Technical Appendix 8 - Implementation and Capital Program

1 Appendix Introduction

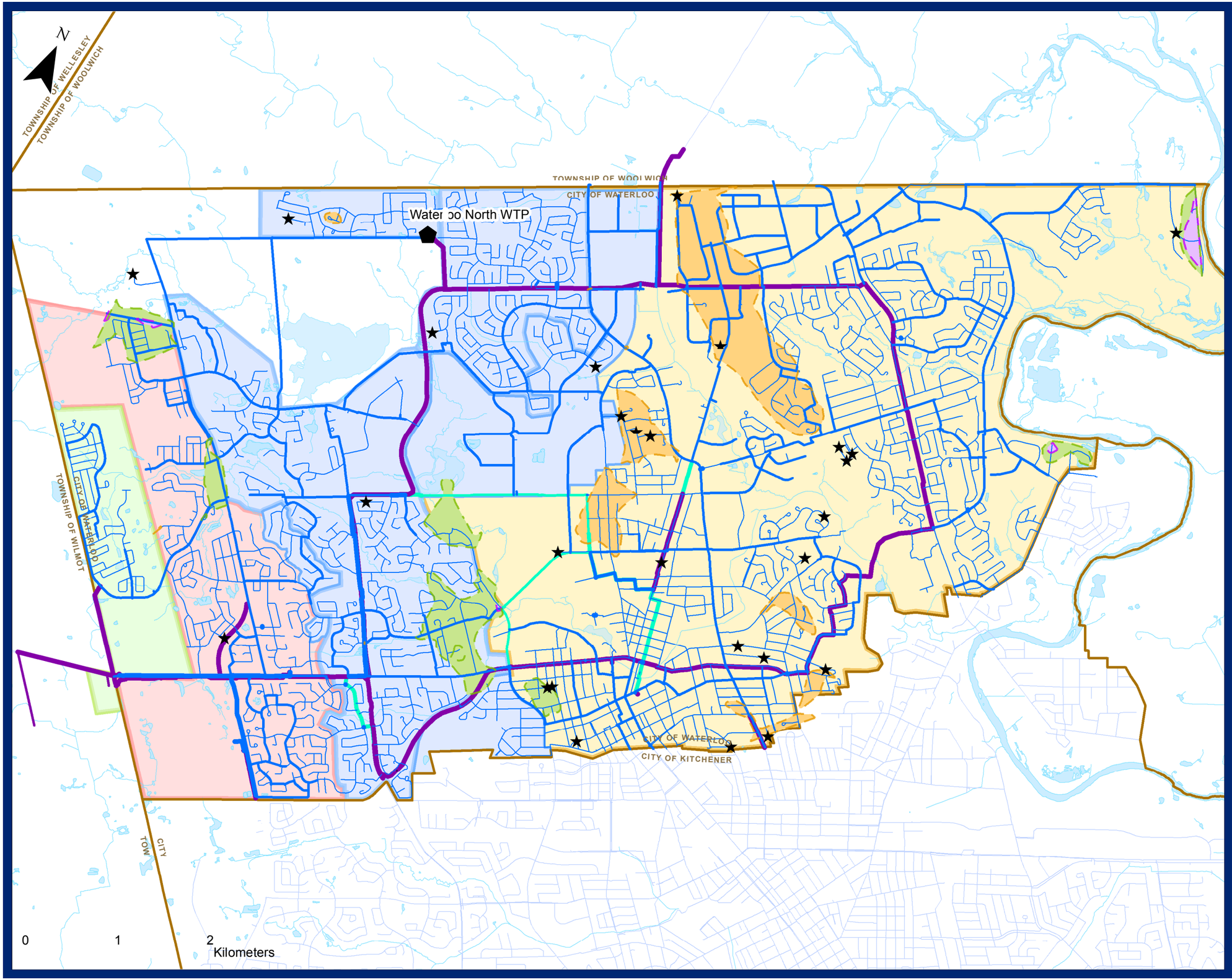
This Technical Appendix is intended to summarize the recommended strategy to implement the recommended alternatives. The implementation strategy will support the City's existing process to establish and execute capital projects and operating activities. In some cases, the information provided is designed to be incorporated into the City's annual decision making processes and therefore does not provide an explicit recommendation on the timing to implement the recommended alternative.

2 Preferred Servicing Strategy

The preferred alternatives for each Cluster Area and other additional areas are combined for a final preferred water distribution system which will service the City of Waterloo up to 2031. The performance of the final alternative is presented in **Figure 1**. This 2031 water distribution system relies on the implementation of the following Regional infrastructure:

- **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
  - Conveyance of William Street Wells flows to the Strange Street Water Treatment Plant
- **Weber Street MTV Control Valve**
  - Upgrade to Weber Street MTV Control Valve to accommodate increase flow transfers into Wat 4
- **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 Tank 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

Table 1 summarizes the recommended system upgrades along with estimated cost and Class EA schedule. Where appropriate, recommended upgrades have been organized into project groups based on their resulting “Cluster Area”.



