Water Treatment

ST. JOHN'S

Outline

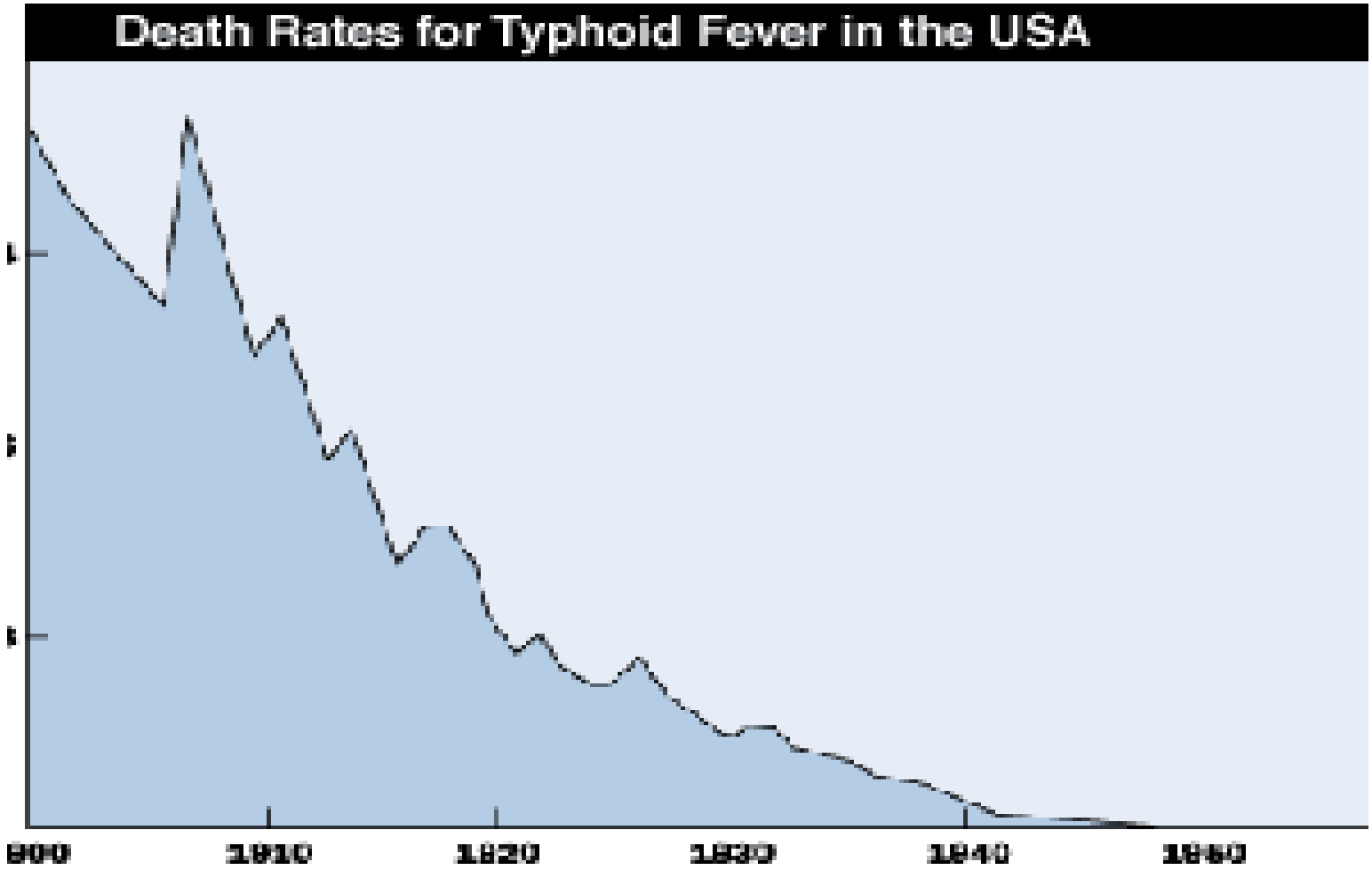
- Why Do We Treat Water?
- City of St. John's
- Bay Bulls Big Pond WTP
- Windsor Lake WTP

WHY DO WE TREAT WATER?

Reasons

✓Protection of Public Health

✓Consumer Demand



Source: Water Quality and Health Council

How Much Treatment Should We Provide?

