Technical Appendix 6 - Problem and Opportunity

1 Appendix Introduction

This Technical Appendix is intended to summarize the baseline water system performance to quantify the impact of planned growth on the water system in context of the City's identified level of service objects. Further, this Technical Appendix identifies existing and growth related system deficiencies as they relate to achieving the goals outlined in the Vision Statement.

2 Level of Service Objectives

In consultation with City Staff, a set of water system planning policies and level of service objectives were developed. The system levels of service objectives were distinguished between an **Action** which is an objective that is required to be achieved to meet regulatory requirements or policy objectives, and a **Flag** which is an aspirational objective that the City would prefer to achieve in their system. The following is a summary of Action versus Flag level of service objectives:

- Action
    - An Action level of service deficiency does not meet specific MOECC water distribution system performance requirements.
    - Action deficiencies require a system upgrade that must be implemented to address the level of service deficiency.
- Flag
    - A Flag level of service deficiency is within MOECC requirements but outside of the City's desired level of service.
    - Flag deficiencies were evaluated on a case by case basis using a cost vs. benefit approach to determine if a reasonable system upgrade could be completed to address the issue before proceeding with a final alternative recommendation.

In addition to the level of service objectives outlined above, the WDMP establishes the objectives that any new Greenfield growth areas will strive to achieve the City desired level of service objectives. **Table 1** summarizes the level of service objectives in the City, together with an explanation of when a system deficiency would be considered an Action and a Flag relative to the objectives. **Technical Appendix #3** further details level of service criteria and rational:

Table 1 - Water Distribution Level 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** – Future developments or 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 exceed 14 days
	8-14 days	**Flag** – Water age is between 8-14 days

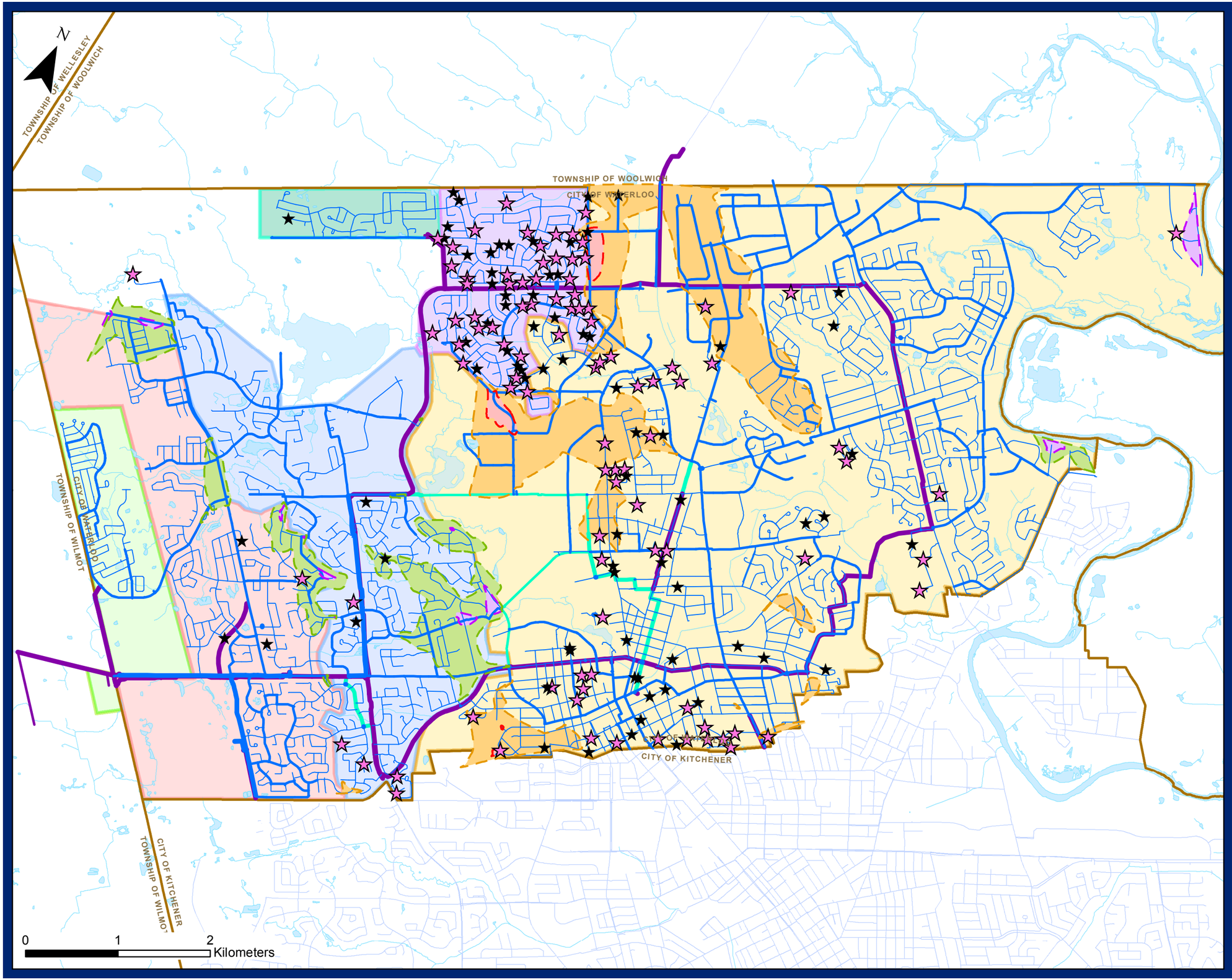
Criteria	Level of Service	Explanation
Dead End Servicing	Maintain balance between fire flow and water quality	Dead end watermains with reduced fire flow will be addressed on a case-by-case basis
Watermain Velocity	<2 m/s	**Action** – Distribution system must maintain velocities below 2 m/s
Easements	-	Easements will be decommissioned based on redundancy in system performance

3 Baseline System Performance

The City's water system was assessed using the Region of Waterloo existing hydraulic "all-pipes" InfoWater model of the ISU.

Figure 1 highlights the existing system deficiencies based on the system performance objectives documented in **Table 1**. The deficiencies are also documented below. Further discussion of system performance is provided in **Section 4**.

- High pressures in Wat 6 at the border between Wat 5 and Wat 6.
- High pressures in Wat 5 at the border between Wat 4 and Wat 5.
- Low pressures in Wat 4 along border between Wat 4 and Wat 5.
- Fire flow deficiencies in Uptown core.
- Fire flow deficiencies in Wat 4B.
- Water quality deficiencies primarily at dead ends or undeveloped areas.
- Localized fire flow deficiencies throughout, primarily concentrated in existing cast iron watermain areas and at dead ends.



