Water Treatment and Service Delivery Matrix for Small Rural Communities

November 2025

Deneen Spracklin
Manager, Drinking Water and Wastewater

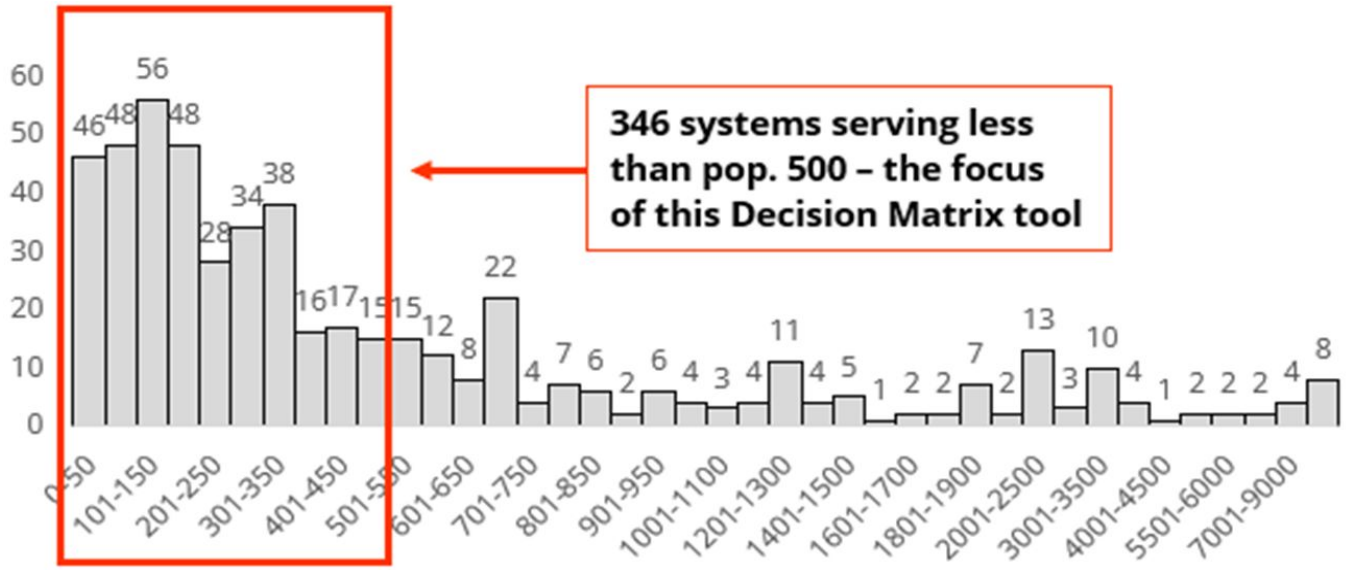
Overview

1. **Challenges for Small Rural Drinking Water Systems**
   - Boil Water Advisories (BWAs)
   - Drinking Water Quality Issues
   - Population and Demographic Changes
   - Economic Capacity
2. **Drinking Water Quality Improvement Initiative**
3. **Water Treatment and Service Delivery Matrix**
   - Purpose of Assessment Tool
   - User Inputs for Public Water Systems
   - Identification of Corrective Measures and Estimated Costs
   - Data Override Options
4. **Conclusions**
5. **Remaining Challenges**

Newfoundland & Labrador

Challenges for Small Rural Drinking Water Systems

- Approximately 471 public drinking water supplies owned/operated by 366 communities
  - Serve ~85% of province's population
  - ~70% service less than 500 people
  - ~35% service less than 100 people



- Small water systems are more likely to experience
  - BWAs
  - Challenging water quality issues
  - Issues retaining trained/certified operators

Newfoundland & Labrador

Boil Water Advisories (BWAs)

- As of March 31, 2025, there were 177 BWAs affecting 136 communities
  - 81% of these BWAs are for systems servicing ≤ 500 people
  - 78 (44%) BWAs are for municipalities and 99 (56%) are for Local Service Districts
  - 165 (93%) of BWAs are for non-microbiological reasons such as:
    - no disinfection system – 23 (13%)
    - system turned off – 20 (11%)
    - disinfection system broken - 20 (11%)
    - operational problems – 22 (12%)
    - issues with chlorine residual – 79 (45%)

Newfoundland & Labrador

Drinking Water Quality Issues in NL

Surface Water

- Aesthetic Parameters
  - Colour
  - Iron
  - Dissolved Organic Carbon (DOC)
  - Manganese*
  - Low pH
- Contaminant Parameters
  - Manganese*
  - Disinfection By-Products (THMs and HAAs)
  - Lead

Groundwater

- Aesthetic Parameters
  - Iron
  - Manganese*
- Contaminant Parameters
  - Manganese*
  - Arsenic
  - Lead
  - Uranium

*Manganese has both an aesthetic objective and maximum acceptable concentration

Newfoundland & Labrador

Population and Demographic Changesin NL

Population of NL is aging rapidly

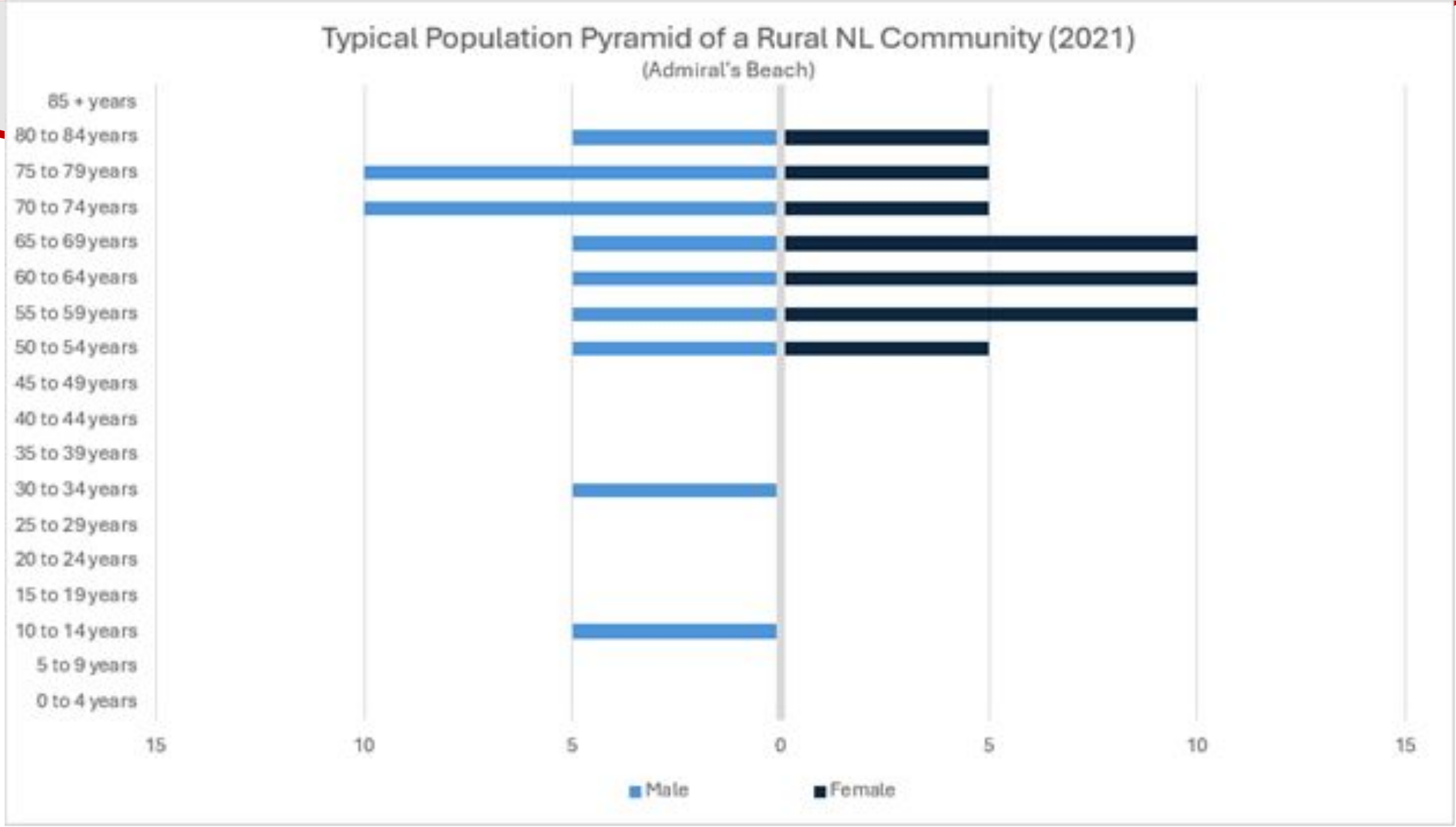
2021 – median age 48.4 years
2016 – median age 46 years
2011 – median age 44 years
1971 – median age 20.9 years

