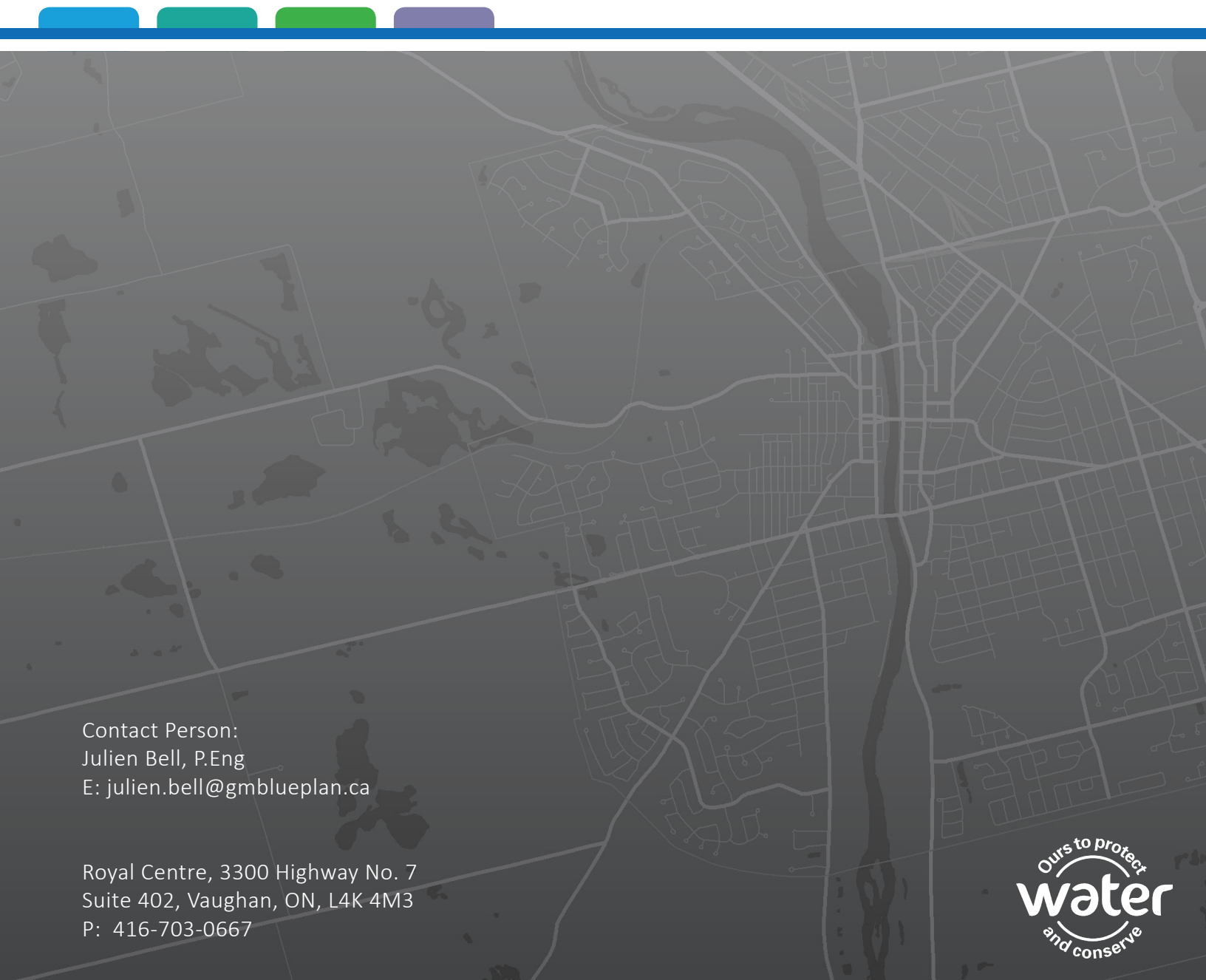


Regional Water System Upgrades in Cambridge and North Dumfries

Project File

Project #716035 | May, 2021



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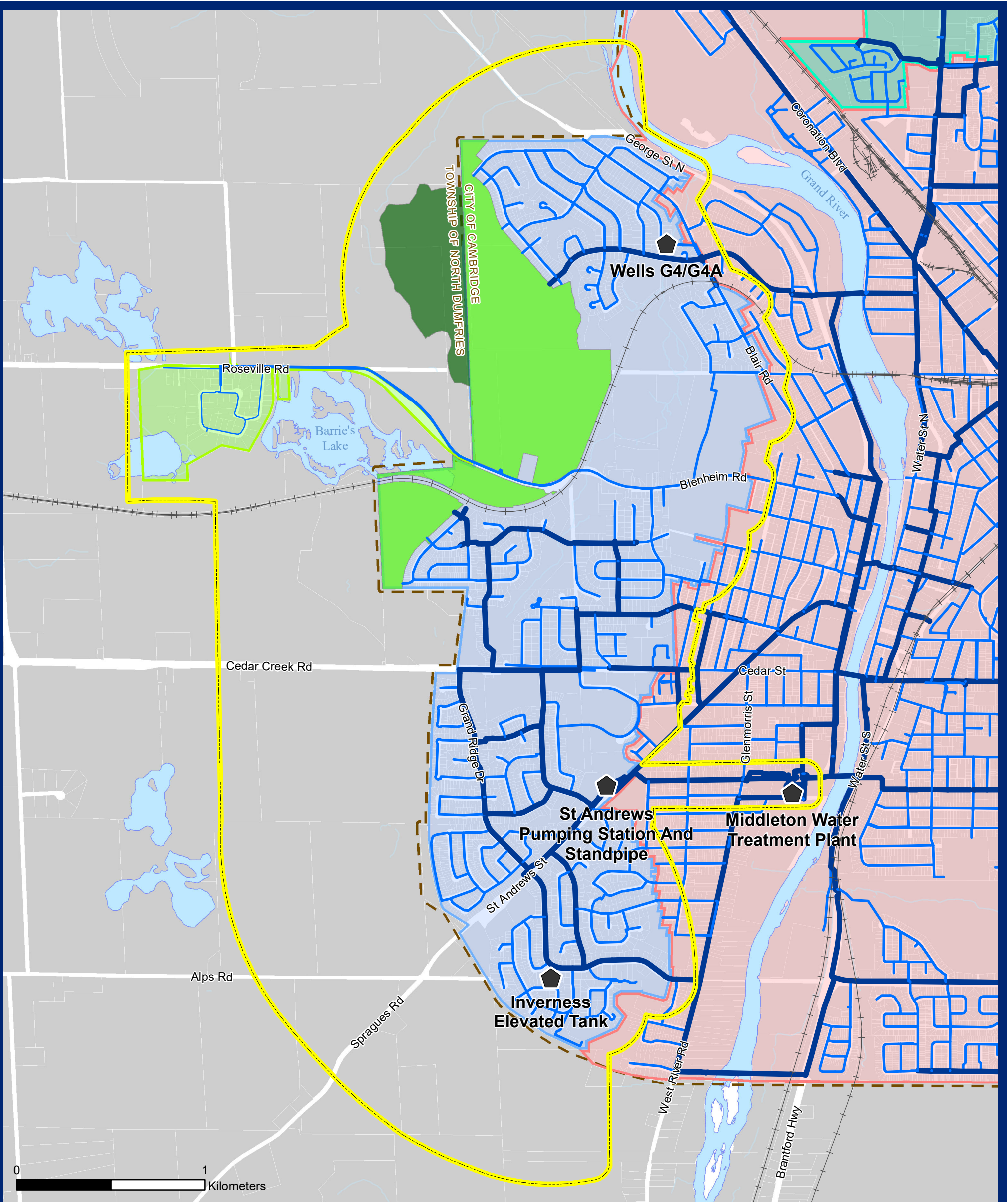
Executive Summary

E1 Project Objectives and History

The study area for the Class EA, presented in **Figure E1**, encompasses the entirety of the Cambridge Pressure Zone 3 (Cam 3) and adjacent lands; generally, within the City of Cambridge, west of the Grand River, and the Township of North Dumfries, immediately west of the municipal boundary and including the Lloyd Brown subdivision. The aim of the Class EA is to confirm the necessary infrastructure requirements and system upgrades needed to strengthen the overall capacity and resiliency of the supply, storage, and transmission within the Cam 3 and Lloyd Brown pressure zones, and to increase the efficiency and flexibility of system operations. This includes:

- Confirmation of the Wells G4/G4A future sustainable withdrawals capacity and quality;
- Identification of the long-term water supply strategy for the Cam 3 and Lloyd Brown pressure zones and required pumping and treatment capacity upgrades;
- Identification of total water storage needs, and development of a consolidated zone storage strategy including, if required, the identification of the location of any new storage and recommendations for decommissioning of existing storage;
- Identification of pumping and storage upgrades/modifications at the existing St. Andrews site to support the new system configuration and supply strategy, including considerations for temporary loss of the existing Middleton Water Treatment Plant (WTP) to St. Andrews trunk watermain and potential localized watermain upgrade work to support temporary bypassing;
- Identification and sizing of new infrastructure, system modification, and operational changes, including expansion of the trunk watermain network; and,
- Refinement of Cam 3 target hydraulic grade line (HGL), and identifying any pressure zone boundary changes to support the long-term Cambridge water system configuration and operational targets.




These projects are needed to address the recommendations of the Region's Water Supply and Distribution Operations Master Plan (WSDOMP) and Water Supply Master Plan Update (WSMP) of its Integrated Urban Water System (IUS). A key objective of the WSMP was to look for opportunities to improve the efficiency, reliability, and sustainability of supplying and transferring water to the areas where it is needed based on water demands. To achieve this objective, the WSMP supply management strategy focused on maximizing the self-sufficiency of the City of Cambridge supply and to limit flow transfers from the remaining IUS into Cambridge.








Regional Water System Upgrades in Cambridge and North Dumfries




Figure E1: Project Study Area

Water Infrastructure

-  Existing Facilities
-  ≤ 250 mm
-  > 250 mm

Pressure Zone

-  Cam 1
-  Cam 1A
-  Cam 2E
-  Cam 3
-  North Dumfries/Lloyd Brown

-  Study Area
-  Greenfield Development Areas
-  ROPA - Future Greenfield Development Areas



December 2020
716035-1
NAD 1983 UTM Zone 17N



E2 Class Environmental Assessment Process

This Class EA study was completed as a Schedule ‘B’ undertaking in accordance with the requirements of the Municipal Class EA process (October 2000, as amended in 2007, 2011 and 2015). The Class EA process includes public and review agency consultation, evaluation of alternatives, an impact assessment of recommended alternatives, and identification of measures to mitigate potential adverse effects.

E2.1 Phase 1 of the Class Environmental Assessment Process – Problem and Opportunity Statement

The initial phase of the Municipal Class EA process is the development of a Problem / Opportunity Statement which documents the factors leading to the conclusion that an improvement or change is required. Phase 1 answers the question:

What is the justification for “this project” to be undertaken?

For this Municipal Class EA study, the need for water system upgrades in Cam 3 arose from the need to support the Cambridge Water System Upgrade Strategy, as detailed in the Implementation Plan (GMBP, 2015). The strategy was developed to support the recommendations made in the Region’s WSDOMP (Stantec, 2015) and WSMP (Stantec, 2015) for the IUS.

The purpose of this EA is to determine the upgrades needed to strengthen the overall capacity and resiliency of the supply, storage, and transmission within Cam 3, and to increase the efficiency and flexibility of system operations. Based on the findings and assessment of opportunities and challenges within the study area, the following statement was developed to capture the key water distribution challenges and opportunities in the study area:

“To establish a preferred servicing plan for the Cambridge Zone 3 water system (which includes areas within the City of Cambridge and the Township of North Dumfries) that:
Meets current and future needs; Maintains or improves service levels; Supports optimization of the Region’s Integrated Urban Water System; and increases overall efficiency, reliability, and flexibility of the Cambridge Zone 3 water system.”

E2.2 Phase 2 of the Class Environmental Assessment Process – Identification and Evaluation of Alternative Solutions

The second phase of the Municipal Class EA process involves the identification and evaluation of feasible solutions to the problem. Regional Water System Upgrades in Cambridge and North Dumfries consists of a combination of dependent and independent components. The interrelationship of the various infrastructure elements is summarized:

- Location of the new elevated tank (ET) and the decommissioning of the existing Inverness ET will have a significant impact on determining watermain needs, and potentially pump capacity needs at both Wells G4/G4A and St. Andrews pumping station (PS);
- The preferred Cam 3 supply strategy is dependent on the revised permit to take water (PTTW) withdrawal rate and anticipated source water quality which governs pump capacity and treatment needs at Wells G4/G4A; further, pump capacity needs may be dependent on the location of a new ET and watermain upgrades;
- Pump capacity needs at St. Andrews PS are dependent on the preferred supply strategy and may also be impacted by the location of the new ET and watermain upgrades; and
- Storage needs at St. Andrews Standpipe (SP) is independent of the ET site, watermain upgrades, and upgrades to Wells GA/G4A.

To facilitate the development and evaluation of servicing options, system needs have been separated into the following components:

- Construction of a new Cam 3 ET – Schedule B project;
- Increase in pumping capacity at Wells G4/G4A more than the existing PTTW yield, and associated site facility upgrades, excluding any new treatment needs – Schedule B project;
- Modification or replacement of the existing water storage at St. Andrews PS – Schedule A/A+ project;
- Expansion/refurbishment/upgrade of the existing St. Andrews PS – Schedule A/A+ project;
- Decommissioning of the existing Inverness ET – Schedule A/A+ project; and
- Installation of new watermains in Cam 3 pressure zone to support the construction and operation of the above noted facilities – Schedule A/A+ project.

For both the Schedule B components, construction of a new Cam 3 ET and increasing pumping capacity at Wells G4/G4A above the existing PTTW, the full Phase 2 process of Identification and Evaluation of Alternative Solutions, in line with the MEA Class EA process, was undertaken utilizing the methodology further outlined in this section.

For the remaining Schedule A/A+ components, recommended upgrades were determined when the preferred new ET location and Wells G4/G4A alternatives were identified.

E2.3 Overview of Public Consultation

The table below provides an overview of the Study’s Public Consultation.

Public Consultation	Date	Content / Objective
Notice of Commencement and Project Sheet	August 1, 2017	Statutory Notice Included a two-page info sheet that provided additional project details and context.
Project E-Newsletters	April 31, 2018 October 9, 2019	Two Project E-Newsletters were prepared to provide interim project updates between Public Consultation Centres (PCCs).
PCC 1	November 30, 2017	Project introduction, presentation of the study objectives, and long-list of potential ET locations.
PCC 1 Survey/ Questionnaire	November 30, 2017	Public survey and questionnaire related to PCC 1 content.
PCC 2	April 1, 2019	Presentation of evaluation criteria, and short list of ET locations and water supply alternatives.
PCC 2 Survey/ Questionnaire	April 1, 2019	Public survey and questionnaire related to PCC 2 content.
PCC 3	December 9, 2020	Presentation of the preliminary preferred strategy, including evaluation of ET locations and water supply alternatives.

Public Consultation	Date	Content / Objective
PCC 3 Survey/ Questionnaire	January 8, 2021	Public survey and questionnaire related to PCC 3 content.
Notice of Completion and 30-Day Review	June 15, 2021	Statutory Notice Public Review of Environmental Study Report

E3 Overview of Analysis Works

The table below provides a brief overview of the assessment and analysis works completed to support the study recommendations

Works Completed		Objective / Key Element
Technical Analysis	Growth and Demand Analysis	Confirm long-term water supply and water storage needs.
	Condition Assessment of Existing Facilities	Assess the condition of the existing facilities to identify opportunities, constraints, and identify scope of works required to maintain the continued reliable operation of the facility.
	Site Visit of Study Area and Various Locations	Supplement other data sources and confirm viability/suitability of alternatives.
	Operations & Stakeholder Consultation	Information collection, confirmation of existing conditions, identification of opportunities and constraints, and validation of study findings.
	Review of Historic /Ongoing Studies	
	Hydraulic Modelling	
	Infrastructure Sizing and Costing Analysis	

Works Completed		Objective / Key Element
Hydro-geological Assessment	Desktop Analysis	Review the potential viability and risk related to increasing the Permit To Take Water (PTTW) and support the development of the study monitoring program.
	Study Monitoring Program	Support the evaluation and impact analysis of increasing the PTTW. Works included: <ul style="list-style-type: none"> • Groundwater well monitoring • Shutdown testing of existing wells • Groundwater quality sampling
	Groundwater Flow Modelling	Evaluate the potential long-term impacts and risk of increasing the PTTW. Includes assessment of potential impacts on other existing wells (with and without existing PTTW), surface water features, and the potential risks related to known groundwater contaminants.
	Well Head Vulnerability Analysis	Identify the changes to Wellhead Projection Areas and potential impacts to existing properties and uses.
Archaeological Investigation	Desktop Review of Study Area	Identify known and potential areas of significance to support screening and shortlisting.
	Stage 1 Archaeological Report	Complete Stage 1 Archaeological assessment of shortlisted elevated tower (ET) sites; included field investigation where access was provided.
Natural Heritage	Desktop Review of Study Area	Identification of known and potential areas of significance to support screening and shortlisting.
	Natural Heritage Existing Conditions Report	Completion of Natural Heritage Existing Conditions Report for shortlisted ET sites; included field investigation where access was provided. Report provides site impacts and mitigation requirements.

Works Completed		Objective / Key Element
Cultural Heritage	Desktop Review of Study Area	Identification of known and potential areas of significances to support screening and shortlisting.
	Shadow Analysis & 3D Rendering	Completion of ET shadow impact analysis to evaluate potential shadowing impacts and set back requirements.
	Cultural Heritage Assessment Report	Completion of Cultural Heritage Assessment Report for shortlisted ET sites; included roadside assessment. Report provides site impacts and mitigation requirements.

E4 Evaluation Approach

The Schedule B component alternatives were evaluated on four key categories:

- Technical factors;
- Environmental factors;
- Social and cultural factors; and,
- Financial viability.

A detailed summary of the evaluation criteria is attached. For each criteria a score between 0 and 4 was assessed:

0. Solution presents permanent negative impacts and/or presents significant technical challenges
1. Solution presents temporary negative impact and/or presents major technical challenges
2. Solutions presents low or neutral impacts after mitigation and/or some technical challenges
3. Solution presents no adverse impacts and has no substantial technical challenges
4. Solution presents ideal conditions and/or generates beneficial impacts

Following the independent evaluation of each individual criterion, a consolidated score was calculated for each of the four categories (technical factors; environmental factors; social and cultural factors; and financial viability). A total score out of 100 was calculated for each alternative using equal category weighting.

Upon completion of the initial alternative scoring, a sensitivity analysis of the category weighting was undertaken to determine if the recommendation for the preliminary preferred alternatives is sensitive to changes in category weighting. Attention was paid to the impacts of increasing the technical factors, environmental factors, and social and cultural factors categories, as these three categories were identified as most important to the public through the public consultation process.

Schedule A/A+ projects are considered pre-approved, as they typically result in minor impacts. Recommendations for Schedule A/A+ projects were identified based on the preliminary preferred new ET locations and water supply alternatives to support the optimization of the overall Cam 3 water system.

E5 Elevated Tank – Schedule B Component

E5.1 Elevated Tank Alternatives

A new ET is needed to support the recommended Cam 3 system upgrades. As several of the other key infrastructure upgrades needed to satisfy the long-term Cam 3 system upgrade strategy are dependent on the new ET location, the development of alternatives focused on first identifying a suitable location of the new ET that addresses the system and operational needs, while minimizing the overall environmental, social, cultural, and financial impacts.

A systematic approach was followed to develop alternatives for a new ET which consisted of first developing a long list of locations for consideration, and subsequently developing a short-list for detailed evaluation.

The results of screening the ET long list to develop a short-list of ET locations identified 3 short listed locations consisting of:

- **Cedar Creek Road (Location A):** This location is along Cedar Creek Road in North Dumfries, 200 m to 1 km west of the City of Cambridge limits. The location south of Cedar Creek Road is slated for future aggregate extraction, and the location to the north of Cedar Creek Road has recently undergone and completed aggregate extraction.
- **Cambridge West Lands Development (Location B):** This location is in Cambridge north and south of Blenheim Road, in the future Cambridge West Lands Development (CWLD) area.
- **Spragues Road (Location C):** This location is in both North Dumfries and Cambridge, along St. Andrews Street and Spragues Road, extending approximately 800 m southwest of the municipal boundary. The location is currently agricultural with planned residential development, for parcels within the City's current municipal boundary, and planned or potential for future aggregate extraction for the remaining areas.

