



Utility Resilience and Reliability

Source to Tap

Talking Points

1. Defining Our mandate
2. Stakeholders
3. Critical Infrastructure
4. Environmental considerations
5. Vulnerabilities and Redundancies
6. Wildfire interface
7. Campbell River's Water System discussion points [PM's]
8. AI and digital threats to utilities



BC Hydros berm separating their project from our plant intake.

Defining our mission

- Following the BC Drinking Water Protection Act and the Drinking Water Protection Regulation as our foundation,
- Our mission is simply put, To provide water, that is suitable for consumption and fighting fire.
- To achieve our mission we have a layered approach. Operational competence, preventative maintenance/asset management, capital investment and stakeholder relationships.



200 mm Cast Iron water main popped.

Essential Service

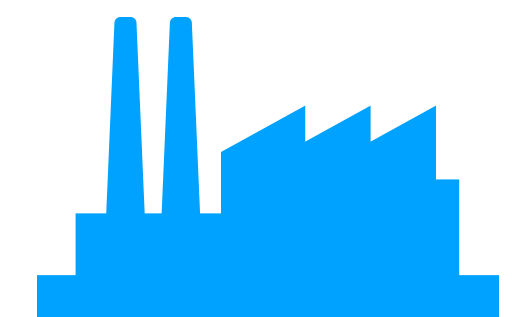
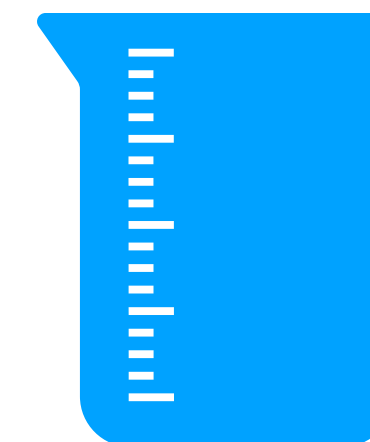
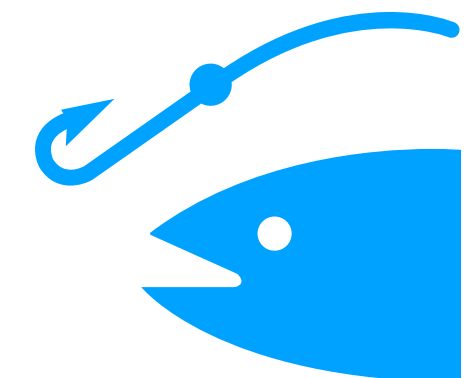
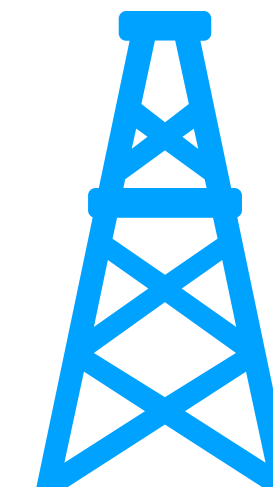
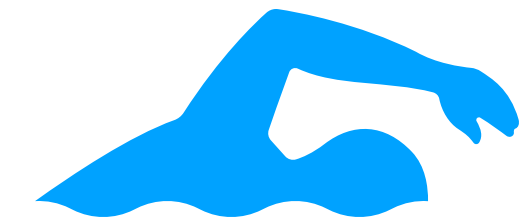
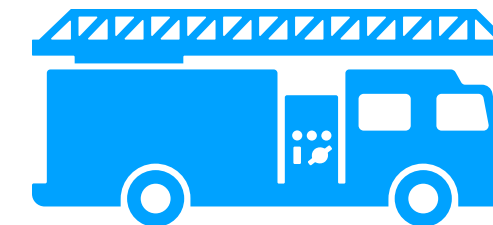
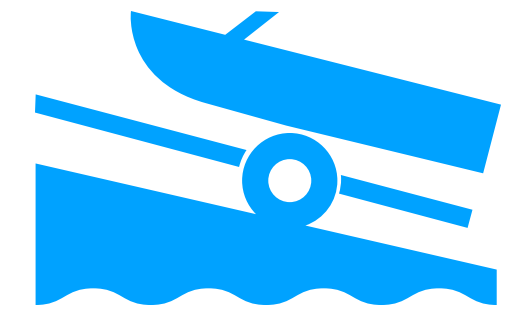
- Resiliency means to **withstand** or recover quickly from emergency conditions.
- Essential Utilities are expected and counted on to perform their duties under any and all circumstances.
- We achieve this by running reliable systems for our customers.
- Emergency response and contingency plans 10 (1) In the case of a prescribed water supply system, the water supplier must have a written emergency response and contingency plan in accordance with the regulations, to be implemented in the event of an emergency or abnormal operational circumstances affecting its water supply system or drinking water source. (2) The drinking water officer may order a water supplier to review and update its emergency response and contingency plan.
- https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/01009_01#section10



Stubborn bolts being removed to make way for PRV upgrades.

Stakeholders are stronger together

- **Definition** People and entities that affect outcomes related to our mission. Friends in high places from different spaces.
- EOC
- BCWWA
- Tax Payers = Ultimately our customers.
- Neighbouring Utilities
- All levels of government = Policy making and funding power. Grants for infrastructure upgrades.
- Water utilities
- BC Parks = Trees to close to our infrastructure, can we get permits to cut down.
- BC Hydro
- Indigenous Nations = Customers and growing political players.
- BC Forestry
- Pulp and Paper Industry
- BC Mining
- Recreational users
- Fire Services = We provide reliable, sustained water, maintenance on fire hydrants.
- Industry Experts = Influence on policy



Critical Water Infrastructure

- Source Water-Is the Source water protection plan working, do we have compiled data?
- Power Supply-Primary/Secondary-Can back up perform under pro-longed heavy demand?
- Treatment Facilities-Are they secured?
- Communications-Radio/Fibre-Is it reliable?
- SCADA Systems-Are Technicians ready and available?
- Chemical and material supply and logistics-Are there multiple routes, are there multiple sources?
- Distribution Systems-Piping/Reservoirs-Are Capital upgrades funded and are they being completed in a timely manner?



This picture highlights the proximity of turbid water being held back from John Hart lake intake.