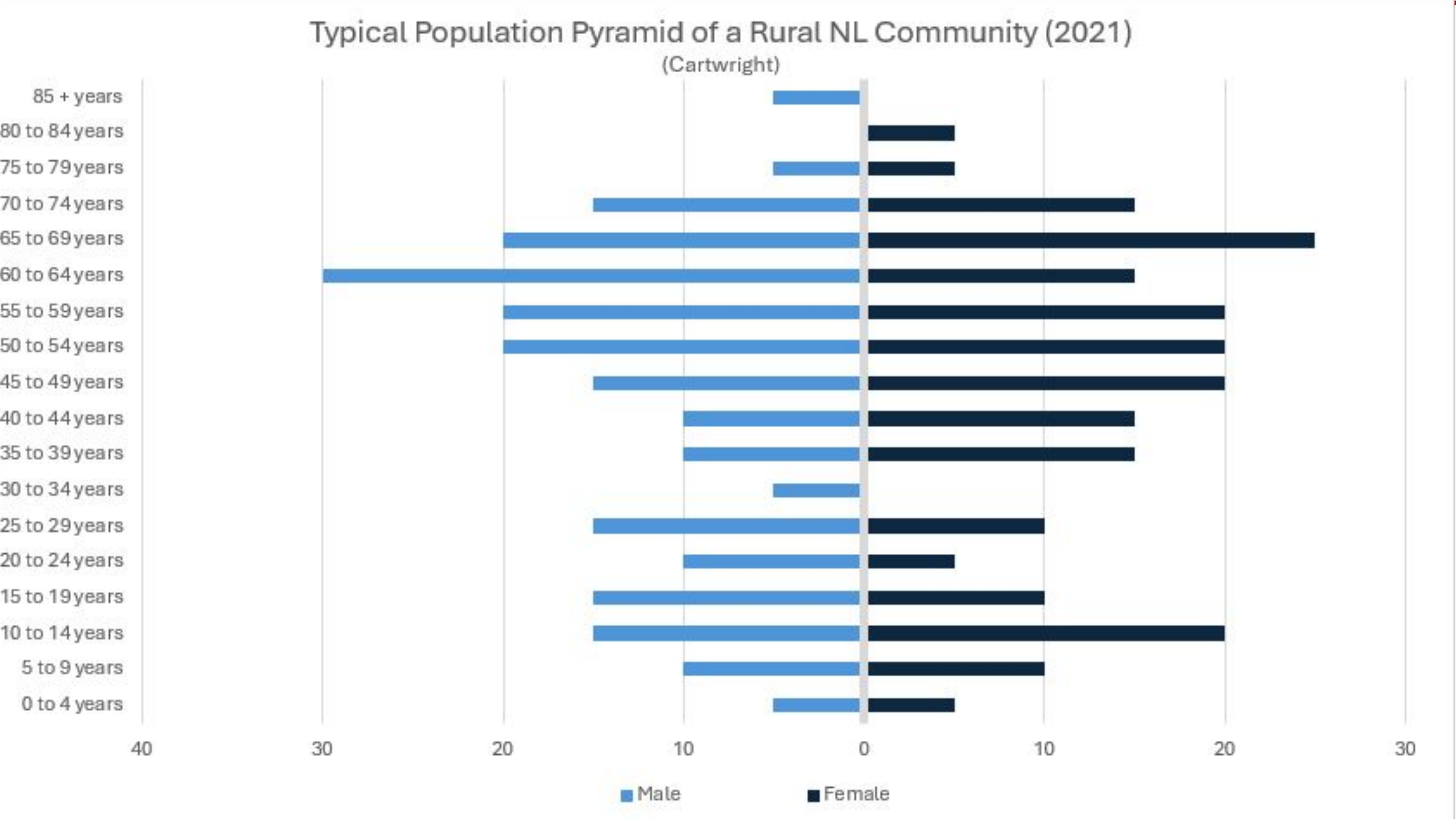
Geographic distribution of the population has changed with

Rural populations have declined

Urban populations have increased

In the 2021 census there was a population decline in 266 of the 372 communities included

