

**WATER SUPPLY AND
DISTRIBUTION OPERATIONS
MASTER PLAN FINAL REPORT**



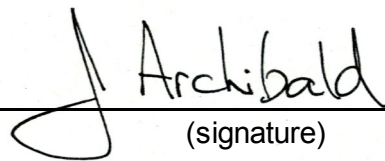
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Sign-off Sheet

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Executive Summary

The Water Services Division of the Region of Waterloo (Region) retained Stantec Consulting Ltd. (Stantec) to complete a Water Supply and Distribution Operations Master Plan (WSDOMP). The purpose of this report is to present the final recommended system approach as identified in Task F, and summarize the results from Tasks A through E. The tasks for the WSDOMP were completed in consultation with the Region and Area Municipalities (A.Mun.) with the purpose of developing both short and long-term strategies for optimization of the operating efficiency of the Integrated Urban System (IUS).

The Region is responsible for supplying potable water throughout the Tri-Cities and surrounding area through the IUS and various individual rural systems. Potable water is delivered to the customer through a two-tier system; the Region provides wholesale water to each A.Mun. within the IUS and the A.Mun.s distribute water to the consumers.

The IUS is a large system consisting of one surface water treatment plant drawing from the Grand River (Mannheim WTP), 83 groundwater production wells, 21 storage facilities, 20 pump stations, 24 pressure zones, in addition to approximately 220 km of trunk watermains. The operation of the IUS is complex and includes the coordination of staff and selected operational responsibilities between the Region and all A.Mun.s. The desired outcome of implementing the recommendations of the WSDOMP is a cost-effective system that is sustainable for long-term population growth within the Region.

Demand forecasting for the Region was updated to quantify the future storage, supply and source requirements of the Tri-Cities up to the year 2031. Historical demand data based on average and maximum day demands of Cambridge, Waterloo, Kitchener, St. Jacobs and Elmira along with the allocation of demands as per the hydraulic model were reviewed. Historical population data and forecasted population data were also incorporated to determine population growth and associated water demands for the Region. Water supply data was based on the 2007 Water Supply Master Plan and was refined by the Water Supply Master Plan Update (WSMP) (Stantec, 2014).

Results from this study show that the forecasted average day (161 ML/day) and maximum week (192 ML/day) demands are less than the available water supply within the Region. Water demands for 2031 can increase up to 128 ML/day beyond the forecasted maximum week demands before exceeding projected system capacity, which includes Aquifer Storage Recovery (ASR) Phase 1 and 2 and new groundwater sources (320 ML/day). Under average day conditions, the forecasted demand for 2031 can increase by up to 58 ML/day beyond the forecasted demand before exceeding projected system capacity (219 ML/D).

Based on the updated demand projections, modifications to the IUS are recommended for Cambridge, Kitchener, Waterloo and Woolwich. High level opinions of probable cost and timing

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of implementation for capital projects are provided for each optimization strategy, as well as justification, overview of work, additional studies required, and the impact on Green House Gas (GHG) emissions. Additionally, other work and linear projects are identified to help address system constraints not related to the overall optimization strategies for each A.Mun.

The proposed reconfiguration for Cambridge included the following major modifications:

- Divide pressure zone Cam 1 into Cam 1 and Cam 1W
 - Cam 1W to be supplied by chloraminated water from Cam 1 via a chloramination station as well as Cam 2W and Kit 2W via PRVs. Cam 1 will continue to be supplied with chlorinated water.
- Improve floating storage for Cam 1
 - Turnbull converted to pumped storage and reconfigured to supply Cam 1 and a new Cam 1 10,000 m³ reservoir to replace St. Andrews Standpipes
- Consolidate sources and increase capacity for Cam 2E
 - Consolidate Rahmans PS, Pinebush TP, Well P9, Well P15, and Well G5 and redirect to Cam 2E
 - Consolidate Hespeler system wells to one new facility (H3, H4, and H5)
- Increase Supply for Cam 2W and East Side Lands
 - Install in-line booster pump station from Cam 2E to Cam 2W
 - Construct new Maple Grove WTP (wells P16 and P19)
- New watermain infrastructure to increase capacity for Cam 3

The proposed optimizations for Cambridge aim to reduce pressure variations, minimize mixing of chlorinated and chloraminated water, provide additional operating flexibility at Middleton TP, reduce operating and maintenance costs, and reduce electricity costs and GHG emissions. The opinion of probable cost is estimated at \$75.0 million for projects to be implemented over the next 10 years and beyond. Some of the optimizations are indicated to have an earlier implementation date should demands increase sooner than projected.

The proposed reconfiguration for Kitchener included the following major modifications:

- Connect pressure transducers to SCADA and update operating strategy
- Install control valves on all feeder mains (existing and proposed) to Kit 4 and Wat 4
 - Victoria Street watermain, proposed hydro-corridor watermain, proposed secondary Kit 4/Wat 4 connection
- Reconfigurations at Mannheim WTP
 - K20 wells directed to Mannheim WTP for storage

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- Wat 4 dedicated discharge from Mannheim Zone 4 PS (if required)

The proposed optimizations for Kitchener aim to improve the control of flow into Kit 4 and Wat 4, optimize the use of watermain capacity for installed and proposed feeder mains, improve feedback and understanding of in-field conditions, decrease pressure fluctuations in Kit 4, and address water quality concerns at the K20 wells. There is a potential for GHG emissions increase from valve energy losses and increased operation and maintenance (O&M), but also a reduction from O&M associated with consolidating facilities. The opinion of probable cost is estimated at \$41.1 million for projects to be implemented over the next 10 years.

The proposed reconfiguration for Waterloo included the following major modifications:

- Re-directing William Street raw water to Strange Street WSS in Kitchener
- Facility capacity restoration at Erb Street wells
- New Waterloo North supply wells and Laurel Water Treatment Plant

The proposed optimizations aim to allow Waterloo to be more self-sufficient, reduce reliance on single transfer connections, and reduce demand on the Mannheim WTP to allow for a potential increase in transfer to Cambridge or future development in Kitchener. There are net GHG reductions expected for Waterloo due to facility consolidations, reduced treatment energy requirements (blending of sources), and reduced pumping. Combining William Street and Strange Street water supply will give flexibility to supply Waterloo, Kitchener, or both. The opinion of probable cost is estimated at \$33.7 million for projects to be implemented over the next 10 years.

The proposed reconfiguration for Woolwich included the following major modifications:

- Realign the Elmira/Elmira East pressure zone boundary and create a direct feed from the Howard Tanks to the new Elmira East zone
- Adjustments to the St Jacobs PRV to increase the hydraulic grade line (HGL) in St. Jacobs
- New watermain connection for emergency conditions between Breslau South and Breslau North

The proposed optimizations for Woolwich aim to simplify operating and maintenance requirements, optimize pressures in Elmira and St. Jacobs, and improve redundancy of supply. GHG emissions are reduced due to the removal of PRVs in Elmira and reduced pumping. The opinion of probable cost is estimated at \$1.6 million for projects to be implemented over the next 10 years with the majority occurring within the first 5 year planning period.

System-wide IUS optimizations include physical and operational modifications.

Recommendations were made in response to discussions with Region operations staff, and include standardization practices for secondary disinfection, design standards for pump stations



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and wells, and tools to improve communication and coordination between the Region and A.Mun.s. The opinion of probable cost for these activities is \$3.0 million.

The total opinion of probable capital cost of the proposed system optimizations is \$93.8 million for Specific Project Totals and \$60.6 million for complementary Region work over the next 20 years. It is recommended that demand and water supply forecasting be updated regularly and the WSDOMP be modified accordingly.

Acronyms

The following section provides the definitions for the acronyms used in this report.

Acronym	Definition
A.Mun.	Area Municipality (i.e. Cities and Towns within the Region Boundary)
CV	Control Valve
EA	Environmental Assessment
ESL	East Side Lands
ET	Elevated Tank
GHG	Greenhouse Gases
HGL	Hydraulic Grade Line
HMI	Human Machine Interface
ICI	Institutional, Commercial, Industrial
IUS	Integrated Urban System
LTWS	Long Term Water Strategy
MOE	Ministry of the Environment
MTV	Motorized Throttle Valve
MV	Motorized Valve
ODWQS	Ontario Drinking Water Quality Standards
O&M	Operations and Maintenance
PIT	Pressure Indicating Transmitters
PRV	Pressure Reducing/Relief Valve
PS	Pump Station
ROP	Region Official Plan
RMOW	Regional Municipality of Waterloo
STELM	St. Jacobs/Elmira
SCADA	Supervisory Control and Data Acquisition
TCE	Trichloroethylene
TDH	Total Dynamic Head
TM	Tech Memo
TP	Treatment Plant

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Acronym	Definition
UV	Ultraviolet
VFD	Variable Frequency Drive
WSS	Water Supply System
WTP	Water Treatment Plant

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1.0 Introduction

The Regional Municipality of Waterloo (Region) is responsible for supplying drinking water throughout the Tri-Cities and surrounding area through the integrated urban system (IUS) and various individual rural systems. The IUS includes the Cities of Cambridge, Kitchener, Waterloo, and Towns of St. Jacobs and Elmira, as well as a number of smaller communities in parts of Woolwich, Wilmot and North Dumfries Townships. The Water Supply and Distribution Optimization Master Plan (WSDOMP) discussed herein is an update on the previous 2009 Tri-City Water Distribution Master Plan Final Report (Tri-City MP) completed by AECOM in May 2009. The WSDOMP was initiated to identify opportunities and develop both short and long-term strategies to optimize the operating efficiency of the IUS system, and to assess Greenhouse Gas (GHG) emissions at Region IUS and rural facilities. The objective of the project is a cost-effective system that is sustainable for long-term population growth within the Region.

The WSDOMP is focused on the most efficient way to distribute water throughout the system. The study incorporates all source information; however, it is not concerned with the optimization of individual wells and well fields. A Water Supply Master Plan Update (WSMP) (Stantec, 2014) was initiated as an independent project and will focus on supply sources for capital planning and the most efficient operation of all sources in the medium-term (10-20 years) and long-term (30-40 years) planning window. The evaluation carried out in the WSMP will consider the final recommendations as outlined in the WSDOMP for distribution of all source water. An overview of the scope for both projects with respect to major water supply and distribution infrastructure is provided in Table 1-1.

Table 1-1: Scope of Work Overview for WSDOMP and WSMP (2014)

Infrastructure	WSDOMP	WSMP
Wells and Well Fields	Reviewed and incorporated for treatment facility, pump station, and direct to distribution well capacities.	Reviewed and alternatives were identified to optimize the operation of existing and future wells/well fields to meet demands.
Treatment Facilities and Pump Stations	Reviewed and alternatives were identified to optimize the distribution of water.	Reviewed and incorporated for overall system strategies.
Storage Facilities	Reviewed and alternatives were identified to optimize the distribution of water.	Reviewed and incorporated for overall system strategies.
Linear Infrastructure	Reviewed and upgrades were identified to implement proposed recommendations or improve hydraulic capacity.	Reviewed and incorporated for overall system strategies.

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A multi-disciplinary approach has been taken for the WSDOMP involving the following:

- Task A: Water Supply and Distribution System Background and Assessment
- Task B: Hydraulic Model Update
- Task C: Greenhouse Gas (GHG) Emission Inventory Survey
- Task D: Identification of Constraints
- Task E: Identification of Alternative Solutions
- Task F: Selection of Preferred Improvement and Optimization Strategy

The objective of Task A, Task B, and Task C was to develop a thorough understanding of the existing system to obtain the necessary baseline information to identify constraints (Task D), develop alternative solutions (Task E), and select preferred alternatives (Task F). The purpose of this final report is to present the final system approach as identified in Task F.

Following the introduction is an overview of the Integrated Urban System (IUS). Section 2 provides an overview of the tasks performed for the master planning update process. Sections 3 to 6 discuss the proposed optimizations for Cambridge, Kitchener, Waterloo, and Woolwich, respectively. High-level opinion of probable costs and timing of implementation for projects are provided for each optimization as well as justification, overview of work, additional studies required, and the impact on Green House Gas (GHG) emissions. Section 7 describes physical and operational IUS-wide proposed solutions and high-level opinion of probable cost. Section 8 provides an overview of the total opinion of probable costs and proposed schedule of implementation of the optimization solutions.

1.1 OVERVIEW OF THE INTEGRATED URBAN SYSTEM (IUS)

The existing IUS services the A.Mun.s of Kitchener, Waterloo, and Cambridge (Tri-Cities) as well as towns and settlement areas within the surrounding Townships, including Woolwich (Elmira, St. Jacobs, and Breslau), Wilmot (Mannheim, Shingletown, and St. Agatha), and North Dumfries (Lloyd Brown).

Potable water in the IUS is delivered to the customer through a two-tier system. The Region provides wholesale water to each A.Mun. in the IUS. The Region owns and operates the water treatment plants, groundwater wells, pumping stations, reservoirs, and trunk watermains. A.Mun.s are responsible for the distribution of water to customers in their respective municipality and own and maintain the local distribution watermains. The combined Regional and A.Mun. distribution system has approximately 2,000 km of watermains. Approximately 220 km are trunk watermains and the remaining watermains (dual use and local watermains) are primarily used for distribution to local customers. The Region owns the trunk watermains while the A.Mun.s own local watermains. Dual use watermains are owned jointly by the Region and the A.Mun.s.

The water supply and distribution system is complex and consists of surface water supply from the Mannheim Water Treatment Plant (Mannheim WTP) with intake from the Grand River and groundwater supplies located throughout the region. The IUS groundwater supplies consist of 83 production wells and 5 groundwater treatment plants. The majority of groundwater wells are located within the urban boundaries of the Tri-Cities, but several wells feeding into the IUS are

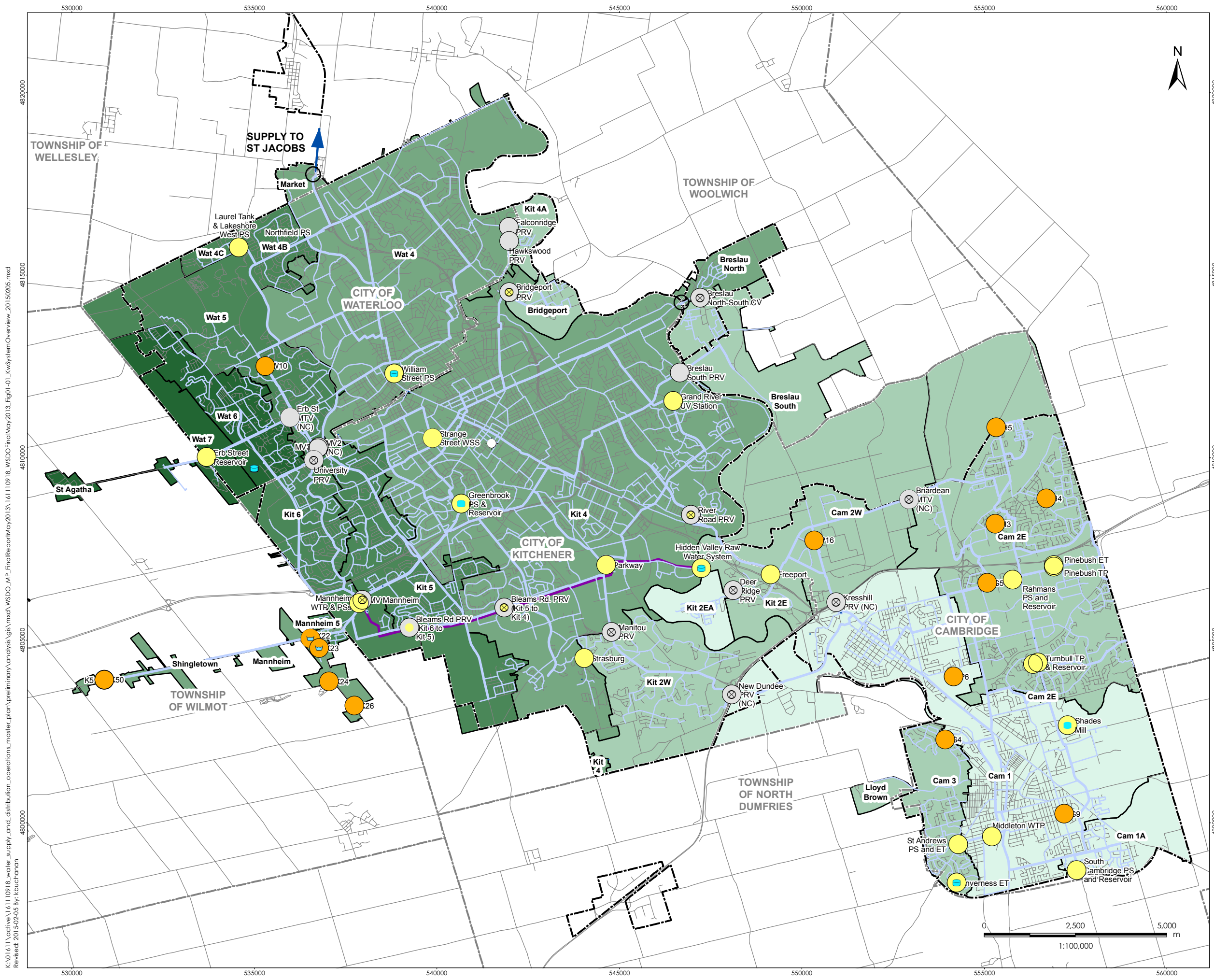
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located in adjacent rural areas (Shingletown, Village of Mannheim, and Erb Street in Wilmot). The wells and facilities are shown in (Figures 1-1 and 1-2) and some of the major groundwater supply systems include:

- Middleton
- Pinebush
- Turnbull
- Shades Mill
- Greenbrook
- Strange Street
- Parkway/Strasburg
- Erb Street
- William Street
- Shingletown and Mannheim Village

The largest IUS supply source is the Mannheim Water Supply System located on the west side of Kitchener. Raw water is drawn from the Grand River at the Hidden Valley Low Lift Pump Station (PS), pumped to an open ground reservoir at the Hidden Valley High Lift PS, and conveyed for treatment at the Mannheim WTP. Treated surface water and disinfected groundwater from nearby wells is collected in the Mannheim Reservoir and conveyed to the distribution system by the Mannheim Zone 4, 5, and 6 PSs.

There are 21 storage facilities and 20 pump stations that provide distribution water for the 26 pressure zones in the existing IUS to service the varying elevations throughout the system. Wells supply various zones based on the service location and operating pressure. The pressure zones and major facilities are shown in Figures 1-1 and 1-2.



- Legend**
- Monitoring Location
 - Valve
 - Tank
 - Well
 - Facility (PS, TP or Reservoir)
 - System Well
 - Important Valve
 - NC** Normally Closed
 - Watermain
 - Feedermain
 - Raw Watermain
 - Road
 - Urban Boundary
 - Municipal Boundary
 - Pressure Zone

- HGL (m ASL)**
- 332.0 - 350.0
 - 350.1 - 375.0
 - 375.1 - 400.0
 - 400.1 - 425.0
 - 425.1 - 450.0

- Notes**
1. Coordinate System: NAD 1983 UTM Zone 17N
 2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2013.

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Regional Municipality of Waterloo
Water Supply and Distribution
Operations Master Plan

Figure No.
1-1

Overview of the Existing Integrated Urban System (IUS) (Tri-Cities)

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Revised: 2015-02-05 by: kbuchanan

Legend

- Tank
- Valve
- Facility (PS, TP or Reservoir)
- Important Valve
- Watermain
- Feedermain
- Road
- Urban Boundary
- Municipal Boundary
- Pressure Zone

HGL (m ASL)

- 332.0 - 350.0
- 350.1 - 375.0
- 375.1 - 400.0
- 400.1 - 425.0
- 425.1 - 450.0

Notes

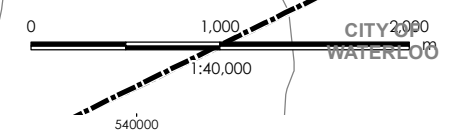
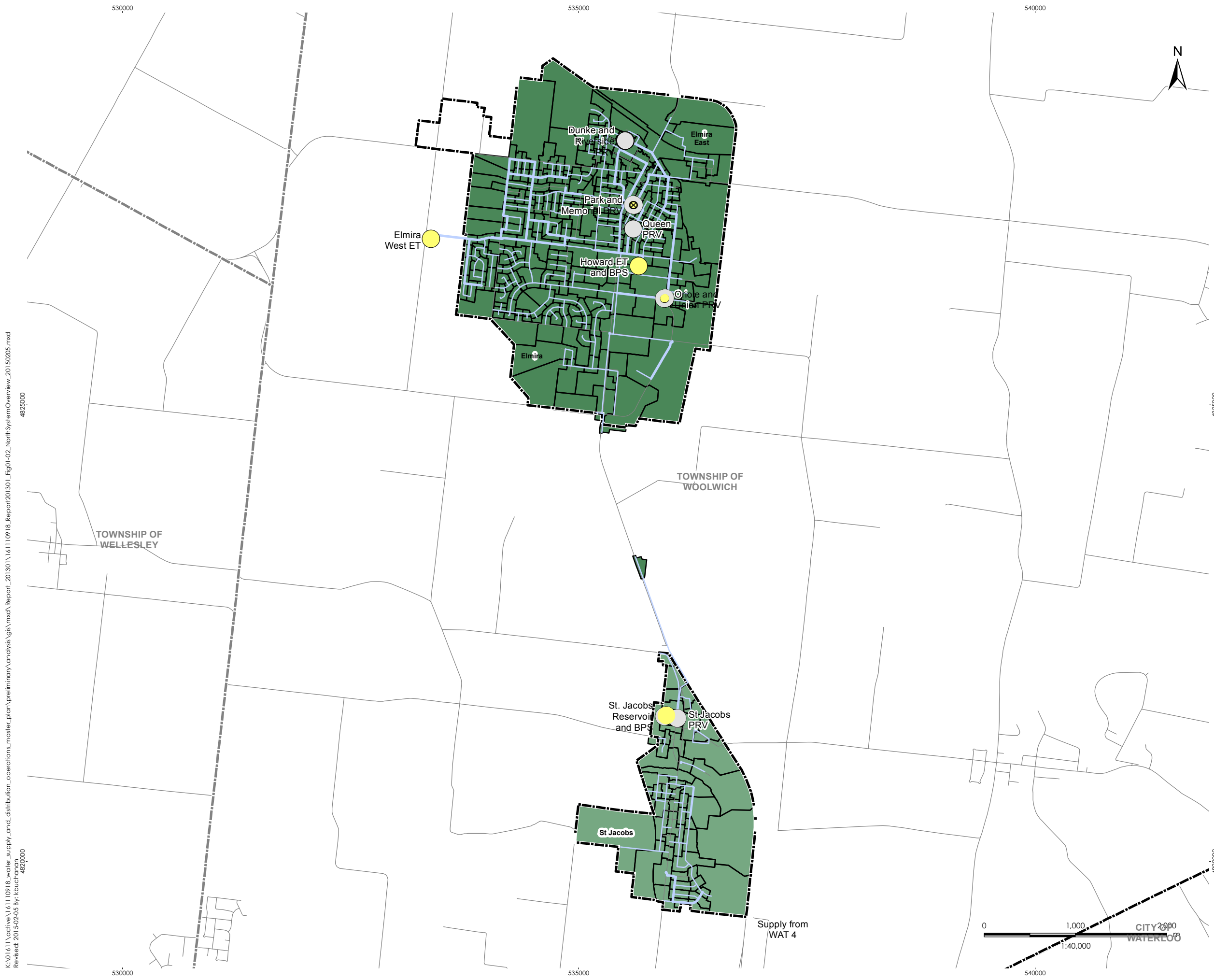
1. Coordinate System: NAD 1983 UTM Zone 17N
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Operations Master Plan

Figure No.
1-2

Title
**Overview of the Existing IUS
(St. Jacobs and Elmira)**



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Revised: 2015-02-05 By: kbuchanan

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The pressure zones are summarized below:

- Cambridge: Cam 1, Cam 1A, Cam 2W, Cam 2E, Cam 3
- Kitchener: Kit 2E, Kit 2W, Kit 2EA, Kit 4, Kit 4A, Kit 5, Kit 6, Bridgeport
- Wilmot: Mannheim, Mannheim Zone 5
- Waterloo: Wat 4, Wat 4B, Wat 4C, Wat 5, Wat 6, Wat 7 (incl. St. Agatha)
- Woolwich: St. Jacobs, Elmira, Elmira East, Breslau North, Breslau South

Interconnectivity between some pressure zones allows water to transfer between zones at select locations to meet demands. Water is transferred between zones when permitted based on the operating hydraulic grade lines (HGL) and distribution system infrastructure (pressure reducing valves (PRVs) and flow control valves). As can be seen from Figures 1-1 and 1-2, there is an overall increase in ground surface elevation from southeast Cambridge to northwest Waterloo which dictates the IUS hydraulics.

The majority of demand in Cambridge is met by groundwater sources located in the City of Cambridge. The supply is augmented from Kitchener via connections to northwest Cambridge (Cam 2W) and west Cambridge (Cam 1).

Kitchener has the largest pressure zone in the IUS (Kit 4), which is responsible for transferring supply to other pressure zones within Kitchener, and areas of Woolwich, Cambridge, and Waterloo. Kit 4 is supplied primarily by the Mannheim WTP and by groundwater sources in central Kitchener.

The Mannheim WTP transfers a significant supply to Waterloo via the connection between the Kit 4 and Wat 4 pressure zones. From Wat 4, water is also transferred to Woolwich (St Jacobs and Elmira) and a small pressure zone in east Kitchener. The supply in Waterloo is also supplemented by groundwater sources within the City.

There are no existing supply sources located in Woolwich that supply water to the IUS. Water is transferred to St. Jacobs and Elmira from Waterloo (Wat 4), and to Breslau from Kitchener (Kit 4).

The IUS water supply system, including sources and all distribution infrastructure, is described in further detail in Task A Technical Memo (refer to Appendix A).

2.0 Overview of Master Planning Process

The WSDOMP update process was executed through the completion of technical memoranda, which included consultation and workshops with Region and A.Mun. Stakeholders, a review of the Tri-City MP (AECOM, 2009), and consideration of concurrent studies and projects.

An overview of the Tri-City MP and the recommendations which were not carried forward in the WSDOMP are provided in Section 2.1. The WSDOMP was also completed through consideration of concurrent studies and projects, particularly the WSMP. The outcomes of the WSMP are summarized in Section 2.2. The WSDOMP tasks completed and presented in technical memoranda are summarized in Section 2.3.

2.1 RECOMMENDATIONS OF THE TRI-CITY MP (2009)

The Water Supply and Distribution Optimization Master Plan (WSDOMP) discussed herein is an update on the previous 2009 Tri-City Water Distribution Master Plan Final Report (Tri-City MP) completed by AECOM in May 2009. In the 2009 Tri-City MP, water demands were reviewed, and critical infrastructure and pressure zone realignments were identified. Two major future events within the Tri-Cities were identified: the East Side Lands (ESL) Development and the Lake Based Water Supply System (WSS).

Many of the recommendations from the Tri-City MP are carried forward to the WSDOMP, with the notable exception of the Lake Based WSS, Grand River Wells Supply and Reservoir, and new Kitchener Zone 4 Storage. As is outlined in the WSMP (2014) recommendations in Section 2.2, the decreasing trend in demands has renewed the focus on improving the efficiency of water distribution in the IUS and addressing localized surpluses and shortages of water, and as such the Lake Based WSS is now considered beyond the WSDOMP planning window. Additionally, as outlined in the WSMP (2014) recommendations, the Grand River Wells Supply and Reservoir are not required in the WSDOMP planning window and are therefore not carried in the WSDOMP, but are recommended to be reviewed in future iterations of the MP. The need for additional Kitchener Zone 4 storage has also been removed from the WSDOMP recommendations, to be re-evaluated after further optimization studies for a Kitchener Zone 4 are completed. A number of individual infrastructure recommendations were re-evaluated and identified as no longer required or applicable. A comparison between the Tri-City MP and WSDOMP recommendations, including justification for items which were removed or the corresponding WSDOMP recommendation for items which are carried forward, is included in Appendix G.

2.2 OUTCOMES OF THE WSMP (2014)

The purpose of the WSMP (Stantec, 2014) is to provide guidance on planning and implementation of capital projects and water management programs for the medium- to long-term planning window to ensure adequate water supply to the IUS. The 2011 WSMP is an update on the 2007 Water Supply Strategy (2007 Strategy). The WSMP was initiated to review

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the impact of recent decreasing trends in demands observed since the 2007 Strategy and evaluate the supply of individual sources compared to demand on a local scale over the medium- to long-term horizon.

Based on the updated demand projections, updated supply rates, and evaluation of supply alternatives, the WSMP Update Strategy includes the following measures:

1. Address Constraints in Supply and Distribution:
 - Addressing constraints in distribution of supply by removing bottlenecks, planning for intensification, and improving energy efficiency. This was supported by and informed by the WSDOMP (Ongoing, 2014).
2. Increase Groundwater, as needed, to maintain sustainable average day capacity at least 20% above projected demand:
 - Constructing new groundwater facilities, including Waterloo North WTP and the Central Grand River/Maple Grove WTP, as required to increase supply. An approximate increase of 317 L/s (27.5 MLD); and,
 - Constructing improvements to existing Cambridge water treatment plants (Turnbull TP and Pinebush TP) and wells (G4/G4A, G5/G5A, Hespeler wells) to optimize the quantity of water produced. An approximate increase of 263 L/s (22.8 MLD)).
3. Continue to improve water efficiency and conservation efforts to reduce demands.
4. Peaking and capacity increases to address peak demands, such as implementing Phase II of the Region's ASR system to manage peak water demands which occur in dry summer months (approximately 266 L/s (23 MLD)) , and performing hydrogeological assessments on constrained well fields.
5. Updating the WSMP regularly (approximately every 5 years).
6. Deferring the Great Lake Supply beyond 2051 and consider water reuse for long-term water supply planning.

Where the 2007 Strategy included the construction of the Great Lake supply, the decreasing trend in demands has renewed the focus on improving the efficiency of water distribution in the IUS and addressing localized surpluses and shortages of water. It was determined that there are enough water supplies available in the Region to meet demands with some investments in source capacity restoration of facilities, new groundwater facilities, and distribution optimization up to 2051. The Great Lake Supply along with Water Reuse are considered as a potential long-term solution beyond 2051.

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The total estimated capital budget up to 2031 (20 year window) to implement the preferred supply alternatives is \$54.6 million.

2.3 WSDOMP TECHNICAL MEMORANDA

The preferred optimizations recommended in the WSDOMP were determined based on the completion of analysis related to background studies of the IUS and consultation with A.Mun.s (Task A), demand forecasting (Task B), Greenhouse Gas (GHG) Emission Inventory Survey (Task C), and the identification of constraints and proposed alternatives (E, D, F). The summary of methodology and results for Task A, Task B, Task C, and Tasks E-D-F are presented in Sections 2.3.1, 2.3.2, 2.3.3 and 2.3.4 respectively. Additional studies associated with the WSDOMP are included in Appendix G.

2.3.1 Task A: Background Assessment and Workshops

Task A involved conducting information gathering workshops, reviewing background information, completing desk-top analyses, and completing hydraulic modeling to consolidate information and complete a preliminary assessment of the IUS. Refer to Appendix A for the Task A Tech Memo 1: Water Supply and Distribution System Background and Assessment.

There were multiple resources available to collect background information to develop a comprehensive understanding of the IUS. Information was obtained from the following sources:

- Tri-City Water Distribution Master Plan (AECOM, May 2009)
- Region Official Plan (June 2009)
- IUS Groundwater Supply Optimization and Expansion Project (Golder, 2010)
- Operation and Maintenance Manuals (where available for major stations)
- Process Control Narratives (where available for major stations)
- Process and instrumentation diagrams (where available for major stations)
- IUS and St. Jacobs/Elmira (STELM) hydraulic water models
- SCADA data (September 2009 to September 2010)
- Stakeholders workshops
- Field visits
- Pump curve tests
- System maps from area municipalities
- Data logger pressure readings

Information from all of the above sources was collected and consolidated to assess the existing urban water supply and distribution system. Information gathering workshops were held to capture concerns and information regarding the operations and physical infrastructure of the

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distribution system. Six separate fact-finding workshops were held to receive input, as indicated below:

- Region Operations, Maintenance, and SCADA Lead Hands – November 18, 2010
- City of Waterloo Operations and Maintenance Staff – November 22, 2010
- City of Kitchener Operations and Maintenance Staff – November 23, 2010
- City of Cambridge Operations and Maintenance Staff – November 24, 2010
- Township of Woolwich Operations and Maintenance Staff – December 2, 2010
- Region Operations, Maintenance, and SCADA Supervisors – December 13, 2010

Subsequent workshops were held to with Regional and A.Mun senior management staff where needed to validate system concerns. The intent of the workshops was not only to gather information, but provide an opportunity for input for those who are impacted the most by the system operations. Key categories discussed in the workshops included dealing with people, information reliability, staff responsibilities, pressure zones, water quality, sources, pump stations, system knowledge, trunk system, and storage.

For each A.Mun. in the IUS, Task A Tech Memo 1 summarizes water demands, existing hydraulic model diurnal patterns, supply sources, system capacity, system pressures, water quality, reliability and redundancy of supply, system operations and control.

2.3.2 Task B: Demand Projection

Task B focused on forecasting and allocating future demands, updating diurnal patterns, and updating infrastructure and control logic to reflect planned projects in the hydraulic model. Provided in the following sections is an overview of the Regional planning environment and an overview of the demand forecasting completed for the WSDOMP. Refer to Appendix B for the Task B Tech Memo 2: *Hydraulic Model Update*.

2.3.2.1 Planning Overview

Region Official Plan (ROP) is a guide for infrastructure planning and strategic investment decisions to develop a community that is both sustainable and livable. Planning and managing infrastructure is essential to achieving these goals. The purpose of the master plan is to allow the prioritization of projects to achieve a coordinated approach to manage urban development.

The ROP was adopted by council in June 2009 and will be used to direct growth and change over the next 20 years. The 2009 ROP focuses on re-urbanization for growth allocation in the Region, which allows for optimization of existing infrastructure. Reducing urban sprawl also minimizes the need for additional infrastructure and results in more sustainable infrastructure systems.

This WSDOMP builds on previous work and provides an opportunity to optimize the use of the existing water distribution system to support re-urbanization. The ROP identifies areas for

projected growth, including areas of intensification and Greenfield development. The WSDOMP evaluated the ability to service projected growth with the existing system and identify when new infrastructure is required.

The optimization of the existing system and requirements to effectively service projected growth is impacted significantly by consumer water demands. The Region has initiated water efficiency measures to optimize the use of local water resources and reduce the demand for energy to pump and treat water resources, outlined in the recently updated Water Efficiency Master Plan (WEMP) in 2014. The overall decrease in system demands, despite an increasing Region population is discussed more in the following Section 2.2.2, Overview of Demand Forecasting.

2.3.2.2 Overview of Demand Forecasting (IUS)

Demand forecasting for the IUS was completed to quantify the future storage, supply, and source requirements for the Region. Information obtained from this study will assist the development of future operating scenarios as indicated in the WSMP. Additionally, demand forecasting allows the Region to evaluate the success of water conservation efforts as well as provide guidance for annual water demand and subsequently pumping rates and consumer water pricing. Demand forecasting was completed based on historical demand data (average and maximum day demands) and the allocation of demands in the hydraulic model. Historical population data and forecasted population data were incorporated into the model to develop future demand scenarios for each planning period (2016, 2021, 2026, and 2031). In addition to forecasting the average and maximum day demands, updated diurnal patterns were developed for the hydraulic model. The updated diurnal patterns impact the magnitude and timing of peak hour demand, as well as the balance between the flow supplied, stored, and demanded for a given time step in the model.

Several predictive scenarios for residential and ICI demand were evaluated and are described in detail in the WSDOMP *Demand Forecasting Water* TM (refer to Appendix E for details). An important consideration for demand forecasting was to reflect the observed declining trend in water demand in the Region. Since the completion of the last update of the WSMP (2007 Strategy), it became evident that there was a new declining water demand trend. The decline is attributed to a number of factors: water conservation and water efficiency efforts, intensification, and economic factors. Environment Canada indicates this decreasing trend is also evident in other Municipalities across Canada¹.

The preferred residential scenario (Scenario 7) predicts an average annual decrease in per capita water usage rate over the past five (5) years continuing until a minimum usage of 150 L/capita/day is met. The preferred ICI scenario (Scenario 5) predicts a demand decrease up to 2016 at a rate equal to one quarter of the equivalent employment population growth. After 2016, the preferred ICI scenario predicts demands will increase at a rate equal to one half the equivalent employment population growth until 2031.

¹ Environment Canada. 2011. *2011 Municipal Water Use Report – Municipal Water Use 2009 Statistics*. Retrieved from: <http://www.ec.gc.ca/doc/publications/eau-water/COM1454/survey2-eng.htm>.

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Similar to residential and ICI demands, unaccounted for water (UFW) was estimated on an A.Mun. basis and summed to get the total UFW flow for the Region. UFW includes any non-revenue water such as distribution system leaks and flushing. Historical UFW data were reviewed from 2005 to 2009 to determine the forecasted UFW values; however, no overall trends were identified. Although it is difficult to identify and correct UFW sources, local municipalities have initiated UFW reduction programs and price increases and conservation efforts will only increase the resources committed to this task. A baseline was assumed for each A.Mun. (refer to Table 2-1) and a reduction of 0.5% per annum was assumed until a rate of 10% was achieved.

Table 2-1: Summary of Baseline Percent UFW for Area Municipalities

Area Municipality	Baseline UFW (%)
Cambridge	18%
Kitchener	11%
Waterloo	12%
St. Jacobs/Elmira	10%

The demand forecasts presented in the WSDOMP *Water Demand Forecasting* Tech Memo and summarized herein represent a best estimate given the available information on historical water demand and population growth data. Further refinement to this forecast and the long-term per capita projections should be carried out annually based on current observed system demands. For instance, ICI consumption can be further refined by monitoring industrial demands as economic profiles evolve and institutional and commercial consumption as conservation practices continue to be implemented. As well, IUS demands can also be further refined by determining if localized per capita differences exist between A.Mun. Additional data collection focusing socioeconomic factors could also allow for future regression demand forecasting to improve the model.

The demand forecasting has been used to identify improvements to the IUS water distribution network and appropriate timing of implementation for the various proposed solutions. It was also used in the complementary WSMP to optimize the planned use of water resources in the Region. As part of the WSMP (2014), the water supply capacity was forecasted up to 2050. Figure 2-1 and Figure 2-2 present the forecasted average day demand versus supply and the forecasted maximum week and maximum day demand versus supply, respectively.

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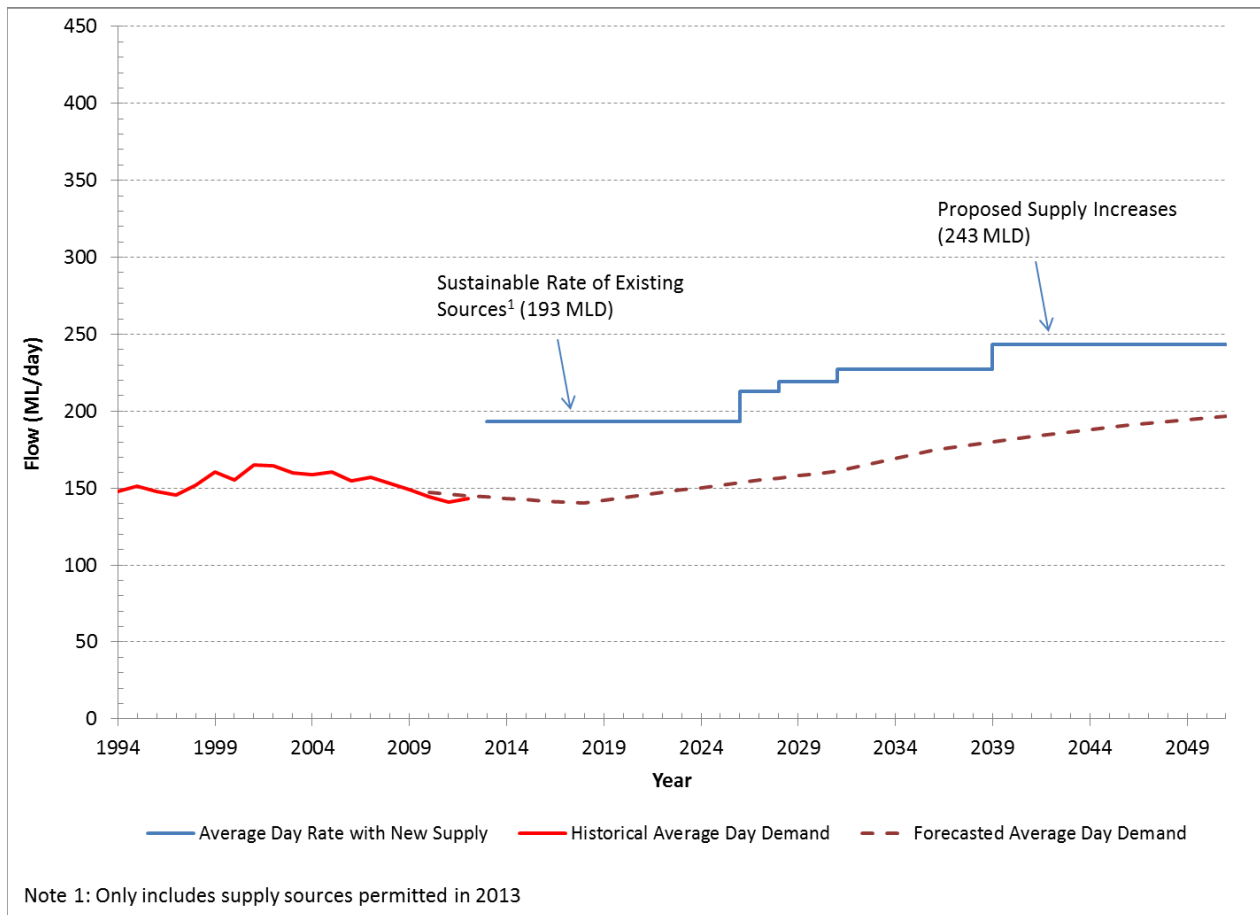


Figure 2-1: Average Day Demand Forecast and Preliminary Proposed Supply Alternatives (WSMP, 2014)

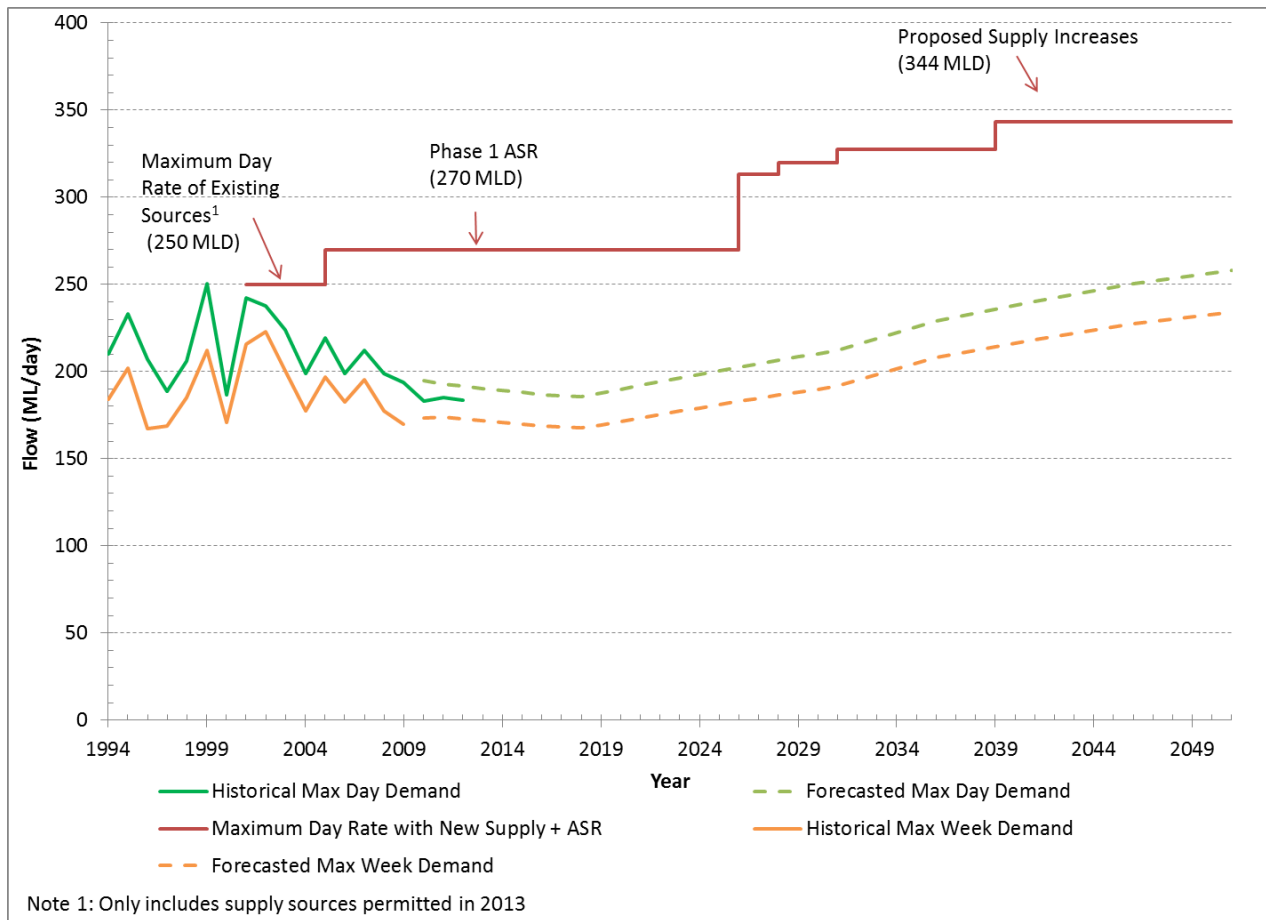


Figure 2-2: Maximum Week and Maximum Day Demand Forecast with Preliminary Proposed Supply Alternatives (WSMP, 2014)

Figure 2-1 and Figure 2-2 indicate the forecasted average day and maximum week/day demands are less than the forecasted water supply within the Region up to 2031. The 2031 forecasted average day and maximum week demands are 161 ML/day and 192 ML/day, respectively. Water demands for 2031 can increase up to 128 ML/day beyond the forecasted max week demand before exceeding projected system capacity, which includes Aquifer Storage Recovery (ASR) Phase 1 and 2 and new groundwater sources (320 ML/day). Under average day conditions, the forecasted demand for 2031 can increase by up to 58 ML/day beyond the forecasted demand before exceeding projected system capacity (219 ML/D).