Treatment Requirements

- *As a minimum*, the chosen treatment technologies must meet:
  - Federal Guidelines
  - Provincial Regulations
  - Any Voluntary Objectives

Other Considerations

- Source Water Quality
- Design and Construction Costs
- Utility Costs
- Operational Costs (Chemicals, Spare Parts)
- Labour Costs (Operator Time)
- Ease of Operations (Operator Training)

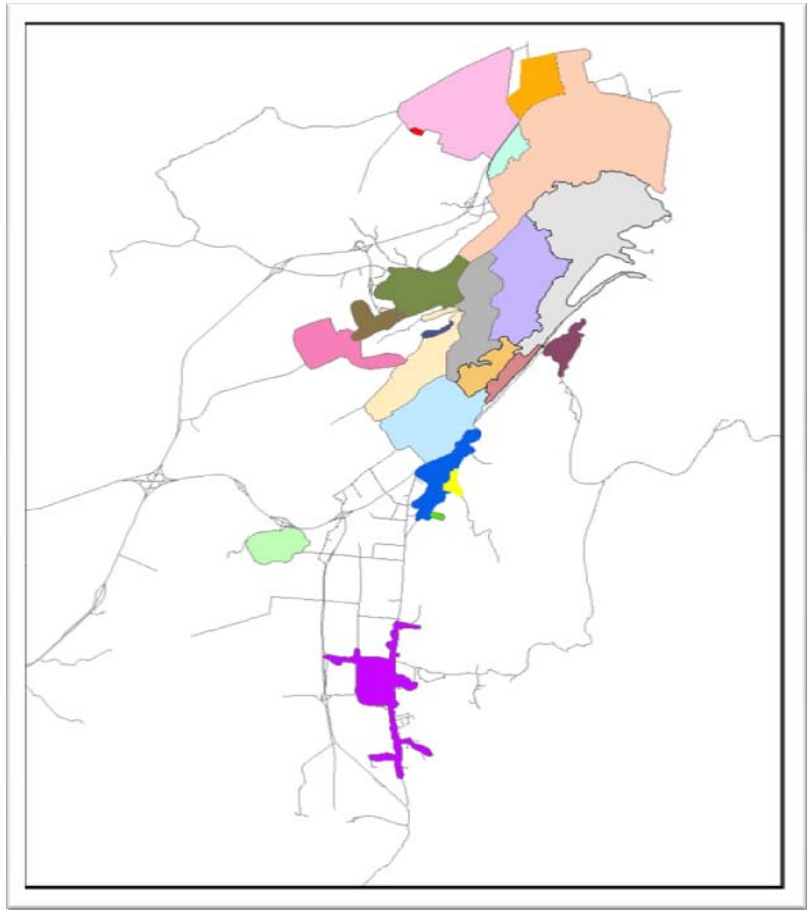
LIFE CYCLE COSTS

City of St. John's

- Population
  - City Proper 100,000
  - Metropolitan Area 180,000
- Treatment Plants
  - Bay Bulls Big Pond WTP
  - Windsor Lake WTP
  - Petty Harbour Long Pond WTP
- Current Daily Water Demand of 140,000,000 litres / day (140 MLD)

City of St. John's

- 10 water reservoirs
- 10 pumping stations
- 12 pressure reducing stations
- 550 km of water main
- 3,000+ fire hydrants
- 9,000+ valves