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Water Distribution Master Plan

Figure 1 - 2031 Water System Performance With All Preferred Alternatives

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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Data Source: City of Waterloo
Scale: 1:40,000 | NAD 1983 UTM Zone 17N

Table 1 - Recommended System Upgrades

Cluster Area	Project	Project Description		Estimated Cost	Class EA Schedule
A	Pressure Zone Boundary Adjustment	Install new boundary valves at existing valve locations:	• 10030626 • 10032238	$70,000	A
		Close existing isolation valves:	• 10035396	$1,000	
		Open existing isolation valves:	• 10033966 • 10029557 • 10034175	$3,000	
C	Pressure Zone Boundary Adjustment	Close existing isolation valves:	• 10028998 • 10033828 • 10032664 • 10036652 • 10030362 • 10036598	$6,000	A
		Install new closed valves:	• On Dietz Avenue South at Westmount Road South • On William Street West at Westmount Road South	$35,000	
		Open existing isolation valve:	• 10034940	$1,000	
	Install New Watermains to Eliminate Dead Ends	• Twin 30 m at Erb Street West and Westmount Road South for valve isolation • Twin 400 m on Westmount Road South from Dawson Street to Alexandra Avenue • Twin 230 m on Westmount Road South from William Street West to John Street West		$741,000	A
D	Pressure Zone Boundary Adjustment	Install new boundary valves at existing valve locations:	• 10029518 • 10033825 • 10029998	$104,000	A
		Close existing isolation valves:	• 10034988 • 10033369 • 10033526 • 10028476 • 10028966 • 10029674	$5,000	
		Install new closed valves:	• On Weber Street North at Northfield Drive West	$17,000	
		Install new check valve:	• On Kumpf Drive at Northfield Drive West	$86,000	

Cluster Area	Project	Project Description	Estimated Cost	Class EA Schedule
		Open existing isolation valve: • 10030917 • 10029755 • 10030754 • 10036282 • 10036782 • 10035168 • 10035860 • 10032860 • 10029406	$7,000	
	Install New Watermain to Supplement Supply to Wat 4	• Twin 25 m at Phillip Street and Columbia Street West for valve isolation • Twin 25 m at Weber Street North and Northfield Drive West for valve isolation • Twin 550 m on Weber Street North from Northfield Drive West to Parkside Drive	$674,000	A
	Install New Trunk Regional Watermain to Supplement Supply to Wat 4	• New trunk watermain on Columbia Street West from Westmount Road North to King Street North requiring old Columbia Street West watermain to be retained and used to service Wat 5	-	A
E	Replacement and/or Upsizing of Watermains to a Minimum Diameter of 200 mm	• Replacement and/or upsizing of watermains in the Uptown core, Northdale neighbourhood, and intensification area to a minimum diameter of 200 mm	$40,435,000	A
Watermain Upsizing	Non-Growth Related Watermain Upsizing	See **Appendix A**	-	A

2.1 Vulnerable Occupancies

In line with the WDMP servicing principles, the recommended upgrades are not expect to not disrupt/decrease the water flows/pressure available to the City of Waterloo's vulnerable occupancies. **Table 2** summarizes the pre/post performance at all Vulnerable Occupancies.

A number of properties experience a slight decrease in fire flows with the implemented WDMP upgrades; however, the fire flows at each property remains above its target level of service objective outlined in **Technical Appendix #3**. It should be noted that prior to decommissioning watermains 10009235 and 10009424, the Waterloo Fire Rescue should be consulted as the decommissioning will decrease available fire flow at the vulnerable property located at 444 Malabar Drive.

It should be noted that all provincially defined vulnerable occupancies are required-or will be required over the next eight years-to have sprinkler systems. These sprinkler systems are required to meet one of several NFPA standards (i.e. 13, 13R, or 13D) depending on what type of vulnerable occupancy is being protected. The presence of a compliant sprinkler system allows a vulnerable occupancy's evacuation time to be increased, and therefore, water system upgrades that disrupt water flows/pressures could negatively impact the occupancy's ability to comply with required evacuation times. As a result, impacted vulnerable occupancies may not be able to comply with the OFC, and a fire safety risk may also be created.

Waterloo Fire Rescue's Fire Prevention Division should be informed whenever a water system upgrades is going to occur that will negatively impact a vulnerable occupancy's sprinkler system water supply. A request for service should be sent to WFR-FPD's Admin.