2.3.3 Task C: GHG Emission Inventory

The sustainability of the distribution system was evaluated in the Greenhouse Gas (GHG) Inventory (Task C) to identify opportunities for energy conservation (refer to Appendix C for Task C Tech Memo 3: *Water System 2009 Greenhouse Gas Inventory*). This report and the approach for this GHG Inventory were completed in accordance with the ICLEI Local Governments for Sustainability, International Local Government GHG Emissions Analysis Protocol (IEAP), and the World Resources Institute’s (WRI) GHG Protocol where relevant. The

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base year considered in this study was 2009 to match with the Region's corporate GHG Inventory which was being prepared concurrently.

GHG emissions were presented in the three commonly accepted "Scope" classifications (as published by the GHG Protocol Initiative). Stantec consulted with the Region to define the activities which would be evaluated in each Scope as listed below:

- Scope 1: Direct GHG emissions resulting from activities in the facility including:
 - Fossil fuel combustion (gasoline, diesel, propane, and natural gas) in fleet vehicles, generators, pumps, and for comfort heating
- Scope 2: Indirect GHG emissions resulting from the consumption of electricity
- Scope 3: Indirect GHG emissions resulting from sources not owned or controlled by the Region, specifically limited to chemical haulage

Total GHG emissions for the Water Services Division are estimated to be 10,277 tonnes carbon dioxide equivalents (CO₂e) for the 2009 reporting year, of which a majority (96%) was attributable to operation of the facilities. Additionally, the Scope 2 GHG emissions from the consumption of electricity represent more than 80% of the total GHG emissions. The ratio of GHG emissions to water consumed within the entire Region is 0.18 tonnes CO₂e per 1,000 cubic meters of water. On a per capita basis, the total Region GHG emissions represents 20.1 tonnes CO₂e per 1,000 residents.

Based on this information, the greatest GHG reduction opportunities correspond to reducing electricity consumption in Region facilities. It is recommended that the Region review Stantec's audit of the electrical account records to ensure proper ownership, potentially disconnect facilities no longer in service, and minimize non-essential energy consumption. Through the WSDOMP, optimized solutions were generated with consideration for the results of this study and proposed solutions were assessed based on their electricity demands and impact on GHG emissions.

2.3.4 Tasks E-D-F: Constraint Analysis and Generation of Proposed Solutions

The identification of constraints (Task D) and identification of alternatives (Task E) were completed simultaneously. Refer to Task D and E Tech Memo 4: *Identification of Alternative Solutions* presented in Appendix D. The background information collected in Task A (which included information gathering workshops, reviewing background information, completing desk-top analyses and hydraulic modeling), was used to identify constraints in the physical distribution system and to identify operational optimization opportunities. Task F represented the selection of preferred improvement and optimization strategies. The purpose of this final report is to present the final system approach as identified in Task F.

The methodology for the evaluation of alternatives involved evaluation of constraints against a set of physical system criteria, scoring and developing alternatives to address the constraints.

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Constraints identified were reviewed to evaluate the affected area, impact, risk of occurrence, and greenhouse gas (GHG) reduction opportunity. The GHG reduction opportunity has been ranked from zero (0) to three (3) where there may be a GHG benefit from changing the existing system. The physical system constraint criteria and ranking are outlined in Table 2-2.

Table 2-2: Summary of Rankings for Physical System Constraints

Affected Area		Impact		Risk of Occurrence (Including Failure Mode Considerations)		GHG Reduction Opportunity	
Rank	Description	Rank	Description	Rank	Description	Rank	Description
1	Localized Area	1	Minor/No Service Impact	0	None (In Operation)	0	None (Not Applicable)
2	Pressure Zone	2	Decreased Level of Service	1	Low	1	Low Impact on Reducing GHG Emissions
3	Area Municipality	3	Water Quality Compliance	2	Moderate	2	Moderate Impact on Reducing GHG Emissions
4	IUS	4	Loss of Service	3	High	3	High Impact on Reducing GHG Emissions

Higher scores represented a more critical constraint or opportunity while low scores represented a less critical constraint or opportunity. The total score possible for a particular constraint is 14 and the following categories have been developed to show the relative priority for each category:

- High: Score of 9 to 14
- Medium: Score of 5 to 8
- Low: Score of 0 to 4

System-wide alternatives, City-wide alternatives, and constraint-specific alternatives were developed depending on the scale or complexity of the constraint. The hydraulic model developed in Task B was used to assess the impact of the constraints and evaluate alternatives. The GHG Inventory developed in Task C was used to evaluate optimization opportunities to reduce emissions. A preliminary schedule of implementation and opinion of probable costs were generated for the proposed optimization strategies. For operational optimization opportunities, current challenges were organized into common categories and alternatives were presented for consideration and discussion by Region and A.Mun. staff.

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Through consultation and workshops with Regional staff and with consideration for concurrent projects, including the WSMP, Master Environmental Servicing Plan (MESP) for the East Side Lands (ESL), and various Class Environmental Assessments, the preferred strategies to optimize the IUS supply and distribution network generated in Tasks D and E were finalized and are presented in this WSDOMP Final Report.

3.0 City of Cambridge Optimizations

3.1 SUMMARY OF PROPOSED SOLUTIONS

Cambridge demands are predominantly met through groundwater sources within the City. Pressure zone Cam 2W is the only exception, which has a primary supply from Kitchener (Kit 4). Connections from Kitchener through PRVs and CVs are otherwise used only to augment the supply to Cambridge during high demand periods. The water distribution system for Cambridge is described in Task A Tech Memo *Water Supply and Distribution System Background and Assessment* in Appendix A.

Middleton TP is considered the primary supply source for Cambridge. Middleton supplies to Cam 1, which currently supplies or supplements three of the four existing adjacent zones in Cambridge (CAM 1A, CAM 3, and CAM 2E). The preferred operating strategy for Middleton TP developed in the WSMP is to maintain a high flow-rate and continue to be the primary supply source for Cambridge, augmented by Shades Mill TP, sources in Cam 2E, and transfer from Kitchener.

The proposed reconfiguration for Cambridge redirects supply sources based on proximity to demands, consolidates supply sources and storage facilities, separates areas with secondary disinfection by chlorination and chloramination, provides additional operating flexibility at Middleton TP, and reduces electricity costs and GHG emissions.

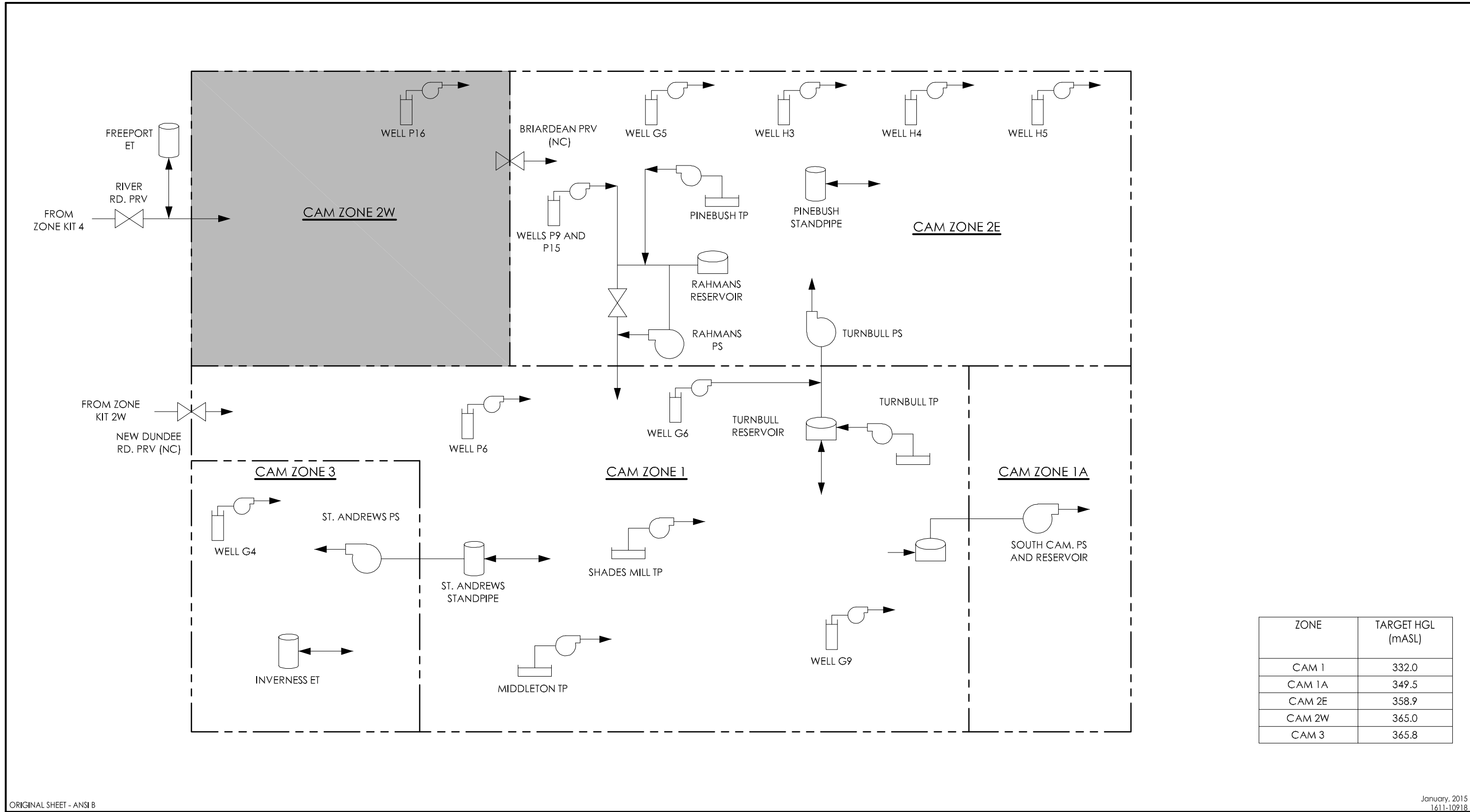
The existing process flow diagram for Cambridge is presented in Figure 3-1. The proposed changes are shown for each upgrade in the following sections.

Each preferred improvement and optimization strategy is described in terms of the following:

- Justification
- Overview of Work
- Layout and PFD for Facilities
- Studies Required
- GHG Impact
- Opinion of Probable Cost

The recommendations referred to as 'additional work' are grouped together in Section 3.2.7. They include recommendations for complementary infrastructure, and linear upgrades to occur along with the more significant WSDOMP proposed solutions described in Sections 3.2.1 through 3.2.6. Estimated time of implementation (schedule) is summarized for all solutions in Table 3-8 at the end of the Cambridge section.

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ZONE	TARGET HGL (mASL)
CAM 1	332.0
CAM 1A	349.5
CAM 2E	358.9
CAM 2W	365.0
CAM 3	365.8

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- WELL
- WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

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REGION OF WATERLOO
WATER SUPPLY AND
DISTRIBUTION WATER PLAN
Figure No.
3.1
Title

EXISTING CAMBRIDGE DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM

3.2 DETAILED REVIEW OF PROPOSED SOLUTIONS

3.2.1 Create New Zone Cam 1W

In the recommended reconfiguration, a new zone Cam 1W will be created by isolating the northwest portion of Cam 1. A chloramination station is proposed on Coronation Blvd. (primary connection from Cam 1) to supply Cam 1W with chloraminated water. In addition, secondary supply connections would be provided via the Dundee Rd. PRV (from Kit 2W) and the proposed upgraded Kresshill PRV (from Cam 2W). Cam 1 would continue to be supplied with chlorinated water from groundwater supply sources within Cambridge. Additionally, it is recommended that system Well P6 be decommissioned and Well G9 be placed on stand-by and maintained for future use in the new configuration.

3.2.1.1 Justification

- Supplementing the zone in the northwestern portion of Cam 1 during high water demands via Dundee Rd. PRV (from Kit 2W) results in mixing zones of chlorinated and chloraminated water, causing taste and odour concerns.
- Mitigation of pressure fluctuations at Conestoga College Cambridge Campus in the NW corner of Cam 1.
- Addresses reported problems with high chlorine residuals. High chlorine residuals in Cam 1 are partially due to the fact it is a large zone and water has to travel a relatively long distance to reach the northwestern portion of town (resulting in low chlorine residual issues in the north west and high residuals in the south eastern portion, which contributes to potential infrastructure deterioration and discolouration).
- There is sufficient supply to Cambridge, and system wells P6 and G9 are not required to meet the 2031 water demands.
- P6 would need to be upgraded and configured with for chloramination as it would be located in Cam 1W (chloraminated zone). The well is a low producer (< 10 L/s).
- The Kresshill PRV will provide an additional supply connection that will provide more flexibility for shut-down of Middleton TP for maintenance.
- Opinion of Probable Cost Justification is detailed in the Task D Tech Memo *Identification of Alternative Solutions*

3.2.1.2 Overview of Work

- Install chloramination station on Coronation Blvd. at the proposed boundary of Cam 1 and Cam 1W. The chloramination station is to be installed north of Cambridge Memorial Hospital on Coronation Blvd, northwest of the hospital and surrounding medical facilities.
 - Design and construct new chloramination station to add ammonium sulphate and convert the chlorinated supply from Cam 1 to chloraminated.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

- Install a new PRV at the Kresshill PS and 401 crossing to provide a connection from Cam 2W to the new Cam 1W.
 - Design/construction of new 450 mm PRV valve, complete with chamber and watermain modifications at the Kresshill site.
 - Watermain upgrades to replace the existing Highway 401 crossing (work underway).
- Place System Well G9 into standby status and decommission Well P6.
 - Develop a maintenance plan to ensure G9 can be brought online when demands necessitate.
- Decommission Kresshill PS.
- Reconfigure Rahmans PS as per Section 3.2.3 for supply directly to Cam 2E for emergencies only via Eagle St PRV.
- Reconfigure Turnbull PS as per Section 3.2.2 for supply to Cam 1.
- Additional supply connection to Kit 2W from Kit 4, as per items 8 and 10 in Section 4.2.5. to provide redundancy of supply to Kit 2W and emergency supply to Cam 1W (via Kit 2W). The need for this second connection is also noted in the report *Kitchener Zone 2 and 4 Optimization Study – Preliminary Design Report* (Stantec, 2009).

3.2.1.3 *Layout and PFD*

Refer to Figure 3-2 for the proposed changes identified on the system PFD for the 2031 Optimizations and to Figure 3-3 for physical location and additional infrastructure required.

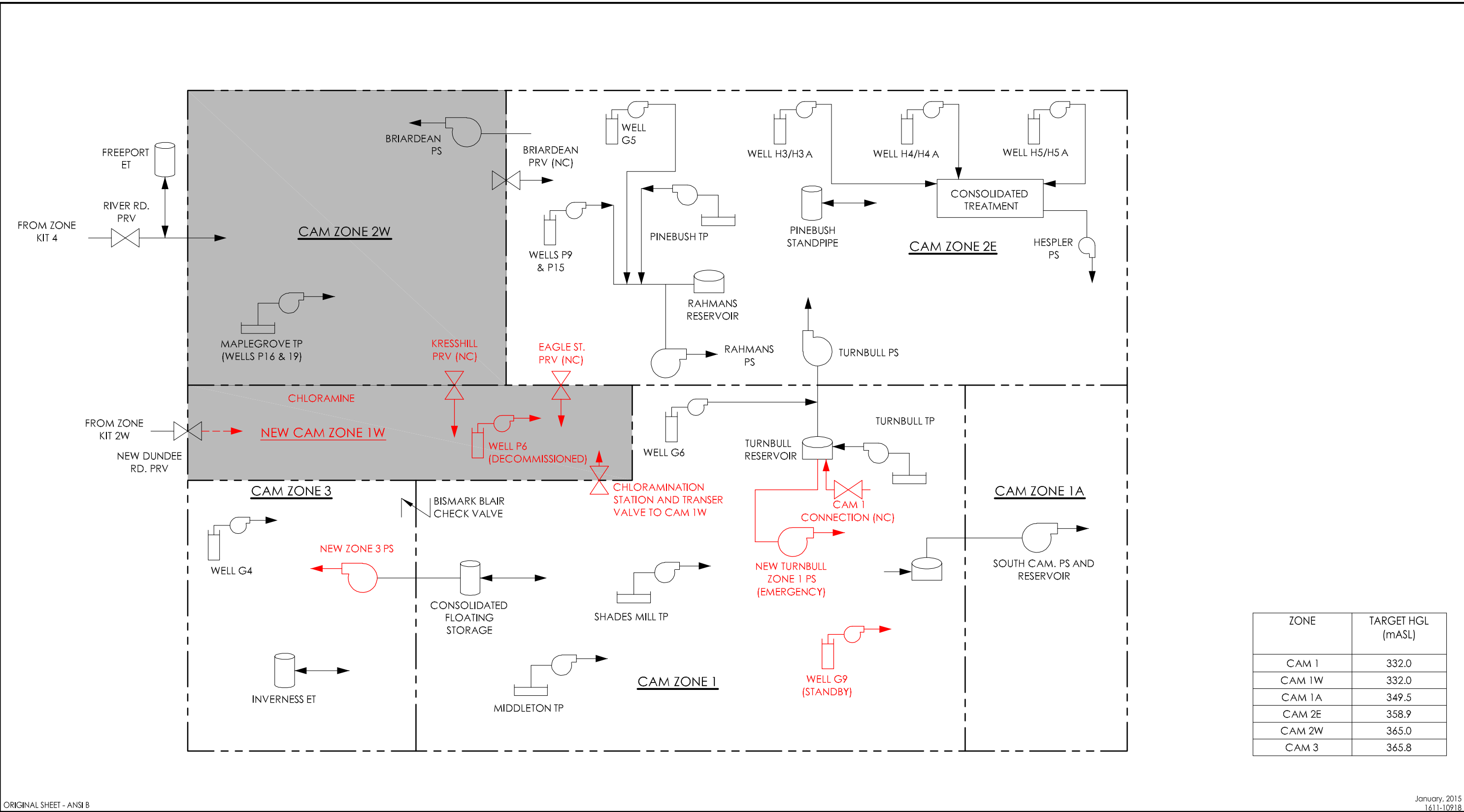
3.2.1.4 *Studies Required*

- Activities related to dividing Cam 1 are pre-approved changes (Schedule A Environmental Assessment).

3.2.1.5 *GHG Impact*

There is no significant impact on GHG emissions in this reconfiguration. Refer to Appendix F for additional information.

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ZONE	TARGET HGL (mASL)
CAM 1	332.0
CAM 1W	332.0
CAM 1A	349.5
CAM 2E	358.9
CAM 2W	365.0
CAM 3	365.8

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- PUMP STATION
- WELL
- WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED
- LOW FLOW CONNECTION

Notes

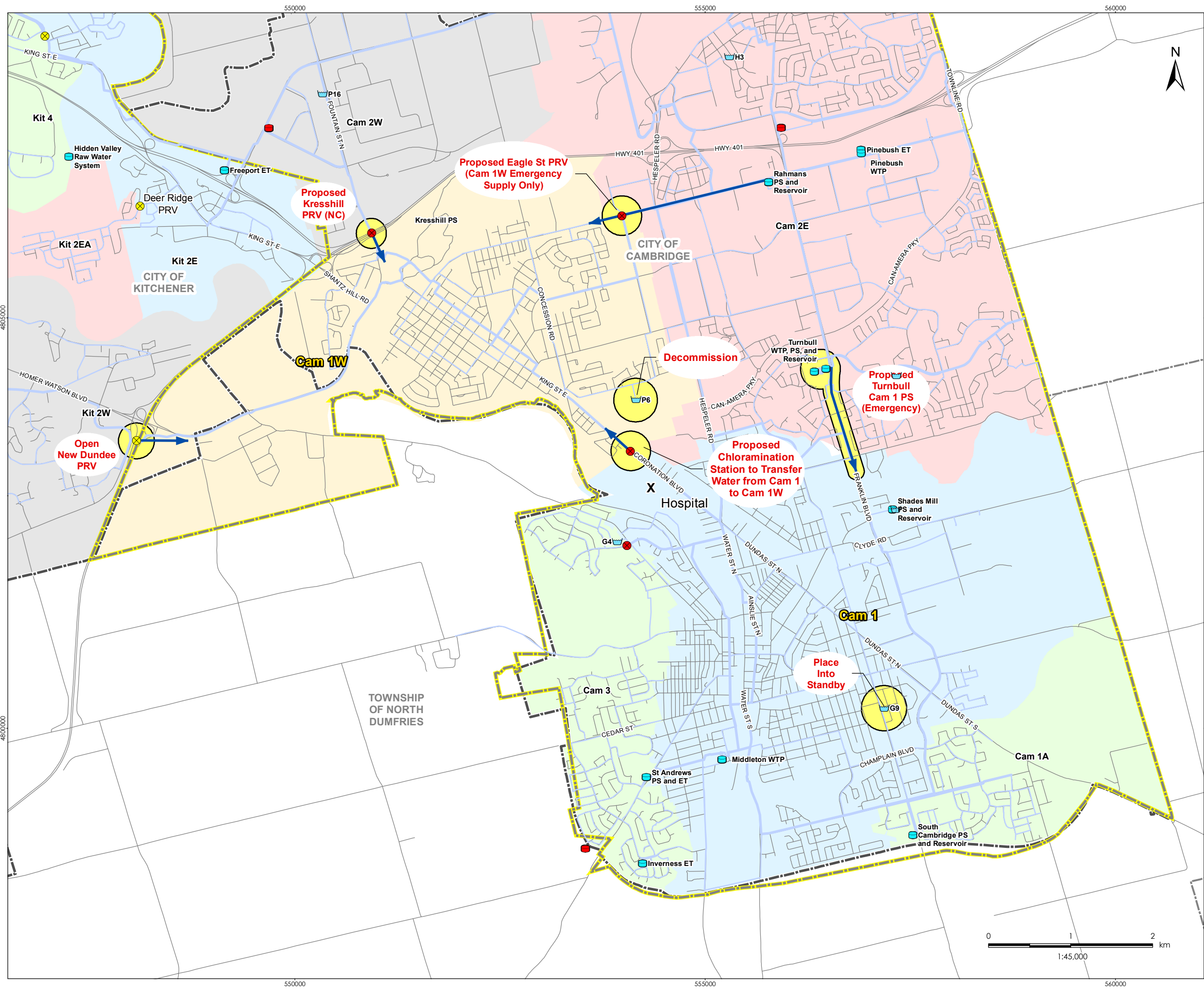
1. ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

Client/Project
REGION OF WATERLOO
WATER SUPPLY AND
DISTRIBUTION WATER PLAN

Figure No.
3.2

Title
**FUTURE CAMBRIDGE DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
CREATE NEW ZONE CAM 1W**

- Legend**
- WELL, PROPOSED**
- Well
 - Tank
 - Proposed Facility Location
 - Existing Valve
 - Proposed Valve
 - NC** Normally Closed
 - Infrastructure Related to Recommendation
 - City of Cambridge
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - Transfer Location



- Notes**
1. Coordinate System: NAD 1983 UTM Zone 17N
 2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2014.
 3. Cambridge Memorial Hospital is in Cam 1.

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Regional Municipality of Waterloo
Water Supply and Distribution
Operations Master Plan

Figure No.
3-3

Title
**Cambridge Optimization - Create
New Zone Cam 1W**

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Revised: 20150205 By: kbuchanan

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WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

3.2.1.6 *Opinion of Probable Cost*

Table 3-1 outlines the opinion of probable capital cost for creating the new zone Cam 1W. This optimization is associated with improving efficiencies and water quality. Operation and maintenance (O&M) costs associated with this alternative are expected to decrease slightly as a result of the removal of two system wells from regular use, which will be offset slightly by the new chloramination station at the connection from Cam 1 to Cam 1W. Refer to Appendix F for additional information.

Table 3-1: Opinion of Probable Cost for the Creating New Zone Cam 1W

Recommended Modification	Opinion of Probable Capital Cost
Install new Kresshill PRV and upgrade watermain to connect Cam 2W and Cam 1W	\$ 500,000
Decommission Kresshill Pump Station	\$ 25,000 ¹
Install chloramination station at connection from Cam 1 from Cam 1W	\$ 350,000
Place system well G9 on standby and decommission P6	\$ 100,000
TOTAL	\$ 975,000

Note 1: Decommissioning opinion of probable cost estimated based on removal of equipment.

3.2.2 **Improvements to Storage for Cam 1**

Consolidate floating storage for Cam 1 at a new location and convert the Turnbull Reservoir from a floating reservoir to pumped storage. Dedicated pump stations will allow the Turnbull Reservoir to supply water to Cam 2E and Cam 1 under emergency conditions in the event Middleton TP is offline.

3.2.2.1 *Justification*

- The existing system has three floating storage facilities in Cam 1 (Rahmans Reservoir, St. Andrews Standpipes, and Turnbull Reservoirs) each with a different top water level. By consolidating the floating storage at one facility, the HGL will be more consistent across the zone and simplify operations.
- St. Andrews Standpipe was constructed in 1949 and is past its design life; as such, it is due to be replaced or rehabilitated.
- Additional storage in Cam 1 will also provide more operating flexibility for the Middleton TP by supplementing the supply to the zone while the station is offline, or at a reduced production rate, for maintenance.
- A storage facility on the southwest side of Cambridge also provides an option to accept lake water, per alignment as outlined in the Lake Based Water Supply Study, should

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

future water demands require capacity above the current available surface and groundwater supplies.

- The new Cam 1 Reservoir would be deep-cycling and have a larger volume than the existing storage facilities, therefore it could be filled at night-time to save on energy costs and be drawn-down during high daytime demand periods. A large volume is recommended for this reservoir (minimum of 10,000 m³) in order to achieve time of day pumping efficiency. Specifically, night-time filling from Cam 1 sources will permit off-peak energy for treatment and pumping to fill the floating reservoir. Day-time peak energy will be minimized by gravity flow from the reservoir.
- The top water level for the Turnbull Reservoir is approximately 326 mASL. This restricts the ability to supply Cam 1, as the operating HGL is typically closer to 330 mASL. Converting to pumped storage will improve the ability of the Turnbull TP to supply water to the approximate HGL in the event of demand needs. Levels maintained in the Turnbull Reservoir will be less critical and can be set by operations to adjust for seasonal demands.
- It is also expected that the Turnbull PS will be required to transfer less water from Cam 1 to Cam 2E, allowing more water from Turnbull TP to supply Cam 1. The additional supply to Cam 1 will also help to reduce the reliance on the Middleton TP and provide more operational flexibility.

3.2.2.2 Overview of Work

- Construct consolidated floating storage and new Cam 3 PS to service Cam 1 at a new location on the west side or southwest side of Cam 3.
 - Install 600 mm watermain connection from Cam 1 trunk mains to proposed storage facility site.
 - Sizing of watermain is to be confirmed based on the intended operating strategy for proposed storage facility. The watermain diameter may be a larger diameter if the storage facility is intended to meet average and maximum day demands in 2031 for all of Cam 1, Cam 1A, and Cam 3 in the event of an emergency.
 - Design and construct the consolidated storage facility with a minimum volume of 10,000 m³.
 - Design and construct a new Zone 3 pump station, to supply water from the new storage facility to Cam 3.
 - Install 300 mm watermain connection from Zone 3 PS to Cam 3 (as required based on preferred pump station location). Connection could potentially be at Grand Ridge Dr. and St. Andrews St.
- Decommission the St. Andrews Standpipes and PS.
- Convert the Turnbull Reservoir to pumped storage, with one pump station to Cam 1 (emergency) and one pump station to Cam 2E

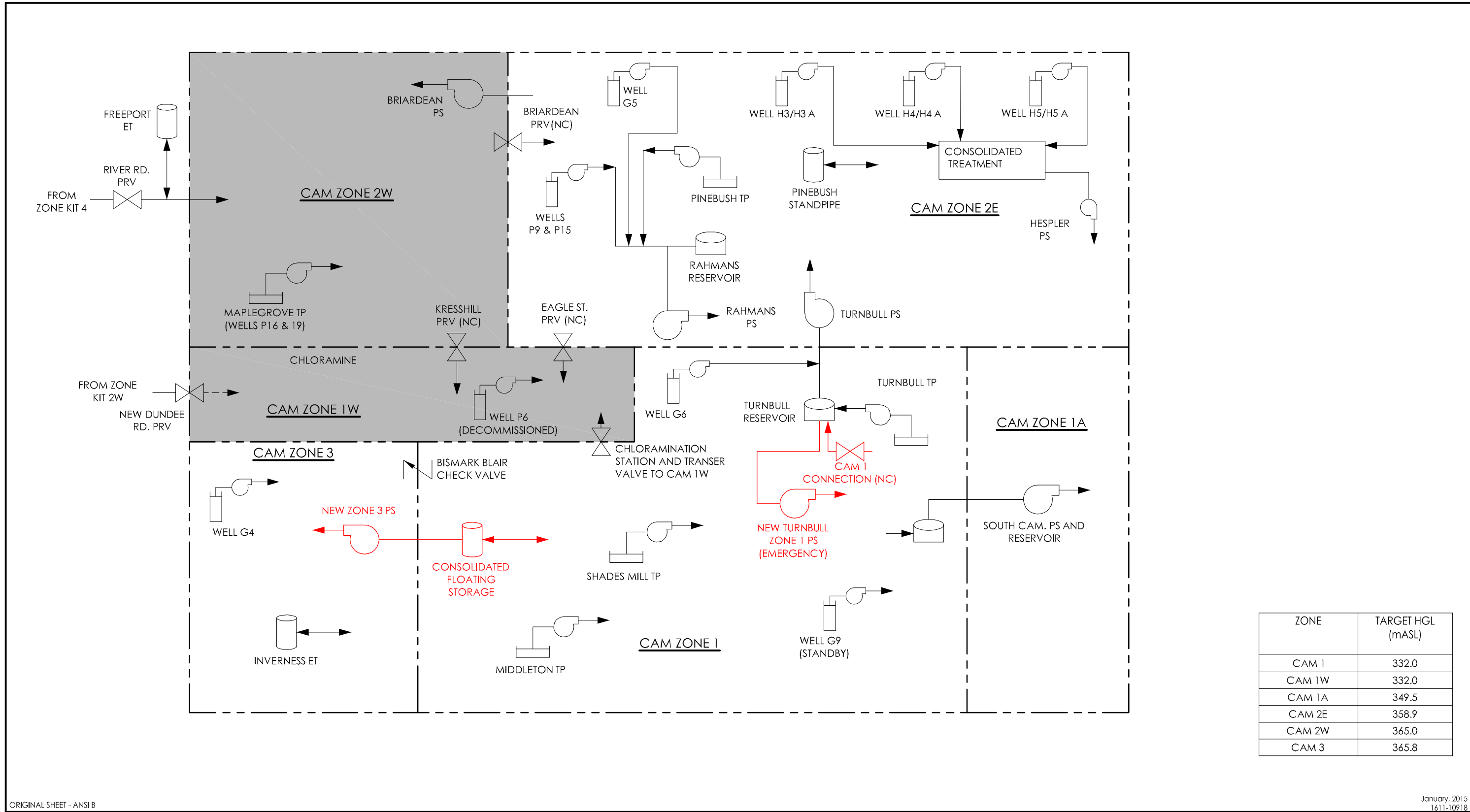
WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

- Design and construct new Cam 1 pump station at Turnbull site.
- Upgrade station and yard piping to have a dedicated discharge from Turnbull Reservoirs to Cam 1 via the new pump station.
- The operating volume of the Turnbull Reservoir is to be reviewed in the context of the overall storage upgrades provided in Cambridge, particularly the consolidated CAM 1 floating storage facility. Should the reservoir size be considered too large, the operating levels in the reservoir can be decreased to reduce operating volume. The cost of maintaining the larger reservoir and operating at a reduced capacity will be less than decommissioning a portion of the reservoir. In addition, maintaining the full reservoir capacity provides flexibility to increase the operating volume should it be required for taking Cam 1 facilities offline for maintenance.

3.2.2.3 Layout and PFD for Infrastructure

Refer to Figure 3-4 for the proposed changes identified on the system PFD for the 2031 Optimizations and to Figure 3-5 for physical location and additional infrastructure required.

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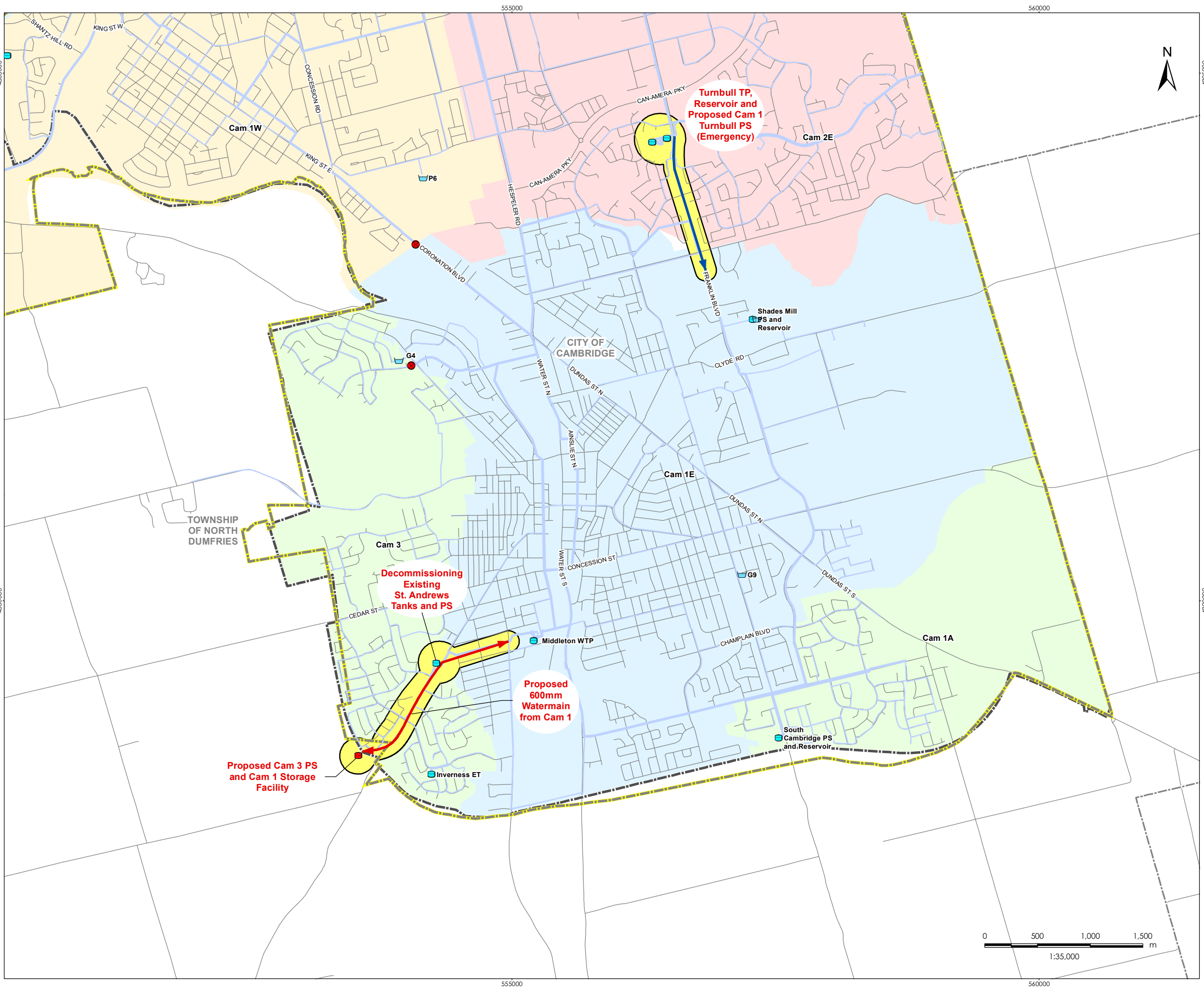
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- WATER SUPPLY STATION
- CHLORAMINE
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- (NC) NORMALLY CLOSED
- LOW FLOW CONNECTION

Notes

- ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

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WATER SUPPLY AND
DISTRIBUTION WATER PLAN
Figure No.
3.4
Title
FUTURE CAMBRIDGE DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
CAM 1 STORAGE

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Revised: 2015-02-09 By: kbuchanan



- Legend**
- Well
 - Tank
 - Proposed Facility Location
 - Existing Valve
 - Proposed Valve
 - Infrastructure Related to Recommendation
 - City of Cambridge
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - Transfer Location

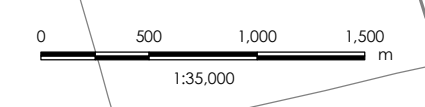
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Figure No.
3-5

Title
**Cambridge Optimization
- Improvements for Cam 1 Storage**



WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

3.2.2.4 Studies Required

A Schedule C Class Environmental Assessment will be required for the new Cam 1 Floating Storage Tank and possible relocation of Zone 3 PS. Note, the Class EA for this project should include evaluation of a dedicated pipe from Middleton TP to Zone 3 PS and alternate connection to Cam 1 from Cam 3 for Middleton TP shut downs, as an alternative to consolidated storage.

3.2.2.5 GHG Impact

There is no significant impact on GHG emissions for this proposed solution. The larger storage volume has optimized pumping efficiency (extended fill and draw) which reduces energy costs but not total emissions. Refer to Appendix F for additional information.

3.2.2.6 Opinion of Probable Cost

Table 3-2 outlines the opinion of probable capital cost of each phase required to improve storage for Cam 1. O&M costs associated with this optimization, which aims to improve operational and energy efficiencies, are expected to decrease slightly due to opportunities for time of day pumping as a result of a larger storage volume. Pumping during lower cost energy periods of the day will result in lower energy costs. Refer to Appendix F for additional information.

Table 3-2: Opinion of Probable Cost for Improvements to Cam 1 Storage

Recommended Modification	Opinion of Probable Capital Cost
Consolidate Floating Storage for Cam 1 (including all related worked including new Zone 3 PS, water mains, and decommissioning St. Andrews Standpipes) ¹	\$ 33,000,000
Create Pumped Storage for Cam 1 (emergency)	\$ 3,500,000
TOTAL	\$ 36,500,000

Note 1: Rehabilitation costs for the existing tanks are not included in the opinion of probable cost above

3.2.3 Consolidate Sources and Restore Capacity for Cam 2E

It is proposed that Rahmans PS, Wells P9 and P15, Pinebush TP, and Well G5 be consolidated into one facility and discharged to Cam 2E. A combined disinfection system will be used to dose chlorine into the water supplied from Wells P9, P15, and G5 before discharging into the Rahmans Reservoir. Consolidating all of these supplies will combine four sources into one facility.

Wells H3, H4, and H5 are located in the northern area of Cam 2E. The production capacities at these well sites are expected to be restored or increased with the proposed wells H3A, H4A, and H5A. Hydrogeological studies are also being conducted to determine if new ground water sources are available in this area or if the existing Permit to Take Water (PTTW) could be increased. The WSMP (2014) included an anticipated increase of 80 L/s from the Hespeler well

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

field in addition to existing supplies, based on hydrogeological studies. Should the production at these locations be restored or increased, it is proposed that these supply wells are consolidated to one facility for treatment and discharge to the distribution system.

3.2.3.1 *Justification*

- Well G5 is a system well that is disinfected and currently pumps directly to the Cam 2E distribution system.
 - A consolidation of supply facilities has been proposed to reduce the operating and maintenance requirements in Cambridge.
 - This will reduce operating costs and GHG emissions.
- Redirecting flow from Rahmans Reservoir to Cam 2E will eliminate inefficient pumping to Cam 1 (reservoir top water level is below the target HGL for Cam 1 and there are also downstream hydraulic restrictions). The consolidation and redirection of sources will help Cam 2E to become more self-sufficient by increasing the water available within the zone.
 - The Rahmans Reservoir has a top water level of approximately 329 mASL and a hydraulic restriction downstream (on Eagle Street North). As a result, pumping is required to overcome this restriction to deliver water to Cam 1 in the existing configuration.
- Rehabilitating the Pinebush TP wells to restore capacity will increase the amount of water supplied to Cam 2E via the proposed consolidated facility, compared to what is presently supplied at a reduced Pinebush TP capacity.
- The additional supply to Cam 2E will reduce the need to transfer water from Cam 2W via the Briardean Control Valve (CV) during high demands and mitigate areas of mixing between chlorinated and chloraminated water (Cam 2E is chlorinated and Cam 2W is chloraminated) and subsequent taste and odour issues.
- Potential restoration of capacity at Turnbull TP is underway by the addition of new wells. The extent of the increase to available supply capacity will be determined in the ongoing Cambridge East EA.
- It is also expected that the Turnbull PS will be required to transfer less water from Cam 1 to Cam 2E, allowing more water from Turnbull WTP to supply Cam 1. The additional supply to Cam 1 will also help to reduce the reliance on the Middleton TP and provide more operational flexibility in the event of an outage at Middleton TP.
- Consolidating the Hespeler wells to one facility for treatment will reduce operating and maintenance requirements and simplify operations for these facilities. Additionally, the electricity and GHG impact will be less with a consolidated facility versus three distributed sites.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

3.2.3.2 Overview of Work

- Consolidate Rahmans PS, Pinebush TP, and Well G5 and redirect to Cam 2E
 - Watermain upgrades at Rahmans PS to have a direct feed from Pinebush TP to Rahmans Reservoir (including miscellaneous isolation works).
 - Install Well G5/G5A (PTTW of 50 L/s) watermain 750 m to connect from Well G5/G5A to Rahmans Reservoir (estimated pipe diameter is 250 mm).
 - Upgrade Rahmans Reservoir to modify discharge piping for new pump station, complete internal modifications/rehabilitation (or replacement if asset condition is too poor), adjust control logic, and upgrade yard piping.
 - Replace pumps at Pinebush TP (3 pumps) and Well G5 to discharge to Rahmans Reservoir. It is beneficial to use well pump replacement as an opportunity to rehabilitate the wells; therefore, costs for rehabilitation have been included.
 - Replace pumps at Rahmans Reservoir to discharge to Cam 2E.
 - Install Rahmans PS discharge watermain to connect from the station to Cam 2E. Minimal piping changes are required but a new valve chamber would be installed and the existing piping would be used as a backup to Cam 1W.
 - Install emergency pressure reducing valve or flow control valve from Cam 2E to Cam 1W on Eagle St.
 - Upgrade chlorine dosing facilities at Rahmans with secondary disinfection; based on WSMP (2014) Rahmans (P9 and P15) is 30 L/s, G5/G5A is 33 L/s, and Pinebush TP would continue to disinfect its own supply (120 L/s).
- Increase capacity at Pinebush Road wells to restore production at the consolidated Pinebush TP/Rahmans PS/Well G5 facility
 - A hydrogeological study has been completed and new wells have been installed. A Class EA is ongoing (Cambridge East EA). Treatment requirements for the new supply wells are unchanged at the Pinebush TP.
 - Construction upgrades for incorporation of new supply wells at Pinebush TP. Assume that new wells are groundwater sources and will use existing treatment equipment at Pinebush with no required upgrades.
 - Install raw watermains as required to connect P10a and P10b to Pinebush TP.
- Consolidate Hespeler Wells (Well H3/H3A, H4/H4A, H5/H5A) to one facility if long-term sustainable production rates increase (greater than 80 L/s recommended)
 - Construction of new supply wells has been completed.
 - Install raw watermains from the wells to the proposed centralized site.
 - New Facility with booster pumps and small reservoir.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

- Install discharge watermains from the proposed centralized site to Cam 2E trunk watermain (using Rahmans as the centralized site above has accounted for this item).

3.2.3.3 Layout and PFD for Facilities

Refer to Figure 3-6 for the proposed changes identified on the system PFD for the 2031 Optimizations and to Figure 3-7 for physical location and additional infrastructure required.