E5.2 Elevated Tank Preferred Alternative

Based on the evaluation, the recommended new ET alternative is **Location A – Cedar Creek Road (along Cedar Creek Road, approximately 300-1,200 m from the municipal boundary)**. A summary of the key benefits for the recommended location are provided below:

- A mid-system location (Cedar Creek Road) requires the least amount of supporting infrastructure upgrades while providing improved long-term system operational flexibility and efficiency relative to north system (CWLD) and south system (Spragues Road) ET placement.
- The recommended location is not in close proximity to significant environmental features or wildlife migration routes and produces the least amount of greenhouse gas due to hydraulic configuration and long-term operational needs.
- The recommended location has a greater separation distance from existing/ future residences, limited construction impacts, and limited impacts to the local landscape.
- The recommended location has similar life cycle costs as the other alternatives

Potential constraints, as they relate to the recommended ET alternative, are as follows:

- Existing and previous land use as an aggregate extraction pit which leads to:
 - Potential impacts to the existing aggregate extraction business and higher land acquisition costs or potential construction complexities related to filling a previously extracted area
 - Construction and implementation risks related to potential delays in land acquisition
- Species at risk and cultural heritage structures identified within the Cedar Creek Road location will require mitigation measures to minimize potential impacts

These factors were accounted for in the evaluation process; however, the benefits of the remaining criteria still resulted in the Cedar Creek Road location being the highest overall scoring ET location.

E5.3 Mitigation Measures

Key mitigation considerations for the ET construction include:

- Timing of construction to mitigate the impacts to the observed barn swallow and bank swallow, which are Species at Risk (SAR)
- Potential SAR habitat compensation if the existing barn structure is demolished
- Site lighting to minimize impacts to local wildlife and to mitigate potential impacts to migratory birds
- Potential documentation and material salvaging if the existing heritage barn structure is demolished
- Site selection and appropriate ET setbacks to avoid impacts to ongoing and future aggregate extraction
- Site selection and appropriate ET setbacks to avoid shadowing impact to nearby heritage buildings
- Appropriate site stormwater runoff and ET overflow management to minimize potential discharge into the existing wetland to the north

E6 Water Supply – Schedule B Component

Two (2) water supply alternatives were developed to meet future demands within Cam 3, and are summarized as follows:

- **Increase Supply from Wells G4/G4A:** Increase the maximum PTTW from 22 L/s to 53 L/s with an average annual taking not exceeding 42 L/s, which would require the replacement of the existing well pump to accommodate the increased flow rate and required process piping, monitoring equipment, and chlorination equipment. To accommodate the equipment, expansion of the existing structure or construction of a new structure is needed. Additionally, to provide improved conveyance from Wells G4/G4A to the existing trunk network, watermain upgrades are needed
- **Increase Reliance on St. Andrews Pumping Station:** Maintaining the existing PTTW of 22 L/s at Wells G4/G4A requires increased demand within Cam 3 to be supplied through transfers from Cam 1 (an adjacent pressure zone) via the St. Andrews PS. As such, the St. Andrews PS will continue to be the primary supply source for Cam 3 and upgrades to the existing pumps are required to meet future demand needs.

E6.1 Overview of Preferred Supply Option

Based on the evaluation of alternatives, the recommended water supply alternative is **Increase Supply from Wells G4/G4A**, based on:

- The highest technical factors score, as it increases the water supply to meet the long-term water supply needs, as identified in the Region’s WSMP (Stantec, 2014)
- If water supply is not increased at Wells G4/G4A, an additional 20 L/s water supply will need to be secured elsewhere. The associated impacts related to increasing the water supply by 20 L/s elsewhere in the system are unknown at this time; however, it can be assumed that developing a new supply well, rather than increasing the supply from an existing well with good water quality, will have a greater impact for technical, environmental, social, and financial considerations.
- The Wells G4/G4A wellhouse and process piping need rehabilitation based on the current asset conditions to maintain the existing supply capacity. The additional cost related to increasing the PTTW at Wells G4/G4A represent a minor increase in the total cost at the site, and represent a lower system wide life-cycle cost
- Watermain needs associated with the upgrades at Wells G4/G4A are subject to further investigations during detailed design to confirm the preferred alignment based on constructability considerations and opportunities to coordinate with planned projects. Both alignment options identified to accommodate an increase in flow from Wells G4/G4A are within existing road right-of-ways or utility easements.

As the **Increase Supply from Wells G4/G4A** scores the highest in all four (4) evaluation categories, a sensitivity analysis was not needed.

E6.2 Monitoring Plan

Any changes in pumping at Well G4A would occur gradually over time to allow for appropriate monitoring. Increased pumping at Well G4A would be supported by enhanced monitoring in the Blair Road Wellfield, which would include:

- Groundwater monitoring in multi-level monitoring wells (bedrock and overburden)
- Shallow groundwater and stream flow monitoring in Devil's Creek

Further, Wellhead Protection Areas (WHPA) and Source Protection Policy Areas will be updated to include consideration of structures that could create preferential pathways beyond the basic vulnerability scoring.

E7 Watermain – Schedule A+ Component

Approximately 4.7 to 7.2 km of new/upgrade watermains are required to support the preliminary preferred strategy consisting of the following:

- 0.3-2.1 km of new watermains constructed within existing road right of ways to connect the existing water system to the new ET
- 1.9 km of new watermains constructed within future road right of ways as part of planned Cambridge West Lands Development
- 2.5 to 3.2 km of watermain upgrades to replace existing watermains within existing road right of ways or easements with new larger diameter watermains
 - 2.3-3.0 km of upgrades to improve the Cam 3 north-south watermain capacity with two (2) alignment options
 - Cemetery Option – Upgrade existing Mt. View Cemetery watermain
 - Blair Road Option – New watermains along Blair Road
 - 0.3-0.6 km of upgrades will support conveyance of increased supply from Wells G4/G4A to the distribution system with two (2) alignment options
 - Upgrade through Morva Rouse Park Easement
 - Upgrade along Dianne Avenue and Leslie Avenue

E8 St. Andrews – Schedule A+ Component

The existing St. Andrews Pumping Station (PS) and Standpipe (SP) are located at St. Andrews Street between Stanley Street and Southwood Drive. The preliminary preferred strategy is as follows:

- Replacement of the existing pumps with new pumps sized to provide a firm capacity of 66 L/s capacity to meet future maximum day demands
- Replacement of the existing 3 ML standpipe (top water level of 339 m) with a new 1 ML standpipe (top water level of 326 m) to accommodate the future decrease in hydraulic grade line in Cam 1. The new standpipe will be located on the existing property.
- Installation of a new standby generator
- Yard piping as required to accommodate the new facility changes

All works are expected to occur within the existing property boundaries.

E9 Inverness – Schedule A+ Component

The existing Inverness Water Tower is located on Grand River Drive and accessed from Dalkeith Drive. The preliminary preferred strategy is to decommission and remove the existing tower once the new ET is constructed. Further, future use of the Inverness Water Tower property will be determined at a future date.

E10 Bismark Check Valve – Schedule A Component

The Bismark Check Valve (CV) is located on a 300 mm watermain aligned on Bismark Drive, near the intersection with Blair Road. The CV is intended to provide additional fire protection and security of supply, within Cam 3 north of Bismark Drive, through transfers from Cam 1. The preliminary preferred strategy is to maintain the existing Bismark CV.

E11 Project Implementation

A summary of the overall project recommendations are illustrated in **Figure E2**.

E11.1 New Cam 3 Elevated Tank

The construction of the new ET at the Cedar Creek Road location can begin following the completion of this EA, detailed design, and acquisition of necessary parcel of land.

The project would consist of:

- Construction of a 47 to 55 m tall 5.39 ML elevated water storage tank
- Stormwater/overflow management pond to safely detain, manage, dechlorinate, and discharge any potential water tower overflows
- Supporting yard piping and site works

To support the construction of the new ET, the 450 mm watermain connecting the ET to the existing water system must be constructed. The existing Inverness ET can be decommissioned following the construction of the new ET and 450 mm watermain; however, the decommissioning is dependent on first constructing the 300 mm watermain which extends through the CWLD and along the realigned Blenheim Road.

E11.2 Increase Supply from Wells G4/G4A

Increasing supply at Wells G4/G4A is not dependent on the other project elements, including the construction of the new ET. To support the increased taking from the Blair Wellfield including the updated PTTW, upgrades are necessary to the existing facility including replacement of the existing well pump, process piping, monitoring equipment, and chlorination equipment. To accommodate the additional process equipment, the existing wellhouse will need to be expanded or a new wellhouse will need to be constructed. Flow from Wells G4/G4A will be increased incrementally and prior to exceeding 32 L/s, watermains from Wells G4/G4A to Blair Road must be upsized to 300 mm. The alignment of these upgrades is reliant on further investigations to confirm constructability considerations and opportunities to coordinate with planned projects.

E11.3 Watermain Upgrades

Additional watermain upgrades, independent of the construction of the new ET and increasing supply from Wells G4/G4A, will be constructed as part of the City of Cambridge or Region of Waterloo's (RoW's) state of good repair (SOGR) program. These upgrades will improve the ability to transfer water between the north and south areas of Cam 3 and the final alignment will be determined following additional stakeholder consultation and investigations.

E11.4 St. Andrews Pumping Station and Standpipe

Upgrades to the St. Andrews PS are dependant on the implementation of the Cam 1W booster pumping station and subsequent lowering of the Cam 1 HGL. Following lowering of the HGL, pumping station upgrades must be completed prior to Cam 3 MDD exceeding 58 L/s. There is potential for variation in the staging of the Cambridge water system upgrades and operational adjustments; as such, the design of the St. Andrews PS upgrades will need to accommodate the operation under the Cam 1 HGL of 332 m and 324-326 m. Further assessment, under a separate study, is required to review and confirm the staging requirements of the St. Andrews PS upgrades in relation to the planned lowering of the Cam 1 HGL and other Cambridge water system upgrades.

Upgrades to the St. Andrews SP are dependent on the implementation of the Cam 1W booster pumping station and subsequent lowering of the Cam 1 HGL. The new SP should be constructed prior to the existing SP scheduled recoating, if possible, to optimize the asset renewal investments.

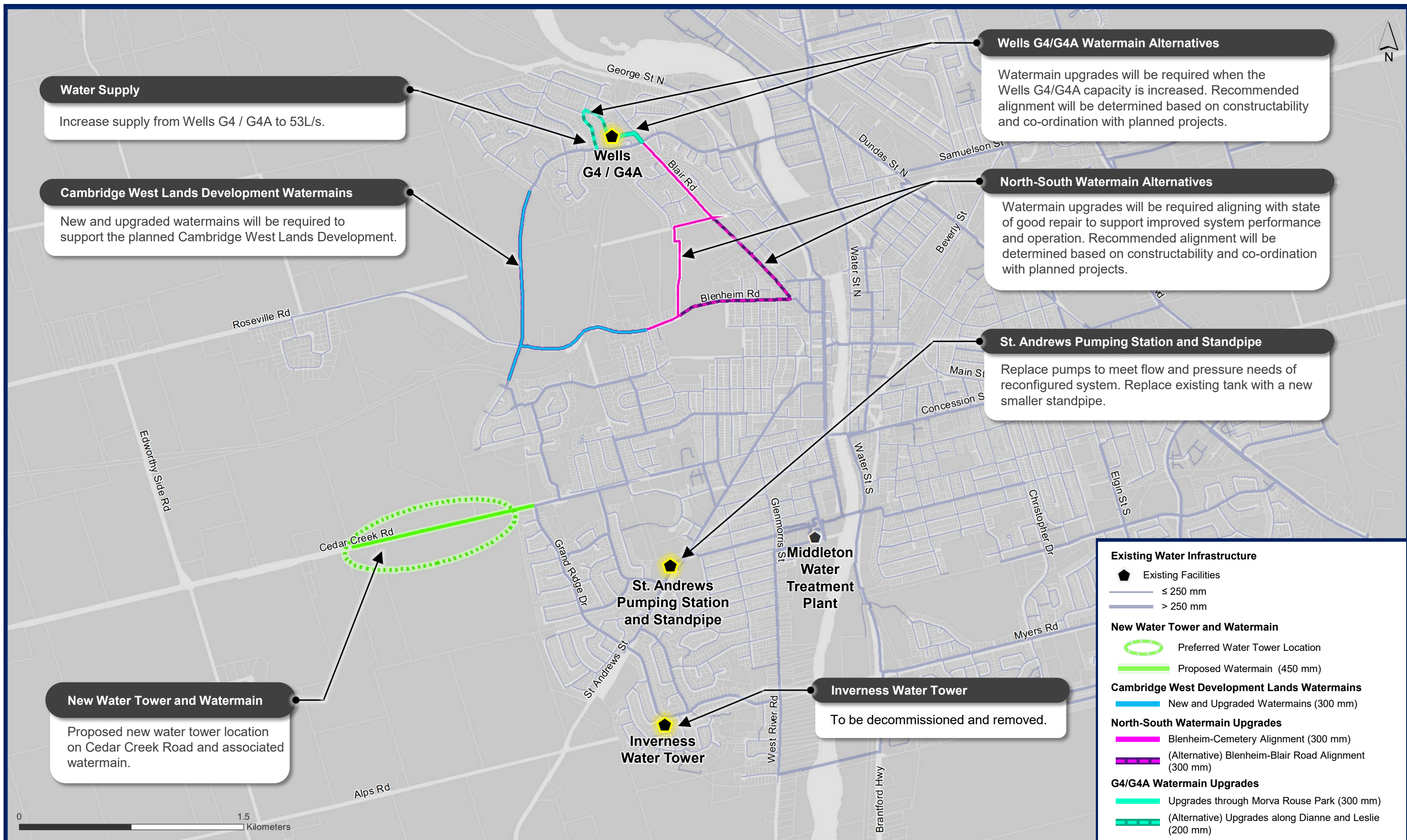


Figure E2: Recommended Options

List of Abbreviations

ADD	Average Day Demand
ANSI	Area of Natural and Scientific Interest
AO	Aesthetic Objective
Cam 1	Cambridge Pressure Zone 1
Cam 1W	Cambridge Pressure Zone 1W
Cam 2W	Cambridge Pressure Zone 2W
Cam 3	Cambridge Pressure Zone 3
CHAR	Cultural Heritage Assessment Report
CHER	Cultural Heritage Evaluation Report
CHIA	Cultural Heritage Impact Assessment
CHVI	Cultural Heritage Value or Interest
CPP	Concrete Pressure Pipe
CV	Check Valve
CWLD	Cambridge West Lands Development
EA	Environmental Assessment
EAA	Environmental Assessment Act
ESA	Endangered Species Act
ESL	Environmentally Sensitive Landscape
ESR	Environmental Study Report
ET	Elevated Tank
FUS	Fire Underwriters Survey
GRCA	Grand River Conservation Authority
GUDI	Groundwater Under Direct Influence of Surface Water
Ha	hectare
HGL	Hydraulic Grade Line
IUS	Integrated Urban Water System
MDD	Maximum Day Demand
MDD+FF	Max Day Demand plus Fire Flow
MECP	Ministry of Environment, Conservation, and Parks
ML	Million Litres
MNRF	Ministry of Natural Resources and Forestry
PCC	Public Consultation Centre
PHD	Peak Hour Demand
POE	Point of Entry
PS	Pumping Station
PSW	Provincially Significant Wetlands
PTTW	Permit to Take Water
RoW	Region of Waterloo

SARA	Species at Risk Act
SCADA	Supervisory Control and Data Acquisition
SOGR	State of Good Repair
TDH	Total Dynamic Head
TWL	Top Water Level
UV	Ultraviolet
WEF	With Effective Filtration
WHPA	Wellhead Protection Area
WSDOMP	Water Supply and Distribution Operations Master Plan
WSMP	Water Supply Master Plan Update
WTP	Water Treatment Plant
WWIS	Water Well Information System
WWR	Water Well Record

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Appendix B: Technical Memorandum #2 and #3 – Blair Road Well Field Hydrogeologic Assessment

Appendix C: Technical Memorandum #4 – Evaluation Methodology

Appendix D: Technical Memorandum #5 – Development of Alternatives

Appendix E: Technical Memorandum #6 – Evaluation of Alternatives

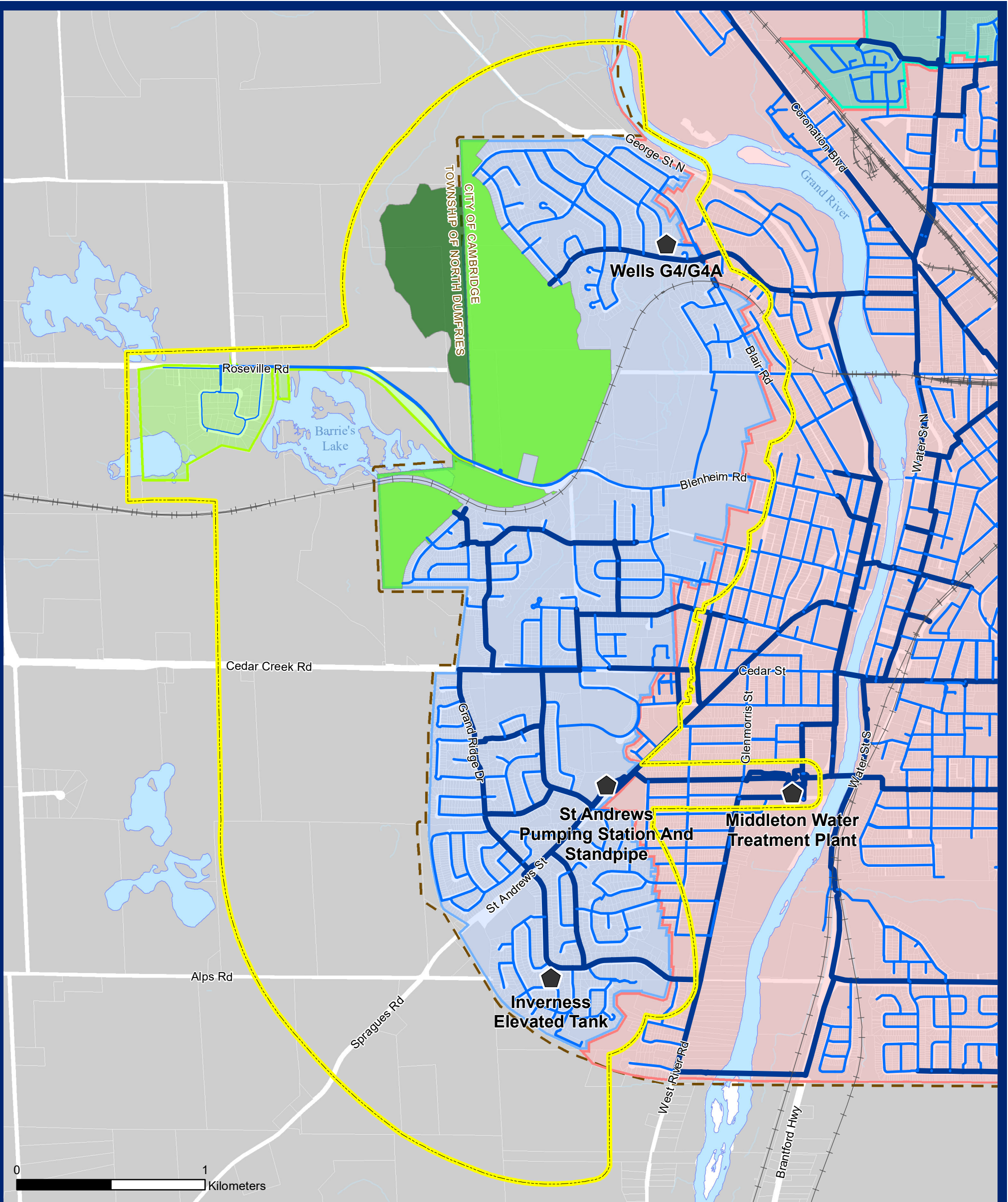
Appendix F: Agency and Public Consultation Report

1 Introduction

The Region of Waterloo (RoW) retained GM BluePlan Engineering Limited to complete a Schedule 'B' Municipal Class Environmental Assessment (EA) for the Cambridge Zone 3 Capacity, Storage, and Transmission Upgrades, subsequently renamed the **Regional Water System Upgrades in Cambridge and North Dumfries**.

The study area for the Class EA, presented in **Figure 1**, encompasses the entirety of the Cambridge Pressure Zone 3 (Cam 3) and adjacent lands; generally, within the City of Cambridge, west of the Grand River, and the Township of North Dumfries, immediately west of the municipal boundary and including the Lloyd Brown subdivision. The aim of the Class EA is to confirm the necessary infrastructure requirements and system upgrades needed to strengthen the overall capacity and resiliency of the supply, storage, and transmission within Cam 3 and Lloyd Brown pressure zones, and to increase the efficiency and flexibility of system operations. This includes:




- Confirmation of the Wells G4/G4A future sustainable withdrawals capacity and quality;
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- Identification and sizing of new infrastructure, system modification, and operational changes, including expansion of the trunk watermain network; and
- Refinement of Cam 3 target hydraulic grade line (HGL), and identifying any pressure zone boundary changes to support the long-term Cambridge water system configuration and operational targets



Regional Water System Upgrades in Cambridge and North Dumfries




Figure 1: Project Study Area

Water Infrastructure

-  Existing Facilities
-  ≤ 250 mm
-  > 250 mm

Pressure Zone

-  Cam 1
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-  North Dumfries/Lloyd Brown

-  Study Area
-  Greenfield Development Areas
-  ROPA - Future Greenfield Development Areas



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1.1 Project Background

In 2011, the RoW retained Stantec to complete the Water Supply and Distribution Operations Master Plan (WSDOMP) and Water Supply Master Plan Update (WSMP) of its Integrated Urban Water System (IUS). The objective of these studies was to develop a comprehensive water supply and water distribution strategy to support the long-term growth within the IUS. A key finding of the WSMP was that current and planned local water sources were sufficient to meet demands beyond 2031, and that development of the previously planned Lake Erie based supply was not needed until beyond 2051. As such, the WSDOMP upgrade recommendations focus on capital projects, system modifications, and operational changes to improve, optimize, and strengthen the IUS.