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Water Distribution Master Plan

Figure 1 - Existing Water System Performance

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
- Municipal Boundary
- River, Lake

Max Day Demand - Minimum Pressure
- <40 PSI
- 40-50 PSI
- 90-100 PSI
- >100 PSI

Available Fire Flow
- <80% of Target Fire Flow
- 80%-100% of Target Fire Flow

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3.1 Growth Areas

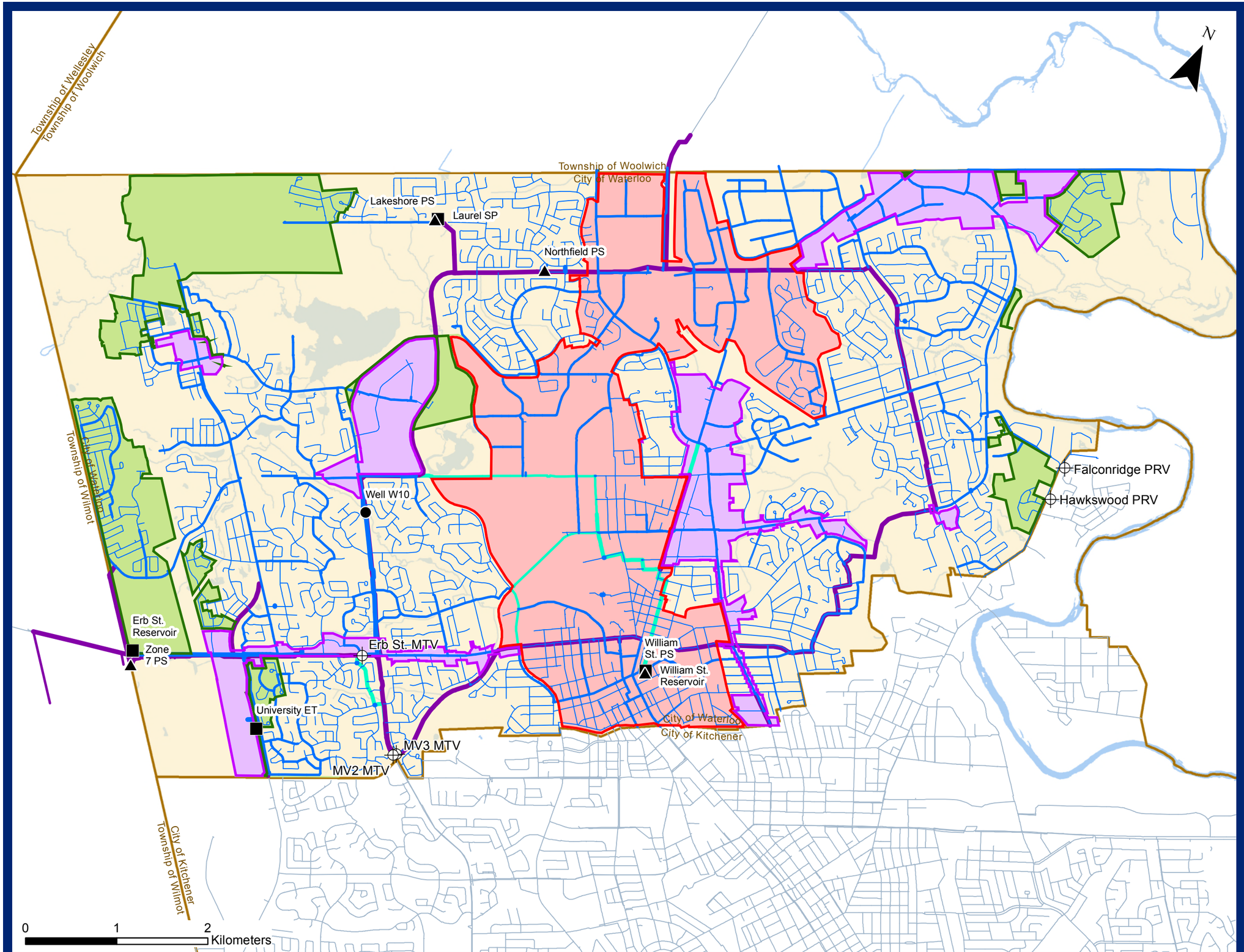
As outlined in **Technical Memo #5**, the 2031 planning scenario consists of growth of 37,269 residents, 4,200 students, and 25,527 jobs. Growth areas are described below and in **Figure 2**:

- LRT station areas, located in Wat 4, will experience the largest increase in people and jobs primarily through medium to high density buildings. Intensification is planned to occur along the new LRT route with the major growth in the Uptown core, Northdale neighbourhood and surrounding nearby intensification area. This is a key area for growth and subsequently future fire flows requirements in this area will no longer use existing land use but instead use a higher "City Center" fire flow requirement which better reflects needs due to larger building in closer proximity.
- Official plan corridor, located along Erb Street through Wat 4, Wat 5, and Wat 6, will experience the second largest increase in people and jobs through primarily medium to high density buildings.
- Designated Greenfield growth areas, located along the outer limits of the City in Wat 4, Wat 4C, and Wat 7, experiences the third largest increase in people and jobs through low density buildings. Deficiencies in these areas are primarily due to larger water ages from a lack of demand and limiting fire flows from a lack of looping. These deficiencies will be addressed through further design and development of these Greenfield areas.
- The remaining growth is expected to occur throughout the other areas of the City.

Table 2 summarizes total growth for the existing and future water demands by pressure zone.

Table 2 - Total Population Growth and Demands

	Wat 4	Wat 4B	Wat 4C	Wat 5	Wat 6	Wat 7
Residential	12,793	678	5,472	7,712	3,363	7,251
Student	4,200	0	0	0	0	0
Employment	17,231	432	712	3,859	1,891	1,402
Existing Average Day Demands (L/s)	254	22	6	52	44	<1
2031 Average Day Demands (L/s)	306	23	17	71	52	16



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Water Distribution Master Plan

Figure 2 - Growth Areas

Water Infrastructure

- Pumping Station
- Well
- Reservoir
- Valve

Growth Corridors

- LRT Station Areas - Medium - High Density
- Official Plan Corridor - Other Medium - High Density Growth
- Designated Greenfield Areas - Low Density Growth
- Remaining City Lands - Stable Areas

Watermain (mm)

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

Environmental Features

- Municipal Boundary
- River, Lake

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3.2 Regional Upgrades

The Region's WSDOMP identified a number of upgrades to the system which were implemented in the hydraulic analysis and evaluation of the future system performance. The Regional upgrades are planned to be completed by 2031 to contribute to supply and transmission of water through the IUS. The Regional upgrade projects are summarized in **Figure 3** and below. Additional project details are outline in **Technical Appendix #1**.

- Upgrade Strange St WTP to Include William Street Wells
  - Supply from William Street Wells is conveyed to the Strange St WTP and back to the City of Waterloo through the Weber St MTV
- Wat 5 Consolidation
  - Wat 4B, 4C, and 5 are consolidated into a single pressure zone through valving and additional Regional transmission infrastructure
- Waterloo North WTP
  - Additional source of supply for the City of Waterloo into the Laurel SP to be conveyed to Wat 4 and optional Wat 5 through the Lakeshore PS
- Erb Street Facility Capacity Restoration
  - Enhanced security of supply at the Erb Street Facility with emergency Wat 6 to 5 PRV

Figure 4 highlights the future system deficiencies. It should be reiterated that the proposed Region of Waterloo IUS system upgrades have been incorporated into the analysis of the future (2031) scenario. The Regional upgrades address a number of the existing system deficiencies; however, several of the identified existing system issues remain and growth does result in additional localized deficiencies. Further discussion of system performance is provided in **Section 4**.