Table 2 - Available Fire Flows at Vulnerable Occupancies

Address	Available Fire Flow (L/s)		
	Existing	2031 with Regional Upgrades	2031 with Regional and WDMP Upgrades
446 Kingscourt Drive	173	170	169
545 Stanwood Crescent	158	156	156
670 Monarch Place	95	235	271
41 Ridgeview Crescent	291	300	253
444 Malabar Drive	142	141	81
41 Laurel Street	203	200	477
25 Westhill Drive	636	629	652
413 Forrestlawn Road	184	181	183
530 Columbia Street West	429	423	422
305 Erb Street West	486	536	541
331 Crimson Crescent	151	149	172
139 Father David Bauer Drive	644	627	657
30 Thornbush Crescent	179	181	182
250 Laurelwood Drive	381	679	699
650 Mountain Maple Avenue	212	209	196
720 New Hampshire Street	530	512	520
241 Pastern Trail	283	279	282
492 Bridge Street	209	206	207

Address	Available Fire Flow (L/s)		
	Existing	2031 with Regional Upgrades	2031 with Regional and WDMP Upgrades
229 Lexington Road	519	499	381
726 New Hampshire Street	503	487	494
325 Cornridge Place	46	46	105
521 Paradise Crescent	310	308	279
141 Father David Bauer Drive	626	611	632
100 Caroline Street South	593	576	657

3 Implementation of Capital Program

The implementation of the preferred alternatives is guided by an understanding of the specific triggers that will result in the need for the alternative. This process allows for works to be initiated as they are needed to meet MOECC requirements, support water demands, and/or align with other projects within the IUS. By not relying on specific timing for projects to commence, projects can be completed on a priority basis if/when they are required.

The implementation strategy of the preferred alternatives fall into three categories:

- **Type 1**
  - Preferred alternative can be implemented without any preceding activities being completed
  - These activities are funded by the operating budget
- **Type 2**
  - Preferred alternative requires the completion of specific Regional projects before it can be implemented
  - Implementation of the preferred alternative requires a full design, tender & inspection project
  - These projects are funded by the capital budget
- **Type 3**
  - Implementation of preferred alternative should be aligned with related capital projects or operating activities
  - Implementation of the preferred alternative requires a full design, tender & inspection project
  - These projects are funded by the capital budget

Table 3 summarizes each preferred alternative by trigger type and if needed, required completed works.

Table 3 - Implementation Trigger for Preferred Alternatives

Recommended Upgrades	Trigger Type	Project Trigger	Assumed Budget
Cluster Area A – Pressure Zone Boundary Adjustment along Keats Way	Type 1 – Project can commence at any time	The pressure zone boundary adjustment can occur at any time.	Operating
Cluster Area C – Pressure Zone Boundary Adjustment to Westmount	Type 3 – Project can commence as aligned work commences	The pressure zone boundary adjustment requires the watermain along Westmount Drive South to be twinned. A Regional project to repave Westmount Drive South is planned for 2020-2021 and the watermain installation and valve installation/ reconfiguration should be aligned with this project.	Operating
Cluster Area D – Pressure Zone Boundary Adjustment to Parkside Drive	Type 2 – Project can commence once Regional projects have been completed	The pressure zone boundary adjustment requires the completion of the Regional trunk watermain along Columbia Street West from Westmount Road North to King Street North which will service Wat 4. The existing Columbia Street watermain will service the new Wat 5. The Waterloo North Water Treatment Plant (Regional project) must be completed with servicing capabilities to the existing Lakeshore Pumping Station from the Laurel Tank. The Lakeshore Pumping Station will provide the new Wat 5 with adequate supply to meet water demands to 2031. The completion of these works are planned for after 2020.	Operating
Cluster Area E – Upsizing of Watermains in Uptown, Northdale, and Intensification Areas	Type 3 – Project can commence as aligned work commences	The upsizing and/or replacement of watermains in Uptown, Northdale or surrounding intensification areas will be aligned with specific development proposal or other right-of-way infrastructure renewal plans.	Capital
Additional Fire Flow Deficiencies – Rehab, Replacement, or Upsizing	Type 3 – Project can commence as aligned work commences	The rehabilitation, replacement, and/or upsizing of watermains causing fire flow deficiencies should be incorporated into the City's integrated infrastructure renewal planning processes to align with specific development proposal or other right-of-way infrastructure renewal plans.	Capital
Easement Watermain Decommissioning	Type 1 – Project can commence at any time	The abandonment or decommissioning of easement watermains can occur at any time.	Operating

4 Prioritization of Projects

The prioritization of each project is meant to assist the City to more accurately plan their operating and capital budget to 2031.

4.1 Prioritization of Type 1 projects

Type 1 projects are those which can commence based on the assumption that they will be funded through the operating budget. These projects are prioritized by the number of properties which experience a resolution to regulatory or Action deficiencies. The preferred alternative for Cluster Area A resolves the Action deficiency of pressure exceeding 100 psi; as such, commencement of this project is of higher importance. The decommissioning of the easement watermains should be coordinated within the City's ongoing infrastructure renewal process. **Table 4** details the prioritization of Type 1 projects.

