



Taste & Odour Issues in Drinking Water: Examples and Solutions from NL

Drinking Water Safety Workshop, Gander

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March 28-30, 2017

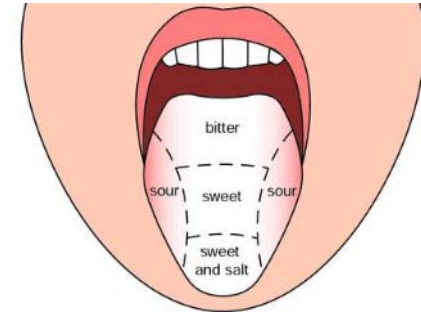
Aesthetics

- Aesthetic effects:
 - Taste
 - Odour
 - Play a role in determining whether consumers will consider the water drinkable
- Parameters determined by human senses
- 2 types of Guidelines for Canadian Drinking Water Quality (GCDWQ)
 - Contaminant Maximum Acceptable Concentrations (MAC)
 - Aesthetic Objectives (AO)
 - levels above the AO would render water unpalatable
- WRMD does not routinely test for taste & odour
- T&O occur in:
 - Unpredictable ways (chemical spill)
 - Come and go
 - Are difficult to define and measure (user complaints confusing or misleading)
- Public perceives T&O issues in water to mean the water is unsafe or unhealthy
 - Creates a public relations problem for the water utility and can result in loss of consumer trust

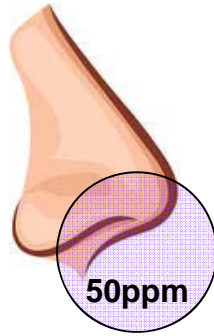




Taste



- Aesthetic objectives for certain parameters based on taste:
 - No offensive taste
 - TDS >500 mg/L
 - Chloride >250 mg/L
 - Copper >1 mg/L
 - Iron >0.3 mg/L
 - Manganese >0.05 mg/L
 - Sodium >200 mg/L
 - Sulphate >500 mg/L
 - Zinc >5 mg/L
- Taste sensations:
 - Sour
 - Sweet
 - Salty
 - Bitter
- Feelings can be triggered by chemicals in mouth/nose
 - Pain
 - Hot and cold
 - Pressure
 - Mouthfeel (eg. astringent, drying, slick, chalky)



Odour

- Aesthetic objectives for certain parameters based on odour:
 - No offensive odour
 - Toluene >0.024 mg/L
 - Zylene >0.02 mg/L
 - Ethylbenzene >0.0016 mg/L
 - Sulphide >0.05 mg/L
- Odour qualities are innumerable and described by
 - Past associations (eg. flowery, eggs)
 - Intensity- weak, strong
- Perceived when substances enter nasal cavity or during tasting/swallowing
- Most people have some inability to smell certain odours

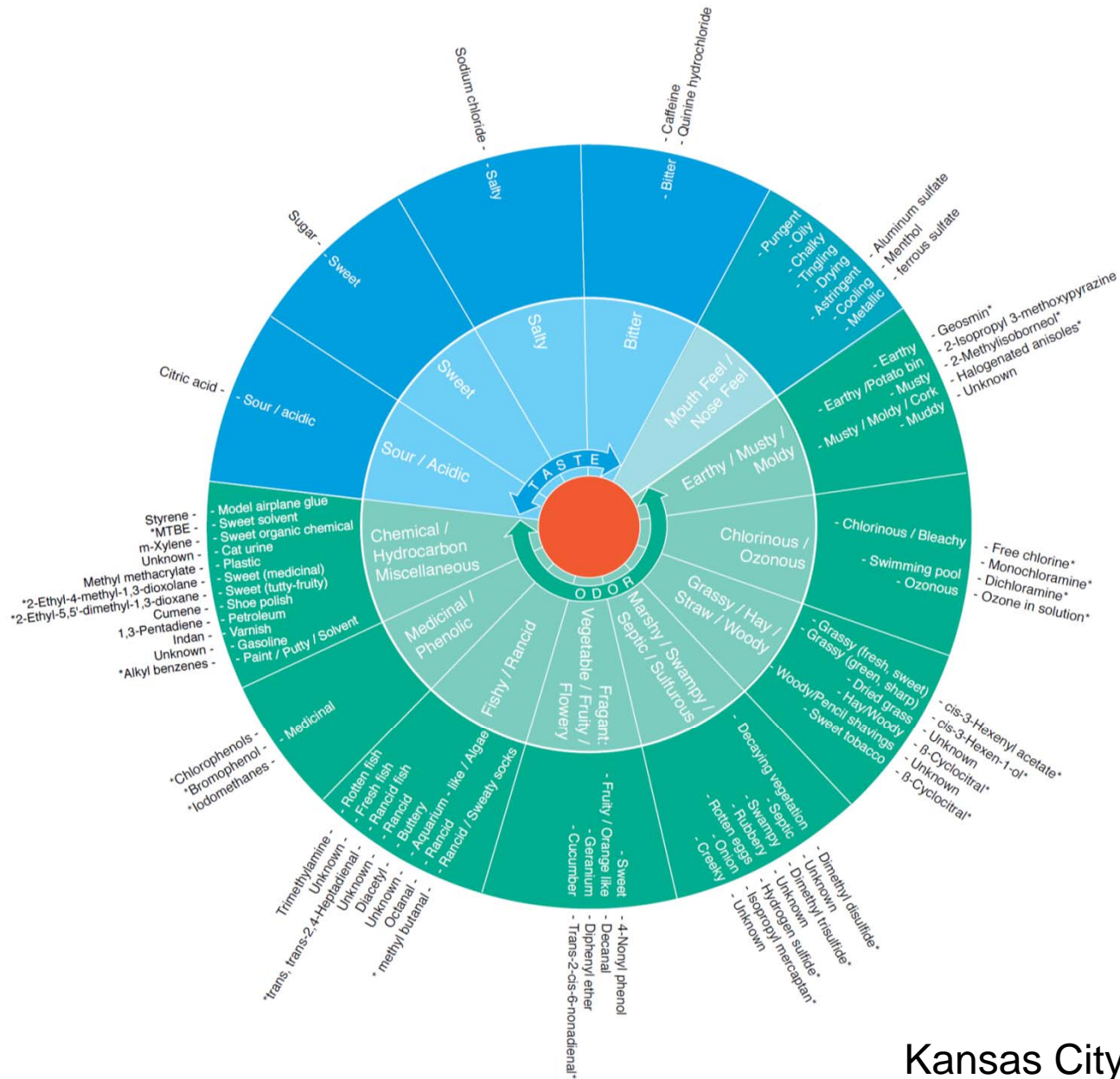


Causes of T&O Issues

- Many causes for T&O problems
- T&O issues commonly caused by:
 - Source water
 - Treatment processes
- 2 origins of odours in drinking water supplies:
 - Natural
 - Synthetic
- Important to collect good systematic information
 - Help identify cause of problem
 - Provide guidance on corrective action
- Water temp and pH can affect the T&O of water