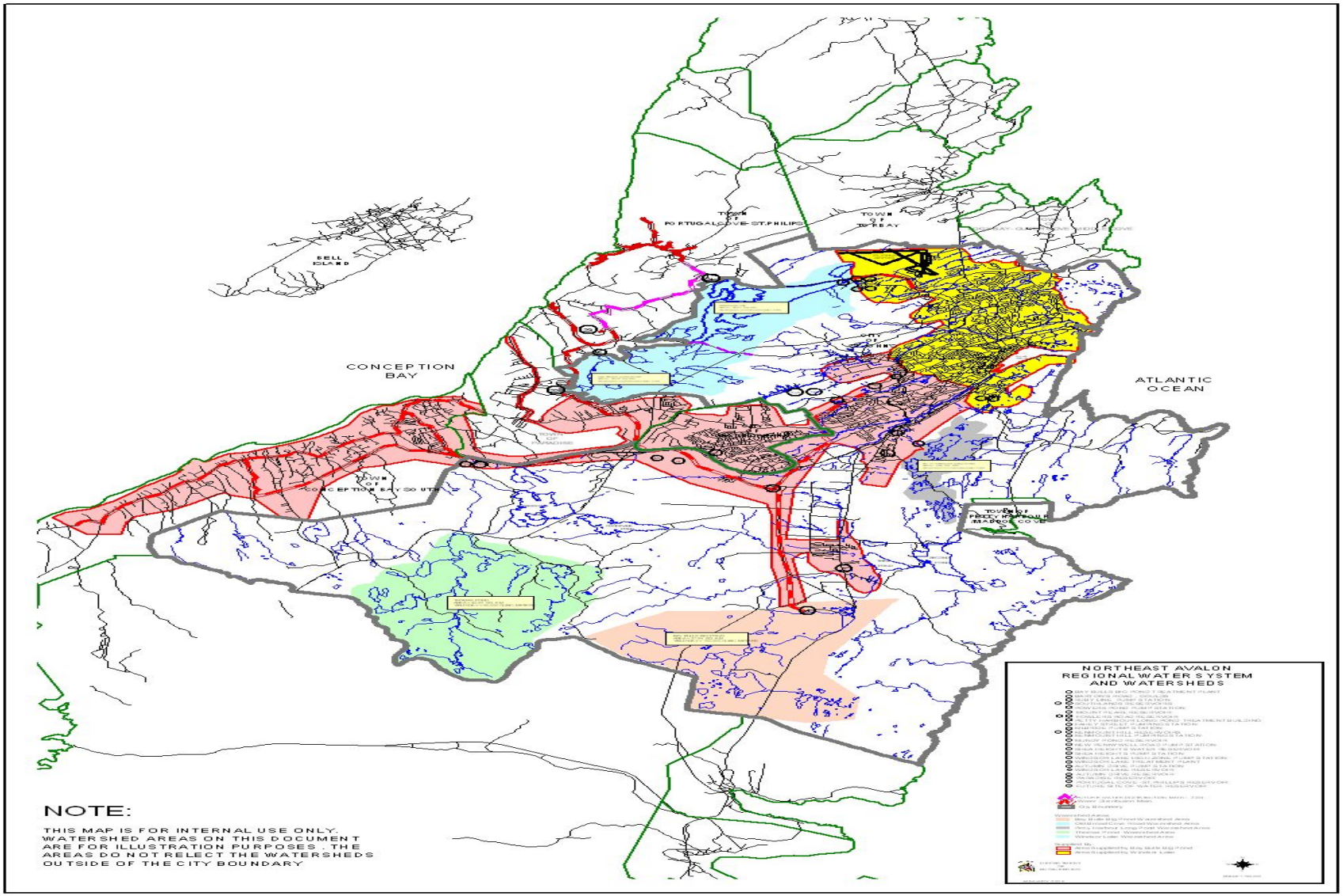


City of St. John's

- The City has recently invested more than $100 million into water and wastewater treatment infrastructure.
- This does not include the additional investments into the distribution and collection systems.
- Nor does it include the on-going operational costs of these facilities.

Water Supplies

- Bay Bulls Big Pond Watershed (7.8 km^2)
  - Windsor Lake Watershed (5.0 km^2)
- Petty Hr Long Pond Watershed (3.6 km^2)
- Broad Cove River Watershed (20.7 km^2)
  - Thomas Pond Watershed (3.9 km^2)


CONCEPTION BAY
ATLANTIC OCEAN
BELL ISLAND
NORTHEAST AVALON REGIONAL WATER SYSTEM AND WATERSHEDS
NOTE:
THIS MAP IS FOR INTERNAL USE ONLY. WATERSHED AREAS ON THIS DOCUMENT ARE FOR ILLUSTRATION PURPOSES. THE AREAS DO NOT RELECT THE WATERSHEDS OUTSIDE OF THE CITY BOUNDARY

Bay Bulls Big Pond WTP

BBBP – History

- Design and Construction began in 1975
- Commissioned in 1977 - 1978
- Operated and maintained by the St. John's Metropolitan Area Board between 1978-1991
- In 1992, the City of St. John's assumed full ownership and operation

Bay Bulls Big Pond WTP

- Conventional Treatment Plant using Rapid Gravity Dual Media Filters
- Design Capacity of 109 MLD
- Ozone used for *Primary Disinfection*
- Chloramines used for *Secondary Disinfection*
- Staffed 24 hours a day

Process Flow

Travelling Screen → Ozonation → Filtration → pH Adjustment → Chloramination

Travelling Screen

- Used to prevent the entry of large debris, fish, and ice.
- 3 mm screen size
- Self – cleaning
- Operates on timed sequence or on differential pressure.

Ozone

- Generated on site through a *Corona Discharge Tube* acting on compressed ambient air.
- Electricity is used to break the stable bonds of the O_2 atom to produce free radicals that combine to form O_3.
- VERY POWERFUL DISINFECTANT!!

Ozone Generators

Filtration

- Rapid Gravity, Dual Media Filters (Sand and Anthracite)
- 6 Filter Trains
- Water flows from top of filter to bottom
- Automatic backwash sequence based on time, turbidity or differential pressure

Filtration

- During a backwash sequence, water is passed quickly (pumped) *up through the filter bed*.
- At the same time, surface wash agitators help breakup any solids accumulation on the filter surface.
- Backwash water is collected in troughs and directed to a waste settling pond.