Threats to Water Infrastructure

- Wildfire Interface
- Landslides, disruption to logistical supply lines
- Cyber Attacks on digital infrastructure
- Lack of Planning, Collaboration between Stakeholders
- Inadequate Resources, Funding, Training
- Lack of Control over Policy
- Single Source/Single Intake
- Ageing infrastructure



Donnie Creek wildfire, Bc Wildfire Service, National Observer

Source Water

- The CR Water Supply Centre monitors the raw water coming into the system, Conductivity, pH, Temp, Turbidity, UVT.
- Regular, organized sampling regime gives us data on pre treated water characteristics.
- Changes in the health of this ecosystem can potentially be detected.
- Long term data can be trended. Short term, we can use data in detection of 'Events' such as algae blooms, turbidity from run off etc, that have potential to change quality.
- Part 5 of the Drinking Water Protection Act.



Parasite sampling, using Filta-Max Hyperion Labs.

Logistic Vulnerabilities

Event description

Highway 5 Nov. 14, 2021, after the Atmospheric River.

Flooding and washouts damaged more than 20 sites along 130 kilometres of the Coquihalla Highway.

Seven bridges where spans completely collapsed or were heavily damaged.



<https://www2.gov.bc.ca/gov/content/transportation-projects/bc-highway-flood-recovery/2021-flood-road-recovery-projects-highway-5> Image: Canadian Press

Stockpiles

- We keep a healthy stockpile of salt on hand for sodium hypochlorite generation.
- Bridge or no bridge we're making bleach.



14 pallets of salt stored on the floor ready to go.

Don't be a one trick pony

- Taking systems offline for maintenance or emergency repair will happen, so expect it.
- Take reasonable steps to imagine outcomes as they might unfold in undesirable situations. Let this determine your systems vulnerabilities and state of readiness.
- Storage capacity and redundancy are key.



Cleaning the hypo storage tanks.

Redundancy

- Practice switching between primary and secondary systems.
- Make sure to cycle through back up supplies to ensure their potency isn't lost. This also supports the first point of practicing these operational changes.



Back up dosing skid. Two Grundfos pumps with two 12% Hypochlor barrels.



Main dosing pump skid. Bottom 2" line left bracket rubbed a small hole do to vibration.

Leak underside of this bracket.



Repair on 1% hypo pump supply line.

Measure twice and be sure union collars
are in their place before glueing.

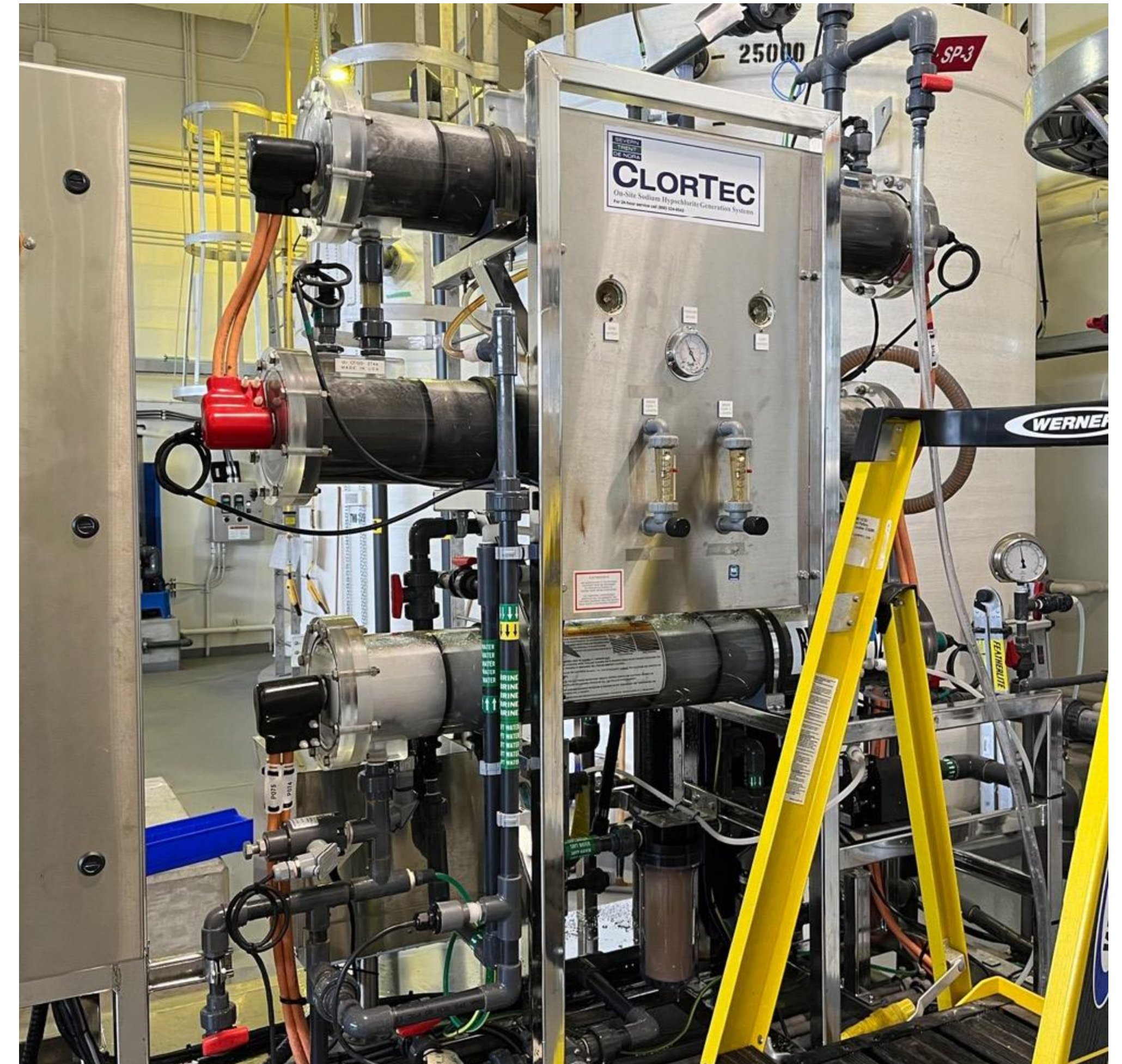


Leak on a fitting required some tight plumbing and a little swearing.

Stocked spare parts and glue specific for
corrosives.

Onsite Generator

- Scheduled muriatic acid washes to remove baked on minerals. Make sure to neutralize the acid and flush the system clean.
- Cell disassembly inspections. Looking at plate screws and general wear.
- Specialty spare part inventory is advised.
- Refer to your specific manufacturer for maintenance requirements.



