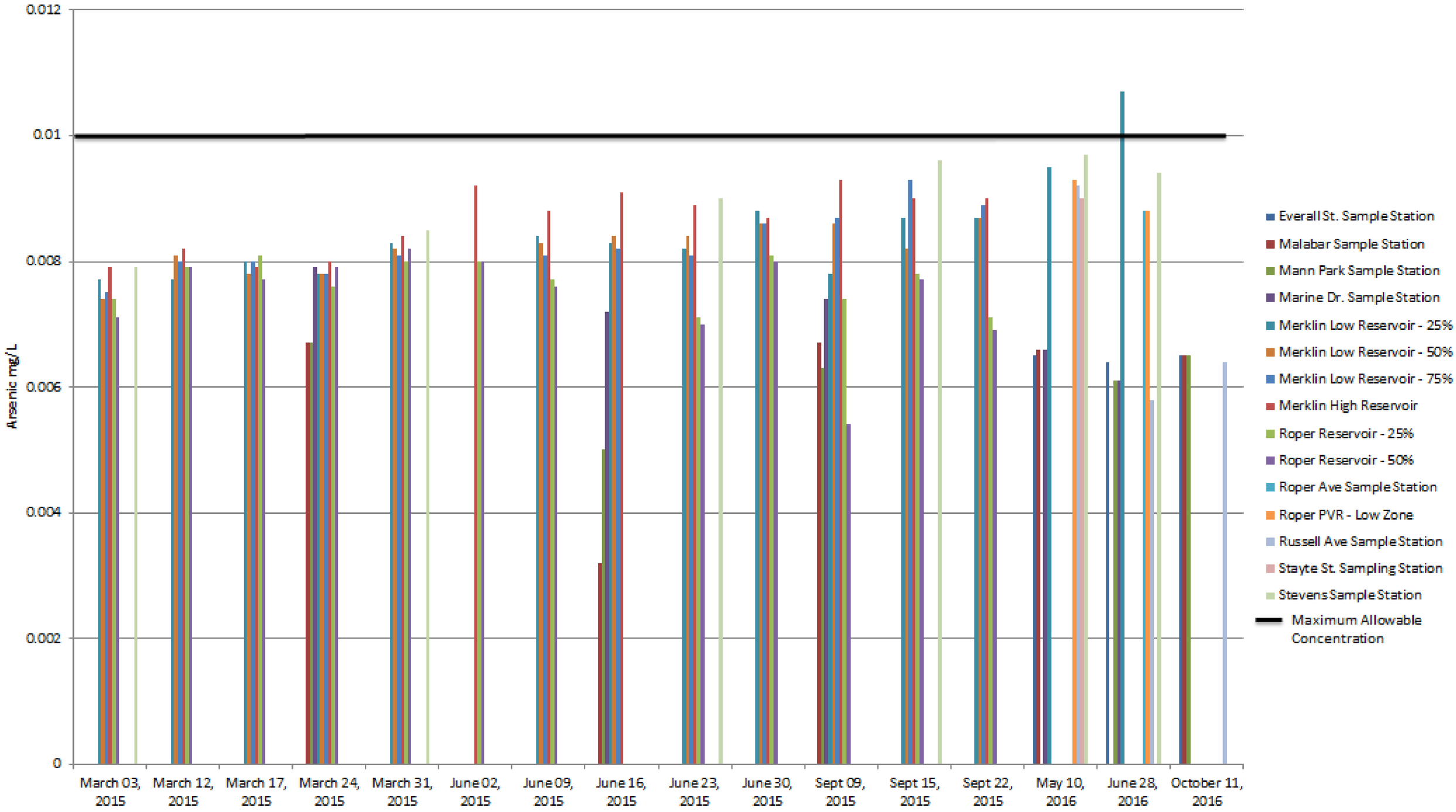
2015 - 2016 Arsenic Levels for Reservoirs and Sample Stations



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City of White Rock Partners with Scientists, Researchers and Water Quality Subject Matter Experts to Reduce Naturally Occurring Arsenic and Manganese

- To identify the best technologies that will provide a significant reduction of naturally occurring arsenic and manganese, and deliver water that is of high quality and clarity, the City partnered with RES'EAU-WaterNET, which is funded by the Natural Sciences and Engineering Research Council of Canada (NSERC).

- The Research & Development team includes 22 world-class scientists from nine universities across Canada.

- A Mobile Pilot Plant was brought to the Merklin Pumping Station to start the research study

- Researchers have been evaluating arsenic and manganese treatment options to determine the best technologies for White Rock.

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Quick Facts About RES'EAU-WaterNET

About RES'EAU-WaterNET:

RES'EAU is the Natural Sciences and Engineering Research Council of Canada's (NSERC) response to the society's changing expectation about what R&D partnership in drinking water should deliver.

RES'EAU-WaterNET Mission:

Achieving Socially and Technologically Sustainable Outcomes in Drinking Water Systems for Small, Rural and Indigenous Communities.

RES'EAU-WaterNET Approach:

RES'EAU Community Circle Model for Problem Solving is our award-winning and globally unique, precision problem-solving model for drinking water in small, rural and indigenous communities.

It proposes the customization of solutions, with decisions, practices, technologies and services being tailored to the individual community.

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Partnership: City of White Rock and RES'EAU-WaterNET

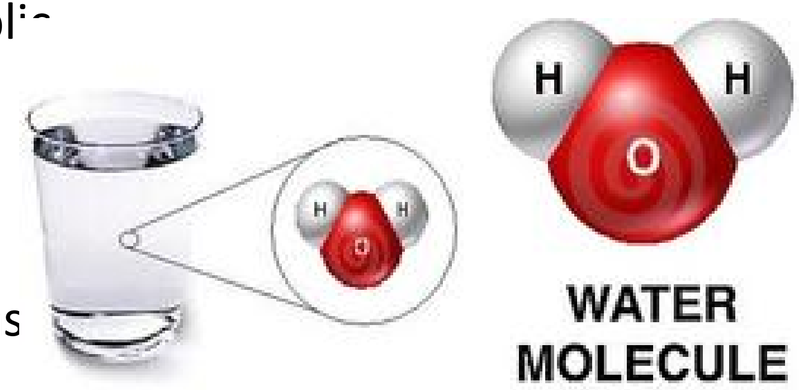
Scope of the collaboration have included:

- Water sampling and analysis: Monitoring and evaluating the quality of source water over the course of the project
- Water research: Researching and assessing potential water treatment alternatives capable of providing high quality water for the City
- Pilot testing: Evaluating short-listed and promising technologies through extensive pilot studies using RES'EAU's mobile water treatment plant, and through collaboration with the City.

Partnership: City of White Rock and RES'EAU-WaterNET

Partnership with RES'EAU-WaterNET has provided the City of White Rock access to experts and a wealth of knowledge and experience in drinking water treatment. Benefits of the partnership include:

- A network of Canada's top academic researchers with extensive and deep knowledge of drinking water systems;
- Access to a seasoned team that has refined experience in outreach and public engagement activities;
- Access to leading Canadian industrial expertise through partners who understand utilities and communities perspectives;
- The cumulative benefit of RES'EAU-WaterNET's knowledge sharing from international organizations with similar research and development programs and
- Access to the Network's Mobile Water Treatment Plant, which has provided timely results and cost effective tests for potential water treatment technologies, operated on site at the Merklin Reservoir.



Partnership with RES'EAU-WaterNET also provides an effective public and private stakeholders outreach based on scientific findings and peer reviewed articles.

RES'EAU-WaterNET Mobile Drinking Water Treatment System

The mobile pilot plant contained a number of technologies to assess their effectiveness for treating the water from City's groundwater sources. The following treatment methods were investigated for Manganese and Arsenic removal during the pilot study:

- Filtration using Birm media with air injection as pre-oxidant
- Filtration using GreensandPlus media with chlorine as pre-oxidant
- Filtration using GreensandPlus media with ozone as pre-oxidant
- Iron injection followed by filteration using GreensandPlus media with chlorine as pre-oxidant
- Arsenic removal using iron based adsorptive media (E33 Bayoxide)
- Biological Filtration Process

Since there was no biofilm growth in the biological filter during this pilot study, this method was deemed ineffective and was not further investigated.

The treatment systems were contained in a 6 m trailer, shown in Figure 1. Source water was provided from well #6 and well #7 (Merklin street reservoir) by connecting the inlet of the pilot directly to the outlet of the well pumps. The system inside the pilot was designed to have two treatment trains running in parallel. Each train contained one filter designed for the removal of manganese followed by a second filter considered for the removal of arsenic. This design provided the ability to investigate the efficiency of each filter for the removal of either manganese or arsenic. The process flow diagram and sampling Locations are shown in Figure 2.

Figure 1 RES'EAU-WaterNET mobile drinking water treatment pilot plant.