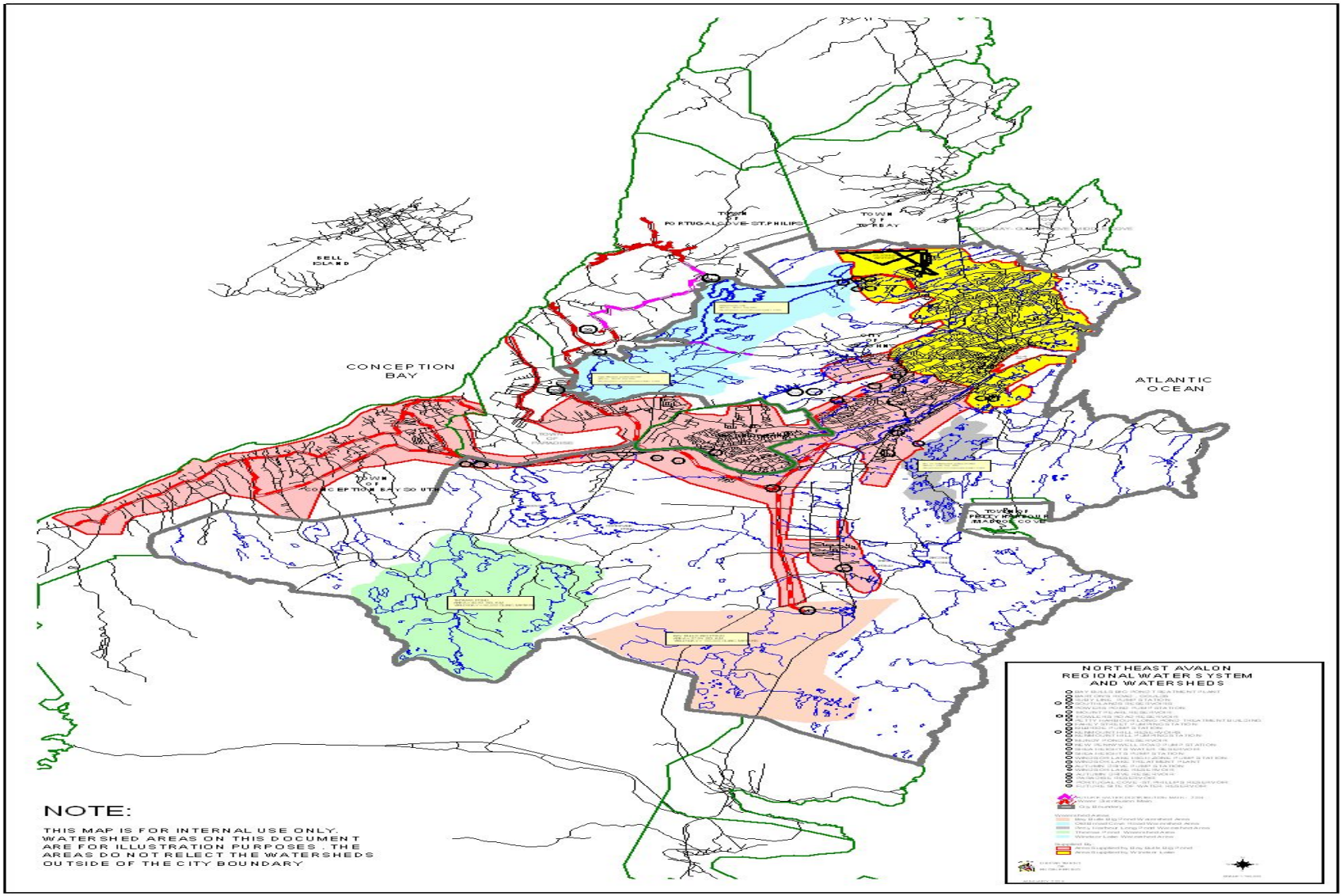
pH Adjustment

- Naturally occurring pH of Bay Bulls Big Pond is slightly acidic (<7)
- Hydrated lime is added to the filtered water to meet provincial regulations (pH 6.5 – 8.5)

Chloramination

- Chloramines are formed by adding chlorine and ammonia
- Not as strong a disinfectant as chlorine but maintains a residual in the distribution system for a greater length of time.
- Less chance for creation of *Disinfection By-Products (DBP)* than chlorine

Chloramination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Windsor Lake WTP