Onsite generator going through an acid wash.

Slow is Fast

- Take your time, think it through.
- Make sure the right valves are in position before starting anything.
- Make sure people around are ready with their own ppe before you get going.
- Refer to the SOP to double check your steps.



Neutralizing muriatic acid with Sodium Carbonate.

Case Study: Carr California WildFire

Summer 2018 230 000 acre fire destroys 1000 structures and forces 36 000 people to flee.

Damage

Power outages combined with undersized generators led to treatment process disruptions for some systems.

One community had to issue a boil water notice for 17 days.

Extreme water system demand due to Fire response and high leakage.

Communication was extremely challenging, especially sharing public notifications

Lessons

Build relationships with local response partners, especially heavy water users (i.e., fire). **Stakeholder Relationship**

Work with emergency responders during an emergency (i.e., local Emergency Operations Centre, central command structure). **Stakeholder Relationship**

Results

Shasta CSD brought online two new pump stations made from cinder block with metals roofs, making them more fire resistant than the previous wood frame/siding construction.

Shasta CSD and Keswick established an interconnection for redundancy. **Stakeholder relationship**

Redding has both groundwater and surface water sources. A pump station was built to provide treated groundwater through interconnections with Clear Creek CSD, Shasta CSD and Keswick. **Stakeholder Relationship**



Source: United States Environmental Protection Agency. Photo by the New York Times, google images.

<https://www.epa.gov/system/files/documents/2022-03/220218-incident-action-checklist-wildfires.pdf>

Case Study: Lytton Fire B.C.

- 6.1 A **reliable domestic water supply and water delivery system be provided and maintained for fire response** at the Lytton community, and that the supply is sufficient to avoid the necessity for water rationing, and to sustain gardening lifestyles and fire-resistant vegetation in an arid climate.
- 6.2 A gravity-flow water delivery capability be established to ensure: **continued water supply during power outages, and increased capacity for fire protection.**
- 6.3 All surviving critical infrastructure, and plans for replacement infrastructure be scrutinized by a WU fire specialist to ensure existing WU fire risks are sufficiently reduced prior to the 2022 fire season.
- 53 page report, three bullets on Critical Infrastructure?
- Source: <https://firesmartbc.ca/wp-content/uploads/2022/05/An-examination-of-the-Lytton-BC-wildland-urban-fire-destruction.pdf>



Photo of Lytton BC by the Canadian Press, google images.

Big Fires Big losses

Shuswap area – Bush Creek East Wildfire

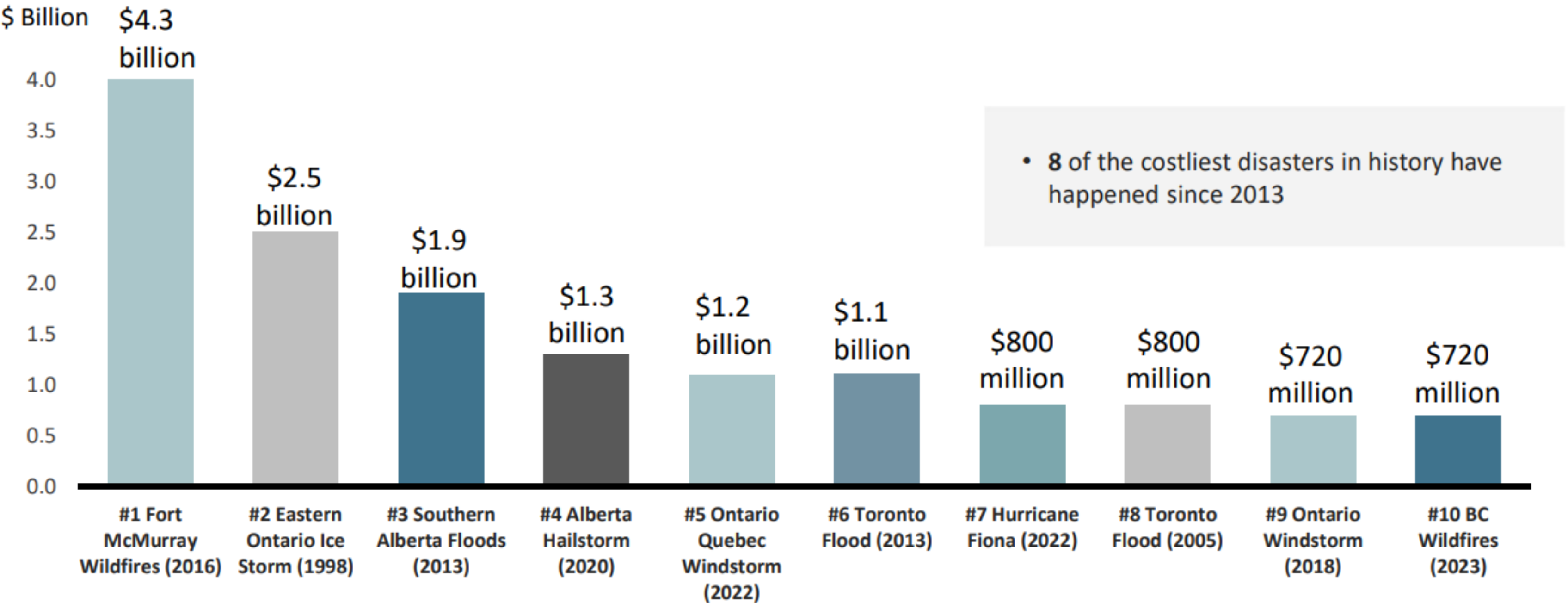
August 18–September 25, 2023 – Over \$240 million in insured damage

Okanagan area – McDougall Creek Wildfire

August 15–September 21, 2023 – Over \$480 million in insured damage

Source: <https://www.ibc.ca/news-insights/news/okanagan-and-shuswap-area-wildfires-cause-over-720-million-in-insured-damage>

Canada: Top 10 Natural Disasters for Insurance Payouts



Losses exclude Loss Adjustment Expenses
Source: IBC Facts Book, PCS, CatIQ, Swiss Re, Munich Re & Deloitte
Values in 2022 \$ CAN

Fort Mac Fire Bus





Campbell River

Water Supply Centre

Campbell River Water System

- System Capacity through the water plant is 1050 l/s max. Velocities become too high against UV Quartz/Lamps.
- 220 l/s are reserved for fire protection flows in accordance with Fire Underwriters requirements, more would be needed in major events such as Wildland interface fire or a major catastrophic event.
- Campbell River has limited storage capacity with only 2 reservoirs in the main distribution zones and an additional 1 in the North System.
- Without residential water meters the City must rely on closely monitored flow data to enact water stage restrictions promptly when summer flows get to an average of 700 l/s.
- Water metering and system storage are serious 2 serious considerations for future improvements.

