



STUDY ON OPERATION AND MAINTENANCE OF DRINKING WATER INFRASTRUCTURE IN NL

Prepared for: Dept Environment & Conservation
Water Resources Management Division
Dept Municipal Affairs

Prepared by: Brian Luffman, P.Eng.
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1.1 Objectives

- ❖ Provide large scale and small scale overview of drinking water system O&M and the impacts on:
 - Existing drinking water infrastructure, and
 - Drinking water quality
- ❖ Review past history and trends of O&M practices related to drinking water quality
 - Municipal structure (Municipality or LSD)
 - Population ranges
 - Region (based on Dept Env & Cons divisions)
 - Water source (surface or groundwater)





1.1 Objectives

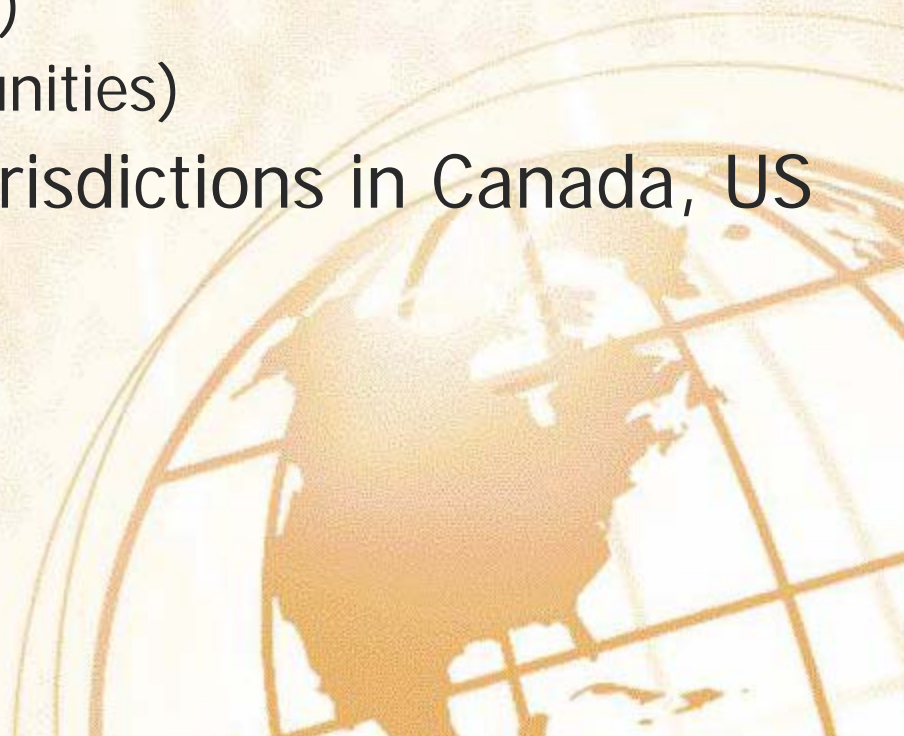
- ❖ Correlate water quality issues with O&M practices
- ❖ Examine financial side of O&M practices
 - Infrastructure funding
 - Community budget allocations
 - Water tax rates
 - Operator wages
- ❖ Identify challenges to improving O&M practices
- ❖ Identify other potential O&M management alternatives
- ❖ Recommend options to decrease gaps in O&M practices





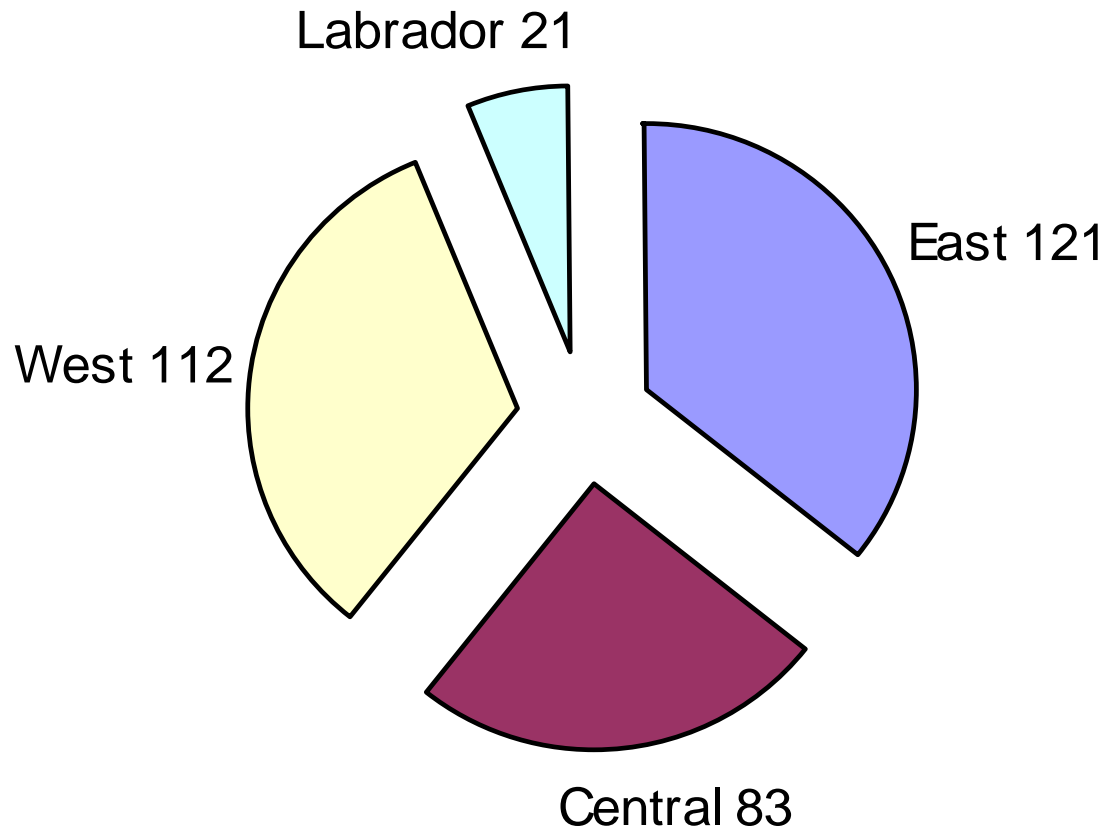
1.2 Information Sources

- ❖ Government of Newfoundland and Labrador reports and database information
- ❖ Survey responses from communities throughout NL
 - Total number of communities 364
 - Basic survey (73 responses)
 - Detailed survey (25 communities)
- ❖ Publications from other jurisdictions in Canada, US

