Technical Appendix 3 - Policy and Level of Service

1 Appendix Introduction

This Technical Appendix is intended to summarize Water Distribution Master Plan Servicing Policies and Level of Service Targets.

2 Problem and Opportunity Statement

Through the Municipal Class EA process, Phase 1 requires the identification of the problem or opportunity statement that guides the process of establishing preferred strategies to address the deficiencies observed in the water distribution systems. The following vision statement is a driver for the WDMP where problems and opportunities are clearly identified through the desire to provide an adequate level of service to water users and improve system performance under both current and future (2031) conditions.

The Vision Statement is as follows:

> "To establish a master plan to achieve a cost effective water distribution system that:
>
> - Meets the needs of existing users, regulatory, and legislative requirements;
> - Supports growth;
> - Considers system resiliency; and,
> - Optimizes the system performance objectives with the long term renewal needs of the system."

3 Water Servicing Principles

The provision of safe and sustainable water services is an important issue to the public and to the municipalities planning, operating and maintaining the systems. Execution of reasonable policies is essential to ensure proper planning and design principles are followed in developing the servicing strategies, implementing the system capital program, as well as in the operation and maintenance practices.

Development of the water principles has been based on existing documentation and related sources, including:

- The City of Waterloo Official Plan;
- Federal and Provincial policies and legislation;
- Design and development standards;
- Municipal By-laws; and,
- Existing municipal policies and procedures.

The principles are designed to:

- Provide direction for planning and identifying water servicing issues that may impact growth options;
- Provide direction for normal operation and maintenance of the water systems (the policies do not replace normal operation and maintenance procedures or best practices);
- Provide direction for development and evaluation of servicing strategies for the Water Distribution Master Plan;
- Ensure appropriate design and costing criteria are utilized for developing and evaluating servicing strategies for the Water Distribution Master Plan;
- Establish policies that are reasonably implemented; and,
- Establish policies that are robust and sustainable.

Although best management practices and criteria are updated over time, the context, intent and validity of the principles should remain intact.

3.1 Vulnerable Occupancies

Further, water system upgrades should not disrupt/decrease the water flows/pressure available to the City of Waterloo's vulnerable occupancies without mitigation. **Figure 1** identifies currently known vulnerable occupancies within the City of Waterloo.

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TOWNSHIP OF WELLESLEY
TOWNSHIP OF WOOLWICH
TOWNSHIP OF WOOLWICH
CITY OF WATERLOO
TOWNSHIP OF WILMOT
CITY OF WATERLOO
CITY OF WATERLOO
CITY OF KITCHENER
CITY OF KITCHENER
TOWNSHIP OF WILMOT

0 1 2 Kilometers

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Water Distribution Master Plan

Figure 1 - Vulnerable Properties

Local Watermains

- < 200 mm
- 250 - 350 mm
- > 400 mm
- Kitchener Watermains
- Vulnerable Properties

Pressure Zone

- Wat 4
- Wat 4B
- Wat 4C
- Wat 5
- Wat 6
- Wat 7
- Municipal Boundary
- River, Lake

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615036-W
March 2017
Data Source: City of Waterloo
Scale: 1:40,000 | NAD 1983 UTM Zone 17N

3.2 Principle Development Approach

The approach in establishing and implementing the water principles is as follows:

1. Establish overall guiding vision for the Water Distribution Master Plan as the foundation for related servicing policies.
2. Highlight key criteria and best practices related to each policy.
3. Review and discuss principles with City Department.
4. Consolidate the general and water policies in the Policy Document.
5. Utilize the principles, and any developed criteria and/or best management practices, outlined in the Policy Document to guide the development and evaluation of servicing strategies for the Water Distribution Master Plan.
6. Implement and utilize the principles, guidelines, criteria and best practices within the day-to-day decision making for planning and operation of the water systems.

3.3 Infrastructure Asset Management Process Integration

The City recently completed the Infrastructure Asset Management Analysis Report (IAMAR). The IAMAR will help the City to develop a Comprehensive Asset Management Plan (CAMP) that establishes the infrastructure expenditure needs that are required to achieve a target performance objective for the services provided by each asset group. The CAMP will also establish a financing strategy to fund the expenditure needs.

Key fundamental and project triggers from the IAMA related to water infrastructure were considered and integrated into the development of the servicing principles.