Water Supply

- It's key to understand where your water is going. This aids us in understanding complex shutdowns, re-routing water in emergency situations and overall balancing of PRV/reservoir discharges.
- Maintaining PRV's and reservoirs is critical to reliable movement of water throughout the system.



Newly installed upgraded PRV's

Zone maps/Water models

- Zone maps are crucial in helping us understand where water goes in the system.
- Additionally it becomes a useful tool in manipulating pressures to change how water flows in special circumstances.



Zone Maps are key

Understanding Options

- Here's an example of using our water model knowledge to redirect water manually.
- On a Thursday 30 mins from quitting time, Communications failed at Beaverlodge Reservoir, unexpectedly. Hardware issue that would be fixed the next day.
- This meant the altitude valve couldn't see the level of the reservoir. So it would stay in its current position which was off.
- Consulting our water model (control logic) we understood that increasing the discharge pressure from these PRV's (Rockland/Alder) by only 4 psi would overtake the head in the reservoir stopping it from an uncontrolled drain down. Thus keeping storage in place.



12" Rockland/Alder PRV's

Reservoirs (Beaverlodge)

- Along with PRV's, Reservoirs need attention.
- Drained and isolated, Operators can enter. A thorough scrub, power wash and bleach follows.
- Inspection for tears in the lining and an overall look at structural components is performed.
- Pictures for future comparisons can be documented.
- Fill and test water quality before going back into service.
- Altitude valves are a critical part of this package. Consider the maintenance of this valve and its components (solenoids, diaphragms, speed controls, etc) on a more frequent basis.





Bi-Annual PRV screen cleaning. This valve had seen high flows do to main breaks and a sustained fire hydrant port blow out.



The main seat of the PRV's are changed out as well every five years.



Five year Preventive Maintenance schedule has the diaphragms replaced in the main valves and pilots.

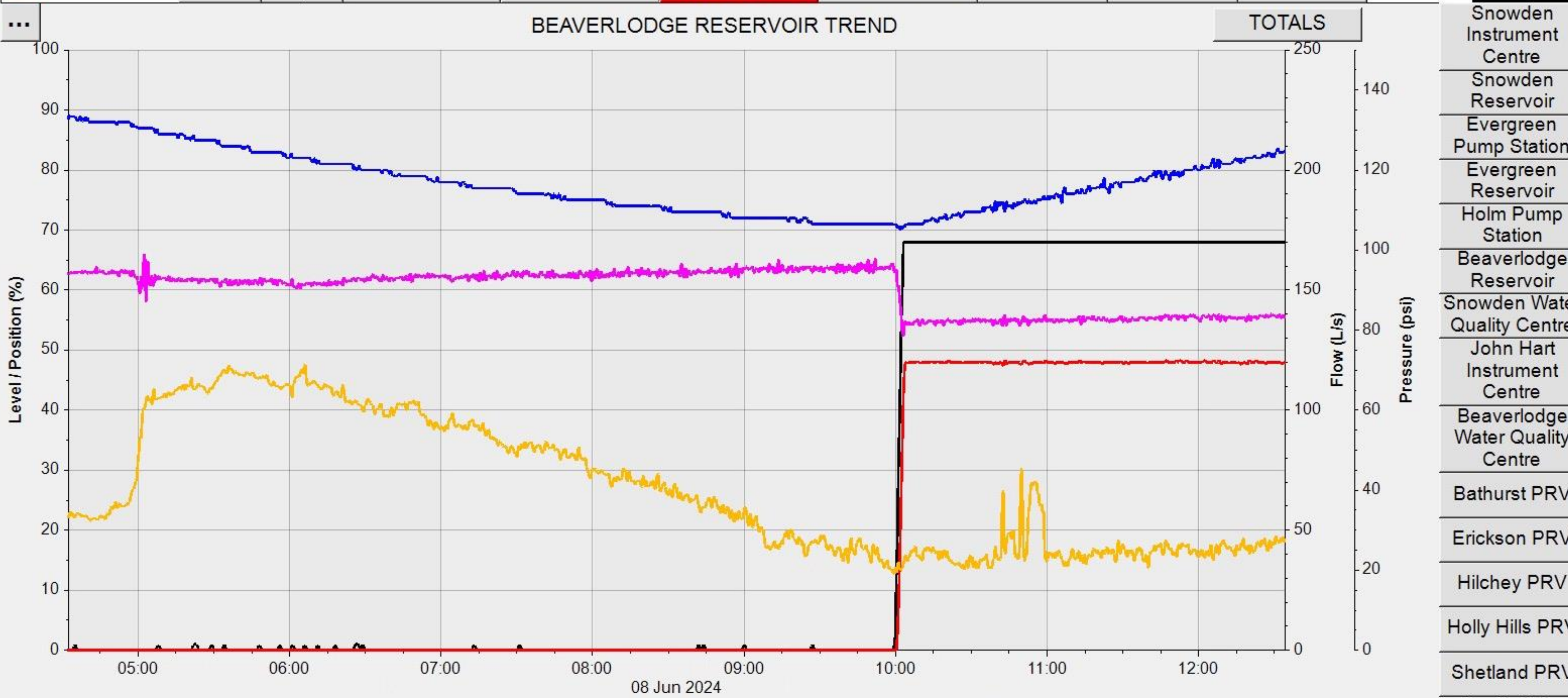
Plugged PRV Port

- This valve loss its ability to regulate pressure because of restricted head supply.
- Highlighting the connection between preventative maintenance practices and reliability.



Plugged port on an unlisted valve. Showing the importance of P.M. schedules.