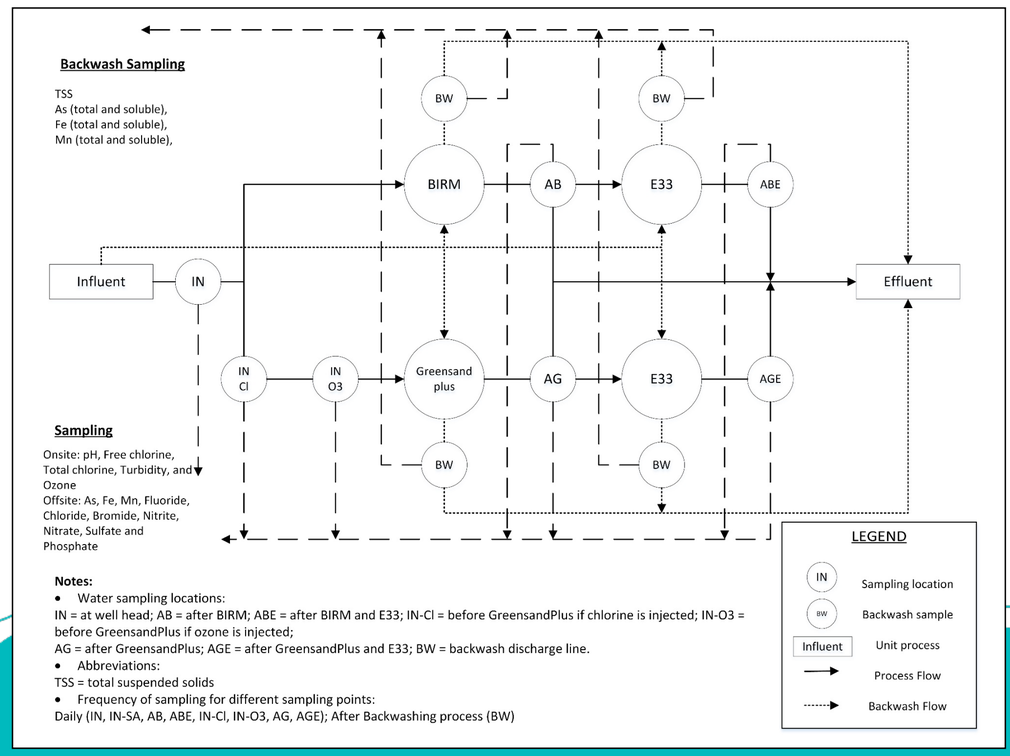


Figure 2 Process flow diagram and sampling location.

Manganese and Arsenic Removal Using Birm Filter Media

Background:

The process of oxidation/filtration involves oxidizing soluble forms of iron and manganese to create insoluble compounds, then removing the insoluble precipitates through filtration. Birm is an acronym that stands for the “Burgess Iron Removal Method” and is a proprietary product manufactured by the Clack Corporation in Wisconsin. The dissolved oxygen oxidizes iron with Birm media serving as a catalyst that enhances the reaction between dissolved oxygen and dissolved iron and manganese in the water. No chemical addition or regeneration is required for Birm.

More information is available at: *www.clackcorp.com*.

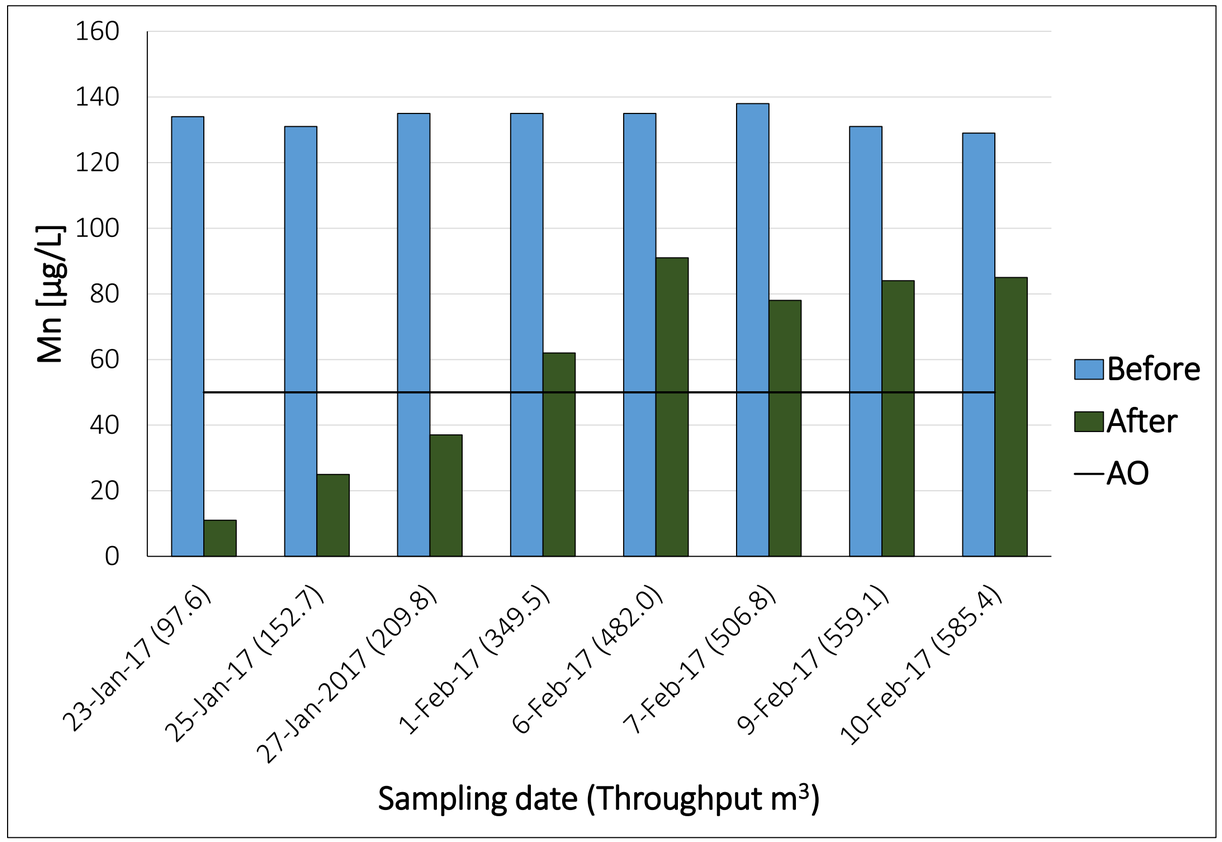


Figure 3 Manganese removal through Birm filter at different sampling dates; values in the brackets represent the cumulative throughput volume of the water.

Treated Drinking Water Quality:

- Manganese concentration in the outlet stream of Birm increased gradually, eventually reaching above the Aesthetic Objective (50 µg/L) after nearly 300 m^3 cumulative volumes (Figure 3).
- Over the course of experiment, no significant removal of arsenic was observed through Birm filter

Manganese and Arsenic Removal Using GreensandPlus Filter Media *with Chlorine* as Pre-oxidant

Background:

GreensandPlus is a black filter media used for removing soluble iron, manganese, hydrogen sulfide, arsenic and radium from groundwater supplies. The capacity of this media for the removal of arsenic is dependant on the water quality and it needs to be evaluated through pilot testing. The combination of a strong oxidant and GreensandPlus filtration media for iron and manganese removal is commonly referred to as the "Manganese GreensandPlus Process."

More information is available at *http://www.inversand.com*.

Performance of GreensandPlus with NaOCl as pre-oxidant

Treated Drinking Water Quality:

- GreensandPlus performed consistently well, with the outlet manganese concentration being below 2µg/L throughout the operation (Figures 4).
- It is concluded that GreensandPlus outperformed Birm by providing consistent and effective removal of manganese.
- Over the course of experiment, no significant removal of arsenic was observed in the GreensandPlus filtration system.

Wastewater Quality:

- The peak value for total suspended solids (TSS) and Mn concentrations in the GreensandPlus backwash water happens within 10-15 minutes from the start of the process and after around 25 to 30 minutes, the backwash water quality reaches that of the feed water (Figures 5 and 6).

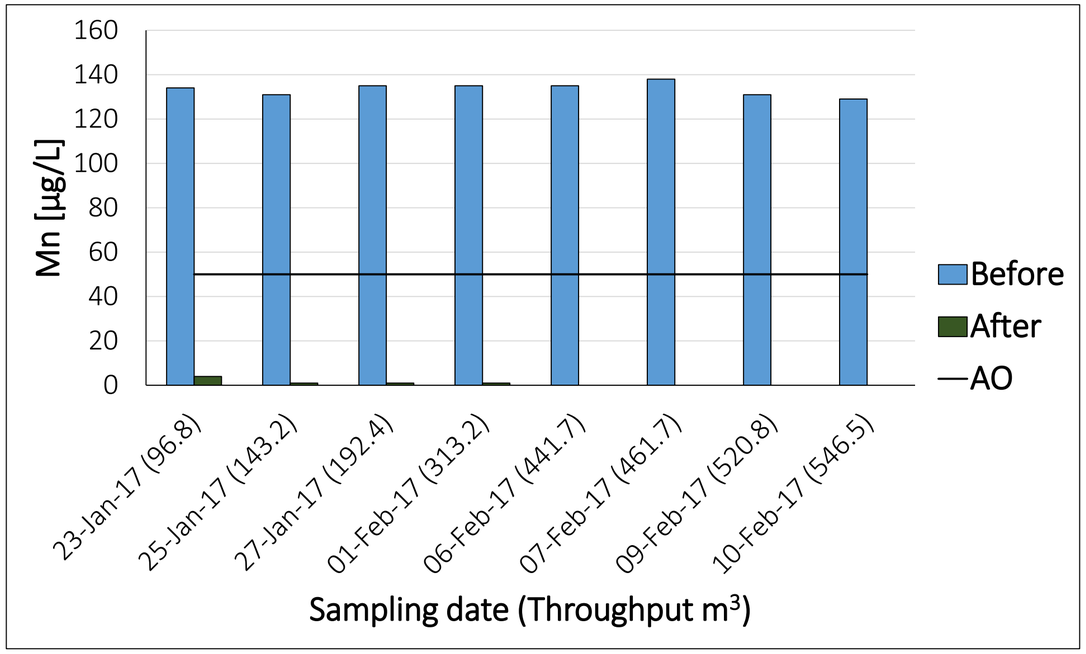


Figure 4. Manganese removal through GreensandPlus filter at different sampling dates; values in the brackets represent the cumulative throughput volume of the water.