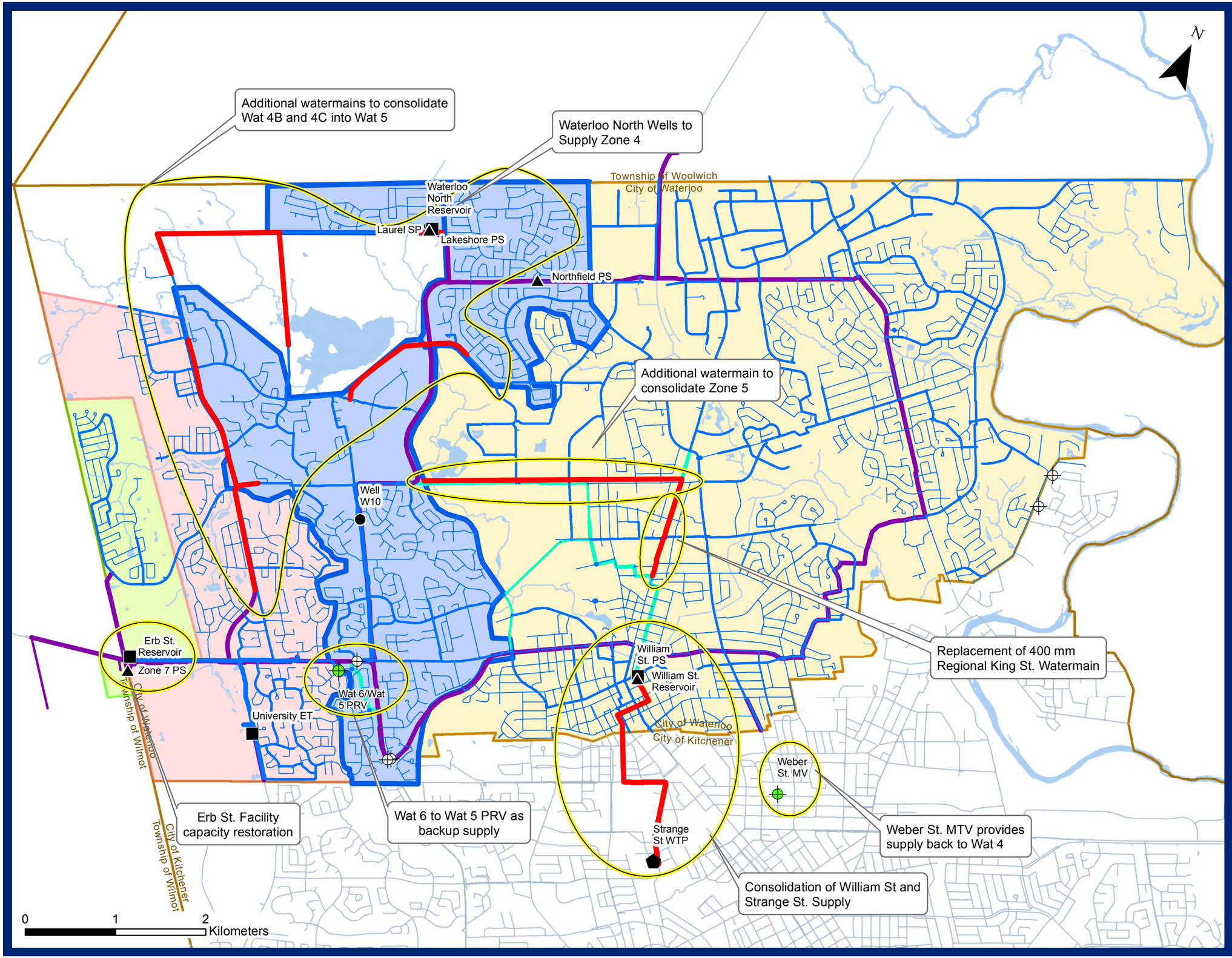

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Figure 3 - Regional WSDOMP Water System Upgrades

Water Infrastructure

- Pumping Station
- Treatment Plant
- Reservoir
- Well
- New Valves
- Valve

Watermain (mm)

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

Water Pressure Zone

- Wat 4
- Wat 7
- Wat 6
- 4B, 4C, and 5 to be consolidated into Wat 5

Environmental Features

- Municipal Boundary
- River, Lake

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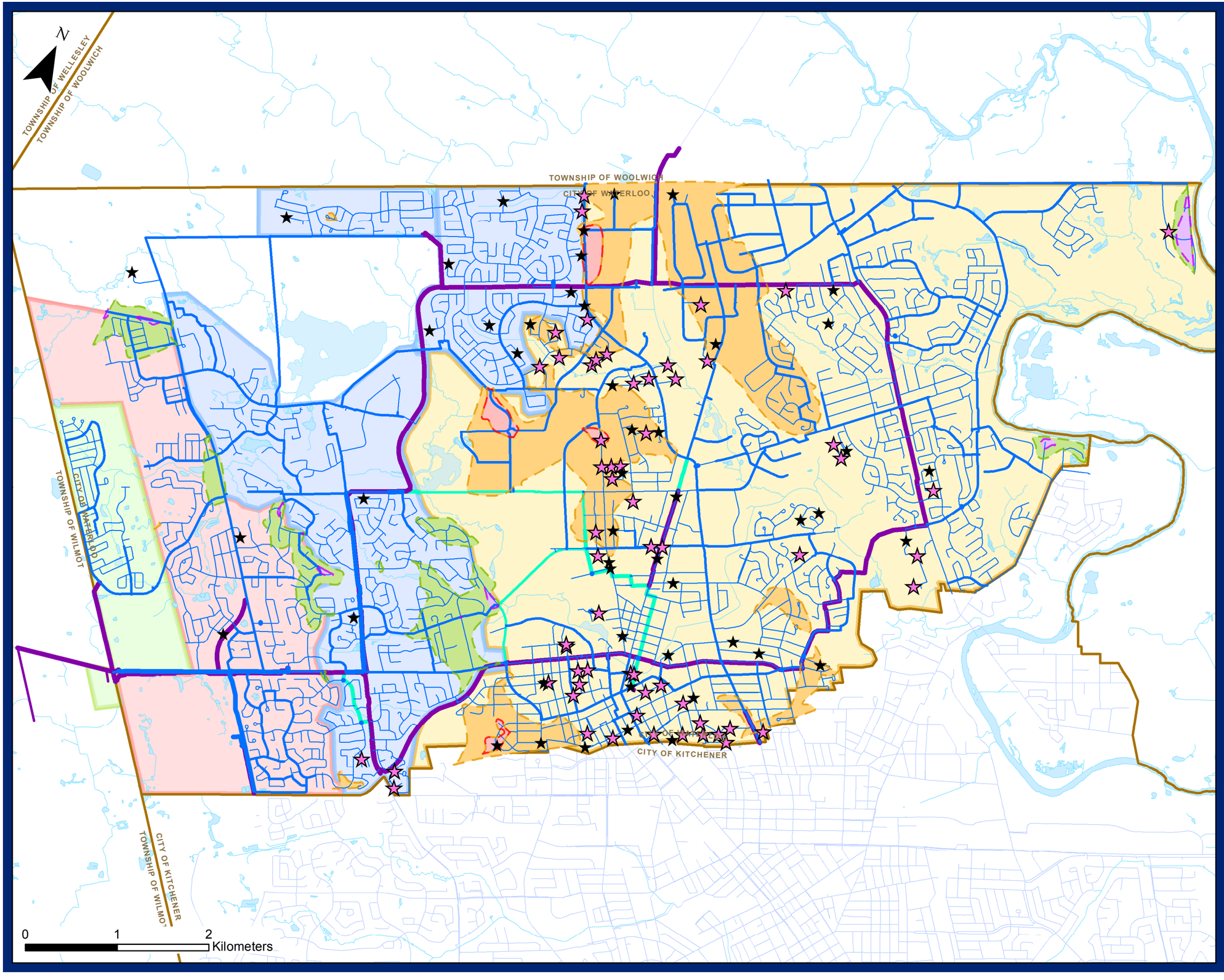