Trace	Axis	Ruler Value	Latest Value	Minimum	Maximum
☒ Reservoir Level (%)	Level / Position (%)	-	6/12/2024 10:26:51.309 AM 76.11	70	89
☒ Reservoir Altitude Valve Position	Level / Position (%)	-	6/12/2024 10:26:51.349 AM 68	0	68
☒ Reservoir Inlet Flow (L/s)	Flow (L/s)	-	6/12/2024 10:26:51.370 AM 119	0	121
☒ Reservoir Discharge Flow (L/s)	Flow (L/s)	-	6/12/2024 10:26:51.411 AM 25.53	31	119
☒ Reservoir Inlet Pressure (psi)	Pressure (psi)	-	6/12/2024 10:26:51.448 AM 83.17	78	104

Snowden Instrument Centre

Snowden Reservoir

Evergreen Pump Station

Evergreen Reservoir

Holm Pump Station

Beaverlodge Reservoir

Snowden Water Quality Centre

John Hart Instrument Centre

Beaverlodge Water Quality Centre

Bathurst PRV

Erickson PRV

Hilchey PRV

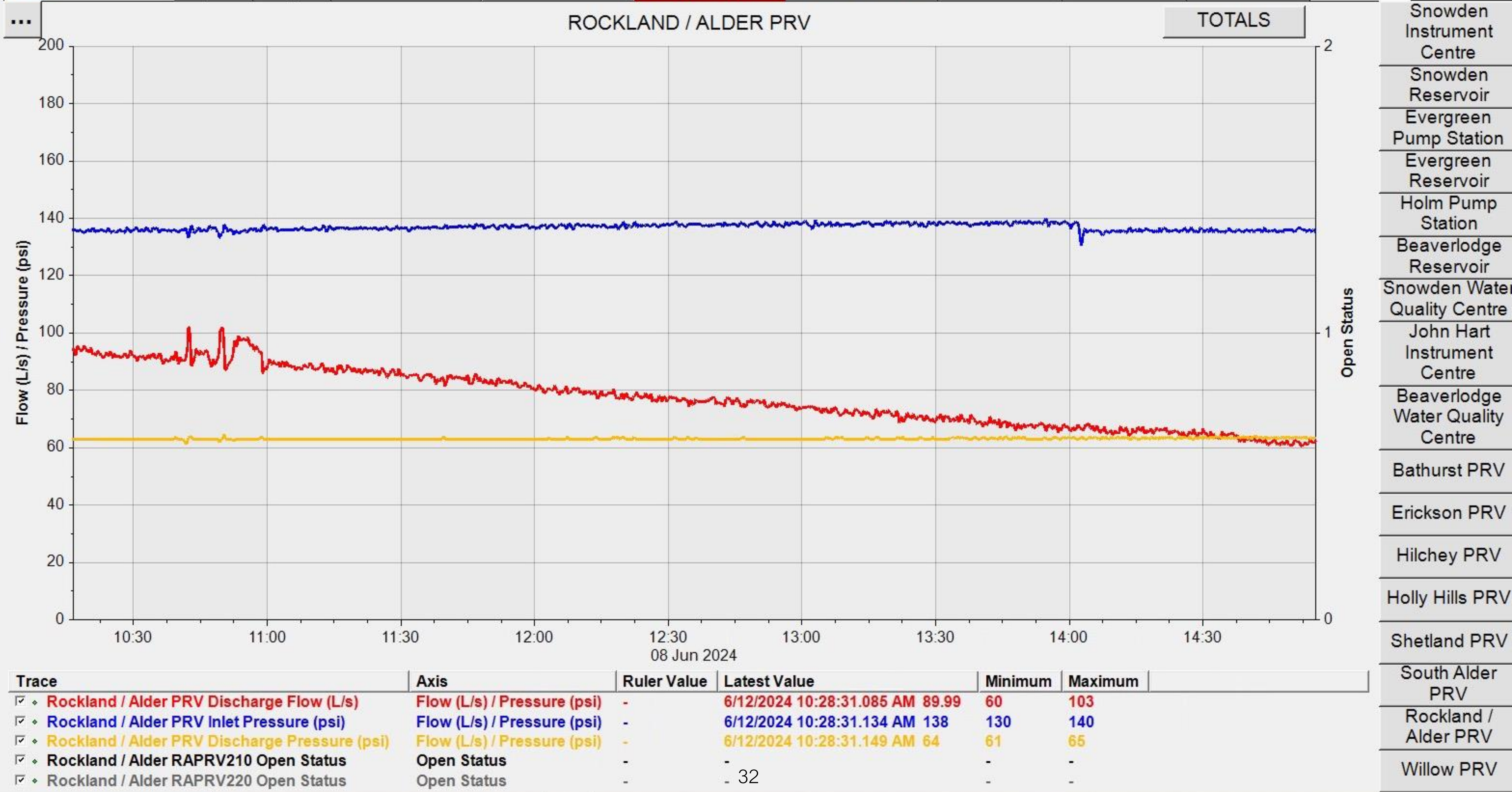
Holly Hills PRV

Shetland PRV

South Alder PRV

Rockland / Alder PRV

Willow PRV



Willow PRV

- Willow PRV feeds the downtown zone.
- New programming and solenoid actuated pilot control has been installed. This new feature allows Evergreen Reservoir which sits in a different zone, to be filled from these valves.
- This new option gives relief to transmission mains used to fill our other reservoir, Beaverlodge.