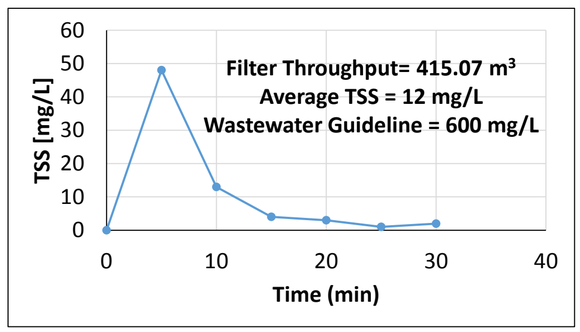


Figure 5. TSS in backwash water versus time.

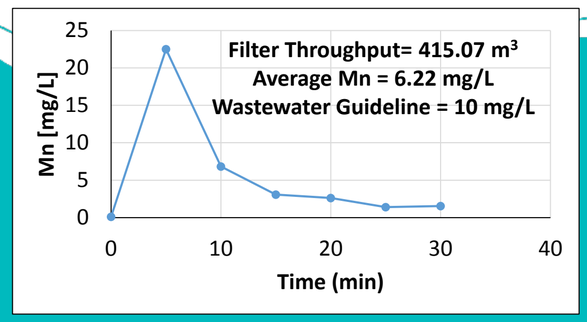


Figure 6. Mn concentrations in backwash water versus time.

Images of Backwash water samples and Total Suspended Solids test results at different sampling times.

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Manganese and Arsenic Removal Using GreensandPlus Filter Media *with Ozone* as Pre-oxidant

Performance of GreensandPlus with O_3 as pre-oxidant

Treated Drinking Water Quality:

- Arsenic Speciation results showed that Arsenite As(III) was oxidized completely to arsenate As(V) using 0.5-1mg/L of ozone.
- Injecting ozone at 0.5-1mg/L, resulted in Mn concentration to decrease to below 5 µg/L in the outlet of the GreensandPlus filter (Figure 7).
- Adding ozone before the GreensandPlus filter had very small impact on the removal of arsenic. About 1µg/L decrease in arsenic concentration was observed through the GreensandPlus filter when ozone was injected in the water (Figure 8).

Wastewater Quality:

- The backwash duration was not enough to bring the water quality back to that of the feed water as the average manganese level in the backwash water was above the standard level. This means that the filter is holding more of the precipitates during the operation and longer backwash time is required for cleaning the filter (Figure 10).

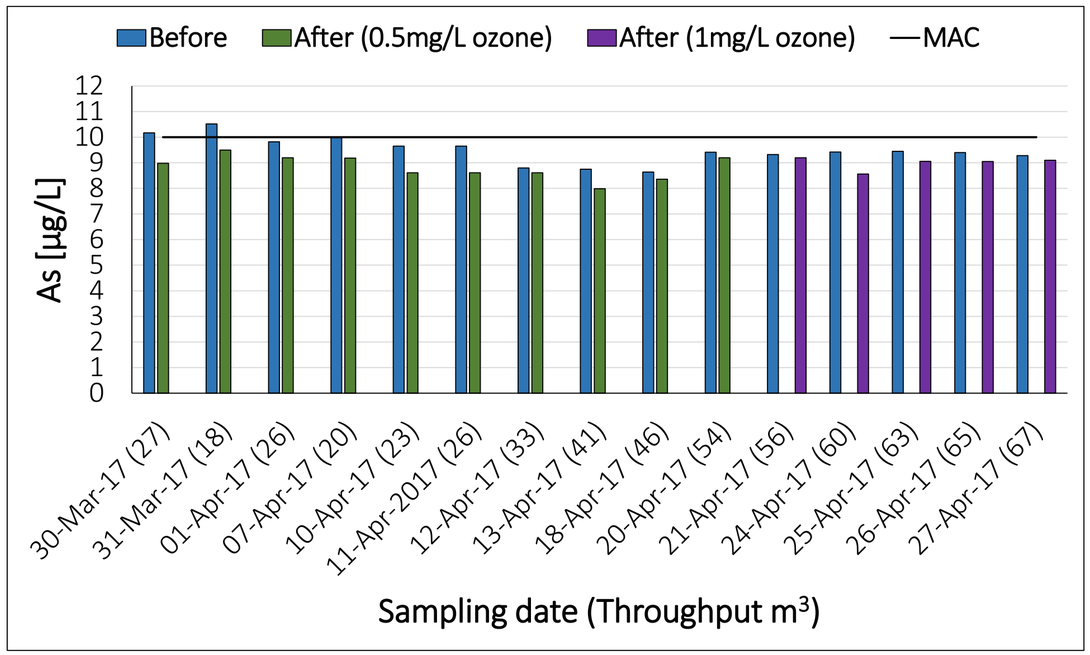
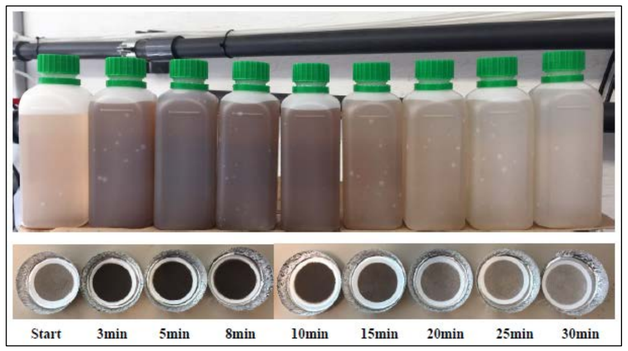


Figure 8. Arsenic concentrations before and after GreensandPlus at different sampling dates; values in the brackets represent the cumulative throughput volume of the water.



Images of Backwash water samples and Total Suspended Solids test results at different sampling times.

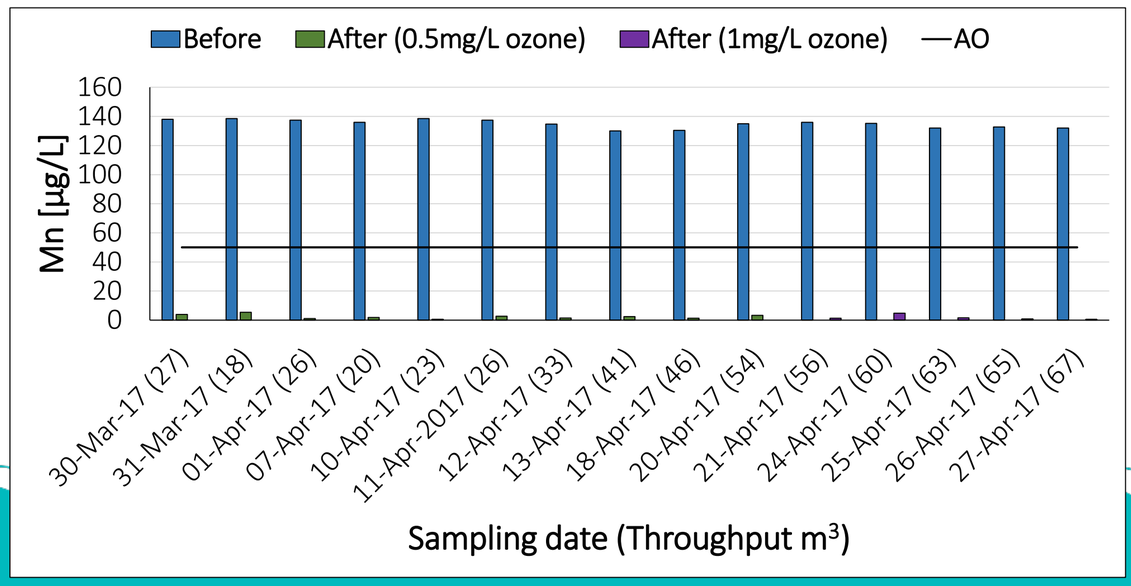


Figure 7. Manganese concentrations before and after GreensandPlus at different sampling dates; values in the brackets represent the cumulative throughput volume of the water.