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Figure 4 - 2031 Water System Performance

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

Pressure Zone
- Wat 4
- Wat 5
- Wat 6
- Wat 7
- Municipal Boundary
- River, Lake

Max Day Demand - Minimum Pressure
- <40 PSI
- 40-50 PSI
- 90-100 PSI
- >100 PSI

Available Fire Flow
- <80% of Target Fire Flow
- 80%-100% of Target Fire Flow

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4 Summary of System Deficiencies

System deficiencies were classified in two (2) distinct groups:

1. Existing localized and independent system deficiencies not impacted by growth
2. "Clustered" areas of system deficiencies that may or may not be impacted by growth

4.1 Group 1 - Existing Localized Deficiencies

Existing localized system deficiencies not impacted by growth are mainly at dead ends, which are usually serviced by a smaller, older watermains. Other locations include areas with adjacent land uses requiring high fire flows, areas without proper system looping, or watermains in easements.

These areas are to be addressed through the City's infrastructure renewal program through completion of one of two interventions:

- Rehabilitation or replacement of older watermains with low C factors with a new waterman with the same nominal diameter; or
- Replacement of the existing watermain with a new larger watermain.

4.1.1 Dead-End Watermains

The City currently has 29 dead end watermains with fire flow deficiencies that are not in a Cluster Area. System dead ends represent unique locations within the water distribution system that can have conflicting level of service performance objectives. As outlined in **Technical Appendix #8**, an individual review of each dead end completed using the following criteria:

- In areas with existing water quality program 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

Figure 5 and **Table 3** summarizes the findings of the dead end upsizing review. In short, approximately 5.6 km of watermains can be upsized to address dead ends with fire flow deficient.

Table 3 - Dead End Upsizing Watermains Summary

Material	Length of Watermain to Rehab or Replace at Same Diameter	Length of Watermain to Upsize to a Diameter of 200 mm	Length of Watermain to Upsize to a Diameter of 300 mm
Cast Iron	1,060 m	1,220 m	820 m
Ductile Iron	130 m	180 m	540 m
PVC	-	760 m	880 m

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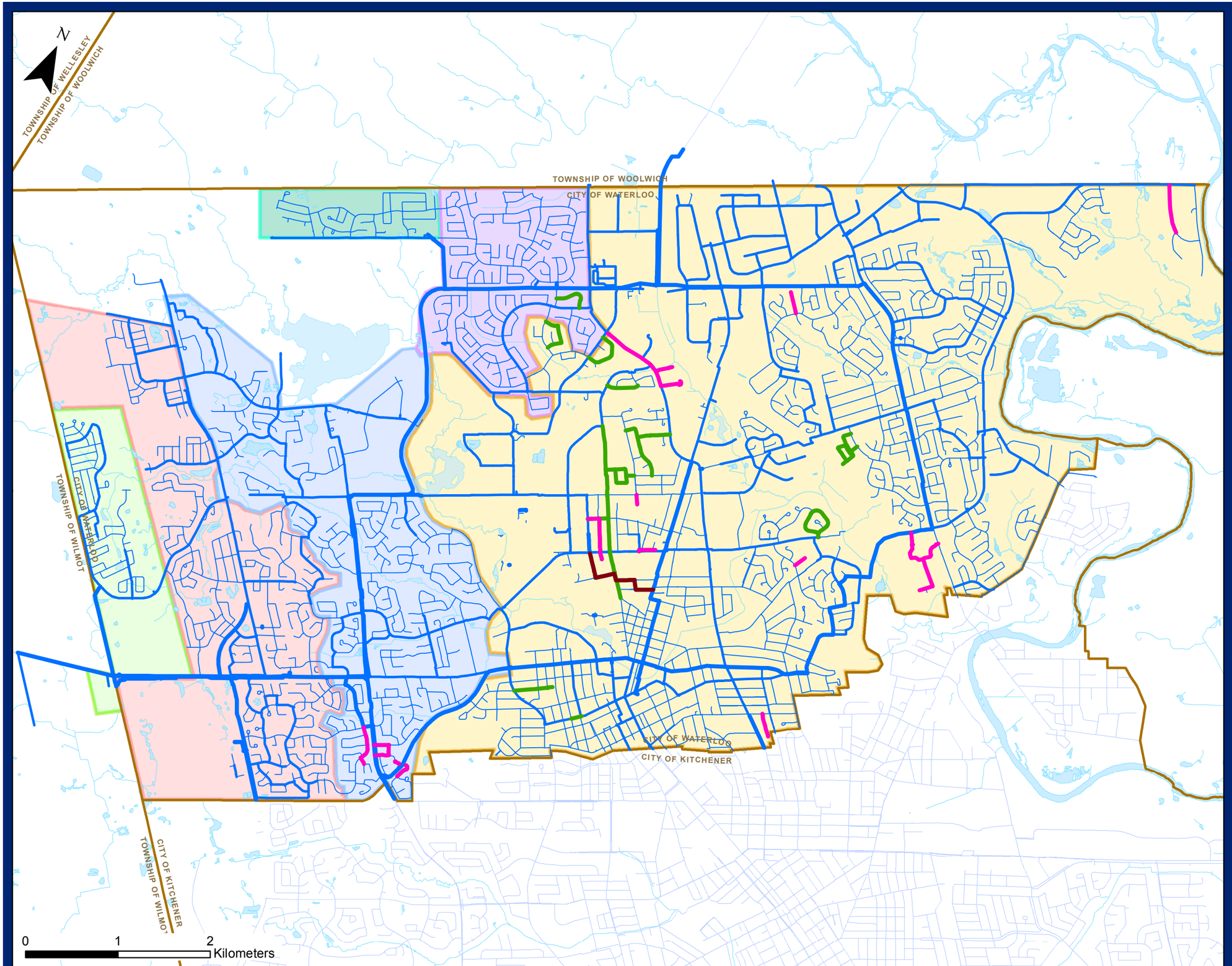
Figure 5 - SOGR and Dead End Upsized Watermains



Local Watermains

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

Changes in Infrastructure

- Dead End Upsized Watermains
- State of Good Repair Watermain Upsize
- 200 mm Downsize

Pressure Zone

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

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4.1.2 Easement Decommissioning

The City currently has 84 watermains which pass through an easement to provide a well looped water system. These watermains have high associated costs and are often difficult to perform maintenance on; as such, their decommissioning would be beneficial as not all are critical in providing an adequate level of service. An individual review of each easement was completed using the following criteria:

- Easement watermains receives 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
    - Additional areas of pressure with Flag or Action deficiencies
    - Experiencing 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 in >2% where future fire flows experience a Flag deficiency
    - Additional areas of water age more than 8 days old
    - **Note**: Watermain 10004358 should remain in operation until the Wat 5 transmission watermain on Beaver Creek Drive Road is completed to Conservation Drive

Figure 6 and **Table 4** summarize the findings of the easement decommissioning review. In short, approximately 22 of the 84 watermains which pass through an easement can be decommissioned.