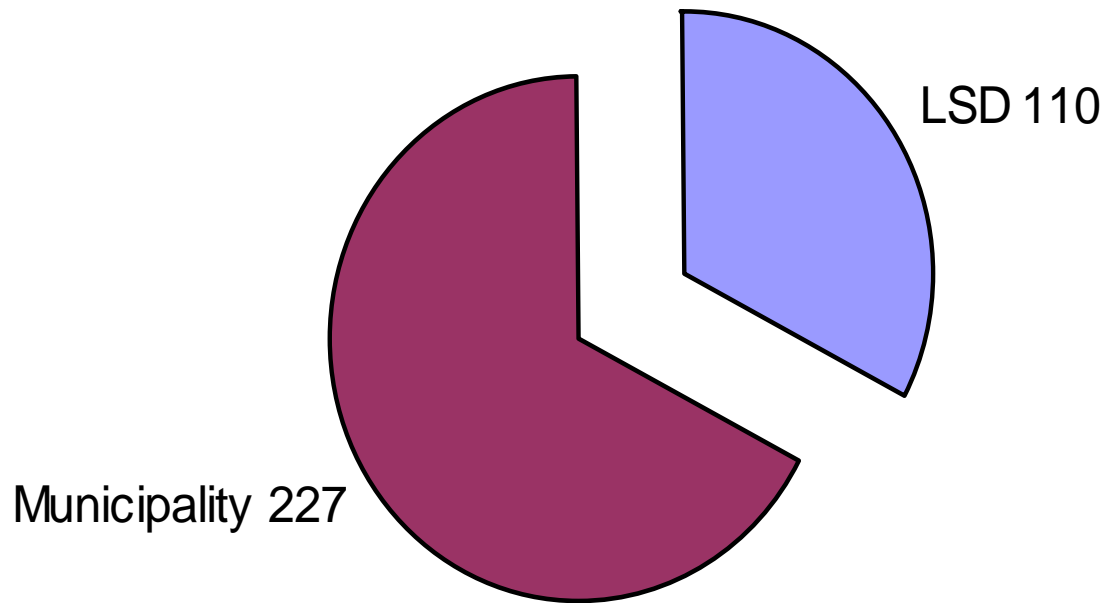




Region (ENVC)