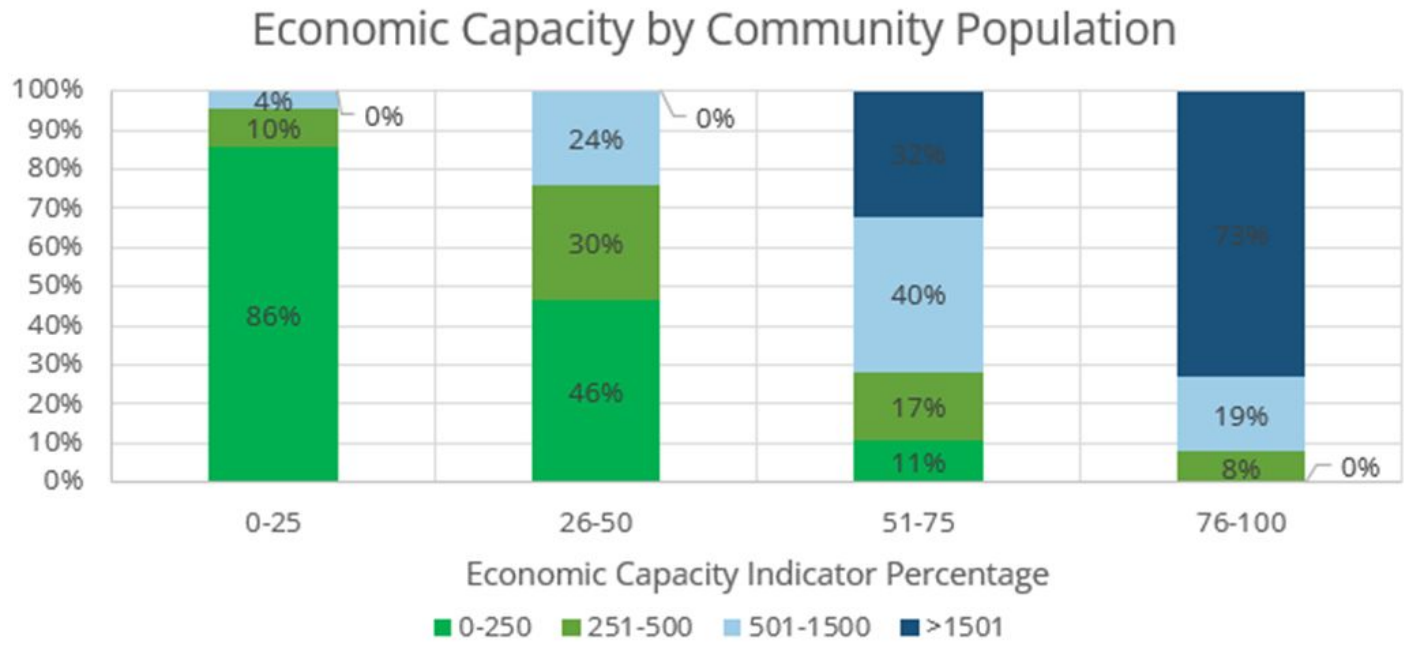

Typical Population Pyramid of a Rural NL Community (2021)
(Admiral's Beach)
85 + years
80 to 84 years
75 to 79 years
70 to 74 years
65 to 69 years
60 to 64 years
55 to 59 years
50 to 54 years
45 to 49 years
40 to 44 years
35 to 39 years
30 to 34 years
25 to 29 years
20 to 24 years
15 to 19 years
10 to 14 years
5 to 9 years
0 to 4 years
15
10
5
0
5
10
15
Male
Female


Typical Population Pyramid of a Rural NL Community (2021)
(Cartwright)
85 + years
80 to 84 years
75 to 79 years
70 to 74 years
65 to 69 years
60 to 64 years
55 to 59 years
50 to 54 years
45 to 49 years
40 to 44 years
35 to 39 years
30 to 34 years
25 to 29 years
20 to 24 years
15 to 19 years
10 to 14 years
5 to 9 years
0 to 4 years
40
30
20
10
0
10
20
30
Male
Female

Economic Capacity and Population Size

Economic capacity varies across different community sizes:

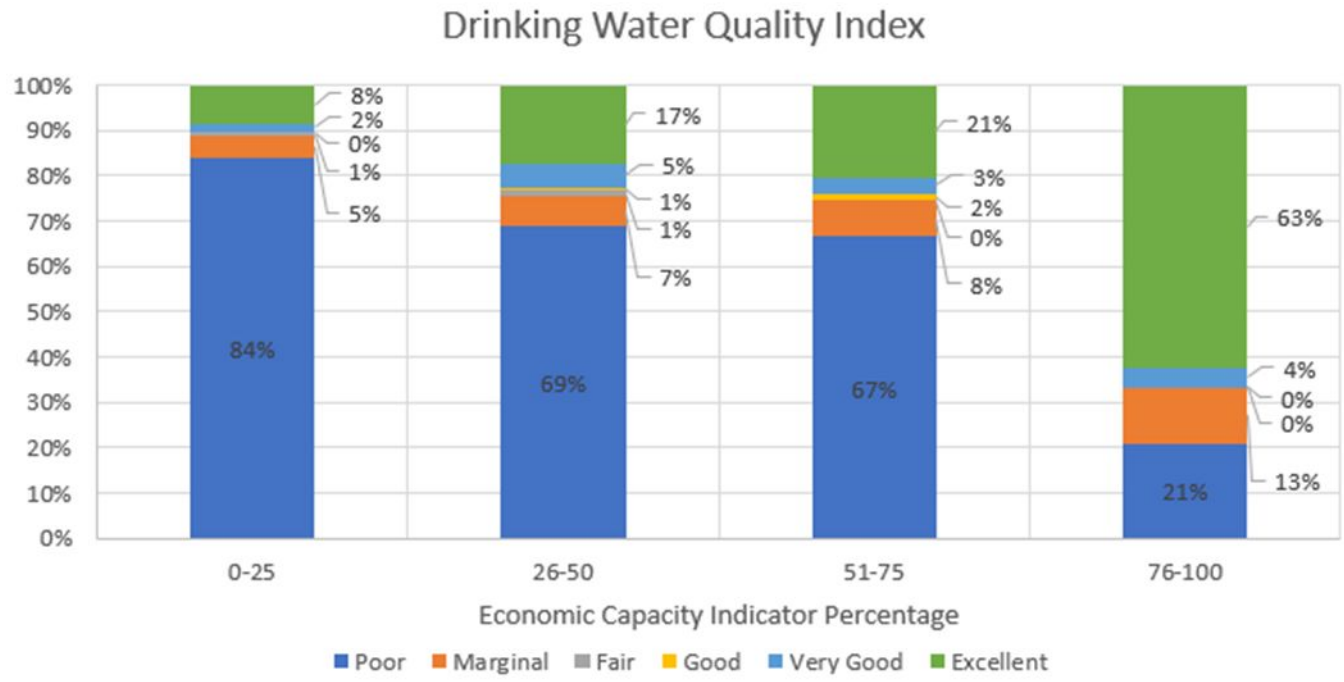
- Smaller communities (0–250) tend to have lower economic capacity, while
- Larger communities (501-1500 and >1500) generally have higher economic capacity
- This suggests that population size may be correlated with economic resources and capacity