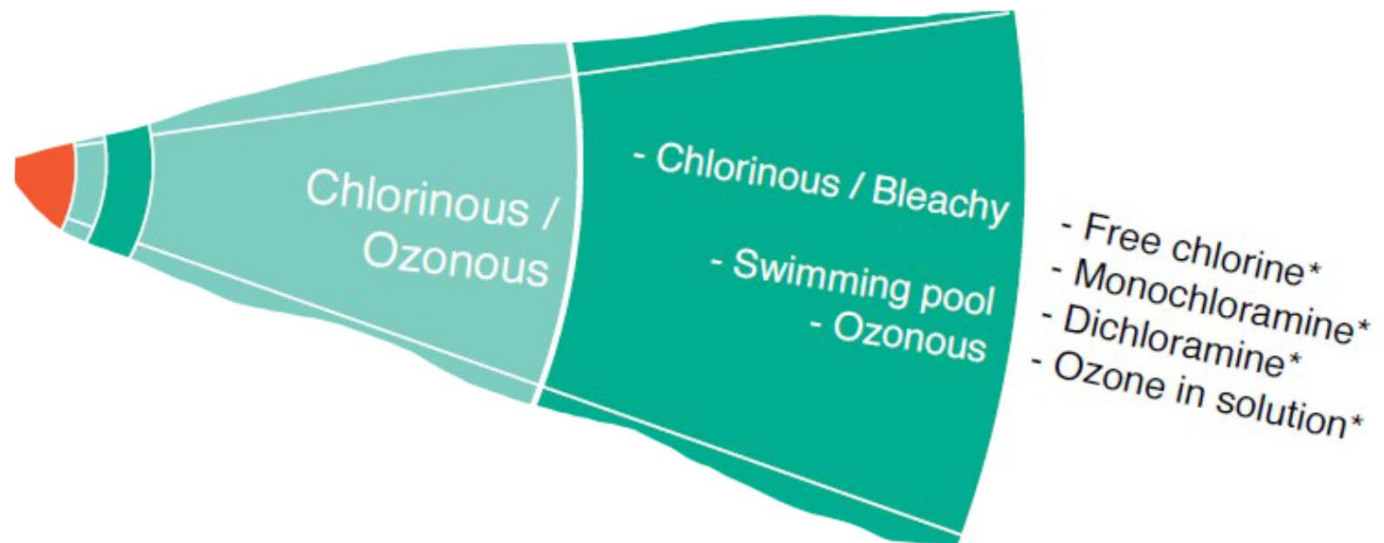


Taste & Odour Wheel





Most Common T&O Issue: Chlorine





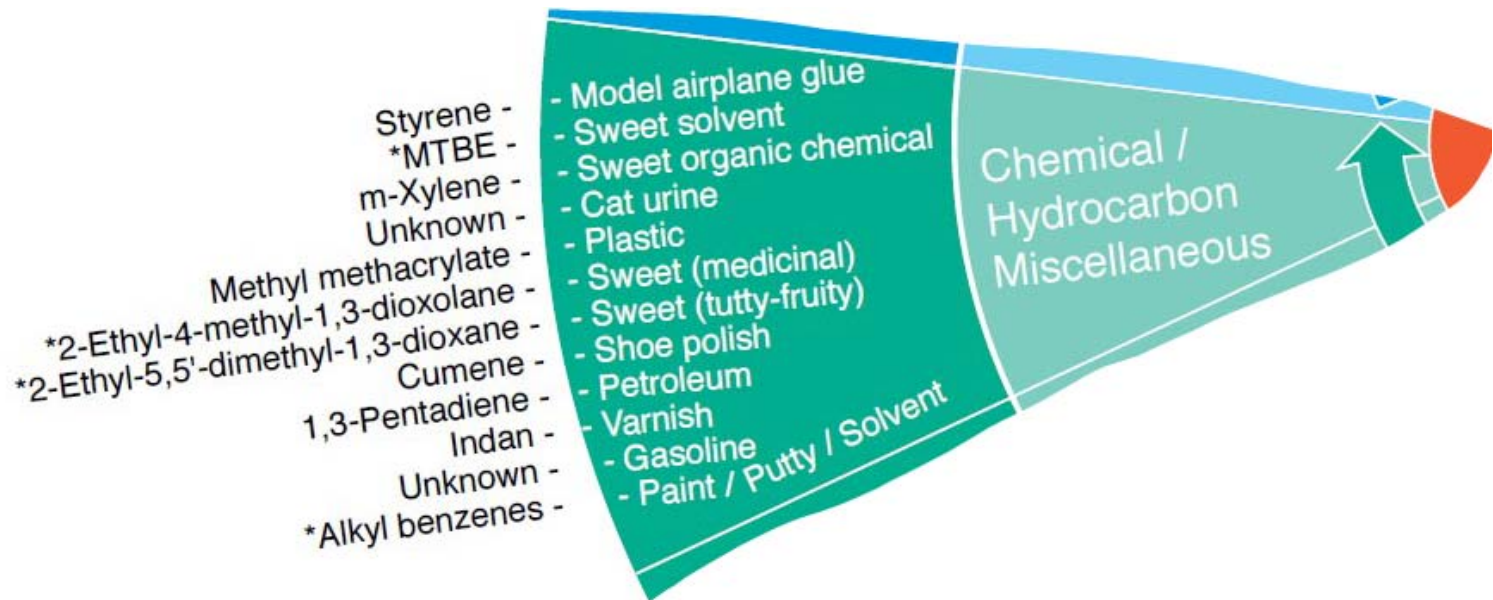
Chlorine Taste and Smell

- All public drinking water systems in NL must have disinfection
 - Majority use chlorine
 - Must maintain a detectable free chlorine residual in all areas of distribution system
- Average water user is sensitive to free chlorine starting at 0.5-1.0 mg/L
- Water described as smelling like:
 - “swimming pool”
 - “bleach”
- BWA Reason Code B1-chlorination system is turned off due to taste or other aesthetic considerations
 - 6 active B1 BWAs
- Solution:
 - Chlorine Demand Management
 - Public awareness