A key objective of the WSMP was to look for opportunities to improve the efficiency, reliability, and sustainability of supplying and transferring water to the areas it is needed based on water demands. To achieve this objective, the WSMP supply management strategy focused on maximizing the self-sufficiency of the City of Cambridge supply and to limit flow transfers from the remaining IUS into Cambridge.

As part of the WSMP and WSDOMP, several system upgrades and capital projects were recommended for the Cambridge Water System. In follow up to the WSMP and WSDOMP, the RoW retained GM BluePlan to develop the Implementation Plan for the Cambridge Water System Upgrades. The objective of the Implementation Plan was to review, evaluate, and refine the proposed Cambridge Water System Upgrades before the RoW proceeds with construction of the proposed upgrades.

This study supplemented WSDOMP and WSMP findings by carrying out further system investigations including site visits, system modelling, system performance testing, and stakeholder consultation.

A total of eight (8) major Cambridge Water System Upgrade projects are summarized in the final Implementation Plan, detailed in **Table 1**.

Table 1: Cambridge Water System Projects

Cambridge Water System Projects		Phase
Project #1	Cambridge Zone 3 Capacity Upgrades (Regional Water System Upgrades in Cambridge and North Dumfries)	Ongoing Schedule B Environmental Assessment (EA)
Project #2	New Kress Hill Pressure Reducing Valve	Commissioning 2020/21
Project #3	Creation of New Cambridge 1 West Pressure Zone	Schedule B EA Complete; Construction scheduled 2020-2022
Project #4	Cambridge 1 Pressure Zone Change	Ongoing; To be completed in alignment with Projects #2/#3
Project #5	Pinebush Re-Configuration	Design and construction anticipated in 2021/2022 in-line with Cambridge 1 West commissioning
Project #6	Rahmans Wells Re-Configuration	Partial design and construction in 2018, remaining anticipated in 2020/2021 in-line with Cambridge 1 West commissioning
Project #7	New Hespeler Water Treatment Plant	EA post 2026
Project #8	New Cambridge 2 West Booster Pumping Station	EA post 2026

The implementation of the **Regional Water System Upgrades in Cambridge and North Dumfries** (Project #1) is independent of the implementation of other Cambridge water system upgrades projects; however, it is possible that other Cambridge water system upgrades projects may be completed prior to the implementation of the water system upgrades for Cam 3, and such considerations have been made in this analysis.

1.2 Report Structure

The Project File for the Regional Water System Upgrades in Cambridge and North Dumfries Schedule ‘B’ Municipal Class EA is outlined within this document as follows:

- Introduction and Study Background (**Section 1**) – Provides an overview of the study, key objectives, and background
- Overview of the Municipal Class EA Process (**Section 2**) – Provides a summary of the Municipal Class EA framework and process including the problem and opportunity statement and key project elements and is further outlined in **Appendix C: Technical Memorandum 4 – Evaluation Methodology**
- Existing Conditions (**Section 3**) – Provides a summary of existing conditions within the study area including existing water system, hydrogeological conditions, natural heritage features, archeological assessment, and cultural heritage resources and is further outlined in **Appendix A: Technical Memorandum 1 – Review of Existing Conditions and Opportunities** and **Appendix B: Technical Memorandum 2 and 3 – Blair Road Well Field Hydrogeologic Assessment**
- Technical Servicing Requirements (**Section 4**) – Provides details on the design criteria and infrastructure servicing needs and is further outlined in **Appendix D: Technical Memorandum 5 – Development of Alternatives**
- Evaluation Methodology (**Section 5**) – Provides a summary of the evaluation approach, scoring, and categories and is further outlined in **Appendix C: Technical Memorandum 4 – Evaluation Methodology**
- Development of Alternatives (**Section 6**) – Details the identification and development of infrastructure alternatives and is further detailed in **Appendix D: Technical Memorandum 5 – Development of Alternatives**
- Evaluation of Alternatives (**Section 7**) – Provides a summary of the evaluation of infrastructure alternatives and is further detailed in **Appendix E: Technical Memorandum 6 – Evaluation of Alternatives**
- Final Recommendations and Implementation (**Section 8**) – Provides a summary of the final recommended servicing strategy and implementation plan and is further detailed in **Appendix E: Technical Memorandum 6 – Evaluation of Alternatives**

- Potential Effects and Mitigations (**Section 9**) – Provides a summary of the temporary and permanent impacts and their mitigation measures
- Agency and Public Consultation (**Section 10**) – Provides a summary of the public consultation and communications completed as part of this EA and is further outlined in **Appendix F: Agency and Public Consultation Report**
- Next Steps (**Section 11**) – Details the next steps for the design and construction of the recommendation servicing strategy

Further to the sections above, five (5) Technical Memorandums and the Agency and Public Consultation Report, appended to this report, have been prepared to fully detail all aspects of this EA.

2 Municipal Class Environmental Assessment Process

2.1 Class Environmental Assessment Process

This Class EA study was completed as a Schedule ‘B’ undertaking in accordance with the requirements of the Municipal Class EA process (October 2000, as amended in 2007, 2011 and 2015). The Class EA process includes public and review agency consultation, evaluation of alternatives, an impact assessment of recommended alternatives, and identification of measures to mitigate potential adverse effects.

2.1.1 Environmental Assessment Act

Ontario’s Environmental Assessment Act (EAA) was passed in 1975 and was proclaimed in 1976. The EAA requires proponents to examine and document the environmental effects that could result from major projects or activities and their alternatives. Municipal undertakings became subject to the EAA in 1981.

The EAA’s comprehensive definition of the environment is:

- Air, land or water;
- Plant and animal life, including human life;
- The social, economic and cultural conditions that influence the life of humans or a community;
- Any building, structure, machine or other device or thing made by humans;
- Any solid, liquid, gas, odour, heat, sound, vibration, or radiation resulting directly or indirectly from human activities; and,
- Any part of combination of the foregoing and the interrelationships between any two or more of them, in or of Ontario.

The purpose of the EAA is the betterment of the people of the whole or any part of Ontario by providing for the protection, conservation and wise management of the environment in Ontario (RSO1990, c.18, s.2). An EAA must also ensure that decisions result from a rational, objective, transparent, replicable, and impartial planning process.

As set out in Section 5(3) of the EAA, an EA document must include the following:

- A description of the purpose of the undertaking;
- The undertaking;
- The alternative methods of carrying out the undertaking; and,
- Alternatives to the undertaking.

The EA document must also include a description of:

- The environment that will be affected or that might reasonably be expected to be affected, directly or indirectly, by the undertaking or alternatives to the undertaking;
- The effects that will be caused or that might reasonably be expected to be caused to the environment by the undertaking or alternatives to the undertaking;
- The actions necessary or that may reasonable be expected to be necessary to prevent, change, mitigate or remedy the effects upon or the effects that might reasonably be expected upon the environment by the undertaking or alternatives to the undertaking; and,
- An evaluation of the advantages and disadvantages to the environment of the undertaking, the alternative methods of carrying out the undertaking and the alternatives to the undertaking (RSO1990, c.18, s.2).

2.1.2 Principles of Environmental Planning

The EAA sets a framework for a rational, objective, transparent, replicable and impartial planning process based on the following five key principles:

- Consultation with affected parties. Consultation with the public and government review agencies is an integral part of the planning process. Consultation allows the proponent to identify and address any concerns cooperatively before final decisions are made. Consultation should begin as early as possible in the planning process.
- Consideration of a reasonable range of alternatives. Alternatives include functionally different solutions, “alternatives to” the proposed undertaking and “alternative methods” of implementing the preferred solution. The “do nothing” alternative must also be considered.
- Identification and consideration of the effects of each alternative on all aspects of the environment. These aspects include the natural, social, cultural, technical, and economic environments.
- Systematic evaluation of alternatives in terms of their advantages and disadvantages to determine their net environmental effects. The evaluation shall increase in the level of detail as the study moves from the evaluation of “alternatives to” to the evaluation of “alternative methods”.

Provision of clean and complete documentation of the planning process followed to allow “traceability” of decision-making with respect to the project. The planning process must be documented in such a way that it may be repeated with similar results.


2.1.3 Class Environmental Assessment

“Class” Environmental Assessments (Class EAs) were approved by the Minister of the Environment in 1987 for municipal projects having predictable and mitigable impacts. The Municipal Class EA process was revised and updated in 1993, 2000, 2007, 2011 and 2015 and an additional amendment is currently underway (expected for 2020). The Class EA approach streamlines the planning and approvals process for municipal projects that are:

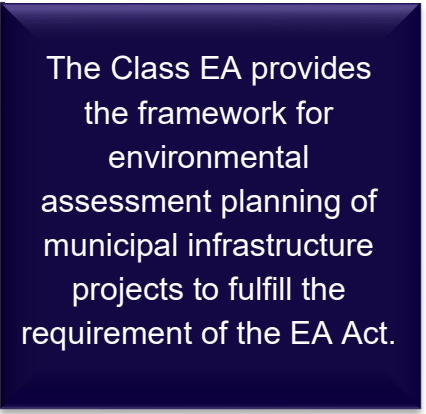
- Recurring;
- Similar in nature;
- Usually limited in scale;
- Predictable in the range of environmental impacts; and,
- Responsive to mitigation.

The Municipal Class EA, prepared by the Municipal Engineers Association (October 2000, as amended in 2007, 2011 and 2015) outlines the procedures to be followed to satisfy Class EA requirements for water, wastewater, stormwater management, and road projects. The process includes five phases:

- **Phase 1: Problem or Opportunity Definition;**
- **Phase 2: Identification and Evaluation of Alternative Solutions** to Determine a Preferred Solution while taking input from the public and other stakeholders into consideration;
- **Phase 3: Examination of Alternative Methods** of Implementation of the Preferred Solution while taking input from the public and other stakeholders into consideration;
- **Phase 4: Documentation of the Class EA process** in the form of an Environmental Study Report (ESR) for public review; and
- **Phase 5: Implementation and Monitoring.**



The Class EA –
A framework for
environmental planning



The Class EA provides
the framework for
environmental
assessment planning of
municipal infrastructure
projects to fulfill the
requirement of the EA Act.

Projects subject to the Class EA process are classified into following four “schedules” depending on the degree of the expected impacts.

Schedule A projects are minor or emergency operational and maintenance activities and are approved without the need for further assessment. These projects are typically smaller in scale and do not have a significant environmental effect.

Schedule A+ projects are also pre-approved; however, the public is to be advised prior to the project implementation. Although projects of this class do not usually have the potential for adverse environmental impacts, they tend to be broader in scale in comparison to Schedule A projects.

Schedule B projects require a screening of alternatives for their environmental impacts and Phases 1 and 2 of the planning process must be completed. The proponent is required to consult with the affected public and relevant review agencies. If outstanding issues remain after the public review period, any party may request that the Minister of the Environment consider a Part II Order, also known as bumping-up the project to a Schedule ‘C’ Class EA or an Individual EA. Provided that no significant impacts are identified and no requests for a Part II Order to a Schedule ‘C’ or Individual EA are received, Schedule ‘B’ projects are approved and may proceed directly to implementation.



Schedule C projects must satisfy all five phases of the Class EA process. These projects have the potential for greater environmental impacts. Phase 3 involves the assessment of alternative methods of carrying out the project, as well as public consultation on the preferred conceptual design. Phase 4 normally includes the preparation of an ESR that is filed for public review. Provided no significant impacts are identified and no requests for Part II Order or “bump-up” to an Individual EA are received, Schedule ‘C’ projects are then approved and may proceed directly to implementation.

2.2 Phase 1 of the Class Environmental Assessment Process – Problem and Opportunity Statement

The initial phase of the Municipal Class EA process is the development of a Problem / Opportunity Statement which documents the factors leading to the conclusion that an improvement or change is required. Phase 1 answers the question:

What is the justification for “this project” to be undertaken?

For this Municipal Class EA study, the need for water system upgrades in Cam 3 arose from the need to support the Cambridge Water System Upgrade Strategy, as detailed in the Implementation Plan (GMBP, 2015). The strategy was developed to support the recommendations made in the RoW’s WSDOMP (Stantec, 2015) and WSMP (Stantec, 2015) for the IUS.

The purpose of this EA is to determine the upgrades needed to strengthen the overall capacity and resiliency of the supply, storage, and transmission within Cam 3, and to increase the efficiency and flexibility of system operations. Based on the findings from the Cambridge Water System Upgrade Strategy, as well as water distribution opportunities and challenges outlined in **Appendix A** (Technical Memorandum # 1), the following statement was developed to capture the key water distribution challenges and opportunities in the study area:

“To establish a preferred servicing plan for the Cambridge Zone 3 water system (which includes areas within the City of Cambridge and the Township of North Dumfries) that:
Meets current and future needs; Maintains or improves service levels; Supports optimization of the Region’s Integrated Urban Water System; and increases overall efficiency, reliability, and flexibility of the Cambridge Zone 3 water system.”

2.3 Phase 2 of the Class Environmental Assessment Process – Identification and Evaluation of Alternative Solutions

The second phase of the Municipal Class EA process involves the identification and evaluation of feasible solutions to the problem. Regional Water System Upgrades in Cambridge and North Dumfries consists of a combination of dependent and independent components. The interrelationship of the various infrastructure elements is summarized:

- Location of the new Elevated Tank (ET) and the decommissioning of the existing Inverness ET will have a significant impact on determining the watermain needs, and potentially pump capacity needs at both Wells G4/G4A and St. Andrews Pumping Station (PS);
- The preferred Cam 3 supply strategy is dependent on the revised Permit to Take Water (PTTW) withdrawal rate and future anticipated source water quality and will determine the pump capacity and treatment needs at Wells G4/G4A; further, pump capacity needs may be dependent on the location of new ET and watermain upgrades;
- Pump capacity needs at St. Andrews PS are dependent on the preferred supply strategy and may also be impacted by the location of the new ET and watermain upgrades; and
- Storage needs at St. Andrews Standpipe (SP) is independent of the ET site, watermain upgrades, and upgrades to Wells GA/G4A.

2.3.1 Selection of Project Schedule

To facilitate the development and evaluation of servicing options, system needs have been separated into the components listed below:

- Construction of a new Cam 3 ET – Schedule B project;
- Increase in pumping capacity at Wells G4/G4A more than the existing PTTW yield, and associated site facility upgrades, excluding any new treatment needs – Schedule B project;
- Modification or replacement of the existing water storage at St. Andrews PS – Schedule A/A+ project;
- Expansion/refurbishment/upgrade of the existing St. Andrews PS – Schedule A/A+ project;
- Installation of new watermains in Cam 3 pressure zone to support the construction and operation of the above noted facilities – Schedule A/A+ project
- Continued operation of the Bismark Check Valve (CV); and
- Decommissioning of the existing Inverness ET – Schedule A/A+ project.

Given the nature of this project, the Municipal Class EA for the Regional Water System Upgrades in Cambridge and North Dumfries was reviewed as a single overall Schedule ‘B’ Class EA undertaking which includes the completion of both Phases 1 and 2 of the Class EA process. Under this approach the inter-related impacts of all project components were considered when evaluating the more significant Schedule “B” components.

3 Existing Conditions

The study area encompasses the entirety of the Cam 3 pressure zone and adjacent lands; within the City of Cambridge, west of the Grand River, and the Township of North Dumfries, immediately west of the municipal boundary and including the Lloyd Brown subdivision. The study area consists primarily of residential neighbourhoods with some local commercial properties. The remaining land uses within the study area include agricultural and industrial pits and quarries, which are located outside the urban boundary, in the Township of North Dumfries.

The boundary of the study area is defined based on where new infrastructure may be located to enhance the operation of Cam 3.

3.1 Existing Water System

3.1.1 Regional Water System Overview

Waterloo Region is a two-tier water system in which the RoW is responsible for the treatment and delivery of wholesale water to the local municipalities through the IUS. The local municipalities are then responsible for water distribution to the local users.

The majority of the IUS is supplied through 83 groundwater production wells distributed throughout the system. The groundwater is treated either locally or at one of five nearby integrated treatment and pumping station facilities (which are supplied by a number of local wells) and is pumped directly into the IUS distribution system.

Supporting the IUS is a network of 220 km of trunk watermains, 2,000 km of local watermains, 21 storage facilities, and 20 pumping stations, supplying 26 pressure zones.

Due to the distributed nature of the IUS supply sources, water from the various sources generally services the local area/pressure zone; however, there is some interconnectivity between adjacent pressure zones to allow transfers needed to meet demands and emergency scenarios.

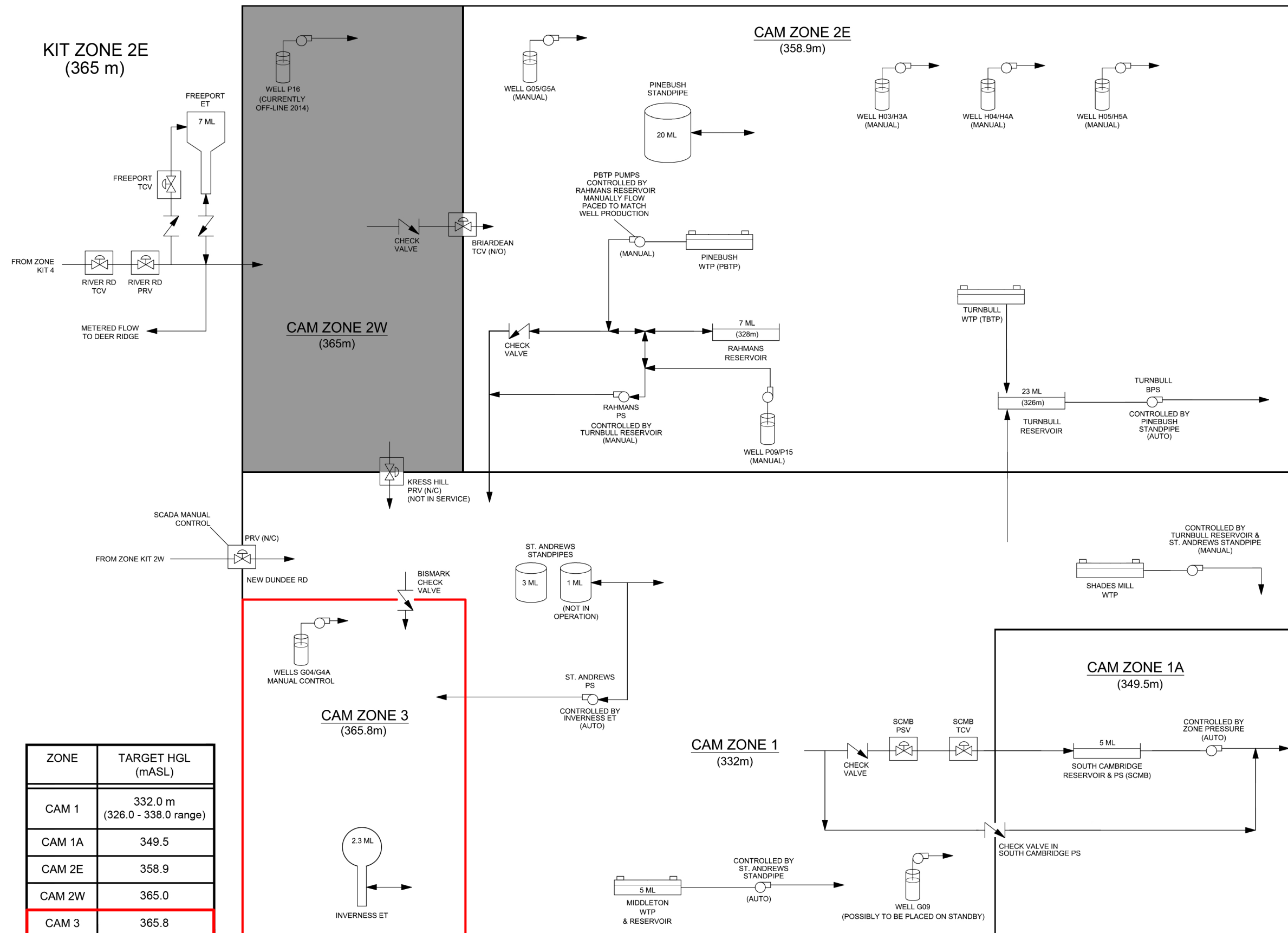
Figure 2 presents a schematic overview of the existing Cambridge water system. The majority of Cambridge water demands are met by groundwater sources located within the City of Cambridge; however, supply to the northwest area of Cambridge Pressure Zone 1 (Cam 1) and Cambridge Pressure Zone 2W (Cam 2W) are supplemented via connections from the City of Kitchener.