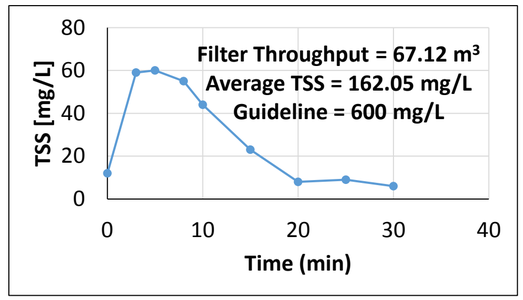


Figure 9. TSS in backwash water versus time.

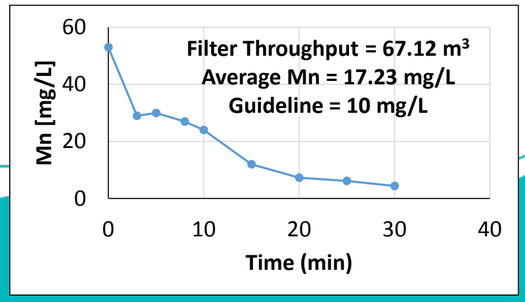


Figure 10. Mn concentrations in backwash water versus time.

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Iron Injection Followed by Filtration using GreensandPlus Media with Chlorine as Pre-oxidant

Background

From previous studies in the field, it is known that the coagulation process using iron could potentially improve the arsenic removal in the GreensandPlus filter. Therefore, it was decided to investigate the efficacy of the iron injection at removing arsenic in the GreensandPlus filter. Based on the preliminary results, it was decided to run the filter continuously with 1mg/L of injected iron to see how filter removes arsenic.

Treated Drinking water quality:

- The concentrations of manganese, arsenic and iron in the outlet of the GreensandPlus filter through three-day experiments are shown in Figure 11, 12 and 13, respectively.
- It was concluded that at constant injection of iron, the performance of the filter in terms of arsenic decreased, which made this option undesirable for further consideration.

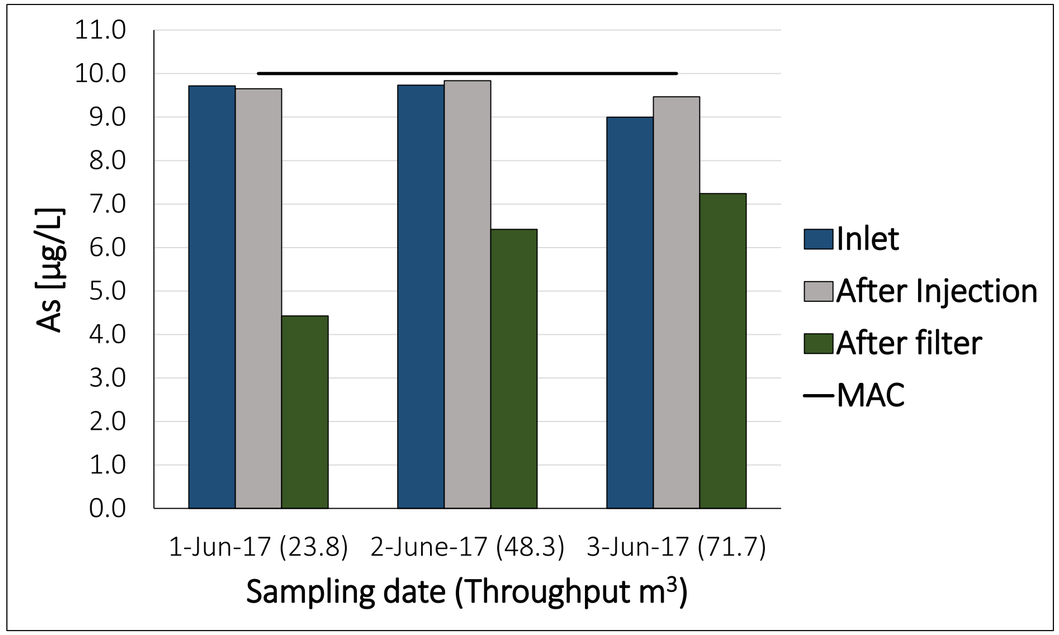

Figure 12. Arsenic concentrations before and after at different sampling dates; values in the brackets represent the cumulative throughput volume of the water.

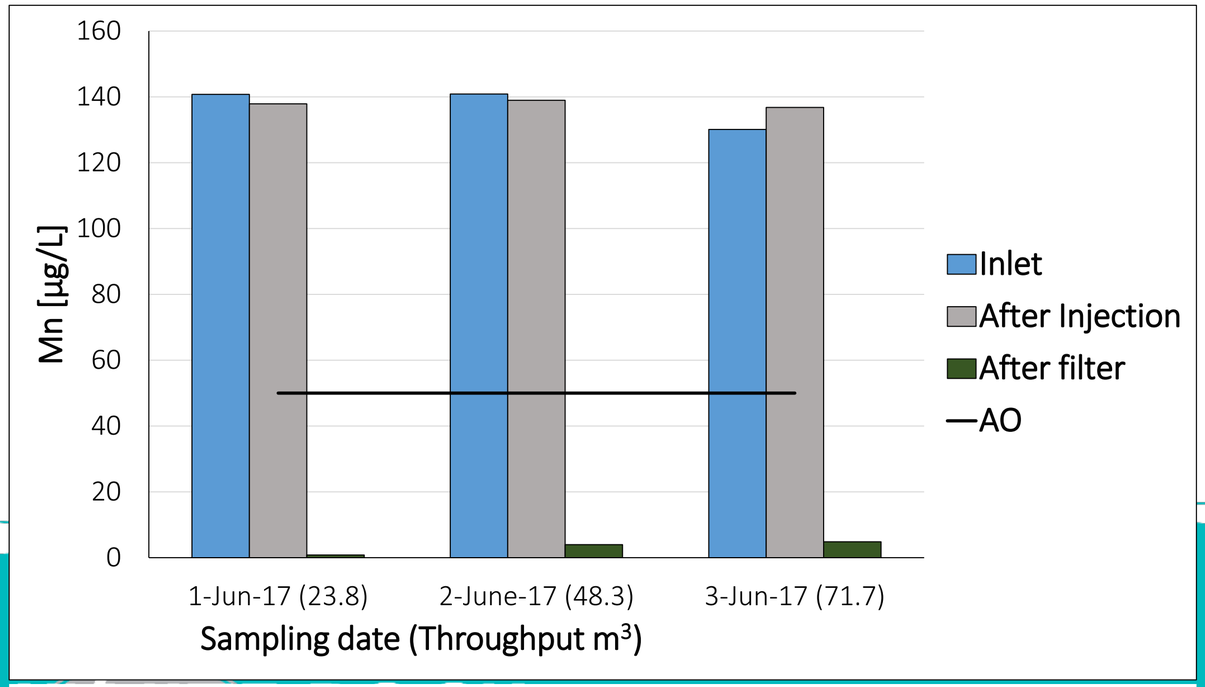

Figure 11. Manganese concentrations before and after filter at different sampling date; values in the brackets represent the cumulative throughput volume of the water.

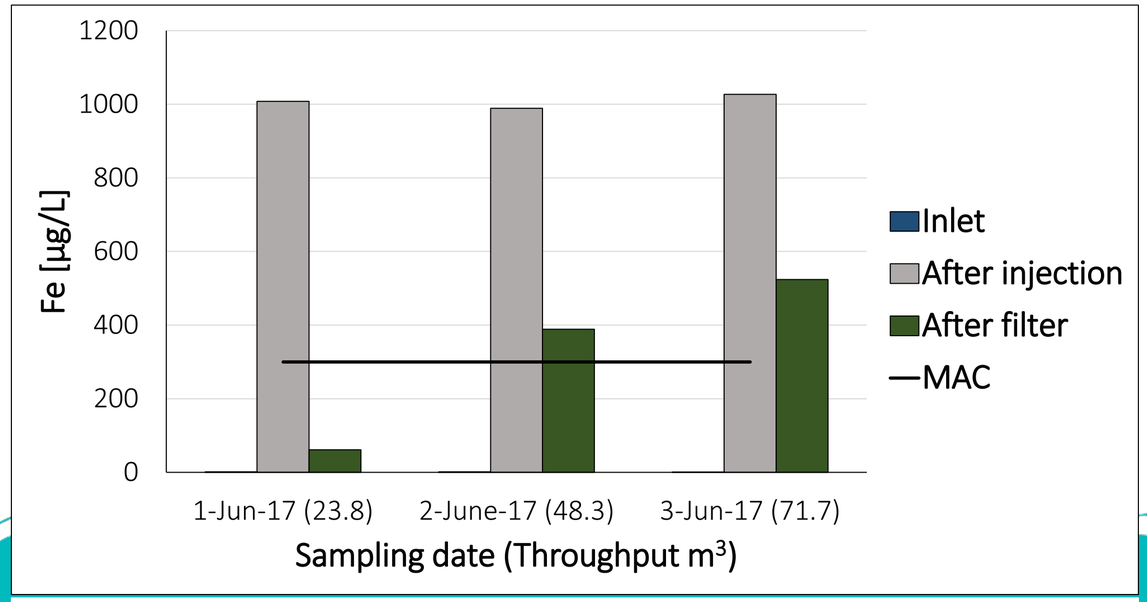

Figure 13. Iron concentrations before and after at different sampling dates; values in the brackets represent the cumulative throughput volume of the water.