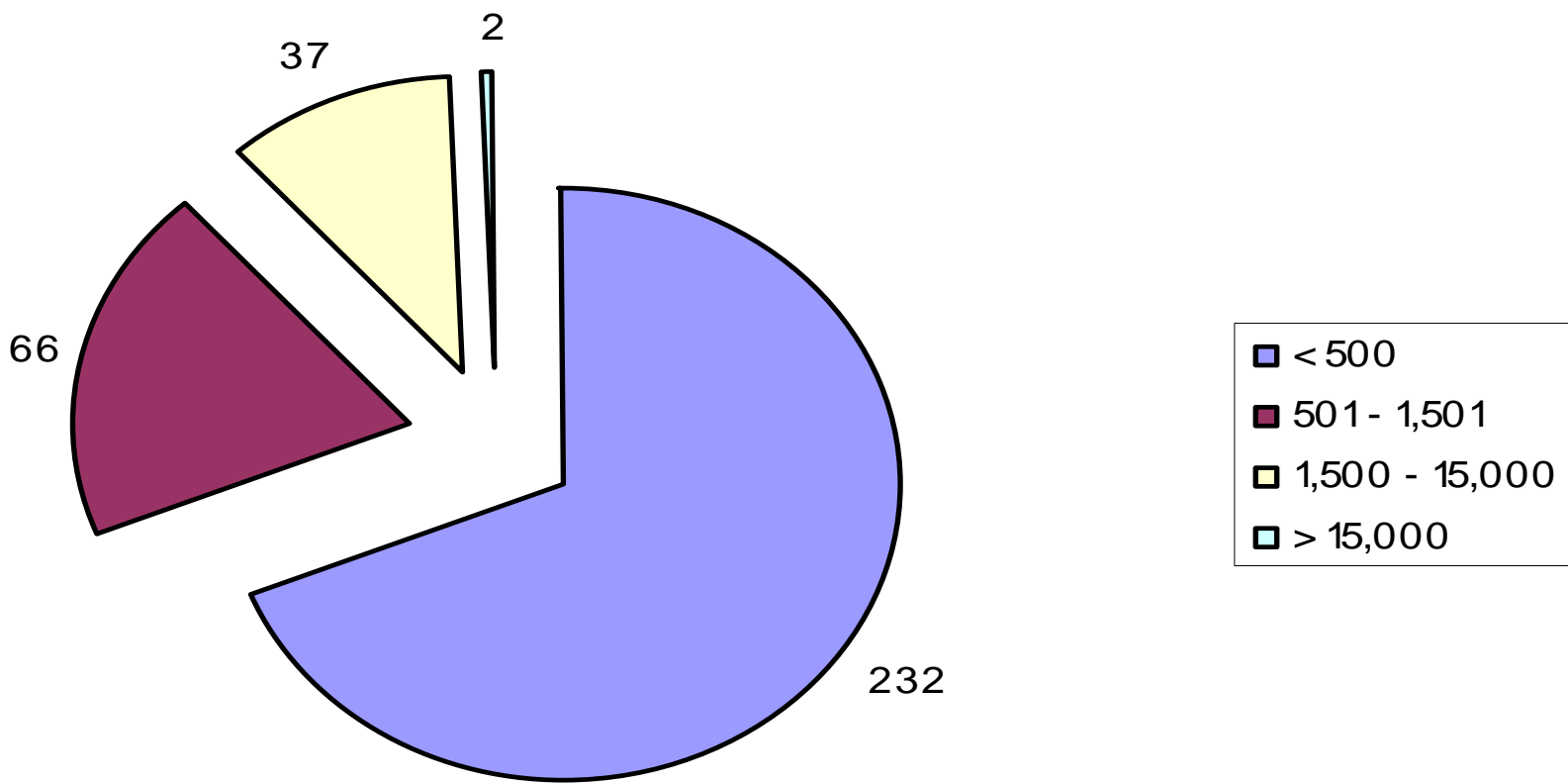


Municipal Structure



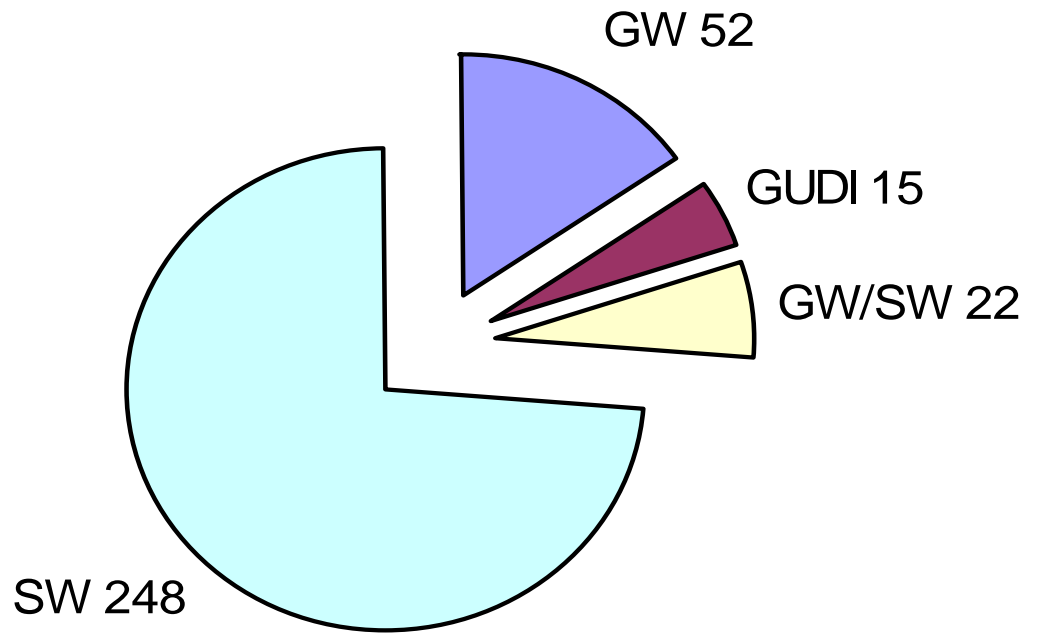


Population Ranges





Water Source



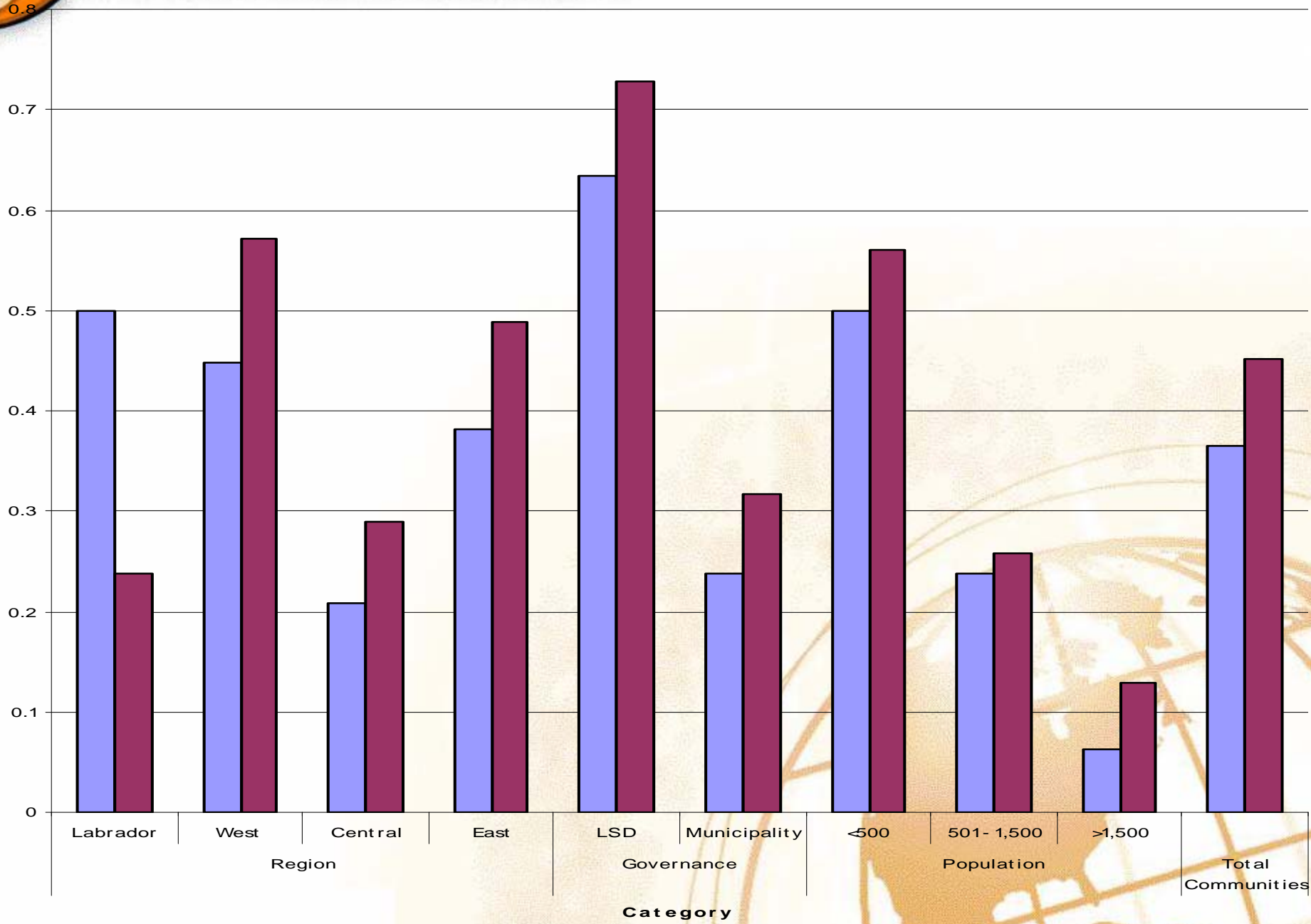
GW: Groundwater

SW: Surface water

GUDI: GW Direct Influence



CONESTOGA-ROVERS & ASSOCIATES

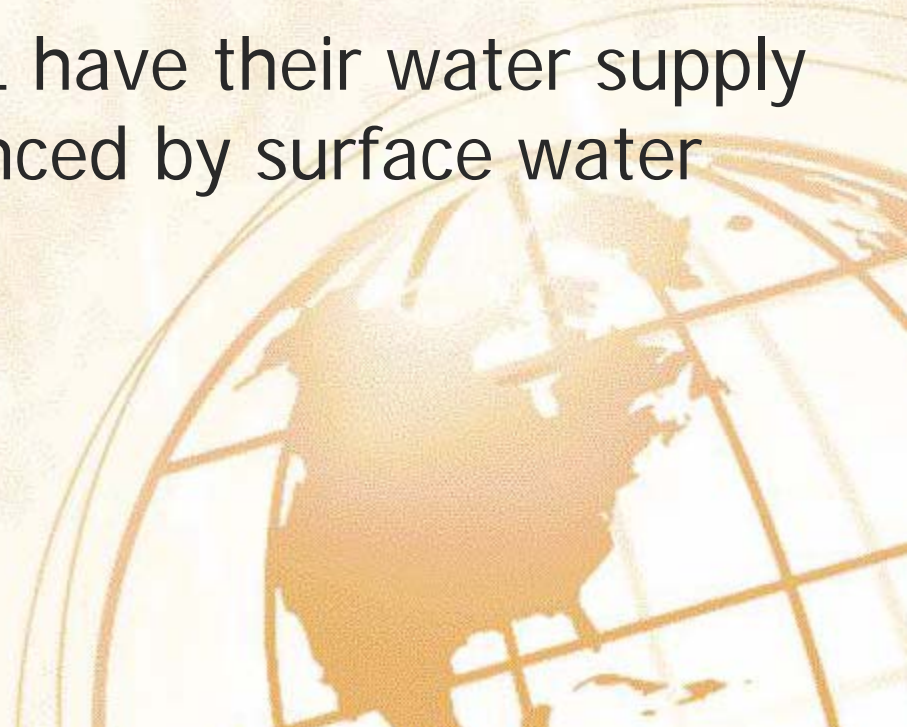


Legend: [Blue Box] Data Set 1, [Maroon Box] Data Set 2



2.1 Basic Info Noted from Study

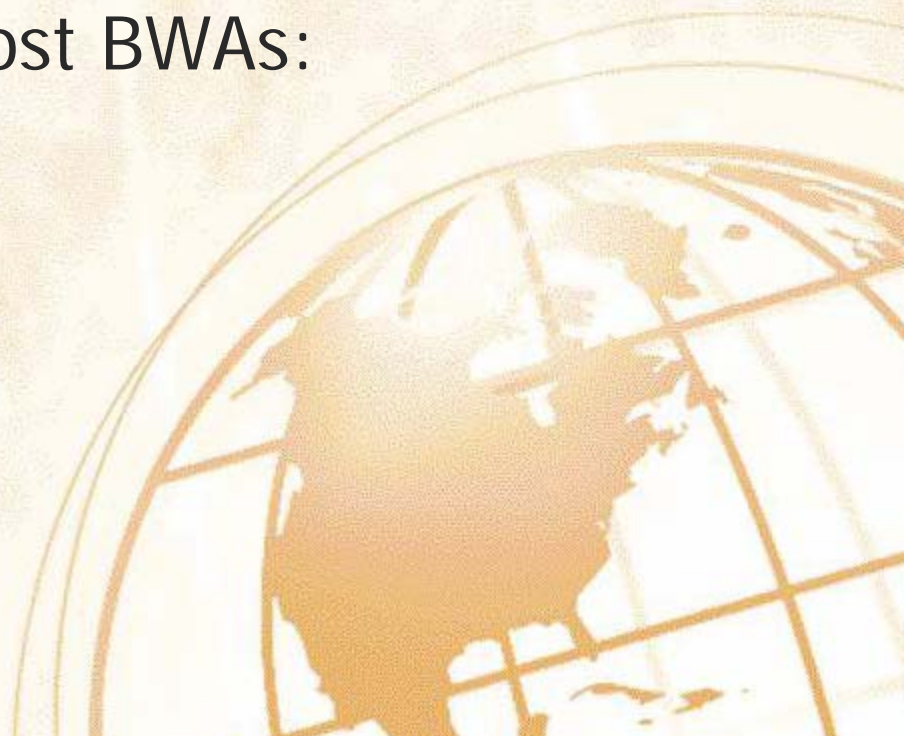
- ❖ 94% of communities are on island portion of NL
- ❖ 33% of communities in NL are LSDs
- ❖ 69% of communities in NL have population < 500
- ❖ 88% of communities in NL have population <1,500
- ❖ 85% of communities in NL have their water supply as surface water or influenced by surface water





2.1 Correlation of O&M Practices to Drinking Water Quality

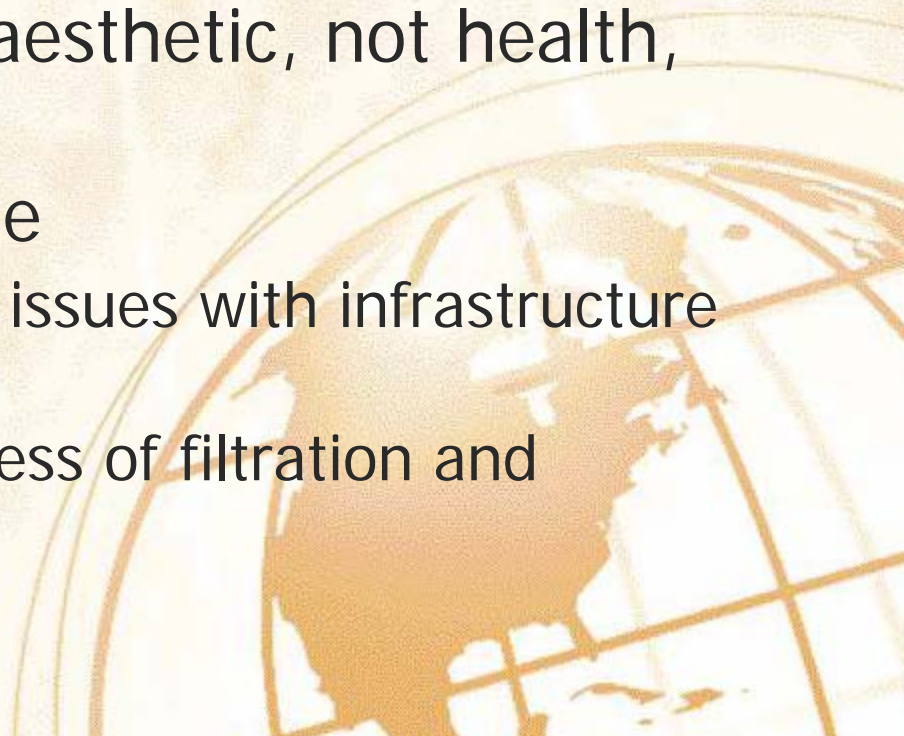
- ❖ BWAs account for most drinking water quality issues
- ❖ Systems most vulnerable to BWAs are LSDs with populations < 500 and surface water sources