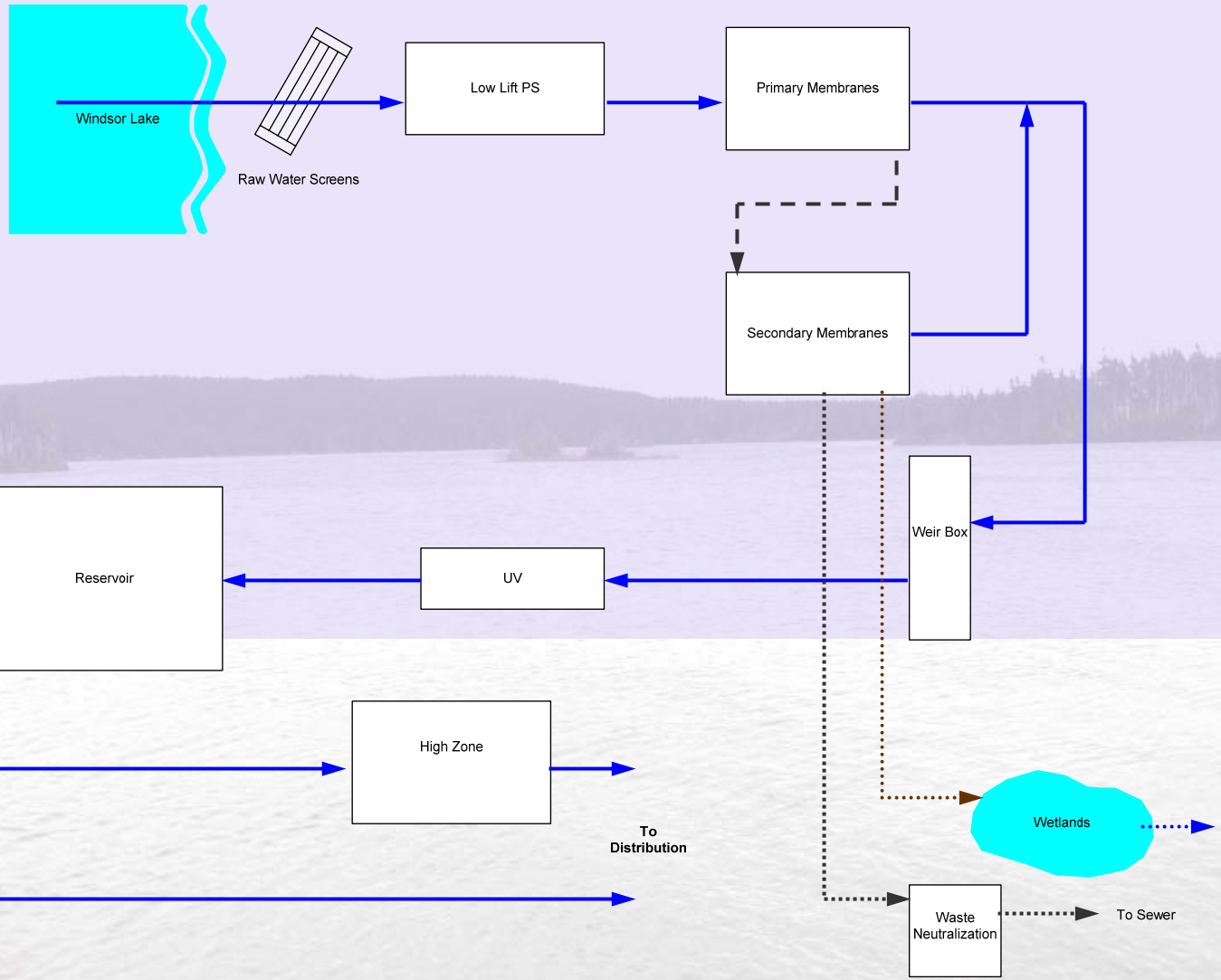
WLWTP - History

- Windsor Lake first used as a water source in 1862.
- Prior to 2007, treatment comprised of screening, pH adjustment and chlorine disinfection.
- Water still consistently exceeded provincial regulations, however the City recognized that legislation was changing and that a true treatment plant was needed.

WLWTP – Design Basis

- As Built maximum draw capacity of 70 million litres / day (MLD)
- Pumps, piping, chemical systems and membrane module capacity for 100 MLD
- To meet current USEPA regulations for the removal/disinfection of Giardia Lamblia and Viruses
- To reduce the corrosivity of Windsor Lake water prior to entering distribution system

Basic Process Flow Diagram:



Raw Water Pretreatment

- Raw water low in alkalinity and calcium concentration with a relatively low pH
- Addition of hydrated lime to increase the alkalinity and pH
- Objective: Treated water alkalinity ≥ 35 mg/L to ensure stability in distribution system
- As a result, pH will increase to unacceptably high levels (> 10)