Newfoundland & Labrador

Economic Capacity and Water Quality

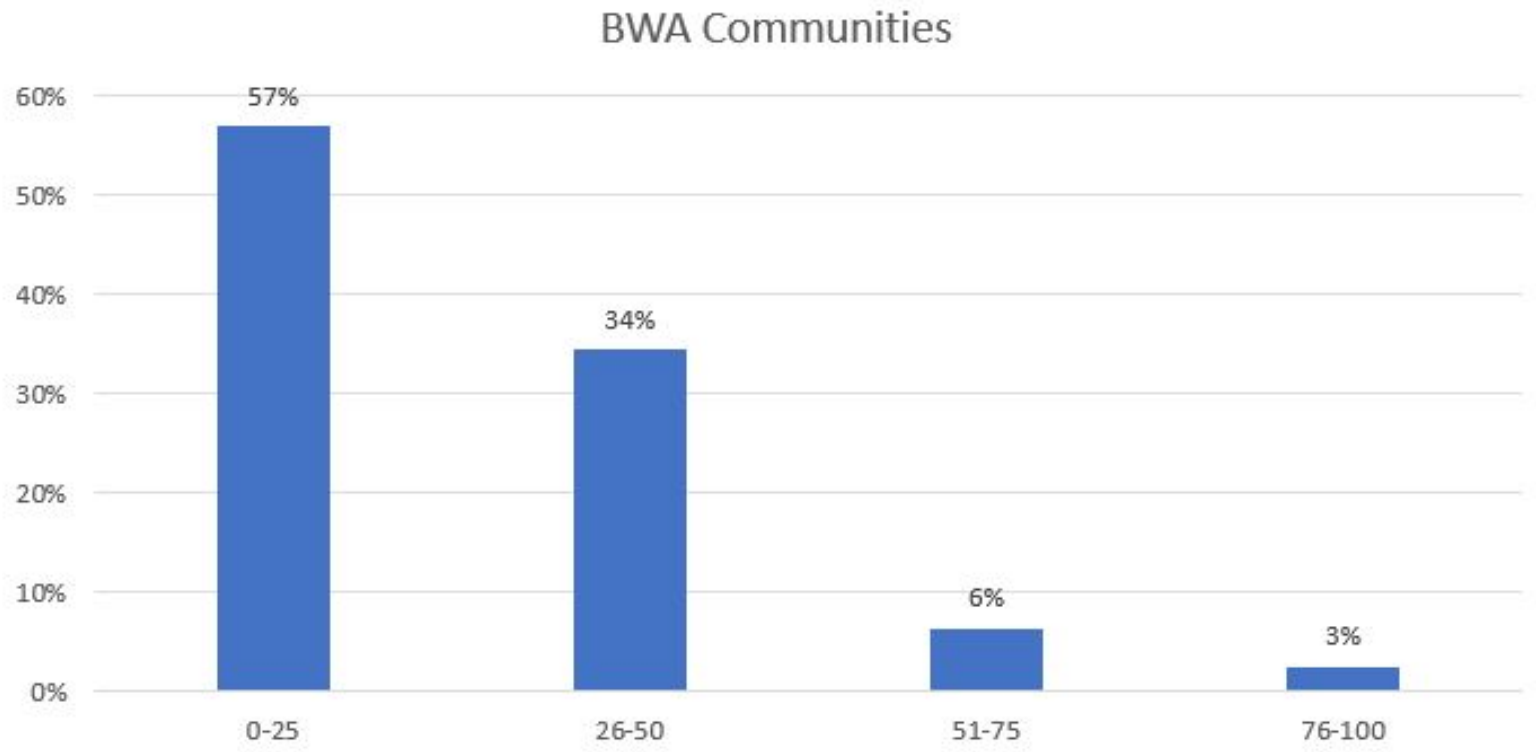
- For top category of the Economic Capacity Indicator (76-100%) most drinking systems were rated as Excellent according to the Drinking Water Quality Index
- The percentage of water systems ranked as excellent decreases with decreasing economic capacity



Newfoundland & Labrador

Economic Capacity and Water Quality

- Number of BWAs decreases and economic capacity increases
- Majority of BWAs (57%) are for communities within the bottom category (0-25) of the Economic Capacity Indicator



Newfoundland & Labrador

Drinking Water Quality Improvement Initiative

- April 2015: Government of NL announced a new Community Sustainability Partnership, one of the capacity supports was related to the improvement of drinking water quality (BWA Reduction Initiative / DWQ Improvement Initiative)
- Annual budget of $180,000 with work being undertaken by external consultants
- 18 projects have been undertaken as part of this initiative, past projects include:
  - Development of Standard Operating Procedure (SOPs) for the removal of BWAs
  - Development of Full Cost Accounting Assessment Tool (FCAT) & subsequent updates
  - Implementation of BWA SOPs and FCAT with pilot communities
  - Development and Delivery BWA Workshops and Mentoring of Communities
  - Mentoring Program for Public Drinking Water System with Contaminant Exceedances
  - Study on BWA Reduction Using Regionalization of Public Drinking Water Systems
  - Saltwater Intrusion Vulnerability in Private, Semi-public, and Public Wells in NL

Newfoundland & Labrador

Water Treatment and Service Delivery Decision Matrix

In 2024 CBCL Limited were contracted to undertake the development of a Water Treatment and Service Delivery Decision Matrix, tasks included:

- Assessment of historical water quality and identification of key issues based on source water type, serviced populations, fiscal indicators, etc.
- Jurisdictional scan of water treatment alternatives (conventional and alternative) used by others with similar water quality issues and demographics
- Jurisdictional scan of water service delivery options for small communities (<500 people)
- Investigation of existing training tools and resources to assist small rural communities
- Development of an Excel-based assessment tool that could be used by small communities to assist in decision making regarding drinking water quality and treatment options

Newfoundland & Labrador

Purpose of Assessment Tool

- Purpose of assessment tool is to identify water quality parameters of concern and an initial screening of potential corrective measures
  - Raw and treated water quality data from every public drinking water system was organized into a database of average and maximum values
  - Tool uses the water quality data and population serviced to determine appropriate corrective measures to improve water quality
  - Tool provides a description of the corrective measures, as well as estimated capital and annual operational cost
- Assessment tool is an Excel-based database
  - **Sheet 1) Description** – provides an overview of assessment tool
  - **Sheet 2) Instructions** – provides step-by-step user instructions

Newfoundland & Labrador

Assessment Tool User Input for Public Water Systems

Water Treatment and Service Delivery Assessment Tool Description:

Community:	Admirals Beach
Supply Name:	2 Well Fields
WS Number:	WS-G-0001
Water Source:	Groundwater
Population:	153
Population (Override):	

- On **Sheet 3) Assessment Tool**, the user selects Community and Supply Name from dropdown lists
- The WS Number, Water Source, and Population cells are populated automatically

Newfoundland & Labrador

Sheet 3) Assessment Tool

- Raw (source) and tap water quality cells will be automatically populated
  - Average and maximum values for key parameters
- Exceedance of MAC in red bold font
- Exceedance of AO in blue bold font

Raw Water Quality:	Average	Maximum	Unit
Turbidity	0.29	0.48	NTU
Colour	3.25	19.00	TCU
Alkalinity	107.3	121	mg/L
pH	8.17	8.25	
Hardness	113.50	130.00	mg/L
Iron	0.006	0.050	mg/L
Manganese	0.028	0.090	mg/L
Copper	0.012	0.068	mg/L
Sulphate	14.43	28.00	mg/L
DOC	1.03	2.7	mg/L
TDS	152.4	204.0	mg/L

Treated Water Quality:	Average	Maximum	Unit
Turbidity	0.36	**1.90**	NTU
Colour	10.41	**20.00**	TCU
Alkalinity	105.5	122.0	mg/L
pH	8.15	8.38	
Hardness	99.06	113.00	mg/L
Iron	0.000	0.000	mg/L
Manganese	0.009	**0.060**	mg/L
Copper	0.083	0.26	mg/L
Lead	0.000	0.001	mg/L
Arsenic	0.002	0.004	mg/L
Sulphate	9.91	15.00	mg/L
DOC	2.06	4.00	mg/L
TDS	166.4	181.0	mg/L
Trihalomethanes (THM)	0.000	0.000	mg/L
Haloacetic Acid (HAA)	0.000	0.000	mg/L

Sheet 3) Assessment Tool

Full view of all information included on **Sheet 3) Assessment Tool**

Water Treatment and Service Delivery Assessment Tool Description:

Community:	Admirals Beach
Supply Name:	2 Well Fields
WS Number:	WS-G-0001
Water Source:	Groundwater
Population:	153
Population (Overri	