Table 4 - Easement Watermains to be Decommissioned

Watermain ID	Watermain Length (m)	Watermain Material	Watermain Diameter (mm)	Easement Width (m)	Location
10006241	108	CI	150	3.6	159-172 Tennyson Pl
10006787	1	PVC	150	3.0 - 4.0	176 Tennyson Pl
10006088	3	CI	150	3.0 - 4.0	176 Tennyson Pl
10003923	110	PVC	200	4.5	269-271 Old Post Rd
10009743	58	CI	150	3.6	307-314 Shakespeare Pl
10009314	128	DI	150	2.3	33-37 Roosevelt Ave
10008009	93	CI	150	4.5	335-337 Craicleith Dr
10004195	1	DI	150	3.0	365-367 Lee Cir
10007869	62	DI	150	3.0	365-367 Lee Cir
10005567	3	DI	150	3.0	365-367 Lee Cir
10004823	87	DI	100	3.0	391-393 Craigleth Dr
10005742	6	DI	200	9.0	393-395 Stillmeadow Cres
10007568	84	DI	200	1.8	408 Clairbrook Cres
10007700	88	PVC	150	3.0	427-429 Barrington Ln

Watermain ID	Watermain Length (m)	Watermain Material	Watermain Diameter (mm)	Easement Width (m)	Location
10006776	50	DI	300	3.0	427-429 Winchester Dr
10009235	39	PVC	150	6.0	435 Malabar Dr
10009424	57	PVC	150	6.0	435 Malabar Dr
10003918	39	PVC	150	6.0	481-484 Citadel Ct
10007822	43	PVC	200	4.0	522 524Heather Hill Pl
10004358	98	PVC	300	8.5	804-806 Cedar Bend Pl
10007148	45	CI	300	4.4	82-84 Lillian Dr
10008833	116	PVC	300	3.0	North Of Beechwood Pl Condos
10008264	2	PVC	300	3.0	North Of Beechwood Pl Condos

N

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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Figure 6 - Easement Watermains to be Decommissioned

Local Watermains

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

Changes in Infrastructure

- Easement Watermains to be Decommissioned

Pressure Zone

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

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4.1.3 Summary of Group 1 Deficiencies

The Group 1 deficiencies represent existing issues are not expected to deteriorate over time and consist primarily of “Flag” deficiencies. Therefore, it was determined that proactive upgrade projects would not be triggered to address these Group 1 deficiencies. Instead, these deficiencies would be addressed on a case by case basis within the existing process to establish the City’s infrastructure renewal program. To this end, the final electronic deliverables provided to the City does identify the specific watermain upgrade recommendations needed to address these deficiencies (i.e. reline or replace with same diameter, replace with 200 mm watermain, etc.); however, no cost project cost or timing was recommended for these infrastructure renewal recommendations. It is expected that the funding will be derived from the City’s existing infrastructure renewal program, and the timing will be coordinated through the City’s Asset Management planning processes.

4.2 Group 2 – Clustered Areas of Deficiencies

The “clustered” system deficiencies were consolidated into a number of Cluster Areas, consisting of grouped deficiencies that can be resolved by a system improvement that impacts the integrated infrastructure components that are in the Cluster Area.

The follow section describes the identified Cluster Area, including a description of the identified deficiencies and potential solutions. In **Technical Appendix #8**, the potential solutions outlined to address the deficiencies in each Cluster Area are allocated into specific projects with associated costs and implementation timing.

4.2.1 Cluster Area A

Cluster Area A is located in Wat 6 at the border of Wat 5 and Wat 6 bordering along Leighland Drive and Keats Way. This area experiences high pressure exceeding 90 psi due to low elevations. Pressures exceed 100 psi on Amberwood Dr, Knightsbridge Court, and Clair Creek Boulevard due local low points. This area impacts 266 properties.

Reducing pressures in this area can be achieved through:

- Pressure zone boundary adjustment by servicing deficient area through Wat 5. This may require looping or installation of boundary valves to resolve dead ends.
- Modification of pressure zone supply operations through a reduction in pressure zone HGL.

Figure 7 highlights the high pressures in Cluster Area A.

4.3 Cluster Area B

Cluster Area B is located in Wat 5 at the border of Wat 5 and Wat 6 along Westvale Drive. This area experiences low pressures between 40-50 psi due to high elevations at the pressure zone boundary. This area impacts 74 properties.

Reducing pressures in this area can be achieved through:

- Pressure zone boundary adjustment by servicing deficient area through Wat 6. This may require looping or installation of boundary valves to resolve dead ends.
- Modification of pressure zone supply operations through an increase in pressure zone HGL.

Figure 8 highlights the low pressures in Cluster Area B.

4.4 Cluster Area C

Cluster Area C is located in Wat 4 at the border of Wat 4 and Wat 5 bordering along Westmount Road South, William Street West, and Avondale Avenue South. This area experiences low pressures between 40-50 psi due to high elevations at the pressure zone boundary. Pressures below 40 psi are experienced along McDonald Place, Stanley Drive, and Laurier Place due to higher elevations at these locations due to local high points. This area impacts 334 properties.

Reducing pressures in this area can be achieved through:

- Pressure zone boundary adjustment by servicing deficient area through Wat 5. This may require looping or installation of boundary valves to resolve dead ends.
- Modification of pressure zone supply operations through an increase in pressure zone HGL.

Figure 9 highlights the low pressures in Cluster Area C.

4.5 Cluster Area D

Cluster Area D is located in Wat 4 at the border of Wat 4 and Wat 5 along Columbia Street West, Weber Street North, Northfield Drive West and the area directly east of Highway 85 north of Lexington Road. This area experiences low pressures between 40-50 psi due to high elevations at the pressure zone boundary. Pressures below 40 psi are experienced along Hagey Boulevard, Albert Street and Phillip Street, and Weber Street North in the Industrial Area due to local high points. Presently, a number of properties experiencing pressures below 40 psi have installed privately owned booster pumps on their property to boost pressures. In addition to pressure issues, fire flow is limited at a number of locations due to older small diameter watermains which do not receive adequate flow at their hydrants. This area impacts 1632 properties.

Reducing pressures and increasing fire flows in this area can be achieved through:

- Pressure zone boundary adjustment by servicing deficient area through Wat 5. This may require looping or installation of boundary valves to resolve dead ends.
- Modification of pressure zone supply operations through an increase in pressure zone HGL.
- Replacement or upsizing of watermains to increase available fire flow.

Figure 10 highlights the low pressures in Cluster Area D.

4.6 Cluster Area E

Cluster Area E is located in Wat 4 in the intensification area located in Uptown Waterloo, Northdale Neighbourhood, and surrounding area. Increasing fire flow needs due to intensification in the area results in a deficient available fire flows.

Increasing fire flows in this area can be achieved through:

- Rehabilitation or replacement of older watermains with low C factors
- Upsizing watermains with smaller diameters

Figure 11 highlights the low pressures in Cluster Area E.