- ❖ LSDs have more BWAs than Municipalities
- ❖ Factors contributing to most BWAs:
 - Poor O&M practices
 - Infrastructure
 - Operator training
 - Operator effort





2.2 Water Quality Chemistry

- ❖ Turbidity and colour common throughout NL surface water sources
 - May impact efficiency of disinfection
 - Increased chlorination may create disinfection by-products
- ❖ Iron and manganese are aesthetic, not health, concerns throughout NL
- ❖ pH is a province wide issue
 - Low pH causes operational issues with infrastructure and distribution systems
 - High pH reduces effectiveness of filtration and chlorination





2.3 Infrastructure & Equipment

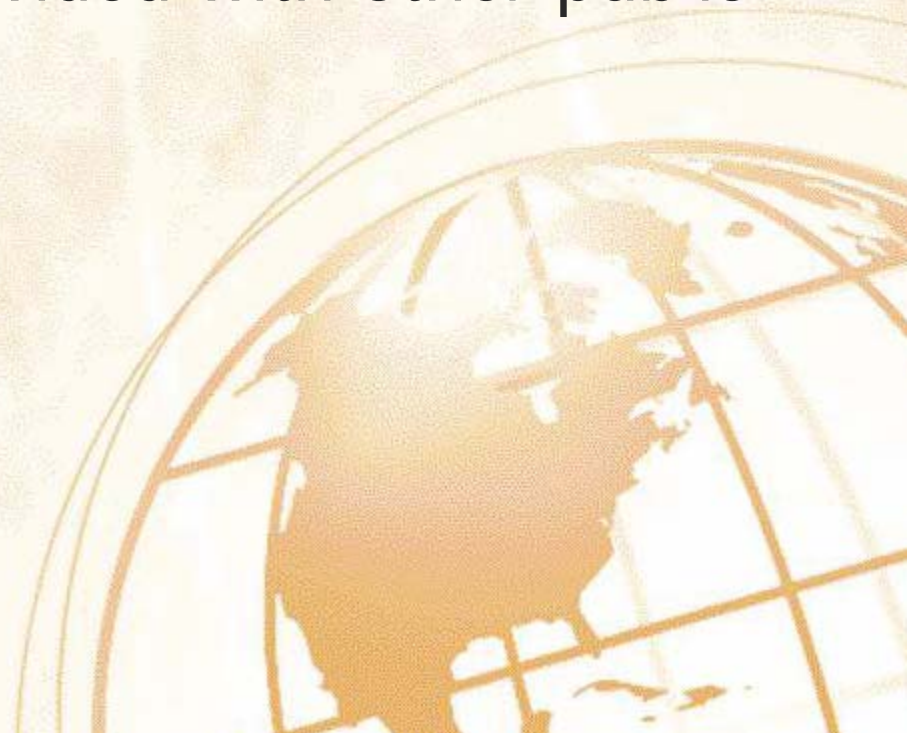
- ❖ Current infrastructure in most communities is not effective against water pathogens without filtration – Giardia and Cryptosporidium
- ❖ Widespread lack of filtration infrastructure to remove colloidal and dissolved matter that contribute to colour