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Granular Adsorptive Media (E33 Bayoxide)

Background:

AdEdge Technologies' Bayoxide® E33 media is the adsorptive media for arsenic reduction that reduces total arsenic, including both arsenic (III) and arsenic (V). It is an iron-based granular adsorption media. The E33 media can be discarded when spent and requires no chemicals or regeneration. Its expected life bed volumes based on the manufacturer data sheet is from 15000 to 125000 bed volumes depending on the water quality.

More information is available at: *https://www.adedgetech.com.*

Treated Drinking water quality:

- The concentration of arsenic in the outlet increased gradually, reaching 5µg/L after around 12000 bed volumes. It is estimated that after 25000-30000 bed volumes, the E33 Bayoxide media will be fully exhausted (Figures 14 and 15).
- Presence of manganese did not have any significant impact on the performance of the adsorptive media. Moreover, E33 Bayoxide showed around 30-40% manganese removal during the experiment (Figure 16).

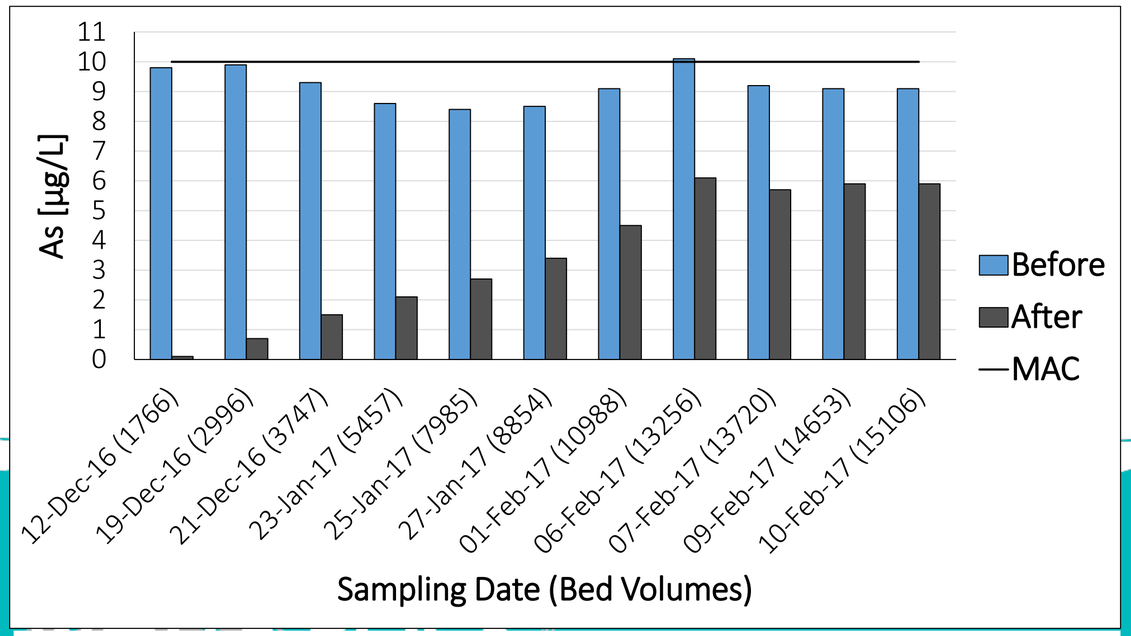

Figure 14. Arsenic removal through E33 Bayoxide adsorptive media (After GreensandPlus filter) at different sampling dates; values in the brackets represent the Bed Volumes.

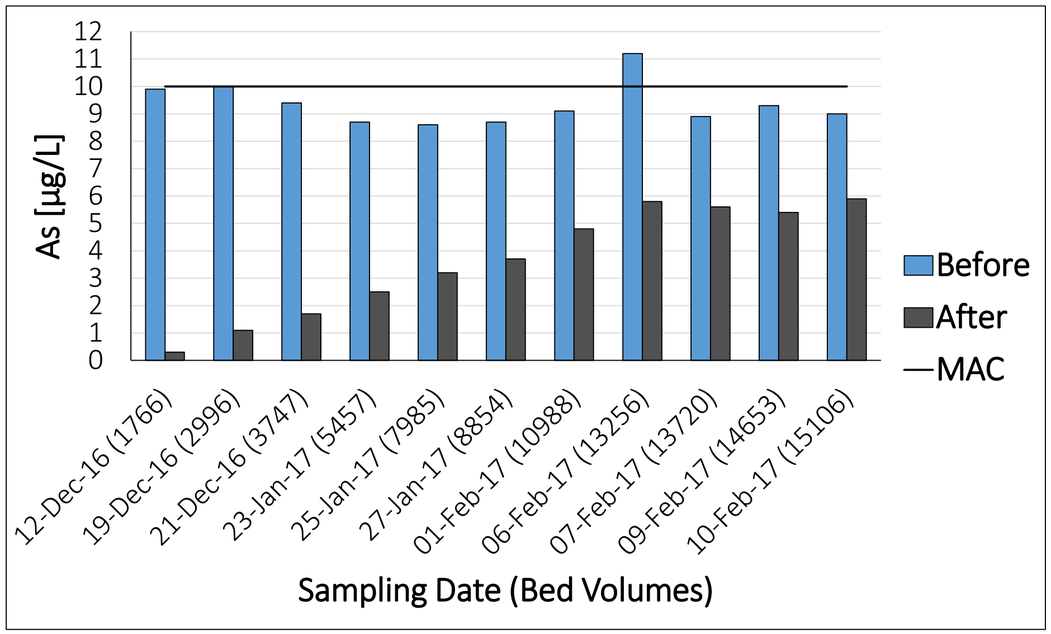

Figure 15. Arsenic removal through E33 Bayoxide adsorptive media (After Birm) at different sampling dates; values in the brackets represent the Bed Volumes.

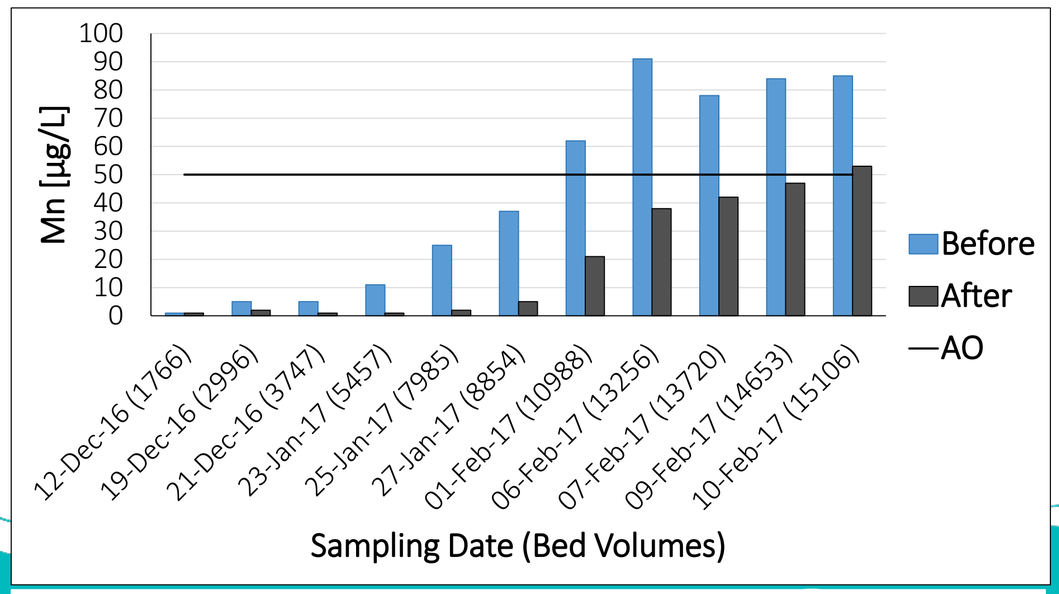

Figure 16. Manganese removal through E33 Bayoxide adsorptive media (After Birm) at different sampling date; values in the brackets represent the Bed Volumes.