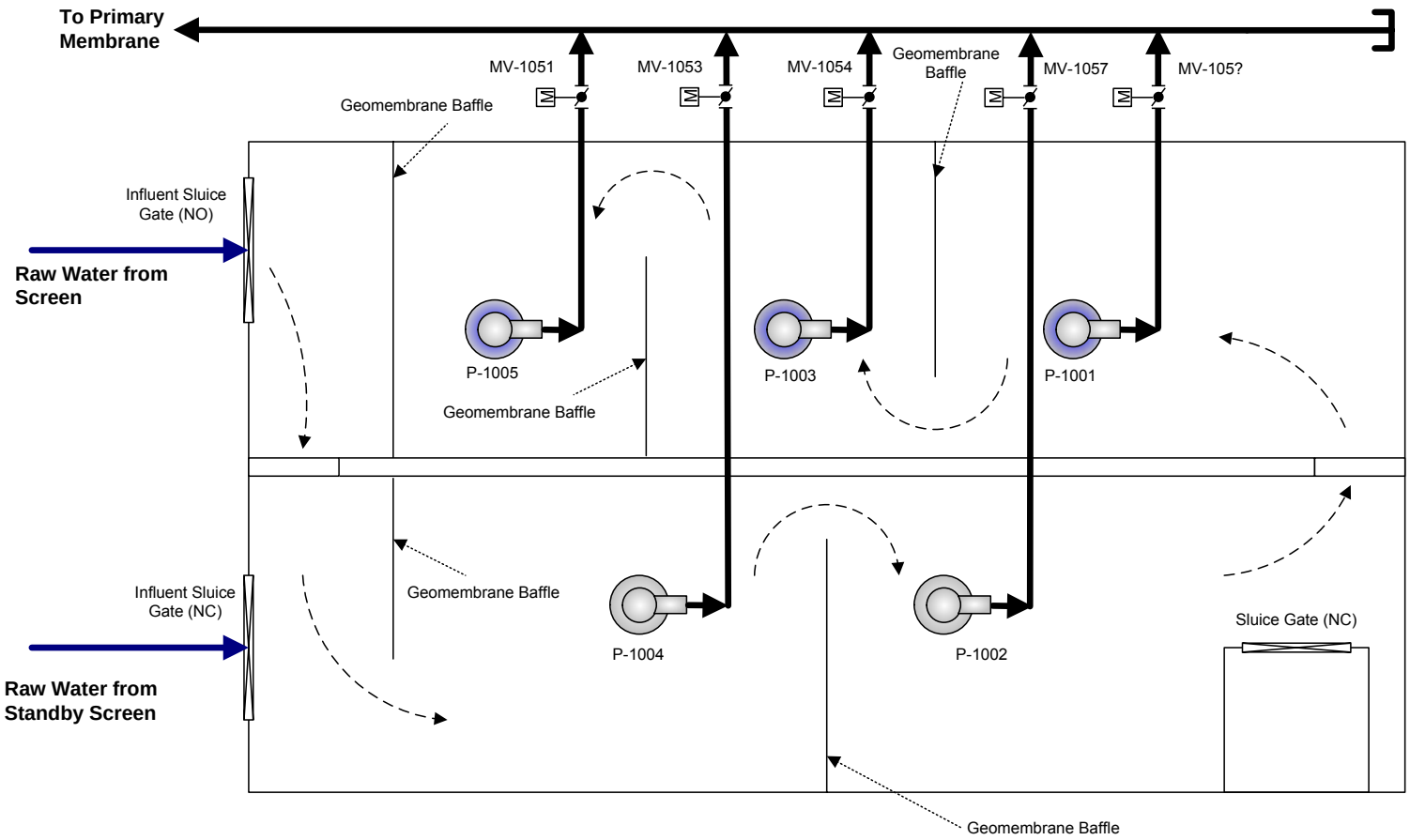
Raw Water Pretreatment

- CO_2 injected into intake header to lower pH to acceptable range without lowering alkalinity
- Lime precipitates carbon dioxide to form calcium carbonate ($CaCO_3$) providing protective coating in distribution system

Low Lift Pump Station

- Two (2) travelling screens
- Five (5) vertical turbine pumps @ 318 L/s each (~27 MLD)
- Pumps lift the raw water to the elevation of the primary membrane system.
- Wet well baffled to improve flow pattern and provide adequate mixing of lime / CO_2

Low Lift Pump Station



Membrane Filtration

- A membrane is an engineered material designed to separate contaminants from water.
- Windsor Lake WTP utilizes *Microfiltration* (MF) membranes (0.1 micron)
- *Giardia Lamblia* and *Cryptosporidium* are physically larger than this pore size.

Membrane Filtration

- Membrane Submodules installed onto racks.
- Currently, 396 submodules in each primary filter cell.
- Each submodule houses approx 10,000 membranes.