3.4 Servicing Principles

Building on the problem and opportunity statement for the Water Distribution Master Plan, specific servicing principles have been developed to guide and provide direction for the development and evaluation of servicing strategies.

In general, City of Waterloo is looking to build and maintain efficient, effective, well managed water systems that provide high level of service to the end users. In order to capture these goals, the servicing principles have been structured as outlined **Table 1.**

Table 1 - Servicing Principles

Policy Area	Principle Statement	Servicing Implications
Municipal Servicing	"The City of Waterloo shall provide adequate municipal water servicing in accordance with the population and employment projections in the time horizon of the City's official plan and the Province of Ontario's Places to Grow Legislation."	• Planning and design of servicing strategies will optimize use of existing infrastructure where possible. • Infrastructure will be planned and designed in accordance of growth projections in the City's official plan and Province of Ontario's Places to Grow Legislation. • Timing of growth will be reviewed with consideration to a reasonable implementation schedule for infrastructure required to meet the projected growth. • Municipal servicing will be implemented under typical standards (MOE Guidelines).
Environmental Protection	"The City of Waterloo shall consider, protect and endeavour to minimize impact to the natural, built and cultural environment and heritage of the community"	• Servicing studies shall consider the City's Official Plan Environmental and Heritage Policies. • Services will be planned through the appropriate Environmental Assessment process to ensure full regard for the natural and cultural heritage.
Planning Horizon	"The City of Waterloo shall ensure that the design of water infrastructure recognizes the potential for growth beyond the time horizon of the Official Plan."	• Recognize that the service life of infrastructure may be 60 years or more. • Consider, where appropriate, potential for growth beyond the time horizon of the Official Plan for the planning and sizing of infrastructure.
Reserve Capacity	"The City of Waterloo will endeavor to maintain sufficient reserve capacity in its water infrastructure to provide operational flexibility and meet potential changes in servicing conditions."	• Recognize the time frame required to implement expansion of the infrastructure and initiate planning, the Environmental Assessment process, design and construction with consideration of the in-service date.
System Reliability and Security	The City of Waterloo shall endeavor to provide reliability, redundancy and security in its water systems with attention to high risk and critical areas. The City of Waterloo will endeavor to align system reliability policy with overall Region of Waterloo system reliability policy."	• Recognize that all systems are susceptible to some level of failure or breakdown, or need to be taken out of service for regular maintenance. It is reasonable to provide a level of reliability to ensure an acceptable level of service is maintained.
Integrate Infrastructure Program	"The City of Waterloo shall coordinate and integrate the WDMP program with City planning, programs and policies where appropriate."	• Coordination and integration will ensure servicing policies and strategies are aligned. • Development of Water Distribution Master Plan Strategies will take into consideration the condition of existing water infrastructure with the objective of aligning growth, non-growth, state of good repair and other infrastructure (road) and utility projects.
Climate Change	"The City of Waterloo shall be aware of and consider the potential impact of climate change on planning and sizing of infrastructure."	• Water infrastructure will be designed with consideration to the potential impacts of climate change.
Energy Efficiency	"The City of Waterloo shall design water infrastructure with consideration to energy use."	• Water infrastructure and system configuration will be planned and designed with consideration to Net Present Value (Capital and Operating Costs) as they relate to energy use (i.e. minimize flow through PRVs; optimize storage and pumping).
Demand Projections	"The City of Waterloo shall consider existing water consumption trends when identifying long-term water system needs."	• When estimating long-term water demand needs, existing water consumption rates will be used to account for existing customer demands and future demands will be estimated using the per capita rates identified in the Water Distribution Master Plan.
Sustainability	"The City will endeavour to undertake sustainable planning, operation and maintenance of the Water Systems."	• The City will strive to plan, operate and maintain Water System that is Environmentally, Financially, Operationally, Legislatively, and Socially Sustainable• Financial Sustainability shall consider and utilize appropriate funding mechanisms including but not limited to Development Charges, local cost to development and rate reserves to provide a long term balanced and equitable plan to fund the delivery of servicing.