Table 4 - Prioritization of Type 1 Projects

Type 1 Prioritization	Preferred Alternative
1	Cluster Area A – Pressure Zone Boundary Adjustment along Keats Way
2	Easement Watermain Decommissioning

4.2 Prioritization of Type 2 projects

The only Type 2 project is the preferred alternative for Cluster Area D which is aligned with Regional watermain on Columbia Street West, operations initiation at Waterloo North WTP, and reconfiguration of the Lakeshore PS. The City needs to discuss the City planned work associated with Cluster Area D with the Region such that project work along the same alignments can be completed in unison through the same design consultant. **Table 5** details the prioritization of Type 2 projects.

Table 5 - Prioritization of Type 2 Projects

Type 2 Prioritization	Preferred Alternative
1	Cluster Area D – Pressure Zone Boundary Adjustment to Parkside Drive

4.3 Prioritization of Type 3 projects

Type 3 projects are those which can commence in alignment with other capital projects or operating activities. The prioritization of these projects are separated in growth and non-growth related projects.

Growth related projects, up to the year 2031, are those occurring in Cluster Area E which require the watermains to be upsized to a minimum diameter of 200 mm in this intensification area. As the Cluster Area has 36 km of watermain which needs to be replacement and/or upsized, prioritization should occur first with planned development and then, in accordance with other related right-of-way improvements. Over the next 15 years, to 2031, the City can plan for a growth related replacement of 2.4 km of watermain per year. **Table 6** details the prioritization of Type 3 growth related projects.

Table 6 - Prioritization of Growth Related Type 3 Projects

Type 3 Growth Prioritization	Preferred Alternative
1	Cluster Area E – Watermain Upgrades to service planned intensification

Non-growth related projects include Cluster Area C – Pressure Zone Boundary Adjustment to Westmount and the replacement or upsizing of watermains relating to deficient fire flows. These projects are prioritized by the number of properties which experience a resolution to regulatory or Action deficiencies. The preferred alternative for Cluster Area C resolves the Action deficiency of pressure below 40 psi; as such, commencement of this project is of higher importance. The remaining watermains which are those which are related to both Action and Flag fire flow deficiencies. These projects should be done when aligned with other deficient right-of-way infrastructure or during the state of good repair program. As such, the City should plan to replace 1 km of watermain per year as part of their capital program. **Table 7** details the prioritization of Type 3 non-growth related projects.

Table 7 - Prioritization of Non-Growth Related Type 3 Projects

Type 3 Non Growth Prioritization	Preferred Alternative
1	Cluster Area C – Pressure Zone Boundary Adjustment to Westmount
2	Deficient Fire Flow Watermains – Aligned Right-of-Way Infrastructure Upgrades Triggered Watermain Upgrades

4.4 Asset Management Systems Integration

To support the integration of the recommendations provided in this Water Distribution Master Plan, the electronic deliverables (excel table and shapefile) contain a complete list of the City's watermains, including their recommended future diameter and classification as a growth or non-growth related project. This information, along with the upgrade prioritization outlined in the WDMP, will be utilized by the City to support their asset management planning process and project prioritization and phasing.

5 Impacts to Regional Infrastructure

The preferred alternatives suggested in the WDMP do result in changes to the overall transmission pumping and storage needs, due primarily to the re-alignment of pressure zone boundaries. A number of the identified zone boundary changes had already been identified and accounted for in the Region's WSDOMP. However, the WDMP has identified further zone boundary changes, in particular, a significant expansion of the Wat 5 service area and demands demonstrated in **Table 8**. To support the Wat 5 expansion there will be an increased reliance on the new Waterloo North WTP and Laurel Tank through the Lakeshore PS to support peak flows. As such, the Region must continue to operate and maintain the Lakeshore PS indefinitely. **Table 9** demonstrate the WDMP proposed 2031 Wat 5 total available and theoretical available supply needs as compared to the Region's WSDOMP.

Table 8 –2031 Zone Demands

Pressure Zone	2031 Demands without WDMP Upgrades (L/s)	2031 Demands with WDMP Upgrades (L/s)
Wat 4	309	278
Wat 5	114	150
Wat 6	53	48
Wat 7	17	17

Table 9 – Wat 5 Supply Needs

Facility	Source Capacity (L/s)	Wat 5 Supply Capacity (L/s)
Erb St Reservoir	245	219
Mannheim Kit 5 (through MV2)	350	189
Lakeshore/ Waterloo North	75	75
Total Available Supply		455 (380 w/o Waterloo North)

A review of the supply needs indicates that there is sufficient surplus capacity in the Region's infrastructure to support the proposed WDMP changes.

6 Additional Recommendations

In addition to the specific recommendations to address the system deficiencies, the following general recommendations are provided for consideration by City staff in their efforts to manage the water distribution system:

6.1 Master Planning Renewal

The City is recommended to complete regular updates to its Water Distribution Master Plan, on a five-year cycle, to review and revise the proposed water system upgrade strategy to account for:

- The implementation of the recommended upgrade projects
- The implementation of Regional projects and/or changes in the Region's long term system operational strategy
- Changes in baseline system demands and projected growth
- Changes in federal and/or provincial regulations and/or City level of service objectives

6.2 Boundary Meter Program

As identified in this Master Plan, the City's water system has several interconnections to external systems. These interconnections consist of closed and unmetered valve connections, open metered connections, and open unmetered connections. **Figure 2** highlights the System's current interconnections.