Raw Water Quality:	Average	Maximum	Unit
Turbidity	0.29	0.48	NTU
Colour	3.25	19.00	TCU
Alkalinity	107.3	121	mg/L
pH	8.17	8.25	
Hardness	113.50	130.00	mg/L
Iron	0.006	0.050	mg/L
Manganese	0.028	0.090	mg/L
Copper	0.012	0.068	mg/L
Sulphate	14.43	28.00	mg/L
DOC	1.03	2.7	mg/L
TDS	152.4	204.0	mg/L

Treated Water Qua	Average	Maximum	Unit
Turbidity	0.36	**1.90**	NTU
Colour	10.41	**20.00**	TCU
Alkalinity	105.5	122.0	mg/L
pH	8.15	8.38	
Hardness	99.06	113.00	mg/L
Iron	0.000	0.000	mg/L
Manganese	0.009	**0.060**	mg/L
Copper	0.083	0.26	mg/L
Lead	0.000	0.001	mg/L
Arsenic	0.002	0.004	mg/L
Sulphate	9.91	15.00	mg/L
DOC	2.06	4.00	mg/L
TDS	166.4	181.0	mg/L
Trihalomethanes (THM	0.000	0.000	mg/L
Haloacetic Acid (HAA)	0.000	0.000	mg/L

Key Water Quality Guidelines

Parameter	Value	Unit
Turbidity	**1.0**	NTU
Colour	15.0	TCU
pH	<7.0 or >10.5	
Iron	0.10	mg/L
Manganese	0.02/**0.12**	mg/L
Copper	**1.00**	mg/L
Lead	**0.005**	mg/L
Arsenic	**0.005**	mg/L
Sulphate	500.0	mg/L
TDS	500.0	mg/L
THM's	**0.10**	mg/L
HAA's	**0.08**	mg/L

Legend

Bold Red	Exceedance of Maximum Acceptable Concentration (MAC)
Bold Blue	Exceedance of Aesthetic Objective (AO) Limit

Water Quality Sample (Override

Parameter	Value	Unit
Turbidity		NTU
Colour		TCU
Alkalinity		mg/L
pH		
Hardness		mg/L
Iron		mg/L
Manganese		mg/L
Copper		mg/L
Lead		mg/L
Arsenic		mg/L
Sulphate		mg/L
DOC		mg/L
TDS		mg/L
THM's		mg/L
HAA's		mg/L

Identification of Corrective Measures

- **Sheet 4)** Identifies the parameters of concern (target) based on source and tap water quality data
- Provides links to technical documents from Health Canada for specific parameters

Target Water Quality Parameters	
Organics (NOM, DOC)	Non Target
Manganese	Target
Lead	Non Target
Arsenic	Non Target
Iron	Non Target
Hardness	Non Target
pH	Non Target
Turbidity	Non Target
DBPs (THM & HAA)	Non Target

Resources	
Health Canada Organic Matter (2020)	
GCDWQ Manganese (2019)	
GCDWQ Lead (2019)	
GCDWQ Arsenic (2006)	
GCDWQ Iron (2024)	
GCDWQ Hardness (1979)	
GCDWQ pH (2015)	
GCDWQ Turbidity (2012)	
GCDWQ THMs (2006)	GCDWQ HAAs (2008)

Newfoundland & Labrador

Identification of Corrective Measures

- **Sheet 4)** Identifies the appropriate corrective measures (CM) based on water quality and population
  - Valid CM in green font
  - Invalid CM in red font
- Includes centralized and de-centralized options

Centralized Corrective Measures (CM)	
New Source(s)	Valid CM
Conventional Treatment	Invalid CM
Membrane Treatment	Valid CM
Slow Sand Filtration	Valid CM
Ion Exchange	Valid CM
Adsorption	Invalid CM
Chemical Disinfection	Valid CM
Oxidative Media	Valid CM
Bank Filtration	Invalid CM
pH Adjustment	Invalid CM
Corrosion Inhibitor	Invalid CM
Pressure Filters	Invalid CM

De-Centralized Corrective Measures (CM)	
PWDU	Valid CM
POE Water Softeners	Invalid CM
POE Particulate Filters	Valid CM
POE Sacrificial Media Filter	Invalid CM
POE Reverse Osmosis	Valid CM
POE Oxidative Media	Valid CM
POU Under Sink RO	Valid CM
POU Activated Carbon Filters	Invalid CM
POU UV System	Valid CM
POU Ultrafiltration	Valid CM
Trucked Water	Valid CM