Policy Area	Principle Statement	Servicing Implications
Water Efficiency and Trends	"The City of Waterloo shall be aware of the impacts water efficiency and conservation has on the water network."	• Continue to assess water demand conditions and determine reasonableness of trends (potential lower water use and consumption). • Utilize water efficiency studies where available. • Apply where appropriate demand trends (efficiency) into future design criteria and growth forecasts. • Apply awareness to how it will impact alternatives and scheduling of future infrastructure.
Health & Safety	"The City of Waterloo will promote health, productivity and safety of the community through design, construction and maintenance of the City's potable water infrastructure"	• The City will prepare a comprehensive strategy to manage existing and future water servicing needs. • Ensure that planning and implementation of the potable water systems are consistent with legislative policies and guidelines. • Municipal servicing will be implemented under typical standards (MOE Guidelines and Region of Waterloo).
Level of Service	"The City of Waterloo shall outline the Level of Service Objectives through the Water Distribution Master Plan and endeavor to meet the minimum requirements as outlined in the objectives."	• The City will review and evaluate alternatives developed through the WDMP based on their ability to meet requirements outlined in the Level of Service Objectives.
Servicing Responsibilities	"The City of Waterloo shall be responsible for the distribution and delivery of potable water to water customers within the City of Waterloo. Raw water supply, treatment, pumping, and system storage shall be the Responsibility of the Region of Waterloo. The City of Waterloo shall develop it Water Distribution Management Strategies in a manner that are consistent with the Region of Waterloo long term water supply, treatment, pumping, and storage management strategies."	• City of Waterloo will be responsible for ensuring adequate pressure, flows, and water quality within the local distribution system. • The Region of Waterloo will be responsible for provide adequate level of storage, pumping, and water supply consistent with Regional level of service objectives and MOE design criteria and standards. • The Region of Waterloo will be responsible for providing adequate combination of reservoir capacity, pumping capacity, and stand-by power to meet the desired level of service under emergency conditions.
Distribution Water Quality	"The City of Waterloo shall meet or exceed legislated water quality criteria in their water distribution system in conjunction with Region of Waterloo water quality practices"	• Water quality will meet, at a minimum, all legislated criteria. • Ensure regularly testing and monitoring for chlorine residual in the system. • Implement industry best practices to ensure water quality is maintained. • Review the economics, reliability and water quality impacts of implementing new technology.
Distribution Requirements	"The City of Waterloo shall provide potable water at adequate pressure and flow to its customers"	• Provide pressures which strive to meet current level of service objectives outlined in the Water Distribution Master Plan. • System to meet minimum MOE Guidelines identify a typical recommended operating range of 275-700 kPa (40-100 psi). • Review existing Pressure Zone Boundaries.
Fire Flow Requirements	"The City of Waterloo shall consider the Ministry of the Environment Guidelines and the Fire Underwriters Guidelines for establishing the acceptable level of fire flow."	• Provide flows and pressures which strive to meet current level of service objectives outlined in the Water Distribution Master Plan.
Location of Municipal Services	"The City of Waterloo shall locate all of its services on public property or on municipally-owned easements."	• The City will ensure that any new and existing infrastructure be located within road right of ways, or on City-owned property (including designated lots and easements). • Adequate property size will be maintained to facilitate all day-to-day activities and emergency response. • Adequate property will be acquired to meet future infrastructure requirements.

3.5 Principle Implementation

The principle statements have been worded such that they should remain relevant over time, though these can also be revised as required. It is anticipated that through technological innovations, regulatory changes, and updated servicing priorities, some of the criteria or best practices will require updating in the future. The structure should allow this to be done without necessarily having to edit the actual principle statement.

4 Design Criteria and Level of Service Objectives

In addition to the servicing principles, this document provides a detailed summary of the water performance objectives under the Water Distribution Master Plan. The design criteria outlines the methodology and values used to estimate growth related flows as well as the decision making rationale related to infrastructure capacity and the trigger for upgrades.

4.1 Water Demands

The existing demands utilized in the WDMP analysis were previously allocated to the current InfoWater model, as provided by the Region, and independently verified using the following methodology. Existing system demands were defined using the "Starting Point" methodology, using the billing data from January 2014 to October 2015 average daily system demands as the baseline 2016 system demands. Maximum day demands were than calculated using a 1.42 peaking factor. **Table 2** highlights the existing average day water demands.