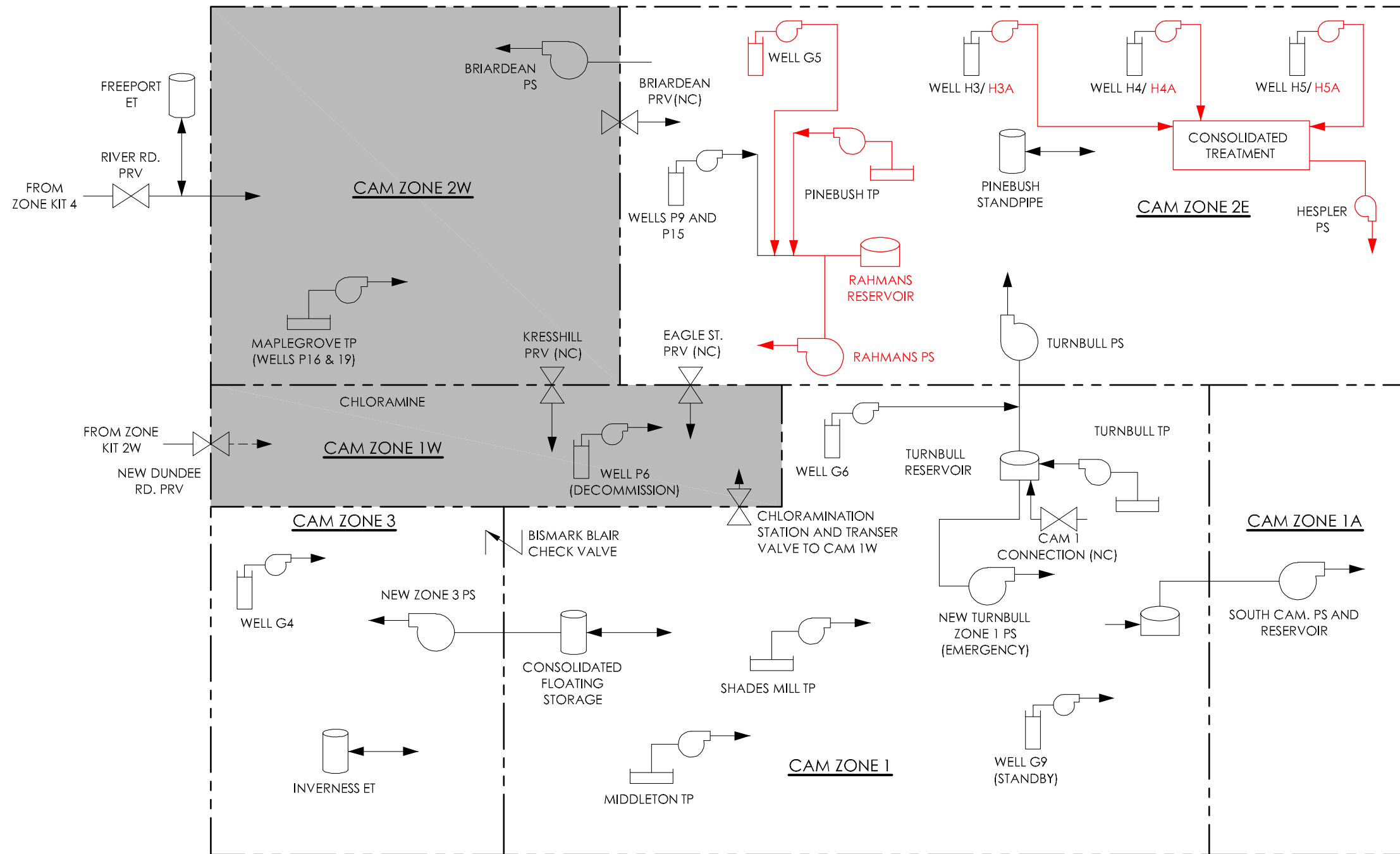
3.2.3.4 Studies Required

- The work related to consolidating supplies at Rahmans Reservoir requires a Schedule B Class Environmental Assessment for the new PS.
- A Schedule B Class Environmental Assessment and Permit to Take Water (PTTW) are required to connect the new Pinebush wells to the Pinebush TP.
- A Schedule C Class Environmental Assessment is required to determine the preferred site location and treatment options for blended water, as well as the associated raw watermains for the Hespeler Wells.

3.2.3.5 GHG Impact

There is a slight decrease in GHG emissions due to the consolidation the Hespeler wells to one facility as more energy efficient pumping can be achieved when wells pump to a clearwell versus directly to the distribution system and reduction in sampling visits will reduce fuel consumption. Savings will be achieved by selecting a pump head at each well matching the required centralized facility pressure. Efficient high-lift pumping from the central facility will be selected to meet the HGL in Cam 2E. Refer to Appendix F for additional information.

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ZONE	TARGET HGL (mASL)
CAM 1	332.0
CAM 1W	332.0
CAM 1A	349.5
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CAM 3	365.8

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Notes

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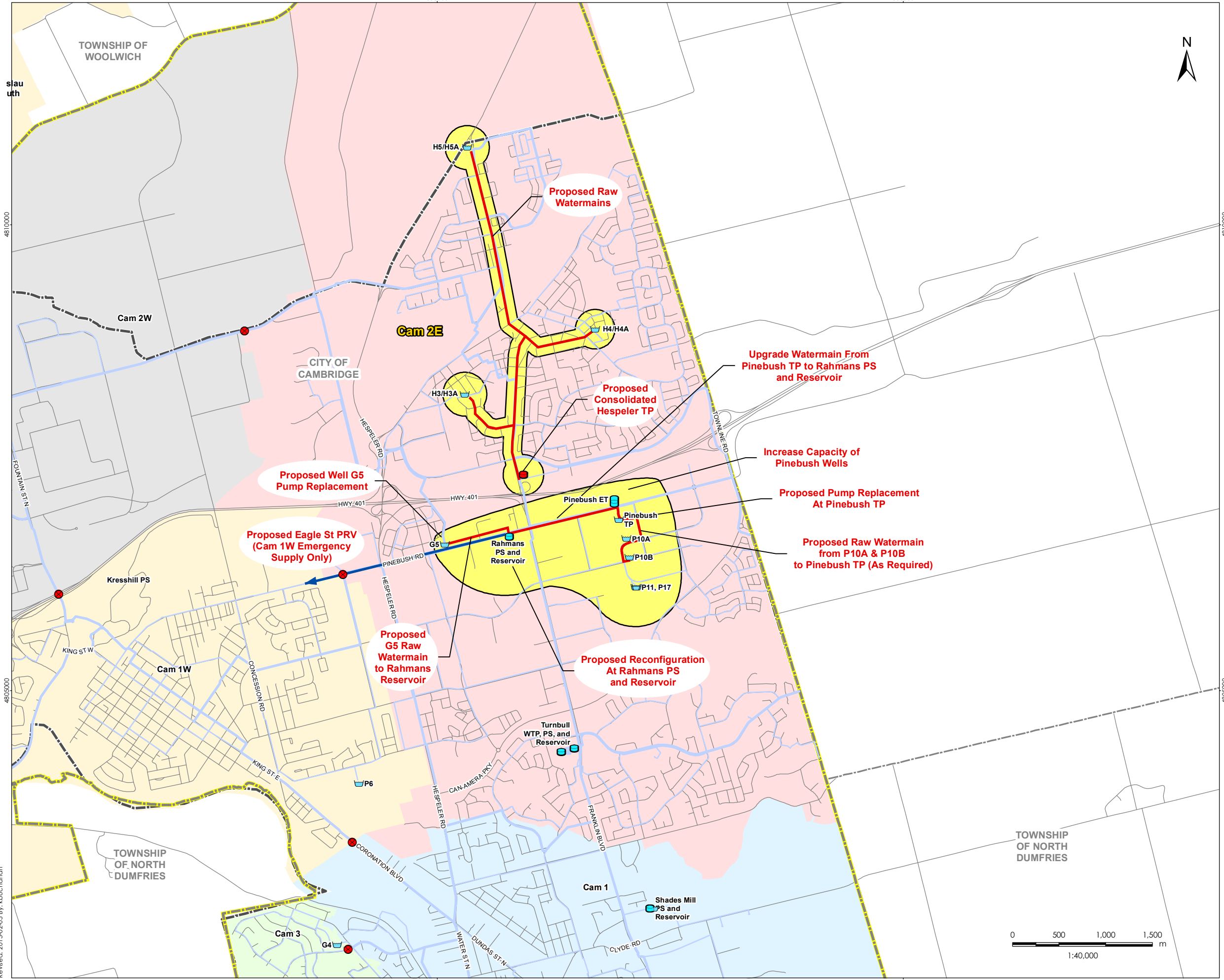
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DISTRIBUTION WATER PLAN

Figure No.
3.6

Title
FUTURE CAMBRIDGE DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
CAM 2E SOURCE CONSOLIDATION



- Legend**
- Well
 - Tank
 - Proposed Facility Location
 - Proposed Valve
 - Infrastructure Related to Recommendation
 - City of Cambridge
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - Transfer Location
 - New Infrastructure



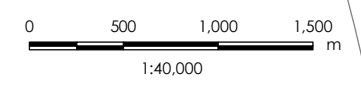
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Figure No.
3-7

Title
**Cambridge Optimization
 - Cam 2E Source Consolidation**



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 Revised: 2015-02-05 By: kbuchanan

3.2.3.6 Opinion of Probable Cost

Table 3-3 outlines the opinion of probable capital cost for each phase in the proposed upgrades to Cam 2E. O&M costs associated with this optimization, which aims to restore supply capacity and improve operational and energy efficiencies, are expected to decrease slightly due to optimized pumping at the consolidated Hespeler facility and fewer individual sites to visit on a regular basis for maintenance and sampling purposes. Refer to Appendix F for additional information.

Table 3-3: Opinion of Probable Cost for Cam 2E Proposed Upgrades

Recommended Modification	Opinion of Probable Capital Cost
Consolidate Rahmans PS, Pinebush TP, Well G5 and redirect to Cam 2E ¹	\$ 3,900,000
Restore capacity at Pinebush Road wells	\$ 500,000
Consolidate Hespeler Wells at New Facility	\$ 7,600,000
TOTAL	\$ 12,000,000

Note 1: Opinion of probable capital cost assumes the existing Rahmans Reservoir can be rehabilitated. Should the asset condition require the reservoir to be replaced, the capital cost will be greater.

3.2.4 Cam 2W and East Side Land Supply Strategy

Projected growth in Cam 2W is expected to require additional supply to accommodate new development (East Side Lands, refer to Section 3.2.6) and reconfigurations to Cam 1 (Section 3.2.1) will require Cam 2W to transfer water to Cam 1W as an emergency supply. A staged approach is recommended to meet future demands, as follows:

- Stage 1: Increase the amount of water transferred from Kitchener through prioritization of new Kitchener/Waterloo supply projects (refer to Sections 5.1 and 5.2.3);
- Stage 2: Install an inline booster pump station from Cam 2E to Cam 2W;
- Stage 3: Optimize use of Middleton TP supply from Cam 1 to Cam 2E; and
- Stage 4: Design, construct, and commission a treatment plant for the Maple Grove wells (P16 and P19 (FSTP1-10)) as a stand-alone or combined facility with the Grand River Wells as outlined in the WSMP (2014) (future demands to dictate, addressed in future Water Supply Master Plan update).

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

3.2.4.1 Justification

- A staged approach allows the optimization of existing and proposed infrastructure to meet demands prior to constructing a new water treatment plant for the Maple Grove wells.
 - The prioritization of new sources in Waterloo (refer to Section 5.0 for additional details) reduces Waterloo demand reliance on Kitchener supplies, providing additional supply capacity to transfer water to Cambridge. Infrastructure is already in place to transfer water to Cam 2W.
 - An inline booster pump station is recommended to transfer water from Cam 2E to Cam 2W after the transfer capacity from Kitchener has been exceeded. The supply capacity in Cam 2E is projected to increase as a result of new and rehabilitated groundwater wells.
 - Maximizing Middleton TP supply capacity is the preferred operating strategy for Middleton TP, and as such water will be transferred from Cam 1 to Cam 2E before developing new supply sources in Cam 2W.
 - After the transfer capacity has been exceeded from Kitchener, Cam 2E, and Cam 1, the Maple Grove wells are to be constructed and commissioned as a stand-alone or combined treatment facility with the Grand River wells. The Maple Grove Treatment Facility as a stand-alone facility would combine water from wells P16 and P19 (FSTP1-10) for centralized treatment and discharge to the distribution system. Treatment is required for these wells to achieve guideline limits for iron and manganese and provide disinfection.

3.2.4.2 Overview of Work

- Install an in-line booster pump station at the pressure zone boundary to transfer water from Cam 2E to Cam 2W. Note that ammonium sulphate will need to be dosed at the station to convert chlorinated water (from Cam 2E) to chloraminated water (Cam 2W).
 - Design and construct booster pump station to increase pressure by 6 m.
- Bring Maple Grove wells (P16 and P19 (FSTP1-10)) online to supplement demands from the East Side Lands development.
 - Construct test well FSTP1-10
 - Install raw water mains from the wells to the proposed centralized site.
 - Install discharge water mains from the proposed centralized treatment site to Cam 2W trunk watermain (500 m of 300 mm pipe).
 - Design and construct treatment facilities with a production capacity of up to 80 L/s, iron and manganese removal, and disinfection.
 - Construct new consolidated high-lift pump station.

3.2.4.3 *Layout and PFD of Facilities*

Refer to Figure 3-8 for the proposed changes identified on the system PFD for the 2031 optimizations and to Figure 3-9 for physical location and additional infrastructure required.

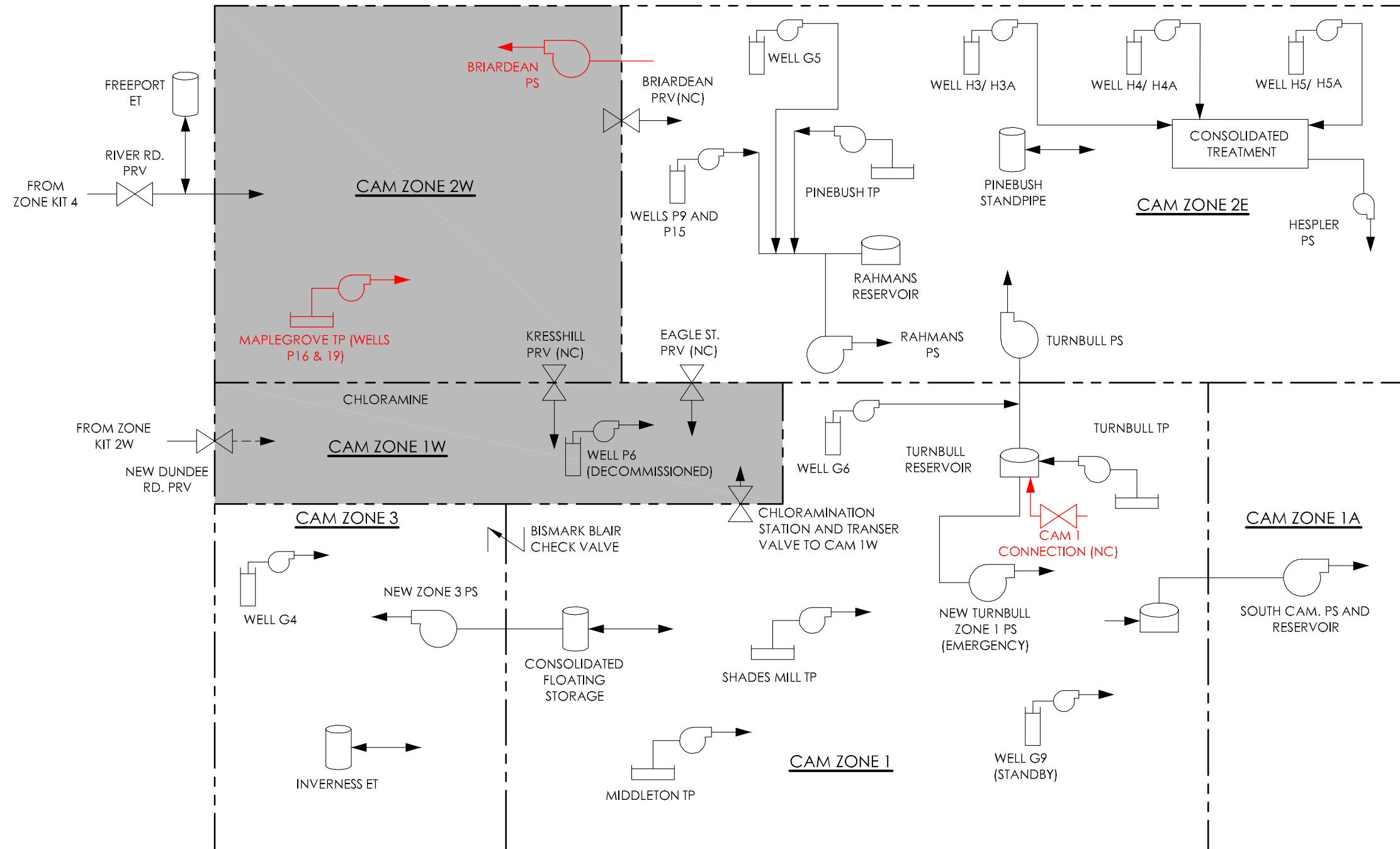
3.2.4.4 *Studies Required*

A Schedule B Class Environmental Assessment is required for the inline booster pump station. A Schedule C Class Environmental Assessment required for the design and placement of the new Maple Grove treatment facility and was completed in May 2014.

3.2.4.5 *GHG Impact*

There is a net increase in GHG because of the addition of the new facilities. Note, at the time of implementation it is assumed these optimizations will be required to maintain supply and redundancy of supply to Cam 2W and ESL. Refer to Appendix F for additional information.

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ZONE	TARGET HGL (mASL)
CAM 1	332.0
CAM 1W	332.0
CAM 1A	349.5
CAM 2E	358.9
CAM 2W	365.0
CAM 3	365.8

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Legend

- RESERVOIR
- ELEVATED TANK
- PUMP STATION
- WELL
- WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED
- LOW FLOW CONNECTION

Notes

- ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

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DISTRIBUTION WATER PLAN

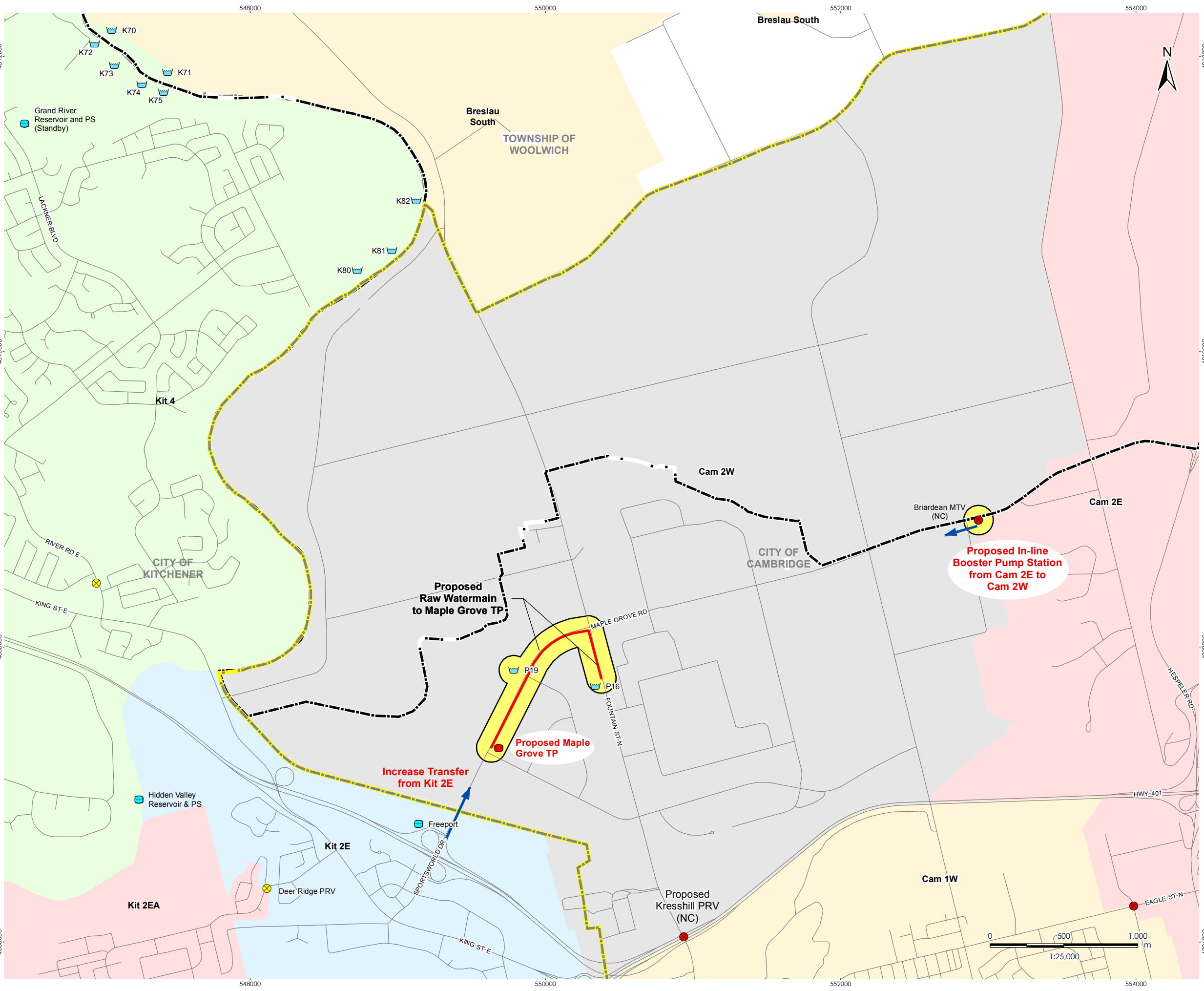
Figure No.

3.8

Title

**FUTURE CAMBRIDGE DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
CAM 2W AND ESL SUPPLY STRATEGY**

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 Revised: 20150209 By: kbuchanan



- Legend**
- Well
 - Tank
 - Proposed Facility Location
 - Proposed Pump Station
 - Existing Valve
 - Proposed Valve
 - Infrastructure Related to Recommendation
 - City of Cambridge
 - Urban Boundary
 - Municipal Boundary
 - Road
 - New Infrastructure
 - Transfer Location

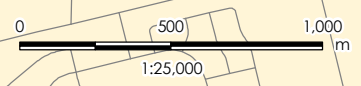
- Notes**
1. Coordinate System: NAD 1983 UTM Zone 17N
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 3. NC = Normally Closed

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 Regional Municipality of Waterloo
 Water Supply and Distribution
 Operations Master Plan

Figure No.
3-9

Title
**Cambridge Optimization
 - Cam 2W and ESL Supply Strategy**



3.2.4.6 Opinion of Probable Cost

Table 3-4 outlines the opinion of probable capital cost for the proposed upgrades to provide additional supply to East Side Lands and Cam 1W. O&M costs associated with this optimization, which adds redundancy of supply and increases supply to Cam 2W and the ESL, are expected to increase. This is a result of a new WTP and PS and the associated energy and maintenance costs. Refer to Appendix F for additional information.

Table 3-4: Opinion of Probable Cost to Increase Supply in East Side Lands and Cam 1W

Recommended Modification	Opinion of Probable Capital Cost
Cam 2W Inline Booster Pump Station	\$ 3,000,000
Centralized Maple Grove Facility (Stand-alone)	\$ 5,700,000
TOTAL	\$ 8,700,000

3.2.5 Modifications to Increase Hydraulic Capacity in Cam 3

Modifications include a new watermain on the northwest side of Cam 3, upsizing the watermains along Blenheim Road and a new check valve in northern Cam 3.

3.2.5.1 Justification

- Modifications are necessary to ensure adequate fire flow to northern Cam 3
 - The single 200 mm watermain, partially aligned within a cemetery, to northern Cam 3 is unable to meet fire demands in the northern section of Cam 3 should Well G4 be offline and there was a watermain break. This may result in the need to utilize tanker trucks to meet fire demands.
- There is anticipated future growth in Cam 3 and infrastructure is needed to ensure demands can be met.
- WSMP (2014) recommends the expansion of capacity of G4 (20 L/s) by bringing G4A online at approximately 35 L/s. Opinion of probable costs and scheduling associated with this upgrade are included in the WSMP (2014).

3.2.5.2 Overview of Work

- Modifications to Cam 3 to improve capacity
 - Install a new 300 mm pipe on the west side of Cam 3 between Salisbury Ave and Bismark Drive to service the proposed new development on the northwest side of Cam 3 (to be completed as part of development by the City)
 - Upgrade the 100 mm and 150 mm sections of pipe on Blenheim Road to 200 mm (to be completed as part of development by the City)

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

- Install a new check valve on the end of Bismark and Blair Rds. which will act as an emergency supply to north Cam 3 (in progress)

3.2.5.3 Layout and PFD

Refer to Figure 3-10 for the proposed changes identified on the system PFD for the 2031 Optimizations and to Figure 3-11 for physical location and additional infrastructure required.

3.2.5.4 Studies Required

Modification to the distribution system and installation of the check valve are both pre-approved changes (Schedule A Environmental Assessment).

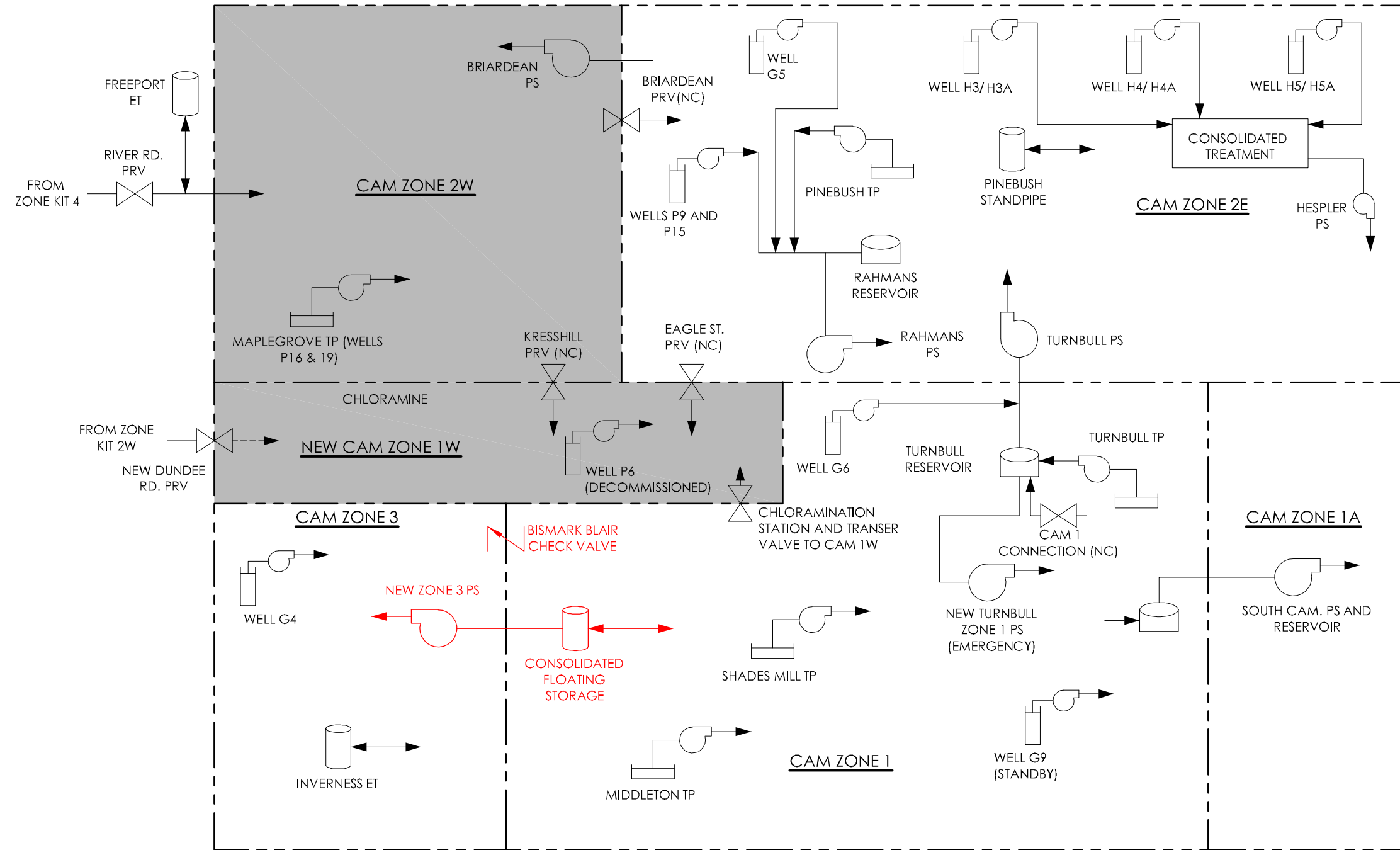
3.2.5.5 GHG Impact

There is no significant impact on GHG emissions from this modification. Refer to Appendix F for additional information.

3.2.5.6 Opinion of Probable Cost

The capital costs of the Cam 3 upgrades are to be completed as part of planned development by the City of Cambridge, and there are no costs to the Region. The check valve installation is being completed by the Region. The costs associated with the increase in capacity for G4/G4A are captured in the WSMP (Stantec, 2014). There are no significant changes to O&M costs associated with this optimization. Refer to Appendix F for additional information.

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ZONE	TARGET HGL (mASL)
CAM 1	332.0
CAM 1W	332.0
CAM 1A	349.5
CAM 2E	358.9
CAM 2W	365.0
CAM 3	365.8

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- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

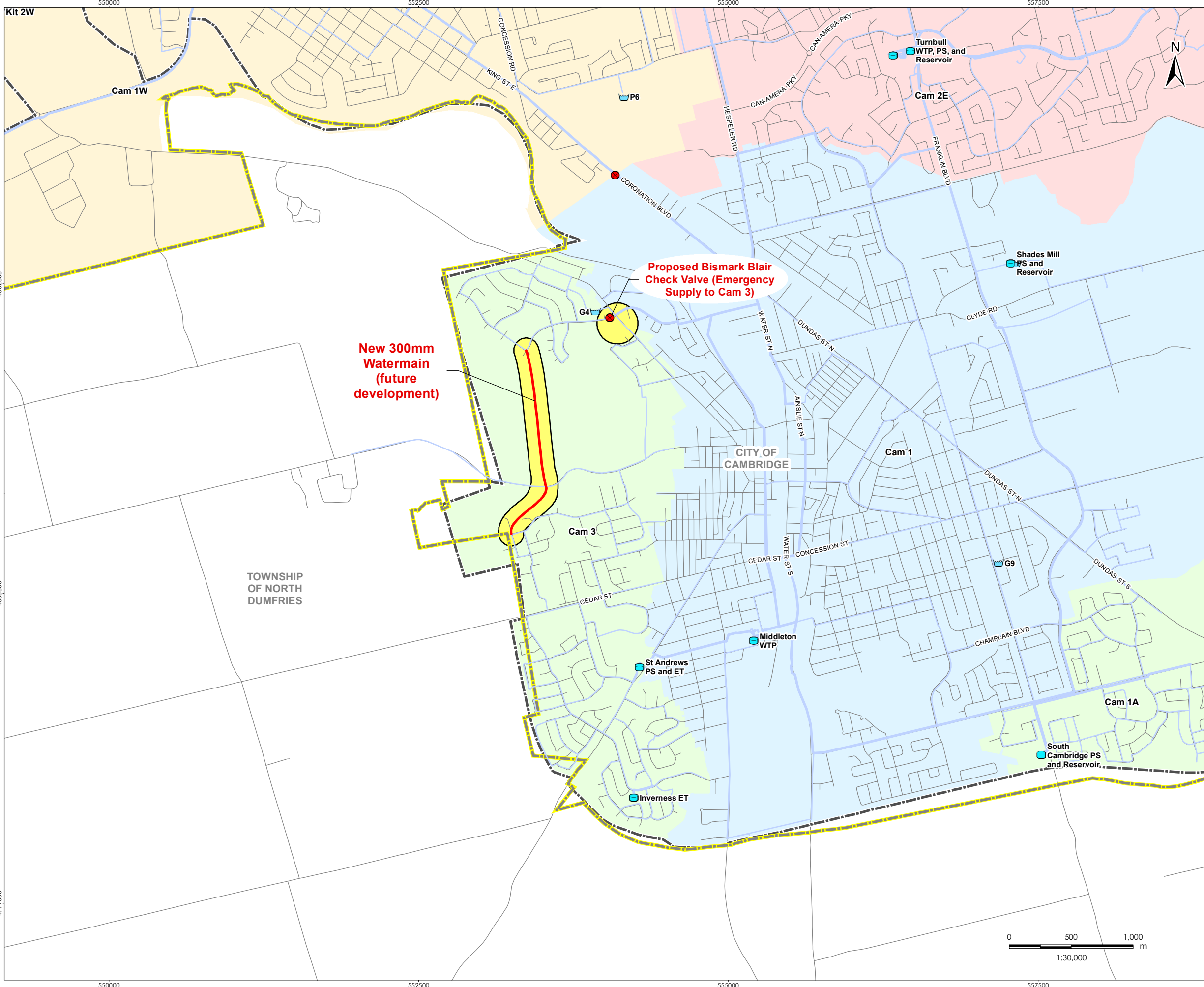
Notes

1. ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

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DISTRIBUTION WATER PLAN

Figure No.
3.10

Title
**FUTURE CAMBRIDGE DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
MODIFICATIONS TO CAM 3**



- Legend**
- Tank
 - Well
 - Proposed Valve
 - Infrastructure Related to Recommendation
 - City of Cambridge
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - New Infrastructure

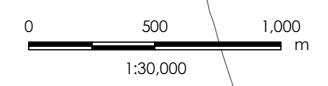
- Notes**
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Figure No.
3-11

Title
**Cambridge Optimization
- Modifications to Cam 3**



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 Revised: 2015-02-09 By: kbuchanan 4777500

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

3.2.6 Consolidate Pressure Zones for the East Side Lands

It is proposed that a small area from the existing Kit 4 pressure zone, Breslau South, Cam 2W, and Kit 2E are consolidated to operate as one pressure zone with a target HGL of 365 mASL. The naming convention of the zones will remain the same, with the exception of the area being transferred from Kit 4, which will be consolidated with Kit 2E.

A Master Environmental Servicing Plan (MESP) was completed for the East Side Lands (ESL). Preliminary water distribution system recommendations based on the MESP Final Report (Dillon Consulting Ltd., 2014) were reviewed in the context of the WSDOMP to confirm recommended watermain sizes to accommodate proposed growth and to consolidate the pressure zones as noted above (refer to Appendix G for details).

3.2.6.1 Justification

- Transferring a small area on the east side of Kit 4 to a pressure zone with a lower target HGL will optimize service pressures for existing development.
- Consolidating pressure zones allows additional looping to strengthen the distribution system and provide redundancy of supply.
- The strengthened distribution system will help accommodate projected growth and new development for the East Side Lands (ESL).

3.2.6.2 Overview of Work

- Install a 200 mm watermain on Fairway Road between Sims Estate Drive and Fairway Crescent.
- Install a 300 mm watermain on Middleblock Road between the future North-South collector and Speedsville Road.
- Install a 300 mm watermain on Allendale Road between the future North-South collector and Fountain Street.
- Install a 300 mm watermain on the future North-South collector between Middleblock Road and north of the King Street Bypass.
- Install a 300 mm watermain on Speedsville Road between Middleblock Road and Maple Grove Road.
- Install a 300 mm watermain on Fountain Street between Middleblock Road and Banat Road.
- Install a 300 mm watermain on Fairway Road between Lackner Boulevard and Upper Mercer Street.
- Install a 300 mm watermain on Morrison Road between north of Quinte Crescent and Sims Estate Drive (approximate alignment, to be confirmed).

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

- Install a 400 mm watermain on Fountain Street between Regional Road 99 and Kossuth Road.
- Install a 450 mm watermain on Fountain Street between Kossuth Road and Maple Grove Road.
- Install a 450 mm watermain on Fairway Road between Upper Mercer Street and Fountain Street.

The above work is the recommended infrastructure for the 2031 build-out conditions. Phasing for the recommended infrastructure will be dependent on the timing of development. Refer to WSDOMP *Review of Distribution System Upgrades to Service the East Side Lands TM* in Appendix G.

3.2.6.3 *Layout for Consolidated Pressure Zone*

Refer to Figure 3-12 and Figure 3-13 for the boundary of the proposed pressure zone consolidation and recommended watermains.

3.2.6.4 *Studies Required*

The MESP (Dillon Consulting Ltd.) recently completed a review of proposed infrastructure to accommodate growth. Additional work required to support the pressure zone consolidation is within existing road right of way and a pre-approved Schedule A Class Environmental Assessment would apply. Should the confirmed alignment of the proposed Morrison Road watermain be outside of an existing road right of way, a Schedule B Class Environmental Assessment would be required.

3.2.6.5 *GHG Impact*

There is no significant impact on GHG emissions that are a result of the consolidated pressure zone. Proposed infrastructure to accommodate this alternative is also required to support growth in the area and will be constructed as development progresses. Refer to Appendix F for additional information.

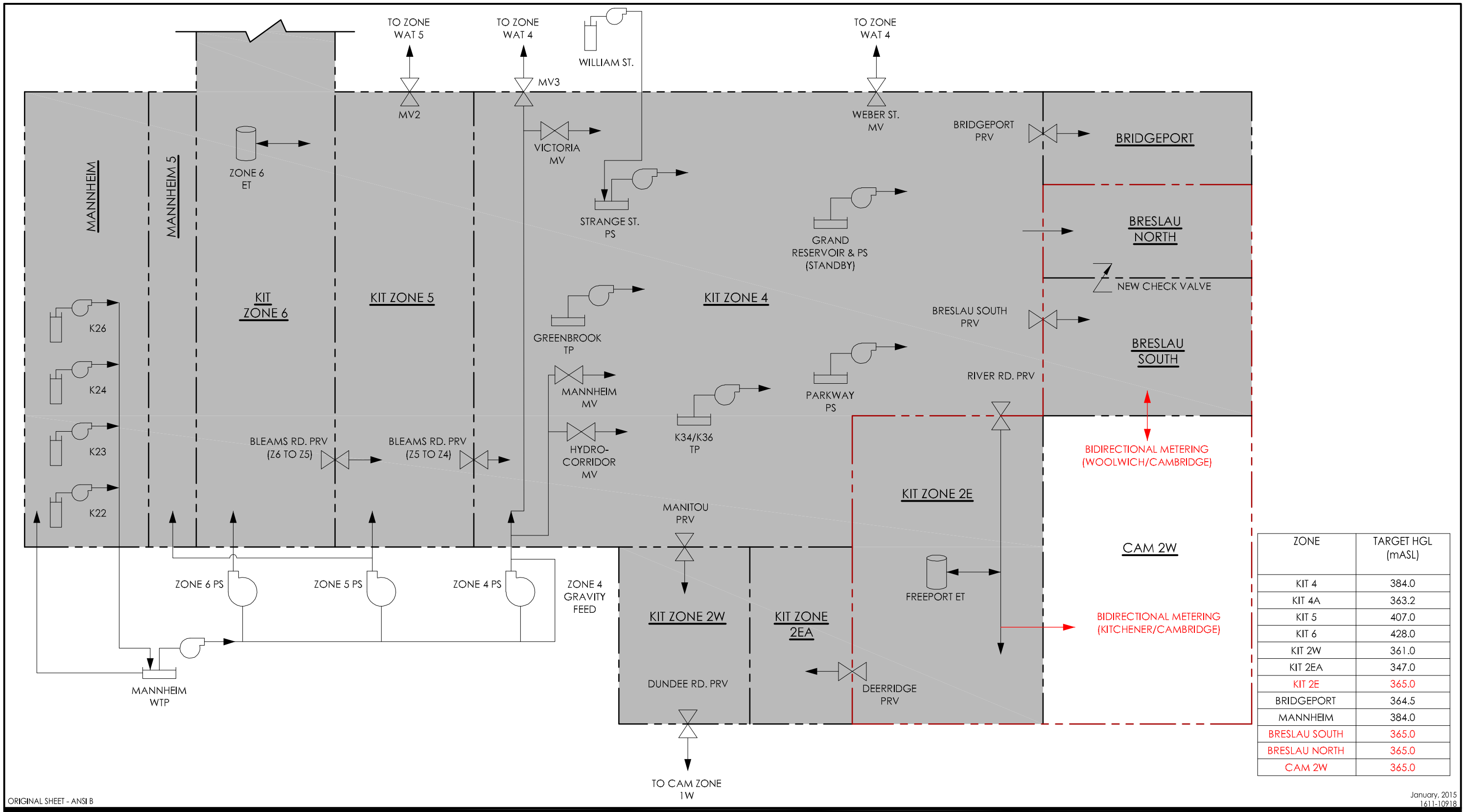
3.2.6.6 *Opinion of Probable Cost*

Table 3-5 outlines the opinion of probable capital cost to accommodate growth and consolidate pressure zones in the ESL area. There are no significant O&M costs associated with this optimization. Refer to Appendix F for additional information.

Table 3-5: Opinion of Probable Cost to Accommodate Growth and Consolidate Pressure Zones in the East Side Lands Area

Recommended Modification	Opinion of Probable Capital Cost
New watermains	Refer to Additional Linear Projects (Table 3-7, Items 12-21)

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




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-  WELL
-  WATER SUPPLY STATION
-  CHLORAMINE
-  FREE CHLORINE
-  (NC) NORMALLY CLOSED

Notes

- ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

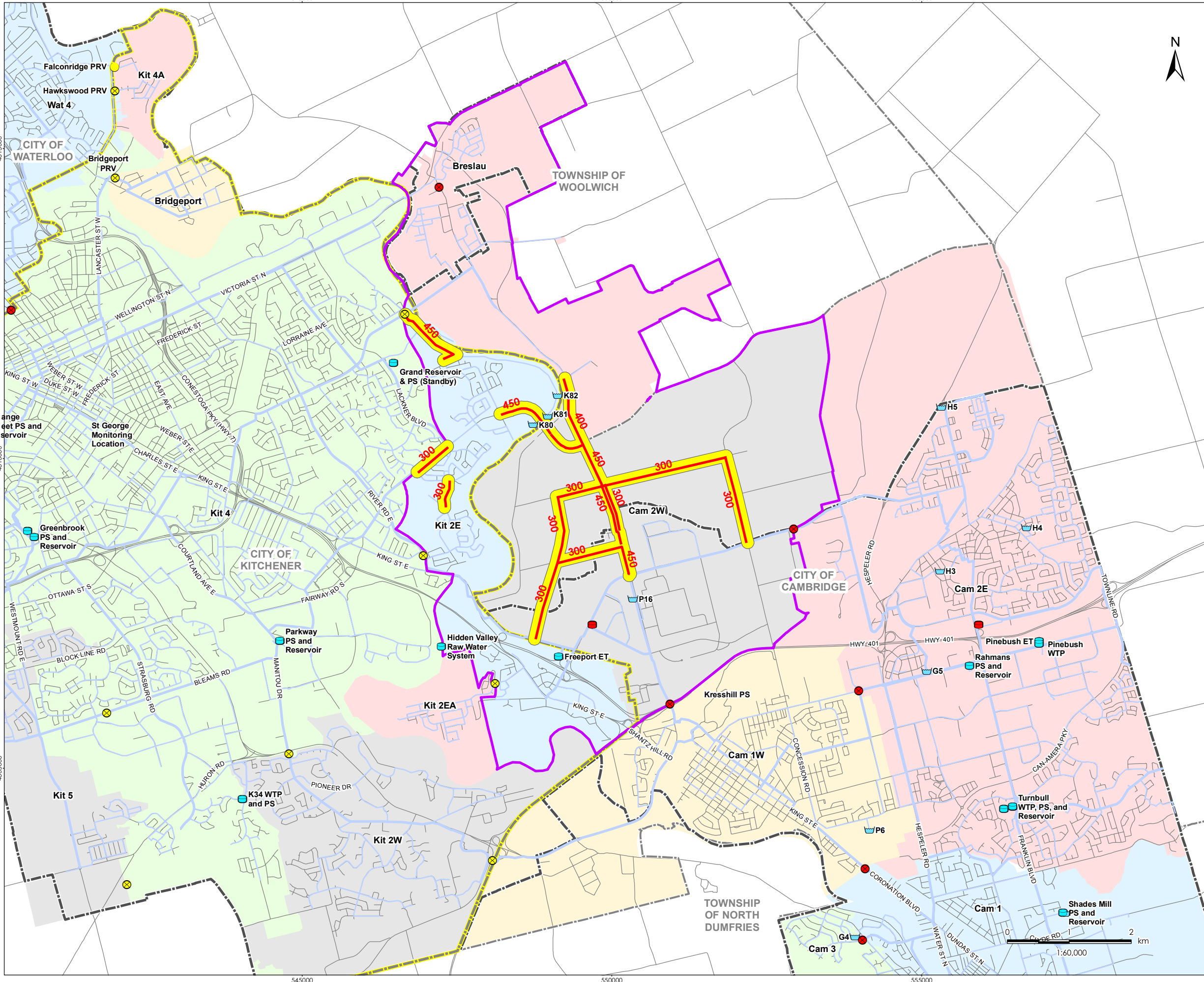
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Figure No.
3.12

Title
**FUTURE CAMBRIDGE & KITCHENER DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
CONSOLIDATED PRESSURE ZONE
IN THE EAST SIDE LANDS**



- Legend**
- Well
 - Tank
 - Proposed Facility Location
 - Existing Valve
 - Proposed Valve
 - Infrastructure Related to Recommendation
 - City of Kitchener
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - New East Side Pressure Zone Boundary
 - Recommended Watermain



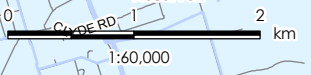
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Figure No.
3-13

Title
**Cambridge Optimization
- Consolidated Pressure Zone
in the East Side Lands**



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 Revised: 2015-02-09 By: kbuchanan

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

3.2.7 Additional Work and Linear Projects

Table 3-6 summarizes additional infrastructure projects proposed alongside the City-wide reconfigurations outlined in the previous sections. These projects will help to address the constraints identified in the Master Planning process to be addressed in the 10 year planning window, and are listed as 'Other Work' in the Implementation Schedule in Section 3.3. Figure 3-14 portrays the location of the proposed additional work in Cambridge. The entity responsible for cost is shown below in brackets for each opinion of probable cost.