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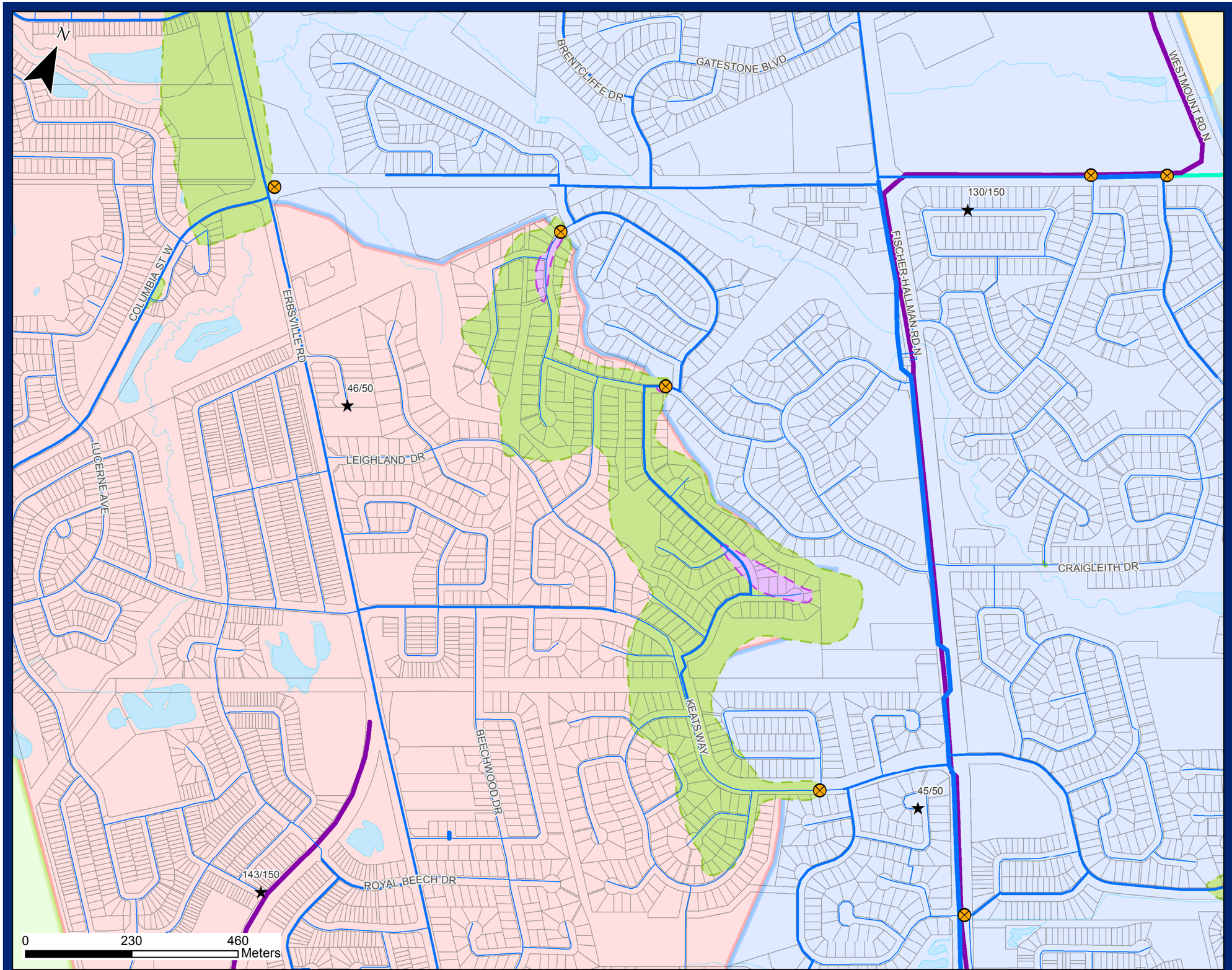
Figure 7 - Water System Upgrade Alternative
Cluster Area A - Baseline



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

Valves
- Closed Valve

Pressure Zone
- Wat 4
- Wat 5
- Wat 6
- Wat 7
- Municipal Boundary
- River, Lake

Max Day Demand - Minimum Pressure
- <40 PSI
- 40-50 PSI
- 90-100 PSI
- >100 PSI

Fire Flow
- <80% of Target Fire Flow
- 80%-100% of Target Fire Flow

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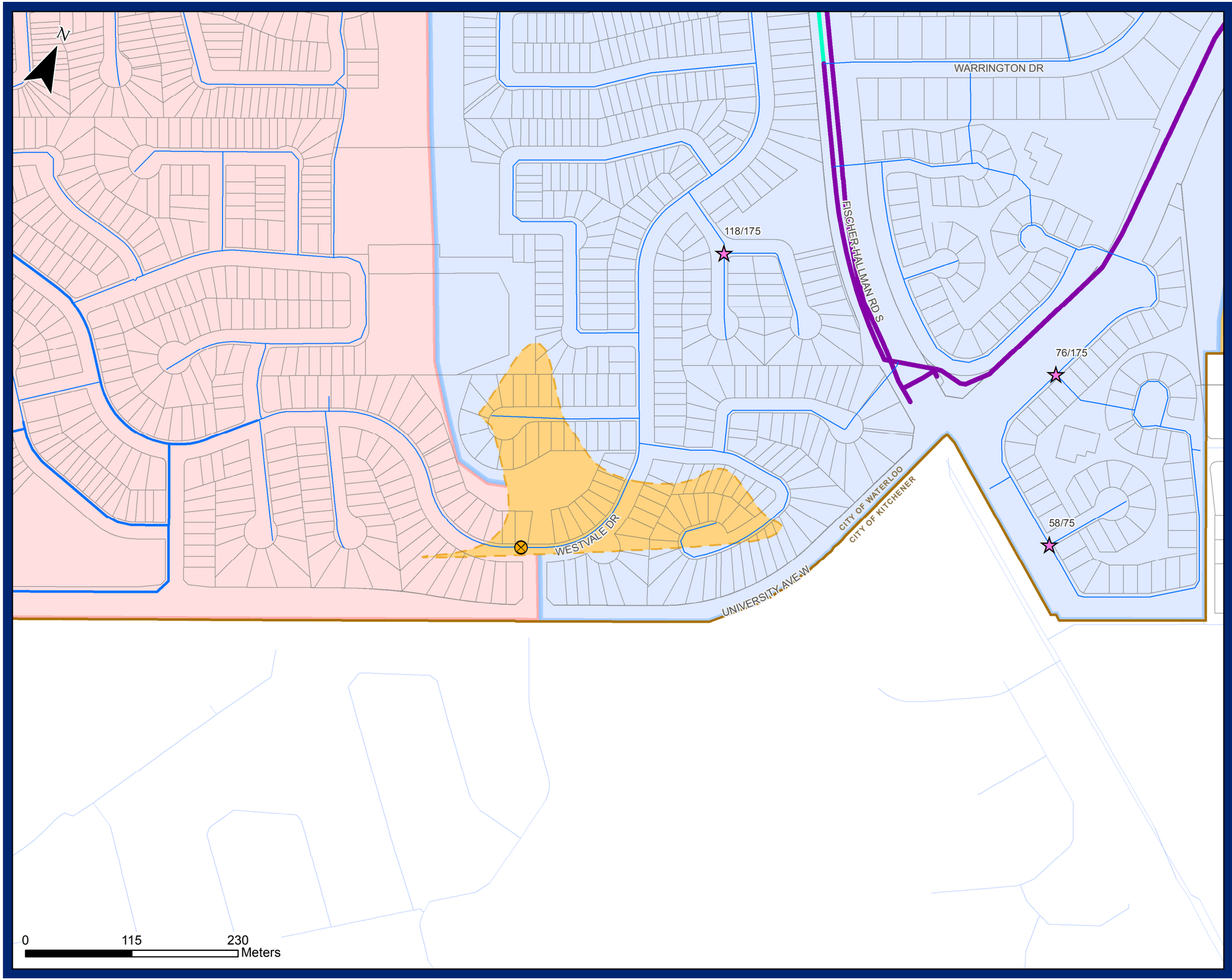
Figure 8 - Water System Upgrade Alternative
Cluster Area B - Baseline