Table 2: Existing Water Demands

Pressure Zone	Existing Demands (L/s)
Wat 4	254
Wat 4B	24
Wat 4C	5
Wat 5	57
Wat 6	48
Wat 7	<1
System	378

Growth related demands were calculated using population projections and water design criteria values provided in **Table 3**. The City's WDMP applied slightly more conservative per capita demand rates and peaking factors than utilized in the Region's WSDOMP and WSMPU. This was due to the WDMP analysis and recommendations focus on smaller service areas, than those considered in the evaluation of Regional facilities.

Table 3: Water Design Criteria

Development Type	Average Day Demand	Max Day Peaking Factor
Residential	170 L/c/d	1.65
Employment	108 L/c/d	1.65

The above growth per capita rates, from the Region's WSDOMP, were utilized as they were more conservative than the 2031 rates outlined in the Region's WSMPU. The conservative max day peaking factor, from the MOECC Design Guidelines for Drinking Water System for municipalities with a population between 75,001- 150,000, was applied to growth demands only.

The Non-Revenue Water rate utilized for growth demands was 10%, in line with the WSMPU and WSDOMP.

4.2 System Criticality

The Region of Waterloo (Region), in collaboration with the Cities of Cambridge, Kitchener, and Waterloo (Cities), has retained GM BluePlan to complete a criticality analysis of the Integrated Urban System (IUS) water distribution infrastructure. This assignment has two primary objectives consisting of:

- Establishing a set of infrastructure Criticality Guidelines that will be used to evaluate and classify the criticality of the IUS system elements
- Use of the Criticality Guidelines to complete an analysis of the IUS system elements, and to classify and rank the criticality of each system component. A list of potential mitigation options which minimize criticality scores will be identified through this analysis.

In the context of this assignment, criticality was defined as the overall impact resulting from the failure of a watermain.

- A high critical watermain is a watermain that would have a significant impact or **Consequence** if it was to fail; either in terms of damage to local environment and property, and/or to the overall system performance
- A low critical watermain is a waterman that would have minimal impact or **Consequence** if it was to fail; in terms of both damage to local environment and property, and to the overall system performance

The Consequence of Failure of a watermain failure (i.e. watermain break) was be determined through the analysis of two discrete categories:

- **Category 1: Direct Impacts**
  - Result of a watermain breaking and flowing freely into the surrounding environment
  - Economic, social and environmental costs from the damage to adjacent properties and infrastructure
- **Category 2: System Impacts**
  - Result of the watermain being isolated from the system while it is being repaired to the time it is online and operational again
  - Disruptions in water service to customers for the period of time that the watermain is disconnected from the system, referred to as **Difficulty to Repair**

The final Consequence of Failure score is the worst case between the Direct Impact and System Impact ranks. This approach recognizes that the important consideration is the worst impact of a failed watermain on either consequence category.

$$\text{Consequence of Failure} = \underbrace{\text{Worst Case}}_{\text{Direct Impact} \quad \text{or} \quad \text{System Impact}}$$

Through this analysis under this assignment, the criticality of all IUS transmission and distribution watermains were be assessed and provided a criticality rank between 1 and 10. The results of this assessment were incorporated into Level of Service performance review.

4.3 Level of Service Objectives

Based on a number of workshops held with the City, target levels of service were developed for desired pressures, fire flows, water quality, and velocity. The level of service objectives were further categorized by **"Action"** and **"Flag"** items.

- Action
    - An action level of service deficiency is not within MOECC requirements.
    - Action deficiencies require a system upgrade and were resolved in each instance.
    - Performance Flags consist of
        - Pressure below 40 psi or above 100 psi
        - Available fire flow below 80% of target
        - Local water age greater than 14 days
- Flag
    - A flagged level of service deficiency is within MOECC requirements but outside City desired level of service.
    - Flag deficiencies were evaluated on a case by case basis which took cost vs. benefit of addressing the issue before proceeding with a final alternative recommendation.
    - Performance Flags consist of:
        - Pressure between 40-50 psi or 90-100 psi
        - Available fire flow between 80-100% of target
        - Local water age between 7-14 days
        - Pipe criticality equal to or greater than 7

Table 4 summarizes the City of Waterloo's level of service objectives to assess the severity of each criteria quantitatively.