Table 3-6: Other Work and Infrastructure Projects for Cambridge

	Proposed Improvement¹	Overview of Implementation Requirements	Opinion of Probable Cost²
1.	Develop a standard operating procedure (SOP) for repair to ensure supply to northern area of Cam 3 (CC1). ³	<ul style="list-style-type: none"> Review of existing infrastructure, required spare parts, and available contractors Complete SOP and circulate 	\$10,000 (RMOW)
2.	1. Develop an SOP to flush water or circulate from Cam 3 to Cam 1 to address stagnant water in Cam 3 (CC2).	<ul style="list-style-type: none"> Identify areas of low chlorine residual based on historical distribution data Identify zone boundary valves and frequency for flushing/circulating Complete SOP and circulate 	\$20,000 (RMOW)
	2. Install an autoflusher to circulate water from Cam 3 to Cam 1 to address stagnant water issue in Cam 3 (CC2).	<ul style="list-style-type: none"> Identify areas of low chlorine residual based on historical distribution data Select autoflusher and determine frequency of flushing Install equipment 	\$50,000 (RMOW)
3.	Develop an SOP for repair for single connection from Turnbull WTP on Franklin Blvd (CC4).	<ul style="list-style-type: none"> Review of infrastructure, required spare parts, and available contractors Complete SOP and circulate 	\$10,000 (RMOW)
4.	Develop an SOP for repair for single connection on Blair Road (CC5). ³	<ul style="list-style-type: none"> Review of existing infrastructure, required spare parts, and available contractors. Complete SOP and circulate. 	\$10,000 (RMOW)
5.	Replace Shades Mill WTP booster pumps to better suit the target operating HGL since Shades Mill WTP Booster Pumps are operating below design point (CC8). Two pumps capable of pumping 150 L/s at TDH of 55. TDH of 35 is required.	<ul style="list-style-type: none"> Detailed design and selection of replacement pumps Installation of equipment 	\$150,000 (RMOW)

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

	Proposed Improvement ¹	Overview of Implementation Requirements	Opinion of Probable Cost ²
6.	Install mixing system in Pinebush ET to address water quality concerns.	<ul style="list-style-type: none"> • Review tank design and select preferred mixing system • Design and install mixing system 	\$150,000 (RMOW)
7.	Replace Well G4 well pump to match the target HGL for Cam 3 and reduce high discharge pressure (CC12).	<ul style="list-style-type: none"> • Complete field testing to confirm discharge pressures are greater than the target HGL. • Selection and installation of preferred well pump 	\$50,000 (RMOW)
8.	Complete study in areas of concern for oversized watermains (CC22).	<ul style="list-style-type: none"> • Identify areas of water quality concerns • Complete study to identify solutions specific to areas of concern 	\$25,000 (RMOW)
9.	Develop an SOP for repair for single connection from Middleton PS to St. Andrews PS (CC29).	<ul style="list-style-type: none"> • Review of existing infrastructure, required spare parts, and available contractors • Complete SOP and circulate 	\$15,000 (RMOW)
10.	Develop an SOP for repair for single connection for the inlet/outlet of the South Cambridge Reservoir (CC30).	<ul style="list-style-type: none"> • Review of existing infrastructure, required spare parts, and available contractors • Complete SOP and circulate 	\$15,000 (RMOW)
11.	Update operating strategy for Pinebush Standpipe to modify the low operating level to 355.3 mASL	<ul style="list-style-type: none"> • Update SCADA alarm setpoints to adjust low operating level • Review operating levels annually to optimize based on up-to-date service areas 	N/A (Operational Change)
	Other related work	TBD	\$90,000 (RMOW)
TOTAL (RMOW)			\$595,000

Note 1: Constraint number is identified as w as outlined in Tech Memo Task D and E of the WSDOMP, "Identification of Alternative Solutions"

Note 2: Total opinion of probable cost for the Region is included in the implementation schedule as 'other work' in Section 3.3.

Note 3: SOP is to be developed as interim solution. Refer to Item 17 under Additional Linear Works (Table 3-7) for proposed watermain that will provide redundancy of supply for these watermains.

Table 3-7 summarizes the Region linear work to be completed in Cambridge identified through hydraulic analysis of the distribution network completed for the City of Cambridge and includes projects outlined in capital planning. The entity responsible for cost is shown in brackets for each opinion of probable cost.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

Table 3-7: Additional Linear Work for Region in Cambridge

	Proposed Work of Related Linear Projects	Overview of Work	Opinion of Probable Cost⁷	Potential Implementation Timing
12.	Install new watermain on Middleblock Rd. between future North-South collector and Speedsville Rd.	<ul style="list-style-type: none"> 2,850 m of 300 mm diameter watermain 	\$1,300,000 (RMOW) \$1,300,000 (City of Cambridge)	Development Dependent
13.	Install new watermain on Allendale Rd. between future North-South collector and Fountain St.	<ul style="list-style-type: none"> 1,100 m of 300 mm diameter watermain 	\$500,000 (RMOW) \$500,000 (City of Cambridge)	Based on Development Planning
14.	Install new watermain on future North-South collector between Middleblock Rd. and north of King St. Bypass	<ul style="list-style-type: none"> 2,400 m of 300 mm diameter watermain 	\$1,100,000 (RMOW/) \$1,100,000 (City of Cambridge)	Based on Development Planning
15.	Install new watermain on Speedsville Rd. between Middleblock Rd. and Maple Grove Rd.	<ul style="list-style-type: none"> 1,450 m of 300 mm diameter watermain 	\$650,000 (RMOW) \$650,000 (City of Cambridge)	Based on Development Planning
16.	Install new watermain on Fountain St. between Regional Road 99 and Kossuth Rd.	<ul style="list-style-type: none"> 1,150 m of 400 mm diameter watermain 	\$700,000 (RMOW) \$700,000 (City of Cambridge)	Based on Development Planning
17.	Install new watermain on Fountain St. between Kossuth Rd. and Maple Grove Rd.	<ul style="list-style-type: none"> 2,300 m of 450 mm diameter watermain 	\$3,100,000 (RMOW)	Based on Development Planning
18.	Install new watermain on Fountain St. between Middleblock Rd. and Banat Rd.	<ul style="list-style-type: none"> 800 m of 300 mm diameter watermain 	\$350,000 (RMOW) \$350,000 (City of Cambridge)	Based on Development Planning
19.	Install new watermain on Morrison Rd. between north of Quinte Cres. and Sims Estate Dr. ¹	<ul style="list-style-type: none"> 450 m of 300 mm diameter watermain 	\$400,000 (RMOW)	Based on Development Planning
20.	Install new watermain on Fairway Rd. between Sims Estate Dr. and Fairway Cres. ⁸	<ul style="list-style-type: none"> 640 m of 300 mm diameter watermain 	\$288,000 (RMOW) \$288,000 (City of Kitchener)	Based on Development Planning
21.	Install new watermain on Otterbein Road from Ottawa St. N to Deer Creek St. ⁸	<ul style="list-style-type: none"> 1,280 m of 450 mm diameter watermain 	\$1,728,000 (RMOW)	Based on Development Planning
22.	Install new watermain on Main St between Flora St. and Franklin Blvd.	<ul style="list-style-type: none"> 650 m of 300 mm diameter watermain 	\$300,000 (RMOW) \$300,000 (City of Cambridge)	2016

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

	Proposed Work of Related Linear Projects	Overview of Work	Opinion of Probable Cost ⁷	Potential Implementation Timing
23.	New Cambridge Zone 1A watermain on Maplebush Dr.	<ul style="list-style-type: none"> 370 m of 400 mm diameter watermain 	\$148,000 ² (RMOW) \$148,000 ² (City of Cambridge)	Based on Development Planning
24.	New Cambridge Zone 1A watermain within proposed development	<ul style="list-style-type: none"> 1,900 m of 300 mm diameter watermain 	\$1,140,000 ² (RMOW)	Based on Development Planning
25.	Install new Cambridge Zone 3 watermain from Bismark Dr. to Salisbury Ave.	<ul style="list-style-type: none"> 2,250 m of 300 mm diameter watermain 	\$1,012,500 (RMOW) \$1,012,500 (City of Cambridge)	<5 years
26.	Upgrade watermain on Pinebush Rd. from Pinebush TP (west of Fleming Dr.) to Rahmans PS (west of Franklin Blvd.) ³	<ul style="list-style-type: none"> 1,300 m of 450 mm diameter watermain 	\$1,800,000 (RMOW)	2016 ⁴
27.	Upgrade watermain from Turnbull Cam 2E PS to Franklin Blvd (watermain within Turnbull site). ³	<ul style="list-style-type: none"> 200 m of 500 mm diameter watermain 	\$300,000 (RMOW)	2021 ⁵
28.	Upgrade watermain on Stanley St. from Middleton PS (west of Middleton St) to St Andrews St.	<ul style="list-style-type: none"> 900 m of 500 mm diameter watermain 	\$1,400,000 (RMOW)	2021 ⁶
TOTAL (A.Mun.s)			\$6,548,500	
TOTAL (RMOW)			\$16,216,500	

Note 1: Proposed watermain alignment is approximate, final alignment to be confirmed.

Note 2: Cost based on Cambridge Zone 1A Pressure Boundary Optimization Study (Stantec, 2011). It can be noted that the study also included costs for watermain upgrades on Dundas St.; however, these upgrades have since been completed.

Note 3: Based on hydraulic model review of linear infrastructure

Note 4: Related to increase in capacity of Pinebush TP; recommended linear upgrade should be coordinated with the Pinebush TP upgrades

Note 5: To be coordinated with upgrades at Turnbull to construct the proposed Cambridge Zone 1 Turnbull Pump Station

Note 6: Related to consolidated storage facility for Cam 1; recommended linear upgrade should be coordinated with the Cambridge Zone 1 floating storage facility upgrades

Note 7: Cost sharing between the Region and the Area Municipalities is assumed to be 50/50. Opinion of probable cost for linear work for the Region is presented in Section 3.3.

Note 8: Potential alternative alignments are presented in the WSDOMP TM *Review of Distribution System Upgrades to Service the East Side Lands* in Appendix G.



Legend

- Well
- Tank
- Proposed Facility Location
- Existing Valve
- Proposed Valve
- City of Cambridge
- Urban Boundary
- Municipal Boundary
- Road
- Watermain
- Feedermain
- Area of Interest

Notes

1. Develop SOP for supply to northern Cam 3
2. Address stagnant water in Cam 3
3. Develop SOP for repair for single connection from Turnbull WTP
4. Develop SOP for repair for single connection on Blair Rd.
5. Shades Mills WTP Booster Pump upgrades
6. Install mixing system in Pinebush ET
7. Replace G4 well pump
8. Address oversized watermain
9. Develop SOP for repair for single connection from Middleton to St. Andrews PS
10. Develop SOP for repair for inlet/outlet of the South Cambridge Reservoir
11. Update operating strategy for Pinebush ET
- 12 - 21. Refer to Table 3-7 and Figure 3-13.
22. New watermain on Main St. between Flora St. and Franklin Blvd.
23. New watermain on Maple Bush Dr.
24. New watermain within proposed development
25. New watermain from Bismark Drive to Salisbury Ave.
26. Upgrade watermain on Pinebush Rd. from Pinebush TP to Rahmans PS.
27. Upgrade watermain from Turnbull Cam 2E PS to Franklin Blvd.
28. Upgrade watermain on Stanley St. from Middleton PS to St Andrews St.

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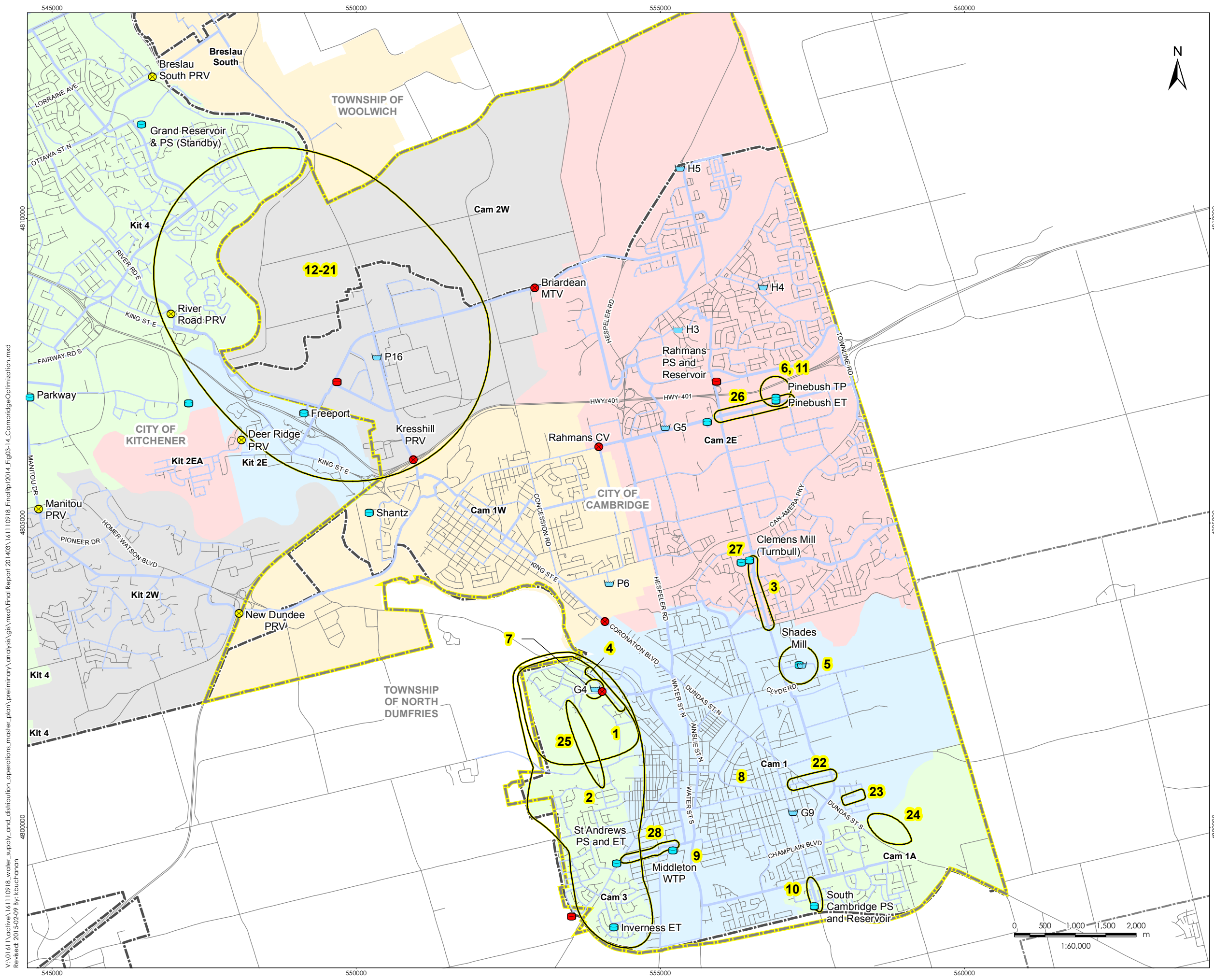
Client/Project

Regional Municipality of Waterloo
Water Supply and Distribution
Operations Master Plan

Figure No.
3-14

Title

**Cambridge Optimization
- Other Work and Linear Projects**



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 Revised: 2015-02-09 By: kbuchanan

3.3 CAMBRIDGE IMPLEMENTATION SCHEDULE

The proposed implementation schedule and opinion of probable cost for the Cambridge Optimizations is presented in the Table 3-8. The total opinion of probable cost for Region projects in Cambridge pressure zones, including other works and linear work, is approximately 75.0 million over the planning period.

Table 3-8: Implementation Timeline and Opinion of Probable Cost for Proposed Cambridge Optimizations

Project	Opinion of Probable Cost ²	Planned Expenditure (Year)										
		2013	2014	2015	2016	2017	2018	2019	2020	2021	>2021	
Rehabilitate existing or install a new PRV at Kresshill PS to provide a connection from Cam 2W to western Cam 1 and decommission Kresshill PS	\$ 525,000											
Place System Wells P6 and G9 into standby status	\$ 100,000											
Split Cam 1 into Cam 1 and Cam 1W and install chloramination station	\$350,000 for Chloramination Station Additional costs included in other projects											
Modifications to Cam 3 to improve capacity	City + Developer											
Consolidate Rahmans PS, Pinebush WTP, and Well G5 and redirect to Cam 2E	\$ 3,900,000											
Rehab Pinebush wells to increase production at the consolidated Pinebush WTP/Rahmans PS/Well G5 facility	\$ 500,000											
Convert the Turnbull Reservoir to pumped storage with one pump station to Cam 1 and one pump station to Cam 2E	\$ 3,500,000											
Construct consolidated floating storage to service Cam 1 and relocate St. Andrews PS to the same site or maintain at existing site	\$ 33,000,000											
Consolidate Hespeler Wells (Well H3, H4, and H5) to one facility if production rates increase	\$ 7,600,000											
Install inline booster pump station from Cam 2E to Cam 2W to supplement demands from the East Side Lands Development	\$ 3,000,000											
Bring Maple Grove Wells (P16 and P19) online to supplement demands from the East Side Lands development	\$ 5,700,000											
Consolidate Pressure Zones for the East Side Lands	Included in Linear Costs											
Other Work to Address Constraints	\$ 595,000											
Region Linear Work (includes East Side Lands related work) ¹	\$ 16,216,500											

Note 1: Implementation is coordinated with Regional and A.Mun. transportation projects

Note 2: Opinion of probable costs includes Region costs only, not costs associated with A.Mun.s

Note 3: dotted line indicates accelerated or delayed implementation should circumstances change (i.e. change in demand trends)

4.0 City of Kitchener Optimizations

4.1 SUMMARY OF PROPOSED SOLUTIONS

Kitchener is supplied water from the Mannheim WTP and groundwater supply systems. Multiple groundwater facilities are located throughout the City to provide centralized treatment for groundwater wells prior to discharge to the distribution system. There are eight (8) pressure zones in Kitchener, the largest being Kit 4. Kit 4 is central to the IUS and responsible for transferring water to many pressure zones within the IUS. Two adjacent IUS pressure zones to Kitchener in Wilmot are Mannheim and Mannheim 5. More information on the water distribution system for Kitchener is provided in the Task A Tech Memo (refer to Appendix A).

The Mannheim WTP and Reservoir is supplied by two peaking supply sources: aquifer storage and recovery (ASR) wells and the K90 wells. Currently underway is Phase 1A for the ASR wells which aims to optimize Phase 1 and evaluate the addition of additional recovery wells. Work is currently underway for the modification of the K90s permit to take water (PTTW). Refer to the WSMP for additional details on these peaking supply projects.

In general, the preferred Kitchener-Wide reconfiguration focuses on providing control valves (CVs) on all major supply feeds to Kit 4 and Wat 4 to balance the supply to each area, as required. Specifically, the proposed optimizations aim to improve the control of flow into Kit 4 and Wat 4, optimize the use of watermain capacity for installed and proposed feeder mains, improve feedback and understanding of in-field conditions, decrease pressure fluctuations in Kit 4, and address nitrate water quality concerns at the K20 wells.

The existing process flow diagram for Kitchener is presented in Figure 4-1. The proposed changes are shown for each upgrade in the following sections.

Each preferred improvement and optimization strategy is described in terms of the following:

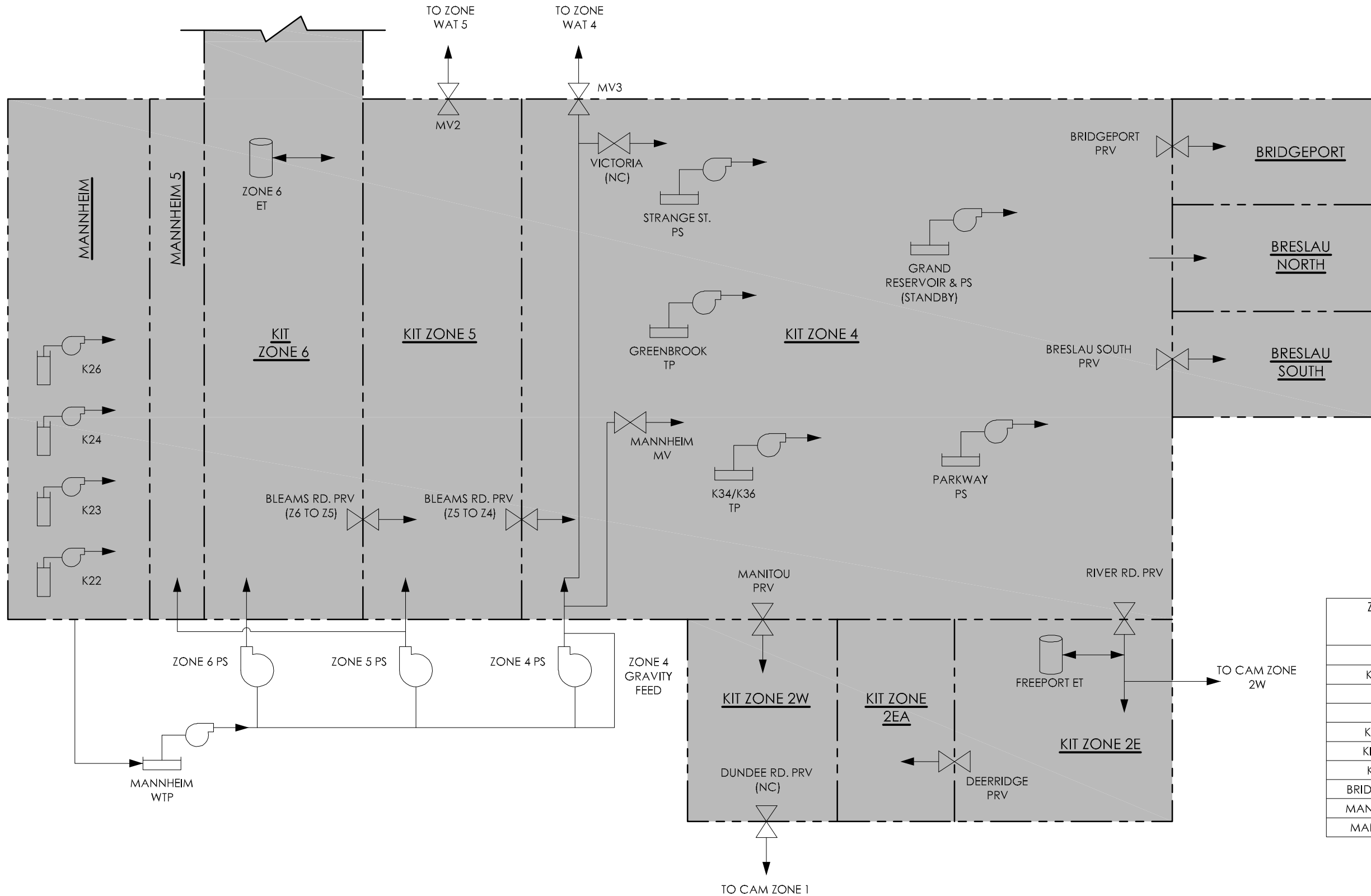
- Justification
- Overview of Work
- Layout and PFD for Facilities
- Studies Required
- GHG Impact
- Opinion of Probable Cost

The recommendations referred to as 'additional work' are grouped together in Section 4.2.5 and include recommendations for complementary infrastructure and linear upgrades to occur along with the more significant WSDOMP proposed reconfigurations described in Sections 4.2.1 through 4.2.4. Note, there are additional recommended optimizations which involve pressure zones and/or infrastructure located in the City of Kitchener which are captured in Cambridge

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

and Waterloo project descriptions. These include the Consolidation of Pressure Zones for the East Side Lands (ESL) outlined in Section 3.2.6, and the Upgrade of Strange Street WSS to Include William Street Wells outlined in Section 5.2.1. The estimated time of implementation (schedule) is summarized for all solutions outlined in Section 4.0 in Table 4-7 at the end of the Kitchener section.

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ZONE	TARGET HGL (mASL)
KIT 4	384.0
KIT 4A	363.2
KIT 5	407.0
KIT 6	428.0
KIT 2W	361.0
KIT 2EA	347.0
KIT 2E	365.0
BRIDGEPORT	364.5
MANNHEIM 5	407.0
MANNHEIM	384.0

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Legend

- RESERVOIR
- ELEVATED TANK
- PUMP STATION
- WELL
- WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

1. REFER TO FIGURE 5-1 FOR KIT 4A

Client/Project
REGION OF WATERLOO
WATER SUPPLY AND
DISTRIBUTION WATER PLAN

Figure No.

4.1

Title

EXISTING KITCHENER DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM

4.2 DETAILED REVIEW OF PROPOSED SOLUTIONS

4.2.1 Connect Pressure Transducers to SCADA

Monitor pressure data from the newly installed communications network to transfer data from in-field pressure transducers to the supervisory control and data acquisition (SCADA) control system.

4.2.1.1 *Justification*

- Kit 4 represents a large geographic area and has multiple supply facilities; therefore, pressure information throughout the zone is important to understanding system conditions.
- Continuous pressure data from the zone will allow supply facilities to be brought online or taken offline as required based on system demands.
- The aim of this work is to update the SCADA programming and the connectivity to SCADA. Once updated, the pressure data available from SCADA will be monitored and summarized in order to assist the complementary Decision Support System, which is being completed as a separate project.

4.2.1.2 *Overview of Work*

The pressure transducers have been newly installed, therefore, the work remaining to complete this project is:

- Installing a communications network to transfer data from the field to the SCADA system.
- Updating the programmable logic controller (PLC) and human machine interface (HMI) programming and automatic control.

4.2.1.3 *Layout and PFD*

N/A.

4.2.1.4 *Additional Studies*

It is not anticipated that any additional studies will be required to carry out the remainder of the work.

4.2.1.5 *GHG Impact*

In optimizing Kit 4, energy is conserved by allowing the system to flow by gravity versus requiring to be pumped to maintain pressure. Therefore there is a net GHG reduction expected with this recommendation. Refer to Appendix F for additional information.

4.2.1.6 *Opinion of Probable Cost*

Since the work is already in progress, the opinion of probable cost to connect pressure transducer data to the SCADA system was not included. The O&M costs associated with this optimization, which aims to improve energy efficiency of supply to Kit 4, are expected to decrease slightly as a result of a reduction in electricity costs associated with pumping. Refer to Appendix F for additional information.

4.2.2 **Increase Flexibility to Control Flow in Kit 4**

Install control valves (CVs) on the Victoria Street watermain, proposed secondary connection between Kit 4 and Wat 4 (Weber Street watermain), and the proposed Hydro-Corridor watermain.

4.2.2.1 *Justification*

- Presently, there are operating difficulties with controlling the flow of water to Kit 4 and transferring water to Waterloo during high demands
 - The Mannheim Zone 4 PS supplies a significant amount of water to Kit 4. The pump station is designed to supply both Kit 4 and Wat 4 through a common discharge header. Historically, one connection from the pump station supplied Kit 4 (Ottawa Street watermain) and one connection supplied Wat 4 (Fischer-Hallman Road watermain). Based on hydraulic restrictions in the Ottawa St. watermain and the transfer distance to Wat 4, the Mannheim Zone 4 PS operated at a higher discharge head to meet the target HGLs for these zones. With the construction of the Victoria Street watermain, the final section of a major loop supplying Kit 4, the Fischer-Hallman watermain is no longer a dedicated supply to Wat 4 and less water is conveyed by the Ottawa Street watermain. As a result, operating difficulties occurred with controlling the flow of water to Kit 4 and transferring water to Waterloo during high demands.
- Installing CVs, specifically motorized throttle valves (MTVs), on all existing and proposed connections to Kit 4 and Wat 4 will provide operators with the ability to control and direct flow from the Mannheim Zone 4 PS, as required based on system demands. Based on the number of existing connections and planned projects, there will be five (5) CVs to modulate.
- Feedback from monitoring locations and a Decision Support System will be critical to operating these valves. It can be noted that the need for modulating the CVs is primarily dictated by the need to transfer water to Waterloo.

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4.2.2.2 *Overview of Work*

- Install control valves on the 600 mm Victoria Street Watermain (in progress), the proposed secondary 600 mm Kit 4/Wat 4 connection on Weber Street, and the proposed 750 mm Hydro-corridor Watermain
 - Installation of motorized throttle valves (MTV) and chambers.
 - The Hydro-corridor and Kit 4/Wat 4 planned watermain projects are included as part of existing Region projects and are included in Table 4-4 (Section 4.2.5).
- Develop a Decision Support System
 - Review available monitoring information, operating scenarios, and optimized control strategy to develop Decision Support System (to be completed as part of a separate project).

4.2.2.3 *Layout and PFD for Facilities*

Refer to Figure 4-2 for the proposed changes identified on the system PFD for the 2031 optimizations and to Figure 4-3 for physical location and additional infrastructure required.

4.2.2.4 *Studies Required*

Work for the installation of the control valves is pre-approved (Schedule A Class Environmental Assessment).

4.2.2.5 *GHG Impact*

There is a potential increase in energy loss and increased GHG emissions associated with the new valves; however this is likely balanced by the fact the water flow can be more efficiently pumped and managed. Refer to Appendix F for additional information.

4.2.2.6 *Opinion of Probable Cost*

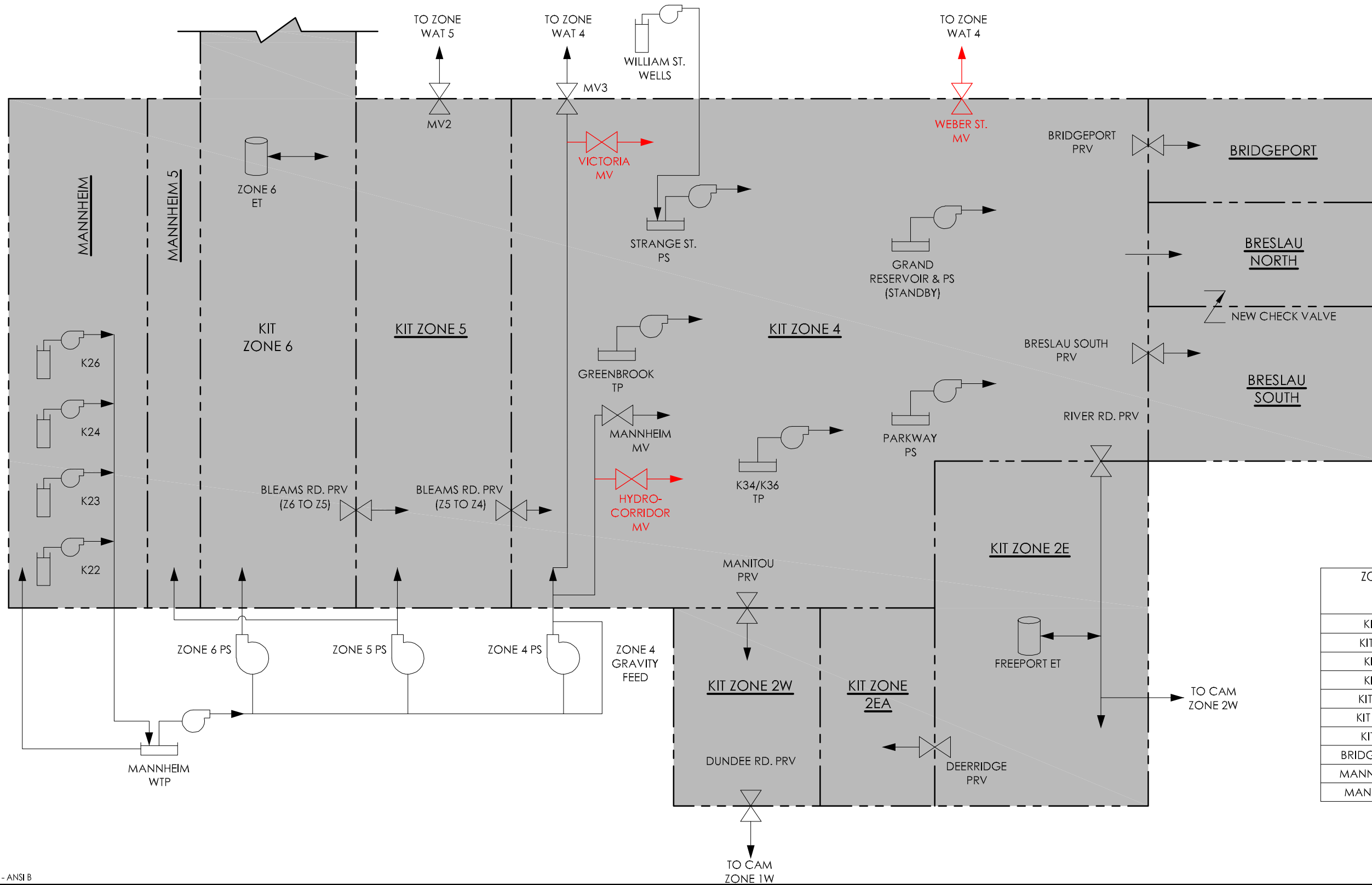
Table 4-1 outlines the opinion of probable capital cost associated with each of the proposed CV installations. The cost of installation for the CV on the proposed Hydro-corridor watermain is not included in the table below as it is already included in the budget of the ongoing Zone 4 Feedermain Project. There is a slight decrease expected in electricity costs associated with this optimization related to the more efficient use of storage volumes allowing for more off-peak pumping and less pump start/stops. Though operations are more complex prior to the installation of the CVs, there are no significant changes anticipated in O&M costs. Refer to Appendix F for additional information.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

Table 4-1: Opinion of Probable Capital Cost for Kit 4 CVs

Recommended Modification	Opinion of Probable Capital Cost
Install a control valve on the Victoria St. Watermain	\$ 500,000
Install a control valve on the proposed secondary Kit 4/Wat 4 watermain connection	Refer to Additional Linear Projects (Table 4-4, item 13)
Install a control valve on the proposed Hydro-corridor Watermain	N/A
Develop a Decision Support System	\$ 2,000,000
TOTAL	\$ 2,500,000

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ZONE	TARGET HGL (mASL)
KIT 4	384.0
KIT 4A	363.2
KIT 5	407.0
KIT 6	428.0
KIT 2W	361.0
KIT 2EA	347.0
KIT 2E	365.0
BRIDGEPORT	364.5
MANNHEIM 5	407.0
MANNHEIM	384.0

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- WELL
- WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

1. ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.
2. REFER TO FIGURE 5-1 FOR KIT 4A

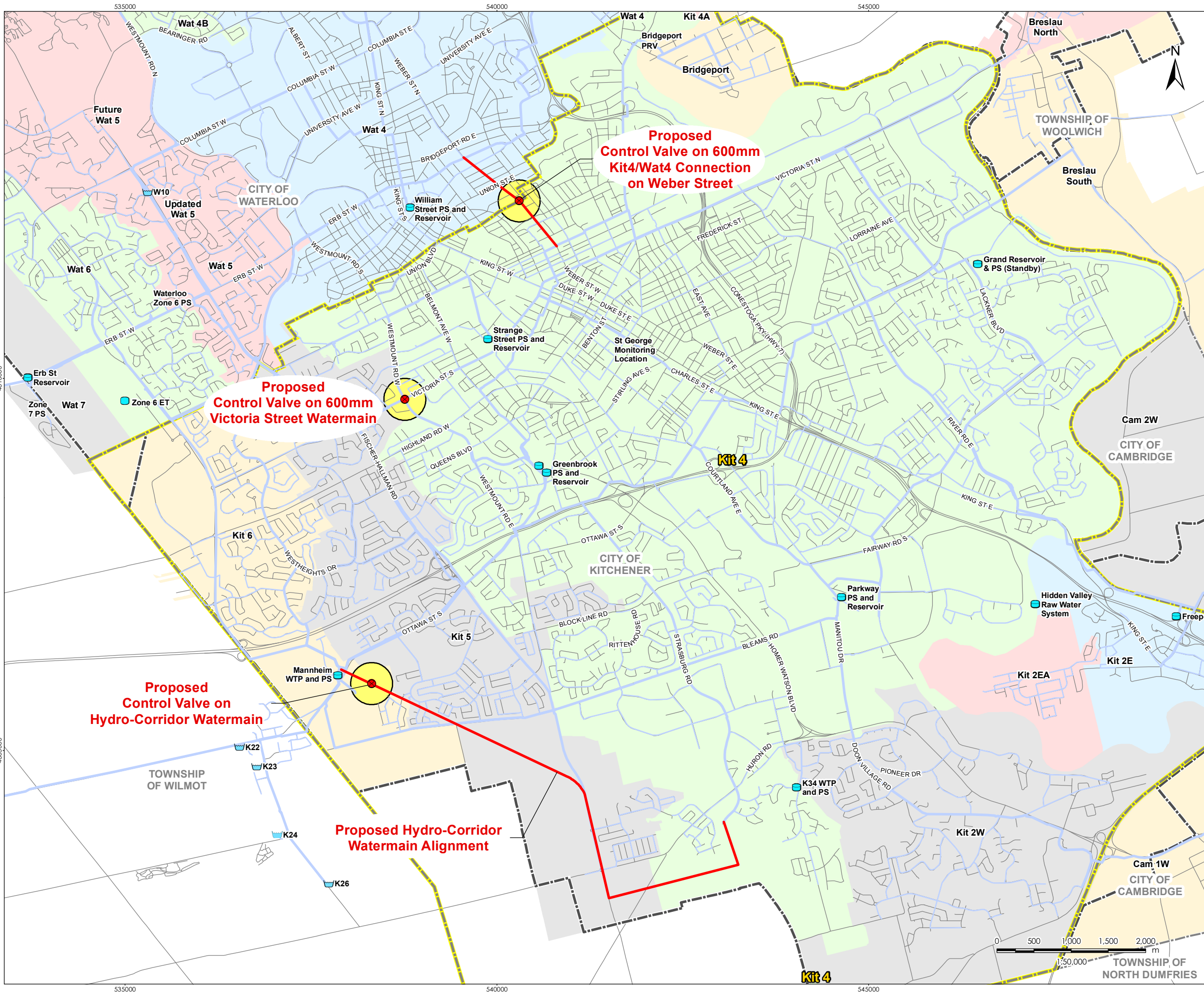
Client/Project
REGION OF WATERLOO
WATER SUPPLY AND
DISTRIBUTION WATER PLAN

Figure No.

4.2

Title

FUTURE KITCHENER DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
INCREASE FLEXIBILITY TO CONTROL FLOW
IN KIT 4



- Legend**
- Proposed Valve
 - Tank
 - Well
 - Infrastructure Related to Recommendation
 - City of Kitchener
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - New Infrastructure

- Notes**
1. Coordinate System: NAD 1983 UTM Zone 17N
 2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2014.

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Water Supply and Distribution
Operations Master Plan

Figure No.
4-3

Title
Kitchener Optimization - Increase Flexibility to Control Flow in Kit 4

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 Revised: 2015-02-09 By: kbuchanan

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

4.2.3 Reconfigurations at Mannheim WTP (Mannheim Village)

Reconfigurations at the Mannheim WTP include incorporating raw water from Mannheim West well field (K26, K24, K23, and K22) at the Mannheim WTP.

4.2.3.1 Justification

- There are increasing nitrate levels at the K20 wells. Therefore, it is proposed to construct a raw watermain connecting K26, K24, K23, and K22 to the Mannheim WTP and PS.
 - Water from these wells will be blended with water at Mannheim WTP, disinfected and supplied to the IUS. Mannheim Village will be supplied by water transferred from Shingletown to the Mannheim Reservoirs, rather than having a direct supply from the Wells K22, K23, K24, and K26.
 - This saves on GHG emissions due to the reduction in the number of facilities to maintain, the associated driving impact, and treatment efficiency.

4.2.3.2 Overview of Work

- Separate Village of Mannheim from K20s
 - Install new 400 mm raw supply watermain to Mannheim WTP
 - New well pumps, site upgrades at each well location, decommission treatment at well houses, and changes to Mannheim Reservoir.

4.2.3.3 Layout and PFD for Facilities

Refer to Figure 4-4 for the proposed changes identified on the system PFD for the 2031 optimizations and to Figure 4-5 for physical location and additional infrastructure required.

4.2.3.4 Studies Required

- A Schedule B Class Environmental Assessment is required for consolidating treatment of the Mannheim West wells at the Mannheim WTP, completing well upgrades, and constructing new raw watermains. Additional studies to analyze water quality may be required to ensure adequate treatment of blended water sources is achieved.

4.2.3.5 GHG Impact

Consolidating treatment at the Mannheim WTP reduces GHG emissions slightly due to the reduction in the amount of driving necessary for O&M and water sampling of system wells as the K20s. Water treatment is also done more efficiently at the Mannheim WTP rather than at individual well sites. Refer to Appendix F for additional information.

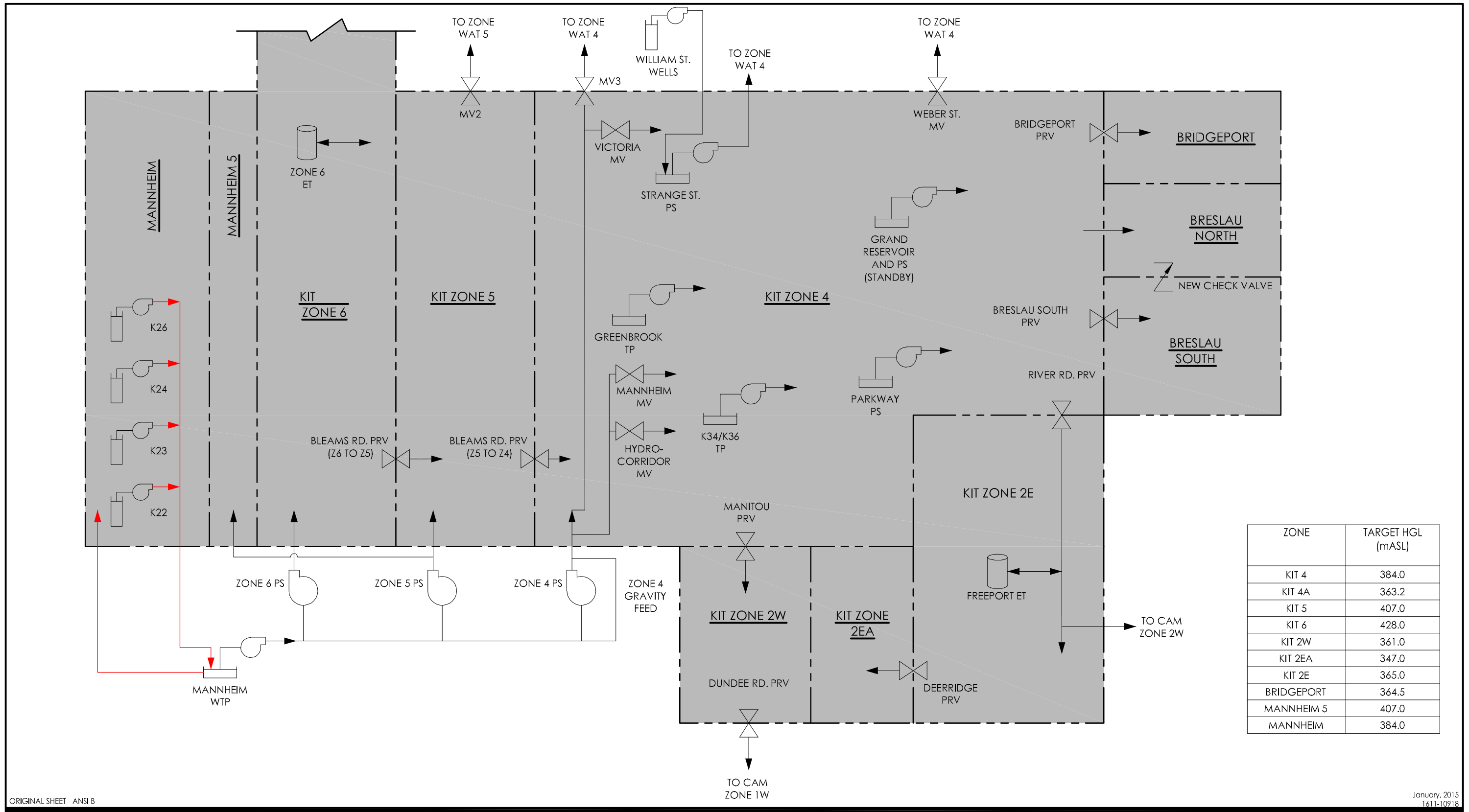
4.2.3.6 Opinion of Probable Cost

Table 4-2 outlines the opinion of probable capital cost associated with the proposed reconfigurations at the Mannheim WTP. The O&M costs associated with this optimization, which aims to maintain security of supply to Mannheim Village and improve energy efficiency, can be expected to improve slightly from existing conditions. The slight decrease in O&M costs is associated with reduced site visits (labour and vehicle expenses) for water sampling on raw water wells compared to system wells. Refer to Appendix F for additional information.

