Framework for Selecting Corrective Measures for Managing Disinfection by-Products (DBPs) in Small Drinking Water Systems in Newfoundland and Labrador

Newfoundland Labrador

Review Water Distribution System for Probable Causes of DBPs → **Match Appropriate DBP Corrective Measures to Probable Causes** → **Assessment of Solution Constraints** → **Select Preferred Solution** → **Implement, Monitor and Review**

Source

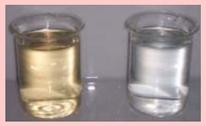
Reservoir contains flooded vegetation

Shallow intake (< 1 m of water) or shallow intake pond with long exposed fetch length

Surface water source exposed to saltwater influence (<1 km to ocean)

DBP Precursors

Mixing of high DOC surface water with groundwater



High DOC in source water (> 4.2 mg/L)

High levels of bromide in source water (> 0.02 mg/L)

High chlorine dose (total dose greater than 7 mg/L or over 4 mg/L at first point of use)

Point of chlorine application in Water Treatment Plant (pre-chlorination)

Higher chlorine use with booster system

Excessive chlorine demand

Extremes of pH (< 6.5 or > 7.5)

Demand

Large occasional demand on system

Operation & Maintenance

Poor operation and maintenance of system

System Characteristics

Long linear system (> 3 km)

Branched system with multiple dead ends (> 3 DE)

Distance of chlorination system to first point of use (> 500 m or contact time > 40 min)

Insufficient chlorination controls on system

System is oversized (max pipe velocity < 0.4 m/s)

High retention time in network (> 48 hrs)

Pipe material and age (> 25 years, cast iron)

Water treatment plant is undersized

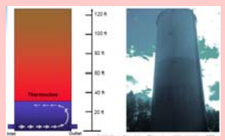
Tanks

Tank location and/or configuration

Balance between pumped supply and demand not optimized with storage

High retention time in tank (> 24 hrs)

Dead zones and/or poor mixing in tank



Little variation in water levels or turnover in tank

Other

Poor design of system

High iron and manganese (Fe > 0.3 mg/L, Mn > 0.05 mg/L)

Problems with chlorine residuals (< 0.05 mg/L, > 4.0 mg/L)

Policy

•Policy of point of use/point of entry treatment
•Policy to promote alternative disinfectants
•Policy to promote Potable Water Dispensing Units

Source

Watershed protection

Alternative water sources:
•groundwater
•surface water sources with DOC < 4.2 mg/L
•avoid shallow ponds with long exposed fetch lengths

Stop mixing groundwater with surface water

Reservoir flooding:
•avoid flooding vegetated areas
•remove vegetation before flooding
•remove submerged vegetation

Wind breaks around exposed coastal water sources with high DBPs

Relocate intake to deeper water

High quality water storage and recovery

Demand Management

Regular system flushing :
•automated flushing device or manual flushing at dead ends

Continuously bleed system at dead ends

Increase demand with new water connections

Chlorine Demand Management

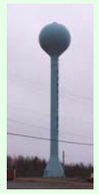
Optimize disinfectant dosage if:
•Cl > 4.0 mg/L at first user
•Cl > 0.2 mg/L (regularly) at last user
•chlorine booster on system

Re-locate chlorination system:
•closer to first user
•downpipe of storage tank

Install chlorine booster at optimal location if:
•combined chlorine dose < single chlorine dose
•chlorine > 4.0 mg/L at first user

Chlorine dose control:
•automated flow or chlorine residual control
•dedicated and certified system operator

Retention Time Management



Tank location and type:
•at beginning of system
•elevated storage

Adjust pump schedule to:
•force turnover of water in tank
•optimize supply/demand balance
•increase velocity of inflow into tank

Reduce storage capacity:
•take tank offline
•reduce maximum water level in tank

Increase mixing in tank:
•separate inlet/outlet
•baffles
•mechanical mixing device
•avoid stratification in tank
•increase active volume in tank
•location and orientation of inlet
•smaller diameter inlet or duckbill valve

Tank aeration

Operational and Infrastructure

Optimize valve arrangement:
•minimize number of shut valves
•locate shut valves in areas of high demand

Re-routing of flows in the system through valving

Pumping to re-circulate water in the distribution system

Abandoning or downsizing mains

Clean, replace or reline:
•old pipe, cast iron pipe

Loop distribution network

Upgrade distribution system:
•reconfigure, replace, abandon pipe
•new intake

System maintenance:
•flushing, reservoir cleaning
•swabbing or pigging
•pump, flowmeter maintenance

Increase capacity of water treatment plant

Regionalization:
•regional system or regional operator

Training

•Operator education and training
•Operator certification

Point of Use

•Point of use/point of entry treatment

Treatment

Water treatment plants:
•conventional water treatment plants
•targeted removal of precursors during seasonal extremes (DOC in summer/fall)

Point of application of chlorine in WTP:
•use alternative pre-disinfectant
•no pre-chlorination

Filtration:
•ultrafiltration or nanofiltration
•appropriately sized and maintained

pH adjustment

Iron and manganese removal:
•oxidation and filtration

Advanced treatment for large systems:
•enhanced coagulation, reverse osmosis, granular activated carbon filtration, dissolved air floatation, ion exchange, peroxide addition

Potable Water Dispensing Units (PWDUs):
•community support

Alternative Disinfectants

•Disinfection with chloramines
•Disinfection with ozone
•Disinfection with UV
•Disinfection with MIOX

Design

Improved design of water distribution and treatment systems:
•modeling
•*Best Management Practices for the Control of Disinfection By-Products*

Water distribution system model of Ferryland, NL in EPANET