WATER INFRASTRUCTURE:
LONG TERM SUPPLY, DEMAND MANAGEMENT AND PLANNING

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KEY MESSAGES FOR DECISION MAKERS

Despite their importance, water distribution systems face many urgent challenges:

- infrastructure deterioration
- insufficient funds and inadequate funding models
- chronic and significant leakage, frequent pipe bursts and disruptive local failures
- challenges like water scarcity, water quality disturbances and boil-water advisories
- high energy use and costs

Problematic conditions not only demand improvement, but create an opportunity to rethink the system. Since every water system has unique features, holistic and integrative approaches must analyse the connections between stakeholders, system function and local conditions, and between the physical state of the built system and overall measures of sustainability.

WHO IS THIS INFORMATION RELEVANT FOR?

- system owners
- planners, designers, operators
- regulatory authorities at the municipal, provincial, and federal levels

WHAT WAS THE RESEARCH METHOD?

Energy use is a critical operational cost, a key indicator of system performance and is closely linked to key environmental consequences. Energy metrics – which are quantitative measures of energy supplied, dissipated, lost and delivered – were calculated and used to assess the efficiency of water distribution in Toronto and Hamilton. Using electricity rates and grid emission factors, the relative costs and greenhouse gas emissions of the infrastructure components were calculated. Four performance metrics were developed to evaluate how infrastructure performs and responds to change: reliability, vulnerability, resilience and connectivity.

All of these metrics assume steady state flows. However, variations in demand caused by everyday fluctuations or significant changes due to events like pipe bursts, power failures and fire produce sometimes disruptive transient phenomena. In a parallel study, a comprehensive set of pump performance tests and system state evaluation was conducted to prioritize refinements, improvements and investments.

To better understand the demands that drive these systems, linkages between water and land use were explored. Water billing records, land use, and demographic data of three Ontario municipalities (London, Barrie and Guelph) were integrated into a linked and comprehensive database. Metrics, benchmarks, conservation targets, and water user clusters were defined.

WHAT WAS THE RESEARCH FOCUS?

The research focused on the development of tools to both understand and address major issues faced by Canadian water systems: high energy costs, water scarcity, on-going leakage, customer frustration and threats associated with transient events, which contribute to high system costs and environmental impacts.

WHAT WERE THE RESEARCH RESULTS?

The energy metrics developed were calculated for each infrastructure component. Together, they provide a geographical snapshot of the system and allow for better identification of "hot spots," pressure districts, or specific mains, pumps, and tanks, where energy dissipation is high, or the energy delivered is excessive and thus changes most beneficial. The balance between pumping and storage was a key factor in maintaining system efficiency and curtailing costs. The energy performance metrics expand the analysis of the network, assessing its performance under different operational conditions. They demonstrate that increasing system redundancy through larger diameter pipes or additional loops generally results in higher efficiencies with less variation.

Integrating water, land use and demographic data organized information, made correlations easier to understand, reduced a "silo mentality" and improved communication to policy makers.

WHAT ARE THE IMPLICATIONS FOR DECISION MAKERS?

The analysis of different scenarios and network configurations can help revise design standards and operational requirements. By applying the findings and metrics to different systems, results can be compared between municipalities and defined benchmarks. Long-term decision-making can be simplified by analysing data that is already available to many utilities.