Table 4-2: Opinion of Probable Capital Cost for the Proposed Mannheim WTP Reconfigurations (Mannheim Village)

Recommended Modification	Opinion of Probable Capital Cost
Install new 400 mm watermain to WTP and local watermain changes	\$3,600,000
New well pumps, site upgrades, and changes to Mannheim Reservoir	\$1,200,000
TOTAL	\$ 4,800,000

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- (NC) NORMALLY CLOSED

Notes

1. ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.
2. REFER TO FIGURE 5-1 FOR KIT 4A

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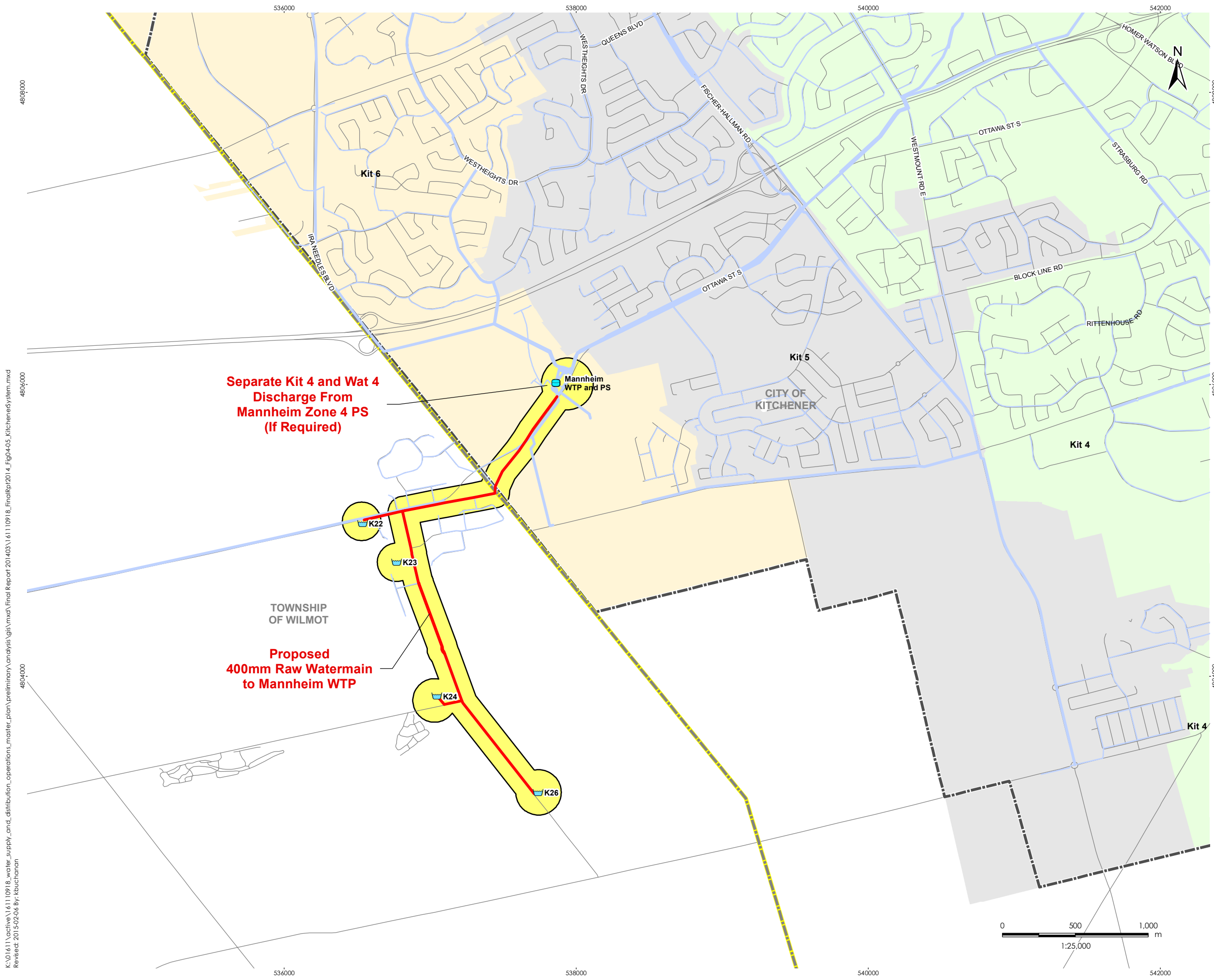
Figure No.

4.4

Title

FUTURE KITCHENER DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
RECONFIGURATIONS AT MANNHEIM WTP

- Legend**
- Tank
 - Well
 - Infrastructure Related to Recommendation
 - City of Kitchener
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - New Infrastructure



Separate Kit 4 and Wat 4 Discharge From Mannheim Zone 4 PS (If Required)

Proposed 400mm Raw Watermain to Mannheim WTP

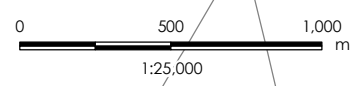
- Notes**
1. Coordinate System: NAD 1983 UTM Zone 17N
 2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2014.

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Figure No.
4-5

Title
**Kitchener Optimization
- Reconfigurations at Mannheim WTP**



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Revised: 20150206 By: kbuchanan

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

4.2.4 Reconfigurations at Mannheim WTP (Zone 4 PS Configuration)

Subject to further optimization work for Kit 4, it may be possible to reconfigure the piping to create a dedicated discharge to Wat 4, separating it from the Kit 4 discharge at Mannheim Zone 4 PS. A preliminary review of site drawings indicates a dedicated discharge to Wat 4 could be achieved through modifications to the pump station inlet and discharge piping, as well as the yard piping onsite, though there may be space constraints at the Zone 4 PS.

4.2.4.1 Justification

- Prior to the full development of future Wat 4 sources, operating complexity due to modulation of the various CVs to transfer water from Kit 4 may arise (MV4, MV3, Victoria MTV, the proposed Kit 4/Wat 4 connection MTV, and the proposed Hydro-Corridor feedermain MTV). If required to simplify operations, consideration could be given to splitting the Mannheim Zone 4 PS to have dedicated supplies to Kit 4 and Wat 4. This would include dedicated Kit 4 and Wat 4 pumps, as well as a separate discharge connection to each zone.
 - Dedicated supplies would allow operators to completely isolate between the zones for transfer of water to Waterloo. This modification would require the Victoria Street connection be completely closed and the Hydro-Corridor feedermain would need to be online to eliminate the Ottawa Street feedermain restriction.
- Based on age of infrastructure, and maintenance needs at other facilities of similar age, these upgrades are recommended for redundancy of supply connections to the Wat 4 and Kit 4 feeder mains.

4.2.4.2 Overview of Work

- Separate Kit 4 and Wat 4 discharge from Mannheim Zone 4 PS
 - Design and install new pumps to discharge to Wat 4.
 - Modify station piping to allow a dedicated Wat 4 discharge, complete with potential gravity feed.
 - Upgrade yard piping at Mannheim Zone 4 PS to connect from dedicated Wat 4 pumps to the Wat 4 feeder main.

4.2.4.3 Layout and PFD for Facilities

Refer to Figure 4-4 for the proposed changes identified on the system PFD for the 2031 optimizations and to Figure 4-5 for physical location and additional infrastructure required.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

4.2.4.4 Studies Required

- Changes to the Mannheim Zone 4 PS are pre-approved changes (Schedule A Class Environmental Assessment).

4.2.4.5 GHG Impact

There is no significant impact on GHG emissions in this reconfiguration. Refer to Appendix F for additional information. Refer to Appendix F for additional information.

4.2.4.6 Opinion of Probable Cost

Table 4-2 outlines the opinion of probable capital cost associated with the proposed reconfigurations at the Mannheim WTP. There are no significant changes anticipated with O&M costs as a result of this optimization. Refer to Appendix F for additional information.

Table 4-3: Opinion of Probable Capital Cost for the Proposed Mannheim WTP Reconfigurations

Recommended Modification	Opinion of Probable Capital Cost
Separate Kit 4 and Wat 4 discharge from Mannheim Zone 4 PS	\$ 2,500,000
TOTAL	\$ 2,500,000

4.2.5 Additional Work and Linear Projects

Table 4-4 summarizes additional infrastructure projects proposed alongside the City-wide reconfigurations outlined in the previous sections. These projects will help to address the constraints outlined in the Master Planning process to be addressed in the 10 year planning window, and are listed as 'Other Work' in the Implementation Schedule in Section 4.3. Table 4-5 outlines relevant linear projects that are scheduled to occur in Kitchener identified through hydraulic analysis of the distribution network completed for the City of Kitchener (refer to Appendix H), and Table 4-5 outlines linear work to be coordinated with the light rail transit (LRT) system that is to be implemented along King Street. Figure 4-6 illustrates the location of the proposed additional work and linear projects in Kitchener. The entity responsible for cost is shown below in brackets for each opinion of probable cost.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

Table 4-4: Other Work and Infrastructure Projects for Kitchener

Proposed Improvements ¹		Overview of Implementation Requirements	Opinion of Probable Cost ²
1.	Install mixer for Freeport ET to address low chlorine residuals (KC3).	<ul style="list-style-type: none"> • Selection and sizing of preferred mixer • Installation of equipment 	\$100,000 (RMOW)
2.	Develop an SOP for repair for the single connection to Kit 2E/Kit 2EA/Cam 2W from Kit 4 (KC5).	<ul style="list-style-type: none"> • Review of existing infrastructure, required spare parts, and available contractors • Complete SOP and circulate 	\$15,000 (RMOW)
3.	Develop an SOP for repair for the single connection to Bridgeport (KC7).	<ul style="list-style-type: none"> • Review of existing infrastructure, required spare parts, and available contractors • Complete SOP and circulate 	\$15,000 (RMOW)
4.	Develop an SOP for repair for the single connection to Hidden Valley (KC8).	<ul style="list-style-type: none"> • Review of existing infrastructure, required spare parts, and available contractors • Complete SOP and circulate 	\$20,000 (RMOW)
5.	Develop an SOP for repair for the single connection to Mannheim Village (KC9).	<ul style="list-style-type: none"> • Review of existing infrastructure, required spare parts, and available contractors • Complete SOP and circulate 	\$15,000 (RMOW)
6.	Install a flow meter and pressure indicating transmitters (PIT) on the Falconridge PRV and Hawkswood PRV for monitoring (KC10).	<ul style="list-style-type: none"> • Selection of preferred equipment for monitoring • Installation of equipment 	\$25,000 (RMOW)
	Adjust the setpoint for the Hawkswood PRV, if required, to address the pressure fluctuations in Kit 4A (KC10).	<ul style="list-style-type: none"> • Adjust PRV setting in field, if required 	\$10,000 (RMOW)
7.	1A. To address the issue of the operation of K50 wells not being adjustable to demands, install PITs in Shingletown and at the 450 mm watermain reduction in Mannheim (KC11).	<ul style="list-style-type: none"> • Installation of PITs • Monitor field data collected 	\$20,000 (RMOW)
	1B. Install a VFD on the K50 wells and ensure adequate feedback for proper operation, if warranted based on field monitoring (KC11).	<ul style="list-style-type: none"> • Installation of VFDs at pumps, if required • Optimization of operating strategy with VFDs, if required 	\$80,000 (RMOW)

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

Proposed Improvements ¹	Overview of Implementation Requirements	Opinion of Probable Cost ²	
8.	Create additional connection from Kit 4 to Kit 2W ³		
	1A. Install additional connection from Kit 4 to Kit 2W at intersection of Biehn Dr. and Black Walnut Dr. (KC21)	<ul style="list-style-type: none"> Remove check valve on Biehn Dr. and install PRV 	\$350,000 (RMOW)
	1B. Install additional connection from Kit 4 to Kit 2W by extending the Strasburg Rd. watermain (KC21). Refer to Additional Linear Work (Item 10)	<ul style="list-style-type: none"> Connection will be constructed as development occurs in this area 	Refer to Additional Linear Work (Item 10)
9.	Update operating strategy for Freeport ET to modify the operating levels to range between 353.2 mASL and 359.5 mASL	<ul style="list-style-type: none"> Update SCADA alarm setpoints to adjust low and high operating levels Review operating levels annually to optimize based on up-to-date service areas 	N/A (Operational Change)
	Other related work	TBD	\$250,000 (RMOW)
TOTAL (RMOW)		\$900,000	

Note 1: Constraint number is identified as w as outlined in Tech Memo Task D and E of the WSDOMP, *Identification of Alternative Solutions*

Note 2: Total opinion of probable cost is included in the implementation schedule as 'other work' in Section 4.3.

Note 3: Cambridge Zone 1W redundancy of supply and alternatives based on Kitchener Zone 2 and 4 Optimization Study (Stantec, 2009) and the WSDOMP TM *Preliminary Review of Transferring K34/36 WTP to Kit 2W* provided in Appendix G.

Table 4-5: Additional Linear Work for the Region in Kitchener

Proposed Work of Related Linear Projects ¹	Overview of Work	Opinion of Probable Cost ^{5,6}	Potential Implementation Timing	
10.	Kitchener Zone 2W/4 upgrades, new watermain to provide an additional connection from Kit 4 (at Strasburg Rd) to Kit 2W	<ul style="list-style-type: none"> 2,850 m of 600 mm diameter transmission main 	\$2,657,000 ² (RMOW)	Dependent on Development Planning
11.	Kitchener Zone 2W upgrades, new watermain to provide looping in the pressure zone	<ul style="list-style-type: none"> 4,000 m of 450 mm diameter watermain 	\$2,437,500 ² (RMOW)	Dependent on Development Planning
12.	Kitchener Zone 2W Watermains	<ul style="list-style-type: none"> 810 m of 300 mm diameter watermains 	\$162,000 ² (RMOW) \$162,000 ² (City of Kitchener)	Dependent on Development Planning
		<ul style="list-style-type: none"> 280 m of 300 mm diameter watermains 	\$56,000 ² (RMOW) 56,000 ² (City of Kitchener)	Dependent on Development Planning
		<ul style="list-style-type: none"> 2,700 m of 300 mm diameter watermains 	\$580,000 ² (RMOW) \$580,000 ² (City of Kitchener)	Dependent on Development Planning

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

Proposed Work of Related Linear Projects ¹		Overview of Work	Opinion of Probable Cost ^{5,6}	Potential Implementation Timing	
13.	Kitchener Zone 4 upgrades, new watermain and 600 mm MTV to connect Kitchener Zone 4 to Waterloo Zone 4 (#4178) for the remaining section from Union St to Erb St.	<ul style="list-style-type: none"> 565 m of 600 mm diameter watermain MTV in existing chamber Asphalt road work 	\$1,267,000 ⁴ (RMOW)	<5 years (2015-2017)	
14.	Kitchener Zone 4 upgrades, new Mannheim Feeder (Hydro-Corridor) (#4161)	<ul style="list-style-type: none"> 6,000 m of 750 mm diameter feedermain Gravel road work 	\$12,700,000 ³ (RMOW)	<5 years (2013)	
15.	Kitchener Zone 5 Dual Watermains (#4068)	Install dual watermain from Huron Rd. to New Dundee Rd.	<ul style="list-style-type: none"> 2,800 of 300 mm diameter watermain Asphalt road work 	\$1,680,000 ³ (RMOW)	<5 years (2016-2017)
		Install dual watermain east to west in the area bound by New Dundee, Fischer Hallman, Trussler and Huron Rd.	<ul style="list-style-type: none"> 2,000 m of 300 mm diameter watermain Asphalt road work 	\$1,200,000 ³ (RMOW)	
16.	Upgrade existing watermain on Ottawa St S. between Heritage Dr. and Keewatin Ave.	<ul style="list-style-type: none"> 800 m of 450 mm watermain 	\$1,000,000 ³ (RMOW)	<5 years	
17.	Replace existing watermain on Charles St. between Victoria Street North and Sydney Street South	<ul style="list-style-type: none"> 2,700 m of 600 mm diameter watermain 	\$4,900,000 ³ (RMOW)	<5 years	
18.	Upgrade existing watermain on Ottawa St. S. between Mannheim Zone 5 PS and west of David Bergey Dr.	<ul style="list-style-type: none"> 1,000 m of 600 mm watermain 	\$1,800,000 (RMOW)	2031	
TOTAL (A.Mun.s)			\$1,065,000		
TOTAL (RMOW)			\$29,439,500		

Note 1: Region reference number for planned watermain projects is provided where available

Note 2: Costs based on Kitchener Zone 2 and 4 Optimization Study (Stantec, 2009)

Note 3: Costs are included as part of Region's planned watermain budget.

Note 4: Opinion of probable costs calculated based on remaining section of watermain to be constructed to date (as of Jan 2015) and MTV opinion of probable cost of \$250,000.

Note 5: Section 4.3 provides a summary of opinion of probable costs for the Region in Kitchener related linear works.

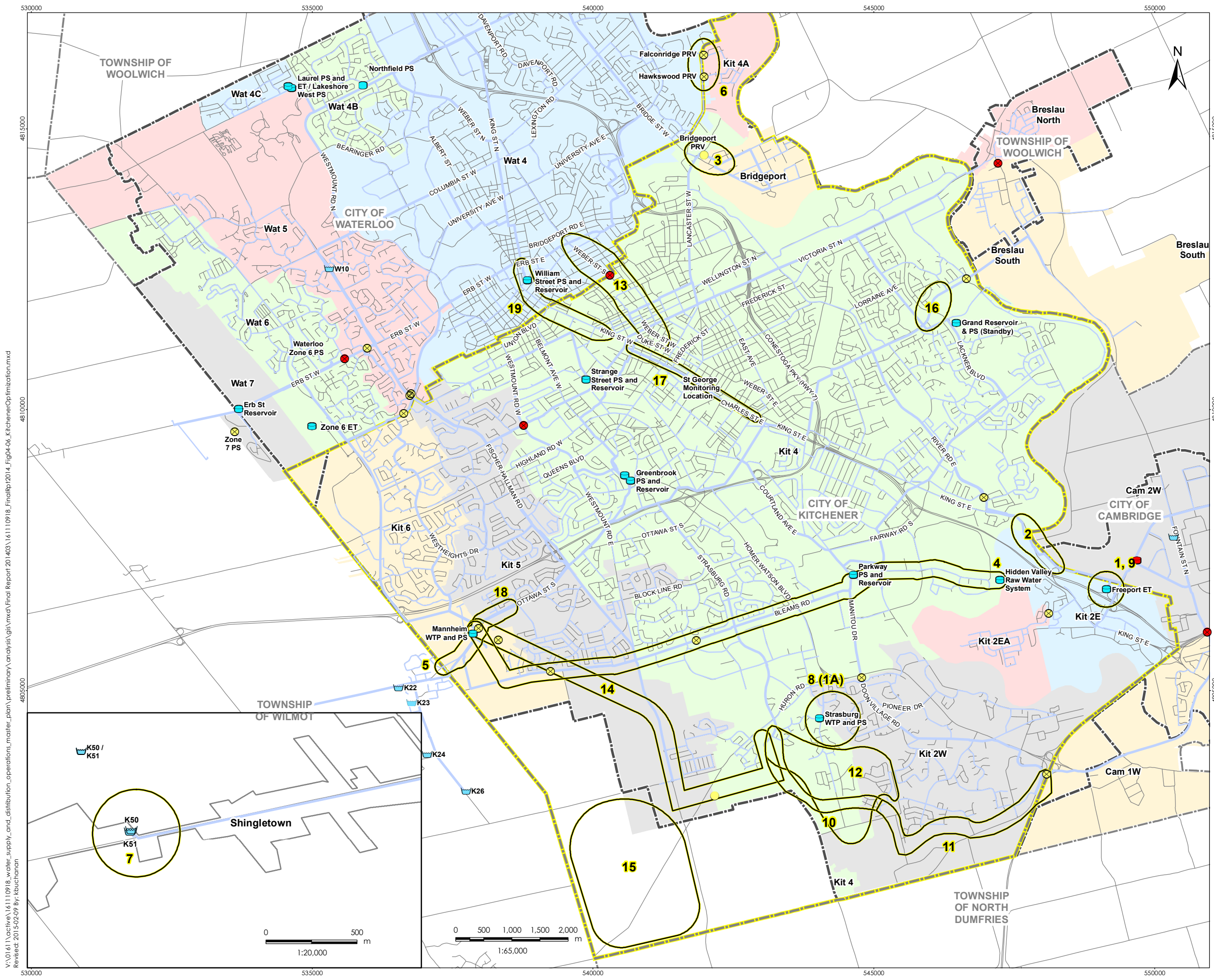
Note 6: Cost sharing between the Region and the Area Municipalities is assumed to be 50/50.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

Table 4-6: LRT-Related Linear Work in Kitchener and Waterloo

Proposed Linear Work Related to LRT	Overview of Work	Opinion of Probable Cost ¹	Potential Implementation Timing
19. King Street Area (Kitchener and Waterloo) upsize watermains			
Replace the existing 250 mm watermain with a new 300 mm watermain during road reconstruction between Victoria Street and Central Market on King Street	<ul style="list-style-type: none"> • 860 m of 300 mm diameter watermain • May need to upsize watermain • Asphalt road reconstruction work 	\$260,000 (RMOW (LRT)) \$260,000 (City of Kitchener)	<5 years (2014)
Replace the existing 250 mm watermain with a new 300 mm watermain during road reconstruction between Central Market and Union Street on King Street	<ul style="list-style-type: none"> • 640 m of 300 mm diameter watermain • May need to upsize watermain • Asphalt road reconstruction work 	\$195,000 (RMOW (LRT)) \$195,000 (City of Kitchener)	<5 years (2014)
Replace the existing 250 mm watermain with a new 300 mm watermain between Union Street and William Street on King Street. No planned road work	<ul style="list-style-type: none"> • 610 m of 300 mm diameter watermain • May need to upsize watermain • Asphalt road work 	\$190,000 (RMOW (LRT)) \$190,000 (City of Kitchener)	<5 years (2014)
Replace the existing 250 mm watermain with a new 300 mm watermain between William Street and Erb Street on King Street. No planned road work, do concurrently with King St. work in Waterloo	<ul style="list-style-type: none"> • 610 m of 300 mm diameter watermain • Asphalt road work 	\$190,000 (RMOW (LRT)) \$190,000 (City of Kitchener)	<5 years (2016)
Replace the existing 250 mm watermain with a new 300 mm watermain between Union Street and William Street on King Street. City road, do work concurrently with King St. work in Waterloo	<ul style="list-style-type: none"> • 300 m of 300 mm diameter watermain • Asphalt road work 	\$90,000 (RMOW (LRT)) \$90,000 (City of Kitchener)	<5 years (2014)
TOTAL (A.Mun.s)		\$925,000	
TOTAL (RMOW - LRT)		\$925,000	

Note 1: Section 4.3 provides a summary of opinion of probable costs for the Region in Kitchener related linear works. Cost sharing between the A.Mun.s and the Region are assumed to be 50/50



- Legend**
- Existing Valve
 - Proposed Valve
 - Well
 - Tank
 - Proposed Facility Location
 - City of Kitchener
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - Area of Interest

- Notes**
1. Install mixer for Freeport ET
 2. Develop SOP for repair for single connection from Kit 4 to Kit 2E/Kit 2EA/Cam 2W
 3. Develop SOP for repair for single connection to Bridgeport
 4. Develop SOP for repair for single connection to Hidden Valley
 5. Develop SOP for repair for single connection to Mannheim Village
 6. Enhancements to Falconridge PRV and Hawkswood PRV
 7. Improvements to operations of K50 wells
 8. Install secondary connection from Kit 4 to Kit 2W
 9. Update operating strategy for Freeport ET
 10. New watermain at Strasburg Rd. between Kit 4 and Kit 2W
 11. New watermain to provide looping in Kit 2W
 12. New watermain in Kit 2W
 13. New watermain to connect Kit 4 and Wat 4 (#4178)
 14. New watermain along the Hydro Corridor (#4161)
 15. Kitchener Zone 5 Dual Watermains (#4068)
 16. Upgrade existing watermain on Ottawa St. S between Heritage Dr. and Keewatin Ave.
 17. Replace existing watermain on Charles St. between Victoria Street N and Sydney Street S
 18. Upgrade existing watermain on Ottawa St. S between Mannheim Zone 5 PS and west of David Bergey Dr.
 19. King Street area watermain upgrades related to LRT construction

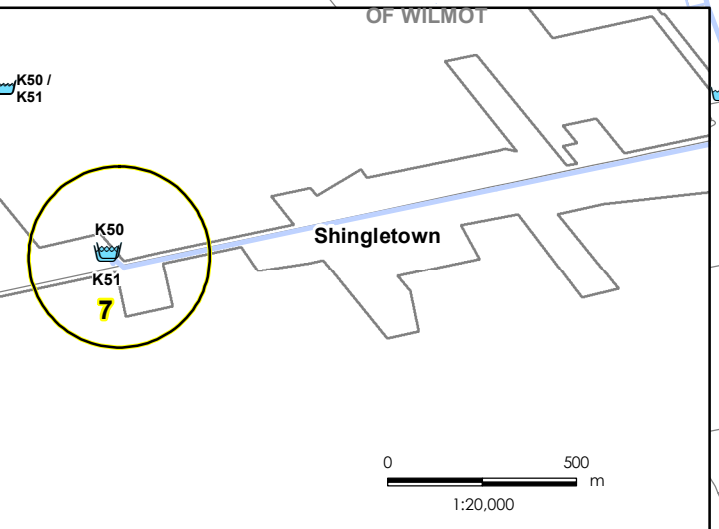
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 Revised: 2015-02-09 By: kbuchanan

February 2015
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Water Supply and Distribution
Operations Master Plan

Figure No.
4-6

Title
**Kitchener Optimization
- Other Work and Linear Projects**



4.3 KITCHENER IMPLEMENTATION SCHEDULE

The proposed implementation schedule and opinion of probable cost for the Kitchener Optimizations is presented in the Table 4-7. The total opinion of probable cost for Region projects in Kitchener pressure zones, including other works and linear work, is approximately 41.1 million over the planning period.

Table 4-7: Implementation Timeline and Opinion of Probable Cost for Proposed Kitchener Optimizations

Project	Opinion of Probable Cost ²	Planned Expenditure (Year)									
		2013	2014	2015	2016	2017	2018	2019	2020	2021	>2021
Connect pressure transducers to SCADA	In Progress	█									
Develop a decision support system	\$ 2,000,000	█	█	█	█						
Install a control valve on the Victoria St. watermain	\$ 500,000	█	█	█							
Install a control valve on the secondary Weber St. connection between Kit 4/Wat 4 connection	Included under Linear Work	█	█	█	█						
Separate Kit 4 and Wat 4 discharge from Mannheim Zone 4 PS	\$ 2,500,000		█	█	█	█					
Install a control valve and Hydro-corridor watermain	Part of Zone 4 Feedermain Project	█	█	█	█						
Separate Village of Mannheim from K20's	\$ 4,800,000					█	█	█	█	█	
Other Work to Address Constraints	\$ 900,000					█	█	█	█	█	█
Linear Work (includes LRT related work) ¹	\$ 30,365,000										

Note 1: Implementation is coordinated with Regional and A.Mun. transportation projects

Note 2: Opinion of probable costs includes Region costs only, not costs associated with A.Mun.s

Note 3: dotted line indicates accelerated or delayed implementation should circumstances change (i.e. change in demand trends)

5.0 City of Waterloo Optimizations

5.1 SUMMARY OF PROPOSED SOLUTIONS

Waterloo is supplied water from Kitchener (Mannheim WTP) and groundwater supply systems within the City. Two groundwater facilities provide centralized treatment for groundwater wells prior to discharge to the distribution system: William St. PS and Erb St. WSS. One individual groundwater well, Well W10, is disinfected (UV and chlorination) and discharged directly to the distribution system. Note that upgrades are in progress to provide secondary disinfection via chloramination for Well W10. More information on the water distribution system for Waterloo is provided in the Task A Tech Memo in Appendix A.

The proposed reconfiguration for Waterloo prioritizes the development of new sources within the City to create a more self-sufficient system. The proposed optimizations also aim to reduce the reliance on single transfer connections and ‘free up’ capacity at Mannheim WTP for a potential increase in transfer to Cambridge or future development in Kitchener. There are net GHG reductions expected for Waterloo due to facility consolidations, reduced treatment energy requirements (blending of sources), and reduced pumping.

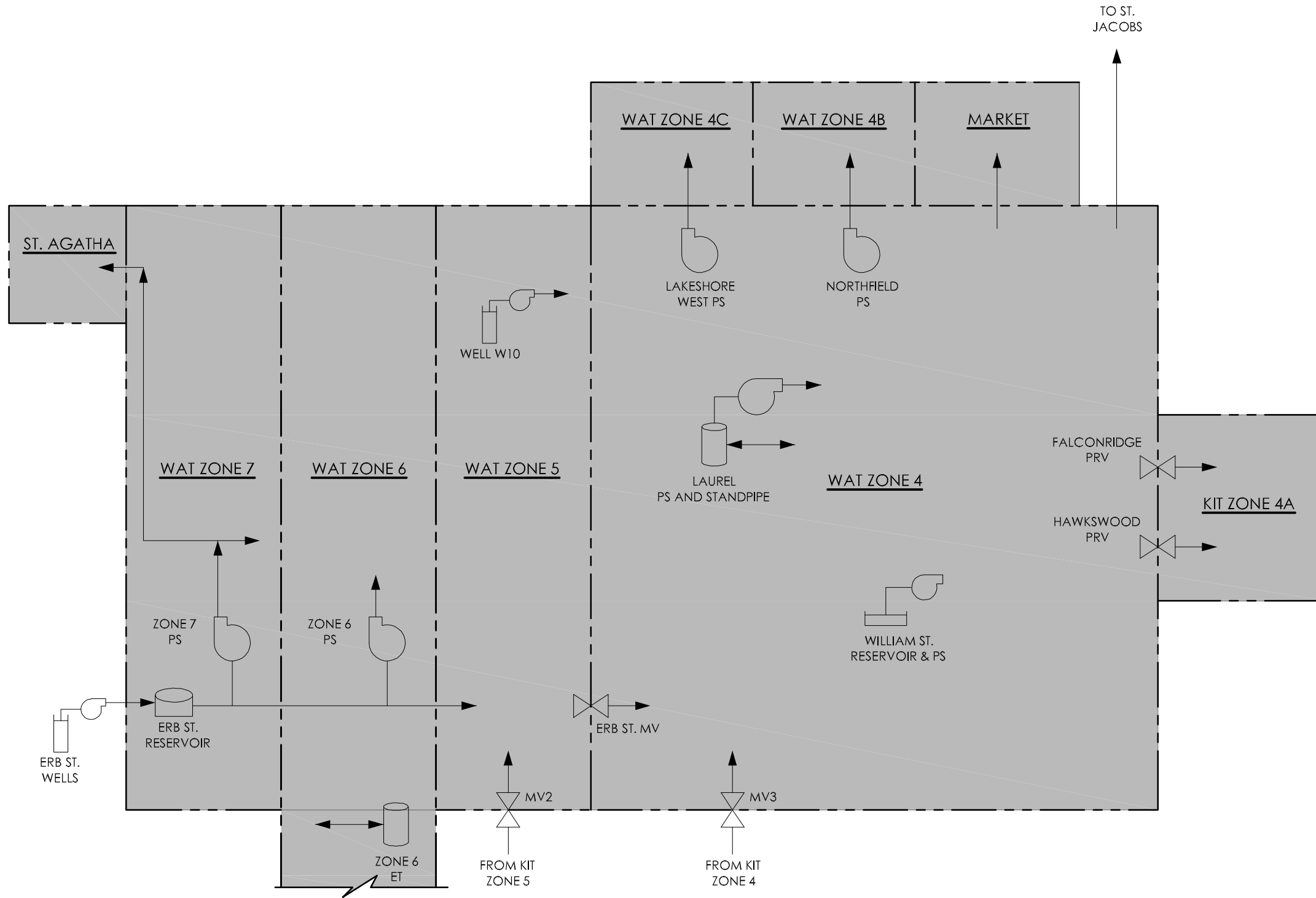
The existing process flow diagram for Waterloo is presented in Figure 5-1. The proposed changes are shown for each upgrade in the following sections.

Each preferred improvement and optimization strategy is described in terms of the following:

- Justification
- Overview of Work
- Layout and PFD for Facilities
- Studies Required
- GHG Impact
- Opinion of Probable Cost

The recommendations referred to as ‘additional work’ are grouped together in Section 5.2.5 and include recommendations for complementary infrastructure and linear upgrades to occur along with the more significant WSDOMP proposed solutions described in Sections 5.2.1 through 5.2.4. Estimated time of implementation (schedule) will be summarized for all solutions in Table 5-7 at the end of the Waterloo section.

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ZONE	TARGET HGL (mASL)
WAT 4	381.0
WAT 4B	401.0
WAT 4C	405.0
WAT 5	405.0
WAT 6	428.0
WAT 7	440.0
ST. AGATHA	440.0

ORIGINAL SHEET - ANSI B

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- ELEVATED TANK
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- WELL
- WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

1. ZONE 6 PS CURRENTLY ON STANDBY.

Client/Project

REGION OF WATERLOO
WATER SUPPLY AND
DISTRIBUTION WATER PLAN

Figure No.

5.1

Title

EXISTING WATERLOO DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM

5.2 DETAILED REVIEW OF PROPOSED SOLUTIONS

5.2.1 Upgrade Strange Street WSS to Include William Street Wells

The William Street Wells are proposed to be combined with the Strange Street Wells via a dedicated raw watermain to the Strange Street WSS. Treatment would be combined for the two sources at a consolidated facility.

5.2.1.1 *Justification*

- Combination of raw water from William Street and Strange Street Wells at the Strange Street WSS site and expansion of treatment capacity will provide a larger supply to Wat 4 from Kit 4 via the proposed Weber Street trunk main.
- Increases flexibility of supply as water can be supplied to Waterloo, Kitchener, or both, as needed.
- The proximity of the facilities, current Strange Street DWWP treated water capacity, condition of the William Street facility, and ability to combine and blend the raw water prior to treatment are noted as the key considerations in recommending this alternative. This also provides the opportunity to re-evaluate the commissioning of new wells or re-activate wells previously on standby at each facility.

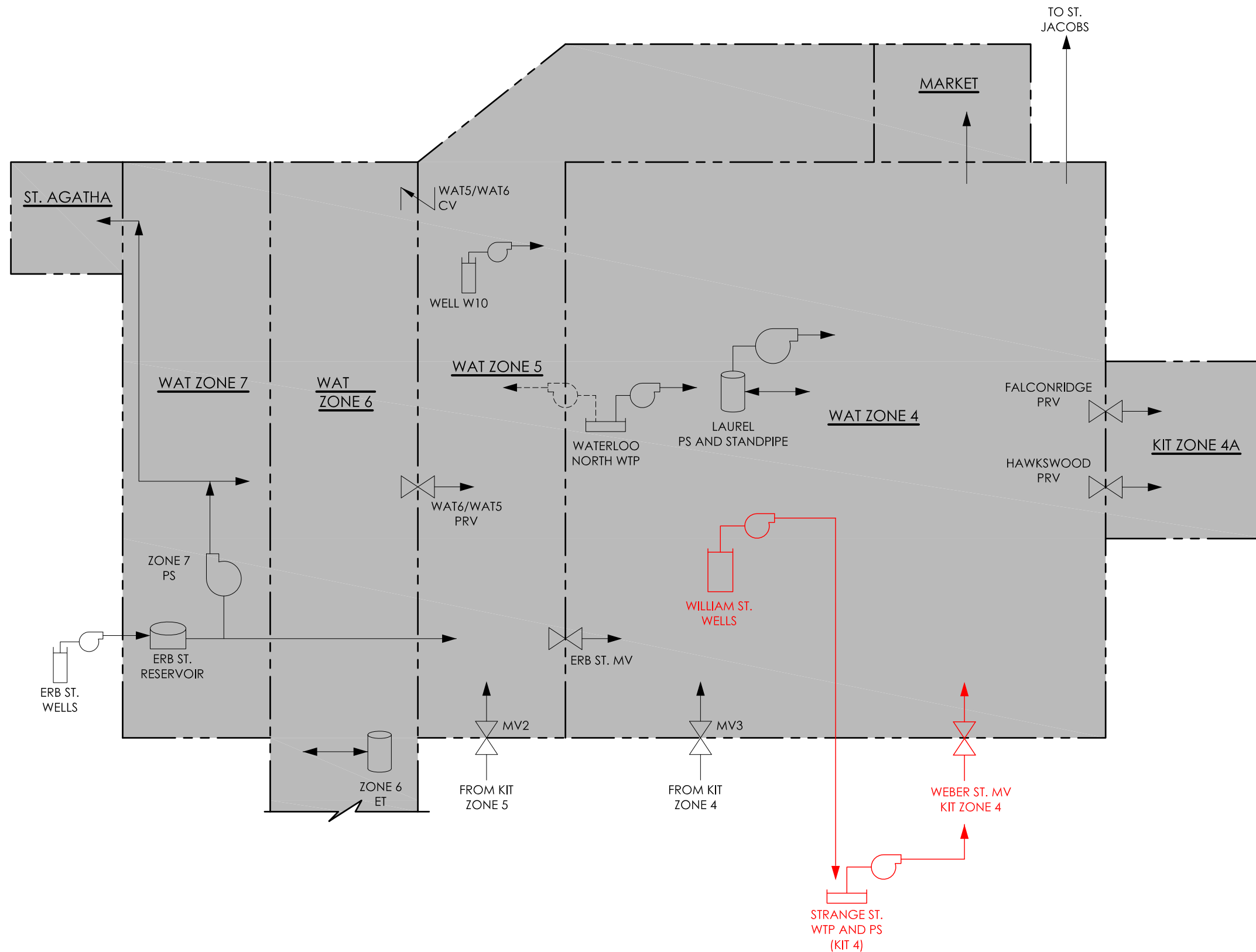
5.2.1.2 *Overview of Work*

- Upgrade Strange Street WSS to increase capacity
 - Upgrade raw watermain capacity and extend raw watermains to connect with William Street PS.
 - Upgrade treatment for iron and manganese removal, centralize chlorine disinfection, and high lift pump replacement (planned Region capital project # 4160).
 - Increase capacity at Strange Street WSS to accept William Street groundwater (60L/s). Additional supply may be possible based on bringing additional wells online. This is dependent on water quality and will be addressed in the ongoing Class Environmental Assessment for the Strange Street and William Street WSS. This upgrade may require new facilities at Strange Street.
- Decommission William Street PS
- Upgrade in distribution network to allow optional discharge to Waterloo.
 - The Weber Street watermain and MTV is being done as part of an ongoing project. Refer to Table 4-5 Item 13 (Section 4.2.5) for additional details.

5.2.1.3 *Layout and PFD for Facilities*

Refer to Figure 5-2 for the proposed changes identified on the system PFD for the 2031 optimizations and to Figure 5-3 for physical location and additional infrastructure required.

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ZONE	TARGET HGL (mASL)
WAT 4	381.0
WAT 5	405.0
WAT 6	428.0
WAT 7	440.0
ST. AGATHA	440.0

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- WELL
- WATER SUPPLY STATION
- ALTERNATIVE WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

- ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

Client/Project

REGION OF WATERLOO
WATER SUPPLY AND
DISTRIBUTION WATER PLAN

Figure No.

5.2

Title

FUTURE WATERLOO DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
WILLIAM ST. WELLS TO STRANGE ST.
FACILITY

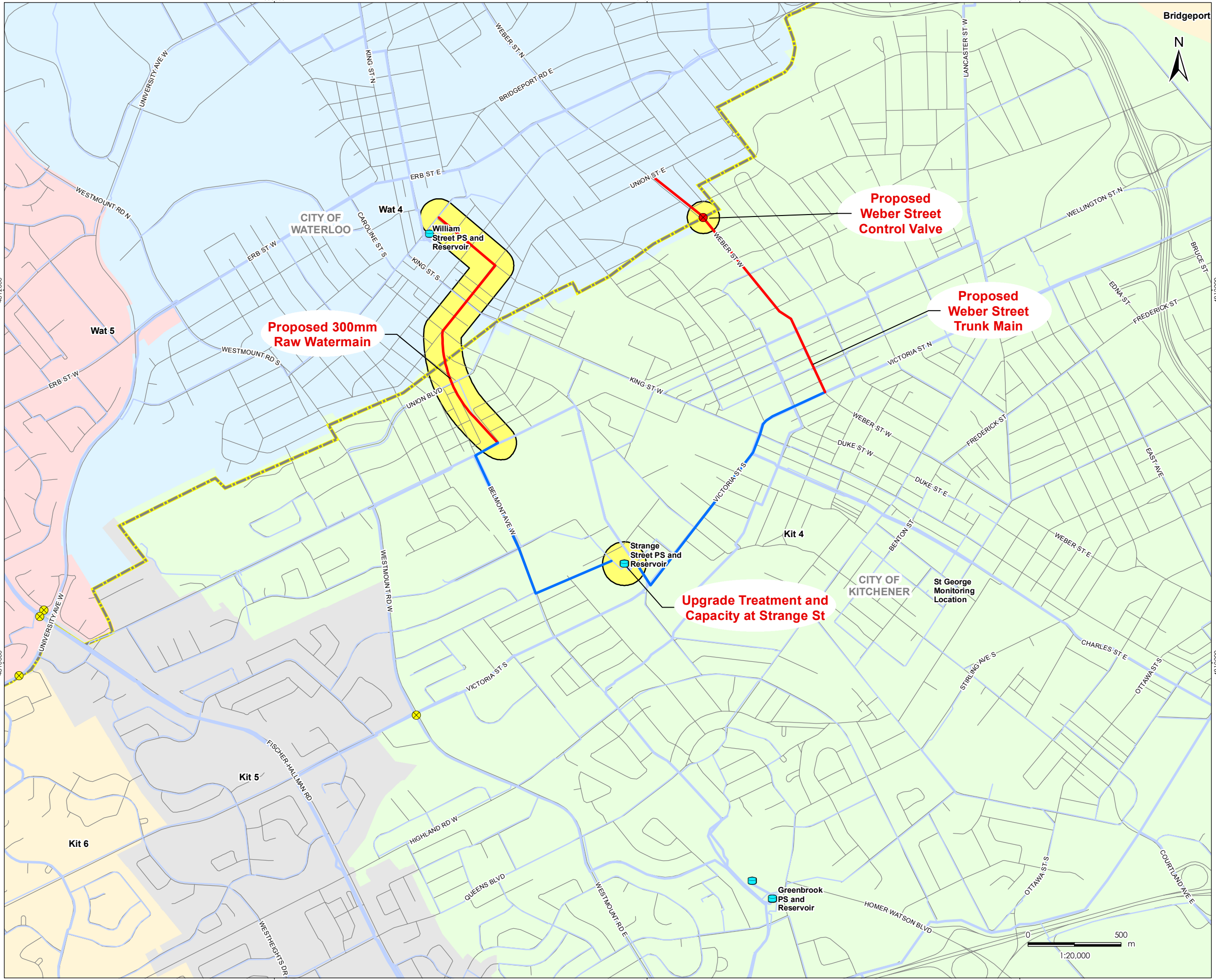
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- Legend**
- Existing Valve
 - Proposed Valve
 - Tank
 - Well
 - Infrastructure Related to Recommendation
 - City of Waterloo
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - Existing Important Infrastructure
 - New Infrastructure



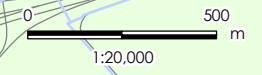
- Notes**
1. Coordinate System: NAD 1983 UTM Zone 17N
 2. Base features produced under license with the Ontario Ministry of Natural Resources © Queen's Printer for Ontario, 2014.

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Client/Project
Regional Municipality of Waterloo
Water Supply and Distribution
Operations Master Plan

Figure No.
5-3

Title
**Waterloo Optimization - Upgrade
Strange Street WSS To Include
William Street Wells**



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540000

542000

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 Revised: 2015-02-06 By: kbuchanan

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

5.2.1.4 Studies Required

A Schedule C Class Environmental Assessment is in progress for expanding treatment capacity at Strange Street and routing raw water mains from William Street PS to the Strange Street Facility PS.

5.2.1.5 GHG Impact

There may be a slight decrease in GHG emissions due to the removal of William Street PS and consolidating treatment at Strange Street WSS. Well pumps can be resized and selected to meet the pressure requirement at the Strange Street Facility. Refer to Appendix F for additional information.

5.2.1.6 Opinion of Probable Cost

Table 5-1 outlines the opinion of probable capital cost to route raw water from William Street Wells to the Strange St WSS and to complete the upgrades to the Strange Street WSS. There is a net decrease in O&M costs expected with this optimization as the treatment effort will be consolidated at one facility. Note, there are additional energy costs associated with pumping water back to Wat 4 which may reduce some of the savings experienced through other cost optimizations associated with the consolidation. Refer to Appendix F for additional information.

Table 5-1: Opinion of Probable Cost for Upgrades to the Strange St. WSS.

Recommended Modification	Opinion of Probable Capital Cost
Upgrade Strange Street WSS	\$ 13,700,000
Decommission William St PS ¹	\$ 160,000
TOTAL	\$ 13,860,000

Note 1: Opinion of probable decommissioning cost assumes reservoirs would be filled in and remain onsite, and reservoir tops above grade would be removed to 1 meter below grade and covered by soil.

5.2.2 Erb Street Water Supply System (WSS) Upgrades

The Erb Street WSS supplies water to Wat 5, Wat 6, Wat 7, and St Agatha. Upgrades are proposed to restore the capacity and improve the operation of the WSS including electrical and pump upgrades, modifications to the chemical injection systems, and an updated operating strategy for the Erb St. control valve. It can be noted that in 2014, Wat 6 was consolidated with Kit 6 and supplied with water from Mannheim Zone 6 PS, replacing the supply transfer from Erb Street WSS (Waterloo Zone 6 PS). Although this will free up some capacity at the Erb Street Facility, demands are expected to increase in the area serviced by Erb Street Reservoir as a result of growth and proposed reconfigurations.

5.2.2.1 *Justification*

- Restoring capacity will help accommodate demand increases projected as a result of development and transferring pressure zones Wat 4B and Wat 4C to Wat 5.
- Water from the Erb Street Wells can also be transferred to Wat 4 via the Erb Street MTV. Additional supply from the Erb Street Wells to Wat 4 will reduce the reliance on water being transferred from Kitchener.

5.2.2.2 *Overview of Work*

- Increase WSS capacity and ease of operation at Erb Street Wells
 - Complete electrical and pump upgrades at well sites.
 - Modify chemical injection system
 - Update the operating strategy for the Erb Street control valve (PRV from Wat 5 to Wat 4).
- Related work includes the addition of a PRV between Wat 6 and Wat 5, detailed in Table 5-5 Item 5 (Section 5.2.5). Design for this PRV is underway as the Waterloo Zone 6 PS is decommissioned.
 - The PRV between Wat 6 and Wat 5 will provide emergency supply to Wat 5 in the event that the Erb Street WSS is temporarily offline.