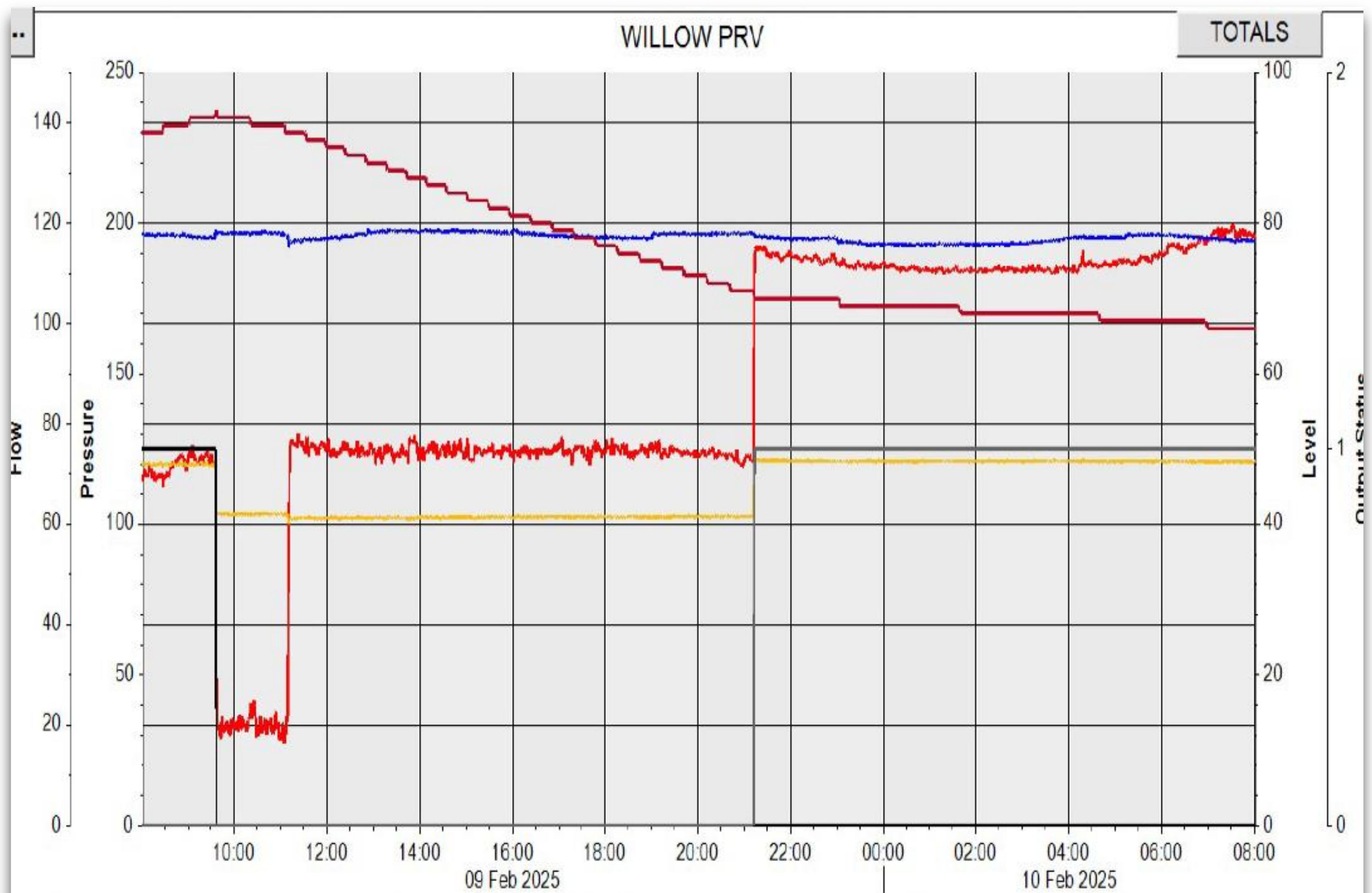


Water Loss/Demand

- Private hydrant left charged and burst in cold weather. Hidden from view behind a warehouse.
- Approximately 47 000 000 million litres lost
- Reservoir stopped loading as a result.



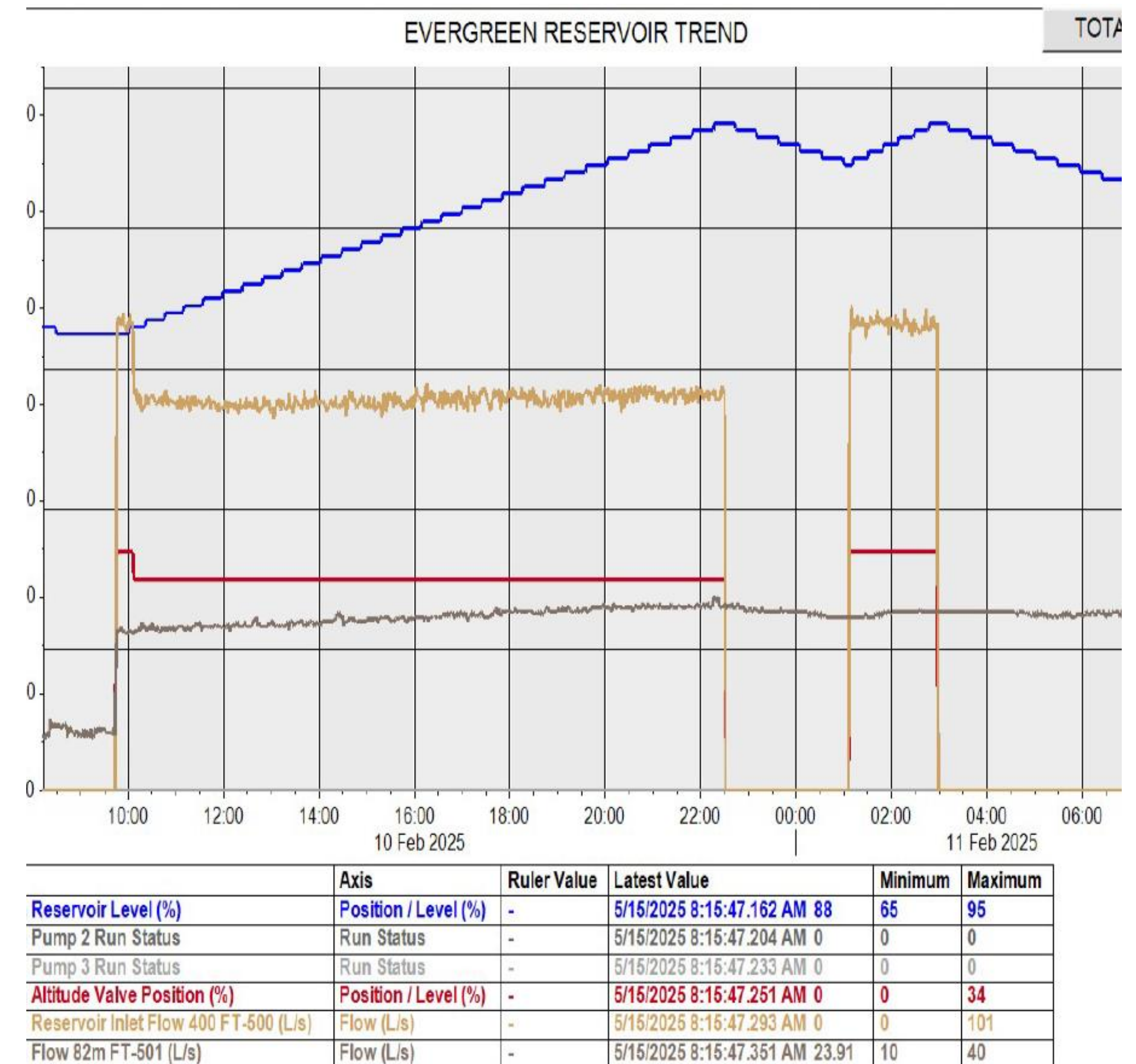
Hydrant left on during freezing temperatures.



