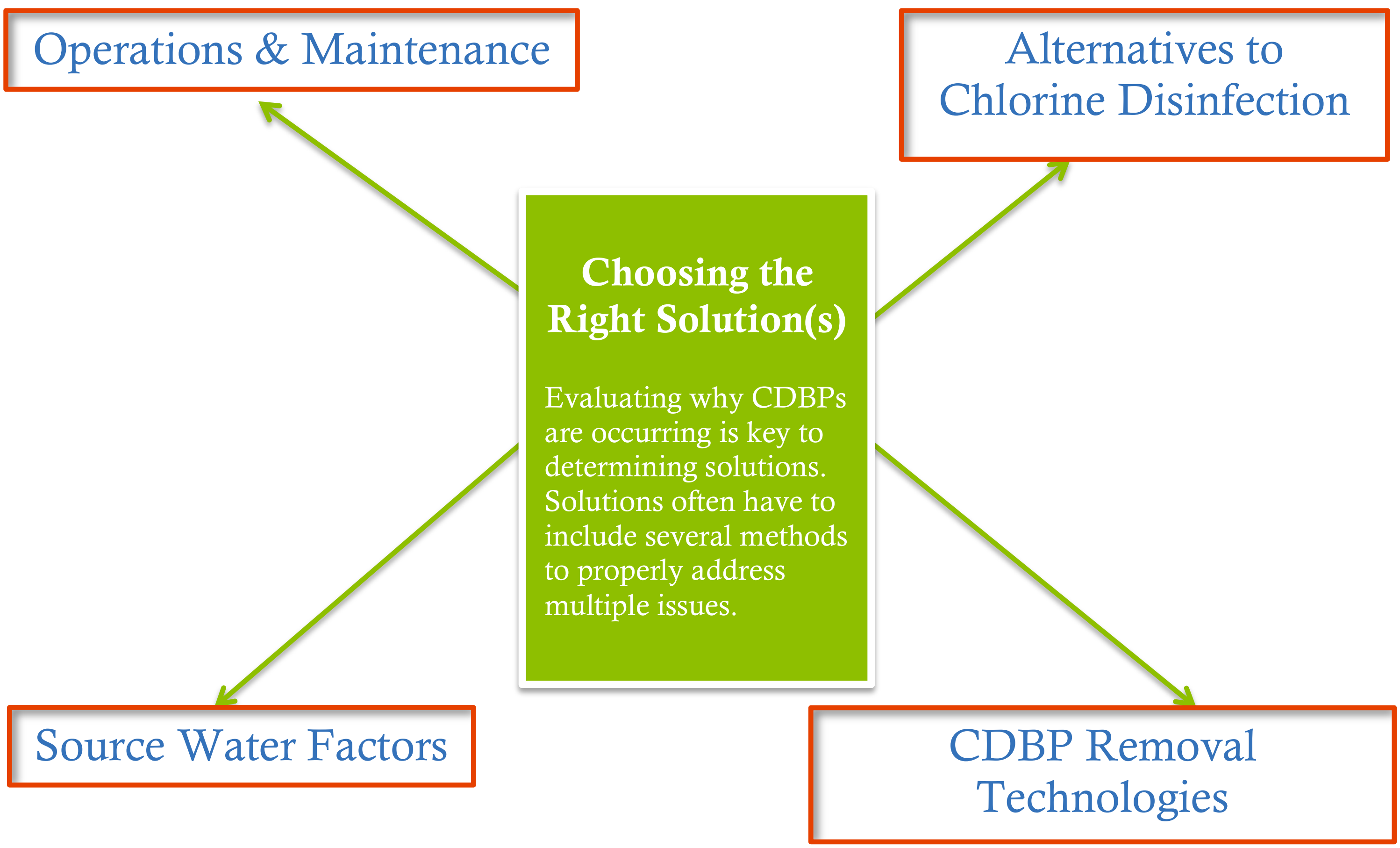
Public Drinking Water Systems

Information on Reducing Chlorination Disinfectant By-Products (CDBPs)

Chlorination disinfectant by-products are formed when chlorine used for disinfection reacts with natural organic matter (e.g., decaying leaves and vegetation) in the water. These by-products have been found to have potential health effects such as cancer and reproductive issues. For more information see the *Health Impacts* factsheet.



"Efforts to reduce DBPs must not compromise the effectiveness of disinfection"

-Health Canada

Guideline levels in NL are based on the maximum acceptable concentration as per the Guidelines for Canadian Drinking Water Quality and are based on lifetime exposure.

- HAAs- 80 µg/L
- THMs- 100 µg/L

Source Water Factors

- Change location of intake or source of water.
- Where a land area is to be flooded to create a surface water reservoir, vegetation must be removed from the area prior to inundation as per permit requirements.
- Any potential new water source that is to be disinfected with chlorine should have a chlorine decay rate test and THM formation potential test performed at an accredited laboratory prior to the final selection, development and commissioning of the new source [1].