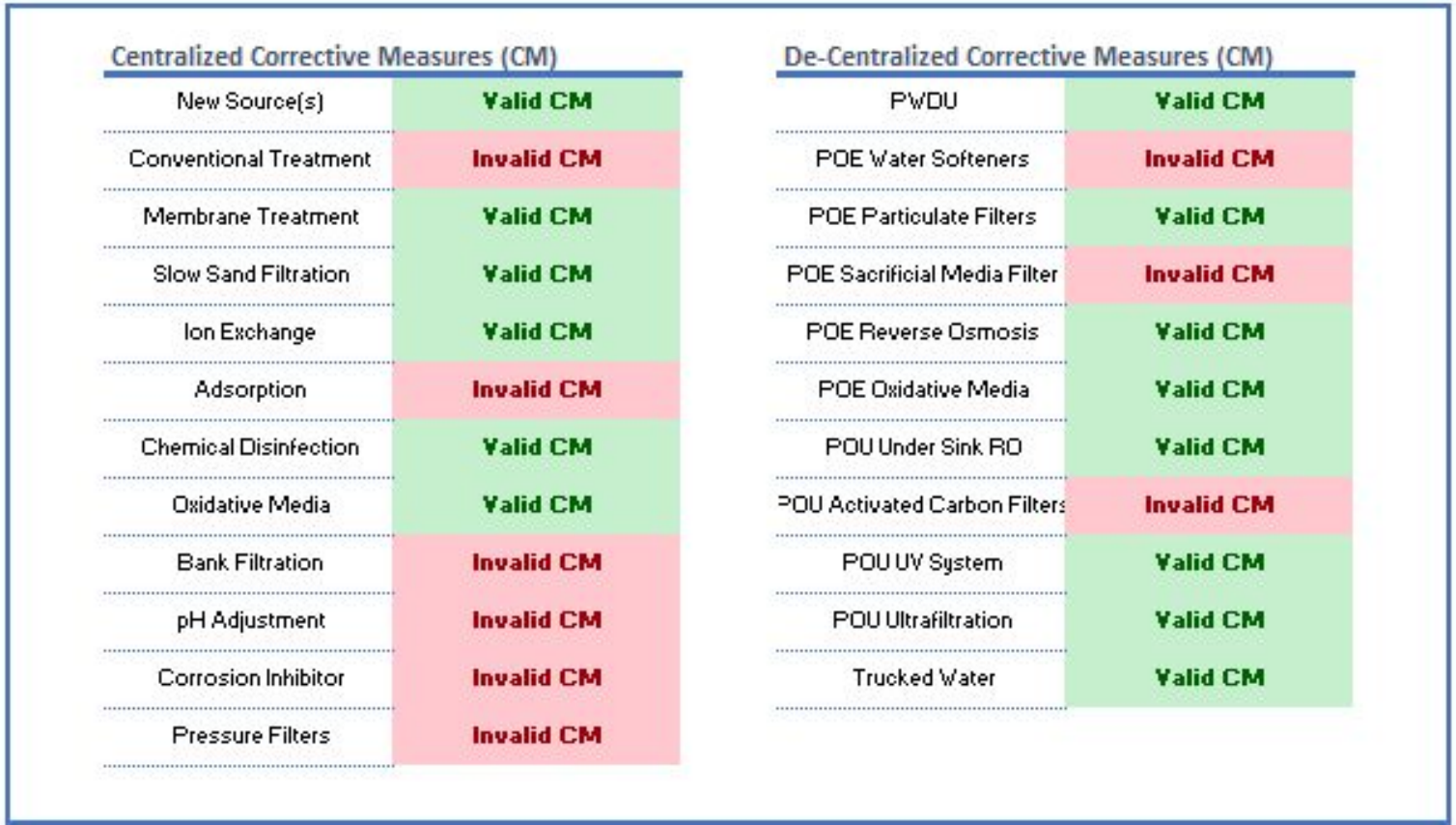
Identification of Corrective Measures

Full view of information included on **Sheet 4) Corrective Measures**

Target Water Quality Parameters	
Organics (NOM, DOC)	Non Target
Manganese	Target
Lead	Non Target
Arsenic	Non Target
Iron	Non Target
Hardness	Non Target
pH	Non Target
Turbidity	Non Target
DBPs (THM & HAA)	Non Target

Resources

- Health Canada Organic Matter (2020)
- GCDWQ Manganese (2019)
- GCDWQ Lead (2019)
- GCDWQ Arsenic (2006)
- GCDWQ Iron (2024)
- GCDWQ Hardness (1979)
- GCDWQ pH (2015)
- GCDWQ Turbidity (2012)
- GCDWQ THMs (2006)
- GCDWQ HAAs (2008)



Centralized Corrective Measures (CM)	
New Source(s)	Valid CM
Conventional Treatment	Invalid CM
Membrane Treatment	Valid CM
Slow Sand Filtration	Valid CM
Ion Exchange	Valid CM
Adsorption	Invalid CM
Chemical Disinfection	Valid CM
Oxidative Media	Valid CM
Bank Filtration	Invalid CM
pH Adjustment	Invalid CM
Corrosion Inhibitor	Invalid CM
Pressure Filters	Invalid CM

De-Centralized Corrective Measures (CM)	
PWDU	Valid CM
POE Water Softeners	Invalid CM
POE Particulate Filters	Valid CM
POE Sacrificial Media Filter	Invalid CM
POE Reverse Osmosis	Valid CM
POE Oxidative Media	Valid CM
POU Under Sink RO	Valid CM
POU Activated Carbon Filters	Invalid CM
POU UV System	Valid CM
POU Ultrafiltration	Valid CM
Trucked Water	Valid CM

Identification of Corrective Measures Decentralized Options

Pros

- Cost effective
- Accessibility to advanced treatment techniques
- Ease of implementation
- Availability of treatment technology in NL

Cons

- Maintenance requirements
- Treatment systems located on private property
- Community acceptance
- Regulatory acceptance

Newfoundland & Labrador

Identification of Centralized Corrective Measures and Estimated Costs

- **Sheet 5)** Provides a description of the centralized corrective measures – treatment options
- Provides estimated capital cost and annual operating cost for each option; cost will be impacted by population

Valid CM?	Corrective Measure	Description	Estimated Capital Cost	Estimated Annual Operational Cost
Valid CM	New Source(s)	This corrective measure involves finding a new surface water source or drilling new source wells that produce drinking water with improved water quality. For surface water sources, a long-term water quality assessment will need to be conducted to determine if the source will provide improved drinking water quality. For groundwater sources, a hydrogeological assessment in tandem with test well sampling could identify possible locations for new wells in a community. This method has the possibility to resolve various water quality issues in drinking water but may result in new drinking water problems	$112,000	$54,000
Invalid CM	Conventional Treatment	Conventional WTPs have been proven to be a robust and reliable treatment method in various jurisdictions. The principal of the conventional water treatment process is the use of coagulation and flocculation to precipitate organics, metals and other contaminants from the water. Coagulation and flocculation conditions water quality parameters for removal in subsequent clarification and filtration process units. Coagulants are chemicals that can be added to water to promote dissolved and colloidal species to agglomerate into larger particles known as flocs. These flocs are often removed in a clarification step, which may be based on gravity or buoyancy. The clarified water is then filtered through sand media filters to remove any remaining flocs.	$3,213,000	$153,000

Centralized Corrective Measures

Centralized corrective measures considered in the assessment tool include:

- New sources
- Conventional treatment
- Membrane treatment
- Slow sand filtration
- Ion exchange
- Adsorption (filter media)
- Chemical disinfection
- Oxidative media
- Bank filtration
- pH adjustment
- Corrosion inhibitor

Identification of De-Centralized Corrective Measures and Estimated Costs

- **Sheet 6)** Provides a description of the de-centralized corrective measures – treatment options and service delivery
- Provides estimated costs:
  - total capital cost and total annual operating cost
  - estimated unit cost and estimated unit annual operational costs

Valid CM?	Corrective Measure	Description	Estimated Unit Cost	Estimated Unit Annual Operational Cost	Estimated Total Capital Cost	Estimated Total Annual Operational Cost
Valid CM	Potable Water Dispensing Unit (PWDU)	Potable water dispensing units, abbreviated as PWDU's, are decentralized drinking water treatment systems that are designed to treat the consumptive fraction of a community's water demand. PWDU are intended to provide high quality drinking water that is only used for consumptive uses (drinking, cooking, baby formula, etc.). As such, water for nonconsumptive uses (showering, toilet, laundry) needs to be supplied from a different drinking water system (centralized distribution or private supply). The treated water from a PWDU is not connected to a centralized distribution system. PWDU's are typically constructed in a standalone building that contains the treatment system and an on site storage tank. The high-quality drinking water produced by a PWDU requires manual collection or a bottle delivery service for consumers to obtain the water. A PWDU can make advanced treatment technologies used in full scale water treatment plants, available to small communities with reduced financial capacity and technical expertise.	$4,255	$183	$651,000	$28,000
Invalid CM	POE Water Softeners	Particulate filters are a POE treatment system that consist of a sand media in an automatic backwashing media tank. The sand media in the particulate filters is designed to trap particulate matter and reduce the turbidity of the source water. Particulate filters are typically run in tandem with other treatment alternatives (oxidative media filters, ion exchange, etc.) when there is elevated turbidity and elevated concentrations of other problematic water quality parameters. The benefit of particulate filters in the configuration will reduce turbidity from a source water, which will generally help to improve the performance/efficiency of the subsequent treatment alternative.	$1,750	$125	$122,000	$8,600