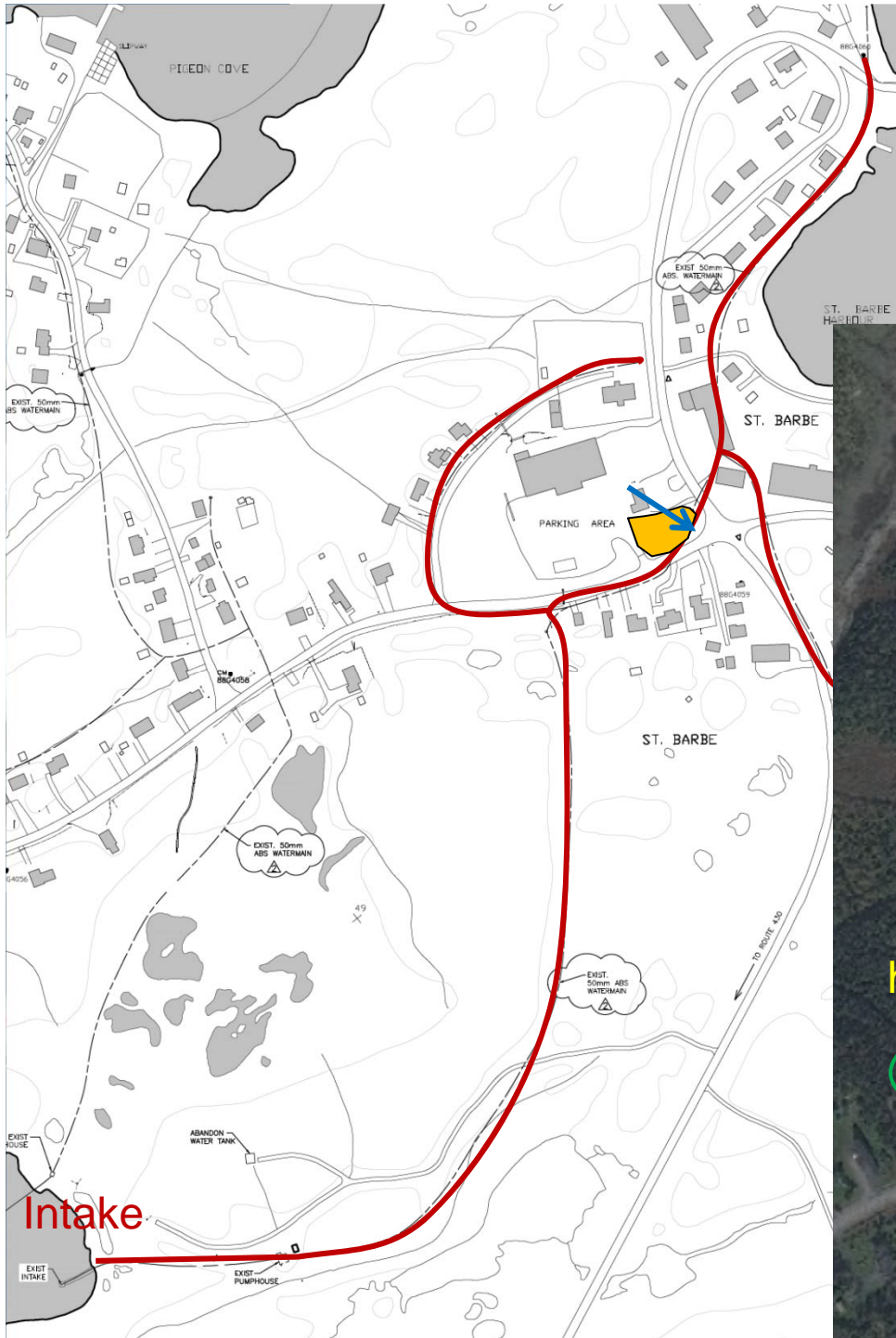
Gasoline Smell





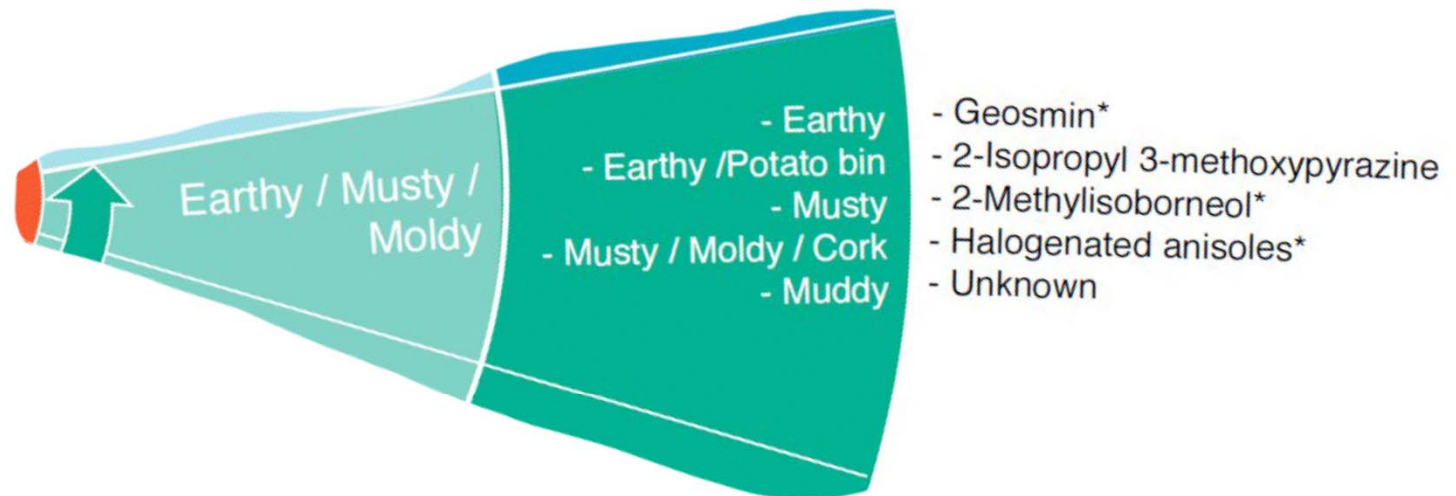
Gasoline Smell: Pigeon Cove-St. Barbe

- Aug 12, 2015:
 - Gas smell detected in tap water by WRMD staff during regular water quality sampling
 - Advised that water in the building not be used- precautionary
 - Special hydrocarbon sample taken- exceedances for benzene and toluene
- Aug 25 & Sept 14, 2015- additional special samples taken by WRMD to determine extent of contamination in distribution system
- Aug 31, 2015:
 - During work on exploration test pits broke watermain at gas station and broke service line to hotel that had to be repaired
 - Stantec took water samples from watermain after 1h flushing- xylenes and toluene detected
- Sept 4, 2015- Partial NCA issued users downpipe of gas station
 - 10-15 houses
 - Dockside Motel
- Nov 3, 2015- gas station owner approves remediation plan
- Fall 2015:
 - Service NL oversaw removal of contaminated soil and site remediation by Stantec
 - Soil sampling and delineation of extent of contamination
 - Nov 20, 2015- Waterline relocated away from contaminated soil (8 joints in line eliminated- possible intrusion points)
- Dec 9, 2015- Post remediation water samples collected by WRMD
- Dec 22, 2015- NCA lifted
- Post event:
 - WRMD continued quarterly hydrocarbon/BTEX sampling for 1 year to ensure no reoccurrence as impacted soil still onsite
 - Town to monitor and maintain pressure in distribution system and report any loss of pressure below 20 psi to WRMD





Musty/Earthy Smell



*Geosmin is a taste and odour chemical produced as a metabolite by different organisms including algae (cyanobacteria), bacteria (Actinomycete bacteria), fungi, amoeba and other organisms. Geosmin is an earthy smelling, volatile compound that is harmless, but unpleasant for water users.



Musty/Earthy Smell: Gander

- Aug 2011- Reports of musty taste/smell in north east section of the Gander distribution network
- Higher water temperatures
- No noticeable algae bloom in Gander Lake
- Usual distribution system flushing undertaken
- No issues with WTP