Table 4: Water Distribution Levels of Service

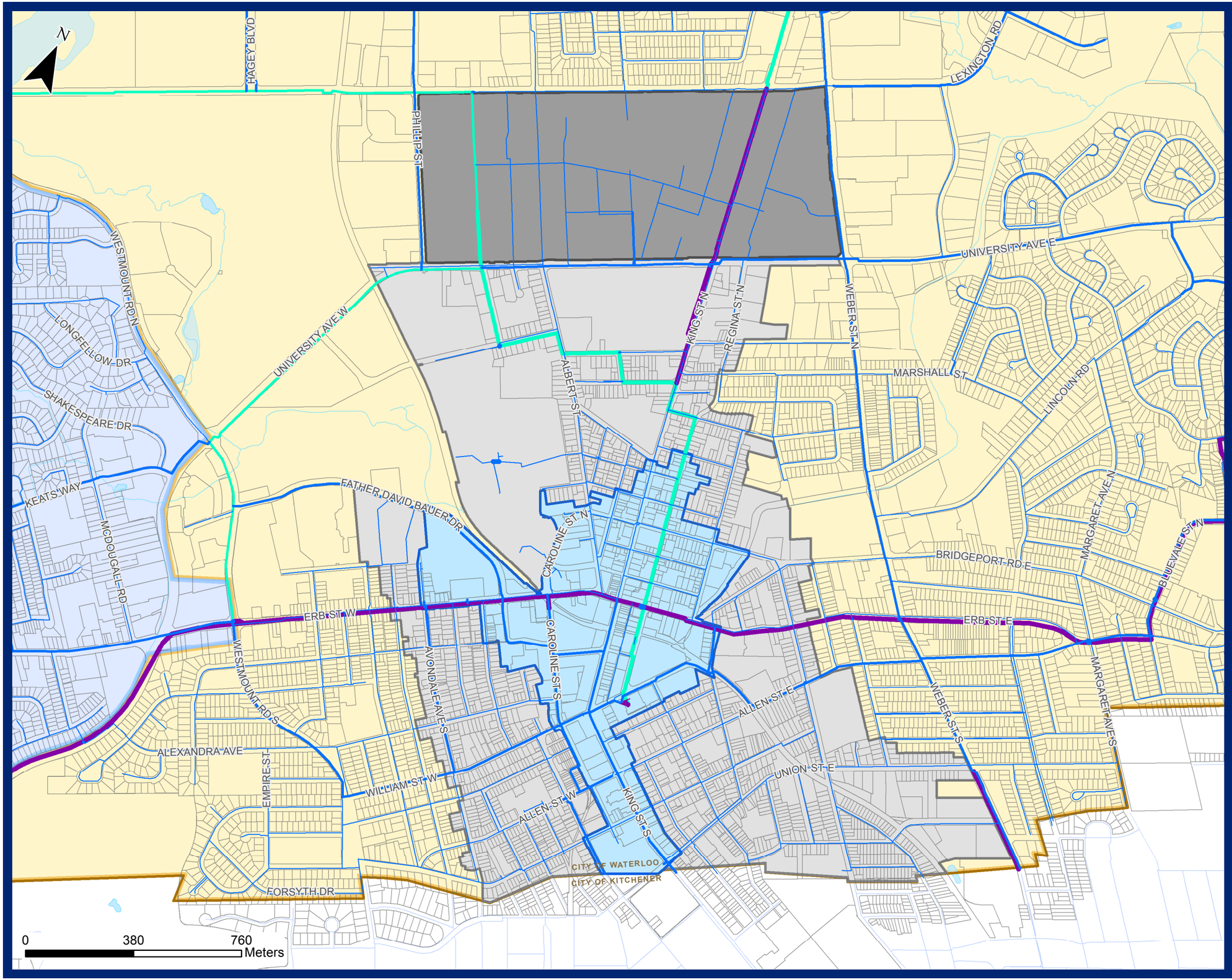
Criteria	Level of Service	Explanation
Pressure	40-100 psi	**Action** – Existing system must maintain pressures between 40-100 psi as per MOECC requirements
	50-90 psi	**Flag** –System upgrades are required to maintain pressures between 50-90* psi to serviced area
Fire Flow (Dead-End Residential)	50 L/s	**Action** – Fire flows unable to maintain above 80% of their target level of service **Flag** – Fire flows are able to maintain a level of service between 80-100% of their target level of service
Fire Flow (Single Family)	75 L/s	
Fire Flow (Multi Family)	150 L/s	
Fire Flow (Commercial)	175 L/s	
Fire Flow (Institutional)	175 L/s	
Fire Flow (Industrial)	250 L/s	
Fire Flow (City Center – Existing)	Based on existing land use	
Fire Flow (City Center – Future)	225 L/s	
Fire Flow (University)	300 L/s	
Chlorine Residuals	>0.5 mg/L	Maintained through management of water age
Water Age	>14 days	**Action** – Water age exceeds 14 days
	8-14 days	**Flag** – Water age is between 8-14 days
Dead End Servicing	Maintain balance between fire flow and water quality	Dead end watermains with reduced fire flow will be addressed on a case-by-case basis
Watermain Velocity	<2 m/s	**Action** – Distribution system must maintain velocities below 2 m/s
Easements	-	Easements will be decommissioned based on redundancy in system performance