Fully Assembled Rack

Ultraviolet Reactors

- Primary disinfection
- Multi-barrier approach
- Three (3) Ultraviolet Reactor (UVR) units in parallel; each UVR contains 4 lamps
- Maximum flowrate = 50 MLD per UVR

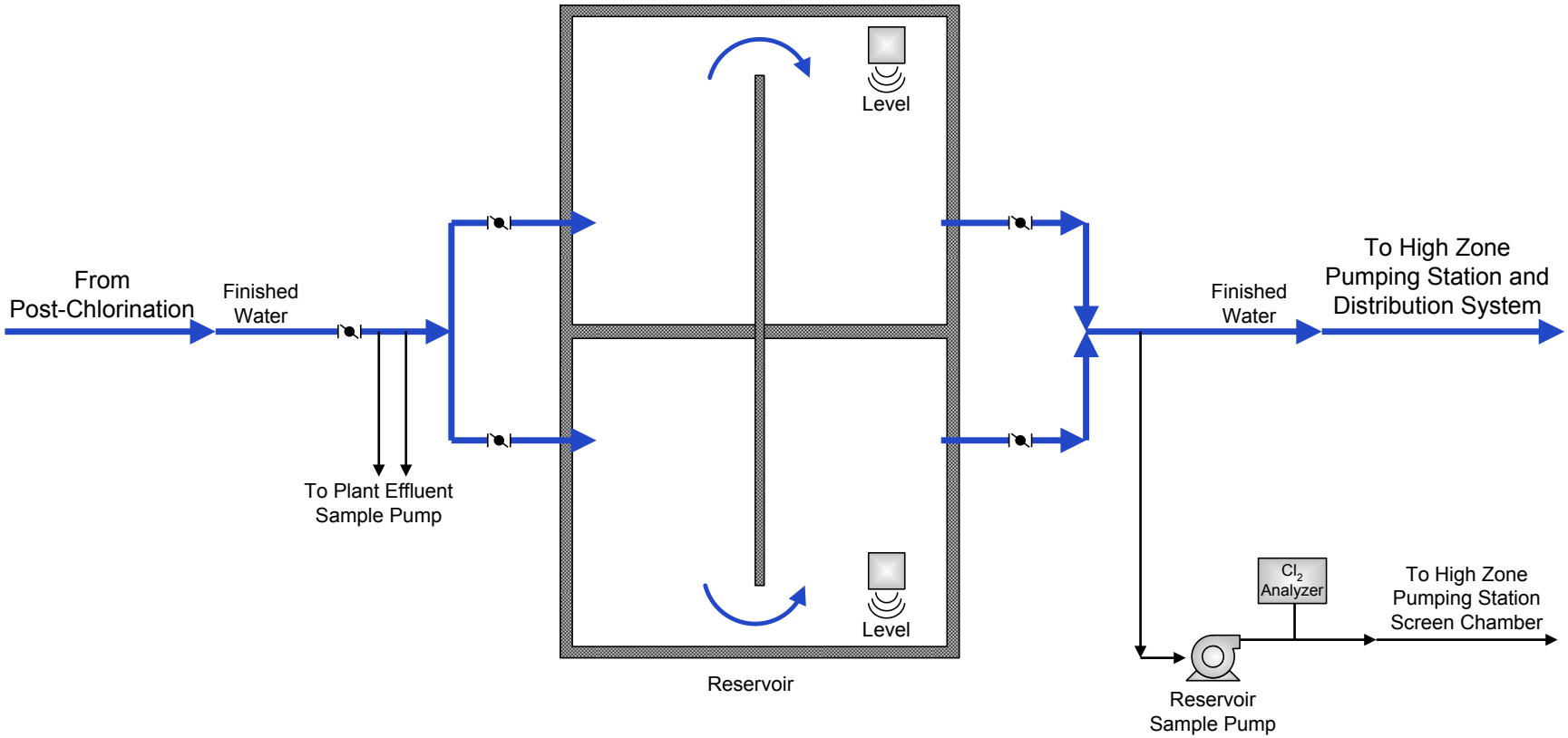
Chlorination

- Secondary disinfection
- Chlorine gas is a strong disinfectant
- Ton cylinders stored in Low Lift P.S. and piped to injection point just prior to reservoir.

Reservoirs

- Provides chlorine contact time and 20 ML storage.
- Reservoir is actually 2 ‘twin’ 10 ML reservoirs.
- Each reservoir has a baffle wall to prevent short-circuiting of flow.
- Finished water enters distribution at outlet of reservoir.