2.4 Operators and O&M

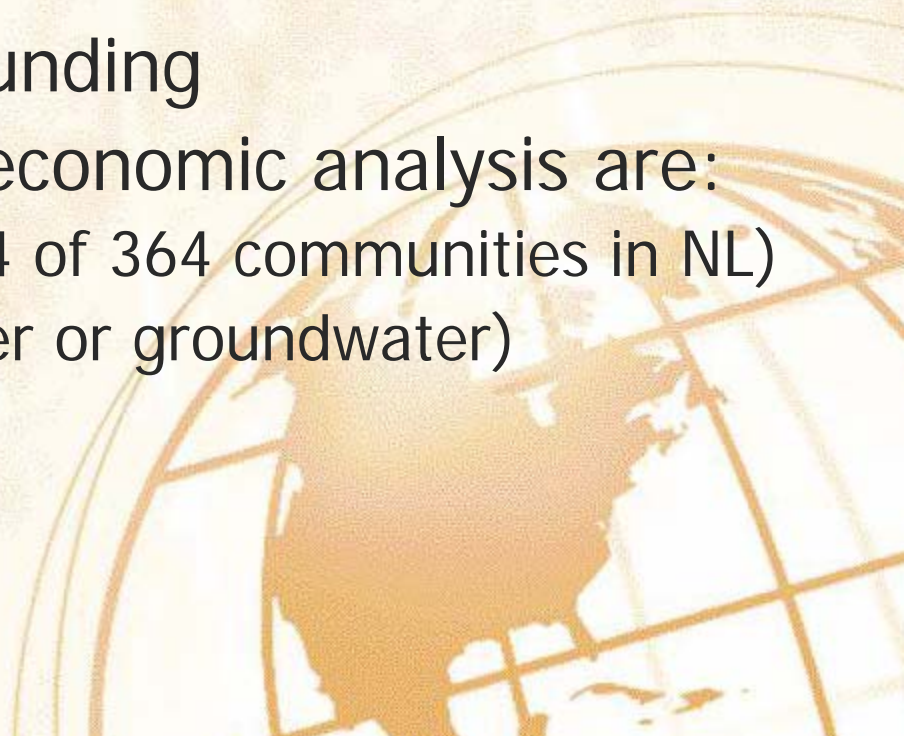
- ❖ Communities are more likely to have BWAs when operators have little or no training
- ❖ Lack of back-up operator hinders training opportunities
- ❖ Operator duties usually divided with other public works responsibilities





3.0 Economic Analysis

- ❖ Based on 25 communities with detailed survey
- ❖ Costing developed for O&M effort to meet Best Management Practices of:
 - Existing infrastructure
 - Upgraded infrastructure
- ❖ Infrastructure and O&M funding
- ❖ Primary factors affecting economic analysis are:
 - Population (<1,501 are 304 of 364 communities in NL)
 - Water source (surface water or groundwater)





3.1 Costs Based on Current Infrastructure

- ❖ 2009 annual flat rate water taxes
 - Average \$200/household
 - Range \$60 to \$325
- ❖ Recommended annual flat rate water taxes
 - Assuming full cost recovery
 - Range \$61 to \$1,688
- ❖ Highest rates typically required for small systems
 - Community has limited funding ability; therefore, higher rates required for cost recovery

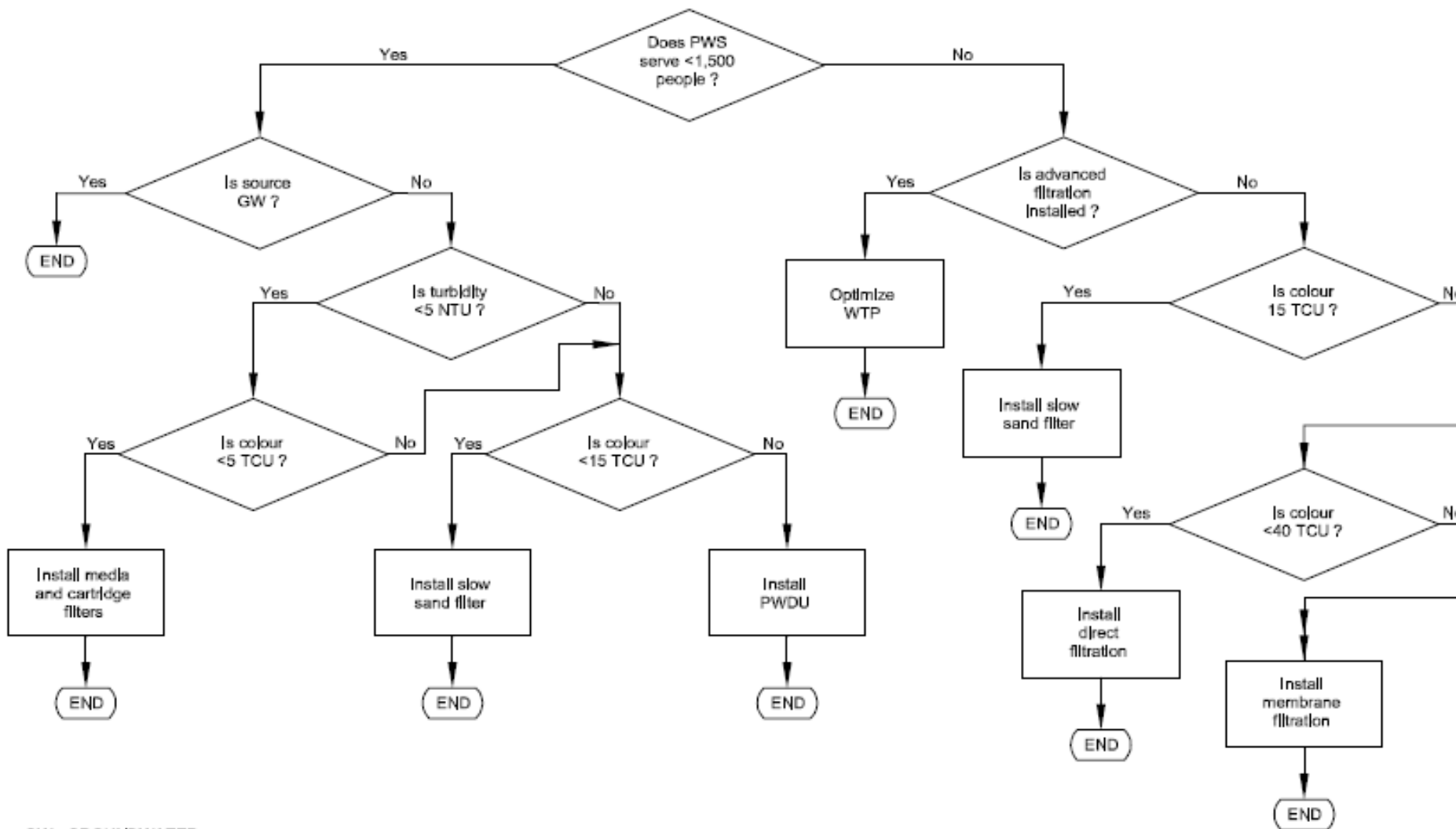




3.2 Costs Based on Recommended Infrastructure

- ❖ Recommended annual flat rate water taxes
 - Assuming full cost recovery
 - Range \$83 to \$1,801 per household
- ❖ Basic process requirements developed for choice of infrastructure based on raw water quality