- Low water use, low velocities and high water age in the area of concern
- Chlorine residual issues in area
 - Chlorine masks geosmin (earthy) odor
- Aug 31, 2011:
 - Geosmin from tap samples in affected area of Gander over odour and taste thresholds
 - Geosmin 26-38 ng/L
 - MIB less than detectable
- June 2012- Complaints of bad smelling water in same area
- Warm early summer
- Flushing and adjustments to chlorine residual
- Oct 2012:
 - Found 4" dead end pipe that was left in the ground ~20 years ago for a future building
 - Summer of 2011 this pipe tied into main
 - Pipe full of biofilm and dirt that contributed to taste/odour issue
- Solutions:
 - Flushing of dead ends
 - 2015-16- Gander pilots and decides to switch to chloramines

Properties	Geosmin	MIB
Detectable Odour Threshold	3.8 ng/L	15 ng/L
Detectable Taste Threshold	16 ng/L	18 ng/L





Musty/Earthy Smell: St. John's- Windsor Lake, Marystown

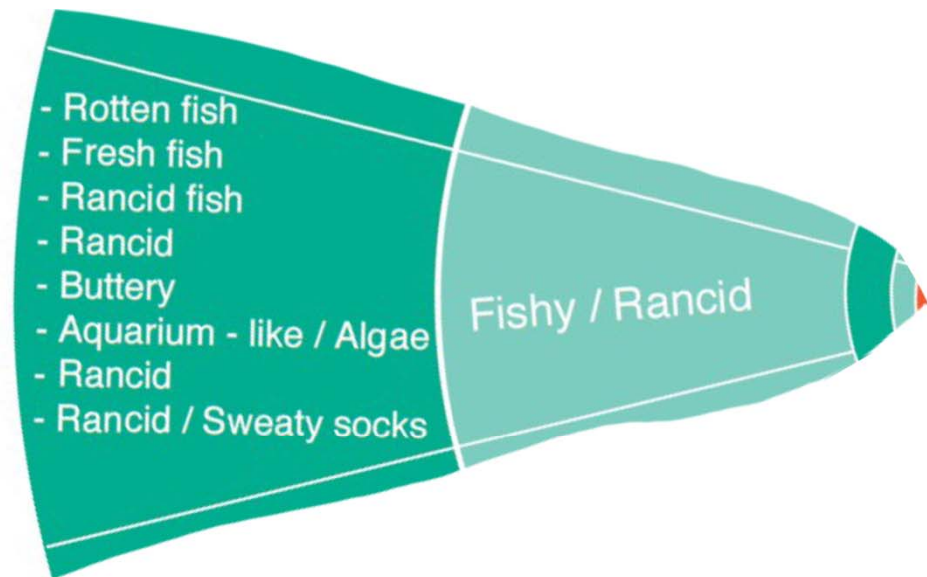
- Most years experience a musty smell event in late summer
 - Most likely due to warm water temps and cyanobacteria growth
- Lasts a couple of weeks
- No observable algal bloom
- City of St. John's tested for geosmin/MIB in 2016
 - Results less than detectable
- Monitor supply, but no treatment options planned



Fishy Smell



- | | |
|---------------------------------|---------------------------|
| Trimethylamine - | - Rotten fish |
| Unknown - | - Fresh fish |
| *trans, trans-2,4-Heptadienal - | - Rancid fish |
| Unknown - | - Rancid |
| Diacetyl - | - Buttery |
| Unknown - | - Aquarium - like / Algae |
| Octanal - | - Rancid |
| * methyl butanal - | - Rancid / Sweaty socks |





Fishy Smell: Bide Arm

- Residents serviced by First Clay Cove Pond complain about a fishy smell in their drinking water
 - Nov 2015- May 2016
 - Nov 2016- Dec 2016
- 90-meter long concrete dam
- No inflow or outflow streams into pond
- Pond 10 m deep
- For over 18 years, town applied copper sulfate to pond each spring to control the growth of algae
- Hypochlorination system
- Water quality typically very good
- No large fish species in pond
- Pond ice covered from Nov-May