Region of Waterloo

REGIONAL WATER SYSTEM UPGRADES IN CAMBRIDGE AND NORTH DUMFRIES

Figure 2: Existing System Process Flow Diagram



ZONE	TARGET HGL (mASL)
CAM 1	332.0 m (326.0 - 338.0 range)
CAM 1A	349.5
CAM 2E	358.9
CAM 2W	365.0
CAM 3	365.8

- WELL
- PUMPING STATION (PS)
- RESERVOIR (GROUND LEVEL)
- STANDPIPE
- ELEVATED TANK (ET)
- WATER TREATMENT PLANT (WTP)
- FLOW CONTROL VALVE
- PRV PRESSURE REDUCING VALVE
- TCV THROTTLING CONTROL VALVE
- PSV PRESSURE SUSTAINING VALVE
- N/C NORMALLY CLOSED
- FREE CHLORINE
- COMBINED CHLORINE (CHLORAMINE)
- ML MILLION LITRES



3.1.2 Existing Cambridge Zone 3 Pressure Zone Overview

The Cam 3 pressure zone, with an HGL of 366 m, is supplied by both internal and external sources. The primary, external source is supplied through transfers from Cam 1 via the St. Andrews PS and SP with emergency backup supply from Cam 1 by the Bismark CV. Internally, Cam 3 is supplied by Wells G4/G4A located within the Blair Road Wellfield. Floating storage is currently provided by the Inverness ET, with the remaining storage needs provided through pumped storage at St. Andrews. Full details for all infrastructure components within Cam 3, including the condition assessment completed for Wells G4/G4A and St. Andrews PS and SP, is provided in **Appendix A** (Technical Memorandum #1).

3.1.2.1 St. Andrews Pumping Station and Standpipe

The St. Andrews PS and SP, accessed from St. Andrews Street between Stanley Street and Southwood Drive, is intended to provide transfers from Cam 1 to Cam 3 to supplement Cam 3 water demands. Cam 1 supplies St. Andrews predominantly from Middleton WTP and PS.

Operations of the St. Andrews PS is controlled by the water level in the Inverness ET through two (2) booster pumps (CB34 and CB35) each with a design point of 70 L/s (retrofitted with VFDs in 2014) and one (1) diesel operated fire pump (CB36) with a design point of 182 L/s.

The existing St. Andrews SP was constructed in 1949 and has a capacity of 3 million litres (ML). The standpipe operates at the Cam 1 HGL of 332 m and supplements Cam 3 storage needs via St. Andrews PS. It can be noted that the old 1 ML St. Andrews SP, constructed in 1891, was decommissioned and removed in 2017 as it was no longer in service and was in poor condition.

3.1.2.2 Bismark Check Valve

The Bismark CV is located on a 300 mm watermain aligned on Bismark Drive, at the intersection with Blair Road. The CV is intended to provide additional fire protection and security of supply, within Cam 3 north of Bismark Drive, through transfers from Cam 1. This is only possible should the Cam 3 HGL reduce to an HGL at or below that of Cam 1, which enables the CV to open and flow directly into Cam 3.

3.1.2.3 Wells G4/G4A

Wells G4/G4A are located in the Blair Road Wellfield on Dianne Avenue. The two production wells directly supply the Cam 3 distribution system and are currently classified as Groundwater Under Direct Influence of Surface Water (GUDI) With Effective Filtration (WEF); as such, their current primary and secondary levels of treatment is a combination of UV and sodium hypochlorite injection.

Presently, the estimated capacities of Wells G4 and G4A are 24 L/s and 55 L/s (WSMP, 2015), respectively. The maximum production rate can only be supplied by Well G4A. The production rate of Well G4 is lower than G4A, and each production rate is reduced when both wells are operated together as a result of mutual interference. Wells G4 and G4A are currently operated under a single existing PTTW, with a maximum allowable instantaneous withdrawal rate of 22 L/s. Typically the newer G4A deep bedrock aquifer well is operated, as it has maintained consistent performance; however, there is flexibility to utilize either well with manual interchange. The original intention was for Well G4 to operate as a backup to Well G4A in the event that Well G4A was out of service. Currently the wells are not configured to operate simultaneously.

The Wells G4/G4A facility is operated manually through the RoW's Supervisory Control and Data Acquisition (SCADA) controller and historically has operated at 16 to 20 L/s.

3.1.2.4 Inverness Elevated Tank

The Inverness ET, a spheroid elevated water tank constructed in 1978, is located on Grand River Drive and accessed from Dalkeith Drive. Inverness provides floating storage to Cam 3 with a capacity of 2.3 ML.

3.1.3 Relevant Cambridge Water System Upgrades and Modifications

3.1.3.1 Cambridge Pressure Zone 1 and Zone 1W

The recently completed Cam 1/Cambridge Pressure Zone 1W (Cam 1W) Class EA (projects previously identified in the WSDOMP and Implementation Plan) proposed the separation of Cam 1 to create a new separate pressure zone, Cam 1W, including the following system modifications:

- Increasing the existing HGL within the new Cam 1W from 332 m to 337 m
- Reducing the existing HGL within the remaining Cam 1 from 332 m to 324-326 m (the existing operating range of the Turnbull Reservoir), which will occur after the implementation of the Cam 1W HGL increase

The modifications of the Cam 1 HGL and changes in the future Cam 1 operations were considered in this analysis as there is potential to impact the following Cam 3 infrastructure:

- Bismark CV
- St. Andrews PS suction pressure
- St. Andrews SP storage needs and operations

3.1.3.2 Middleton to St. Andrews Supply Watermain

Currently the St. Andrews PS and SP are supplied directly from the Middleton WTP via a single 400 mm concrete pressure pipe (CPP) watermain. The increased Cam 3 storage and increased Wells G4/G4A capacity will serve to reduce the criticality of the existing Middleton to St. Andrews trunk watermain. However, the transmission of water from Middleton to St. Andrews will remain a key conduit in the system. As part of the road work completed along St Andrews, a new 250 mm watermain between Stanley Street at Glenmorris Street and St. Andrews PS was installed to twin the existing 400 mm watermain to provide redundancy between Middleton WTP and St Andrews PS. The remaining section of 400 mm watermain does not have a dedicated twin; however, there is a substantial local distribution network with multiple interconnection to the 400 mm watermain that can be utilized to provide redundancy between Middleton and St. Andrews PS.

3.2 Greenfield Growth Lands

An area of greenfield growth (primarily residential) is located within the study area, referred to as the Cambridge West Lands Development (CWLD), and is part of a proposed expanded urban boundary. The CWLD consists of the following:

- City of Cambridge land area located primarily in the northwest of Cam 3; and,
- Additional development lands, currently outside of the municipal boundary within the Township of North Dumfries, are proposed to be serviced by the City of Cambridge

Figure 1 presents the location of the CWLD within the context of the existing Cambridge water system. **Table 2** details the projected development area population growth within the City lands and additional lands currently outside the municipal boundary as per the Cambridge West Master Environmental Servicing Plan (MHBC, MTE, Paradigm, ecoplans, & LVM, 2013).

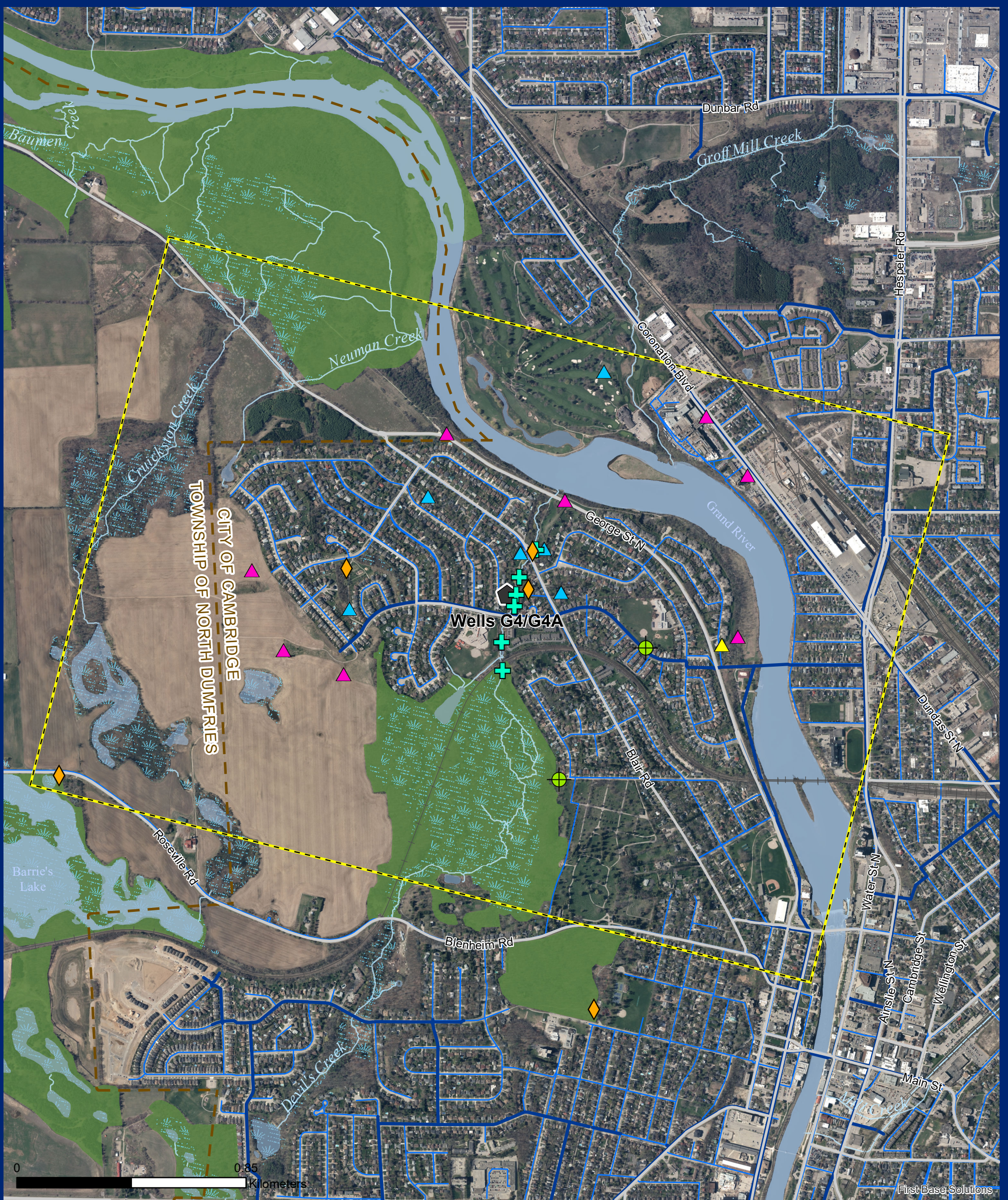
Table 2: Cambridge West Lands Development Populations

Scenario	Development within City Lands	Development within Additional Lands
Residential Population	4,147	1,580
Institutional Equivalent Population ¹	2,296	0
Total Development Population	6,443	1,580

Note 1 - Institutional equivalent population was estimated by converting the Cambridge West Master Environmental Servicing Plan projected school institutional flows to population assuming the residential per capital demand rate.

3.3 Hydrogeological Conditions

The Blair Road Wellfield study area, consisting of the area surrounding production wells G4 and G4A, is generally located within the Regional Water System Upgrades in Cambridge and North Dumfries study area, north of Blenheim Road, and is shown in **Figure 3**. The existing hydrogeological conditions within the Blair Road Wellfield, summarized in the sections below, are detailed in **Appendix B** (Technical Memorandum #2 and #3).



Regional Water System Upgrades in Cambridge and North Dumfries

Figure 3: Blair Road Wells (Wells G4/G4A) Study Area

Water Infrastructure

- Existing Facilities
- ≤ 250 mm
- > 250 mm

Blair Road Well Field

- Drivenpoint Piezometer/ Staff Gauge
- New Monitoring Well
- Region Monitoring Well

MECP Water Wells Records (within 1 km of Blair Road Wells)

- Monitoring/Observation Well
- Water Supply - Domestic
- Water Supply - Industrial

Blair Road Wellfield Study Area

- Blair Road Wellfield Study Area
- Lakes, Rivers and Creeks
- Wetland
- Environmentally Sensitive Area



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3.3.1 Quaternary Geology

The Blair Road Wellfield study area is located within the Guelph Drumlin Field physiographic region, within a glacial spillway landform (Chapman and Putnam, 2007). Outwash plains of coarse-grained sand and gravel deposits (Unit 7) and ice-contact stratified deposits (Unit 6) are present at surface in much of the Blair Road Wellfield study area. A silty to sandy till (Unit 5b) is found in a ridge to the south of Wells G4/G4A, roughly parallel to Blair Road. This till has been mapped as Wentworth till (Stantec, 2011a). More recent organic deposits (Unit 20) of muck and peat are found in the areas of the wetland complexes. Bedrock (Unit 3) is exposed in the Grand River valley with some modern alluvial deposits at the edges of the river.

The overburden in the Blair Road Wellfield is generally thin, ranging in thickness from 0 m at the Grand River to approximately 4.6 m at Wells G4/G4A and 13.5 m at monitoring well OW5-95 to the northeast. At Wells G4/G4A, overburden sediments are coarse-grained gravelly sand, likely corresponding to Outwash deposits (Unit 7) that sit unconformably on bedrock. Dolostone bedrock that subcrops beneath the Cambridge area was deposited in a marine environment during the Silurian Period. These thick carbonate rocks are the source of groundwater for bedrock wells in Cambridge.

3.3.2 Bedrock Geology

The bedrock formation sequence from youngest to oldest within the Blair Road Wellfield includes the following:

- **Guelph Formation** – The surface of the Guelph Formation slopes in a southerly to southeasterly direction and represents an aquifer unit; Production Well G4 is open through the Guelph Formation.
- **Eramosa Formation** – The Reformatory Quarry and Vinemount Members of the Eramosa Formation are generally a regionally significant bedrock aquitard, with the Vinemount Member typically less permeable than the Reformatory Quarry Member. In the Blair Road Wellfield, the Reformatory Quarry Member is an aquifer resulting in most of the groundwater flow in Well G4A is within the Reformatory Quarry Member. The Vinemount Member is not present near Wells G4/G4A but may be present to the southeast of the Blair Road Wellfield.
- **Goat Island Formation** – The Goat Island Formation consists of two members: the upper Ancaster Member and the lower Niagara Falls Member. Well G4A is open through the lower Guelph Formation, Eramosa Formation (Reformatory Quarry Member) and into the Goat Island Formation. The deepest flow zone in G4A is within the top of the Goat Island Formation.
- **Gasport Formation** – The Gasport Formation is one of the main water producing bedrock aquifer units in the Cambridge area. Due to poor groundwater quality in the Gasport Formation at G4A, the lower part of the borehole was plugged using bentonite pellets capped with neat cement.
- **Base of Gasport Formation** – This unit includes the lower Gasport Formation and the Rochester, Irondequoit, Rockway and Merriton Formations, where present, which rest unconformably above the Cabot Head Formation.
- **Cabot Head Formation** – The Cabot Head Formation is a shale unit which is a regional aquitard.

3.3.3 Groundwater Flow System Characterization

The uppermost Guelph Formation is generally fractured and weathered and is hydraulically connected to overlying coarse granular deposits. This unit is sometimes referred to as the Contact Zone aquifer. Groundwater flow in the overburden and the Contact Zone generally follows surface topography and is mapped to flow from the southwest to the east or northeast towards the Grand River with some convergence to Devil's Creek.

In other parts of Cambridge, the Guelph Formation is a shallow bedrock aquifer and the Gasport Formation is a deep bedrock aquifer, with the intervening Eramosa Formation (Reformatory Quarry Member) and Goat Island Formation acting as poor aquifers or poor aquitards. It is noted that in the Middleton Street wellfield, the middle portion of the Guelph Formation forms a bedrock aquitard (Stantec, 2011b). Where present, the Vinemount member of the Eramosa Formation, located between the Reformatory Quarry Member and the Goat Island Formation, is an aquitard. The lower part of the Gasport Formation and the underlying Cabot Head Formation are also aquitards.

In the Blair Road Wellfield, the Vinemount member of the Eramosa Formation is interpreted to be absent. The Reformatory Quarry Member is hydraulically connected to the overlying Guelph Formation and the underlying Goat Island Formation. The Reformatory Quarry Member is a productive aquifer; water from Well G4A is largely from the Reformatory Quarry.

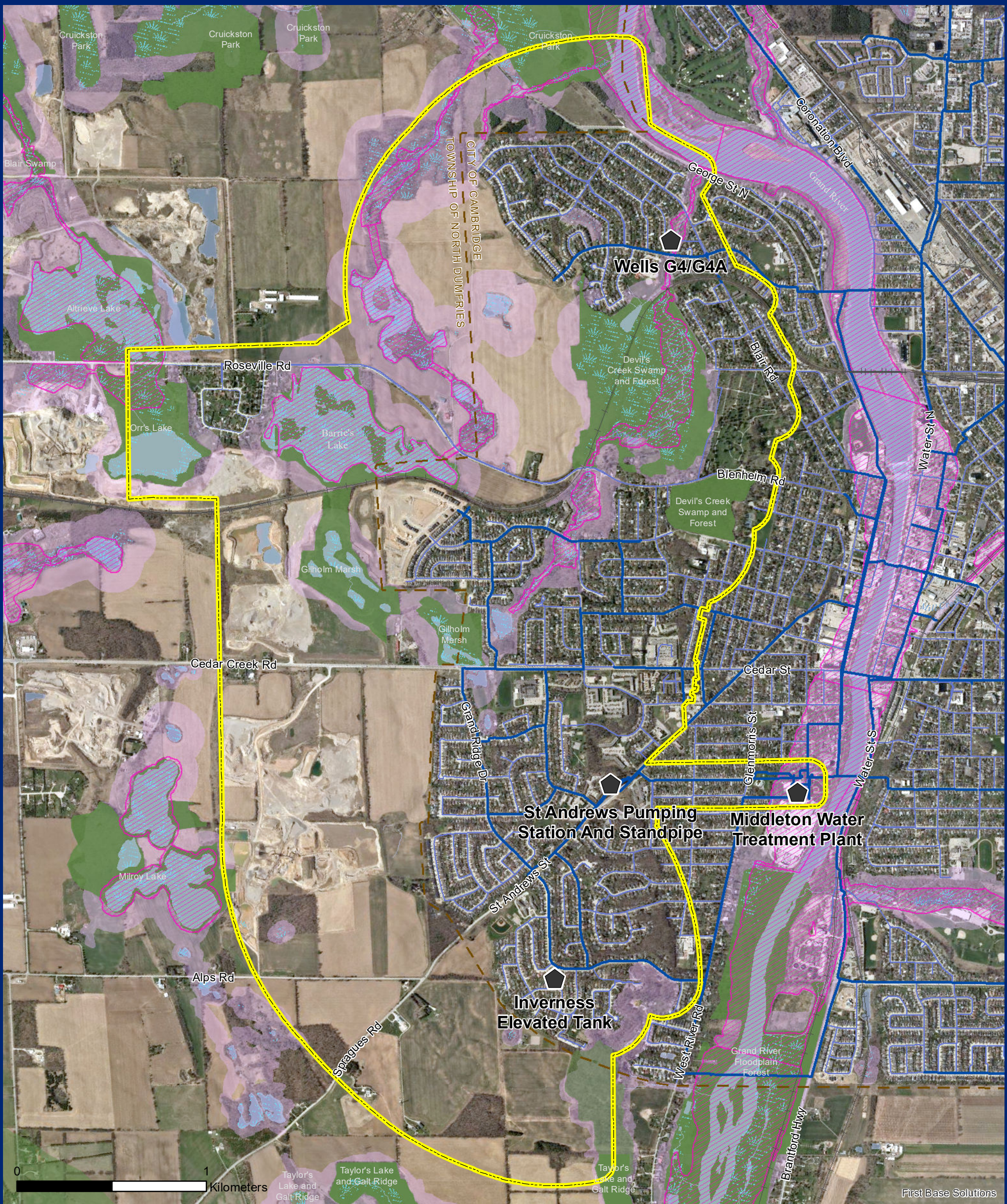
Groundwater flow in the bedrock aquifer generally flows from the southwest to the east / northeast towards the Grand River.