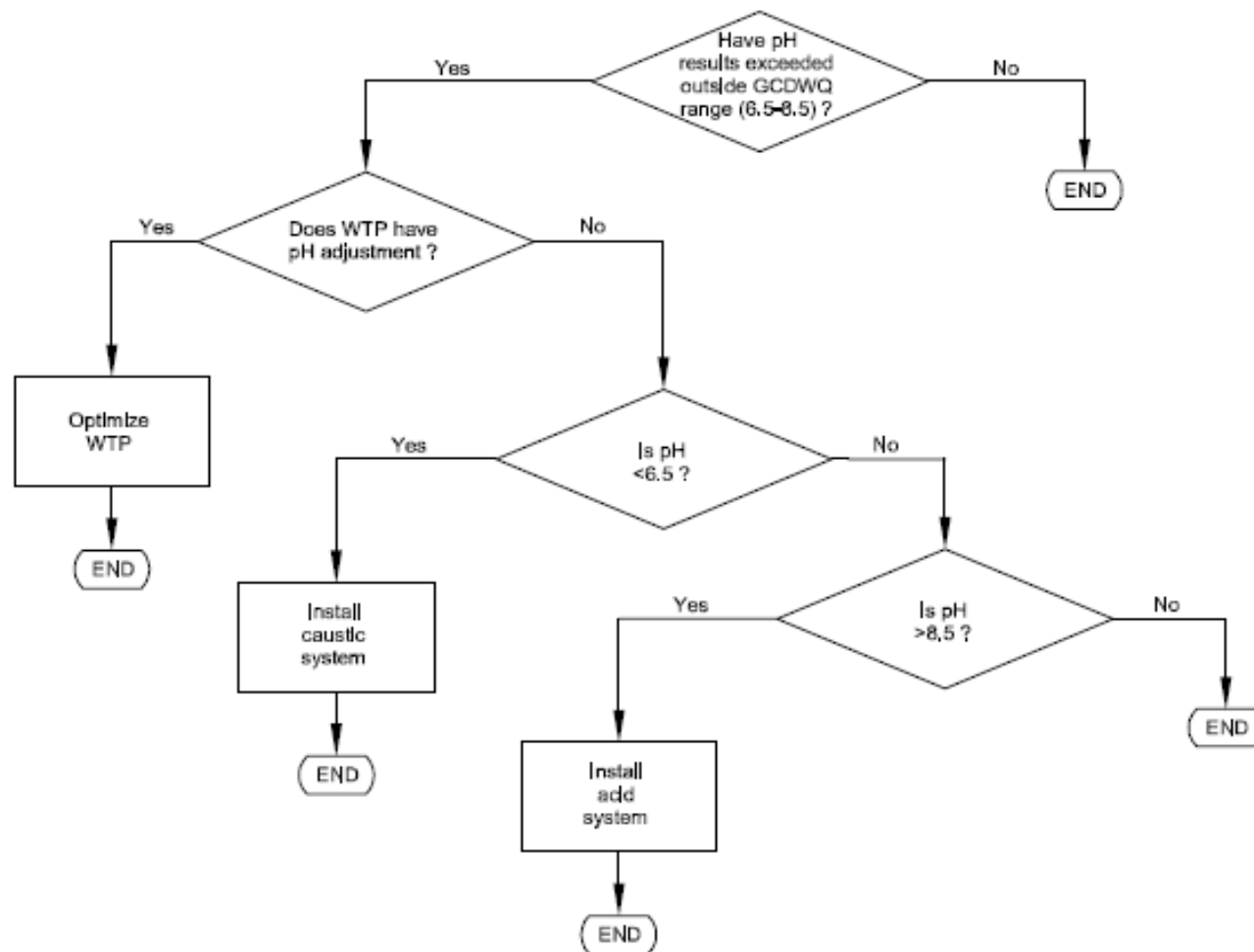




GW : GROUNDWATER
 PWS : PUBLIC WATER SAFETY
 PWDU : POTABLE WATER DISPENSING UNIT

figure 4.1.2

FLOW CHART FOR FILTRATION INFRASTRUCTURE
ECONOMIC ANALYSIS OF DRINKING WATER
INFRASTRUCTURE IN NEWFOUNDLAND AND LABRADOR
Government of Newfoundland and Labrador