Trace	Axis	Ruler Value	Latest Value	Minimum	Maximum
✓ ◊ Willow PRV Discharge Flow (L/s)	Flow	-	5/15/2025 8:03:18.257 AM 28.95	15.61	119.96
✓ ◊ Willow PRV Inlet Pressure (psi)	Pressure	-	5/15/2025 8:03:18.310 AM 198.1	185.39	210.05
✓ ◊ Willow PRV Discharge Pressure (psi)	Pressure	-	5/15/2025 8:03:18.335 AM 103.81	98.02	122.59
✓ ◊ Willow PRV1 Solenoid Output	Output Status	-	5/15/2025 8:03:18.352 AM 0	0	1
✓ ◊ Willow PRV2 Solenoid Output	Output Status	-	5/15/2025 8:03:18.366 AM 0	0	1
✓ ◊ Evergreen Reservoir Level (%)	Level	-	5/15/2025 8:03:18.386 AM 88.82	66	95

Understanding where water is going

- Unable to load the reservoir from downtown and understanding that a lot of water is going somewhere, we look at options.
- We searched for the leak but could not find it. This happened for days.
- In the mean time, we switched to filling to the Evergreen reservoir from a different zone through an altitude valve located at the reservoir itself.
- When the leak was found and isolated we returned to our normal operating procedure of filling from the downtown zone.



Proactive Leak Detection

- For the more subtle leaks
- Retrofit hydrant, pressure sensing hardware/software.
- Tracking down water losses
- Pressure swings



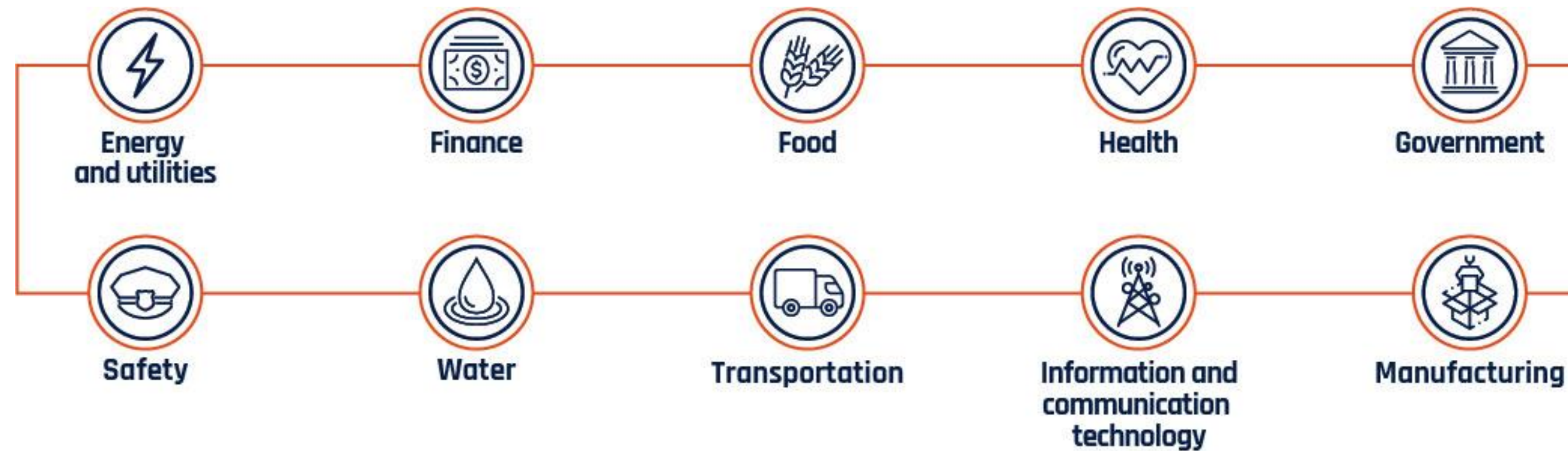
Leak Detection retrofit

Digital World of Water- Emerging Threats

- Automation is advancing
- Technology is great but so are the threats
- AI is still largely unregulated
- Tech companies and state actors are in the next arms race to create machine learning
- Image: Google images Terminator

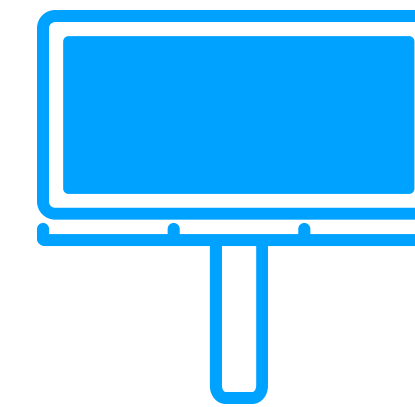
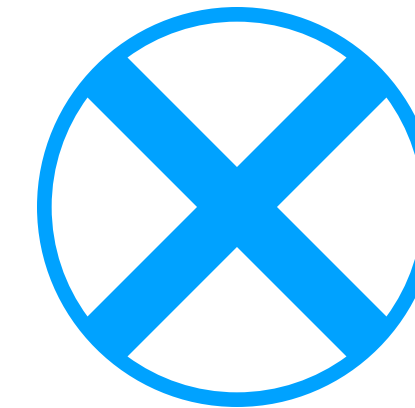


State-sponsored actors targeting critical infrastructure



- State-sponsored actors target critical infrastructure to collect information through espionage, to pre-position in case of future hostilities and as a form of power projection and intimidation.
- Source: <https://www.cyber.gc.ca/en/guidance/national-cyber-threat-assessment-2023-2024>

Cases Rising



Cybercriminals target critical infrastructure

Footnote

- 53 The Cyber Centre is aware of over 100 cases of cyber threat activity targeting Canadian municipalities since the beginning of 2020.
- Source:
<https://www.cyber.gc.ca/en/guidance/national-cyber-threat-assessment-2023-2024>