3.3.4 Groundwater Users

Based on a review of the Ministry of Environment, Conservation, and Parks' (MECP) Water Well Information System (WWIS) database, there are 18 water well records (WWR) within a one km radius of Wells G4/G4A. There are also three active PTTW in the study area, including the PTTW for Wells G4/G4A.

3.4 Natural Environment

Within the study area, there are a number of natural features and species at risk (SAR). A desktop-level review of the existing natural environment was conducted, detailed in **Appendix A** (Technical Memorandum #1), presenting the desktop findings and assessing potential project impacts within the study area. **Figure 4** presents the existing natural environment features within the study area. Further to the desktop-level review, a natural heritage existing conditions report was prepared to identify significant natural heritage features, including SAR, animal movement corridors, and migratory bird stopover locations, was completed at each of the short-listed ET sites, discussed in **Section 6** and detailed further in **Appendix D** (Technical Memorandum #5).



First Base Solutions



Regional Water System Upgrades in Cambridge and North Dumfries

Figure 4: Natural Environment

Water Infrastructure		Natural Environmental Features	
	Existing Facilities		Wetlands
	≤ 250 mm		Environmentally Sensitive Areas (ESA)
	> 250 mm		Areas of Natural and Scientific Interest (ANSI)
	Study Area		Waterbodies and Watercourses
	Municipal Boundary		Regulatory Floodplain
			Regulation Limit



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3.4.1 Natural Areas

There is one (1) provincially significant life science area of natural and scientific interest (ANSI), as defined by the Ministry of Natural Resources (MNRF), in the study area. The Grand River Forests Life Science ANSI overlaps the southern tip of the study area, south of Fairlake Drive. The ANSI is associated with the forest south of Fairlake Drive, west of West River Road and east of the agricultural fields.

Two (2) provincially significant wetlands (PSW), as designated by MNRF, have been identified within the study area. The Gilholm-Salisbury PSW is located in the north-central portion of the study area, generally north of Blenheim Road and along Devil's Creek. Barrie's Lake Bauman Creek Wetland Complex is also in the north-central portion of the study area, south of Roseville Road.

Significant woodlands within the study area are defined by City of Cambridge and RoW Official Plans as woodlands with the following characteristics:

- Greater than 4 hectares (ha) in size (excluding adjoining hedgerows);
- Consisting primarily of indigenous (i.e. native) species of trees; and,
- Meets the criteria of a woodland in accordance with the provisions of the Regional Woodland Conservation By-Law.

There is one significant valleyland within the study area, the Grand River valley, as defined by the City of Cambridge and RoW Official Plans.

The Blair-Bechtel-Cruickston Environmentally Sensitive Landscape (ESL) is located north of Cedar Creek Road and west of the municipal boundary, as defined by the City of Cambridge, RoW, and Township of North Dumfries Official Plans.

3.4.2 Species at Risk

Based on the desktop assessment, 51 species designated as special concern, threatened or endangered under the Endangered Species Act (ESA) or Species at Risk Act (SARA), or ranked S1-S3, were assessed to have moderate or high potential to occur within the study area. Of these, 17 are designated as threatened or endangered under the ESA and receive individual and habitat protection. The other species with moderate or high potential do not have regulatory protection; however, habitat for these species must still be considered under the Significant Wildlife Habitat criteria of the Provincial Policy Statement in the impact assessment for the Class EA. Threatened or endangered species with moderate to high potential to occur in the study area include:

- Seven (7) birds (bank swallow, barn swallow, bobolink, cerulean warbler, chimney swift, eastern meadowlark, least bittern);
- Four (4) mammals (small-footed myotis, little brown myotis, northern myotis, and tri-colored bat);
- Two (2) herpetofauna (Jefferson salamander, Blanding's turtle); and
- Four (4) vascular plants (American chestnut, American columbo, butternut, and false hop sedge).

The majority of potential suitable habitat for these SARs are concentrated in the Gilholm-Salisbury Wetland and Barrie's Lake Bauman Creek Wetland Complex, other areas of woodland, riparian habitat, and ponds within the study area. Some species, such as chimney swift and barn swallow, may also use anthropogenic structures for habitat.

The presence of SARs at each short listed ET location, as observed during field work conducted in the summer 2018 and summer 2019, is outlined in **Section 6** and detailed in **Appendix D** (Technical Memorandum #5).

3.4.3 Aquatic Features and Fish Habitat

Watercourses and waterbodies occurring within the study area are components of the Grand River watershed. The Grand River watershed supports a number of coldwater and warmwater aquatic features; each having unique aquatic communities linked to their thermal characteristics. Named watercourses and waterbodies in the study area and their thermal designations, indicated by Grand River Conservation Authority (GRCA) mapping, are as follows:

- Devil's Creek (Coldwater downstream of Salisbury Avenue; warmwater upstream of Salisbury Avenue);
- Cruickston Creek (Unknown);
- Newman Creek (Unknown); and
- Barrie's Lake (Unknown, likely warmwater).

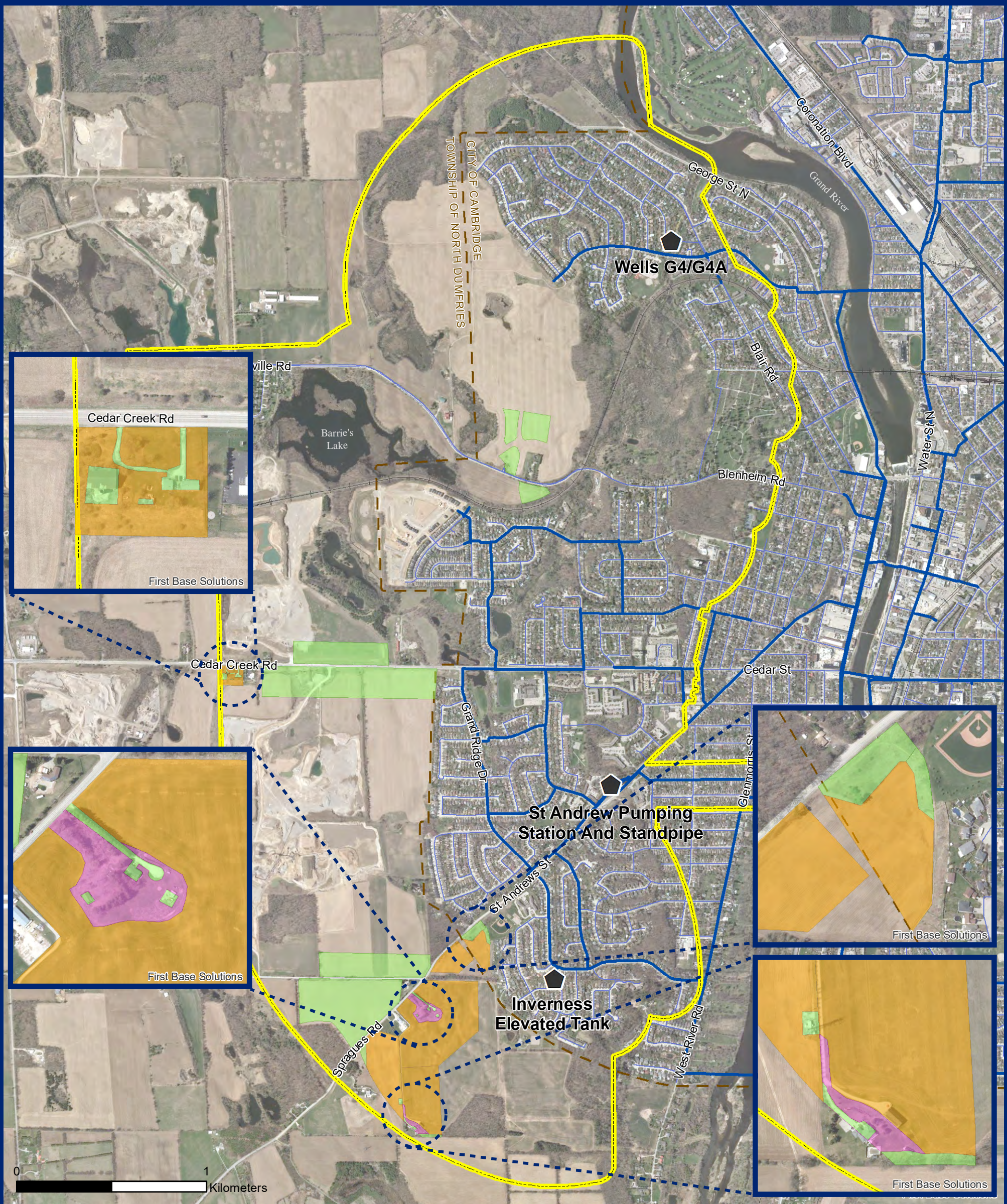
Warm water aquatic features are generally considered to be more robust and tolerant to external effects. Fish species occupying warm water are likewise considered to be more tolerant to changes in groundwater discharge. In contrast, coldwater systems are supported by groundwater inputs and are considered to be capable of supporting cold water fish species, which may be sensitive to reductions in groundwater discharge. Many cold water systems contain transitional coolwater areas that often support both cold water and warmwater species. Coolwater features and fish species are generally considered similarly to those designated cold water.

Devil's Creek is known to support coldwater fish species such as Brown Trout (*Salmo trutta*) and Brook Trout (*Salvelinus fontinalis*) (Wright and Imhof, 2001; LESPRTT, 2008). Other species known to occur in Devil's Creek include Brook Stickleback (*Culaea inconstans*), Pumpkinseed (*Lepomis gibbosus*), Redbelly Dace (*Phoxinus eos*), and Largemouth Bass (*Micropterus salmoides*) (GRCA, 2016).

Approximately 83 native and non-native fish species are present in waterbodies of the Grand River watershed. Cold headwater species such as Brook Trout and Mottled Sculpin (*Cottus bairdii*) and top predator warm species such as Largemouth Bass, Northern Pike (*Esox Lucius*) and Walleye (*Stizostedion vitreum vitreum*) are resident in many areas, but the more dominant and common fish groups are represented by baitfish (i.e., minnows) (Wright and Imhof, 2001).









3.5 Archeological Assessment

An Archeological Screening, detailed in **Appendix A** (Technical Memorandum #1), identified that there is continuous occupation of the study area from pre-contact indigenous time through to the historical Euro-Canadian period. A review of available resources indicated that the study area exhibits archaeological potential; as such, a Stage 1 Archaeological Assessment, detailed in **Appendix D** (Technical Memorandum #5), was completed for all short listed ET locations to confirm the archaeological potential and provide further recommendations as needed. Locations requiring a Stage 2 Archeological Assessment are highlighted in **Section 6**, detailed in **Appendix D** (Technical Memorandum #5) and shown in **Figure 5**.



Regional Water System Upgrades in Cambridge and North Dumfries

Figure 5: Archaeological Assessment

Water Infrastructure		Stage 1 Archaeological Assessment Schematics	
	Existing Facilities		Stage 2 pedestrian survey at 5m interval recommended
	≤ 250 mm		Stage 2 test pit at 5m interval recommended
	> 250 mm		No further archaeological concern
	Study Area		
	Municipal Boundary		



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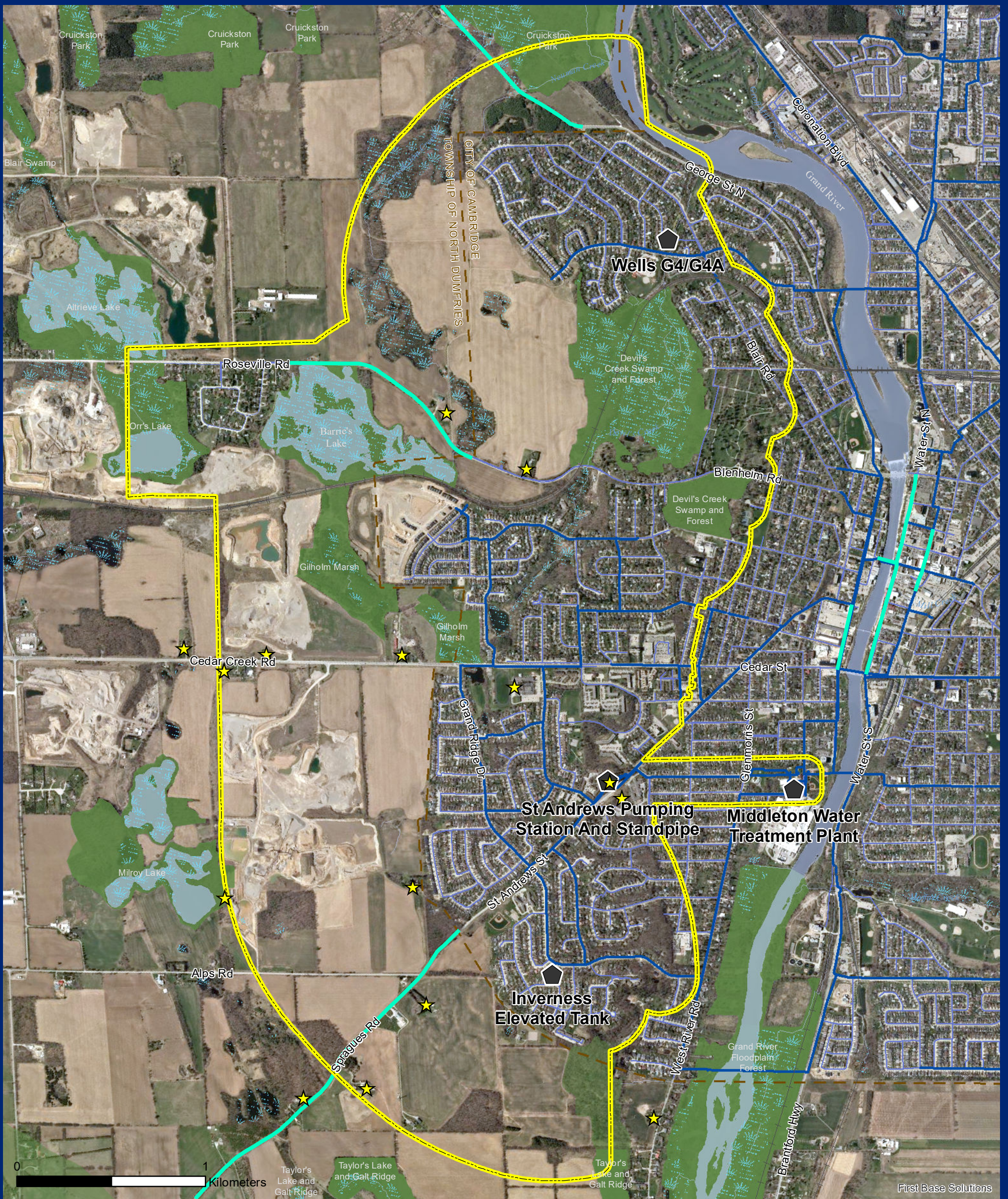


3.6 Cultural and Built Heritage Assessment

A Cultural Heritage Screening, detailed in **Appendix A** (Technical Memorandum #1), determined that viable parcels, for a new ET, within the study area contained:

- Three (3) properties in the Township of North Dumfries classified as “Properties of Historical Interest”;
- Five (5) properties with structures that exceeded 40 years of age, and may require evaluation for cultural heritage of interest;
- Twenty-three (23) properties lying within the limits of the Grand River floodplain, which is a designated Canadian Heritage River System;
- Thirteen (13) properties that are adjacent to properties listed on the City of Cambridge Heritage Properties Register;
- One (1) property that is adjacent to a property of interest;
- Nine (9) properties containing structures with unknown cultural heritage value or interest;
- Twenty-seven (27) properties within an area featuring unique cultural heritage landscapes; and,
- Two (2) scenic roads, Spragues Road categorized as extremely scenic and Roseville Road categorized as some scenic qualities.












Further to the screening, a Cultural Heritage Assessment Report (CHAR), detailed in **Appendix D** (Technical Memorandum #5), was completed for all short listed ET locations and their adjacent parcels to confirm direct and indirect impacts as well as necessary mitigation measures. These impacts are further detailed in **Section 6**. A summary of relevant cultural heritage resources is provided in **Figure 6**.



Regional Water System Upgrades in Cambridge and North Dumfries

Figure 6: Overview of Cultural Heritage Resources

Water Infrastructure

- | | | | |
|---|---------------------|---|---|
|  | Existing Facilities |  | Cultural Heritage Resource |
|  | ≤ 250 mm |  | Scenic Roads |
|  | > 250 mm |  | Wetlands |
|  | Study Area |  | Environmentally Sensitive Areas (ESA) |
|  | Municipal Boundary |  | Areas of Natural and Scientific Interest (ANSI) |
| | |  | Waterbodies and Watercourses |



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4 Technical Servicing Requirements

The long-term water system configuration, proposed for Cam 3, is based on the Implementation Plan (GMBP, 2015) and is similar to the existing configuration.

- The proposed Cam 3 system will continue to operate as an open zone (i.e. it will have floating storage); however, a new ET is proposed to increase the volume of storage provided for equalization, fires, and emergencies.
- Additional watermain upgrades are recommended to increase the redundancy in supply, and aid in the conveyance between the northern and southern areas of the pressure zone. The location and size of the watermain upgrades is dependent on the location of the new ET; however, the upgrades build on the existing watermain network to strengthen the overall system.
- Wells G4/G4A will remain as the only production supply source within Cam 3, with water supply augmented by the St. Andrews PS. The long-term proposed configuration includes increasing the production capacity (an increase in the PTTW) at Well G4A based on the confirmed sustainable pumping rate, such that Well G4A will be able to meet the majority of the Cam 3 water demands under average day conditions. Well G4 can be operated as a back-up to Well G4A; however, Well G4 is not expected to be able to supply the full PTTW capacity.

The design criteria that guided the recommended infrastructure sizing, and the evaluation of alternatives is described in detail in the following section and in **Appendix D** (Technical Memorandum #5).

4.1 System Pressure

The system pressures design criteria to be maintained within the Cam 3 study area are detailed as follows:

- Target operating pressure range of 345 kPa (50 psi) to 550 kPa (80 psi)
- Maintain a minimum pressure of 275 kPa (40 psi) under normal operating conditions (peak hour demand)
- Maintain a maximum pressure of 700 kPa (100 psi) under normal operating conditions (minimum night time flow) for the majority of the system
- Maintain a minimum pressure of 140 kPa (20 psi) under a max day demand + fire flow (MDD+FF) conditions

4.1.1 Cam 3 Target Hydraulic Grade Line

The existing Cam 3 HGL is maintained between approximately 363-367 m, governed by the levels of the Inverness ET and operations at St. Andrews PS. Based on the HGL assessment in **Appendix D** (Technical Memorandum #5), it is recommended that the optimal Cam 3 operating HGL range be generally maintained with minor adjustments in the Top Water Level (TWL), which is dependant on the location of a new ET. The preferable Cam 3 TWL is 365 m for south system (south of St. Andrews Street) or a middle system ET (between St. Andrews Street and Blenheim Road) ET locations and a 366 m TWL for the north system (north of Blenheim Road) ET location.

4.1.1.1 Cam 3 Pressure Zone Boundary Expansion

As part of the Cam 1/Cam 1W project, the existing Cam 1 will be divided, and the remaining Cam 1 will reduce the operating HGL from 332 m to 324-326 m. The reduced Cam 1 HGL will decrease pressures at higher elevation locations within Cam 1, adjacent to the Cam 1/ Cam 3 boundary. As such, a pressure zone boundary realignment is possible to service these Cam 1 properties from Cam 3. The boundary realignment, detailed in **Appendix D** (Technical Memorandum #5), will have the following characteristics:

- General eastern extension of the Cam 3 boundary
 - Berkley Road
 - Osborne Street from Cedar Street to Dumfries Street
 - Caledon Court
- Additional demands to be serviced by Cam 3
 - Average Day Demand (ADD) – 0.69 L/s
 - Maximum Day Demand (MDD) – 0.92 L/s

4.2 Cam 3 System Demands

The Cam 3 capacity upgrades were evaluated under existing 2016 and future 2031, ultimate buildout demands. The finalized Cam 3 ADD and MDD, including the full buildout of the CWLD and boundary expansion demands are summarized in **Table 3**. Further, detailed methodology is provided in **Appendix D** (Technical Memorandum #5).

Table 3: Cam 3 Existing and Future Demands

Cam 3 Demand Scenario		Residential Demands (L/s)	Employment Demands (L/s)	Total Demands (L/s)
2016	Average Day Demand	29.0	1.5	30.5
	Maximum Day Demands	38.2	2.0	40.2
2031 (Ultimate Build Out)	Average Day Demand	40.7	7.3	48.0
	Maximum Day Demands	54.5	9.7	64.2
2031 with Cam 3 Boundary Expansion	Average Day Demand	41.4	7.3	48.6
	Maximum Day Demands	55.4	9.7	65.1

4.2.1 Recommended Fire Flow

The Cam 3 fire flow needs were estimated following a review of MECP supply fire flow recommendations, Fire Underwriters Survey (FUS) guidelines, and the RoW’s Engineering and Planning design practise, detailed in **Appendix D** (Technical Memorandum #5).