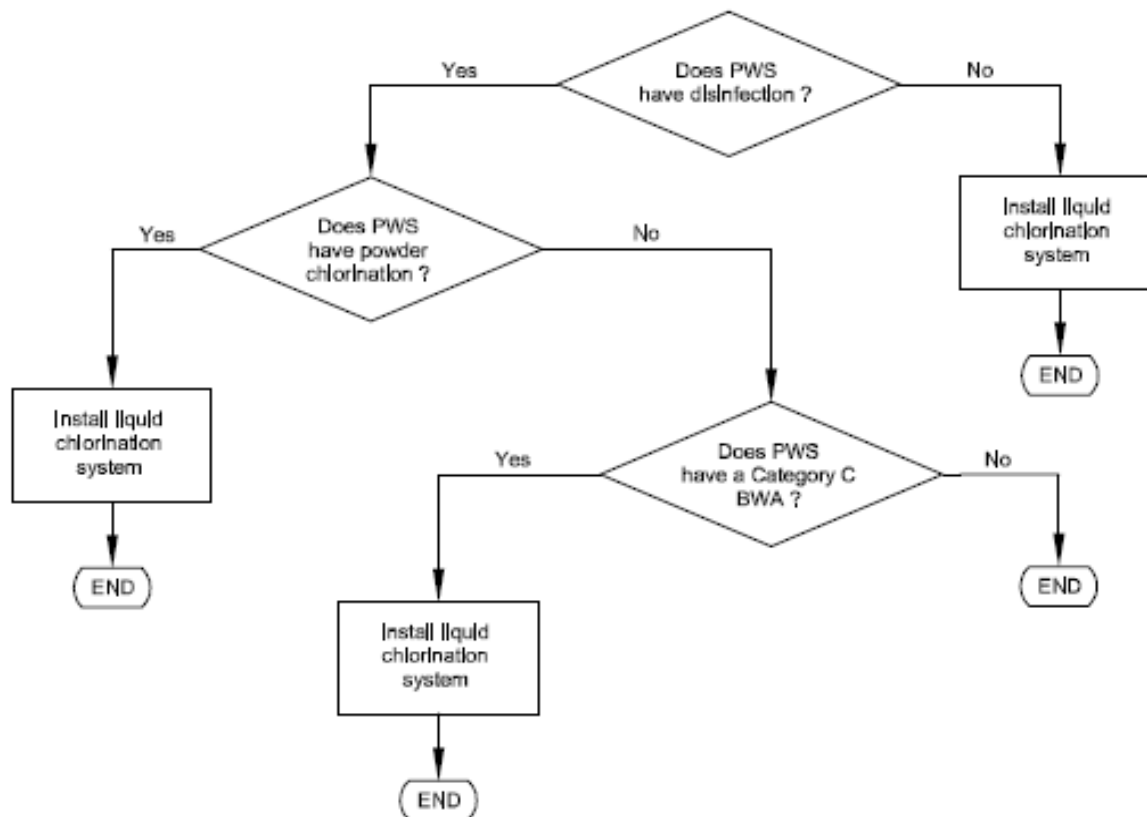


WTP : WATER TREATMENT PLANT

figure 4.1.1

FLOW CHART FOR pH ADJUSTMENT
ECONOMIC ANALYSIS OF DRINKING WATER
INFRASTRUCTURE IN NEWFOUNDLAND AND LABRADOR
Government of Newfoundland and Labrador





BWA : BOIL WATER ADVISORY
 PWS : PUBLIC WATER SUPPLY

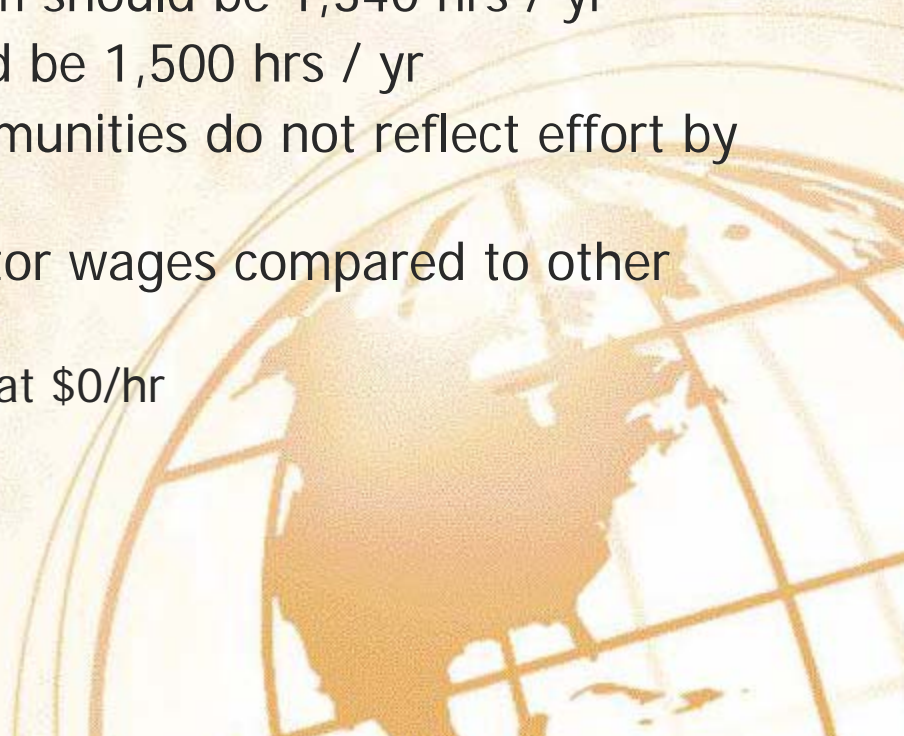
figure 4.1.3

FLOW CHART FOR CHLORINATION INFRASTRUCTURE
ECONOMIC ANALYSIS OF DRINKING WATER
INFRASTRUCTURE IN NEWFOUNDLAND AND LABRADOR
Government of Newfoundland and Labrador



3.3 Key Differences in Current vs Recommended Costs (<1,500)

- ❖ Current operator effort considerably less than required to meet Best Management Practices (BMP) effort per community:
 - Avg NL effort for existing system 450 hrs / yr
 - Avg BMP effort for existing system should be 1,340 hrs / yr
 - Avg BMP upgraded system should be 1,500 hrs / yr
- ❖ Current costs reported by some communities do not reflect effort by volunteers
- ❖ Discrepancy between average operator wages compared to other jurisdictions
 - Need to account for volunteer effort at \$0/hr





3.4 Cost Savings from Regular O&M

- ❖ Existing water treatment systems will not likely reach expected service life due to inadequate O&M effort
- ❖ Useful service life of existing infrastructure can be extended by completion of rehab work at specified intervals
 - Would decrease frequency of equipment replacement when considering life cycle costs
- ❖ Proactive O&M would increase associated costs; however, capital investment would also decrease





3.5 Issues Impacting O&M Costs

- ❖ Community revenues
 - Directly related to population (number of consumers)
 - Based on water/sewer tax rates, mil rate
 - Municipal Operating Grants (Province)
- ❖ Community expenses
 - Wages (including operator)
 - Debt
 - Infrastructure funding
- ❖ Drinking Water Treatment System
 - Components more complex than necessary – third party servicing required more often





4.0 Potential O&M Alternatives

- ❖ Conventional approach of one water treatment system per community
- ❖ Regionalization
- ❖ Public-Private Partnerships (PPPs, 3Ps)
 - Service Contracts
 - Management contracts
 - Leases
 - Concessions
 - Build-Operator-Transfer
- ❖ Privatization





4.1 One System per Community

- ❖ Historically, the most familiar to communities
- ❖ More financially feasible for larger communities (>1,500) due to larger tax base
- ❖ Community retains full control of O&M, management, and infrastructure investment
- ❖ Community still fully responsible for delivery of clean and safe drinking water to consumers





4.2 Regionalization

- ❖ Few communities take advantage of this approach
- ❖ Dept Municipal Affairs introducing this as one option through Integrated Community Strategic Plan
 - Required to obtain funding through Gas Tax Fund
- ❖ Consolidation of administration, O&M effort, and equipment replacement allows for sharing of financial costs
- ❖ Communities retain full control of O&M, joint-management, and infrastructure investment
- ❖ Communities still fully responsible for delivery of clean and safe drinking water to consumers



4.3 Public-Private Partnerships

- ❖ Already being used in most basic form
 - Consultants
 - Contractors
 - Suppliers
- ❖ Allows the strengths of the private and public sectors to maximize public value for a project
- ❖ Gaining more acceptance throughout Canada as necessary funding to upgrade/replace public infrastructure is very limited
 - Alberta implemented a PPP program in 2003
- ❖ Community retains ownership of all infrastructure
- ❖ Public involvement from the outset mandatory for success



4.4 Types of PPPs

- ❖ Service Contracts
 - Short term, specified duties/tasks (one year or less)
 - Infrastructure investment by community
- ❖ Management Contracts
 - Short to medium term (one to five years)
 - Some decision-making on management by private sector
 - Infrastructure investment by community
- ❖ Leases
 - Medium to long term (five to 10 years)
 - Full decision making on management by private sector
 - Infrastructure investment becomes complicated