Attention Utility Operators

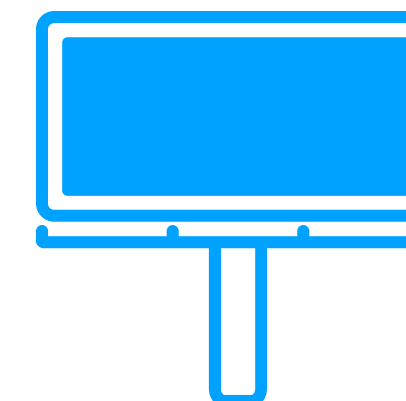
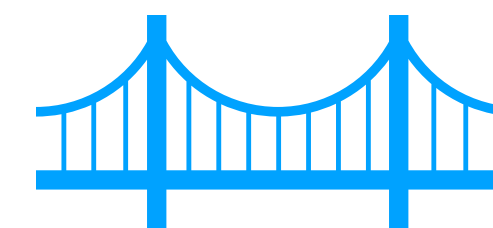
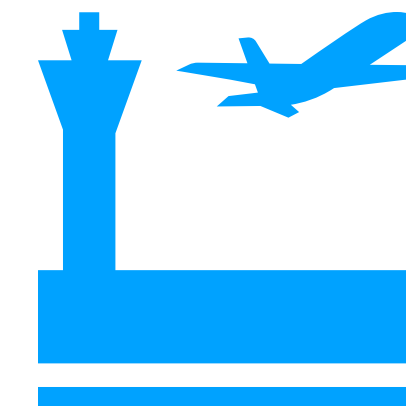
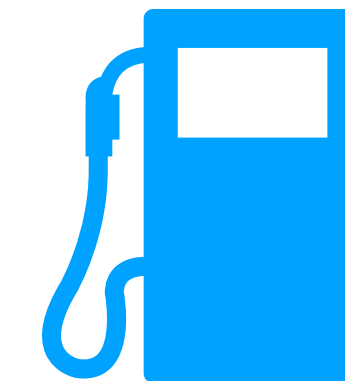
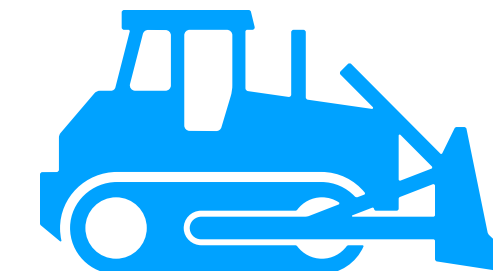
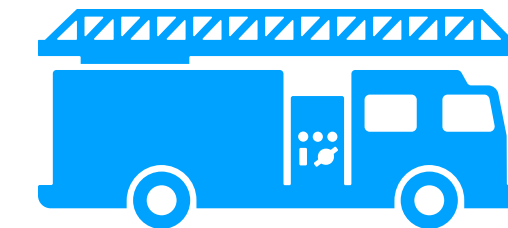
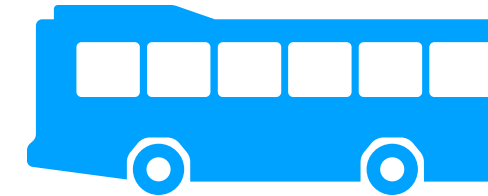
- "Drinking water and wastewater systems are an attractive target for cyberattacks because they are a lifeline, critical infrastructure sector often lacks the resources and technical capacity to adopt rigorous cybersecurity practices," Reagan and Sullivan wrote in a March 18 letter to all 50 U.S. governors.
- EPA Administrator Michael Reagan, National Security Advisor Jake Sullivan
- <https://www.cbsnews.com/news/cyberattacks-on-water-systems-epa-utilities-take-action/#:~:text=Drinking water and wastewater systems,to all 50 U.S. governors.>

Solutions for our Institutions

The sky isn't falling...not yet

Proper Preparation Prevents Poor Performance

- How do we manage risk?
- Start with the basics of developing an Emergency Response Plan.
- Identify Risks
- Mitigate Risks
- Emergency Contacts List, who is qualified for the situation?
- Standard Operating Procedures e.g. Mercury cleanup, Dosing pump failure, Pump faults, SCADA communication failures ect.
- Use the experts, Have the Fire Service inspect your sites for interface fire threat. Have a pre plan in place so critical roles are pre determined and rehearsed.
- Invest in IT security, it will only become more critical.
- Everyone involved needs to know the plan.
- Revisit and Revise, Revisit and Revise never stop.



Doing what we can

- Solutions aren't always perfect
- We attempt to mitigate problems with the tools at our disposal.
- Making the effort and noise for the sake of due diligence.



Fire Bozz Mini sprinkler being deployed for summer months. Part of our effort to protect critical infrastructure from the potential threat of wildfire.

Regular Inspections

- Inspections lead to identifying issues before they become problems.
- Planned work is better than reactive chaos.
- When it's an option, we choose the controlled version of system improvements.



This is a problem. Removal plans in the queue.



Proximity of trees to the main building and power house not ideal.



Testing out some new gear.



The Fire Bozz Mini

Be Resilient

- Engage with stakeholders
- Have multiple sources and routes for material
- Build in redundancies for critical systems
- Train and qualify your people
- Develop, revise and practice emergency response procedures
- Be reliable
- Keep the Water safe and flowing



Use Available Resources

- <https://www.epa.gov/system/files/documents/2022-03/220218-incident-action-checklist-wildfires.pdf>
- <https://firesmartbc.ca/>
- <https://www2.gov.bc.ca/gov/content/safety/wildfire-status>
- <https://eocp.ca/>
- <https://www.bcwwa.org/>
- Local Fire Departments
- Water Distribution Operators Facebook Page
- BC Small Water Systems Online Help Centre



That time a contractor ripped into the 30" on April 1st. Convincing the Super over the phone that it wasn't a joke was the hardest part.

Dedicated Fire Protection System

- Honourable mention to the City of Vancouver for their fire protection redundancy system.
- An impressive fire system outside of the normal distribution system.
- Check out Brenden Kergen's piece in the Vancouver is awesome news page.



DFPS hydrant Vancouver BC. Photo by Brenden Kergen-Vancouver is awesome.

Special Thanks

To all the operators and staff at the
CR Water Dept. for their shared
experiences and lessons.

Extra Thanks to the Chief Operator of
Facilities Ed T. for sharing his
expertise and professional
mentorship.



Typical

Sources

- Pictures from slides 1, 2, 3,4,8,10, 11,12, 13,14, 15, 16, 22, 24, 25, 26, 27, 28, 29, 33, 34, 44, 45, 46, 47, 48, 49, 51 taken by Nick Olson.
- Slide 21 video taken by Denis Rogers
- Slide 30 taken by Campbell River Mirror
- Email me at nicholas_olson@live.ca