In consultation with the RoW, the fire flow used for the purposes of confirming storage needs was based on the RoW’s Engineering and Planning department’s design practise of 250 L/s for 3.25 hours.

The watermain upgrade needs, as it relates to available fire flow capacity, was based on the estimated FUS fire flow (based on available building information) for nine (9) key properties within Cam 3 as well as a fire flow 250 L/s at the institutional property within CWLD as detailed in the Cambridge West Master Environmental Servicing Plan (MHBC, MTE, Paradigm, ecoplans, & LVM, 2013). Fire flow deficiencies that are a result of constraints in local watermains are noted; however, local watermain upgrades are not within the scope of this study.

4.3 Cam 3 Storage Needs

The Cam 3 storage needs were determined using the standard MECP equation (Design Guidelines for Drinking Water System, MECP, 2008) of:

$$\text{Total Storage} = \text{Fire Storage (A)} + \text{Equalization Storage (B)} + \text{Emergency Storage (C)}$$

Multiple scenarios were considered comprising of various methodologies used in the determination of each component in the above equation. Each methodology was fully evaluated and presented to the RoW as discussed in **Appendix D** (Technical Memorandum #5). The final storage recommendations are summarized in **Table 4**.

Table 4: Recommended Elevated Tank Storage

Storage	Methodology Utilized	Methodology Description	Volume (ML)
Fire Storage (A)	Region of Waterloo Engineering and Planning Design Practise	250 L/s for 3.25 hours	2.93
Equalization Storage (B)	Ministry of the Environment, Conservation, and Parks (MECP) Guideline	25% of Max Day Demands under 2031 Ultimate Buildout Conditions	1.41
Emergency Storage (C)	MECP Guideline	25% of the sum of Fire and Equalization Storage	1.08
Total Storage	MECP Guideline	Sum of Fire, Equalization, Emergency Storage	5.41

4.3.1 Existing Storage Assessment

Currently, Cam 3 storage is provided by the Inverness ET, with a design capacity of 2.3 ML, and is supplemented via pumped storage from the St. Andrews SP; however, with the expected operational changes to Cam 1, as part of the creation of Cam 1W and decrease of the Cam 1 HGL, available storage at St. Andrews SP will be reduced to less than 1.0 ML. Once the Cam 1 operational changes are implemented, an existing system and 2031 storage deficit of 1.5 ML and 2.2 ML, respectively, is anticipated.

4.3.1.1 Inverness ET Site

The existing Inverness ET is located on a size constrained site, with less than 2 m of separation between the outer most wall and the closest adjacent residential property boundary and currently does not have any onsite overflow storage. The Inverness ET's location within a residential neighbourhood and its proximity to existing residents increases the general complexity and cost of major operational and maintenance activities. Further, the overall site area prevents the further expansion of storage capacity on the site.

4.3.1.2 St. Andrews SP Site

The existing St. Andrews PS and SP site has a localized high ground elevation, with steep embankments along the northern and eastern limits of the property. Presently, the St. Andrews site does not have any overflow storage and there are concerns regarding the risk to the existing residential properties to the north in the event of an overflow.

The St. Andrews SP is an important part of the operation of Cam 1; however, the planned operational changes to Cam 1 and the recently completed twinning and local interconnections of trunk supply watermain from Middleton WTP to the St. Andrews site are expected to reduce its importance for storage. Storage at the St. Andrews site will continue to provide transient protection to the St. Andrews supply trunk and maintain adequate suction pressure to St. Andrews PS.

4.3.2 New Storage Site

A new storage site will be needed to meet the existing and future Cam 3 storage needs. Through both the WSDOMP and the Implementation Plan for the Cambridge Water System Upgrades, it was recommended that Cam 3 storage needs be consolidated into a new single storage facility, the existing Inverness ET be decommissioned, and decommissioning and/or replacing the St. Andrews SP be explored.

4.4 Wells G4/G4A Supply

Appendix B (Technical Memorandum #2 and #3) summarizes the results of the hydrogeological investigation that was completed to assess the ability to sustainably increase the PTTW at Wells GA/G4A. The existing PTTW (1224-88MK7Q) at Wells G4/G4A is 22 L/s. Results of the hydrogeological investigation indicated that the PTTW can be increased to a maximum withdrawal of 53 L/s and an annual average of 42 L/s, along with the following recommendations and observations:

- Wells G4/G4A current zone of influence is less than 1 km with drawdowns of 1 m or less in the deep bedrock aquifer and no impacts to the shallow overburden
- Increasing the withdrawal rates are expected to:
 - Increase Wells G4/G4A zone of influence
 - Increase Wells G4/G4A drawdown to 5 m (42 L/s) and to 7.5 m (53 L/s) in the deep bedrock aquifer and less than 0.2 m in the shallow overburden
 - Reduce the baseflow to Devil’s Creek by less than 2% (42 L/s) and by 3% (53 L/s)
- The source classification or treatment needs are not anticipated to change with an increase in pumping

4.4.1 Wells G4/G4A Treatment

Wells G4/G4A directly supply the Cam 3 distribution system and are currently classified as GUDI WEF; as such, their current primary and secondary levels of treatment is a combination of ultraviolet (UV) and sodium hypochlorite injection. The following treatment considerations are made based on the proposed changes to the MECP drinking water requirements:

- Minimum treatment requirements for primary disinfection wells classified as groundwater targeting 99.99% (4-log) inactivation of viruses at the Points-Of-Entry (POE)
- Provide second barrier UV treatment for Giardia and Cryptosporidium inactivation

GUDI WEF wells that can demonstrate a long-term history of effective filtration do not need to provide Giardia and Cryptosporidium inactivation requirements. Following the increase in withdrawal at Wells G4/G4A, the RoW could undertake the required two (2) years of monitoring and, if adequately demonstrated that WEF is achieved, remove the UV treatment.

The aesthetic objective (AO) for manganese within the distribution system has been lowered to 0.02 mg/L in the Guidelines for Canadian Drink Water Quality (Health Canada, 2017), which is likely to be adopted by the MECP. The RoW has identified a target of 0.015 mg/L, outlined in the System Wide Water Supply Facility Assessment for the Proposed Health Canada Manganese Guidelines (Stantec, 2017), to ensure the AO of 0.02 mg/L is adequately met.

Historic source manganese concentrations readings at Wells G4/G4A from 1985 to 2012, showed no observed trend and ranged from 0.001 mg/L to 0.014 mg/L, with two transitory spikes of 0.037 mg/L in May 2002, and 0.023 mg/L to 0.05 mg/L in March 2012 while work was being done on the wells. Further, the 2017 System Wide Water Supply Facility Assessment for the Proposed Health Canada Manganese Guidelines Report (Stantec 2017) present manganese concentration from 2012 to 2016 to be typically below 0.01 mg/L

Sampling during the hydrogeological field investigation, conducted from November 30, 2017 to December 6, 2017, identified manganese concentrations ranged from 0.0042 mg/L to 0.0057 mg/L and no trend was observed in concentrations during the sampling events. Based on these results, the increase in withdrawal is not expected to result in manganese concentrations above the AO trigger for treatment; as such, additional treatment to reduce manganese is not expected.

Concentrations of iron, sodium, and chloride measured historically at G4/G4A have been increasing over time but remain below guideline levels. Iron concentration sampling during the hydrogeological field investigation, conducted in November 30, 2017 to December 6, 2017, ranged from 0.01 mg/L to 0.065 mg/L which is below the AO of 0.3 mg/L.

During the 2009 field testing, water quality testing results remained consistent throughout the pumping test with manganese concentrations between 0.012 mg/L to 0.018 mg/L and iron concentrations below the detection limit.

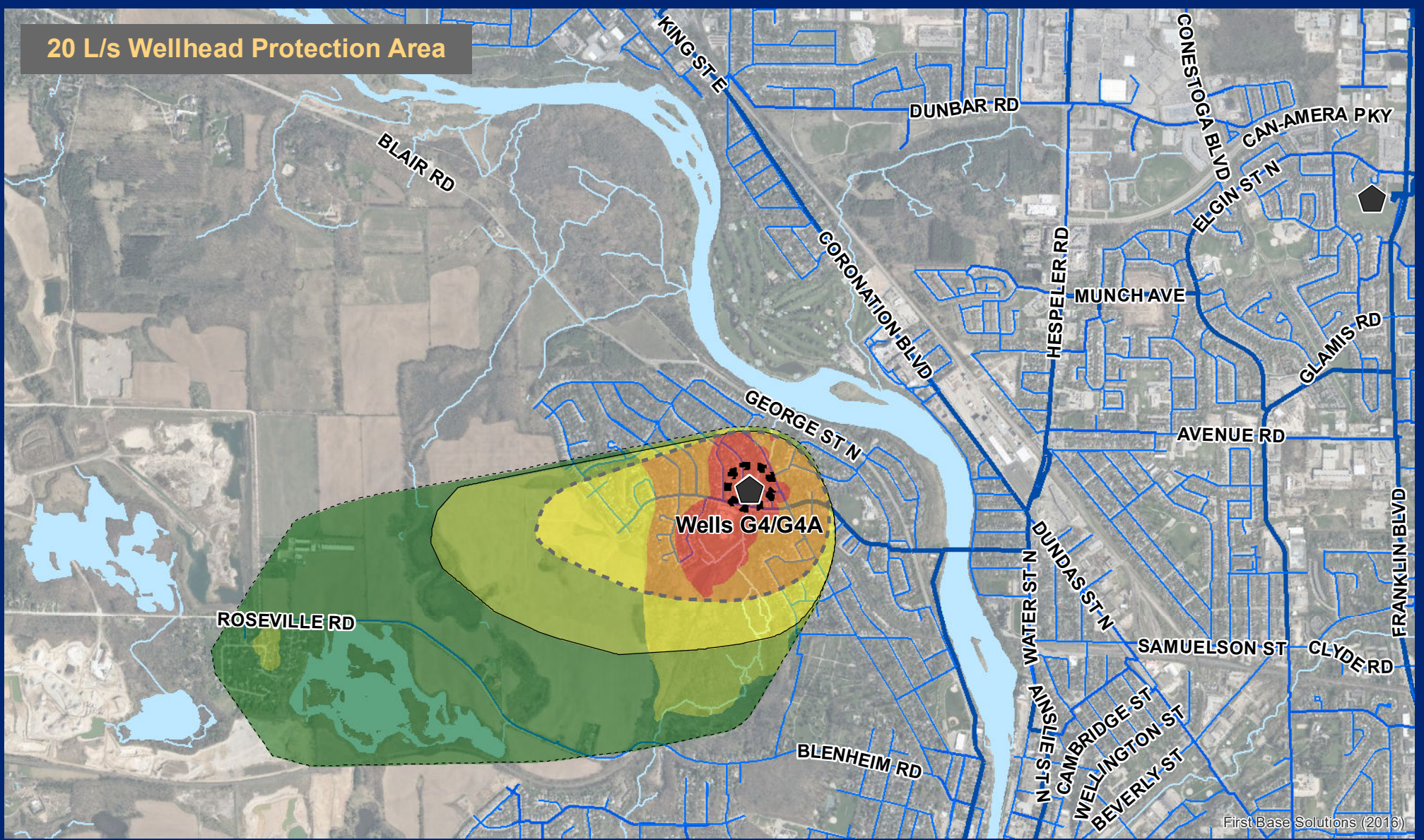
4.4.2 Wells G4/G4A Pumping Capacity

The current well pump at Wells G4/G4A is sized such that the current PTTW of 22 L/s can be provided; however, historically the facility has operated at 16 to 20 L/s. As the proposed PTTW represents an increase in capacity that is nearly double the existing pumping rate, a new well pump is required to operate at a flowrate up to a maximum flow rate of 53 L/s and an average annual flow rate of 42 L/s.

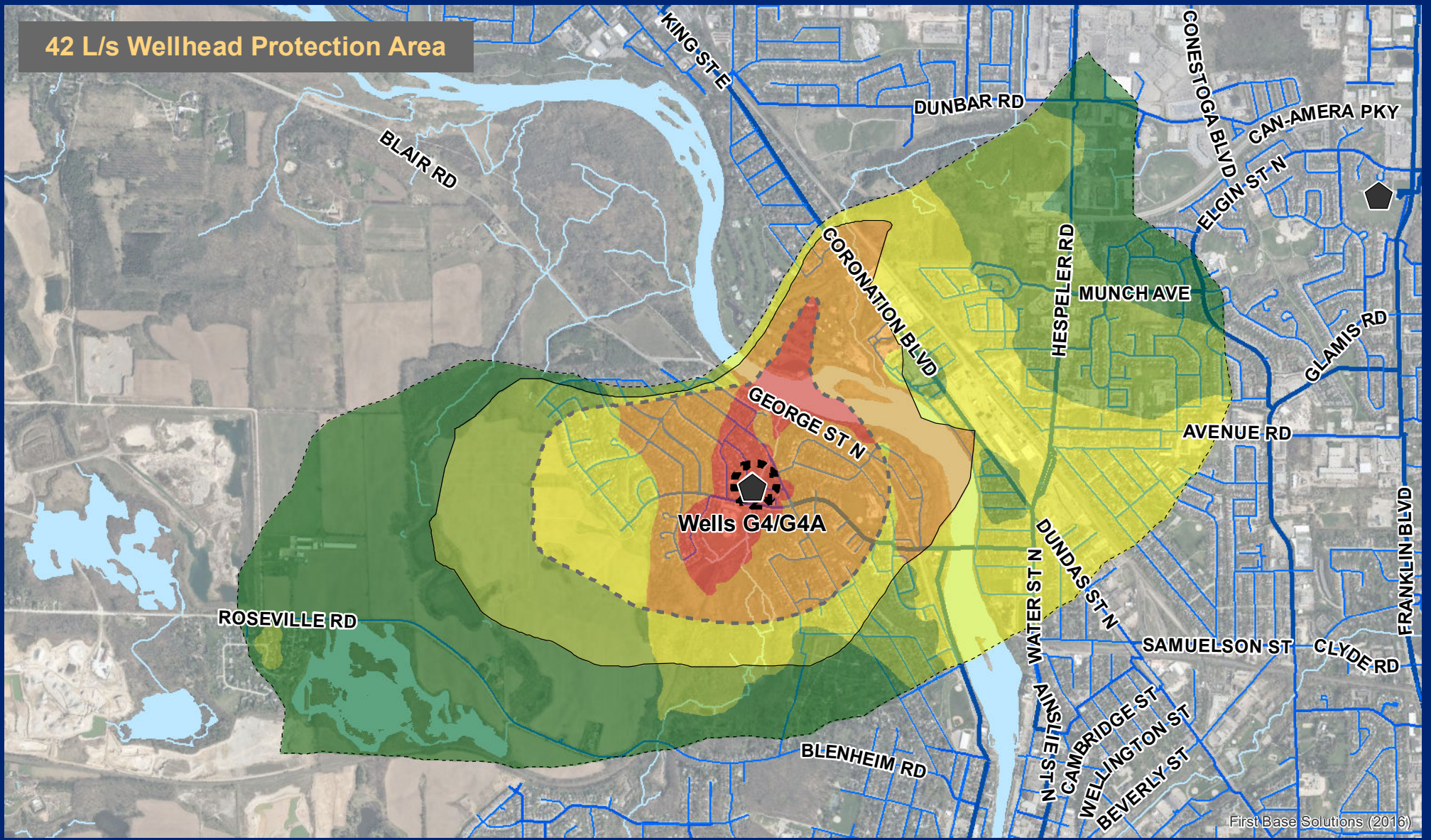
4.4.3 Source Protection Considerations

Wells G4/G4A existing wellhead protection area (WHPA) is included in the approved Grand River Source Protection Plan, as required by the Clean Water Act. The approved WHPA for Wells G4/G4A was delineated by the RoW in 2017 using the Region's Tier 3 FEFLOW groundwater model for the Cambridge area. The WHPAs were delineated for the 100 m, 2-year, 5-year and 25-year time of travel capture zones in accordance with regulations and rules in the Clean Water Act. Within the WHPAs, the intrinsic susceptibility index was used to assess the aquifer vulnerability as low, moderate, or high scores. Preferential pathways which impact contaminants travel from the surface into the aquifer were overlain on the aquifer vulnerability and the WHPAs were scored from two (2) to ten (10) in accordance with provincial regulations and rules. To establish impacts of increasing the PTTW from Wells G4/G4A to an average flow of 42 L/s, the groundwater model was updated to reflect the results of the hydrogeologic analysis completed as part of this EA and the WHPAs were delineated and scored in the same manner as above. **Figure 7** shows the WHPAs and vulnerability scoring at Wells G4/G4A for a withdrawal rate of 20 L/s and 42 L/s.

20 L/s Wellhead Protection Area



42 L/s Wellhead Protection Area



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Figure 7: Wells G4/G4A Wellhead Protection Areas and Vulnerability Scores

Water Infrastructure	Wellhead Protection Areas	Vulnerability Score for Contact Zone
Existing Facilities	WHPA-A (100 m zone)	2 (Low)
≤ 250 mm	WHPA-B (2-year capture zone)	4
> 250 mm	WHPA-C (5-year capture zone)	6
	WHPA-D (25-year capture zone)	8
		10 (High)

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4.4.4 Existing Structure and Mechanical

The condition assessment and review of current process equipment at Wells G4/G4A indicate that the majority of the existing equipment will need to be upgraded to support the increase in the PTTW or replaced based on assets that are nearing the end of their service life.

The existing structure is noted to be in good condition, however, the existing floor area is constrained and limits the capacity to accommodate replacement or upgrading of the existing piping and process equipment. The existing property parcel has sufficient space to accommodate the expansion or replacement of the existing building to accommodate the piping and process equipment upgrades.

4.5 St. Andrews Pumping Station

St. Andrews PS pumping needs are dependent of the recommendations for the new ET and Wells G4/G4A. The pumping station capacity is reliant on the available supply from Wells G4/G4A and the quantity of storage provided within Cam 3 to supplement during high flow conditions.

The capacity needs of the St. Andrews PS are defined as follows:

- St. Andrews PS pumps will provide, at minimum, a firm capacity (i.e. the capacity with the largest pump out of service) to meet the future Cam 3 MDD (MECP Design Guidelines for Drinking Water Systems, 2008) to ensure system redundancy for events such as the ET being out of service for maintenance
- Pump total dynamic head (TDH) needs will consider the decreased HGL within Cam 1 from 332 m to 324-326
- An additional pump to provide fire flow is not required to meet the Cam 3 fire flow needs; however, if redundant Cam 3 fire flow capacity is desired, a fire pump is needed, and will be sized to provide a total installed capacity or the greater of either MDD+FF or Peak Hour Demand (PHD)
- Standby power capacity will be sized to meet firm capacity of the station, inline with the recommendations of the Water Supply and Distribution Standby Power Master Plan (2015)

A capacity assessment of the pumping needs at St. Andrews PS is provided in **Appendix D** (Technical Memorandum #5).

4.6 Linear Watermain Needs

New and/or replaced watermains will facilitate the distribution of water throughout Cam 3 while maintaining peak velocities below 1.5 m/s during normal operating conditions. The location of the watermains are dependent on the new ET location; however, a new watermain through the CWLD, connecting to the existing watermains at Bismark Drive, Blenheim Road, and Freure Drive, is required regardless of the ET location.

New watermain upgrade recommendations will consider the following:

- Capacity to provide peak flows between the new ET location and the supply sources of Wells G4/G4A and St. Andrews PS;
- Capacity to address existing and/or growth related PHD and MDD+FF pressure and flow requirements within the Cam 3;
- Potential installation of a secondary loop north of Cedar Street to strengthen the interconnection between the north and south Cam 3 system; and
- Cost/difficulty of the alignment, in context of achieving the above objectives.

4.7 Standby Power Supply Needs

The RoW's current approach to standby power for the IUS, based on the Water Supply and Distribution Standby Power Master Plan (Stantec, 2015), focuses on providing standby power to facilities such that ADD, in combination with available storage, can be adequately supplied for a period of 48 hours. This includes implementing standby generators to treatment facilities and booster pumping stations to maintain operational flexibility and removal of diesel pumps.

Currently, standby power is provided at the primary water supply sources, Mannheim WTP (Kitchener and Waterloo) and the Middleton WTP (Cambridge), and the booster pumping stations.

The identified strategy for Cam 3 in the RoW's current Standby Power Master Plan is to provide standby power capacity at the St. Andrews PS to maintain supply to Cam 3. The St. Andrews PS has a greater capacity than Wells G4/G4A, providing more operational flexibility. In addition, the St. Andrews PS is supplied directly from the Middleton WTP. As the Middleton WTP is one of the primary supply sources during a power outage, the Middleton WTP has adequate supply to feed St. Andrews PS, and its proximity will allow easier re-fueling for standby generators during an extended power outage.

4.7.1 Backup Power – Sizing

Standby power capacity will be sized to meet booster pumping station firm capacity, inline with the recommendations of the Water Supply and Distribution Standby Power Master Plan (Stantec, 2015).