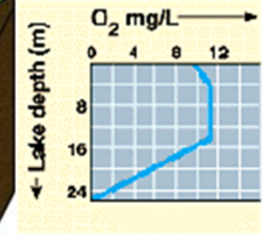
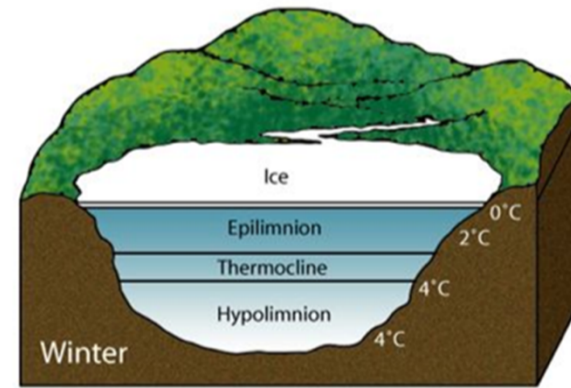
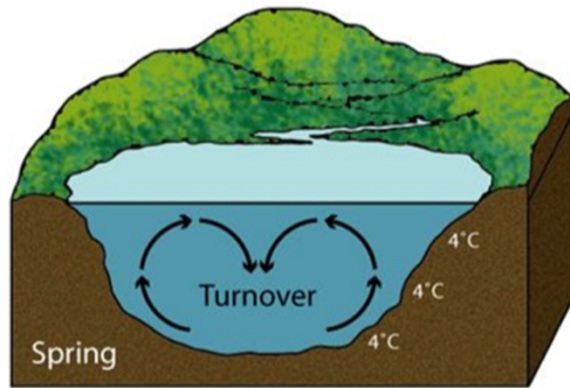
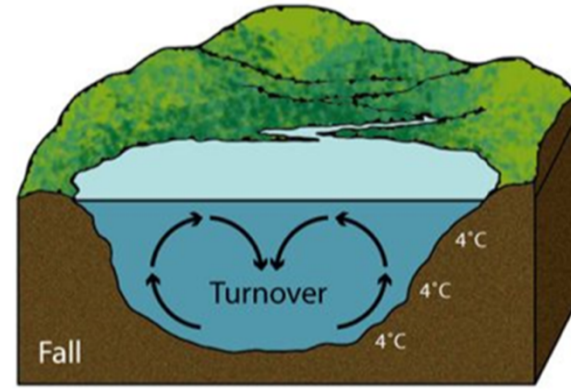
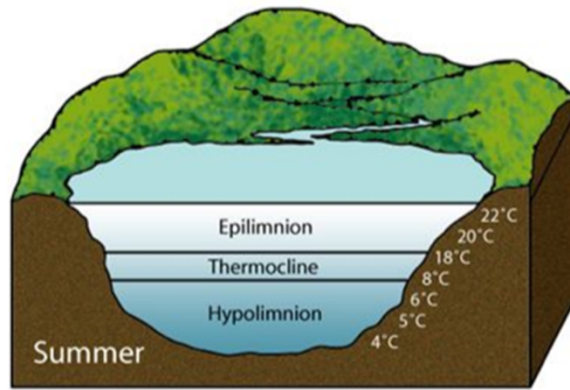
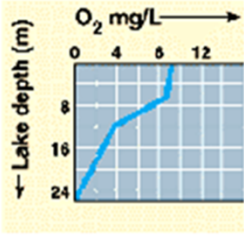
Fishy Smell: Bide Arm

- Odours that have a fishy or musty smell are associated with algae
 - Natural in origin
- Odours of natural origin are of aesthetic concern
 - Not a health risk according to Health Canada
 - Specific odour agent is commonly unknown
- Odours can arise during:
 - Algal growth
 - Algal blooms
 - Develop from products of decomposition as the algae die off
- No geosmin or MIB detected
- Sample results indicated nothing uncommon to a freshwater pond in NL

Group	Algae
Blue-Green (musty smell)	<i>Anabaena</i>
	<i>Lyngbya</i>
	<i>Oscillatoria</i>
	<i>Phormidium</i>
Green	<i>Dictyosphaerium</i> (when present in large numbers)
	<i>Pandorina</i>
Diatoms (fishy smell)	<i>Asterionella</i> (when present in large numbers)
	<i>Tabellaria</i> (when present in large numbers)
	<i>Synedra</i>
	<i>Cyclotella</i>
	<i>Melosira</i>
Flagellates	<i>Synura</i> (when present in large numbers)
	<i>Dinobryon</i>
	<i>Ceratium</i>
	<i>Volvox</i>
	<i>Chlamydomonas</i> (when present in large numbers)

Types of algae identified in pond that are known to produce a fishy or musty smell

Lake Turnover

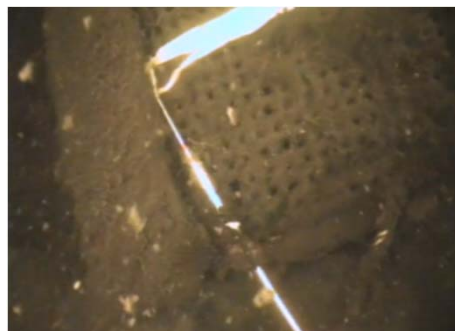


- Lack of circulation, mixing and aeration in the water column in general
- Pond froze over rapidly in Nov 2015
- May 2016:
 - Top of pond: DO = 11 mg/L, temp = 11°C
 - Bottom of pond: DO = 3.5 mg/l, temp = 3.6°C
- Ice cover in winter further reduces the ability for oxygen exchange in the water column



Fishy Smell: Bide Arm- Action Taken

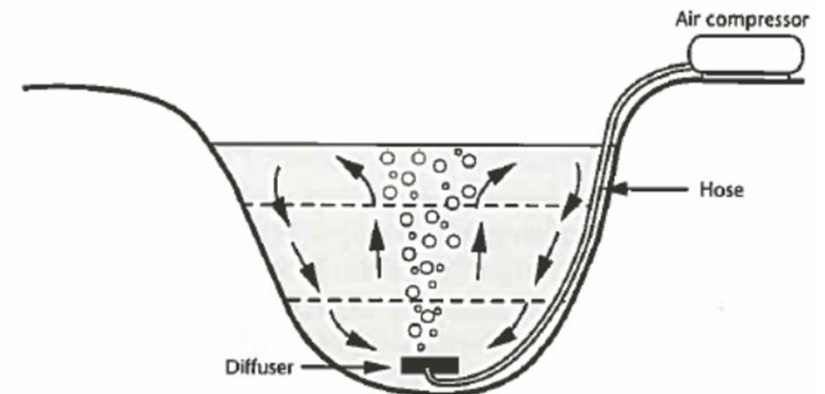
- Drinking water made available to residents of Bide Arm from the fire hall in Roddickton
- Dec 2015- town cleaned the wet well screens and flushed their system
- May 2016- town hired a diver to inspect intake:
 - Intake screen had heavy buildup of organics
 - Organics and sediment removed by the diver
 - No breaks in the intake pipe
- May 2016:
 - Town flushed system again
 - Cleaned basket strainer
- Multiple site visits by WRMD staff
 - Operator training
 - Special sampling
 - Meeting with town
- Technical memo prepared by WRMD on causes and possible corrective measures
- Town decided not to apply copper sulfate in 2016