Upon completion and approval of this Master Plan, it is recommended that the City undertake a review to investigate and confirm the status of all existing system inter-connections, and implement a program to install, monitor, and maintain boundary billing meters at all open interconnections.

6.3 Zone Boundary Implementation and Consultation Plan

This Master Plan identifies several zone boundary realignments. As such, it is recommended that the City create a general zone boundary implementation and consultation plan to outline:

- The process to consult with and inform the public of any planned change(s) in system pressure
- Development of a clear implantation plan to ensure maintenance of service, which would include a valve opening-and-closing staging program and the required flushing process to ensure adequate water quality
- Any changes required of the City's current local operation and maintenance practices, including modifications to the City's regular flushing program

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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 2 - Existing Intermunicipal Connections

Local Watermains

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

Boundary Meters and Valves

- Closed Valves
- Unmetered
- Metered

Pressure Zone

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

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Data Source: City of Waterloo
Scale: 1:40,000 | NAD 1983 UTM Zone 17N

6.4 Review of Hydrant Flushing Program

As part of City's ongoing chlorine residual management, operations should review the results of the system's water age analysis and identify existing hot sports of high water age.

The City should continue their ongoing in field chlorine measurements as part of the hydrant flushing, and continue to revise the frequency of the flushing program based on the results of the field investigation.

- Identified hot spots not currently within the City current flushing program, as well as,
- Flushing locations not identified as water age hot spots

The City should consider ongoing refinement of the hydraulic water quality model using infield chlorine residual reading in an effort to further optimize the City residual management program.

Further, at locations requiring regular system flushing, the City should explore the installation of automated flushing devises, equipped with water meter to track usage, in an effort to reduce the total operational and maintenance costs associated with the City's residual management program.

6.5 Hydrant Testing Program

Improvements and/or modifications of the City's flushing program should incorporate the collection of hydrant flow and pressure readings. This information should tie directly to hydrant asset ID and be recorded within the City's GIS database. This additional system performance information will improve current system understanding and support future infrastructure planning studies and updates to the hydraulic model.

6.6 Valve Turning Program

The valve exercising program should be adjusted to include using a hydrophone to confirm that certain critical isolation valves are properly seated and are operating as intended when in a closed position.

As part of the valve turning program, the City should establish appropriate protocols to track and replace any/all valves that do not fully operate.

6.7 Non-Review Water Audit and Reduction Strategy

The City should undertake non-revenue water reduction analysis in an effort to develop a comprehensive Non-Revenue Water Reduction Strategy and Remediation Plan. The goal of the strategy would to identify operational procedures and to identify locations where the rehabilitation or replacement of existing watermains in order reduce the total volume of lost water. This Non-Revenue Water Reduction Strategy and Remediation Plan will support the City's long-term non-revenue water targets.

The scope of activities that may be included in Non-Revenue Water Reduction Strategy and Remediation Plan includes:

- Annual residential water meter replacements;
- Large industrial, commercial or institutional (ICI) meter replacements;
- Testing of decommissioned water meters to establish degradation curves (aids in estimating NRW and establishing life-cycle replacement schedules);
- Leak detection programs for watermains;
- Watermain replacements
- Tracking fire use more accurately
- Tracking new construction use (non-metered)
- Zone metering to determine NRW
- Undertaking annual water audit and Infrastructure Leakage Index exercises

6.8 Zone Metering Leak Detection Program

Key component of the Remediation Plan, is the implementation of advanced metering capabilities in the form of a Zone Metering and Leak Detection Plan. Full implementation of the Zone Metering and Leak Detection Plan Consist would consist of the following phases:

Step 1. **Confirm Zone Meter Location:** Complete additional field investigation and hydraulic modelling to confirm viability of Zone Metering locations and boundary delineations. Included in this step is the detailed design of new metering chambers.

Step 2. **Develop Leak Detection Program:** Develop Leak Detection Program, system isolation plan and strategy for adjustment of zone boundary's to further isolate/discretize the system with the objective of further isolating the system leakage areas. Implementation plan should also identify duration of system isolation, data collection frequency, and any temporary reduction in system pressure or fire flows that may need to be communicated to the public or fire department ahead of implementation.

Step 3. **Zone Meter Installation:** Installation of Zone Meter chambers. Full integration of Zone meter with the Region's SCADA system is required to effectively manage the leak detection investigation.

Step 4. **Implementation of Leak Detection Program:** Complete leak detection program and identify existing system leaks by location and loss potential

Step 5. **Leak Remediation Plan:** Establish the minimum level of leakage recovery to justify the remediation cost and implement system repairs to system leak exceeding the minimum recovery threshold

The above plan can be incorporated with advanced real-time metering of services to allow for near immediate notification and locating of watermain breaks.