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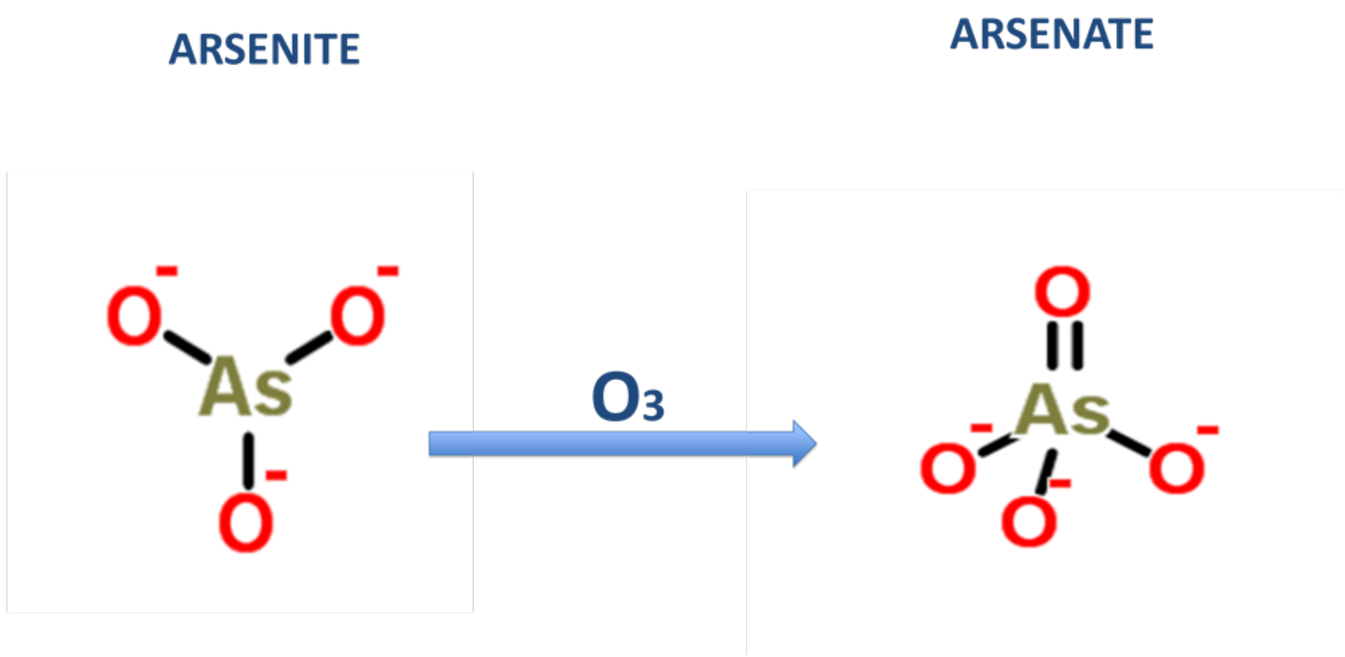
Oxidation Process

- Many arsenic removal technologies are most effective at removing the pentavalent form of arsenic “Arsenate”.
- Therefore, many treatment systems include an oxidation step to convert Arsenite As(III) to arsenate As(V).
- Oxidation alone does not remove arsenic from solution, and must be coupled with a removal process such as coagulation, adsorption or ion exchange.

Ozone Impact on Arsenic



Effect of Ozone on Arsenic Speciation

The species of arsenic depend on the oxidation-reduction conditions and pH of water. In most cases not always, arsenite, the reduced, trivalent form [As(III)], is found in groundwater; and arsenate, the oxidized, pentavalent form [As(V)], is found in surface water. In most treatment processes, arsenate was found to be removed more efficiently than arsenite. Therefore, it is important to make sure all the arsenite in the water is converted to arsenate during oxidation stage.

Treated Drinking Water Quality:

- The result of arsenic speciation for different wells in City of White Rock is shown in Figure 17. As it can be seen, arsenate is more than arsenite for all the wells except well #7. The more recent results (24-Oct-16 and 25-Jan-17) indicate that arsenite and arsenate have almost the same concentration in well #7.
- For both well #6 and well #7, arsenite As(III) was oxidized completely to arsenate As(V) using 0.5mg/L of ozone. In addition, increasing the ozone concentration to 1mg/L did not have any significant impact on the conversion of As(III) to As(V) for these wells (Figure 18 and 19)

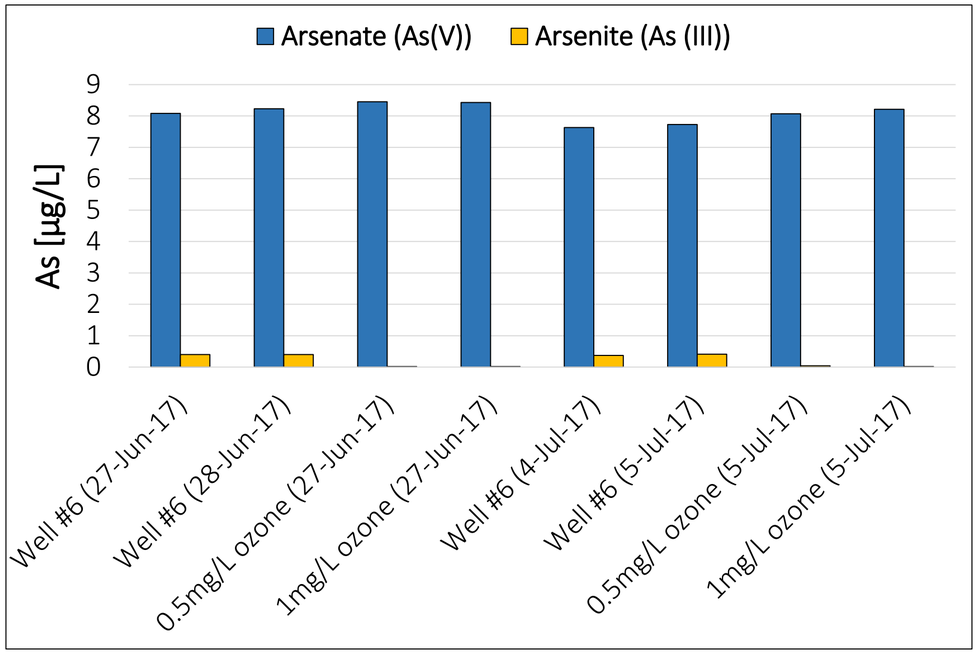


Figure 18. Arsenic speciation before and after ozonation (Well #6).

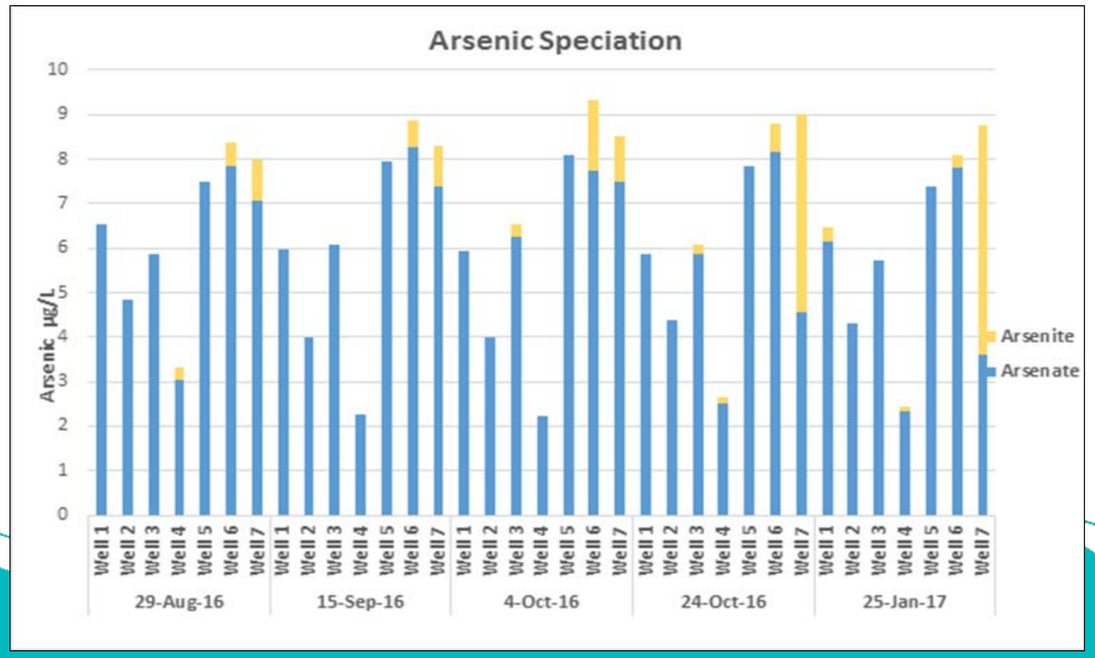


Figure 17. Arsenic speciation results for different wells.