* - 50-80 psi in the DGSSMS; however, due to scope of 80-90 psi area with the existing system, reduction in peak pressure requirement from 90 psi to 80 psi was not logistically or financial feasible. The focus of the WDMP was primarily related to minimum pressures issues.

4.4 Special Intensification Area

Two special intensification areas, consisting of the Uptown Core and Northdale Area highlighted in **Figure 2**, are expected to see significant growth and increased densities.

Existing system fire flow needs within these areas were calculated using existing land use criteria. However, to account for these special intensification area's potential increase in density, the future system needs were assessed using a global fire flow demand of 225 L/s which was assigned in these areas.



THE CITY OF Waterloo

Water Distribution Master Plan

Figure 2 - Intensification Area

Local Watermains

- < 200 mm
- 250 - 350 mm
- > 400 mm
- Regional Watermains
- Dual Watermains
- Kitchener Watermains

Pressure Zone

- Wat 4
- Wat 4B
- Wat 4C
- Wat 5
- Wat 6
- Wat 7

Intensification Areas

- Uptown
- Northdale
- Uptown Buffer
- Municipal Boundary
- River, Lake

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January 2017
Data Source: City of Waterloo
Scale: 1:13,000 | NAD 1983 UTM Zone 17N

4.5 Easements

Through consultation with the City, the final water system capital program should strive to eliminate and/or minimize watermain outside of City/Regional owned right of ways. Specifically through the WDMP, a review to abandon existing watermains which are outside of City/Regional owned right of ways was done to supplement the capital program.

The following methodology was applied to identify candidate watermains for abandoning.

- Easement watermains receiving a System Regional Criticality Analysis score less than 4
    - Indicates minimal impact to system pressures or fire flows when the watermain is offline
- Combined water system impacts of decommissioning easement watermains through the following:
    - Additional areas of pressure with Flag or Action deficiencies
    - Experiences a decrease in fire flows
        - Does not result in additional areas of Flag or Action deficiencies
        - Does not experience a drop in fire flow greater than 25%
        - Does not result in a drop greater than 2% where future fire flows experience a Flag deficiency
    - Additional areas of water age more than 8 days old

4.6 Dead-End Upgrades

System dead ends represent unique locations within the water distribution system that can have conflicting level of service performance objectives. Key issues at dead-ends typically consist of:

- Low fire flow; and
- High water age.

Potential solutions to address dead-end issues present the following issues:

  - Flushing Program – Only addresses water age issues
  - Watermain Upsizing – Improves fire flow; however, results in increasing water age
  - System Looping – Addresses both issues, however, is often difficult to implement due to land/easement acquisition requirements

Through consultation with the City's engineering and Fire Rescue the following philosophy will be applied to upsizing of dead-end watermains to address fire flow issues.

- Will attempt to achieve target fire flows at all dead ends provide it does not substantially impact existing water quality
- Upsizing will not be considered if it would initiate a new water quality program
- In areas with existing water quality programs, upsizing will be considered
- Watermain upsizing recommendations are based on the following criteria:
  - Water Age < 7 days = Upsizing recommended
  - Water Age 7-14 days
    - Increase < 1 day = Upsizing recommended
    - Increase > 1 day = Upsizing not recommended
  - Water Age > 14 days = Upsizing not recommended