APPENDIX A:

Table 1: Non-Growth Related Watermain Upsizing, Replacement, or Rehabilitation

ID	Current Material	Install Year	Current Diameter (mm)	Future Diameter (mm)	Action
10003384	Ductile Iron	1979	200	300	Upsize
10003389	PVC	2013	200	300	Upsize
10003422	Cast Iron	1954	400	200	Downsize
10003461	Cast Iron	1967	150	150	Rehab or Replace
10003603	Cast Iron	1967	150	150	Rehab or Replace
10003690	Ductile Iron	1981	150	150	Rehab or Replace
10003874	Ductile Iron	1981	150	150	Rehab or Replace
10003898	Cast Iron	2000	150	200	Upsize
10003906	Cast Iron	1959	150	200	Upsize
10003916	Cast Iron	1953	100	150	Upsize
10004065	Cast Iron	1967	150	150	Rehab or Replace
10004157	Cast Iron	1956	150	300	Upsize
10004157	Cast Iron	1956	150	300	Upsize
10004198	Cast Iron	1953	150	200	Upsize
10004217	Ductile Iron	1965	200	300	Upsize
10004232	Cast Iron	1913	150	200	Upsize
10004290	Cast Iron	1966	200	300	Upsize
10004290	Cast Iron	1966	200	300	Upsize
10004290	Cast Iron	1966	200	200	Rehab or Replace
10004291	Cast Iron	1962	150	200	Upsize
10004298	Cast Iron	1966	300	300	Rehab or Replace
10004337	Cast Iron	1965	150	200	Upsize
10004477	Cast Iron	1908	150	200	Upsize
10004661	Ductile Iron	1969	150	200	Upsize
10004661	Ductile Iron	1969	150	200	Upsize
10004825	Ductile Iron	1979	200	300	Upsize
10004833	Ductile Iron	1979	200	200	Rehab or Replace
10004889	Ductile Iron	1969	150	200	Upsize
10004889	Ductile Iron	1969	150	200	Upsize

ID	Current Material	Install Year	Current Diameter (mm)	Future Diameter (mm)	Action
10004953	PVC	1955	150	150	Rehab or Replace
10005059	Cast Iron	1962	200	300	Upsize
10005154	Cast Iron	1953	100	200	Upsize
10005200	Cast Iron	1963	150	150	Rehab or Replace
10005222	Ductile Iron	1981	100	100	Rehab or Replace
10005250	Ductile Iron	1970	100	100	Rehab or Replace
10005261	Cast Iron	1962	150	300	Upsize
10005332	Cast Iron	1913	150	200	Upsize
10005419	Cast Iron	1955	150	150	Rehab or Replace
10005444	PVC	1987	200	300	Upsize
10005504	Cast Iron	1954	150	150	Rehab or Replace
10005523	Cast Iron	1955	150	200	Upsize
10005640	Cast Iron	1955	150	150	Rehab or Replace
10005740	Ductile Iron	1977	150	300	Upsize
10005796	Cast Iron	1941	150	200	Upsize
10005798	Cast Iron	1941	150	200	Upsize
10005822	Ductile Iron	1981	150	150	Rehab or Replace
10005823	Ductile Iron	1981	150	150	Rehab or Replace
10005936	Cast Iron	1963	150	200	Upsize
10006038	Cast Iron	1967	150	150	Rehab or Replace
10006069	Ductile Iron	1971	150	150	Rehab or Replace
10006384	Ductile Iron	1981	150	150	Rehab or Replace
10006388	Cast Iron	1908	150	200	Upsize
10006401	Cast Iron	1963	200	200	Rehab or Replace
10006409	PVC	1987	150	200	Upsize
10006458	Cast Iron	1963	200	200	Rehab or Replace
10006460	PVC	2009	150	200	Upsize

ID	Current Material	Install Year	Current Diameter (mm)	Future Diameter (mm)	Action
10006594	Ductile Iron	1980	200	300	Upsize
10006595	PVC	1979	200	300	Upsize
10006648	Ductile Iron	1980	200	200	Rehab or Replace
10006718	Cast Iron	1955	150	200	Upsize
10006754	Cast Iron	1954	400	200	Downsize
10006768	Cast Iron	1956	150	200	Upsize
10006864	Cast Iron	1974	150	150	Rehab or Replace
10006892	Cast Iron	1967	300	300	Rehab or Replace
10006898	Cast Iron	1968	150	150	Rehab or Replace
10006924	Ductile Iron	1980	200	300	Upsize
10006926	Ductile Iron	1982	200	450	Upsize
10006930	Ductile Iron	1980	200	300	Upsize
10006959	Cast Iron	1969	150	150	Rehab or Replace
10006960	Cast Iron	1955	150	200	Upsize
10006991	Cast Iron	1953	100	200	Upsize
10006996	Cast Iron	1962	150	200	Upsize
10007027	Cast Iron	1954	400	200	Downsize
10007049	Cast Iron	1967	150	200	Upsize
10007112	Cast Iron	1954	400	200	Downsize
10007113	Cast Iron	1954	400	200	Downsize
10007212	Cast Iron	1954	300	200	Downsize
10007396	Cast Iron	1954	150	150	Rehab or Replace
10007418	Cast Iron	1947	150	200	Upsize
10007458	Cast Iron	1963	200	200	Rehab or Replace
10007476	Ductile Iron	1981	150	150	Rehab or Replace
10007490	Cast Iron	1954	400	200	Downsize
10007511	Cast Iron	1953	100	150	Upsize
10007536	Cast Iron	1963	150	150	Rehab or Replace
10007538	Cast Iron	1963	200	200	Rehab or Replace
10007571	Cast Iron	1954	300	200	Downsize