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

Valves
- Closed Valve

Pressure Zone
- Wat 4
- Wat 5
- Wat 6
- Wat 7
- Municipal Boundary
- River, Lake

Max Day Demand - Minimum Pressure
- <40 PSI
- 40-50 PSI
- 90-100 PSI
- >100 PSI

Fire Flow
- <80% of Target Fire Flow
- 80%-100% of Target Fire Flow

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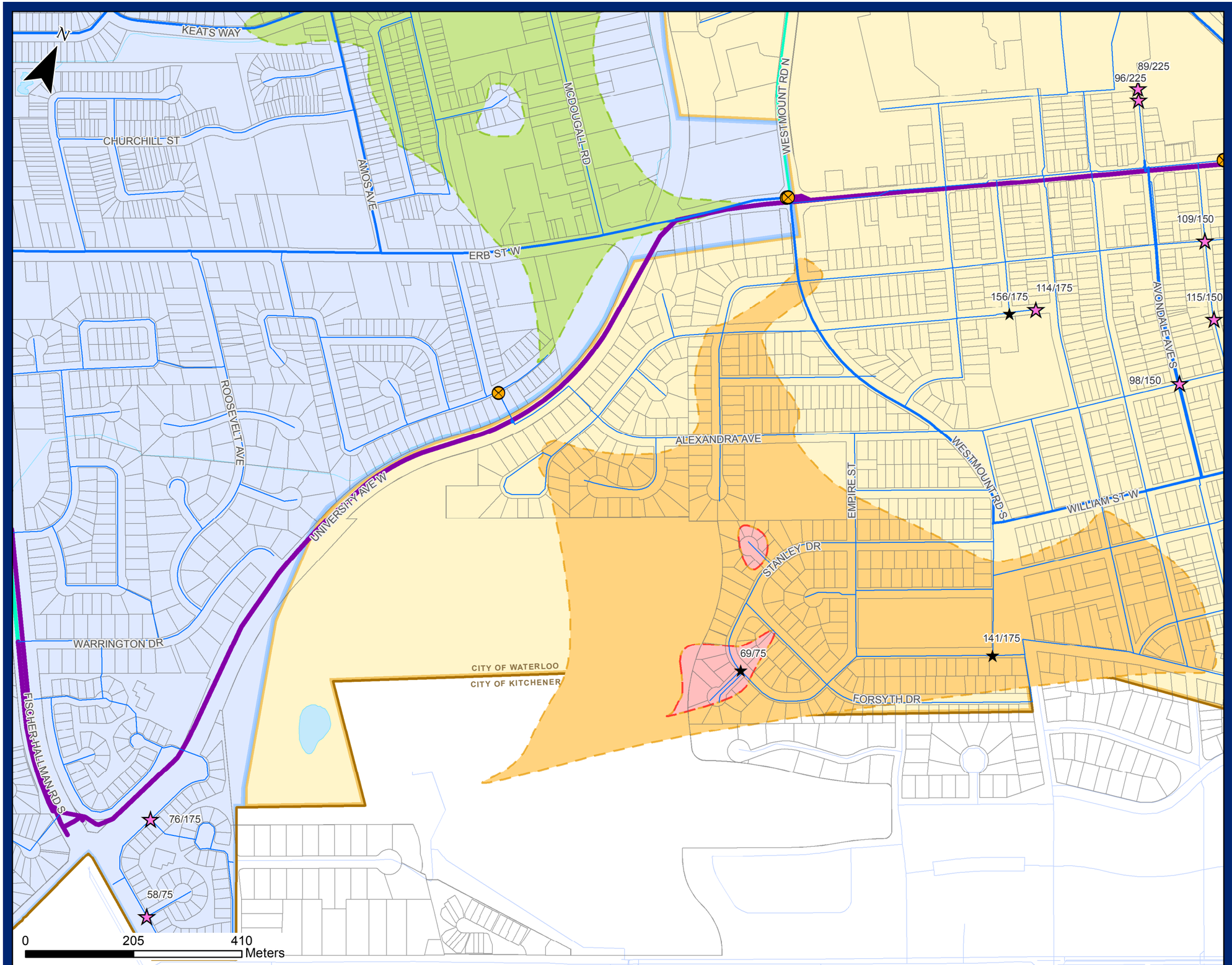
Figure 9 - Water System Upgrade Alternative
Cluster Area C - Baseline



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

Valves
- Closed Valve

Pressure Zone
- Wat 4
- Wat 5
- Wat 6
- Wat 7
- Municipal Boundary
- River, Lake

Max Day Demand - Minimum Pressure
- <40 PSI
- 40-50 PSI
- 90-100 PSI
- >100 PSI

Fire Flow
- <80% of Target Fire Flow
- 80%-100% of Target Fire Flow

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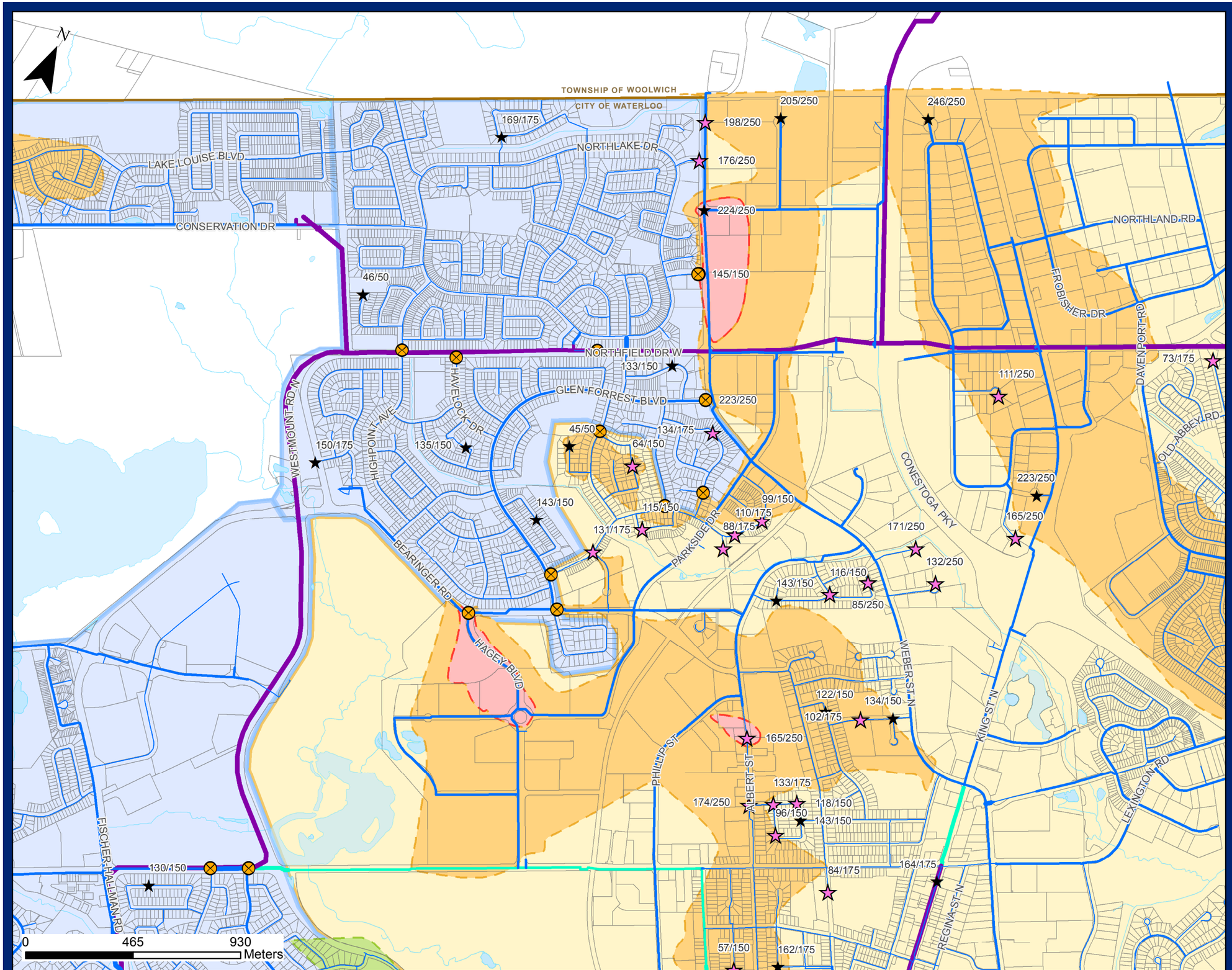