5 Evaluation Methodology

The development of the evaluation methodology and criteria used to evaluate the servicing alternatives pertaining to the Regional Water System Upgrades in Cambridge and North Dumfries is outlined in the section below and further detailed in **Appendix C** (Technical Memorandum #4).

For both the Schedule B components, construction of a new Cam 3 ET and increasing pumping capacity at Wells G4/G4A above the existing PTTW, the full Phase 2 process of Identification and Evaluation of Alternative Solutions, inline with the Municipal Engineers Association (MEA) Class EA process, was undertaken utilizing the methodology further outlined in this section.

For the remaining Schedule A/A+ components, recommended upgrades were determined when the preferred new ET location and Water Supply (Wells G4/G4A) alternatives were identified. However, the potential Schedule A/A+ component needed to support each of the Cam 3 ET alternatives and water supply alternatives were considered in the evaluation of the Schedule B components.

5.1 Evaluation of Schedule B Components

The Schedule B component alternatives were evaluated on four key categories:

- Technical factors;
- Environmental factors;
- Social and cultural factors; and,
- Financial viability.

Through the EA public consultation process, evaluation factors and specific criteria were presented to the public to solicit feedback on how the individual factors should be considered.

Table 5 summarizes the categories and criteria that used to evaluate each alternative against technical factors; environmental factors; social and cultural factors; and financial viability. For each criteria a score between 0 and 4 was assessed:

0. Solution presents permanent negative impacts and/or presents significant technical challenges
1. Solution presents temporary negative impact and/or presents major technical challenges
2. Solutions presents low or neutral impacts after mitigation and/or some technical challenges
3. Solution presents no adverse impacts and has no substantial technical challenges
4. Solution presents ideal conditions and/or generates beneficial impacts

Following the independent evaluation of each individual criterion, a consolidated score was calculated for each of the four categories (technical factors; environmental factors; social and cultural factors; and financial viability). A total score out of 100 was calculated for each alternative using equal category weighting.

Upon completion of the initial alternative scoring, a sensitivity analysis of the category weighting was undertaken to determine if the recommendation for the preliminary preferred alternatives is sensitive to changes in category weighting. Attention was paid to the impacts of increasing the technical factors, environmental factors, and social and cultural factors categories, as these three categories were identified as most important to the public through the public consultation process.

5.2 Evaluation of Schedule A/A+ Components

Schedule A/A+ projects are considered pre-approved, as they typically result in minor impacts. Recommendations for Schedule A/A+ projects were identified based on the preliminary preferred new Cam 3 ET site and Wells G4/G4A upgrades to support the optimization of the overall Cam 3 water system. As part of the recommendations, mitigation measures were developed for the environmental and social impacts.

Table 5: Evaluation Criteria Table for Schedule B Projects

Category	Criteria	Definition
Technical Factors	Meets existing and future servicing needs	To assess the alternative’s ability to satisfy the project problem and opportunity statements and to achieve the desired system technical level of service objectives (pressure, fire flow, pumping, storage, water quality, water quantity/supply). This includes capacity to meet existing level of service and capacity to support future growth.
	Aligns with existing system and strategy	To assess whether the proposed infrastructure varies significantly from current/planned configuration and operation. This includes minimizing the length of new watermain and watermain upgrade needs and maximizing the capacity/use of existing facilities.
	Provides a reliable water supply	To assess the overall system configuration’s ability to support flexibility in system operations, redundancy in system supply capacity, and minimizes the risk related to single element failure. Includes the feasibility and maintenance of implementation (i.e. length of watermain with associated operation and maintenance factors, additional pumping due to hydraulic conditions, or regular maintenance requirements) and adaptation to increases in system demands or reduction in supply capacity.
	Minimizes and manages construction risk	To assess the alternative’s constructability including scope of infrastructure upgrades, environmental significance, time required to complete construction, and impact on existing utilities. This also includes assessing the timing and technical suitability of project implementation with the aim of improving the overall flexibility in project phasing and reducing the number of critically dependent components.
	Aligns with existing and future land use	To assess the potential impact any required property may have on the implementation process (expropriation of land/land purchase or temporary/permanent easements) and compatibility with surrounding land use.
	Ability to adapt to climate change	To assess the alternative’s resiliency to maintain the desired system technical level of service objectives based on potential climate changes impacts. This includes assessment of system resiliency due to the increase in system demands or reduction in supply capacity, and/or the facility and network vulnerability to climate related failures such as flooding.
Environmental Factors	Protects environmental features	To assess, monitor and ensure the preservation and protection of aquatic resources and natural features within the site location, watermain alignment, and surrounding environment. This includes potential impacts to wetlands, terrestrial habitat/features, vegetation, wood lots, and steep slopes identified by Conservation Authorities, Municipalities, or the Province of Ontario.
	Protects wildlife and species at risk	To assess potential impacts to wild life (including species at risk) within the site location and construction zone. The implementation must not affect the function of habitat for locally significant wildlife, including endangered or threatened species. The habitat includes nesting sites, hibernation areas, foraging areas, areas of wildlife travel, migratory birds/ paths.
	Protects groundwater and well supplies	To assess the potential impact construction and operations may have on the quantity or quality of groundwater, including potential impacts on private well supplies. This may include the investigation of potential, temporary, or permanent issues.
	Minimizes climate change impacts	Uses technology and best practices, where applicable, to minimize climate change impacts and reduce greenhouse gas contributions. This includes consideration during the construction process, day to day operations, and future maintenance requirements.

Category	Criteria	Definition
Social and Cultural Factors	Minimizes impacts to residents related to noise, traffic, and aesthetics	To minimize short and long-term impacts to existing and/or future residents, including noise/dust/vibration, traffic, sightlines, and shadows.
	Minimizes impacts to businesses	To minimize short and long-term impacts to existing and/or future businesses, including noise/dust/vibration, traffic, sightlines, and shadows.
	Minimizes source water protection impacts (Wells G4/G4A Only)	To assess the number of new or existing properties where a new and/or increased land use restriction and/or mitigation measure is required as a result of changes in the Well Head Protection Area boundary and/or Vulnerability Scores. This includes consideration for the number of properties effected, the effected user (private resident, business, public facility, etc.), and the degree of mitigation needed.
	Manages and minimizes construction impacts	To assess potential impacts to existing built-up areas (residents, businesses) due to construction activities, including creating noise/dust/vibrations, traffic and traffic flow, limiting access to properties (temporary), or other. This also includes identifying needs to alter timing and scope of the construction practices to minimize impacts.
	Protects cultural heritage features	To assess potential impacts to a structure, property, district, feature, or landscape that has been previously identified to be of cultural heritage value or interest. Impacts may be deemed as temporary (i.e. site access) or permanent (i.e. altering the existing conditions).
	Protects archaeological features	To assess potential impacts to areas previously determined to have high archeological potential, moderate/unknown archeological potential, or low/no archeological potential.
Financial Viability	Low lifecycle costs	To minimize the lifecycle costs of new infrastructure. The lifecycle cost includes capital, operating, and maintenance costs over a 50 year period.

6 Development of Alternatives

The development of servicing alternatives for each of the Schedule B and Schedule A/A+ components are outlined in the sections below.

6.1 Elevated Tank Alternatives

A new ET is needed to support the recommended Cam 3 system upgrades. As several of the other key infrastructure upgrades needed to satisfy the long-term Cam 3 system upgrade strategy are dependent on the new ET location, the development of alternatives focused on first identifying a suitable location of the new ET that addresses the system and operational needs, while minimizing the overall environmental, social, cultural, and financial impacts.

6.1.1 Development of Elevated Tank Alternatives

A systematic approach was followed to develop alternatives for a new ET which consisted of first developing a long list of locations for consideration, and subsequently developing a short-list for detailed evaluation. This process is detailed further in **Appendix D** (Technical Memorandum #5).

6.1.1.1 Development of Elevated Tank Location Long List

The development of the ET location alternatives first “screened” the study area to identify areas that could satisfy minimum technical requirements related to the construction and long-term operation as detailed in **Table 6**.

Areas meeting the criteria identified in **Table 6** are highlighted in the purple in **Figure 8** with ET candidate areas shown as green circles. The long list of potential ET locations was identified based on:

- Site access, including proximity to existing/future road network and need for potential environmental crossing
- Proximity to the existing water system
- Site area and land ownership configuration

To streamline the site selection process, similar sites and locations were grouped and further screened together. Using reasoned judgement, technical and environmental components were factored in to give preference to the closest logical location while minimizing the distance from the existing distribution system.

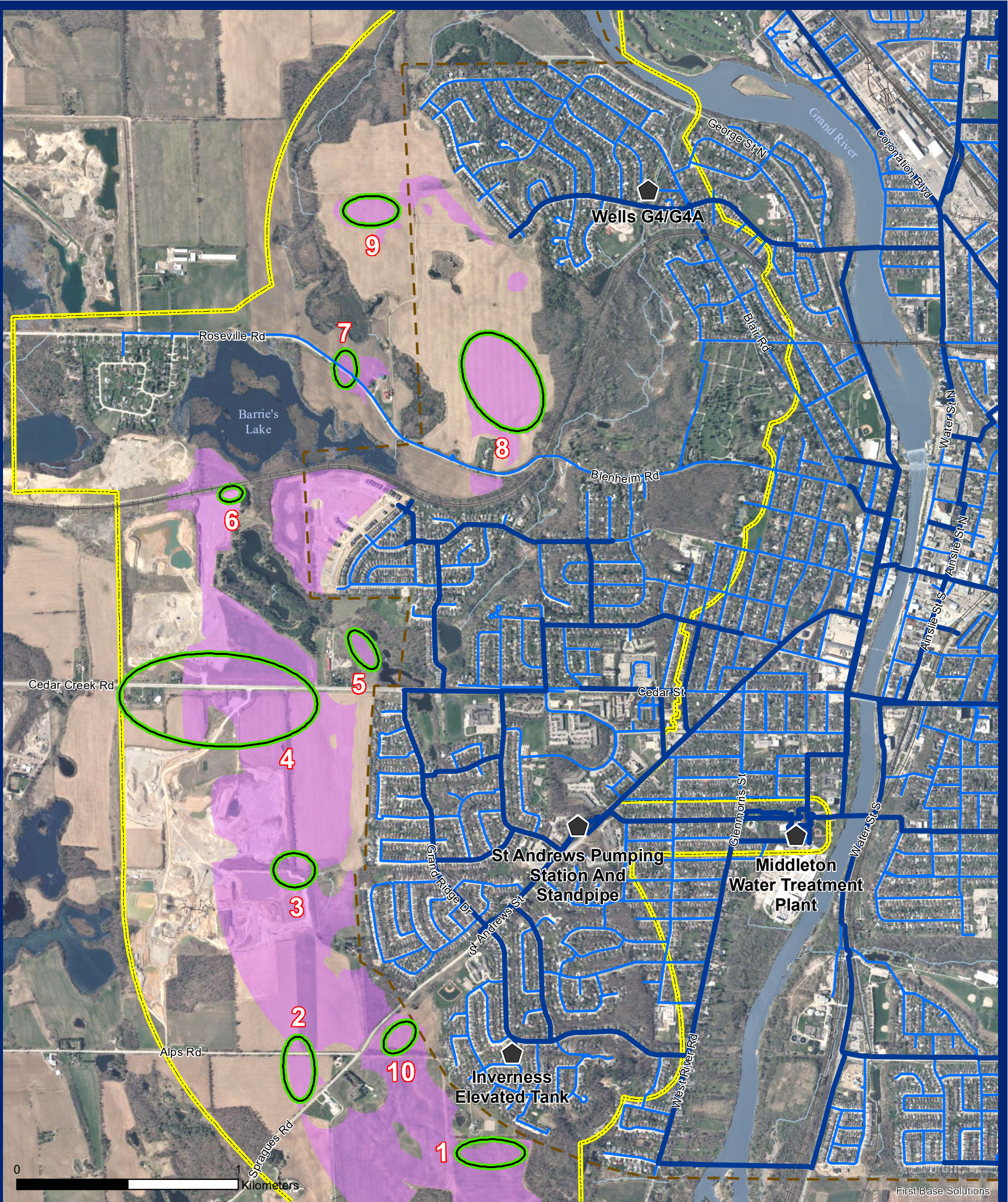
Table 6: Site Screening Technical Requirements

Technical Requirement	Criteria
Site Size	<ul style="list-style-type: none"> • Minimum permanent site of 60 m x 60 m • Ideal construction work space of 80 m x 80 m with additional construction staging area of 30 m x 60 m (additional construction area can be accommodated through temporary work easements) • Ideal permanent site size of 100 m x 100 m
Site Elevation	<ul style="list-style-type: none"> • Site elevation of greater than 315 m
Site Location	<ul style="list-style-type: none"> • Distance from the existing Cam 3 transmission watermains (diameter \geq 250 mm) system to be approximately 1 km or less • Avoid areas of environmental significance • Avoid crossing Union Gas transmission lines
Shadow Impacts on Adjacent Parcels	<ul style="list-style-type: none"> • Buffer of 100 m from existing residential structures • Buffer of 50 m from future residential structures

A total of ten (10) long list ET locations were identified. **Figure 4** highlights the ten (10) locations, further summarized in Appendix C.

6.1.1.2 Development of Elevated Tank Location Short List








The ten (10) long list ET locations were further screened with locations best satisfying all the identified screening criteria identified in **Table 7**. The results of screening the ET long list to develop a short-list of ET locations is summarized in **Table 8**.



Regional Water System Upgrades in Cambridge and North Dumfries

Figure 8: Long List Elevated Tank Location Options - Overview

Water Infrastructure

-  Existing Facilities
-  ≤ 250 mm
-  > 250 mm
-  Study Area
-  Potential Water Tower Sites
-  Areas Meeting Technical Criteria
-  Lakes, Rivers and Creeks



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First Base Solutions

Table 7: Site Screening Guiding Principles

Guiding Principles	Criteria
Site Technical Viability	<p>Does the site meet all technical criteria?</p> <ul style="list-style-type: none"> • Land use, land size, & elevation • Location <ul style="list-style-type: none"> ○ Distance from existing water system ○ Proximity to existing environmental features ○ Shadow exposure on residential structures • Priority given to parcels with commercial, greenfield, agricultural, or industrial land use • Ability to satisfy the Problem and Opportunity Statement
Environmental Impacts	<p>What are the potential environmental impacts of this site relative to the other sites? Can the environmental impacts be avoided/mitigated?</p> <ul style="list-style-type: none"> • Proximity to environmental features or protected areas • Ecological linkages, known areas with Species at Risk, or migratory birds • Crossing of environmental feature • Within a wellhead protection area
Social/Cultural Impacts	<p>What are the potential social/cultural impacts of this site relative to the other sites? Can the social/cultural impacts be avoided/mitigated?</p> <ul style="list-style-type: none"> • Proximity to cultural heritage and areas of scenic value • Existing land use • Protected Countryside and Prime Agricultural Area • Mineral Aggregate Resource Area • Feedback from public to date
Technical Servicing Impacts and Viability	<p>What are the potential technical servicing impacts and viability of this site relative to the other sites?</p> <ul style="list-style-type: none"> • Minimize potential risks associated with surroundings • Ease of integration with existing system • Ease of construction and operations & maintenance

Table 8: Long List Elevated Tank Site Evaluation Summary

Site	Site Technical Viability	Environmental Impacts	Social/ Cultural Impacts	Technical Servicing Impacts and Viability	Short List
1	✓	✓	✓	✗	No
2	✓	✓	✓	✓	Yes
3	✓	✓	✓	✗	No
4	✓	✓	✓	✓	Yes
5	✓	≈	✓	✓	No
6	✓	≈	✓	✗	No
7	✓	≈	✓	✓	No
8	✓	✓	✓	✓	Yes
9	✓	✓	✓	≈	No
10	✓	✓	✓	✓	Yes

✓ Meets criteria

≈ Additional mitigation/
investigation needed

✗ Does not meet criteria

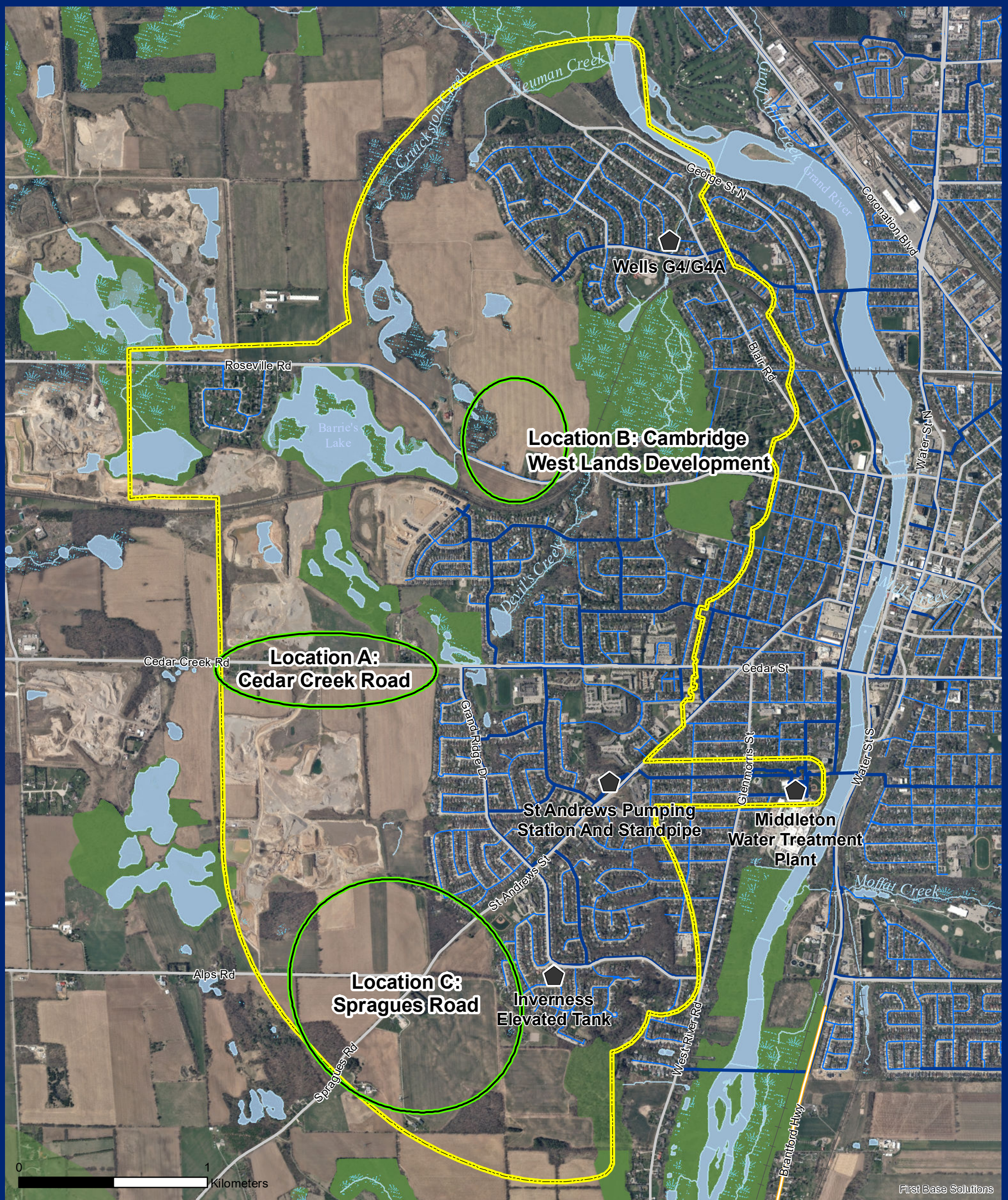
6.1.2 Elevated Tank Short Listed Location Opportunities and Constraints

The results of screening the ET long list to develop a short-list of ET locations is presented in **Figure 9**. Within these three (3) potential ET locations, several sites were identified for further investigations including a natural heritage existing conditions report, archaeological assessment, cultural heritage assessment, and shadow analysis. It can be noted that the short listed ET locations were renamed for ease of communication when discussing options moving forward in the study.

Each location is summarized below:

- **Cedar Creek Road (Location A):** This location is along Cedar Creek Road in North Dumfries, 200 m to 1 km west of the City of Cambridge limits. The location south of Cedar Creek Road is slated for future aggregate extraction, and the location to the north of Cedar Creek Road has recently undergone and completed aggregate extraction.
- **Cambridge West Lands Development (Location B):** This location is in Cambridge north and south of Blenheim Road, in the future Cambridge West Lands Development area.
- **Spragues Road (Location C):** This location is in both North Dumfries and Cambridge, along St. Andrews Street and Spragues Road, extending approximately 800 m southwest of the municipal boundary. The location is currently agricultural with planned residential development for parcels within the City's current municipal boundary, and planned or potential for future aggregate extraction for the remaining areas.







The opportunities and constraints of each short listed ET alternative are outlined in **Table 9** and further detailed in **Appendix D** (Technical Memorandum #5).