Operations & Maintenance

- Specific design requirements (i.e., filtration, redundancy, continuous monitoring, log reduction using prescribed treatment processes) and water quality goals (turbidity, coliforms, CDBPs) should be written clearly at the beginning of the design guidelines.
- Regularly flushing your system, making use of automatic flushing systems.
- Retention time management (e.g., limit time in storage tank).
- Chlorine management and the use of booster stations.
- Operator training and ensuring you have a certified operator[1].
- Lowering pH value reduces THM concentration, but increases formation of HAAs [2].

Alternatives to Chlorine Disinfection

- Changing primary disinfectant from chlorine to alternatives such as chloramine, ozone, chlorine dioxide, and mixed oxidants lower disinfectant by-products[1], and ultraviolet (UV) radiation does not produce any disinfection by-products[3]. However, ozone and UV have to be paired with a disinfectant that can leave a residual in the distribution system (e.g., chlorine, chloramine, chlorine dioxide, mixed oxidants). Other alternatives include: potassium permanganate, peroxone, and combined disinfectant[4]. However, these are not all approved technologies in NL for disinfection. For pros and cons of these and other alternatives see:
    - United States EPA:
        - http://ocw.tudelft.nl/fileadmin/ocw/courses/DrinkingWaterTreatment1/res00066/embedded/alternative_disinfectants_guidance.pdf
    - Government of NL:
        - http://www.env.gov.nl.ca/env/waterres/reports/cwws/Combined_Strategy_for_Managing_DBPs_April_13_2009.pdf
        - http://www.env.gov.nl.ca/env/waterres/reports/drinking_water/Pathogen_Inactivation_Study_July_2011.pdf
- Monochloramine can be used to provide a secondary disinfectant residual within distribution, in order to reduce THM formation and subsequent development within the distribution system[2].
- Chlorine dioxide can be considered as a potential alternative to both chlorine and ozone disinfection. The main concerns with chlorine dioxide are with the residual concentrations of chlorine dioxide and the by-products chlorite and chlorate [2].

CDBP Removal Technologies

Removing precursors for CDBPs would include increasing the removal of total organic carbon. Some options for this, as part of the overall treatment process, include:

- Dissolved air floatation[1]
- Zirconium coagulation
- Regenerative magnetic TiO_2
- Granular activated carbon
- Nano membrane filtration
- Microfiltration/ultrafiltration
- Ultrasound and quartz sand
- Aluminum sulphate or PAC dosing (flocculent)

For more on these technologies see[5]: http://nlwater.ruralresilience.ca/wp-content/uploads/2013/04/Technologies-to-remove-DBPs-in-Drinking-Water_FINALNov5.pdf as well as the "Resources for Further Reading" below.

How much do some of These Technologies Cost?[6]

		Capital costs	**Operation and maintenance costs**	**Annual cost (Based on 10 Year Life Cycle)**
Disinfection systems	Chloramine	$ 62,608	$ 4,861	$ 11,122
	Chlorine Dioxide	$ 47,531	$ 21,217	$ 25,970
	UV Disinfection	$ 359,359	$ 10,855	$ 46,791
	Ozone	$ 974,973	$ 91,862	$ 189,359
Filtration systems	Granular Activated Carbon	$ 863,696	$ 61,531	$ 147,900
	Nano filtration	$ 1,057,344	$ 133,392	$ 239,126
	Microfiltration/Ultrafiltration	$ 1,786,445	$ 78,573	$ 257,218

*Costs based on 1 million gallons/day

Choosing the Right Solution

When it comes to choosing the right solution(s) for your town various factors have to be considered, such as the reasons contributing to the formation of CDBPs in your system. Solutions should be based on operational factors considering the capacity in your town (e.g., ease of operations could be important), the available funding and regulatory requirements. Unfortunately, there is no one-size-fits-all solution when it comes to CDBPs and sometimes multiple solutions are required.

Resources for Further Reading

- Government of Newfoundland and Labrador:
  - http://www.env.gov.nl.ca/env/waterres/reports/cwws/Combined_Strategy_for_Managing_DBPs_April_13_2009.pdf
  - http://www.env.gov.nl.ca/env/waterres/reports/drinking_water/Pathogen_Inactivation_Study_July_2011.pdf
  - http://www.env.gov.nl.ca/env/waterres/training/adww/decade/06_Floyd_Barnes_and_Paula_Dawe.pdf
  - http://www.env.gov.nl.ca/env/waterres/reports/cwws/index.html
  - http://www.env.gov.nl.ca/env/waterres/reports/cwws/Poster_for_Gander.pdf
- Health Canada
  - THMs: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/trihalomethanes/index-eng.php
  - HAAs: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/haloaceti/index-eng.php
- World Health Organization
  - http://whqlibdoc.who.int/publications/2011/9789241548151_eng.pdf?ua=1
- US Environmental Protection Agency
  - http://ocw.tudelft.nl/fileadmin/ocw/courses/DrinkingWaterTreatment1/res00066/embedded/alternative_disinfectants_guidance.pdf

References

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