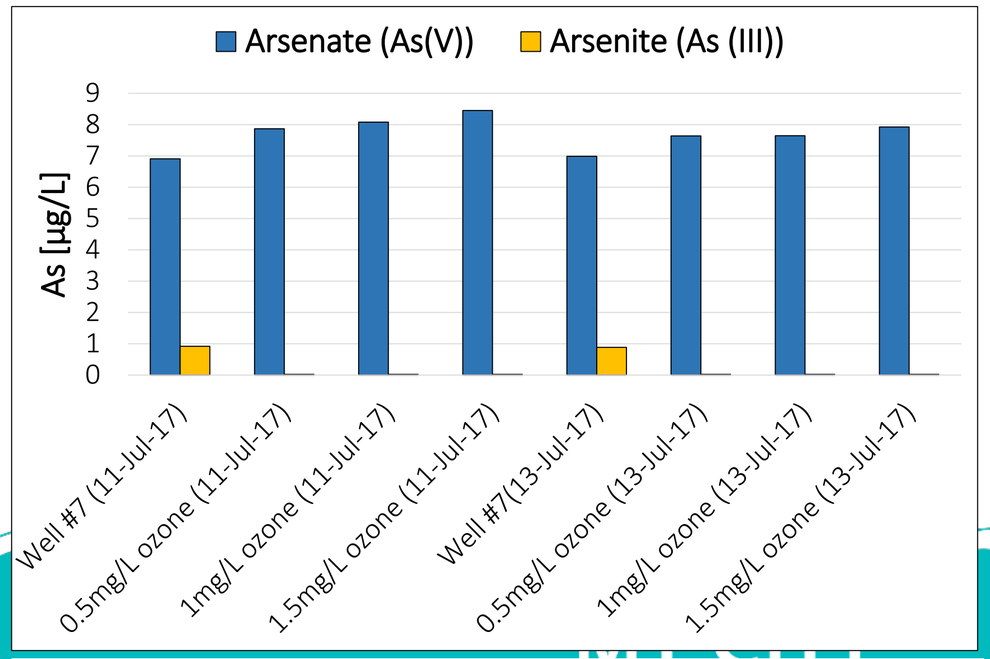


Figure 19. Arsenic speciation before and after ozonation (Well #7).

MY WATER

Constructors for the Water Treatment Design Build

About NAC Constructors:

- Canadian general contractor focused entirely on environmental projects
- Master Builders with over 80% work in municipal water and wastewater
- Extensive construction projects in the Lower Mainland including:
    - Seymour Capilano Filtration Plant - Canada's largest direct filtration plant providing 2 billion litres per day of drinking water to Metro Vancouver
    - Sperling pump station in Burnaby for $6.9M
    - Chilliwack wastewater treatment plant design build project

NAC CONSTRUCTORS

Engineering Firm for the Water Treatment Design Build

About Brybil Projects Ltd:

- Brybil has a market focus to provide engineering services on design build and P3 projects for contractors.
- Brybil has teamed with NAC Constructors to deliver White Rock's water treatment project, with the project being led from Brybil's Vancouver office, with support from several offices from across Canada.

Recent Water Projects:

- South Fork Water Treatment Plant (Nanaimo BC)
- Arbutus WTP (Ladysmith BC)
- Cannell Lake WTP (Abbotsford BC)
- Tagish Arsenic Removal WTP (Tagish, Yukon)
- Clayton, Fleetwood and Jericho Reservoirs (Metro Vancouver)

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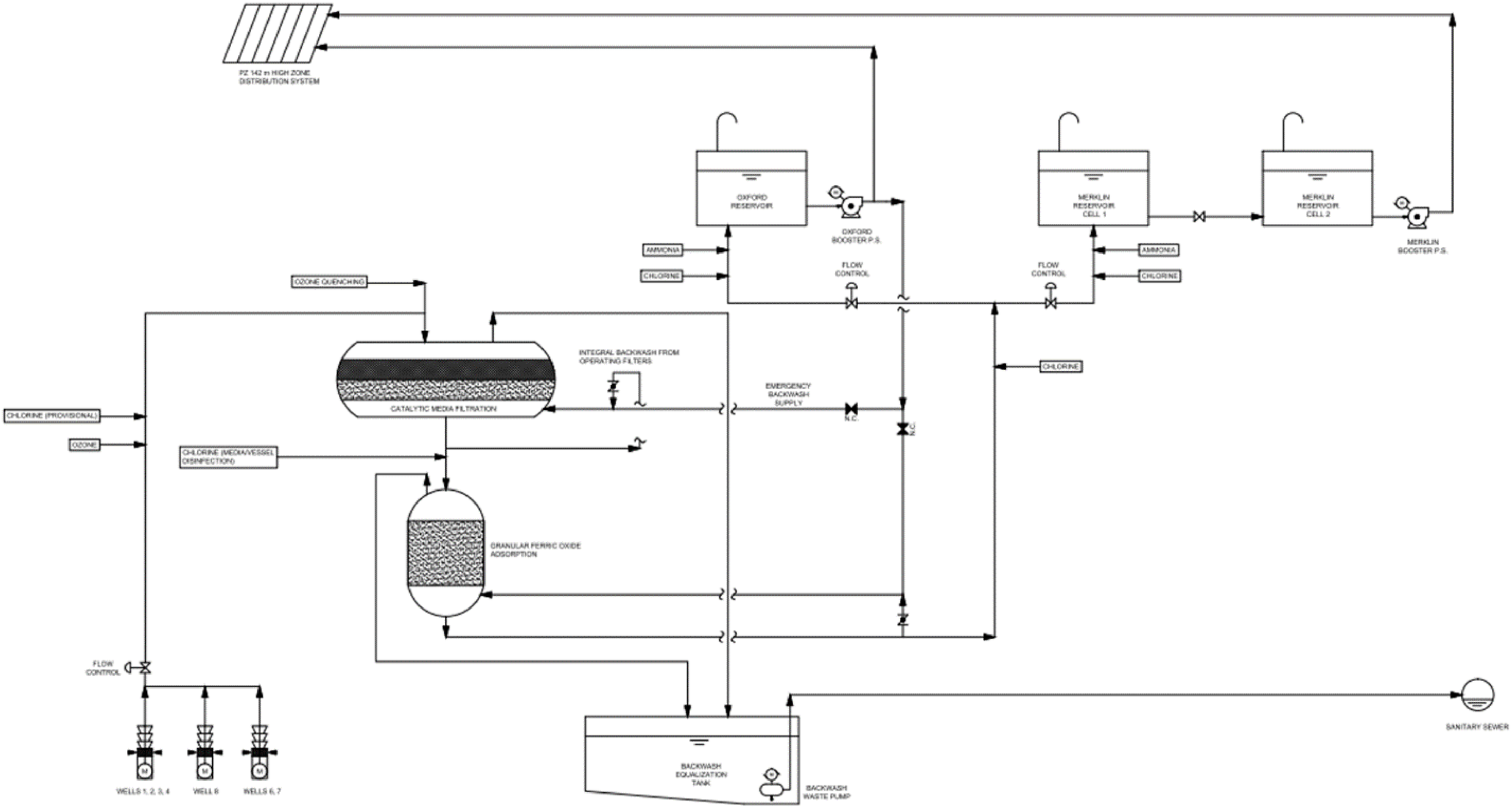

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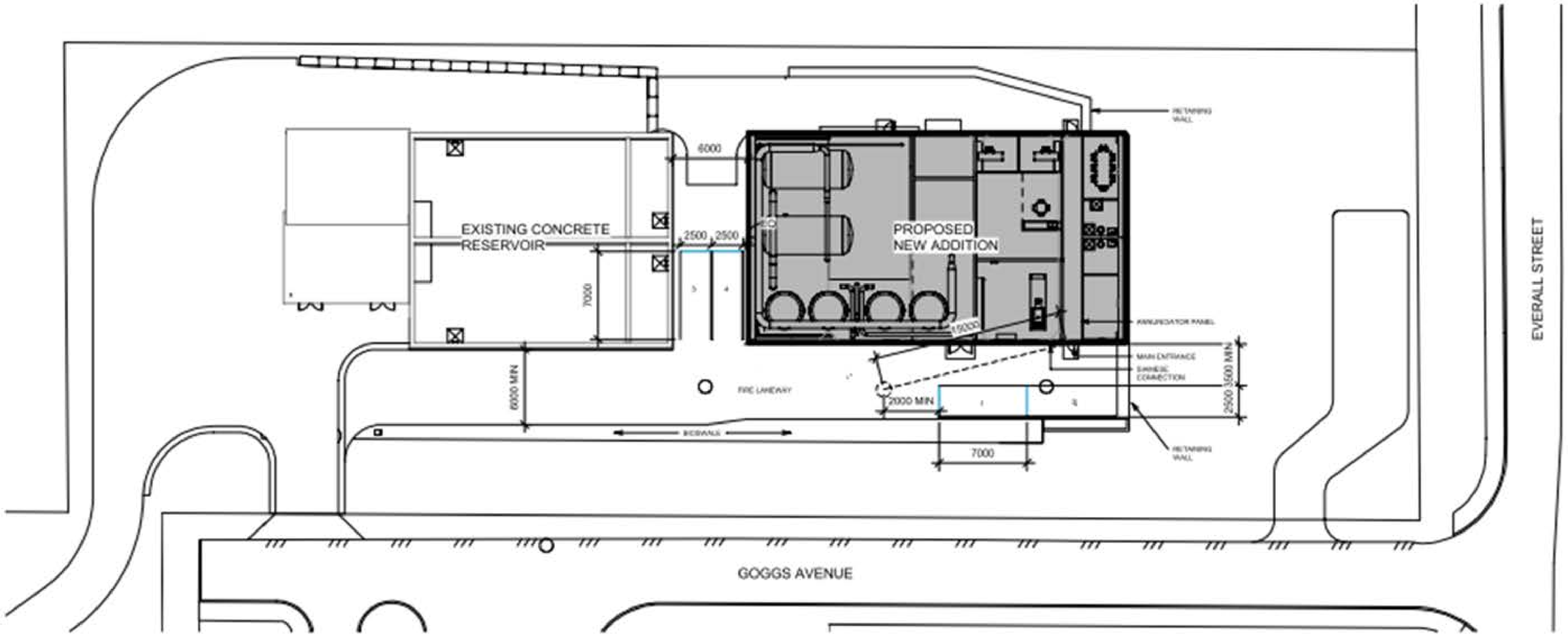