ID	Current Material	Install Year	Current Diameter (mm)	Future Diameter (mm)	Action
10007637	Cast Iron	1954	300	200	Downsize
10007652	Cast Iron	1997	150	200	Upsize
10007729	Ductile Iron	1969	150	200	Upsize
10007729	Ductile Iron	1969	150	200	Upsize
10007733	Ductile Iron	1980	200	300	Upsize
10007748	Cast Iron	1956	150	300	Upsize
10007748	Cast Iron	1956	150	300	Upsize
10007750	Cast Iron	1967	150	200	Upsize
10007762	Cast Iron	1998	150	200	Upsize
10007981	Ductile Iron	1980	200	300	Upsize
10008044	Cast Iron	1968	200	200	Rehab or Replace
10008065	Cast Iron	1967	150	200	Upsize
10008068	Cast Iron	1967	150	200	Upsize
10008070	Cast Iron	1967	150	200	Upsize
10008071	Cast Iron	1947	150	200	Upsize
10008096	Cast Iron	1954	300	200	Downsize
10008129	Cast Iron	1963	200	200	Rehab or Replace
10008130	Cast Iron	1963	200	200	Rehab or Replace
10008170	Ductile Iron	1981	150	150	Rehab or Replace
10008283	Cast Iron	1964	150	150	Rehab or Replace
10008294	Cast Iron	1965	300	300	Rehab or Replace
10008297	Cast Iron	1963	150	200	Upsize
10008330	Cast Iron	1964	150	150	Rehab or Replace
10008331	Cast Iron	1964	150	150	Rehab or Replace
10008332	Cast Iron	1964	150	150	Rehab or Replace
10008342	Cast Iron	1962	150	200	Upsize
10008356	Cast Iron	1964	150	200	Upsize
10008364	Ductile Iron	1971	150	150	Rehab or Replace
10008390	PVC	1980	150	300	Upsize

ID	Current Material	Install Year	Current Diameter (mm)	Future Diameter (mm)	Action
10008447	Cast Iron	1974	150	150	Rehab or Replace
10008457	Cast Iron	1963	150	300	Upsize
10008457	Cast Iron	1963	150	300	Upsize
10008512	Cast Iron	1964	150	150	Rehab or Replace
10008517	Cast Iron	1969	150	150	Rehab or Replace
10008572	Cast Iron	1966	300	300	Rehab or Replace
10008575	Cast Iron	1955	150	150	Rehab or Replace
10008612	PVC	2009	150	200	Upsize
10008626	PVC	1955	150	150	Rehab or Replace
10008648	PVC	1988	150	300	Upsize
10008680	PVC	2013	200	300	Upsize
10008699	Cast Iron	1954	150	150	Rehab or Replace
10008727	Ductile Iron	1970	100	100	Rehab or Replace
10008732	Cast Iron	1913	150	200	Upsize
10008746	Cast Iron	1993	150	200	Upsize
10008774	Cast Iron	1974	150	150	Rehab or Replace
10008805	Cast Iron	1966	300	300	Rehab or Replace
10008826	Cast Iron	1954	400	200	Downsize
10008829	Cast Iron	1954	400	200	Downsize
10008841	Cast Iron	1962	150	300	Upsize
10008856	Ductile Iron	1981	100	100	Rehab or Replace
10008917	Cast Iron	1962	150	150	Rehab or Replace
10008919	Cast Iron	1974	150	150	Rehab or Replace
10008920	Cast Iron	1962	150	150	Rehab or Replace
10008924	Cast Iron	1964	150	150	Rehab or Replace