5.2.2.3 *Layout and PFD of Facilities*

Refer to Figure 5-4 for the proposed changes identified on the system PFD for the 2031 optimizations and to Figure 5-5 for physical location and additional infrastructure required.

5.2.2.4 *Studies Required*

- The activities associated with this optimization are pre-approved changes (Schedule A Environmental Assessment).

5.2.2.5 *GHG Impact*

There is no significant impact on GHG emissions for this optimization. Refer to Appendix F for additional information.

5.2.2.6 *Opinion of Probable Cost*

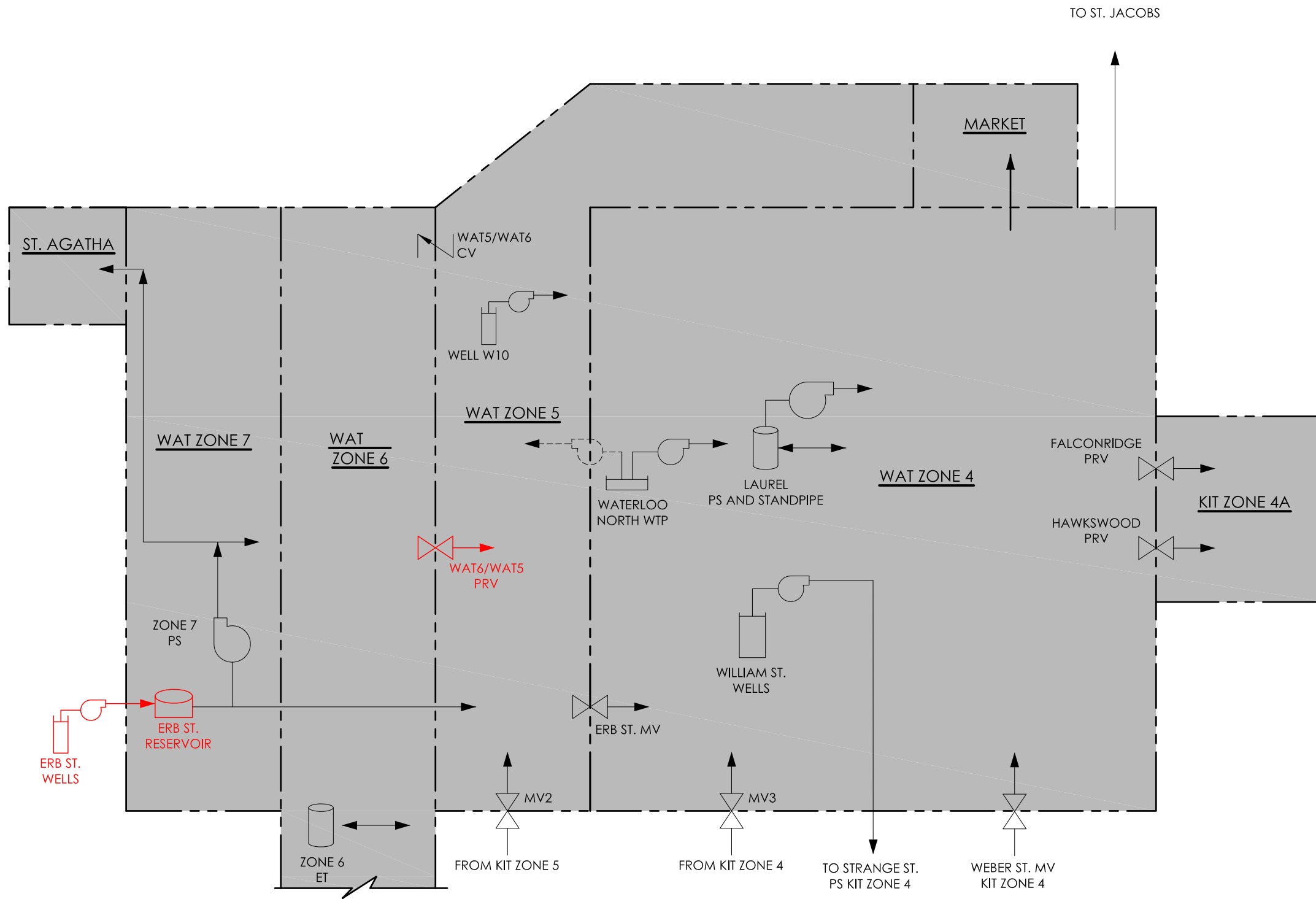
Table 5-2 outlines the opinion of probable capital cost associated for upgrades to the Erb Street WSS. There are no significant impacts anticipated for O&M costs. Refer to Appendix F for additional information.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

Table 5-2: Opinion of Probable Cost for the Erb Street WSS Upgrades

Recommended Modification	Opinion of Probable Capital Cost
Erb Street WSS Upgrades	\$ 500,000
Wat 6 to Wat 5 PRV	\$500,000
TOTAL	\$ 1,000,000

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TO ST. JACOBS

ZONE	TARGET HGL (mASL)
WAT 4	381.0
WAT 5	405.0
WAT 6	428.0
WAT 7	440.0
ST. AGATHA	440.0

ORIGINAL SHEET - ANSI B

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Legend

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- ELEVATED TANK
- PUMP STATION
- WELL
- WATER SUPPLY STATION
- ALTERNATIVE WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

- ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

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REGION OF WATERLOO
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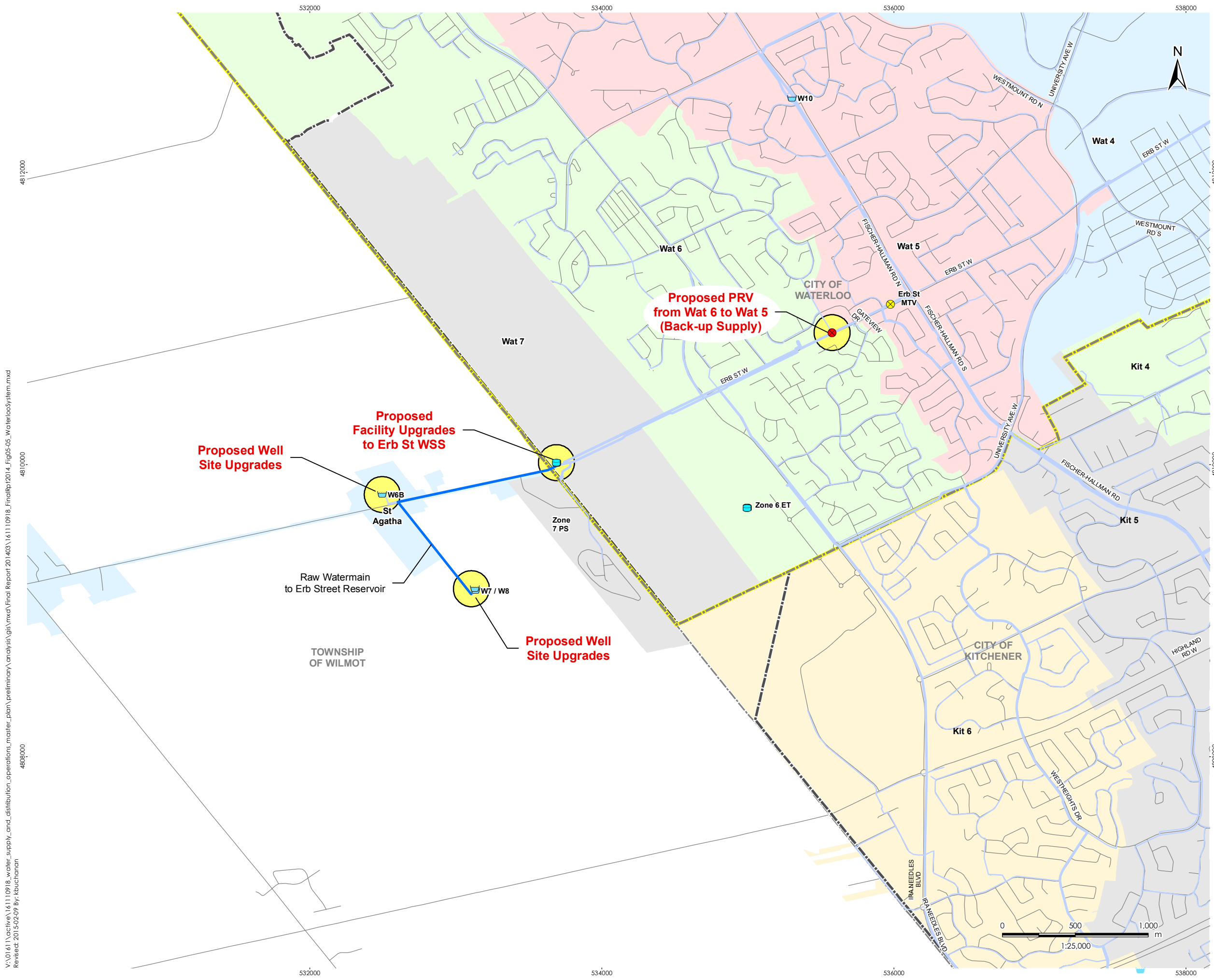
Figure No.

5.4

Title

FUTURE WATERLOO DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
ERB ST. WSS CAPACITY RESTORATION

- Legend**
- Existing Valve
 - Proposed Valve
 - Tank
 - Well
 - Infrastructure Related to Recommendation
 - City of Waterloo
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - Important Existing Infrastructure



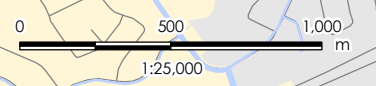
- Notes**
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Figure No.
5-5

Title
**Waterloo Optimization
- Erb Street WSS Upgrades**



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 Revised: 2015-02-09 By: kbuchanan

5.2.3 Consolidate Waterloo North Wells at New Waterloo North Water Treatment Plant

Construct a new water treatment plant, referred to as the Waterloo North Water Treatment Plant (WTP), to include new sources for the IUS in northern Waterloo. Based on the information available at this time, the capacity of this treatment plant is estimated at 80 L/s and will supply directly to Wat 4. It is also a possibility for the Waterloo North WTP to supply directly to Wat 5 in addition to Wat 4, depending on future needs.

5.2.3.1 Justification

- Wells located in Waterloo North (W5A and Laurel Tank test wells) have been identified as potential sources for the IUS. The Waterloo North WTP is proposed to bring these wells online and provide iron and manganese treatment, as necessary.
- This supports the Waterloo-wide reconfigurations to increase supply capacity within the city, and IUS-reconfigurations to supply more water from Mannheim WTP to Cambridge.
 - The current Waterloo-supply configuration has a heavy reliance on trunk watermains from Kit 4 to transfer water from the Mannheim WTP.
 - Supplying Waterloo from a more local supply source than the Mannheim WTP reduces the amount of pumping required from a longer distance to supply Waterloo.
- As flow transfer from MV2 has been limited due to changes of HGL in Kit 5, Waterloo North WTP could be constructed with a dual PS to supply to either into Wat 4 or Wat 5 (configuration to be determined in Class EA).
- There is an opportunity for decommissioning or re-purposing the unused Laurel PS for the potential new Waterloo North WTP location.

5.2.3.2 Overview of Work

- Design and construct Waterloo North WTP
 - Construct new supply wells and raw watermains to the WTP.
 - Construct new treatment system and pump station.

5.2.3.3 Layout and PFD for Facilities

Refer to Figure 5-6 for the proposed changes identified on the system PFD for the 2031 optimizations and to Figure 5-7 for physical location and additional infrastructure required.

5.2.3.4 Studies Required

- A hydrogeological study has been completed to confirm capacity of wells
- A Schedule C Class Environmental Assessment was completed for the proposed supply wells and treatment facility (AECOM, 2011).

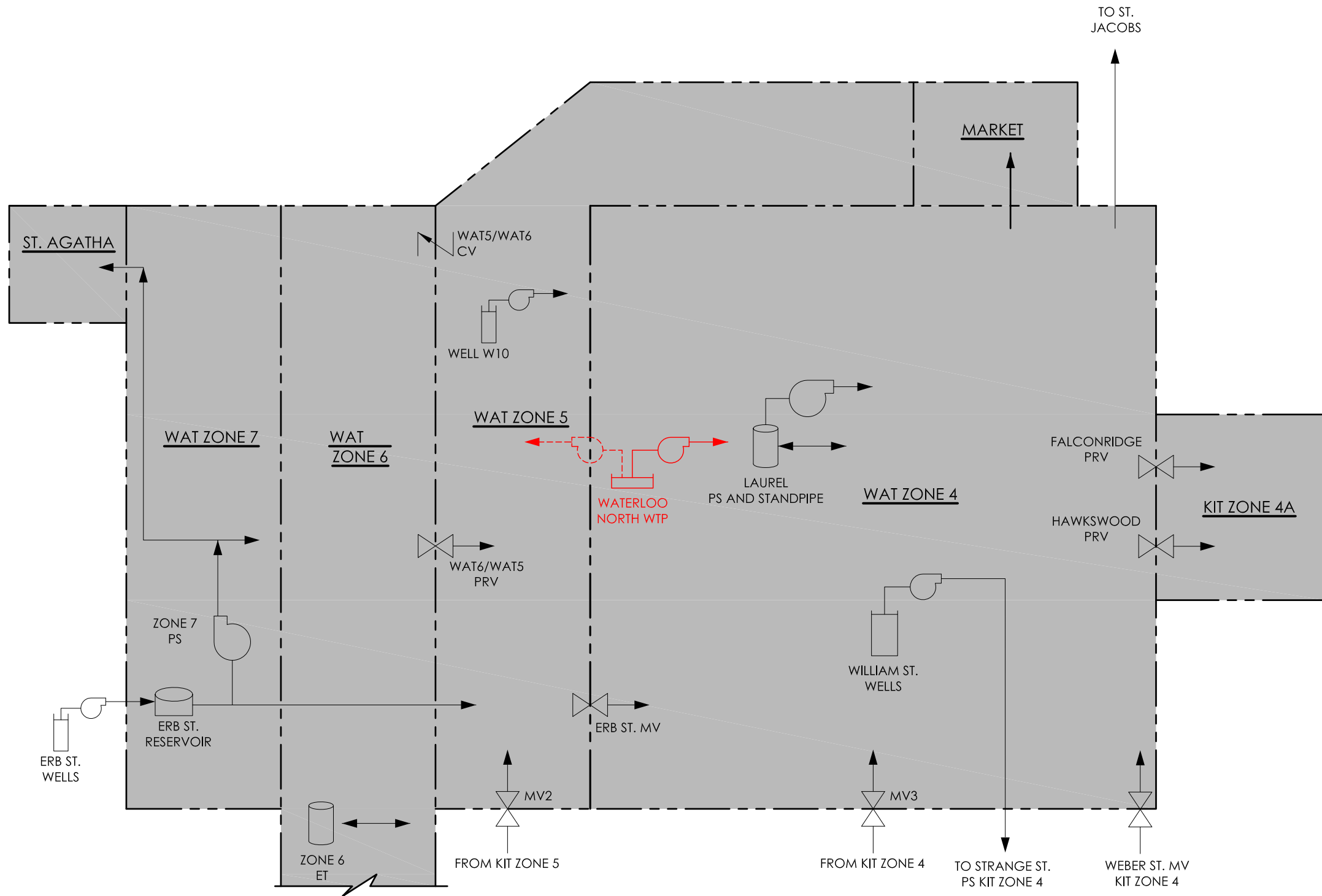
WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

- A Schedule C Class Environmental Assessment amendment will be required for the configuration of the proposed supply wells and treatment facility, and staged planning.

5.2.3.5 GHG Impact

Overall the GHG impact for this recommendation is neutral. There will be an increase in GHG emissions as a result of introducing a whole new system, which will include a new facility and two new raw water wells. However, there will be a reduction in GHG as a result of reducing the need for long distance water transfers from Mannheim Zone 4 PS (900 mm feedermain losses). Refer to Appendix F for additional information.

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ZONE	TARGET HGL (mASL)
WAT 4	381.0
WAT 5	405.0
WAT 6	428.0
WAT 7	440.0
ST. AGATHA	440.0

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Legend

- RESERVOIR
- ELEVATED TANK
- PUMP STATION
- WELL
- WATER SUPPLY STATION
- ALTERNATIVE WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

- ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

Client/Project

REGION OF WATERLOO
WATER SUPPLY AND
DISTRIBUTION WATER PLAN

Figure No.

5.6

Title

FUTURE WATERLOO DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
NEW WATERLOO NORTH WTP

532000

534000

536000



- Legend**
- ▲ Test Well
 - ⊕ Well
 - ⊕ Tank
 - Proposed Facility Location
 - Infrastructure Related to Recommendation
 - ▭ City of Waterloo
 - ▭ Urban Boundary
 - ▭ Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - New Infrastructure



481 6000

481 6000

481 4000

481 4000

532000

534000

536000

TOWNSHIP OF WOOLWICH

Proposed Waterloo North WTP

Proposed Supply Well (Laurel Tank)

Proposed Raw Watermain From Supply Wells To Waterloo North WTP

Proposed Supply Well (W5A)

Laurel PS and ET / Lakeshore West PS

Wat 4C (Future Wat 5)

Wat 4B (Future Wat 5)

CITY OF WATERLOO

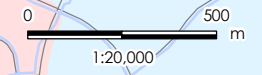
Wat 4

Wat 5

Wat 6

Wat 6

W10



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Operations Master Plan

Figure No.
5-7

Title
**Waterloo Optimization
- New Waterloo North WTP**

5.2.3.6 Opinion of Probable Cost

Table 5-3 outlines the opinion of probable capital cost for consolidating the Waterloo North wells at the site of the Laurel Standpipe and constructing a new Waterloo North WTP. Waterloo North WTP will support improved security of supply to northern Waterloo. There will be a net increase O&M costs associated with operating and maintaining the new facility, and the energy costs associated with the new facility are expected to be balanced out by the reduced need for pumping from Mannheim WTP. Refer to Appendix F for additional information.

Table 5-3: Opinion of Probable Cost for the Consolidation of Waterloo North Wells at the New Waterloo North WTP

Recommended Modification	Opinion of Probable Capital Cost
Construct Waterloo North WTP	\$ 9,900,000
TOTAL	\$ 9,900,000

5.2.4 Transfer Pressure Zones Waterloo 4B and Waterloo 4C to Waterloo 5

Pressure zones Wat 4B and Wat 4C are located in north Waterloo that boost water from Wat 4 to improve service pressure. It is proposed that both of these zones be transferred to Wat 5 and the booster pumping stations supplying these areas be decommissioned. The transfer of Wat 4B and 4C to Wat 5 is described in detail in the WSDOMP *Review of Pressure zones in North-Central Waterloo* TM (refer to Appendix G for details).

5.2.4.1 Justification

- Wat 4B, Wat 4C, and Wat 5 all operate at a similar HGL so the transfer will have minimal impact on service pressures.
- Consolidating zones will allow the Northfield PS (Wat 4B) and Lakeshore West PS (Wat 4C) to be decommissioned, which will simplify operations and reduce operating and maintenance costs.

5.2.4.2 Overview of Work

- Install a 300 mm watermain on Columbia Street between Erbsville Road and Cavendish Drive.
- Install a 400 mm watermain on Erbsville Road between south of Keats Way and Willow Wood Drive.
- Isolate existing watermains at intersection of Parkside Drive and Bearinger Road (operational change).

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

- Transfer a section of 300 mm watermain on Erbsville Road from Wat 6 to Wat 5 and install 300 mm watermains to connect from Willow Wood Drive to Laurelwood Drive.
- Install a 300 mm watermain on Laurelwood Drive to between Erbsville Road and Creekside Drive to connect to the existing Wat 5 watermains.
- Install a 300 mm watermain between the existing Wat 5 and Wat 4C zones. Based on development applications, the recommended alignment is on Erbsville Road and Conservation Drive to connect between the intersection of Erbsville Road and Laurelwood Drive and just east of the intersection between Conservation Drive and Rideau River Street. Alternatively, a 300 mm watermain aligned on Beaver Creek Road and Conservation Drive could be used to connect between Wat 5 and Wat 4C should development in this area proceed first.
- Install a 300 mm watermain on Conservation Drive near the intersection with Westmount Road to connect between existing Wat 4B and Wat 4C infrastructure.
- Operational Changes:
 - Open connection on Lake Louise Boulevard.
 - Open the existing 300 mm watermain on Hagey Boulevard at intersection with Bearinger Road (operation change).
 - Open the existing 300 mm watermain on Bearinger Drive between Parkside Drive and Glen Forrest Boulevard (operational change).
 - Open the existing 450 mm watermain on Columbia Street near the intersection of Old Post Road and Westmount Road (operational change).
- Decommission Northfield PS.
- Decommission Lakeshore West PS.
- Install a 300 mm watermain on Bearinger Road between Laurelwood Drive and east of Pineridge Road (which includes a small segment on Laurelwood Drive from Laurel Gate Drive to Bearinger Road) to provide an additional connection between Wat 5 and the existing Wat 4B area.

The above work is the recommended infrastructure for the 2031 build-out conditions. Phasing for the recommended infrastructure will be dependent on development timing.

5.2.4.3 Layout and PFD for Facility

Refer to Figure 5-8 for the proposed changes identified on the system PFD for the 2031 Optimizations and to Figure 5-9 for physical location and additional infrastructure required.

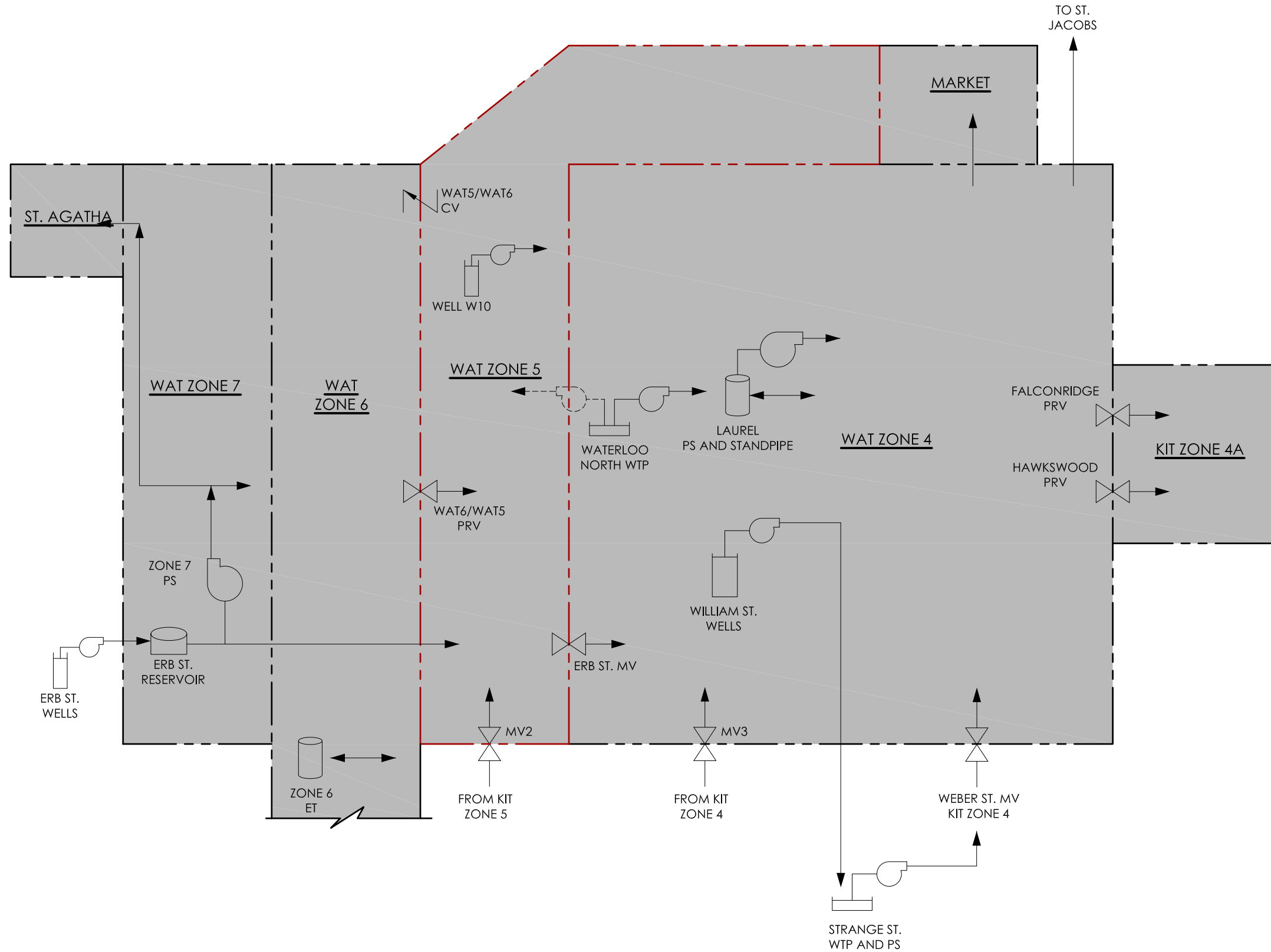
5.2.4.4 Studies Required

Recommended watermains will be within existing road allowances or as part of development and are pre-approved changes (Schedule A Environmental Assessment).

5.2.4.5 GHG Impact

The transfer of Wat 4B and Wat 4C to Wat 5 will reduce GHG emissions by eliminating two (2) pump stations. Refer to Appendix F for additional information.

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Legend

- RESERVOIR
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- PUMP STATION
- WELL
- WATER SUPPLY STATION
- ALTERNATIVE WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

- ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

Client/Project
REGION OF WATERLOO
WATER SUPPLY AND
DISTRIBUTION WATER PLAN

Figure No.
5.8

Title
FUTURE WATERLOO DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
TRANSFER PRESSURE ZONES
WAT 4B AND WAT 4C TO WAT 5

- Legend**
- Well
 - Tank
 - Proposed Facility Location
 - Existing Valve
 - Proposed Valve
 - Infrastructure Related to Recommendation
 - City of Waterloo
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - Updated Wat 5 Boundary
 - Proposed 300 mm and 400 mm Watermain
 - Operational Change

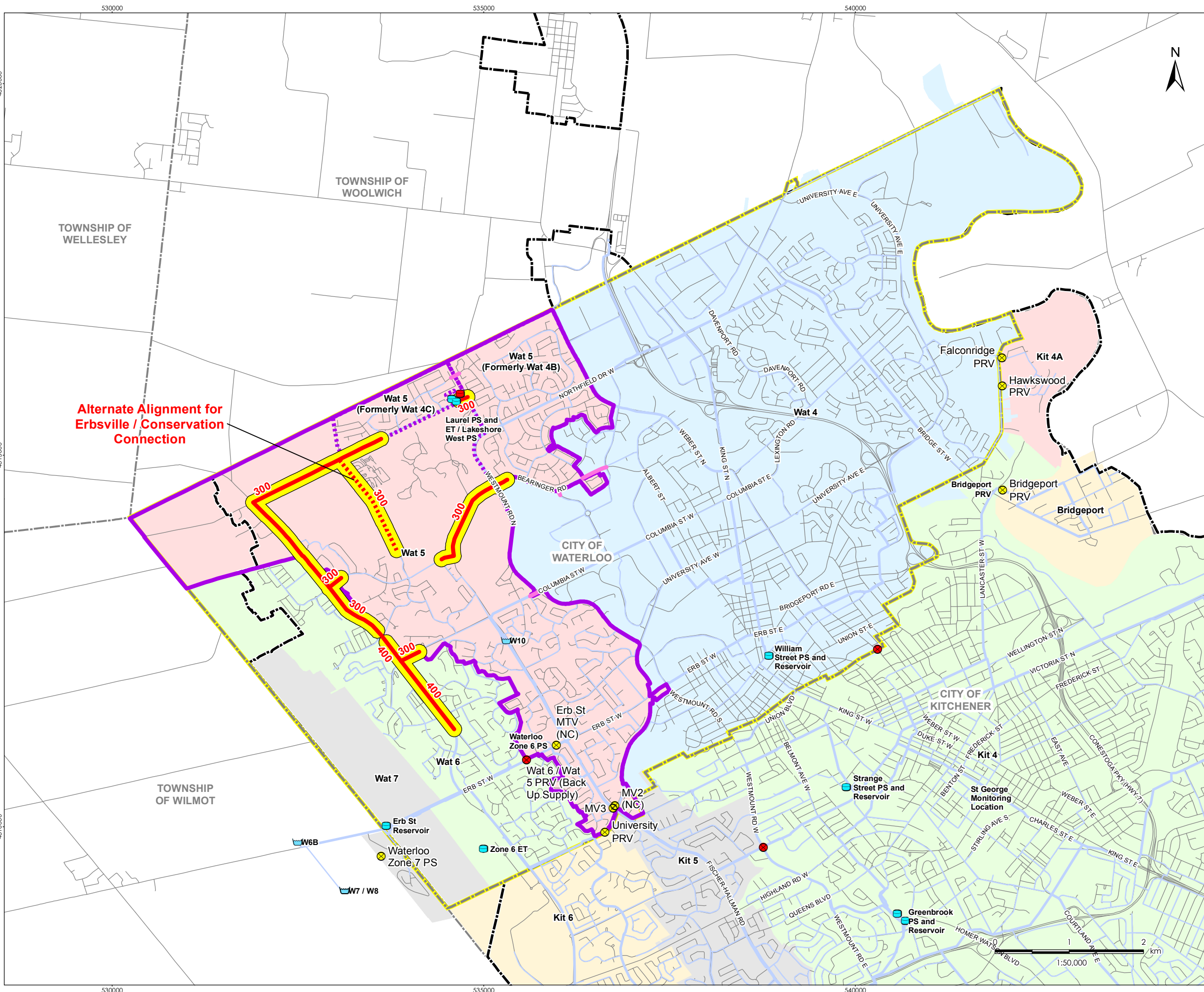
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Water Supply and Distribution
Operations Master Plan

Figure No.
5-9

Title
**Waterloo Optimization - Transfer
Pressure Zones Wat 4B and
Wat 4C to Wat 5**



**Alternate Alignment for
Erbsville / Conservation
Connection**

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WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

5.2.4.6 Opinion of Probable Cost

Table 5-4 presents the opinion of probable capital cost associated with the transfer of pressure zones Wat 4B and Wat 4C to Wat 5. The O&M costs associated with this optimization are expected to decrease as a result of the removal of two pump stations and the associated energy costs. Refer to Appendix F for additional information.

Table 5-4: Opinion of Probable Cost Transferring Wat 4B and Wat 4C to Wat 5

Recommended Modification	Opinion of Probable Capital Cost
New watermains	Refer to Additional Linear Projects (Table 5-6)
Decommission Northfield PS	\$ 50,000
Decommission Lakeshore West PS	\$ 50,000
TOTAL	\$100,000

5.2.5 Additional Work and Linear Projects

Table 5-5 summarizes additional infrastructure projects proposed alongside the City-wide reconfigurations outlined in the previous sections. These projects will help to address the constraints identified in the Master Planning process to be addressed in the 10 year planning window, and are listed as 'Other Work' in the Implementation Schedule in Section 5.3. Table 5-6 outlines relevant linear projects that are scheduled to occur in Waterloo identified through hydraulic analysis of the distribution network completed for the City of Waterloo (refer to Appendix H), many of which are related to the transfer of pressure zones WAT 4B and 4C to WAT 5 (refer to section 5.2.4). The upgrades associated with the LRT construction along King Street are discussed in Section 4.2.5. Figure 5-10 portrays the location of the proposed additional work and linear projects in Waterloo. The entity responsible for cost is shown below in brackets for each opinion of probable cost.

Table 5-5: Other Work and Infrastructure Projects for Waterloo

Proposed Improvements ¹		Overview of Implementation Requirements	Opinion of Probable Cost ²
1.	<ol style="list-style-type: none"> 1. Develop SOP to flush water or circulate from Wat 6 to Wat 5 to improve chlorine residual levels (WC3) 2. Install a control valve from Wat 6 to Wat 5 and develop operating strategy to circulate water when required to deal with Wat 6 low chlorine residuals (WC3). 	<ul style="list-style-type: none"> • No longer needed based on addition of new Elevated Tower in Kit 6/Wat 6, as noted in item 6 below. 	N/A

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

Proposed Improvements ¹		Overview of Implementation Requirements	Opinion of Probable Cost ²
2.	Expand Wat 5 boundary east where feasible to include high elevation areas in the western area of Wat 4 (UW Industrial Park) to address low service pressures in Wat 4 (WC5).	<ul style="list-style-type: none"> Proposed boundary alignment already determined in area of Wes Graham Way and Hagey Blvd. as part of separate Region study Additional study recommended to identify if additional low pressure areas could be transferred to Wat 5 	\$55,000 (RMOW)
3.	Expand Wat 5 boundary west where feasible to include low elevation areas in the eastern area of Wat 6 to address high service pressures (WC11).	<ul style="list-style-type: none"> Preliminary boundary alignment identified in Kitchener Zone 5/6 Boundary Optimization Review Confirm preferred alignment and complete operational changes to implement new alignment 	N/A
4.	Install mixer for Laurel Standpipe to address low chlorine residuals (WC12).	<ul style="list-style-type: none"> Investigation in progress 	\$100,000 (RMOW)
5.	1. Install a control valve from Wat 6 to Wat 5 to address pressure fluctuations in Wat 5 (WC14).	<ul style="list-style-type: none"> Project to add PRV between Wat 6 and Wat 5 (see Section 5.2.2) will enable pressure stabilization when connection is open. Install in location of decommissioned Waterloo Zone 6 PS 	Included in Section 5.2.2
	2. Install PITs to monitor pressure fluctuations in Wat 5 (WC14). Note, this is only recommended if pressure fluctuations persist after PRV installation	<ul style="list-style-type: none"> Select locations of interest Install PITs Monitor data to confirm pressure fluctuations 	\$30,000 (RMOW)
6.	Consolidate Zones Wat 6 and Kit 6 with the new storage tank to supply both zones from Kitchener.	<ul style="list-style-type: none"> New Zone 6 ET has been constructed and consolidation of Wat 6 and Kit 6 is to be implemented by 2014 	Included in existing plans
7.	Decommission Waterloo Zone 6 PS following the commissioning of the Zone 6 ET.	<ul style="list-style-type: none"> Commission Zone 6 ET to consolidate Kit 6 and Wat 6 into one hydraulic pressure zone 	\$25,000 (RMOW)
8.	Install check valve from Wat 5 to Wat 6	<ul style="list-style-type: none"> Install valve near intersection of Erbsville Rd. and Wideman Rd. for emergency fire flow conditions^{3,4} 	\$50,000 (RMOW)
TOTAL (RMOW)			\$260,000

Note 1: Constraint number is identified as w as outlined in Tech Memo Task D and E of the WSDOMP, "Identification of Alternative Solutions"

Note 2: Total opinion of probable cost is included in the implementation schedule as 'other work' in Section 5.3.

Note 3: Check valve proposed to improve available fire flow in northern area of Wat 6. Should the proposed check valve location be modified, hydraulic modeling should be completed to confirm the available fire flow is adequate.

Note 4: Installation of proposed check valve to be coordinated with proposed Wat 5 watermain on Erbsville Rd.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

Table 5-6: Additional Linear Projects Waterloo

Proposed Work of Related Linear Projects ¹		Overview of Work	Opinion of Probable Cost ⁵	Potential Implementation Timing
9.	Install new watermain on Erbsville Rd. from south of Keats Way to Willow Wood Dr.	<ul style="list-style-type: none"> 1,610 m of 400 mm diameter watermain 	\$1,932,000 (RMOW)	<5 years
10.	Install new watermain on Erbsville Rd. from Willow Wood Dr. and to Conservation Dr. ^{2,3}	<ul style="list-style-type: none"> 2,050 m of 300 mm diameter watermain 	\$922,500 (RMOW) \$922,500 (City of Waterloo)	Dependent on development planning
11.	Install new watermain on Laurelwood Dr from Erbsville Rd. to Creekside Dr.	<ul style="list-style-type: none"> 240 m of 300 mm diameter watermain 	\$108,000 (RMOW) \$108,000 (City of Waterloo)	Dependent on development planning
12.	Install new watermain on Conservation Dr. from Erbsville Rd. to east of Rideau River St. ³	<ul style="list-style-type: none"> 1,910 m of 300 mm diameter watermain 	\$859,500 (RMOW) \$859,500 (City of Waterloo)	Dependent on development planning
13.	Install new watermain on Conservation Dr. from Lakeshore West PS to Westmount Rd. N	<ul style="list-style-type: none"> 160 m of 300 mm diameter watermain 	\$72,000 (RMOW) \$72,000 (City of Waterloo)	Dependent on development timing
14.	Install new watermain on Bearinger Rd. from Laurelwood Dr. to east of Pineridge Rd. (a small section of which is on Laurelwood Dr from Laurel Gate Dr to Bearinger Rd)	<ul style="list-style-type: none"> 1,630 m of 300 mm diameter watermain 	\$733,500 (RMOW) \$733,500 (City of Waterloo)	Dependent on development planning
15.	Install new watermain on Columbia Street between Erbsville Road and Cavendish Drive	<ul style="list-style-type: none"> 350 m of 300 mm diameter watermain 	\$175,000 (RMOW) \$175,000 (City of Waterloo)	Dependent on development planning
16.	Install a new watermain on Columbia St between Westmount Rd. and Lester St. ⁴	<ul style="list-style-type: none"> 2,000 m of 600 mm diameter watermain 	\$3,600,000 (RMOW)	Dependent on development planning
17.	Install a new watermain on Columbia St between Phillip St and Albert St. ⁴	<ul style="list-style-type: none"> 500 m of 300 mm diameter watermain 	\$225,000 (RMOW) \$225,000 (City of Waterloo)	Dependent on development timing
TOTAL (A.Mun.s)			\$3,095,500	
TOTAL (RMOW)			\$8,627,500	

Note 1: Region reference number for planned watermain projects is provided where available

Note 2: A 500 m section of the 300 mm watermain recommended between these cross streets is an existing watermain to be transferred from Wat 6 to Wat 5

Note 3: Recommended linear work assumes a connection between Wat 5 and Wat 4C aligned on Erbsville Rd./Conservation Dr. Alternatively, an alignment on Beaver Creek Rd. and Conservation Dr. The preferred alignment is dependent on how development progresses.

Note 4: Recommended linear work based on Waterloo Core Area Infrastructure Assessment: Final Report (Stantec, 2011)

Note 5: Section 5.3 provides a summary of opinion of probable costs for the Region in Waterloo related linear works. Cost sharing between the A.Mun.s and the Region are assumed to be 50/50

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

As noted in Table 5-6, recommended linear work has been included based on the *Waterloo Core Area Infrastructure Assessment: Final Report (Core Area Study)* (Stantec, 2011). These recommendations were reviewed as part of the WSDOMP (refer to *WSDOMP Review of Waterloo Core Area Recommended Regional Water Distribution Infrastructure* TM in Appendix G) and it was determined the linear upgrades may not be required based on the revised demand forecasting and proposed IUS upgrades. The need for Core Area linear upgrades are dependent on:

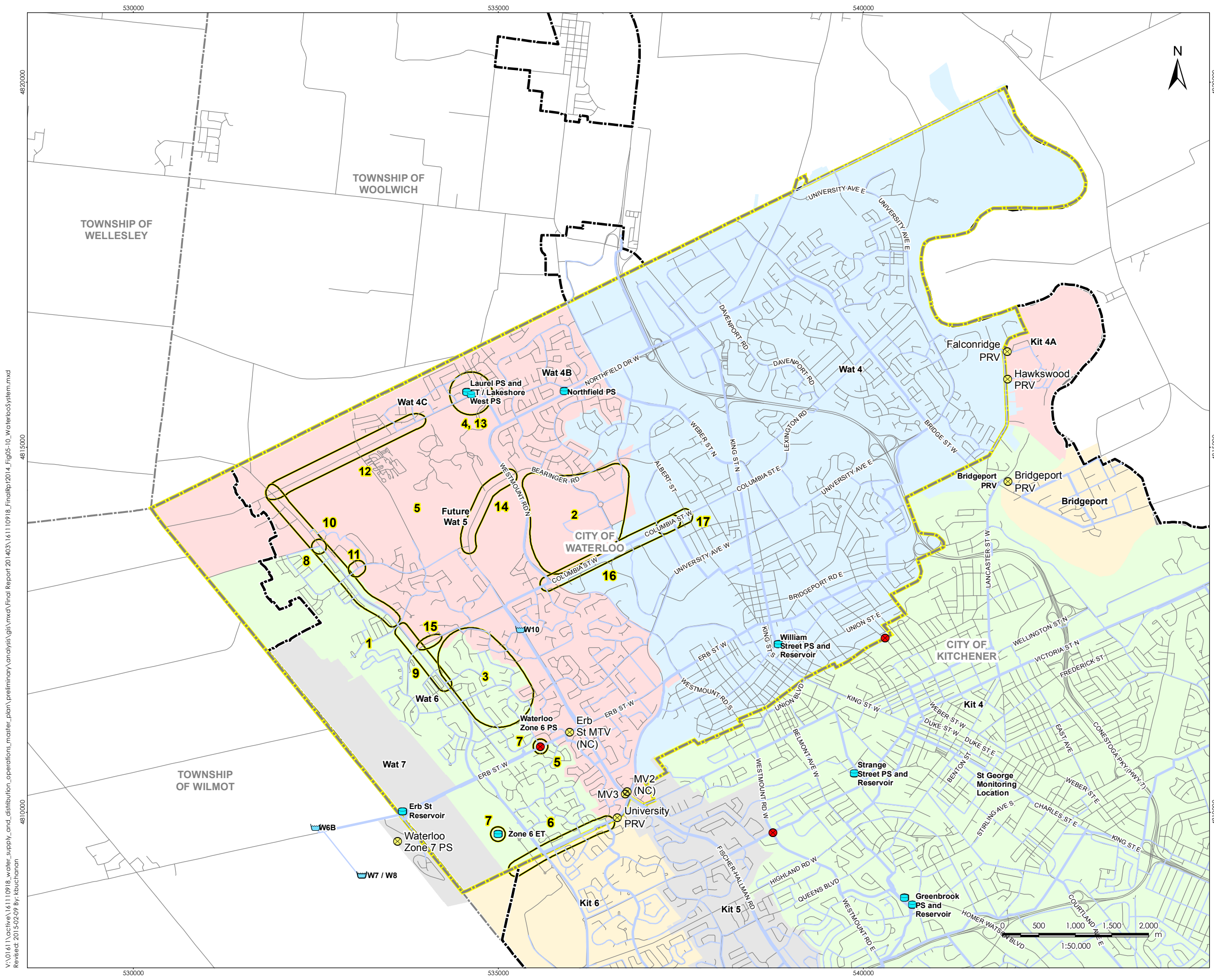
- Development staging and implementation.
- Actual demands versus forecasted demands.
- Actual timing and implementation of proposed WSDOMP upgrades.

As development proceeds, monitoring is recommended for system pressure and headlosses in the Core Area. If actual demands increase above the forecasted demands or planned infrastructure upgrades are not implemented as recommended in the WSDOMP, upgrades recommended as part of the Core Area study should be re-evaluated.

As part of the analysis to identify upgrades for additional work and linear projects, the available fire flow was reviewed at key locations in each pressure zone. Constraints were noted for available fire flow in WAT 7; however, they were related to high ground elevations within proposed development areas. The grading plan and distribution system within the proposed development areas are to be finalized and it was assumed that upgrades would be recommended if required as part of the design for services to this area.

- Legend**
- Existing Valve
 - Proposed Valve
 - Tank
 - Well
 - City of Waterloo
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - Area of Interest

- Notes**
1. Chlorine residuals in Wat 6 improved by addition of new ET in Kit 6/Wat 6
 2. Expand Wat 5 zone boundary east to include higher elevation areas in western Wat 4
 3. Expand Wat 5 zone boundary west to include lower elevation areas in eastern Wat 6
 4. Install Mixer for Laurel Standpipe
 5. Project to install PRV between Wat 6 and Wat 5 underway. If pressure fluctuations persist, install PITs in Wat 5 to monitor pressure.
 6. Consolidate Wat 6 and Kit 6, to be supplied by Kit 6.
 7. Decommission Waterloo Zone 6 PS; Commission Zone 6 ET
 8. Install check valve from Wat 5 to Wat 6 near intersection of Erbsville Rd. and Wideman Rd.
 9. New watermain on Erbsville Rd. from south of Keats Way to Willow Wood Dr.
 10. New watermain on Erbsville Rd. from Willow Wood Dr. to Conservation Dr.
 11. New watermain on Laurelwood Dr. from Erbsville Rd. to Creekside Dr.
 12. New watermain on Conservation Dr. from Erbsville Rd. to east of Rideau River St.
 13. New watermain on Conservation Dr. from Lakeshore West PS to Westmount Rd. N
 14. New watermain on Bearinger Rd. from Laurelwood Dr. to east of Pineridge Rd.
 - 9-14: Refer to Table 5-6 and Figure 5-9
 15. Install new watermain on Columbia St. between Erbsville Rd. and Cavendish Dr.
 16. Install new watermain on Columbia St. between Westmount Rd. and Lester St.
 17. Install new watermain on Columbia St. between Philip St. and Albert St.



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Figure No.
5-10

Title
**Waterloo Optimization - Other
Work and Linear Projects**

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 Revised: 2015-02-09 By: kbuchanan

5.3 WATERLOO IMPLEMENTATION SCHEDULE

The proposed implementation schedule and opinion of probable cost for the Waterloo Optimizations is presented in the Table 5-7. The total opinion of probable cost for Region projects in Waterloo pressure zones, including other works and linear work, is approximately 33.7 million over the planning period.