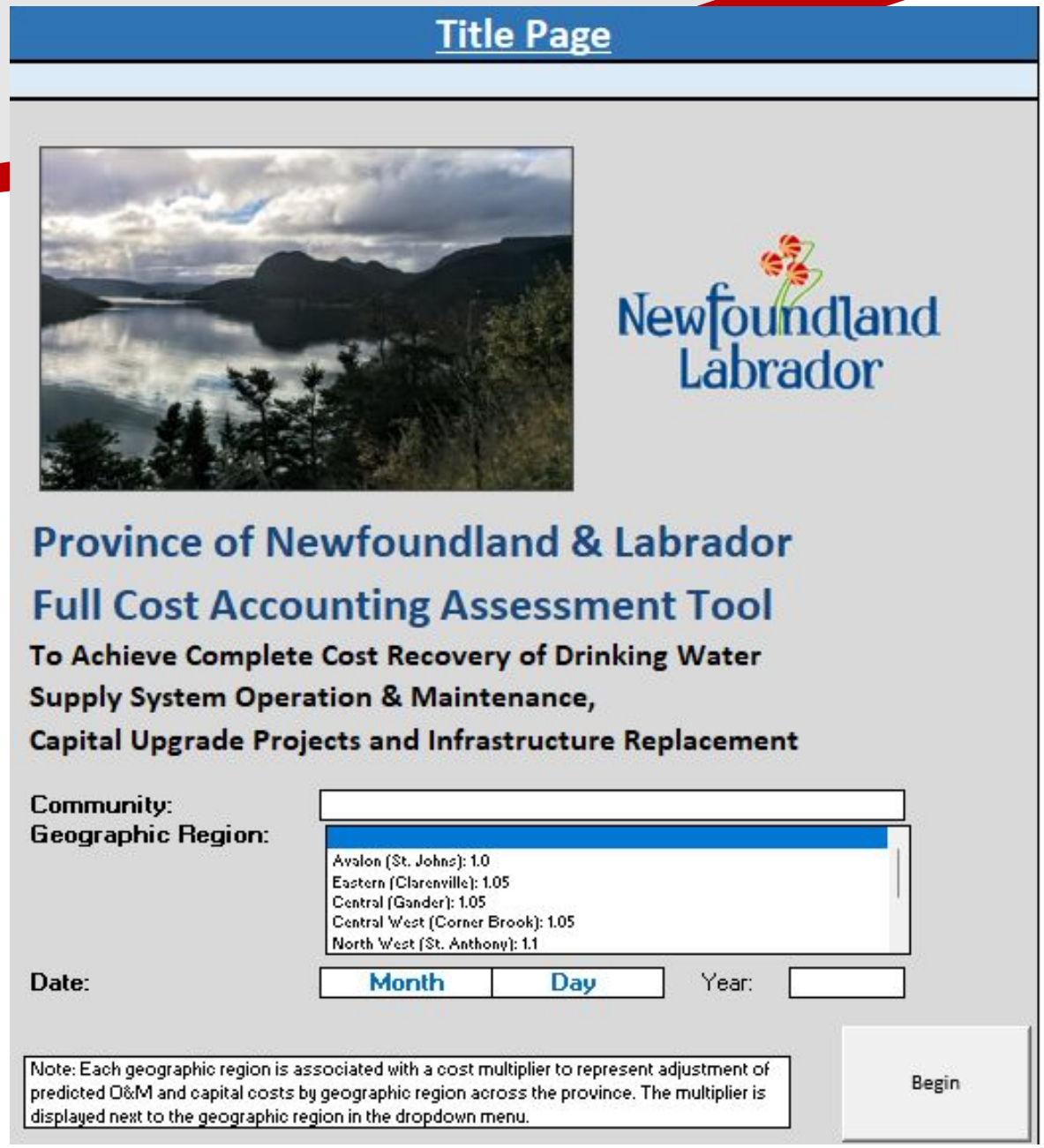
De-Centralized Corrective Measures

De-Centralized corrective measures considered in the assessment tool include:

- Potable Water Dispensing Unit (PWDU)
- POE Water Softeners
- POE Particulate Filters
- POE Sacrificial Media Filter
- POE Reverse Osmosis
- POU Reverse Osmosis
- POU Activated Carbon Filters
- POU UV Disinfection System
- POU Ultrafiltration (membrane filters)
- Trucked Water

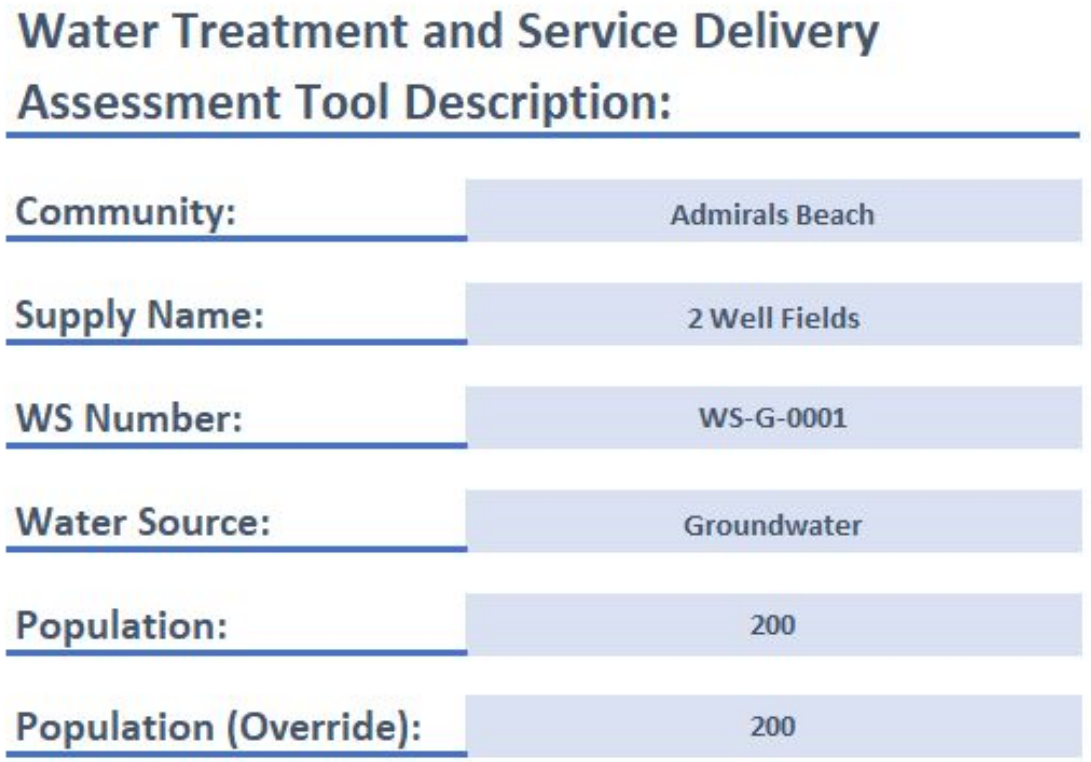
Estimated Costing Data

- Estimated costs from the assessment tool should not be used for capital budgets or funding applications but serve solely as an approximate guideline
- Water system owners can use the Full Cost Accounting Assessment Tool
  - More comprehensive cost assessment
  - Recommended annual water fee to achieve full cost recovery



Assessment Tool - Override Data Options

- User can override the population that is automatically entered by entering a value on Sheet 3) Assessment Tool in the Population (Override) cell
- Population may impact corrective measures and costs
- To return to automatically entered population, user can delete the value entered in the Population (Override) cell