Fishy Smell: Bide Arm- Path Forward

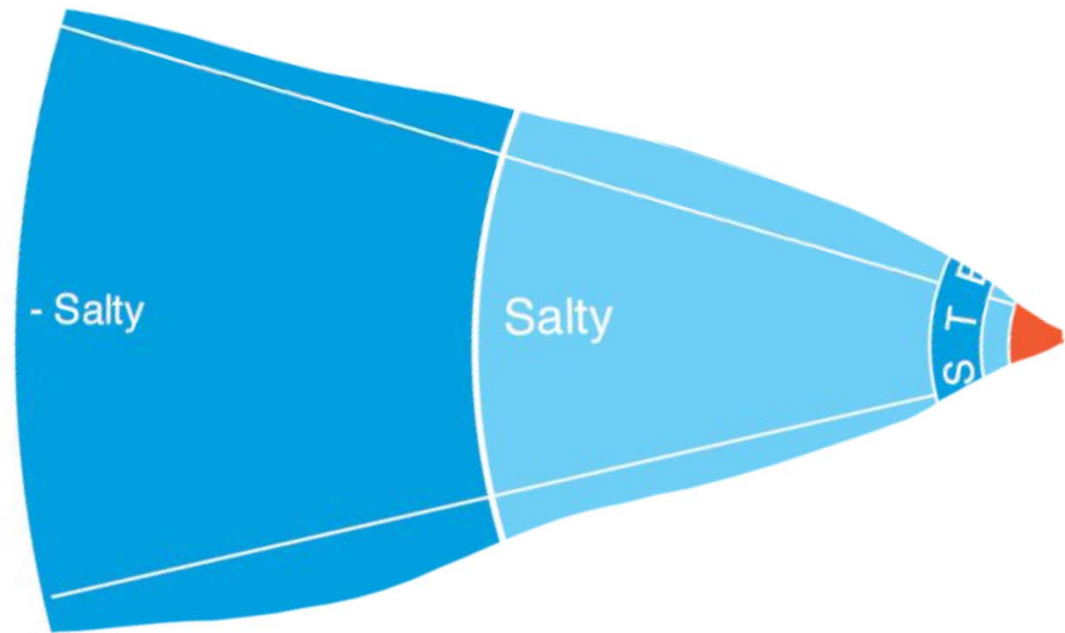
- Monitor conditions in intake pond
- Complaints by residents concerning taste and odour should be logged by the town
- Town must collect operations data for the drinking water treatment and distribution system
 - Flow
 - Chlorine dosage
 - Chlorine residuals in the distribution system
 - Water temperature
- Any future use of copper sulfate for algae control must follow Design Guidelines
 - NSF certified
- Manually remove algae from pond
- Clean screens regularly
- Long-term options:
 - Install a circulation/oxygenation system in First Clay Cove Pond to improve circulation and O₂ levels in the pond
 - Elevate the intake or have a multi-level intake
 - Installation of an activated carbon system:
 - GAC filter (granular activated carbon)
 - PAC dosing system (powdered activated carbon)
 - Installation of an ozone system before chlorination
 - Installation of potassium permanganate dosing system before chlorination



Salty Taste



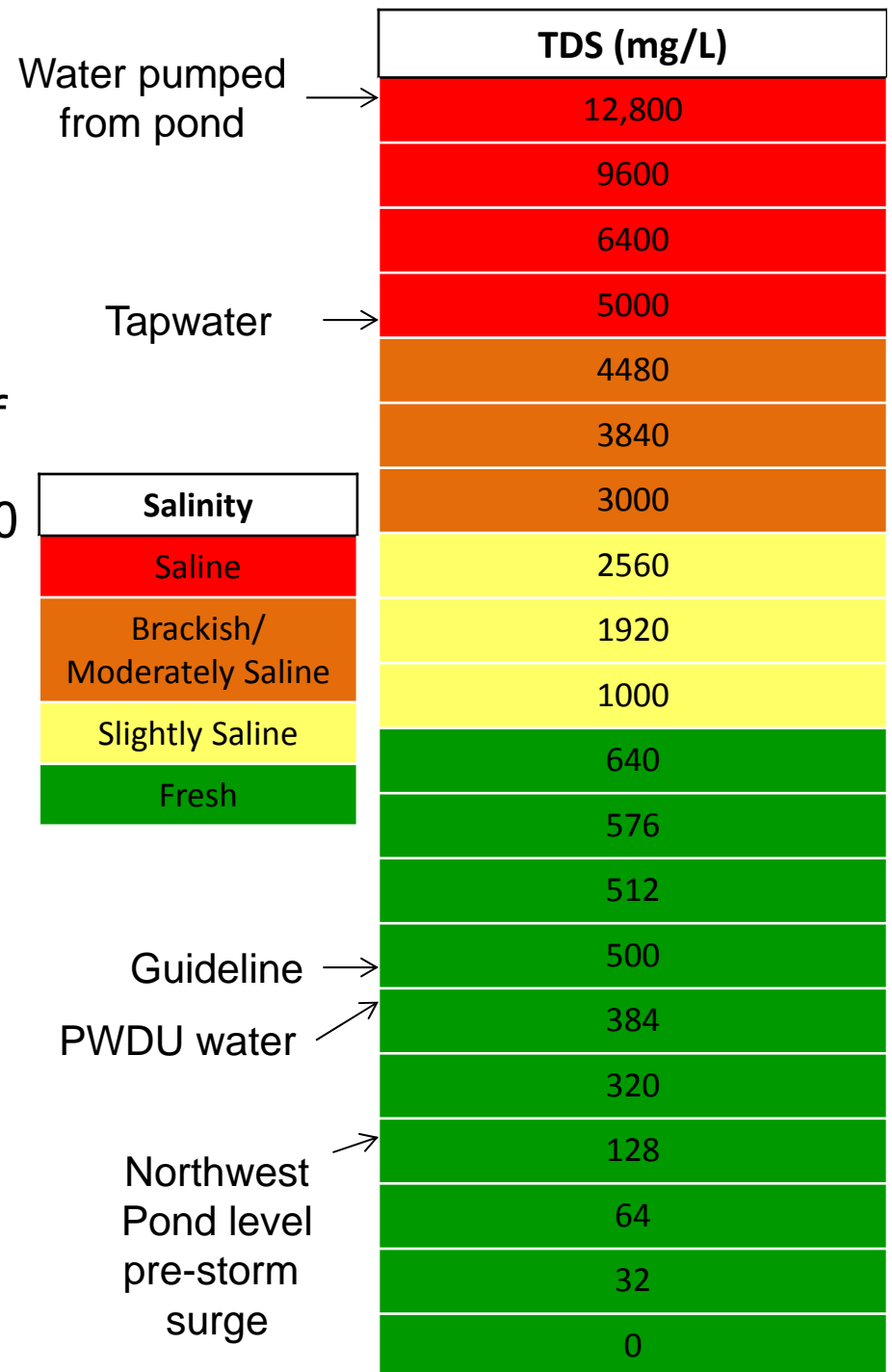
Sodium chloride - - Salty





Salty Taste: Ramea

- Dec 16, 2016
 - Sustained NW winds of 87 km/h
 - High tide ~2m at 11:20 am
 - Storm surge over 4m
 - Ice in Northwest Pond lifted ~ 0.3m
 - At least 33,751 m³ of saltwater in intake pond
- TDS:
 - Seawater 30,000 mg/L
 - Tap 5100 mg/L
 - PWDU 370 mg/L