Table 5-7: Implementation Timeline and Opinion of Probable Cost for Proposed Waterloo Optimizations

Project	Opinion of Probable Cost ²	Planned Expenditure (Year)										
		2013	2014	2015	2016	2017	2018	2019	2020	2021	>2021	
Upgrade Strange St. PS to increase capacity and allow optional discharge to Waterloo and decommission William St PS	\$ 13,860,000											
Erb St. WSS Upgrades + Wat 6 to Wat 5 PRV	\$ 1,000,000											
Construct Waterloo North WTP	\$ 9,900,000											
Consolidate Wat 4B an Wat 4C with Wat 5	\$ 100,000											
Other Work to Address Constraints	\$ 260,000											
Linear Work (includes work related to consolidating Wat 4B and Wat 4C with Wat 5) ¹	\$ 8,628,000											

Note 1: Implementation is coordinated with Regional and A.Mun. transportation projects

Note 2: Opinion of probable costs includes Region costs only, not costs associated with A.Mun.s

Note 3: dotted line indicates accelerated or delayed implementation should circumstances change (i.e. change in demand trends)

6.0 Township of Woolwich Optimizations

6.1 SUMMARY OF PROPOSED SOLUTIONS

Communities within Woolwich that are supplied water from the IUS include: St. Jacobs, Elmira, and Breslau. There are no local sources within these towns; all of the water supplied is from the Tri-City distribution system. St. Jacobs and Elmira are supplied water via a transmission main from Waterloo and Breslau is supplied water through connections to Kitchener. More information on the water distribution system for Woolwich is provided in the Task A Tech Memo in Appendix A.

The proposed reconfiguration for Woolwich focuses on realigning the pressure zone boundary in Elmira to improve service pressures, reduce operations and maintenance, and reduce the energy spent in transferring water from Elmira to Elmira East. Additional minor modifications are proposed to improve system pressure and provide redundancy of supply.

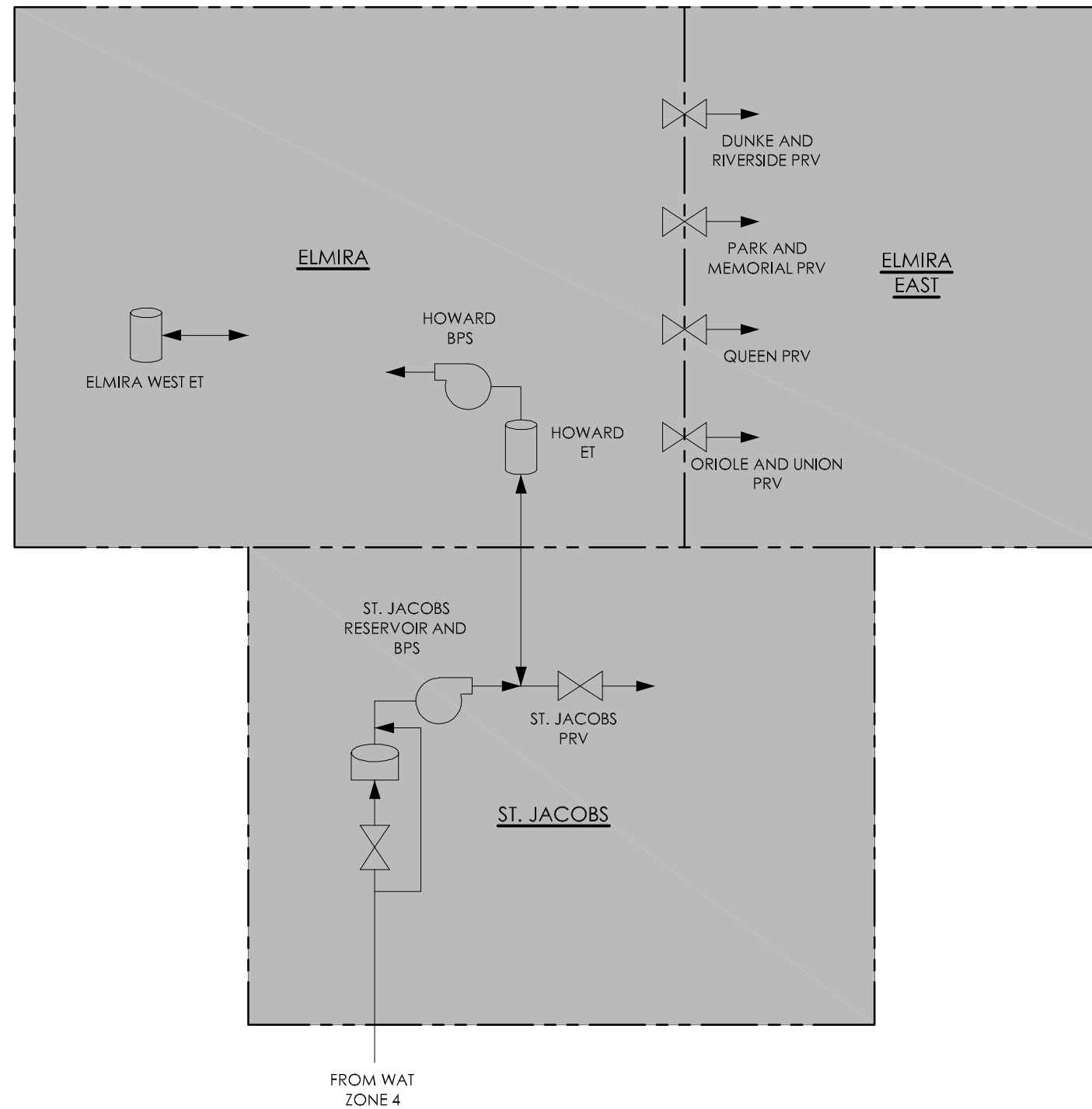
The existing process flow diagram for Woolwich is presented in Figure 6-1. The proposed changes are shown for each upgrade in the following sections.

Each preferred improvement and optimization strategy is described in terms of the following:

- Justification
- Overview of Work
- Layout and PFD for Facilities
- Studies Required
- GHG Impact
- Opinion of Probable Cost

The recommendations referred to as 'additional work' are grouped together in Section 6.2.4 and include recommendations for complementary infrastructure and linear adjustments and upgrades to occur along with the more significant WSDOMP proposed solutions described in greater detail in Sections 6.2.1 through 6.2.3. Estimated time of implementation (schedule) will be summarized for all solutions in Table 6-5 at the end of the Woolwich section.

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ZONE	TARGET HGL (mASL)
BRESLAU NORTH ¹	381.0
BRESLAU SOUTH ¹	365.0
MARKET ²	381.0
ST. JACOBS	380.0
ELMIRA	422.0
ELMIRA EAST	405.0

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Legend

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- WELL
- WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

1. REFER TO FIGURE 4-1 FOR BRESLAU NORTH AND BRESLAU SOUTH
2. REFER TO FIGURE 5-1 FOR MARKET

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REGION OF WATERLOO
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DISTRIBUTION WATER PLAN

Figure No.

6.1

Title

EXISTING WOOLWICH DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM

6.2 DETAILED REVIEW OF PROPOSED SOLUTIONS

6.2.1 Re-develop Elmira East Pressure Zone

The new Elmira East pressure zone will extend south to include the area east of Arthur Street South and south of Howard Drive. The HGL for Elmira East will be modified to 398.5 mASL, based on the top water level for Howard Tank.

6.2.1.1 Justification

The existing system in Elmira draws water from the Howard Tank and boosts pressure to a target HGL of 422 mASL feeding the Elmira West ET. Four PRVs reduce the pressure from Elmira to service the Elmira East pressure zone. Under these conditions, the target HGL of 422 mASL results in high service pressures. To alleviate these high pressures, the Elmira West ET is currently operated at a reduced top water level (420 mASL) based on 2009 SCADA data. This results in reduced operating flexibility for the tank and causes problems with freezing during the winter. Freezing shortens the life of the elevated tank and increases maintenance effort throughout the winter. Additional problems occur in Elmira East, as supply to the zone via four PRVs causes operating difficulties and requires additional maintenance effort.

- The Elmira East pressure zone will be extended south to include the area east of Arthur Street South and south of Howard Drive and will alleviate high pressures.
- The HGL for Elmira East will be modified to 398.5 mASL, based on the top water level for Howard Tank. Modifying the Elmira East HGL allows the Howard Tank and St. Jacobs Booster PS to service Elmira East, eliminating the need for PRVs.
 - A target HGL of 398.5 mASL indicates static pressures are within the target range (350 kPa to 550 kPa); however, fluctuations in the tank operating level and headlosses in the distribution system will cause service pressures to decrease below 350 kPa at some locations.
 - Water quality is expected to improve with less system latency.
- Transferring the area east of Arthur Street South and south of Howard Drive to the Elmira East pressure zone alleviates high pressure areas (greater than 700 kPa) when operating the Elmira West Tank at the top water level.
 - This will allow the tank to operate as intended, providing additional operating flexibility, additional operating storage volume, and mitigate freezing during the winter.

6.2.1.2 Overview of Work

- Develop a new pressure zone to replace Elmira East that operates at a target HGL of 398.5 mASL
 - Watermain upgrades as required in south-eastern Elmira to connect and expand the Elmira East pressure zone.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

- Decommission existing PRVs and isolate boundary connections
- Develop storage operating level guidelines.
- Install tank mixer (included in Section 6.2.4 Additional Work, Table 6-4 Item 2).

6.2.1.3 *Layout and PFD for Facilities*

Refer to Figure 6-2 for the proposed changes identified on the system PFD for the 2031 Optimizations and to Figure 6-3 for physical location and additional infrastructure required.

6.2.1.4 *Studies Required*

Activities to create the new Elmira East Pressure Zone are pre-approved changes (Schedule A Environmental Assessment).

6.2.1.5 *GHG Impact*

There is a net decrease in GHG emissions associated with this reconfiguration due to the replacement of the PRVs with direct feed from Howard Tank to service Elmira East. Presently, water that services Elmira East is pumped to Elmira West ET and then flows back to Elmira East via the PRVs. This configuration results in a loss of energy from the unnecessary pumping from Howard Tank to Elmira West and from the energy losses associated with the PRVs. Refer to Appendix F for additional information.

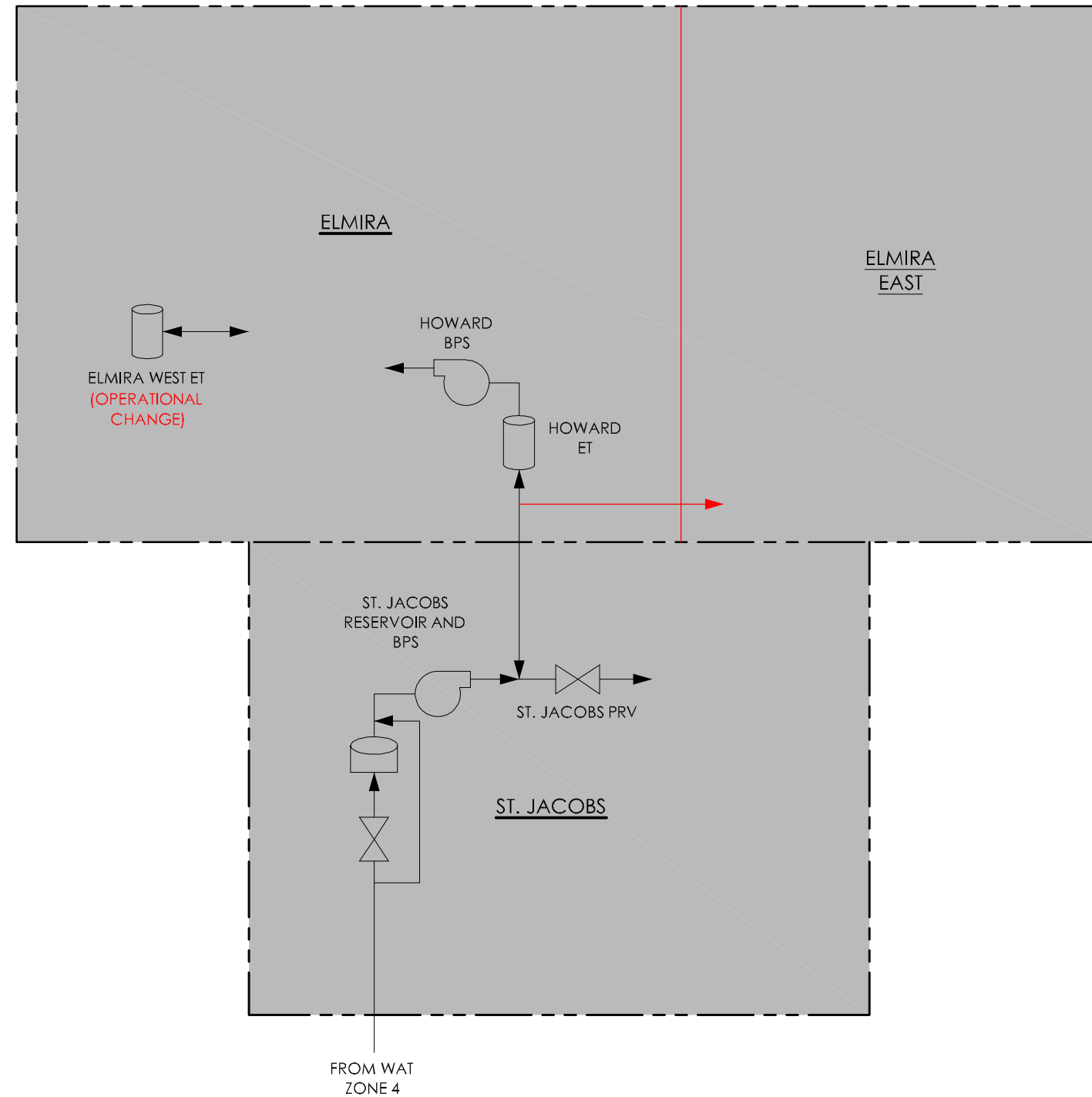
6.2.1.6 *Opinion of Probable Cost*

Table 6-1 outlines the opinion of probable capital cost to optimize the Elmira East pressure zone. O&M costs associated with this optimization are expected to decrease as a result of the savings on electricity related to pumping, and reduction of maintenance effort associated with the Elmira West ET operating level and the four PRVs. Refer to Appendix F for additional information.

Table 6-1: Opinion of Probable Cost for Optimizing the Elmira East Pressure Zone

Recommended Modification	Opinion of Probable Capital Cost
Optimize the Elmira East Pressure Zone	\$ 500,000
TOTAL	\$ 500,000

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ZONE	TARGET HGL (mASL)
BRESLAU NORTH ¹	365.0
BRESLAU SOUTH ¹	365.0
MARKET ²	381.0
ST. JACOBS	385.0
ELMIRA	422.0
ELMIRA EAST	398.5

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- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

1. REFER TO FIGURE 6-6 FOR BRESLAU NORTH AND BRESLAU SOUTH
2. REFER TO FIGURE 5-1 FOR MARKET
3. ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

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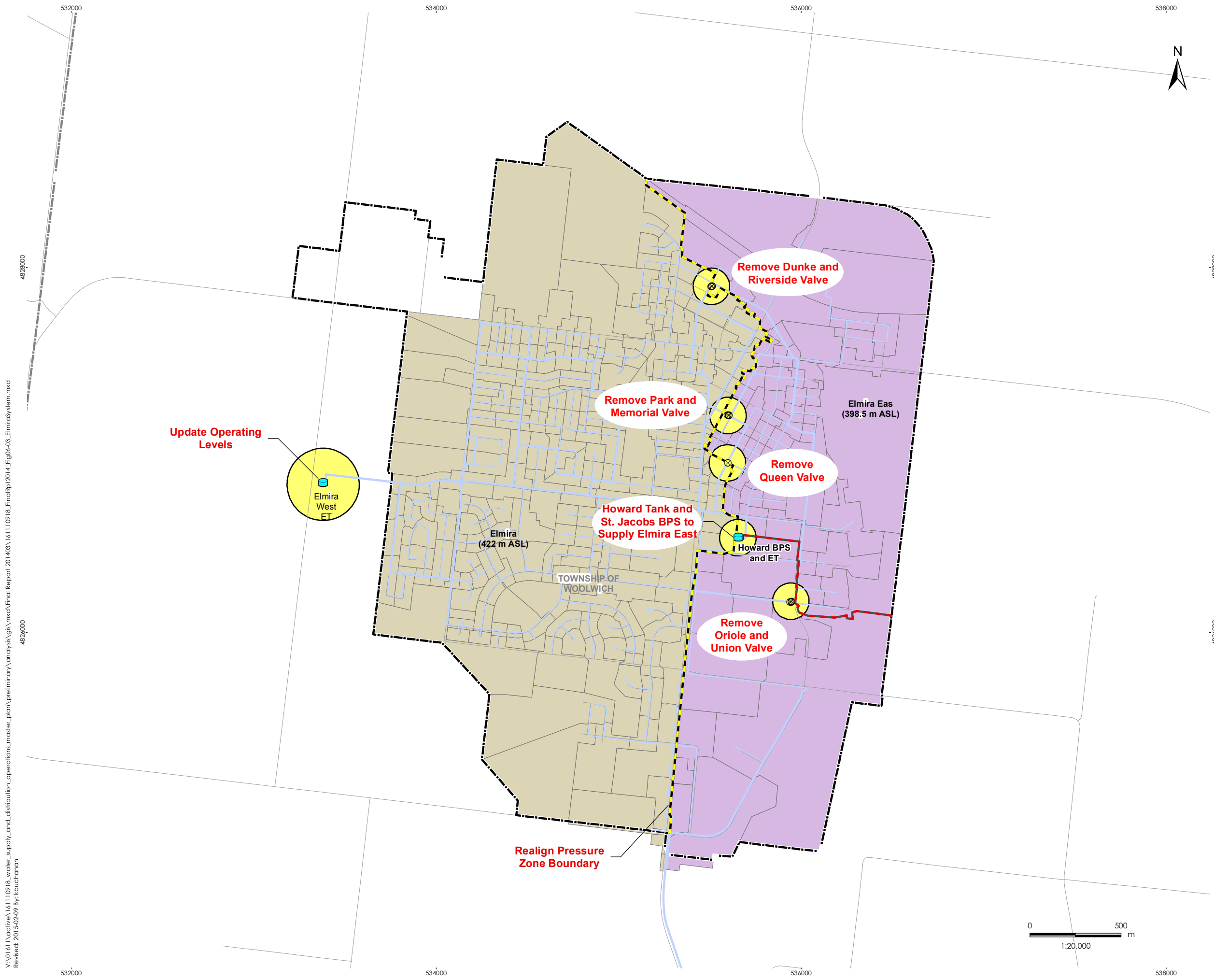
Figure No.

6.2

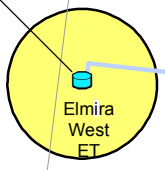
Title

FUTURE WOOLWICH DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
REDEVELOP ELMIRA EAST
PRESSURE ZONE

- Legend**
- Existing Valve
 - Tank
 - Municipal Boundary
 - Urban Boundary
 - Road
 - Watermain
 - Feedermain
 - New Pressure Zone Boundary
 - Old Pressure Zone Boundary



Update Operating Levels



Remove Park and Memorial Valve

Remove Dunke and Riverside Valve

Remove Queen Valve

Howard Tank and St. Jacobs BPS to Supply Elmira East

Remove Oriole and Union Valve

Realign Pressure Zone Boundary

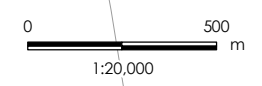
- Notes**
1. Coordinate System: NAD 1983 UTM Zone 17N
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Figure No.
6-3

Title
Woolwich Optimization - Redevelop Elmira East Pressure Zone



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Revised: 20150209 By: kbuchanan

6.2.2 Minor Modifications to St. Jacobs

Adjust pressure valve setting in St. Jacobs to increase service pressures and fire flow.

6.2.2.1 Justification

- In St. Jacobs, constraints were noted for low service pressures and fire flow restrictions. Low pressure concerns could be alleviated by increasing the PRV setting.
 - Increasing the target HGL to 385 mASL (from 380 mASL) will increase pressure in the north and south areas of town, where static pressures are currently less than 50 psi.
 - Based on a target HGL of 385 mASL, static pressure near the intersection of Hachborn Street East and Water Street exceed 550 kPa (up to 572 kPa); however, they are still close to the target range (350 kPa to 550 kPa), below the Region's maximum pressure guideline of 700 kPa, and service pressures would be slightly reduced based on system head losses (Design Guidelines and Supplemental Specifications for Municipal Servicing, 2014).

6.2.2.2 Overview of Work

- Service St. Jacobs PRV as necessary and adjust valve setting and set HGL to 385 HGL
 - Field investigation of valve to ensure proper operation and to adjust the valve setting.

6.2.2.3 Layout and PFD for Facilities

Refer to Figure 6-4 for the proposed changes identified on the system PFD for the 2031 optimizations.

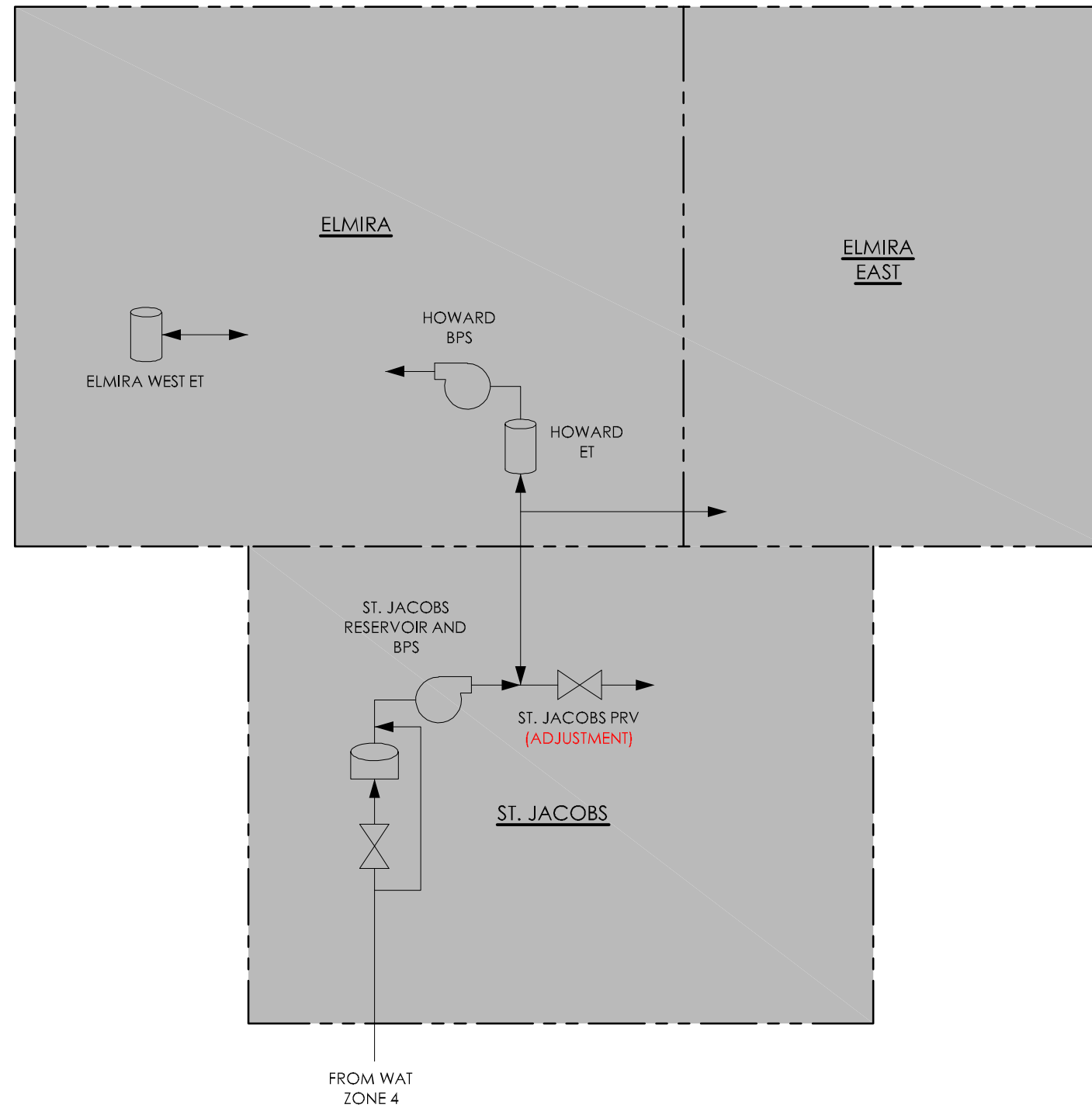
6.2.2.4 Studies Required

- Activities pre-approved changes (Schedule A Environmental Assessment).

6.2.2.5 GHG Impact

There is no significant impact on GHG emissions for this optimization. Refer to Appendix F for additional information.

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ZONE	TARGET HGL (mASL)
BRESLAU NORTH ¹	365.0
BRESLAU SOUTH ¹	365.0
MARKET ²	381.0
ST. JACOBS	385.0
ELMIRA	422.0
ELMIRA EAST	398.5

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- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

1. REFER TO FIGURE 6-6 FOR BRESLAU NORTH AND BRESLAU SOUTH
2. REFER TO FIGURE 5-1 FOR MARKET
3. ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

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DISTRIBUTION WATER PLAN

Figure No.

6.4

Title

FUTURE WOOLWICH DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
ST. JACOBS PRV ADJUSTMENT

6.2.2.6 Opinion of Probable Cost

Table 6-2 outlines the opinion of probable capital cost associated with the prescribed modifications to St. Jacob’s. There are no significant changes in O&M costs associated with this optimization. Refer to Appendix F for additional details.

Table 6-2: Opinion of Probable Cost for the Modifications to St. Jacobs

Recommended Modification	Opinion of Probable Capital Cost
Service St. Jacobs PRV	N/A (Operational Changes)

6.2.3 Breslau North – South Connection

A 300 mm watermain complete with a CV is proposed in Breslau between Breslau North and Breslau South pressure zones, with no change in the HGL of either zone.

6.2.3.1 Justification

- The proposed connection can supply water from Breslau South (at a reduced service pressure) to Breslau North should the Victoria Street watermain be offline.
- Based on analysis completed in the WSDOMP *Review of Breslau North and Breslau South Pressure Zones* TM (refer to Appendix G for details), it was recommended that Breslau North continue to be serviced at a target HGL of 381 mASL to maintain service pressures for future development areas. Although combining Breslau North and Breslau South presented an opportunity to provide additional looping in Breslau, upgrades are currently underway to provide a connection between these two pressure zones, complete with a check valve, to provide redundancy in supply for emergency conditions while maintaining service pressures in Breslau North. Additionally, transferring Breslau North to an HGL of 356 mASL would result in low service pressures, and it was assumed that the high service pressures noted in Breslau North when operating at a target HGL of 381 mASL were acceptable given that these are existing conditions.

6.2.3.2 Overview of Work

- Install a 300 mm watermain, complete with check valve, between Breslau North and Breslau South.

6.2.3.3 Layout and PFD for Facilities

Refer to Figure 6-5 for the proposed changes identified on the system PFD for the 2031 optimizations and to Figure 6-6 for physical location and additional infrastructure required.

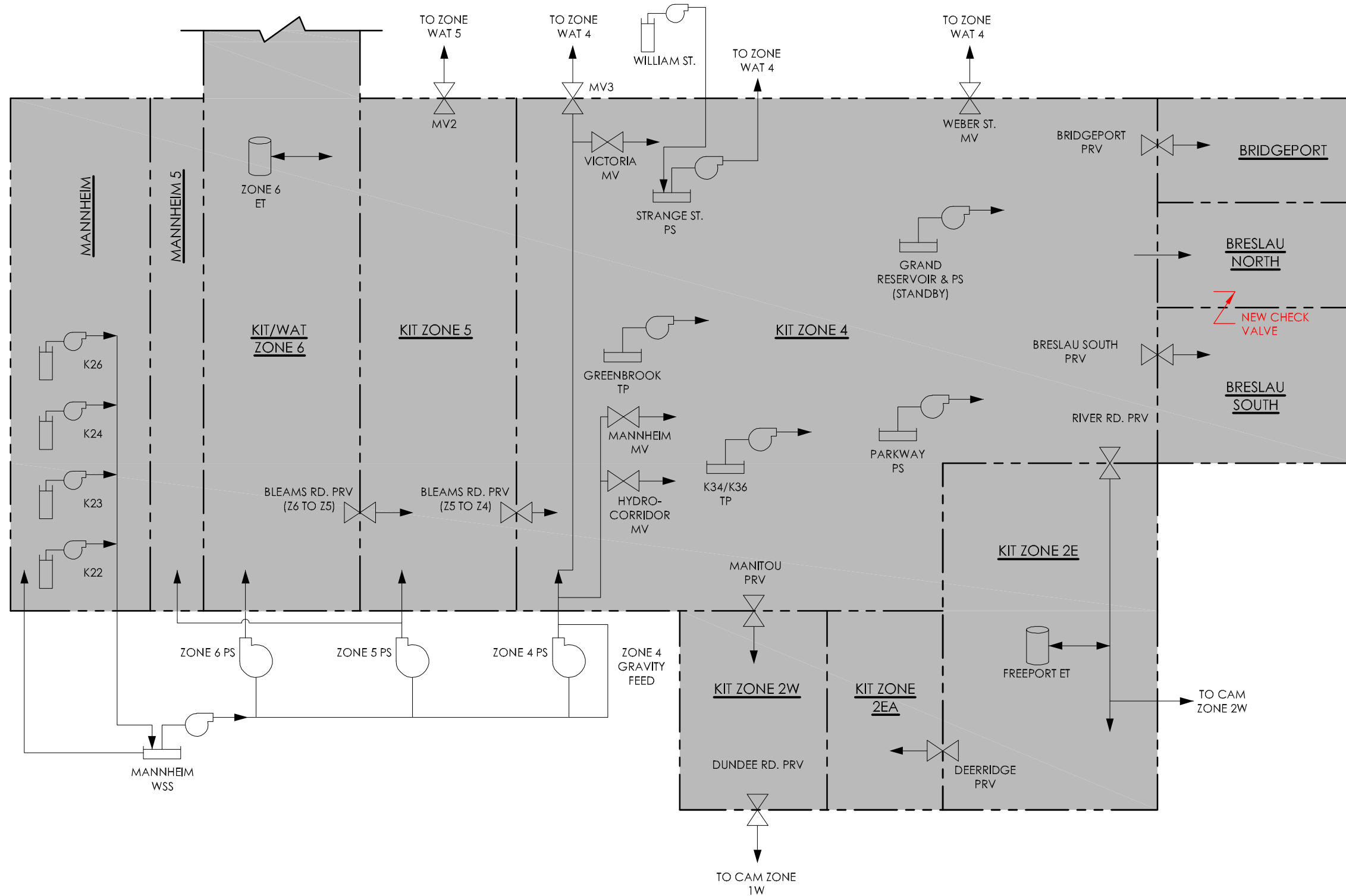
6.2.3.4 *Studies Required*

- Activities for install of the check valve between Breslau North and South are pre-approved changes (Schedule A Environmental Assessment).

6.2.3.5 *GHG Impact*

There is no significant impact on GHG emissions for this optimization. Refer to Appendix F for additional information.

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ZONE	TARGET HGL (mASL)
KIT 4	384
KIT 4A	363.2
KIT 5	407
KIT 6	428
KIT 2W	361
KIT 2EA	347
KIT 2E	365
BRIDGEPORT	364.5
MANNHEIM 5	407
MANNHEIM	384
BRESLAU NORTH	381
BRESLAU SOUTH	365
MARKET ²	381
ST. JACOBS ¹	385
ELMIRA ¹	422
ELMIRA EAST ¹	398.5

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- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

- REFER TO FIGURE 6-2 FOR ELMIRA, ELMIRA EAST AND ST. JACOBS.
- REFER TO FIGURE 5-1 FOR MARKET
- ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

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DISTRIBUTION WATER PLAN

Figure No.

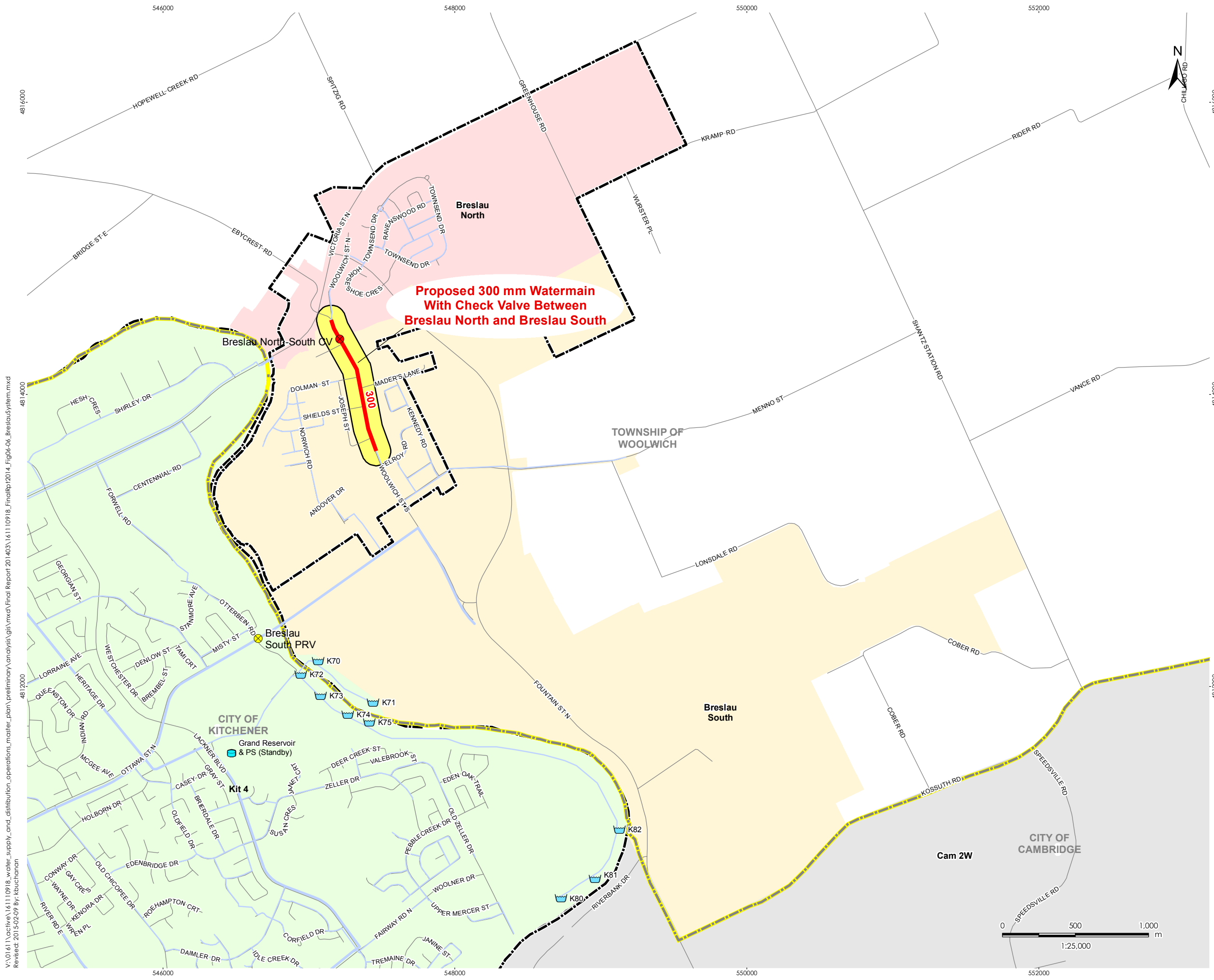
6.5

Title

FUTURE WOOLWICH DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
BRESLAU NORTH-SOUTH CONNECTION

- Legend**
- Existing Valve
 - Proposed Valve
 - Tank
 - Well
 - Infrastructure Related to Recommendation
 - Township Of Woolwich
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain

**Proposed 300 mm Watermain
With Check Valve Between
Breslau North and Breslau South**



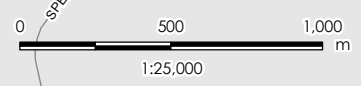
- Notes**
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Figure No.
6-6

Title
**Woolwich Optimization
- Breslau North-South Connection**



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Revised: 2015-02-09 By: kbuchanan

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

6.2.3.6 Opinion of Probable Cost

Table 6-3 outlines the opinion of probable capital cost associated with the prescribed modifications to Breslau. There are no significant changes in O&M costs associated with this optimization. Refer to Appendix F for additional details.

Table 6-3: Opinion of Probable Cost for the Modifications to Breslau

Recommended Modification	Opinion of Probable Capital Cost
New 300 mm watermain between Breslau North and Breslau South (complete with check valve)	\$ 500,000
TOTAL	\$ 500,000

6.2.4 Additional Work

Table 6-4 summarizes additional infrastructure projects proposed alongside the City-wide reconfigurations outlined in the previous sections. These projects will help to address the constraints identified in the Master Planning process to be addressed in the 10 year planning window, and are listed as 'Other Work' in the Implementation Schedule in Section 6.3. Figure 6-7 illustrates the location of the proposed additional work and linear projects in Woolwich. The entity responsible for cost is shown below in brackets for each opinion of probable.

Table 6-4: Other Work and Infrastructure Projects for the Township of Woolwich

Proposed Improvement ¹	Overview of Implementation Requirements	Opinion of Probable Cost ²
1. Install flow meter at Elmira West Tank to allow flow pacing (WOC2).	<ul style="list-style-type: none"> • Selection and sizing of flow meter • Installation of equipment 	\$50,000 (RMOW)
2. Install mixer for Elmira West Tank to improve water quality.	<ul style="list-style-type: none"> • Review tank design and select preferred mixing system • Design and install mixing system 	\$150,000 (RMOW)
3. Install a new PRV at the Howard PS using one of the spare pump tie-ins (WOC3).	<ul style="list-style-type: none"> • Selection and sizing of valve • Selection and sizing of internal piping modifications (approximately 10 m of piping required) • Installation of equipment 	\$75,000 (RMOW)
4. Develop an SOP for repair for single connection to Breslau North (WOC4).3	<ul style="list-style-type: none"> • Review of existing infrastructure, required spare parts, and available contractors • Complete SOP and circulate 	\$15,000 (RMOW)
5. Develop an SOP for repair for single connection to Breslau South (WOC5).3	<ul style="list-style-type: none"> • Review of existing infrastructure, required spare parts, and available contractors • Complete SOP and circulate 	\$15,000 (RMOW)

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

Proposed Improvement ¹		Overview of Implementation Requirements	Opinion of Probable Cost ²
6.	Modify piping to have two smaller inlet pipes/valves to address operational difficulties with St. Jacobs Reservoir (WOC6).	<ul style="list-style-type: none"> Detailed design of process piping modifications and relocation of existing flow meters Design and selection of preferred inlet valves Installation of equipment 	\$150,000 (RMOW)
7.	Develop an SOP for repair for single connection between north and south St. Jacobs (WOC8).	<ul style="list-style-type: none"> Review of existing infrastructure, required spare parts, and available contractors Complete SOP and circulate 	\$15,000 (RMOW)
8.	Develop an SOP for repair for single connection from Waterloo to St. Jacobs (WOC9).	<ul style="list-style-type: none"> Review of existing infrastructure, required spare parts, and available contractors Complete SOP and circulate 	\$15,000 (RMOW)
9.	Develop an SOP for repair for single connection from St. Jacobs to Elmira (WOC10).	<ul style="list-style-type: none"> Review of existing infrastructure, required spare parts, and available contractors Complete SOP and circulate 	\$15,000 (RMOW)
10.	Install PITs to gather more information on low service pressures in Breslau North (WOC12).	<ul style="list-style-type: none"> Install PITs Monitor field data collected 	\$50,000 (RMOW)
11.	Decommission Well E10 (WOC14).	<ul style="list-style-type: none"> Decommission well or maintain as pump and treat 	\$25,000 (RMOW)
12.	Review operation of the Breslau North autoflusher to address pressure fluctuations (WO15).	<ul style="list-style-type: none"> Install PITs Monitor field data collected and compare with autoflusher operating data Adjust operation of autoflusher if necessary 	\$25,000 (RMOW)
13.	Update operating strategy for Howard ET to modify the low operating level to 382.7 mASL	<ul style="list-style-type: none"> Update SCADA alarm setpoints to adjust low operating level Review operating levels annually to optimize based on up-to-date service areas 	N/A (Operational Change)
14.	Update operating strategy for Elmira West ET to modify the operating levels to range from 412.8 mASL to 419.5 mASL	<ul style="list-style-type: none"> Update SCADA alarm setpoints to adjust low and high operating levels Review operating levels annually to optimize based on up-to-date service areas 	N/A (Operational Change)
TOTAL (RMOW)			\$600,000

Note 1: Constraint number is identified as was outlined in Tech Memo Task D and E of the WSDOMP, *Identification of Alternative Solutions*

Note 2: Total opinion of probable cost is included in the implementation schedule as 'other work' in Section 6.3.