ID	Current Material	Install Year	Current Diameter (mm)	Future Diameter (mm)	Action
10008925	Cast Iron	1964	150	150	Rehab or Replace
10008926	Cast Iron	1963	150	150	Rehab or Replace
10008927	Cast Iron	1962	150	150	Rehab or Replace
10008928	Cast Iron	1962	150	150	Rehab or Replace
10009028	Cast Iron	1964	150	150	Rehab or Replace
10009029	Cast Iron	1964	150	150	Rehab or Replace
10009031	Cast Iron	1964	150	150	Rehab or Replace
10009035	Cast Iron	1964	150	150	Rehab or Replace
10009037	Cast Iron	1962	150	150	Rehab or Replace
10009041	Cast Iron	1964	150	150	Rehab or Replace
10009098	Cast Iron	1995	150	200	Upsize
10009110	Cast Iron	1968	150	150	Rehab or Replace
10009134	Cast Iron	1974	150	150	Rehab or Replace
10009142	Cast Iron	1955	150	200	Upsize
10009142	Cast Iron	1955	150	200	Upsize
10009252	Cast Iron	1963	150	300	Upsize
10009252	Cast Iron	1963	150	300	Upsize
10009278	Cast Iron	1967	150	150	Rehab or Replace
10009313	Cast Iron	1968	200	200	Rehab or Replace
10009313	Cast Iron	1968	200	200	Rehab or Replace
10009360	Ductile Iron	1971	150	150	Rehab or Replace
10009381	PVC	1988	150	300	Upsize
10009413	Cast Iron	1959	150	200	Upsize
10009437	Cast Iron	1967	300	300	Rehab or Replace

ID	Current Material	Install Year	Current Diameter (mm)	Future Diameter (mm)	Action
10009442	Cast Iron	1954	400	200	Downsize
10009507	Cast Iron	1962	150	200	Upsize
10009582	Ductile Iron	1971	150	150	Rehab or Replace
10009675	PVC	1977	150	300	Upsize
10009753	Cast Iron	1956	150	300	Upsize
10009753	Cast Iron	1956	150	300	Upsize
10009808	PVC	1941	150	200	Upsize
10009865	PVC	2000	150	300	Upsize
10009953	PVC	1986	150	200	Upsize
10009985	Ductile Iron	1981	150	150	Rehab or Replace
10009999	Cast Iron	1967	300	300	Rehab or Replace
10010117	Ductile Iron	1980	150	300	Upsize
10010125	PVC	1955	150	150	Rehab or Replace
10010133	Cast Iron	1913	150	200	Upsize
10010136	Cast Iron	1965	150	300	Upsize
10010245	Cast Iron	1965	150	200	Upsize
10010252	Cast Iron	1968	200	200	Rehab or Replace
10010257	Ductile Iron	1981	150	150	Rehab or Replace
10010267	PVC	2013	200	300	Upsize
10010352	Cast Iron	1964	150	150	Rehab or Replace
10010450	Cast Iron	1913	150	200	Upsize
10010459	Cast Iron	1967	300	300	Rehab or Replace
10010589	Cast Iron	1974	150	150	Rehab or Replace
10010617	Cast Iron	1967	300	300	Rehab or Replace
10010680	Cast Iron	1963	200	200	Rehab or Replace
10010717	Cast Iron	1962	150	300	Upsize
10010754	Cast Iron	1964	300	300	Rehab or Replace
10010796	Cast Iron	1958	150	300	Upsize

ID	Current Material	Install Year	Current Diameter (mm)	Future Diameter (mm)	Action
10010796	Cast Iron	1958	150	300	Upsize
10010840	PVC	1987	200	300	Upsize
10010857	Cast Iron	1962	150	200	Upsize
10010869	Cast Iron	1965	150	200	Upsize
10010893	Cast Iron	1954	400	200	Downsize
10010895	Cast Iron	1955	150	150	Rehab or Replace
10010997	Cast Iron	1850	150	200	Upsize
10011000	Ductile Iron	1971	150	150	Rehab or Replace
10011002	Ductile Iron	1971	150	150	Rehab or Replace
10011018	Cast Iron	1954	400	200	Downsize
10011040	Ductile Iron	1981	150	150	Rehab or Replace
10011045	Cast Iron	1964	150	200	Upsize
10011046	Cast Iron	1963	200	200	Rehab or Replace
10011224	Cast Iron	1966	300	300	Rehab or Replace
10011255	Cast Iron	1956	150	300	Upsize
10011255	Cast Iron	1956	150	300	Upsize
10011272	Cast Iron	1955	150	200	Upsize
10011276	Cast Iron	1964	200	300	Upsize
10011277	Cast Iron	1964	200	300	Upsize
10011338	Cast Iron	1963	150	150	Rehab or Replace
10011341	Cast Iron	1963	200	200	Rehab or Replace
10011354	Cast Iron	1962	150	200	Upsize
10011357	Cast Iron	1913	150	200	Upsize
10011373	Ductile Iron	1981	150	150	Rehab or Replace
10011384	Cast Iron	1965	150	200	Upsize
10132098	PVC	2014	150	200	Upsize
10132102	Cast Iron	1964	150	200	Upsize
10139128	Cast Iron	1964	150	200	Upsize
10141956	None	1993	150	200	Upsize
10141957	PVC	1986	150	200	Upsize

ID	Current Material	Install Year	Current Diameter (mm)	Future Diameter (mm)	Action
10141958	None	1993	150	200	Upsize