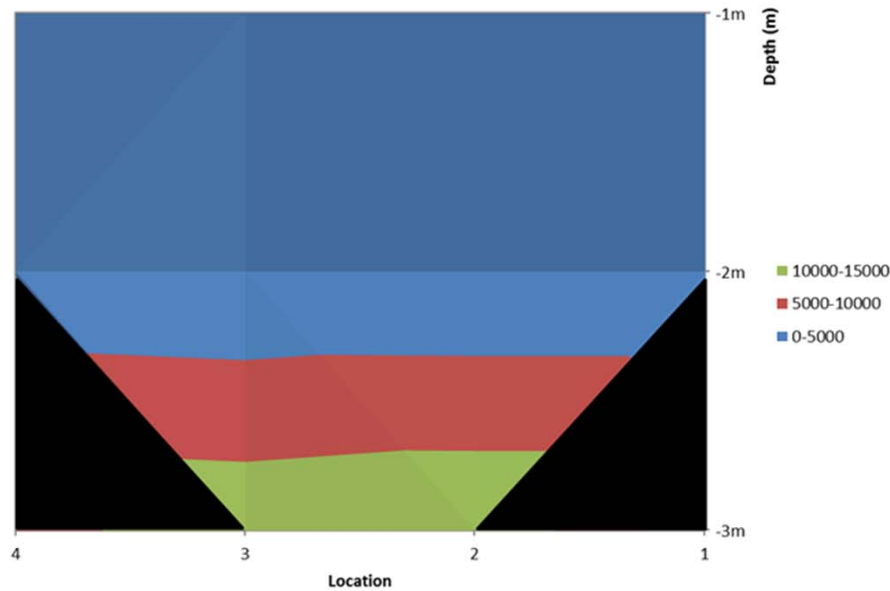


NW winds: 87 km/h
Storm surge: >4 m



Salty Taste: Ramea

Ramea Intake Pond TDS (mg/L) Profile- Jan 30, 2017



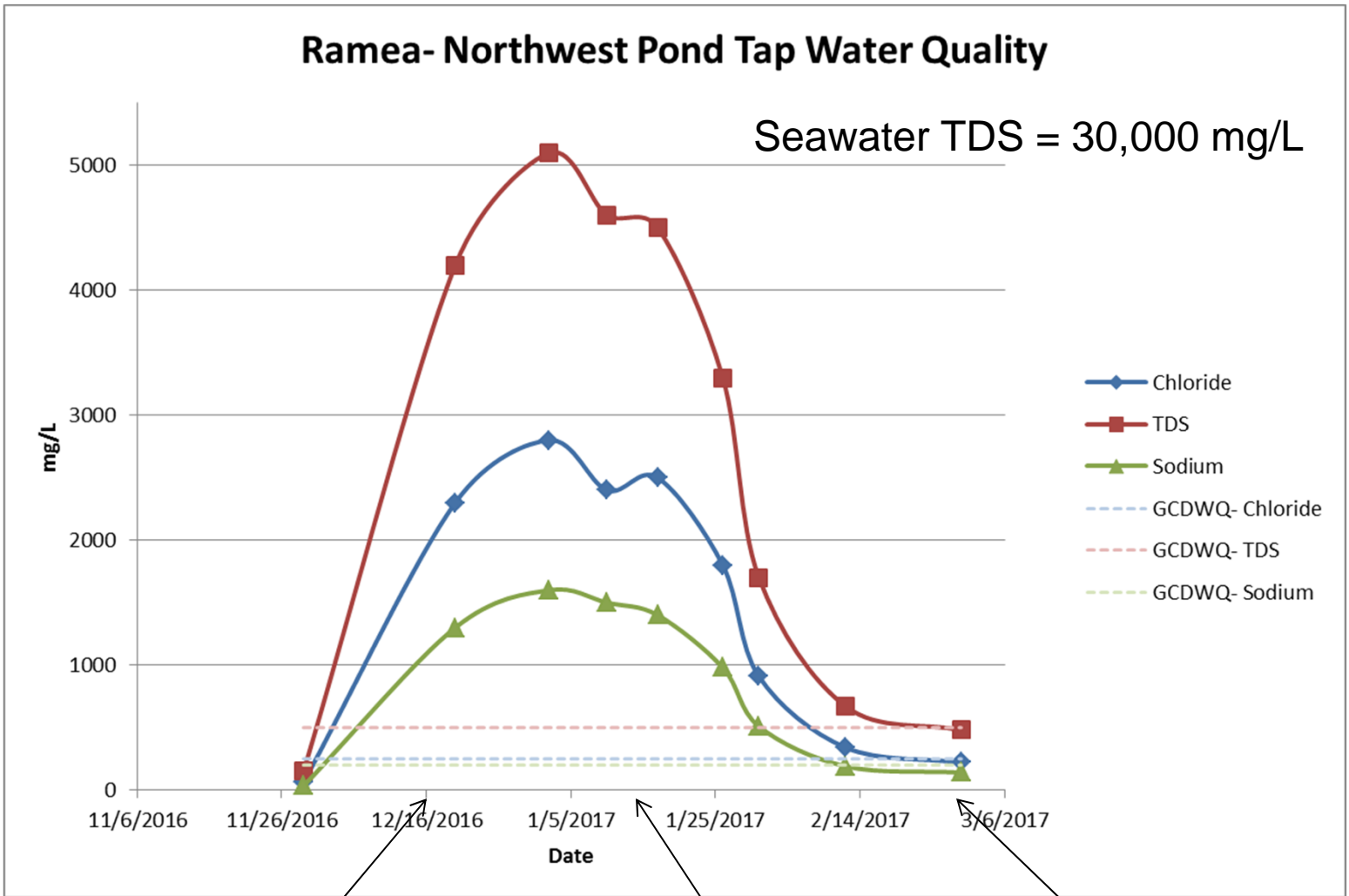
- Tap TDS increased for 2 weeks after surge
- Saltwater started to stratify at bottom of pond
- Intake ~0.9 m from bottom of pond
- Options:
 - Pumping out pond
 - Repair and install berms
 - Saltwater PWDU RO membranes
- Changed PWDU RO membranes
 - 91% removal to 98% removal of TDS
- Jan 11, 2017- started pumping from bottom of pond
- Jan 22, 2017- 2nd pump installed
 - ~2300 m³/d
 - operating 24h per day
 - Jan 27th- first significant drop in tap TDS detected
- Feb 16, 2017- pumps removed
- Bottom salt layer decreased in size over time
 - Target TDS of 500 mg/L at intake