Water Treatment and Service Delivery Assessment Tool Description:	
Community:	Admirals Beach
Supply Name:	2 Well Fields
WS Number:	WS-G-0001
Water Source:	Groundwater
Population:	200
Population (Override):	200

Assessment Tool - Override Data Options

User can override water quality data by entering values in the override cells provided

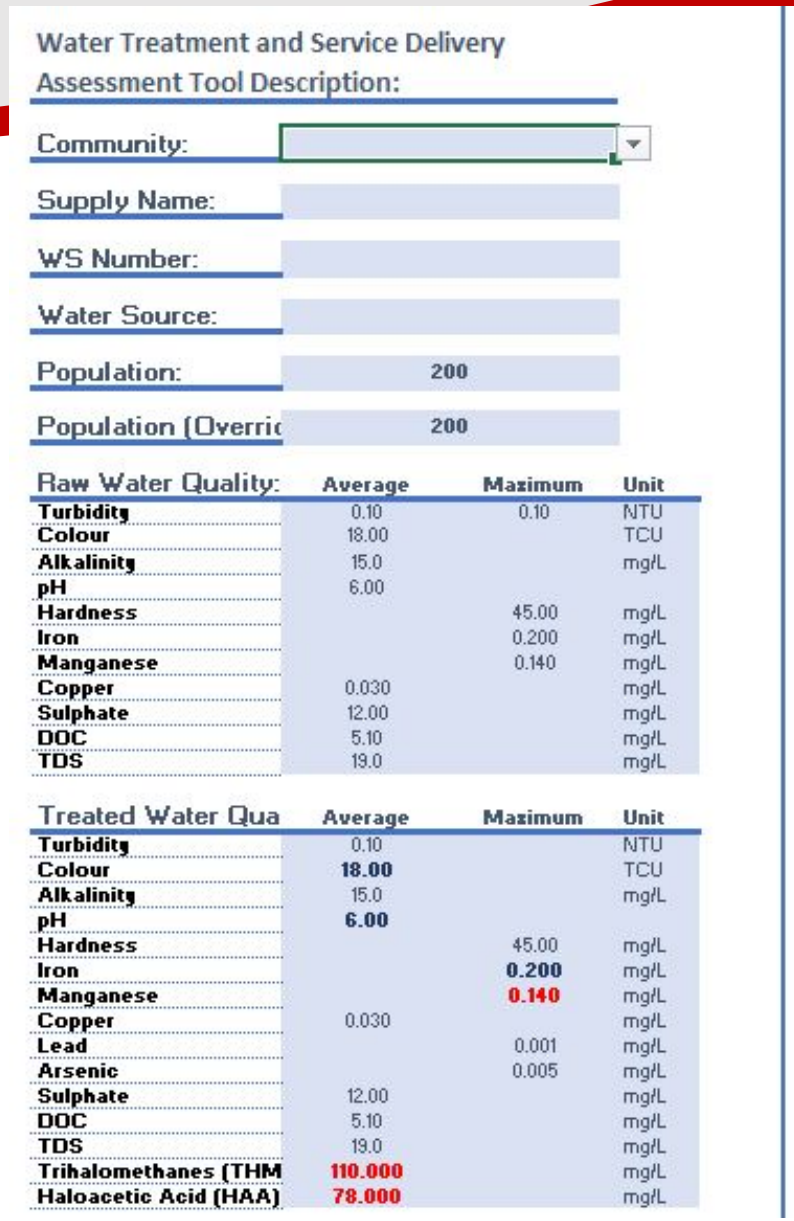
- Override values will then automatically appear in the raw and treated water quality cells
- Override values will be used to identify appropriate corrective measures and estimated costs

Water Quality Sample (Override)

Parameter	Value	Unit
Turbidity		NTU
Colour		TCU
Alkalinity		mg/L
pH		
Hardness		mg/L
Iron		mg/L
Manganese		mg/L
Copper		mg/L
Lead		mg/L
Arsenic		mg/L
Sulphate		mg/L
DOC		mg/L
TDS		mg/L
THM's		mg/L
HAA's		mg/L

Assessment Tool – Override Data Options

- The assessment tool can be used by owners of private or semi-public systems
- Leave Community and Supply Name cells blank
- Enter a value in Population (Override) cell
- Enter water quality data in Water Quality Sample (Override) cells



Water Treatment and Service Delivery

Assessment Tool Description:

Community:	
Supply Name:	
WS Number:	
Water Source:	
Population:	200
Population (Overric	200

Raw Water Quality:	Average	Maximum	Unit
Turbidity	0.10	0.10	NTU
Colour	18.00		TCU
Alkalinity	15.0		mg/L
pH	6.00		
Hardness		45.00	mg/L
Iron		0.200	mg/L
Manganese		0.140	mg/L
Copper	0.030		mg/L
Sulphate	12.00		mg/L
DOC	5.10		mg/L
TDS	19.0		mg/L

Treated Water Qua	Average	Maximum	Unit
Turbidity	0.10		NTU
Colour	**18.00**		TCU
Alkalinity	15.0		mg/L
pH	**6.00**		
Hardness		45.00	mg/L
Iron		**0.200**	mg/L
Manganese		**0.140**	mg/L
Copper	0.030		mg/L
Lead		0.001	mg/L
Arsenic		0.005	mg/L
Sulphate	12.00		mg/L
DOC	5.10		mg/L
TDS	19.0		mg/L
Trihalomethanes (THM	**110.000**		mg/L
Haloacetic Acid (HAA)	**78.000**		mg/L

Legend

Bold Red	Exceedance of Maximum Acceptable Concentration (MAC)
Bold Blue	Exceedance of Aesthetic Objective (AO) Limit

Water Quality Sample (Override

Parameter	Value	Unit
Turbidity	0.1	NTU
Colour	18	TCU
Alkalinity	15	mg/L
pH	6	
Hardness	45	mg/L
Iron	0.2	mg/L
Manganese	0.14	mg/L
Copper	0.03	mg/L
Lead	0.001	mg/L
Arsenic	0.005	mg/L
Sulphate	12	mg/L
DOC	5.1	mg/L
TDS	19	mg/L
THM's	110	mg/L
HAA's	78	mg/L

Conclusions

- WT and Service Delivery Matrix is an easy-to-use assessment tool for small rural communities with a public water system
  - Could also be used by semi-private and private water system owners with water quality data
- Can be used as a planning tool for communities to make informed decisions regarding their drinking water systems
  - Water treatment infrastructure improvement planning
  - Budgetary planning
- Assessment tool identifies ***appropriate corrective measures*** based on site-specific water quality and population
- Government departments could use estimated cost data to plan future funding programs that target water quality improvement

Newfoundland & Labrador

Remaining Challenges

- Implementation of some decentralized corrective measures may require policy changes
  - Eligibility for funding programs (MCW or CCBF)
  - Water quality monitoring
  - Protocol for BWAs and NCAs
  - Operation and maintenance responsibilities (community or homeowner)
- Some communities may struggle with operation and maintenance of centralized water treatment systems
  - Financial and technical capacity issues
  - High water usage rates

Newfoundland & Labrador

Link to Water Treatment and Service Delivery Assessment Tool:
https://www.gov.nl.ca/ecc/waterres/drinkingwater/sopbwa/

dspracklin@gov.nl.ca

water@gov.nl.ca