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Figure 10 - Water System Upgrade Alternative
Cluster Area D - Baseline

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

Valves
- Closed Valve

Pressure Zone
- Wat 4
- Wat 5
- Wat 6
- Wat 7
- Municipal Boundary
- River, Lake

Max Day Demand - Minimum Pressure
- <40 PSI
- 40-50 PSI
- 90-100 PSI
- >100 PSI

Fire Flow
- <80% of Target Fire Flow
- 80%-100% of Target Fire Flow

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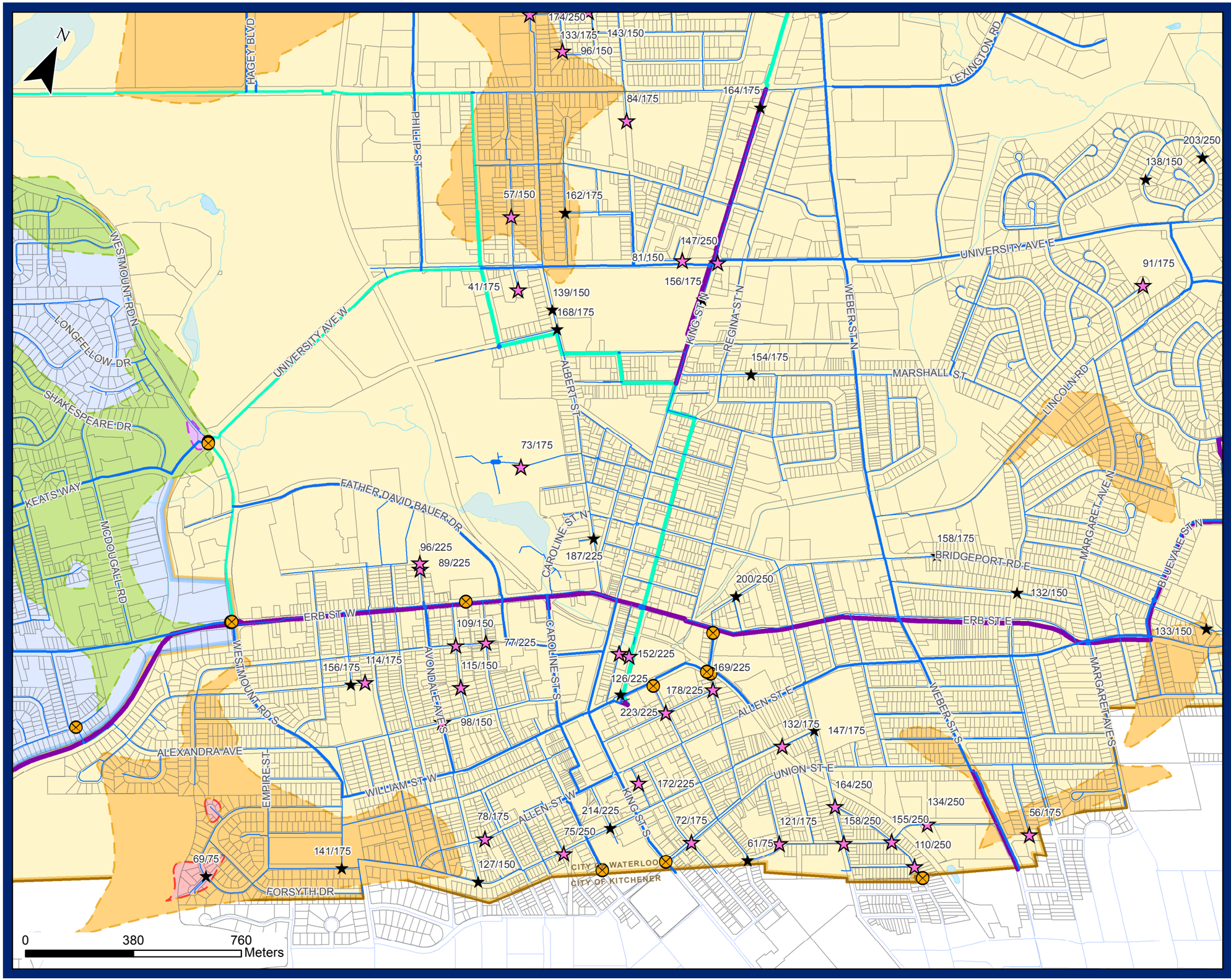

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Figure 11 - Water System Upgrade Alternative
Cluster Area E - Baseline

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

Valves
- Closed Valve

Pressure Zone
- Wat 4
- Wat 5
- Wat 6
- Wat 7
- Municipal Boundary
- River, Lake

Max Day Demand - Minimum Pressure
- <40 PSI
- 40-50 PSI
- 90-100 PSI
- >100 PSI

Fire Flow
- <80% of Target Fire Flow
- 80%-100% of Target Fire Flow

BluePlan ENGINEERING

615036-1-W
January 2017
Data Source: City of Waterloo
Scale: 1:13,000 | NAD 1983 UTM Zone 17N

4.7 Highway 85 Crossings

A supplementary review of the Highway 85 crossings was completed in order to develop a long-term Highway 85 crossing strategy. The summary of this review is included in **Technical Appendix #7**.

The summary of the Highway 85 Crossings Review is as follows:

- The City does not need to repair the Lexington crossing as adequate system performance can be achieved through the Region owned Northfield and University highway crossings.
- Abandoning the crossing does cause available fire flows to drop, however they remain above target land use requirements. There is an opportunity to minimize the localized drop in available fire flows within the high fire flow industrial and commercial area along Lexington Road, Lexington Court, and Dearborn Boulevard through the upsizing of 213 m of watermain along Forwell Creek Road from a diameter of 200 mm to 300 mm.
- Abandonment of the Lexington crossing does create water quality concerns; however, it is expected that water quality can be managed through the installation of an auto flusher just to the west of the Highway. Use of an auto flusher is preferred as re-servicing the Lexington Road properties from the back, along Lexington Court, would complicate future re-development of these properties.
- The King crossing needs to be maintained due to its importance in maintaining system resiliency in the event of a Northfield crossing outage.