Salty Taste: Rame

Ramea- Northwest Pond Tap Water Quality



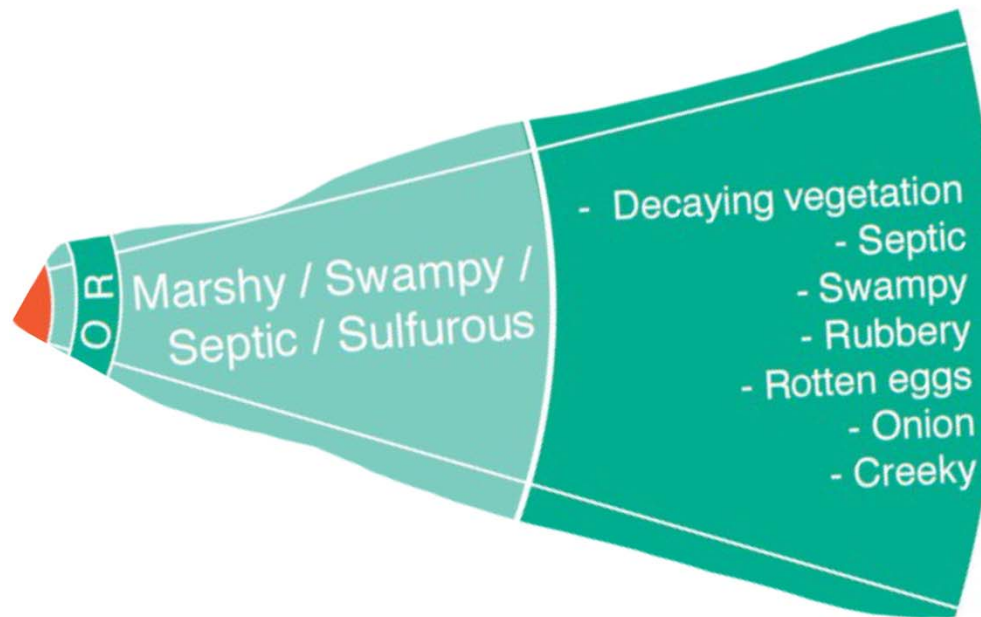
Dec 16-
Inundation event

Jan 11-
Started pumping

Feb 28-
GCDWQ met



Rotten Egg Taste & Smell



- Dimethyl disulfide*
- Unknown
- Dimethyl trisulfide*
- Unknown
- Hydrogen sulfide*
- Isopropyl mercaptan*
- Unknown



Rotten Egg Smell: Groundwater



- Caused by hydrogen sulphide gas (H_2S)
 - Occurs naturally
 - Produced by sulfate reducing bacteria (SRB)
 - Pollution (rare)
- Aesthetic issue
- Sulfur bacteria produce a slime and can promote the growth of other bacteria, such as iron bacteria
 - Slime can clog wells, plumbing
- Sulfur bacteria can be difficult to remove once established in a well
- Have the well bacteriologically tested:
 - Total coliforms (PHL)
 - E. Coli (PHL)
 - Sulfur bacteria
 - Iron bacteria
- WRMD tests for sulphate (>500 mg/L)
- Options:
 - Shock chlorination of well
 - Physical scrubbing of the well casing, use of special treatment chemicals, and agitation of the water may be necessary prior to chlorination to remove the bacteria
 - Drilling a new well into a different formation capable of producing water that is free of hydrogen sulfide gas
 - Connecting to an alternate water source
 - Treatment:
 - Activated carbon (<1 mg/L of H_2S)
 - Oxidizing greensand filter (<6 mg/L of H_2S)
 - Oxidation filtration system (>6 mg/L of H_2S)



Logging T&O Complaints

- Town should log T&O complaints in a systematic manner
- Complainants should be asked to clearly identify the taste or odour of concern using common and consistent descriptors
 - “The water smells bad”- not good enough
- If many water users call to report similar taste and odour issues, a potential problem may exist and the cause should be further investigated

Odour	Taste
Earth, musty, moldy	Sour, Acidic
Chlorinous, Ozonous	Sweet
Grassy, Hay, Straw, Woody	Salty
Marshy, Swampy, Septic, Sulfurous	Bitter
Vegetable, Fruity, Flowery	Odd mouth or nose feel (oily, chalky, tingling, drying, cooling, metallic, etc.)
Fishy, Rancid	Other
Medicinal	
Chemical	
Hydrocarbon	
Other	



Additional Steps after T&O Issue Identified

- Collection of operations data for the drinking water source, treatment and distribution system is vital in order to help identify the cause of T&O issues
- Includes:
 - Visual monitoring of source conditions
 - Monitoring of flow
 - Chlorine dosage
 - Chlorine residuals in the distribution system
 - Water temperature
- Contact Water Resources Management Division (WRMD)
 - Technical expertise
 - Special sampling
 - Coordinate with H&CS if any health risk

Conclusions

- NL is seeing more T&O issues associated with drinking water
- People's sensitivity to T&O varies
- T&O issues of natural origin typically aesthetic issues and not a health concern
- T&O issues make users distrust the safety of the drinking water system
- T&O issues tend to come and go
 - Motivation to resolve can be insufficient
- Sometimes hard to figure out what is the specific T&O causing agent
- Dealing with T&O issues may require source interventions, changes in treatment or new treatment
- Climate change likely to increase frequency of T&O issues



Path Forward

- T&O section added to the updated Guidelines for the Design of Drinking Water Systems (to be released in 2017)
- Communities should use standardized descriptors when users report T&O complaints
 - T&O wheel
- Communities report any major T&O issues to WRMD
- Communities must record operations information: flow, Cl residual, etc.
- Deal with T&O issues on a case-by-case basis

Questions?