Reservoirs

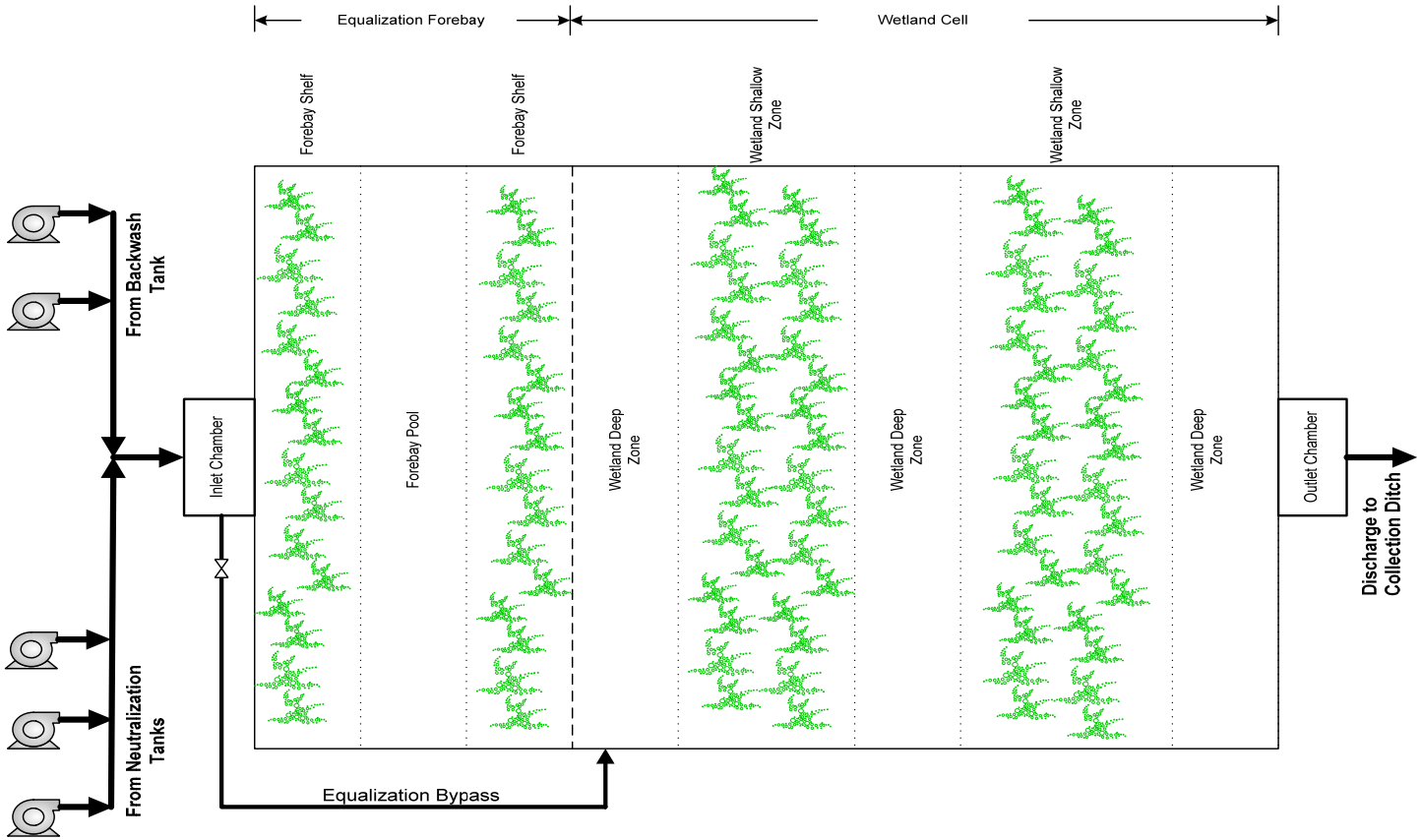

From
Post-Chlorination
Finished
Water
To Plant Effluent
Sample Pump
Level
Level
Reservoir
Finished
Water
To High Zone
Pumping Station and
Distribution System
Cl_2
Analyzer
To High Zone
Pumping Station
Screen Chamber
Reservoir
Sample Pump

Reservoirs

Engineered Wetland

- Constructed wetland used to polish backwash water generated by backpulsing secondary membranes
- Main function is reduction of TSS (from BW water prior to discharge back to source)
- **Target TSS reduction of 60% to 80%**

Engineered Wetland



Engineered Wetland

- Consists of a variety of selected emergent plants.
- System supports aerobic microorganisms that further promote the bacteriological breakdown of organic material
- Stalks and leaves above the surface shade the water keeping it cool and limiting algae growth.

Engineered Wetland

Comparison of WTPs

Bay Bulls Big Pond WTP	Windsor Lake WTP
• Conventional Treatment Plant using Dual Media Filters • Ozone is Primary Disinfectant • pH Adjustment with Hydrated Lime • Chloramination is Secondary Disinfectant	• Membrane Microfiltration Plant • Ultraviolet (UV) Light is Primary Disinfectant • Alkalinity Enhancement with Hydrated Lime • pH Adjustment with CO_2 • Chlorine is Secondary Disinfectant.

Comparison of WTPs

Bay Bulls Big Pond WTP	Windsor Lake WTP
• Consistently produces potable water that exceeds regulatory guidelines.	• Consistently produces potable water that exceeds regulatory guidelines. • Greater reliance on one particular proprietary technology.

Questions

Thank You

ST. JOHN'S