4.4 Types of PPPs

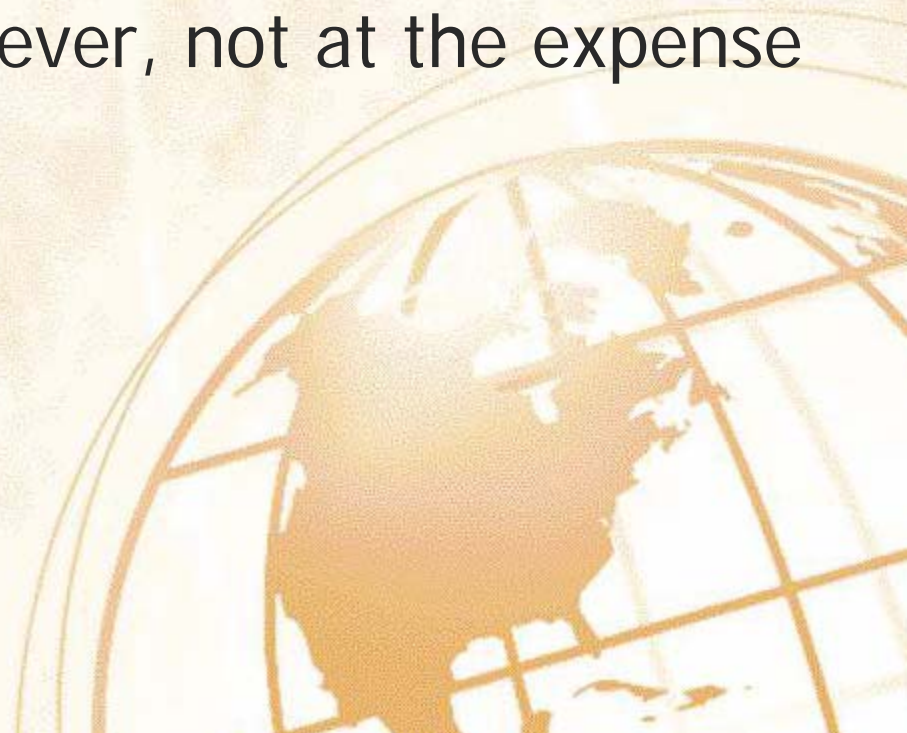
- ❖ Concessions
 - Long term (more than 10 years)
 - Full decision making on management by private sector
 - Infrastructure investment by private sector
 - Balance of private sector revenues with efficient management of system required

- ❖ Build-Operate-Transfer
 - Long term (more than 10 years)
 - Full decision making on management by private sector
 - Infrastructure investment by private sector
 - Private sector responsible for financing, design, build, and operate, then turn over to community at end of agreement



4.5 Privatization

- ❖ Permanent transfer of system to private sector
- ❖ Treated water then sold to community or consumers
- ❖ Vast network of legislation, standards, guidelines required
- ❖ Private sector profits to be reasonable based on financial investment; however, not at the expense of the public





5.0 Challenges

- ❖ Infrastructure
- ❖ Operations
- ❖ Management
 - Local level
 - Provincial level





5.1 Challenges – Infrastructure

- ❖ Standardize water treatment equipment for particular raw water quality
 - Filtration
 - Disinfection
 - pH Adjustment
 - Advanced – Colour, Turbidity
- ❖ Treatment equipment evaluations to determine why chlorine residuals low
- ❖ Increase the amount of water quality data for systems with low chlorine
- ❖ Determine volumes of raw and treated water volume throughput
- ❖ Identify branched distribution networks and insufficient flushing valves/hydrants



5.2 Challenges – Operations

- ❖ Identify all tasks currently being completed by operators, including tasks not related to water treatment
- ❖ Determine level of training required for operators to be adequately qualified to operate and maintain existing systems
- ❖ Identify communities without O&M manuals and Standard Operating Procedures
- ❖ Determine typical list of spare and emergency parts for similar water treatment system configurations





5.3 Challenges – Local Management

- ❖ Balance the level of required operating funds with revenues
- ❖ Decrease debt/service ratios and arrears
- ❖ Consider appropriate levels of compensation for operators
- ❖ Only use qualified operators, with back-up
- ❖ Minimize operator turnover
- ❖ Understand the necessity of trained and certified operators
- ❖ Provide necessary tools and equipment of O&M
- ❖ Discuss potential for communities to use non-conventional management practices



5.4 Challenges – Provincial Management

- ❖ Regulations do not exist that are specific to water treatment requirements
- ❖ Application process for infrastructure funding is lengthy and complicated
- ❖ Funding to provide adequate drinking water infrastructure to all communities is much less than available financial resources
- ❖ Number of communities with water quality issues
- ❖ No consistent level of O&M across the Province
- ❖ Operator training is voluntary, not mandatory
- ❖ Average amount of operator training is about 10% of required



5.4 Challenges – Provincial Management

- ❖ Extremely diverse treatment system configurations
- ❖ Training provided by Province has to address a large variety of system components and configurations
- ❖ General public does not fully understand water quality



6.0 Recommendations

- ❖ Assess potential for different management alternatives
- ❖ Local government level
- ❖ Provincial government level





6.1 Management Alternatives

- ❖ Carefully assess alternatives to ensure it will suit the community or region
- ❖ Determine the minimum service population base with minimum water tax rates for one water treatment system per community to be sustainable
- ❖ Identify areas for communities with BWAs to form a regionalized management approach
- ❖ Develop a complete network of guidelines and legislation if considering PPPs
- ❖ Develop a very detailed blueprint for privatization
- ❖ Public consultation key to non-conventional approaches



6.2 Local Government Level

- ❖ Establish appropriate budgets for O&M and infrastructure
- ❖ Determine reasonable wages for operators and ensure operators are paid
- ❖ Improve operator retention
- ❖ Provide support for operator training
- ❖ Provide necessary tools and equipment for O&M tasks
- ❖ Review existing maintenance and service contracts to identify efficiencies





6.3 Provincial Government Level

- ❖ Establish regulations for treatment and monitoring equipment based on water source and population
- ❖ Provide consistent regulatory oversight and enforcement
- ❖ Establish provincial standards or best management practices for O&M
- ❖ Consider using a quality management approach that addresses system-specific issues rather than end-of-pipe monitoring
- ❖ Prioritize capital funding projects to target communities that do not meet GCDWQ



6.3 Provincial Government Level

- ❖ Implement mandatory operator training and certification standards
- ❖ Expand operator training programs to focus on O&M activities, including development of Standard Operating Procedures
- ❖ Develop operator compensation guidelines based on certification levels, experience, and types of treatment systems
- ❖ Update design guidelines to consider service population and a community's ability to financially operate and maintain treatment system
- ❖ Provide "plain language" versions of technical and policy documents



7.0 Highlights of Provincial Efforts

- ❖ Continued financial investment in infrastructure
- ❖ Commitment of resources and staff to continue with studies and data collection
- ❖ Publication of data results, including BWAs, has been at forefront of many jurisdictions for more than 5 years
- ❖ Mobile Training Unit program developed by Province picked up by the Walkerton Clean Water Centre and used in other remote areas of Canada as training aid
- ❖ Much effort focused on small, rural drinking water system issues