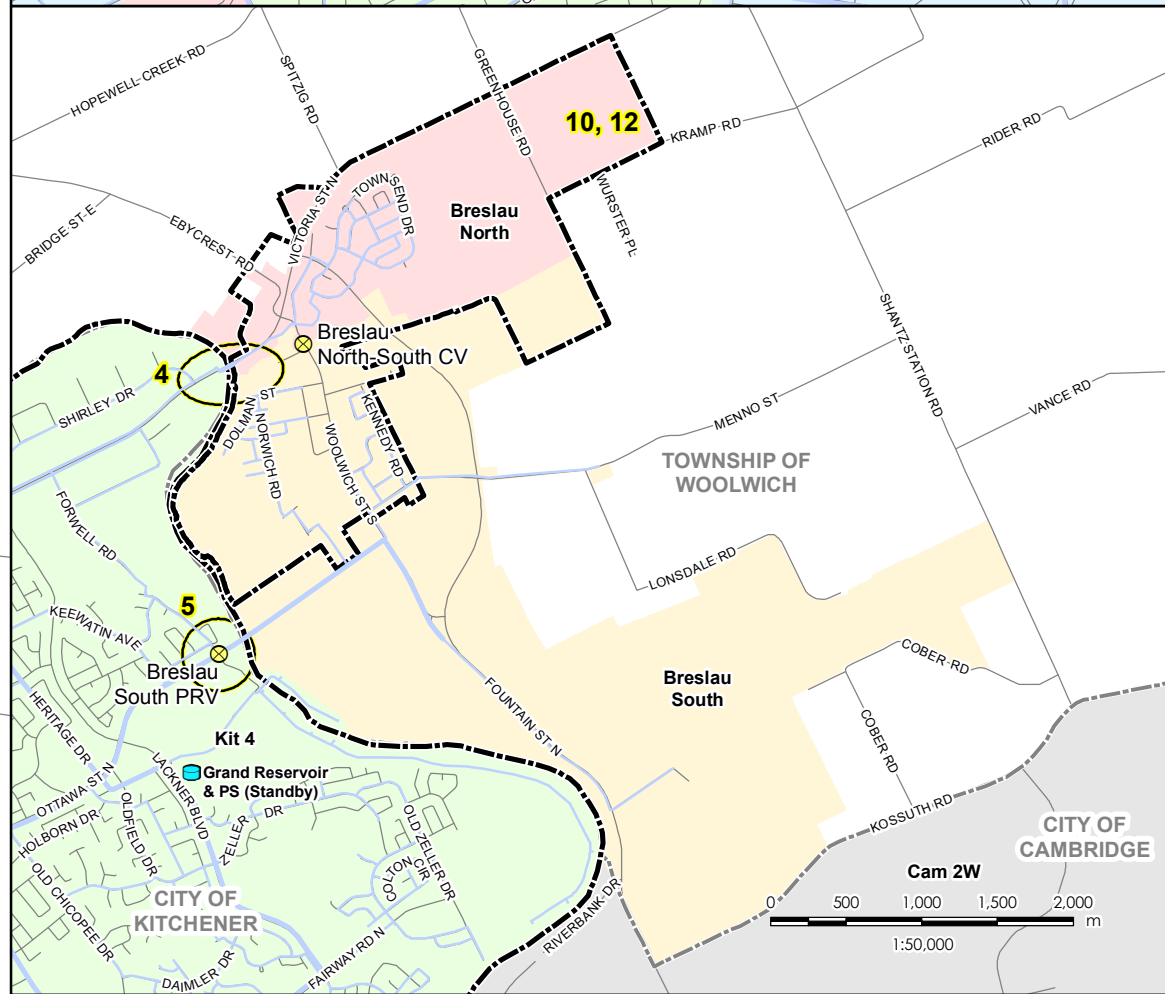
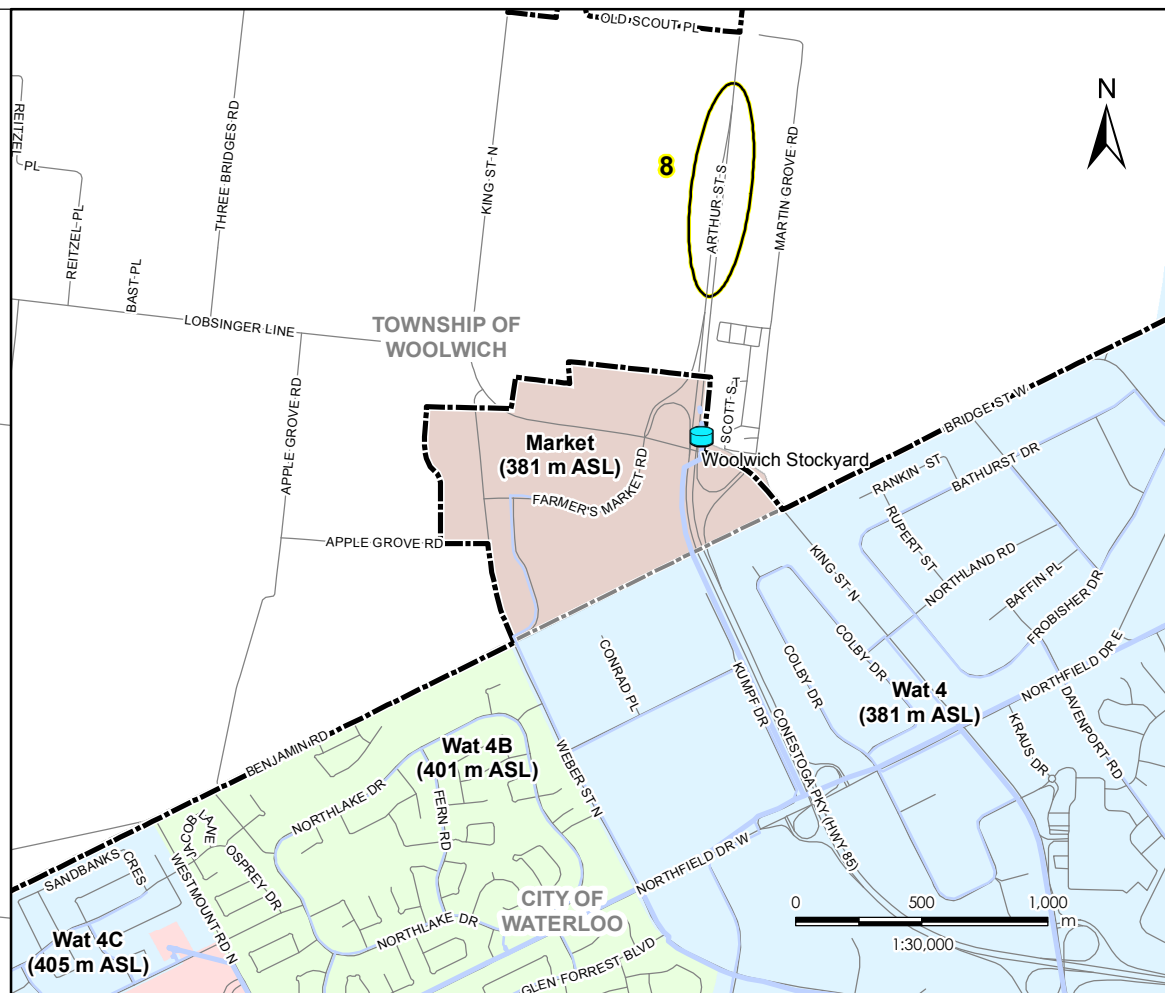
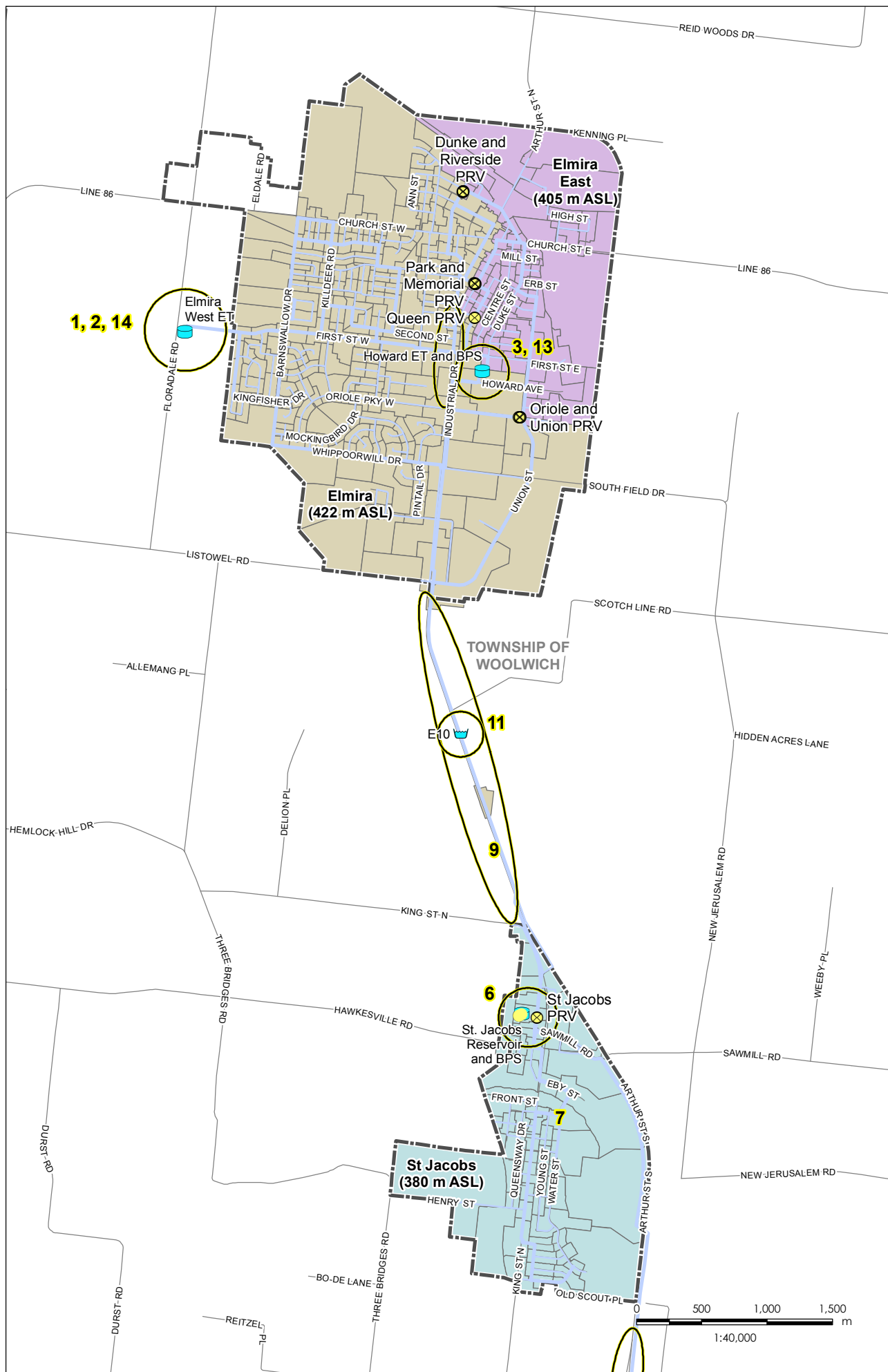
Note 3: SOPs recommended as interim solution. Consolidating Breslau South pressure zones with the proposed East Side Lands pressure zone will provide redundancy of supply in future.

There are no proposed upgrades for linear infrastructure in Elmira and St Jacobs. Velocities remain below 1.5 m/s for all watermains in the distribution system. It can be noted that the Tri-City MP recommended twinning a 400 mm watermain from Arthur Street to Howard Avenue. The flow rate in this watermain is governed by the discharge of the St. Jacobs BPS. Under existing conditions, this watermain is a dedicated feed from St. Jacobs BPS to Howard ET and the velocity exceeds 1.5 m/s based on the hydraulic model. Under the proposed reconfiguration for the new Elmira and Elmira East boundary alignment, connections are proposed with local distribution mains south of Howard ET to distribute water to the southern area of the newly

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

delineated Elmira East pressure zone. This reduces the flow that must be transferred via the 400 mm watermain, therefore, reducing the velocity in the hydraulic model below 1.5 m/s. The need for this upgrade, for either twinning the 400 mm watermain or upgrading to a 600 mm watermain at the end of its service life, should be reviewed in the next MP update.

As noted previously, the analysis to identify upgrades for additional work and linear projects included reviewing the available fire flow at key locations in each pressure zone. The locations in the Township were selected based on discussions with the Township Operations staff and recommended fire flows were estimated based on the *Water Supply for Public Fire Protection* (Fire Underwriters Survey, 1999). Limited information was available regarding the construction of buildings at key locations; therefore, conservative estimates were made for the recommended fire flow. Details regarding the key fire flow locations and associated fire flows that were used for the purpose of this analysis are provided in Appendix H. Constraints were noted through the hydraulic analysis for the available fire flow in the Breslau North, Market, St. Jacobs, and Elmira pressure zones. An additional investigation is recommended to confirm these constraints prior to completing upgrades. As part of this investigation, the construction of buildings at key locations should be reviewed to confirm recommended fire flows and hydrant testing is recommended to confirm the available fire flow in the distribution system. It can be noted that as part of the Tri-City MP (AECOM, 2009), a 500 mm watermain was recommended to address fire flow constraints in the Market area. The need for this upgrade should be confirmed in the additional investigation based on up-to-date recommended fire flows. The key location previously used to review the Market pressure zone was the St. Jacobs Market, which is currently being reconstructed and will have revised recommendations for fire flow protection.



- Legend**
- Valve
 - Tank
 - Well
 - Urban Boundary
 - Municipal Boundary
 - Road
 - Watermain
 - Feedermain
 - Area of Interest

- Notes**
1. Install flow meter at Elmira West Tank
 2. Install a mixer to Elmira West Tank
 3. Install new PRV at the Howard PS
 4. Develop SOP for repair for the single connection to Breslau North
 5. Develop SOP for repair for the single connection to Breslau South
 6. Modify piping at St. Jacobs Reservoir
 7. Develop SOP for repair for single connection between north and south St. Jacobs
 8. Develop SOP for repair for single connection from Waterloo and St. Jacobs
 9. Develop SOP for repair for single connection from St. Jacobs to Elmira
 10. Install PITs in Breslau North to gather information
 11. Decommission Well E10
 12. Optimize operation of Breslau North auto-flusher
 13. Update operating strategy for Howard ET to modify the low operating level to 382.7 mASL.
 14. Update operating strategy for Elmira West ET to modify the operating levels to range from 412.8 mASL to 419.5 mASL.

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Figure No.
6-7

Title
**Woolwich Optimization
- Other Work and Linear Projects**

6.3 WOOLWICH IMPLEMENTATION SCHEDULE

The proposed implementation schedule and opinion of probable cost for the Woolwich Optimizations is presented in the Table 5-7. The total opinion of probable cost for Region projects in Woolwich IUS pressure zones, including other works and linear work, is approximately 1.6 million over the planning period.

Table 6-5: Implementation Timeline and Opinion of Probable Cost for Proposed Woolwich Optimizations

Project	Opinion of Probable Cost ¹	Planned Expenditure (Year)										
		2013	2014	2015	2016	2017	2018	2019	2020	2021	>2021	
Develop a new pressure zone to replace Elmira East that operates at a target HGL of 398.5 mASL	\$ 500,000	[Bar spanning 2013-2017]										
Service St. Jacobs PRV as necessary and adjust valve setting	N/A (Operational Changes)	[Bar spanning 2013-2015]										
Install a check valve between Breslau North and Breslau South	\$ 500,000	[Bar spanning 2013-2015]										
Other Work to Address Constraints	\$ 600,000	[Bar spanning 2013-2021]										

Note 1: Opinion of probable costs includes Region costs only, not costs associated with A.Mun.s

7.0 IUS-Wide Proposed Solutions

7.1 ADDITIONAL OPTIMIZATION RECOMMENDATIONS

The majority of the physical opportunities have been presented in Sections 3.0 to 6.0. However, other optimization opportunities exist that are relevant across the IUS. Summarized in this section are a number of system-wide recommended optimization opportunities. These standardization practices and system-wide physical improvements should be discussed in greater detail and championed at the Best Management Practices (BMP) meetings with the Area Municipalities.

7.1.1 Standardization of Secondary Disinfection System

Secondary disinfection strategies are to be optimized to reduce chlorine residuals when possible. High chlorine residuals contribute to water quality concerns such as the precipitation of iron and manganese in the distribution network and decrease the lifecycle of the distribution infrastructure. This is of particular concern in the City of Cambridge. A phased approach for reducing chlorine residuals is recommended as treatment upgrades are completed to ensure regulatory compliance is maintained. For example, recent upgrades completed at Middleton TP include UV disinfection, which will allow a reduction in chlorine residuals at this facility. Middleton TP is a significant supply source for Cambridge and it is anticipated that a reduction of chlorine residuals at this facility will have a large impact throughout the city.

Opportunities to standardize the secondary disinfection strategy to chloramines throughout the distribution system should be reviewed and evaluated as the IUS evolves. If feasible in the future, the standardization of secondary disinfection would increase operational flexibility and may provide further opportunities to reduce chlorine residuals. Additionally, standardizing the disinfection strategy would eliminate areas where mixing of chlorinated and chloraminated disinfectants. Under the current system design, mixing occurs when water is transferred between chloraminated and chlorinated pressure zones during high demand conditions and results in taste and odor complaints.

7.1.2 Standardize Pump and Pumping Station Design Standards

Standardization of pump and pumping station design across the IUS is recommended to reduce energy losses and promote automation. Many pump stations do not have variable frequency drive (VFD) pumps or lack automation in addition to being oversized for existing production rates. A standardized design across the system for all new projects and retrofits is recommended such that new pumps are appropriately sized and with a VFD to allow operation and a range of flows.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

7.1.3 Source Water Operating Strategy

The development of a source water operating strategy will help optimize sources utilized to minimize water quality impacts and optimize the operating strategy of each source. Currently, operating strategies are developed bi-annually and communicated informally to staff members. This procedure is to be formalized to ensure all staff have up-to-date working knowledge. Recommendations for source water operating strategies will also be reviewed as part of a separate study.

7.1.4 Storage Reservoir Operating Guideline

The operating methodologies for storage reservoirs in the IUS were reviewed and identified as part of the WSDOMP analysis. The recommended storage operating levels, considering normal operating data, fire flow data, and usable volume, are presented in Table 7-1.

Table 7-1: Existing Conditions Storage Operating Guideline

Tank	Existing Lo Level Alarm (mASL)	Existing High Alarm (mASL)	Recommended Low Operating Level (mASL)	Recommended High Operating Level (mASL)
St. Andrews	327.5	334.8	High water levels recommended to maintain service pressures	
Rahmans	326.8	328.9	High water levels recommended to maintain service pressures	
Pinebush	357.4	359.3	355.25	359.3 ¹
Inverness	362.0	365.9	High water levels recommended to maintain service pressures	
Freeport	361.0	364.6	353.2	359.5 ²
Laurel	373.0	379.3	High water levels recommended to maintain service pressures	
Howard	395.2	398.7	382.65	398.7
Elmira West	416.0	421.6	412.8	419.5 ³

Note 1: Variation in topography points to recommending the high operating level unchanged.

Note 2: May need to revise zone HGL or increase the high operating level target. Recommended to be re-evaluated in future studies.

Note 3: Temporary until revised boundary alignment is implemented.

The recommended levels are based on information from Tech Memo 1 (Appendix A) and recommended levels in Table 7-1 are yet to be confirmed based on any potential physical limitations.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

7.2 PHYSICAL IUS-WIDE ALTERNATIVES IMPLEMENTATION SCHEDULE

The implementation of the IUS-wide physical alternatives described in Section 7.1 above is proposed over 10 years for the development of standards. The opinion of probable cost for the above standards development and retrofit of pilot sites has been set at \$1.5 million.

7.3 OPERATIONAL IMPROVEMENT RECOMMENDATIONS

The complexity of the IUS poses many challenges as the Region is responsible for water supply and the four Area Municipalities are responsible for distribution within their boundaries. While staff at both levels perform well in their tasks, opportunities for improved coordination and communication have been identified during workshops with operations staff from both the Region and the Area Municipalities.

7.3.1 Standardization for System Documentation

Standardization of documentation across the Region and Area Municipalities will greatly improve access to and understanding of record drawings. Creation of a common electronic format for drawings and a single virtual repository for these records will ensure the most accurate and up to date information is available to operations personnel. Recommendations to achieve this include a standardized digital submission for all drawings received from consultants. The Region is currently working with the Area Municipalities to create an all pipe model, which will contain infrastructure locations and attributes. Once completed, this model will provide a common an up-to-date resource for both Region and Area Municipality water distribution assets.

7.3.2 Formalize Maintenance Standards

Formalization of maintenance standards and equipment parts is to ensure preventative maintenance practices are in place and completed across the IUS. Standardization of equipment will simplify maintenance and repair practices and will allow the formulation of preventative maintenance plans to increase the life cycle of system components. Particular consideration should be given to standards for isolating infrastructure, swabbing and flushing, equipment use during normal operating conditions, and ability to rotate equipment. These considerations become increasingly important given the declining demand conditions over recent years to ensure equipment is not oversized and has adequate turn-down.

7.3.3 Increase Coordination among Parties

Coordination among the Region and Area Municipalities to define roles, responsibilities and reporting structure is critical for completed preventative maintenance as described above. Additionally, standard operating procedures for system emergency repairs will ensure work is completed efficiently and to the same standard across the system and will reduce redundancy. A joint coordination role within Engineering and Planning should be considered to facilitate this initiative.

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

7.3.4 Enhance Communication

The introduction of a standardized e-system for work orders and communication records across the IUS system will help decrease misunderstandings resulting from verbal communications. Additionally, e-tracking of work completed in IUS system can provide important statistical information that can be used for future infrastructure planning.

Further to the creation of an online database, regularly scheduled meetings would be beneficial to improve work and communication between staff within the Region and A.Mun. In addition to enhancing overall staff understanding of the IUS, these sessions could potentially be used as training credits to provide a cost effective alternative to external training sessions.

Each organization is in various stages of implementing an electronic program to provide access to system information, generate work orders, and document infrastructure status (similar to the Region of Niagara's LiveBoard). To allow ease of information sharing and minimize overlapping efforts between organizations, it would be beneficial to have a common electronic system for each organization to allow collaboration when developing and implementing systems. Given the progress of the City of Kitchener's electronic system (CityWorks) and the fact that Kitchener represents the largest geographical area of the IUS, it may be beneficial to coordinate with them to implement their system for the entire IUS at both the Regional and A.Mun. level. An internal evaluation is recommended to confirm an electronic system of this nature would be beneficial to both the Region and the A.Mun.

7.3.5 Increase Regulatory Flexibility

It is recommended that consideration be given to amending applicable DWWPs to permit alternative equipment and operating methods (which is currently underway). This is due to the fact that some DWWPs are overly restrictive with respect to specification and operating practice. This limits operational flexibility and amendments to the permit could improve efficiency.

7.4 ORGANIZATIONAL IUS-WIDE ALTERNATIVES IMPLEMENTATION SCHEDULE

The implementation of the organizational opportunities described in Section 7.2 is proposed over the next 5 to 10 years. The proposed organizational opportunities will improve operating efficiencies in the future by improving: staff system knowledge, available tools and resources, and the prioritization and allocation of staff resources. In the interim, additional resources will be required to implement these recommendations. It is approximated that 3 full-time equivalent positions will be required over the next 10 years to implement the organizational recommendations. These additional staff resources could potentially be accommodated through new hires, external resources, or internal resources. In general, the implementation of the recommendations will require coordination between supervisors, managers, and front-line staff at both the Regional and Area Municipality levels.

The opinion of probable cost for the above operational work is \$1.5 million for the tools and standard operating procedures only. The costs for staff are assumed to be carried in the

WATER SUPPLY AND DISTRIBUTION OPERATIONS MASTER PLAN FINAL REPORT

Region's operating budgets. This opinion of probable capital cost is combined with the opinion of probable cost from the previous section for a total of \$3.0 million. The opinion of probable cost is presented in Table 8-1 and timing for implementation in Table 8-2, both in Section 8.0.

8.0 Summary and Recommendations

Figures 8–1 to 8–4 provide an overview for each of the proposed optimizations for Tri-Cities and the Township of Woolwich by 2031. Refer to Sections 3.0 through 6.0 for more details on each A.Mun.

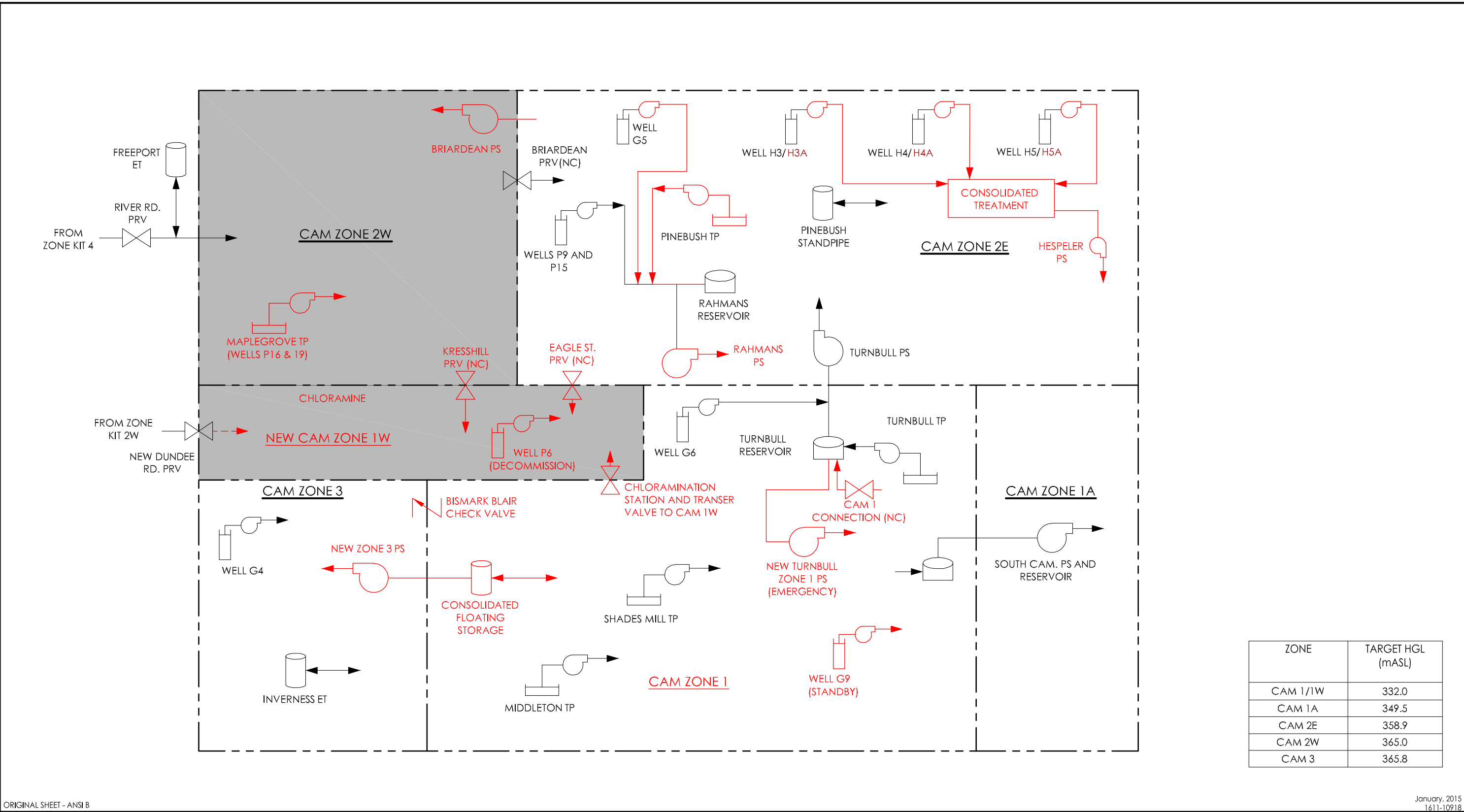
8.1 OPINION OF PROBABLE COST

A summary of the opinion of probable cost for the proposed solutions, including additional work to address system constraints and associated linear projects planned by the Region is provided in 2013 dollars in Table 8-1. Refer to Appendix F for further details on the opinion of probable cost.

8.2 IMPLEMENTATION SCHEDULE

The majority of the proposed work for the WSDOMP is summarized in Table 8-2. The planned implementation timing for the linear work is indicated in Sections 3.2.7, 4.2.4, and 5.2.5 as they are coordinated with transportation projects in the Region and in the A.Mun.s.

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






ORIGINAL SHEET - ANSI B

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Legend

-  RESERVOIR
-  ELEVATED TANK
-  PUMP STATION
-  WELL
-  WATER SUPPLY STATION
-  CHLORAMINE
-  FREE CHLORINE
-  (NC) NORMALLY CLOSED
-  --- LOW FLOW CONNECTION

Notes

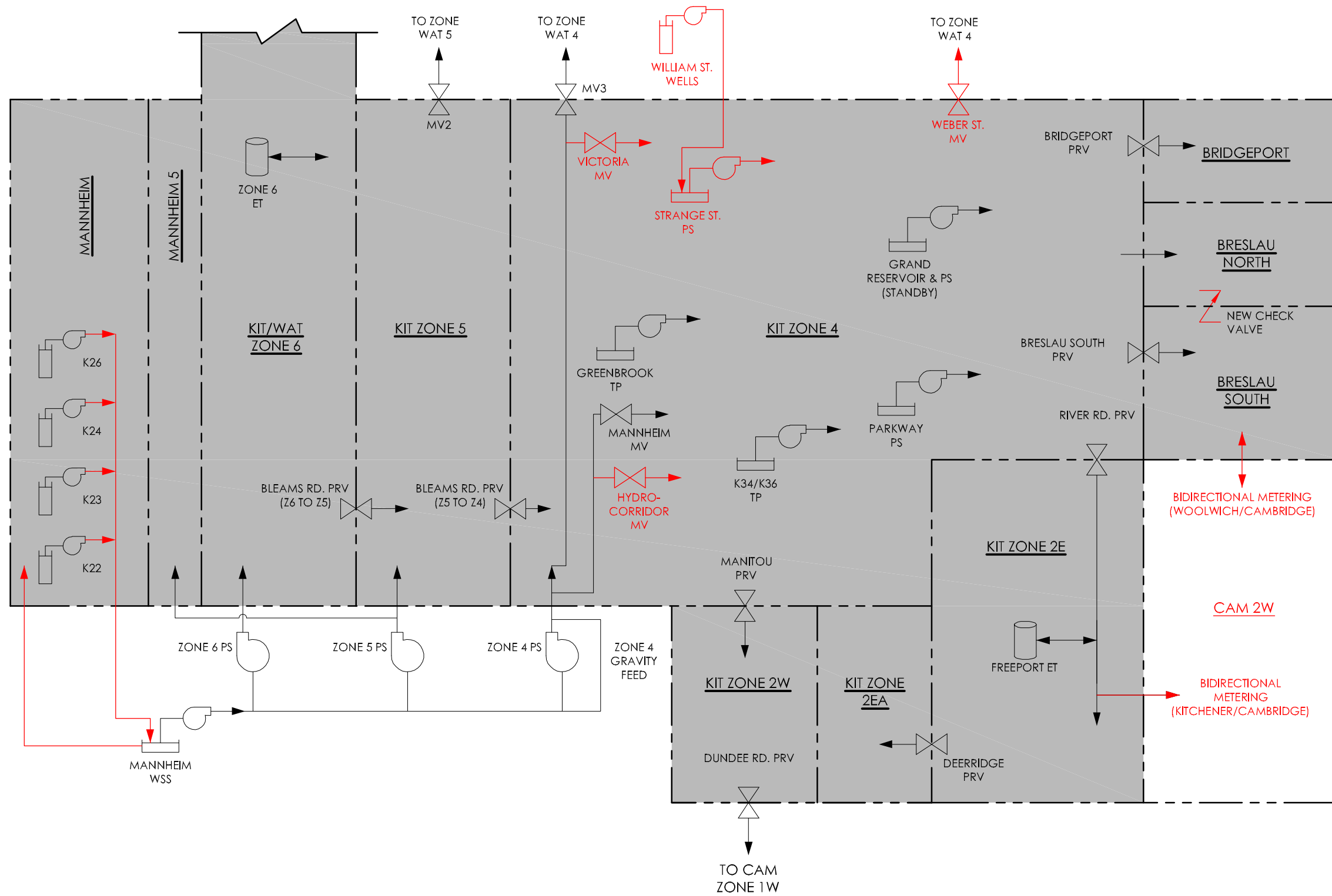
1. ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

Client/Project
REGION OF WATERLOO
WATER SUPPLY AND
DISTRIBUTION WATER PLAN

Figure No.
8.1

Title
FUTURE CAMBRIDGE DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
SUMMARY OF PROPOSED RECOMMENDATION.

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ZONE	TARGET HGL (mASL)
KIT 4	384.0
KIT 4A	363.2
KIT 5	407.0
KIT 6	428.0
KIT 2W	361.0
KIT 2EA	347.0
KIT 2E	365.0
BRIDGEPORT	364.5
MANNHEIM 5	407.0
MANNHEIM	384.0

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- RESERVOIR
- ELEVATED TANK
- PUMP STATION
- WELL
- WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

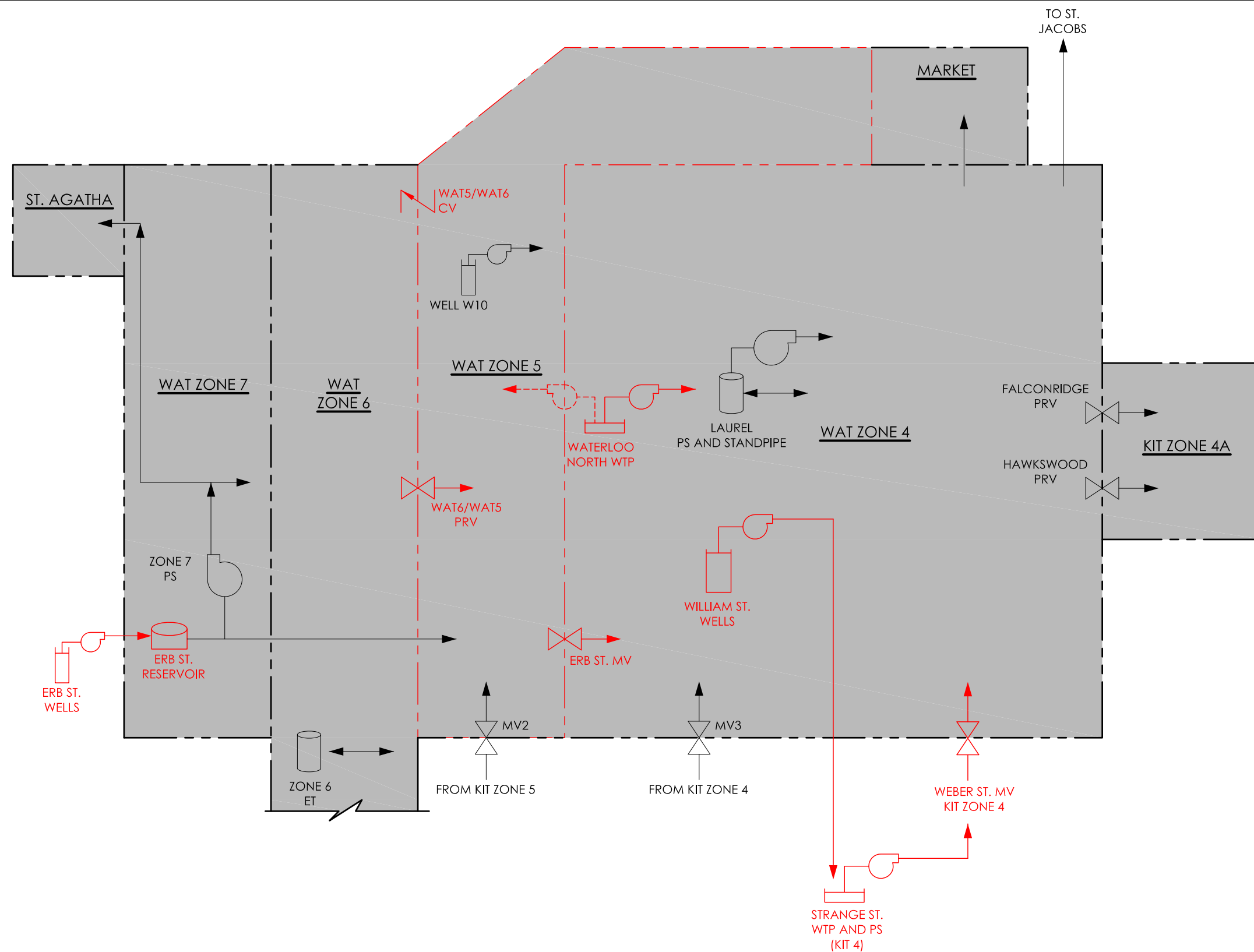
- ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

Client/Project
REGION OF WATERLOO
WATER SUPPLY AND
DISTRIBUTION WATER PLAN

Figure No.
8.2

Title
FUTURE KITCHENER DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
SUMMARY OF PROPOSED RECOMMENDATION.

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ZONE	TARGET HGL (mASL)
WAT 4	381.0
WAT 5	405.0
WAT 6	428.0
WAT 7	440.0
ST. AGATHA	440.0

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Legend

- RESERVOIR
- ELEVATED TANK
- PUMP STATION
- WELL
- WATER SUPPLY STATION

ALTERNATIVE CONFIGURATION

- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

1. ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

Client/Project
 REGION OF WATERLOO
 WATER SUPPLY AND
 DISTRIBUTION WATER PLAN

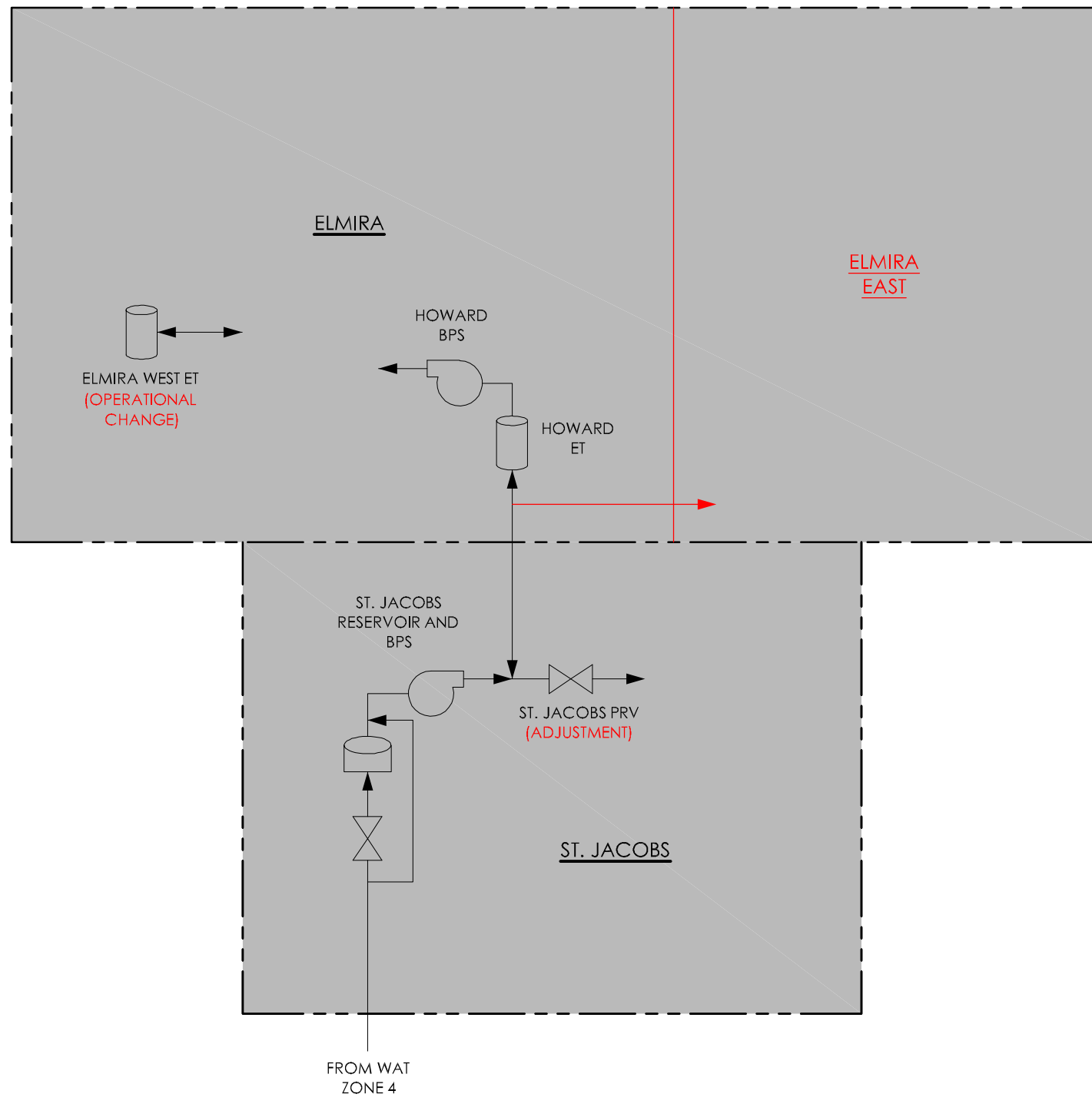
Figure No.

8.3

Title

FUTURE WATERLOO DISTRIBUTION
 SYSTEM PROCESS FLOW DIAGRAM
 SUMMARY OF PROPOSED RECOMMENDATIONS

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ZONE	TARGET HGL (mASL)
BRESLAU NORTH ¹	381.0
BRESLAU SOUTH ¹	365.0
MARKET ²	381.0
ST. JACOBS	385.0
ELMIRA	422.0
ELMIRA EAST	398.5

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- RESERVOIR
- ELEVATED TANK
- PUMP STATION
- WELL
- WATER SUPPLY STATION
- CHLORAMINE
- FREE CHLORINE
- (NC) NORMALLY CLOSED

Notes

1. REFER TO FIGURE 6-6 FOR BRESLAU NORTH AND BRESLAU SOUTH
2. REFER TO FIGURE 5-1 FOR MARKET
3. ITEMS IN RED INDICATE NEW INFRASTRUCTURE RELATED TO PROPOSED SOLUTION.

Client/Project
REGION OF WATERLOO
WATER SUPPLY AND
DISTRIBUTION WATER PLAN

Figure No.

8.4

Title
FUTURE WOOLWICH DISTRIBUTION
SYSTEM PROCESS FLOW DIAGRAM
SUMMARY OF PROPOSED RECOMMENDATION.

Table 8-1: Summary of Cost Estimates for Proposed Solutions

Area Municipality	Project	Report Section	Opinion of Probable Cost ¹
Cambridge	Rehabilitate existing or install a new PRV at Kresshill PS to provide a connection from Cam 2W to western Cam 1	3.2.1	\$ 500,000
	Decommission Kresshill PS	3.2.1	\$ 25,000
	Split Cam 1 into Cam 1 and Cam 1W	3.2.1	Costs included in other Region projects
	Install Cam 1/Cam 1W Chloramination Station	3.2.1	\$ 350,000
	Place System Wells P6 and G9 into standby status	3.2.1	\$ 100,000
	Modifications to Cam 3 to improve capacity	3.2.5	City + Developer
	Consolidate Rahmans PS, Pinebush WTP, and Well G5 and redirect to Cam 2E	3.2.3	\$ 3,900,000
	Increase capacity at Pinebush Rd. wells to increase production at the consolidated Pinebush WTP/Rahmans PS/Well G5 facility	3.2.3	\$ 500,000
	Convert the Turnbull Reservoir to pumped storage with one pump station to Cam 1 and one pump station to Cam 2E	3.2.2	\$ 3,500,000
	Construct consolidated floating storage to service Cam 1 and relocate St. Andrews PS to the same site or maintain at existing site	3.2.2	\$ 33,000,000
	Consolidate Hespeler Wells (Well H3, H4, and H5) to one facility if production rates increase	3.2.3	\$ 7,600,000
	Install inline booster pump station from Cam 2E to Cam 2W to supplement demands from the East Side Lands development	3.2.4	\$ 3,000,000
	Bring Maple Grove Wells (P16 and P19) online to supplement demands from the East Side Lands development	3.2.4	\$ 5,700,000
	Consolidate Pressure Zones for the East Side Lands	3.2.6	Costs included in Linear Works
	Other Work to Address Constraints	3.2.7	\$ 595,000
	Linear Work (includes ESL related work)	3.2.7	\$ 16,216,500
	Cambridge Total		\$ 74,986,500
Kitchener	Connect pressure transducers to SCADA	4.2.1	In Progress
	Develop a decision support system	4.2.2	\$ 2,000,000
	Install a control valve on the Victoria St. watermain	4.2.2	\$ 500,000
	Install a control valve on the secondary Weber St. connection between Kit 4/Wat 4 connection	4.2.2	Included under Linear Work
	Separate Kit 4 and Wat 4 discharge from Mannheim Zone 4 PS	4.2.4	\$ 2,500,000
	Install a control valve on the proposed Hydro-corridor watermain	4.2.2	Part of Zone 4 Feedermain Project
	Separate Village of Mannheim from K20s	4.2.3	\$ 4,800,000
	Other Work to Address Constraints	4.2.5	\$ 900,000
	Linear Work (includes LRT related work)	4.2.5	\$ 30,365,000
	Kitchener Total		\$ 41,065,000
Waterloo	Upgrade Strange St. PS to increase capacity and allow optional discharge to Waterloo	5.2.1	\$ 13,700,000
	Decommission William St PS	5.2.1	\$ 160,000
	Erb St. WSS Upgrades and new Wat 6 to Wat 5 PRV	5.2.2	\$ 1,000,000
	Construct Waterloo North WTP	5.2.3	\$ 9,900,000
	Consolidate Wat 4B and Wat 4C with Wat 5	5.2.4	\$ 100,000
	Other Work to Address Constraints	5.2.5	\$ 260,000
	Linear Work	5.2.5	\$ 8,628,000
	Waterloo Total		\$ 33,748,000
Woolwich	Develop a new pressure zone to replace Elmira East that operates at a target HGL of 398.5 mASL	6.2.1	\$ 500,000
	Service St. Jacobs PRV as necessary and adjust valve setting	6.2.2	N/A (Operational Changes)
	Install a check valve between Breslau North and Breslau South	6.2.3	\$ 500,000
	Other Work to Address Constraints	6.2.4	\$ 600,000
	Linear Work	6.2.4	\$ -
	Woolwich Total		\$ 1,600,000
IUS-Wide	General System Optimization (Physical and Operational Modifications)	7.0	\$ 3,000,000
Specific Project Totals			\$ 93,800,000

Note 1: Opinion of probable costs includes Region costs only, not costs associated with A.Mun.s

Table 8-2: Summary of Timing of Implementation for Proposed Solutions

Note: dotted line indicates accelerated or delayed implementation should circumstances change (i.e. change in demand trends)

Area Municipality	Project	2013	2014	2015	2016	2017	2018	2019	2020	2021	>2021	Report Section	
Cambridge	Rehabilitate existing or install a new PRV at Kresshill PS to provide a connection from Cam 2W to western Cam 1 and decommission Kresshill PS											3.2.1	
	Place System Wells P6 and G9 into standby status											3.2.1	
	Split Cam 1 to create Cam 1W and install chloramination station											3.2.1	
	Modifications to Cam 3 to improve capacity											3.2.5	
	Consolidate Rahmans PS, Pinebush WTP, and Well G5 and redirect to Cam 2E											3.2.3	
	Increase capacity at Pinebush Rd. wells to increase production at the consolidated Pinebush WTP/Rahmans PS/Well G5 facility												3.2.3
	Convert the Turnbull Reservoir to pumped storage with one pump station to Cam 1 and one pump station to Cam 2E												3.2.2
	Construct consolidated floating storage to service Cam 1 and relocate new Cam 3 PS to the same site or maintain at existing site as St. Andrews PS												3.2.2
	Consolidate Hespeler Wells (Well H3, H4, and H5) to one facility if production rates increase												3.2.3
	Install inline booster pump station from Cam 2E to Cam 2W to supplement demands from the East Side Lands development												3.2.4
	Bring Maple Grove Wells (P16 and P19) online to supplement demands from the East Side Lands development												3.2.4
	Consolidate Pressure Zones for the East Side Lands												3.2.6
	Other Work to Address Constraints												3.2.7
Kitchener	Connect pressure transducers to SCADA											4.2.1	
	Develop a decision support system											4.2.2	
	Install a control valve on the Victoria St. watermain											4.2.2	
	Install a control valve on the secondary Weber St. connection between Kit 4/Wat 4 connection											4.2.2	
	Separate Kit 4 and Wat 4 discharge from Mannheim Zone 4 PS											4.2.4	
	Install a control valve on the proposed Hydro-corridor watermain											4.2.2	
	Separate Village of Mannheim from K20's											4.2.3	
	Other Work to Address Constraints											4.2.5	

Table 8-2: Summary of Timing of Implementation for Proposed Solutions

Note: dotted line indicates accelerated or delayed implementation should circumstances change (i.e. change in demand trends)

Area Municipality	Project	2013	2014	2015	2016	2017	2018	2019	2020	2021	>2021	Report Section
Waterloo	Upgrade Strange St. PS to increase capacity and allow optional discharge to Waterloo and decommission William St PS											5.2.1
	Erb St. WSS Upgrades and new Wat 6 to Wat 5 PRV											5.2.2
	Construct New Waterloo North WTP											5.2.3
	Consolidate Wat 4B and Wat 4C with Wat 5											5.2.4
	Other Work to Address Constraints											5.2.5
Woolwich	Develop a new pressure zone to replace Elmira East that operates at a target HGL of 398.5 mASL											6.2.1
	Service St. Jacobs PRV as necessary and adjust valve setting											6.2.2
	Install a check valve between Breslau North and Breslau South											6.2.3
	Other Work to Address Constraints											6.2.4
IUS	General System Optimization											7.0