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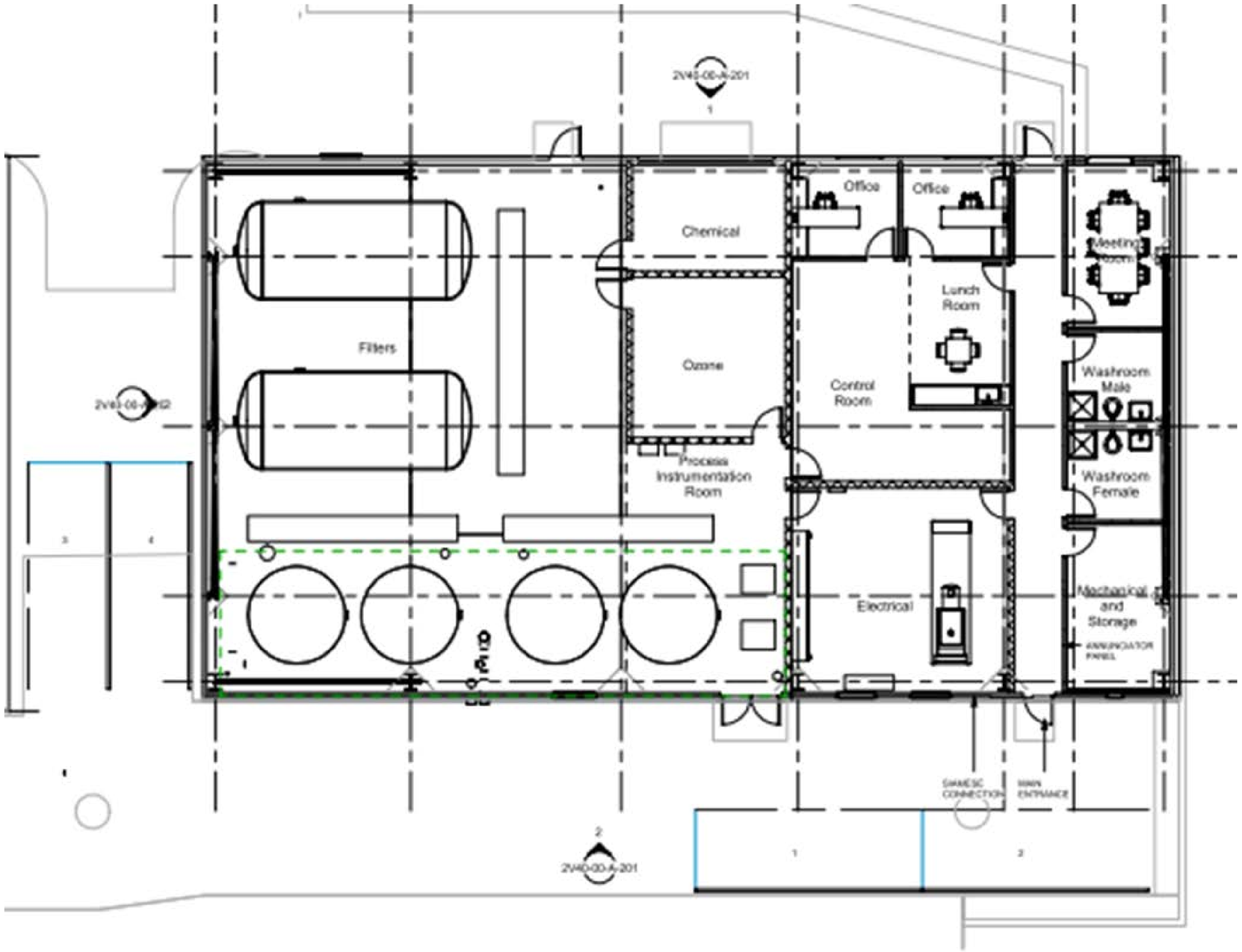

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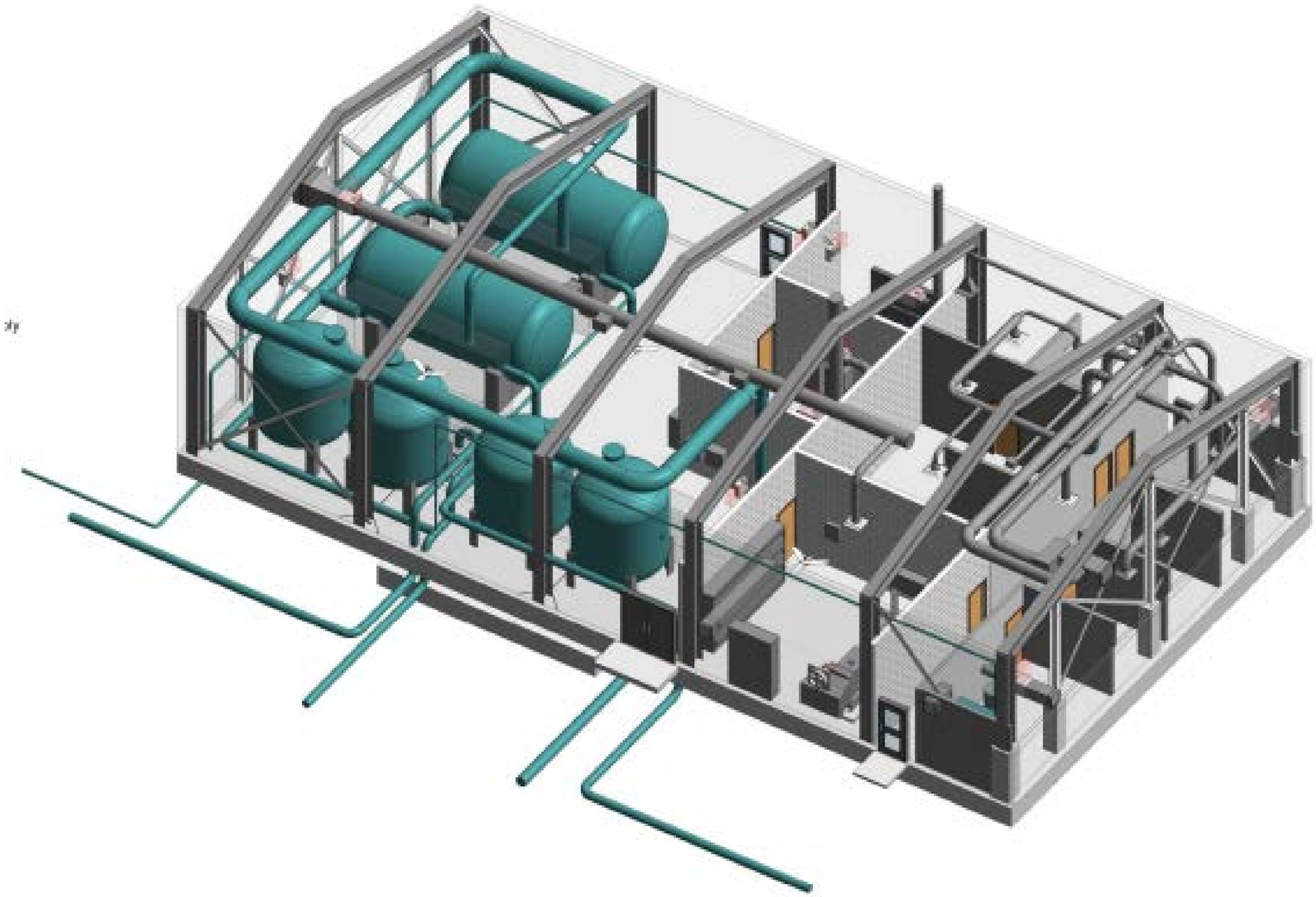

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Thank You for Coming!

Please Join us on February 21, 2018 for our Water System Master Open House

Thank you for Coming!

Thank you for attending the City of White Rock's Water Research Open House. We appreciate you taking the time out of your busy schedule to learn about the work the City has been doing, and will continue to do, to improve the City's water quality.

The boards you see here tonight will be available on the City's website on Friday, January 26, 2018. To review them, please go to www.whiterockcity.ca/mywater and click, "Event and Communication Material".

If you have water related questions, please email us at water@whiterockcity.ca.

Water System Master Plan Open House, Wednesday, February 21, 2018

Please join us from 6:00pm to 8:00pm at White Rock Community Centre to learn more about the City's Water Master Plan. This plan is an all-encompassing comprehensive guide to addressing the City's water system needs to the year 2045. Implementation begins in 2018.

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