Regional Water System Upgrades in Cambridge and North Dumfries

Figure 9: Elevated Tank Alternatives

Water Infrastructure

-  Existing Facilities
-  ≤ 250 mm
-  > 250 mm
-  Study Area
-  Potential Water Tower Locations
-  Lakes, Rivers and Creeks



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Table 9: Summary of Opportunities/Constraints for Short-Listed Elevated Tank Locations

Alternative	Opportunities	Constraints
Cedar Creek Road (Location A)	<ul style="list-style-type: none"> Mid-system location is hydraulically preferred Shortest length of upgrades to increase the size of existing watermains Site drainage away from Gilholm Marsh if located south of Cedar Creek Road Located far from existing residential neighbourhoods No archaeological potential within disturbed areas within existing or previous aggregate extraction Potential for low property acquisition costs (applies to select areas within this location depending on planned future land uses) 	<ul style="list-style-type: none"> Lower ground elevation, if located north of Cedar Creek Road, which requires taller ET and potentially more complex foundation and construction work Potential impacts related to adjacent aggregate extraction Potential species at risk (SAR) habitat which requires mitigation measures Need for more comprehensive onsite stormwater management if located north of Cedar Creek Road as site drains towards Gilholm Marsh Proximity to cultural heritage properties may require mitigation measures Stage 2 Archaeological Assessment recommended for undisturbed areas Potential for high property acquisition cost (applies to select areas within this location depending on planned future land uses) Potential for longer length of new watermain required to connect the ET to the existing water distribution system (applies to sites further from the municipal boundary)
Cambridge West Lands Development (Location B)	<ul style="list-style-type: none"> Environmental mitigation measures can be incorporated with the Cambridge West Lands Development (CWLD) mitigation and compensation plan SAR habitat and proximity to wetland require mitigation measures addressed through CWLD, environmental mitigation and compensation plan No archaeological potential Region of Waterloo has a provision on the current draft plan for the CWLD to identify this may be a possible location for a new ET Lower length of new watermains to connect to the existing water system 	<ul style="list-style-type: none"> North-system location is less ideal hydraulically but meets system needs Longer length of upgrades to increase the size of existing watermains for north system locations Construction may be more complex due to phasing of the development Partially located within the Grand River Conservation Area (GRCA) regulated area and would require a permit Need for more comprehensive onsite stormwater management as site drains towards GRCA regulated area Potential encroachment issues in the future with residential development buildout Proximity to cultural heritage properties and historic viewsheds and may require mitigation measures Potential for high property acquisition cost
Spragues Road (Location C)	<ul style="list-style-type: none"> Far from existing residential neighbourhoods if located within the Township of North Dumfries, No archaeological potential if located west of Spragues Road Potential for lower property acquisition costs for sites with agricultural zoning Lower length of new watermains to connect to the existing water system if located within the City of Cambridge 	<ul style="list-style-type: none"> South-system location is less ideal hydraulically but meets system needs Consideration for the telecommunications tower Longer length of upgrades to increase the size of existing watermains for south system locations Potential SAR habitat which requires mitigation measures Proximity to cultural heritage properties and viewsheds may require mitigation measures Stage 2 Archaeological Assessment recommended if located east of Spragues Road and St. Andrews Street Potential for high property acquisition costs for if located within a future development area within the City of Cambridge or future aggregate extraction area, west of Spragues Road Potential for longer length of new watermains to connect the ET to the existing distribution system (applies to sites further from the municipal boundary)

6.2 Water Supply Alternatives

Two (2) water supply alternatives were developed, to meet future demands within Cam 3, and summarized as follows:

- **Increase Supply from Wells G4/G4A:** Increase the maximum PTTW from 22 L/s to 53 L/s with an average annual taking not exceeding 42 L/s, as outlined in **Appendix B** (Technical Memorandum #2 and #3), requires the replacement of the existing well pump to accommodate the increased flow rate and required process piping, monitoring equipment, and chlorination equipment. To accommodate the equipment, expansion of the existing structure or construction of a new structure is needed. Additionally, to provide improved conveyance from Wells G4/G4A to the existing network, watermain upgrades have been identified to support the increased PTTW capacity when a flow rate greater than 32 L/s is realized. Two (2) alignment alternatives exist as follows:
 - Upgrade through Morva Rouse Park Easement
 - 200 mm through the Morva Rouse Park easement from Wells G4/G4A to Blair Road
 - 200 mm on Blair Road from the Morva Rouse Park easement to Bismark Drive
 - Upgrades on Dianne Avenue and Leslie Avenue
 - 200 mm on Dianne Avenue from Wells G4/G4A to Leslie Avenue
 - 200 mm on Leslie Avenue from Dianne Avenue to Bismark Drive
- **Increase Reliance on St. Andrews Pumping Station:** Maintaining the existing PTTW of 22 L/s at Wells G4/G4A requires increased demand within Cam 3 to be supplied through transfers from Cam 1 via the St. Andrews PS. As such, the St. Andrews PS will continue to be the primary supply source for Cam 3 and upgrades to the existing pumps are required to meet future demand needs. Long-term, a new supply well would be needed to meet Cambridge's overall water supply needs based on the Region's WSMP (Stantec, 2014).

The opportunities and constraints of each water supply alternative are outlined in **Table 10** further detailed in **Appendix D** (Technical Memorandum #5).

Table 10: Water Supply Alternatives

Alternative	Opportunities	Constraints
Increase Supply from Wells G4/G4A	<ul style="list-style-type: none"> Reduces transfers from Cam 1 and increases independence of Cam 3, optimizing pressure zone operations Upgrades needed to accommodate higher permit to take water (PTTW) including new well pump and variable frequency drive (VFD), process piping, monitoring equipment, ultra-violet (UV), and chlorination equipment which align with service life of many of these assets Satisfies the recommendations of the Water Supply Master Plan (Stantec, 2014) 	<ul style="list-style-type: none"> Additional properties impacted by revised Wellhead Protection Area Increased construction along residential roads Existing structure constraints require expansion of the existing structure or new structure Costs are related to additional equipment and structure at Wells G4/G4A
Increase Reliance on St. Andrews Pumping Station (PS)	<ul style="list-style-type: none"> Reduces upgrade needs and need for new wellhouse at Wells G4/G4A No additional environmental considerations as upgrades are in the existing pump house Short-term upgrade costs are related to new pumps at St. Andrews PS 	<ul style="list-style-type: none"> Increases transfers from Cam 1 and maintains or decreases independence of Cam 3, operational flexibility is not improved Reduces available water supply for Cambridge to meet future demands Deviation from the Water Supply Master Plan (Stantec, 2014) Potential for reduced level of service during outages or maintenance Replacement of the UV system at Wells G4/G4A is still needed as the equipment is near the end of service life Unknown impacts as they relate to an alternate supply source being secured within the City of Cambridge to meet long-term future water demands

6.3 Watermain Upgrade Alternatives

To strengthen the current Cam 3 watermain conveyance capacities and reduce constraints, watermain upgrades were proposed in the Implementation Plan and WSDOMP, including a new 300 mm watermain through the greenfield development area to support interconnection between the northern and southern areas of Cam 3. Further, conditional on the location of the potential new ET, watermain upgrades may be required to connect to the existing network and strengthen the hydraulic capacity to convey water from the ET throughout Cam 3.

The linear watermain upgrade alternatives are outlined below and includes sub-alternatives of watermain alignment iterations:

- **Previously Planned Watermain Upgrades:** No additional watermain upgrades within the existing system, with the exception of the following planned watermain upgrade works are needed to support the future development area and construction and operation of a new ET:
 - 450 mm watermain from the new ET connecting to the existing system
 - 300 mm CWLD development watermain connecting at Bismark Drive, Blenheim Road, and Freure Drive
- **Watermain Upgrades to Blenheim Road:** Upgrades specifically focus on strengthening the connection of north and south Cam 3 through additional watermain upgrades north of Blenheim Road, primarily to replace the existing watermain through the Mount View Cemetery. Three (3) alignment options are as follows:
 - **Alignment through Cemetery**
 - 300 mm watermain through the CWLD connecting at Bismark Drive, Blenheim Road, and Freure Drive
 - 300 mm watermain on Blair Road from Bismark Drive to Grant Street
 - 300 mm watermain on Grant Street from Blair Road to Kenmore Avenue
 - 300 mm watermain through Mount View Cemetery from Grant Street to Blenheim Road
 - 300 mm watermain on Blenheim Road from Mount View Cemetery to CWLD watermain

- **Alignment along Blair Road**
 - 300 mm watermain through the CWLD connecting at Bismark Drive, Blenheim Road, and Freure Drive
 - 300 mm watermain on Blair Road from Bismark Drive to Blenheim Road
 - 300 mm watermain on Blenheim Road from Blair Road to CWLD watermain
- **Upsize through Development Lands**
 - 450 mm watermain through the CWLD connecting at Bismark Drive, Blenheim Road, and Freure Drive
 - 300 mm watermain on Blenheim Road from Parkwood Drive to CWLD watermain
- **Watermain Upgrades to Cedar Street:** Watermain upgrades, in addition to upgrades outlined in the Watermain Upgrades to Blenheim Road Alternative, to further strengthen the system. The additional watermains identified are south of Blenheim and north of Cedar Street and include the following:
 - 300 mm watermain on Parkwood Drive from Blenheim Road to Hillcrest Drive
 - 300 mm watermain on Hillcrest Drive from Parkwood Drive to Churchill Drive
 - 300 mm watermain on Churchill Drive from Hillcrest Drive to Southgate Road
 - 300 mm watermain on Southgate Road from Churchill Drive to Cedar Street
 - 300 mm watermain on Cedar Street from Southgate Road to Southwood Drive
- **Watermain Upgrades to St. Andrews Street:** Watermain upgrades in addition to upgrades outlined in the Upgrades to Cedar Street Alternative to further strengthen the north-south conveyance of the system. The additional watermains identified are south of Cedar Street and include the following:
 - 450 mm watermain on Cedar Street from Southwood Drive to Grand Ridge Drive
 - 450 mm watermain on Grand Ridge Drive from Cedar Street to St. Andrews Street

The opportunities and constraints of each alternative are outlined in **Table 11** and further detailed in **Appendix D** (Technical Memorandum #5).

Table 11: Watermain Upgrade Alternatives

Alternative	Opportunities	Constraints
Previously Planned Upgrades	<ul style="list-style-type: none"> • Lowest cost alternative • Minimal construction impacts 	<ul style="list-style-type: none"> • Minimal benefit to the system • Does not improve redundancy • Is not able to sustain or improve fire flow capacities at all critical locations for all elevated tank (ET) locations
Upgrades to Blenheim	<ul style="list-style-type: none"> • Strengthens watermain network and system conveyance • Meets trunk fire flow needs if an ET is constructed at the Cedar Creek Road location 	<ul style="list-style-type: none"> • Additional upgrades to sustain or improve fire flow needs if an ET is constructed at the Cambridge West Lands Development (CWLD) and Spragues Road locations
Upgrades to Blenheim-Cemetery Alignment	<ul style="list-style-type: none"> • Shortest Upgrades to Blenheim Road alignment upgrade distance 	<ul style="list-style-type: none"> • Difficult for construction • High consequence of failure due to location within cemetery
Upgrades to Blenheim-Blair Road Alignment	<ul style="list-style-type: none"> • Reduced construction risks compared to the Cemetery Alignment 	<ul style="list-style-type: none"> • Longest Upgrades to Blenheim watermain length • Construction on collector road • Higher internal pressures in watermains within Cam 1
Upgrades to Blenheim-Upsize Through Development Lands	<ul style="list-style-type: none"> • Removes upgrades through Cemetery or Blair Road 	<ul style="list-style-type: none"> • Single watermain reduces system redundancy
Upgrades to Cedar Street	<ul style="list-style-type: none"> • Improves conveyance, fire flows, and system redundancy • Meets trunk fire flow needs if an ET is constructed at the Cedar Creek Road or CWLD locations 	<ul style="list-style-type: none"> • Requires additional upgrades to meet trunk fire flow needs if an ET is constructed at the Spragues Road location • High cost and construction
Upgrade to Spragues Road	<ul style="list-style-type: none"> • Greatest system benefit • Improves conveyance, fire flows, and system redundancy • Meets trunk fire flow at all key locations for all ET locations 	<ul style="list-style-type: none"> • Highest cost alternative • Highest construction impact

6.4 St. Andrews Pumping Station Upgrade Alternatives

The existing St. Andrews PS will remain, with potential rehabilitation and/or pump capacity upgrades depending on the ultimate system configuration and needs. In the future, the pumping station will continue to supply Cam 3 via Cam 1; however, the flows provided by St. Andrews PS are intended to supplement supply from Wells G4/G4A. Currently the St. Andrews PS is configured with 3 pumps (2 duty pumps and 1 diesel fire pump). The two duty pumps currently operate in an alternating duty/standby configuration.

The proposed Cam 1 HGL and operational changes will alter the existing operations at St. Andrews, as the Middleton PS controls will no longer be based on the St. Andrews SP levels and instead be based on the levels in Turnbull Reservoir. Although the existing pumps have sufficient capacity based on flow, the revised HGL in Cam 1 will result in the need for an increased TDH.

Established in the Water Supply and Distribution Standby Power Master Plan (Stantec, 2015) and further identified in the Implementation Plan, the standby power within the St. Andrews facility has the potential to be improved beyond its current diesel pump. Installation of a generator would provide the opportunity to have standby power for pumping and communication needs.

The St. Andrews PS alternatives are detailed as follows:

- **Maintain Existing Duty Pumps:** Consists of maintaining the existing duty pumps at the St. Andrews PS. Due to the future planned decrease in the Cam 1 operational HGL, maintaining the existing duty pumps will result in a future decrease in the station's operational capacity due to the increased TDH. Station electrical upgrades would be required to replace the existing diesel fire pump with an electrical fire pump and to support the new standby power generator, as recommended by the Water Supply and Distribution Standby Power Master Plan (Stantec, 2015). The backup power generator would be sized to provide the station with firm station capacity.

- **Supply Maximum Day Demand:** Consists of modifying the configuration of the St. Andrews PS to a three (3) pump configuration (duty (A), lag (A), and standby(A)) capable of providing ultimate build out (2031) MDD, requiring the full replacement of all existing pumps. This alternative relies on fire storage from the new ET. Station electrical upgrades would be required to replace the existing diesel fire pump with an electrical fire pump and to support the new standby power generator, as recommended by the Water Supply and Distribution Standby Power Master Plan (Stantec, 2015). The generator would be sized to provide standby power for the firm capacity of the station.
- **Supply Max Day Demand and Supplement Fire Flow:** Consists of replacing all the pumps at St. Andrews PS with replacement of duty pumps designed to supply MDD utilizing 2 pumps and supplement fire flow utilizing a new electric fire pump. A backup power generator would be sized to provide the station with firm capacity. Station electrical upgrades would be required to replace the existing diesel fire pump with an electrical fire pump and to support the new standby power generator.

The opportunities and constraints of each alternative are outlined in **Table 12** and further detailed in **Appendix D** (Technical Memorandum #5).

Table 12: St. Andrews Pumping Station Upgrades Alternatives

Alternative	Opportunities	Constraints
<p>Maintain Existing Duty Pumps</p>	<ul style="list-style-type: none"> • Reduces reliance on transfers from Cam 1 as the capacity is decreased • Can achieve average day demand with Cedar Creek Road or Spragues Road location 	<ul style="list-style-type: none"> • Cannot support Cambridge West Lands Development (CWLD) fire flows without watermain upgrades • Reduced security of supply as lowered Cam 1 hydraulic grade line requires more head gain and a lower flow rate would be available • Larger pumps are difficult to operate during normal conditions
<p>Supply Maximum Day Demand</p>	<ul style="list-style-type: none"> • Optimizes pumping station operation • Removal of a fire pump reduces station's energy consumption 	<ul style="list-style-type: none"> • Reduction in redundancy and long-term operations and maintenance issues with planned elevated tank shutdowns • Increases reliance on conveyance from the watermain network
<p>Supply Maximum Day Demand plus Fire Flow</p>	<ul style="list-style-type: none"> • Provides operational flexibility and security 	<ul style="list-style-type: none"> • Larger pumps are difficult to operate during normal conditions

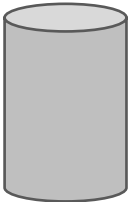

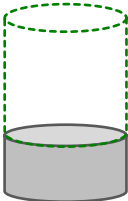
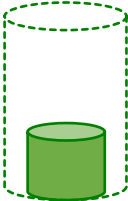
6.5 St. Andrews Standpipe Upgrade Alternatives

The St. Andrews SP currently provides floating storage to Cam 1, as well as suction pressure and transient protection for the St. Andrews PS. With the proposed Cam 1 HGL and operational changes, Turnbull Reservoir will be able to provide a greater amount of floating storage to Cam 1 and the full volume of the existing St. Andrews SP will no longer be needed. The future purpose of the St. Andrews SP would be to maintain adequate suction pressure and transient protection of the St. Andrews PS. The following presents the St. Andrews SP upgrade alternatives as follows:

- **Maintain Existing Standpipe Alternative:** Consists of preserving the existing standpipe as is and requires no works to alter system configuration.
- **Remove Standpipe Alternative:** Consists of removing the SP completely and St. Andrews PS will rely on a direct feed from the Middleton WTP
- **Modify Existing Standpipe Alternative:** Considers the modification of the existing SP at St. Andrews PS and involves the shortening of the SP to accommodate the reduced Cam 1 HGL. By completing the SP modification, it is intended that the SP will continue to be in service.
- **New Standpipe Alternative:** Consists of the construction of a new SP at St. Andrews PS designed to accommodate the decreased HGL in Cam 1 and may further refine storage volume needs.

The opportunities and constraints of each alternative are outlined in **Table 13**.

Table 13: St. Andrews Standpipe Upgrade Alternatives

Alternative	Opportunities	Constraints
Maintain Existing Standpipe (SP) 	<ul style="list-style-type: none"> Upgrade costs limited to work on existing structure 	<ul style="list-style-type: none"> Future operations and maintenance (O&M) costs may be high due to aging infrastructure May present operation and safety concerns
Remove SP 	<ul style="list-style-type: none"> Reduces future O&M costs due to SP 	<ul style="list-style-type: none"> May require additional surge protection and may increase long term O&M costs
Modify existing SP 	<ul style="list-style-type: none"> Reduces construction costs and yard piping required Reduces water quality issues due to partially empty SP 	<ul style="list-style-type: none"> At risk of transient spikes during construction process Need to be timed with upgrades to elevated tank (ET) and Wells G4/G4A Future O&M costs may be high due to aging infrastructure
New SP 	<ul style="list-style-type: none"> Optimizes volume, height, configuration, and location of a new SP Easier staging and normal pumping station (PS) operations during construction process Lowest long-term O&M cost to maintain a SP 	<ul style="list-style-type: none"> Highest capital costs

6.6 Existing Inverness Elevated Tank

The existing Inverness ET is undersized to meet existing and projected Cam 3 storage needs. Further, the existing site is constrained based on limited available space; it is not well suited to support ongoing and long-term maintenance needs and cannot accommodate capacity expansions. In the future, it is expected that the Inverness ET will not be necessary once a new storage facility is constructed. The following alternatives have been identified:

- **Maintain Inverness Alternative** – Maintains the existing Inverness ET
- **Decommission Inverness Alternative** – Removes the existing Inverness ET

The opportunities and constraints of each Inverness ET alternative are outlined in **Table 14**.

Table 14: Inverness Elevated Tank Alternatives

Inverness Elevated Tank Alternatives	Opportunities	Constraints
Maintain Inverness	<ul style="list-style-type: none"> • Provides redundancy of floating storage during future major rehabilitation work for the new Elevated Tank (ET) 	<ul style="list-style-type: none"> • Increases operational complexity of the system • High operation and maintenance cost to maintain two tanks
Decommission Inverness	<ul style="list-style-type: none"> • Reduced operational complexity 	<ul style="list-style-type: none"> • Complicated removal due to proximity to existing residential homes

6.7 Bismark Check Valve

The existing Bismark CV supplements fire flows within north Cam 3, generally north of Bismark Drive, and provides security of supply in the event of a watermain failure. Following the completion of the Cam 1/Cam 1W works, resulting in a reduced Cam 1 HGL, the CV's ability to supplement fire flows will be reduced. The following alternative have been identified:

- **Maintain Bismark**– Maintains the existing Bismark CV
- **Decommission Bismark** – Removes the existing Bismark CV

The opportunities and constraints of each Bismark CV alternative are outlined in **Table 15**. Further, it should be noted that additional watermain upgrades will not improve flow capacity from the Bismark CV as flow is limited by the future HGL differential between Cam 1 and Cam 3.

Table 15: Bismark Check Valve Alternatives

Bismark Check Valve Alternatives	Opportunities	Constraints
Maintain Bismark	<ul style="list-style-type: none"> • Provides supplemental fire flow to the adjacent area in Cam 3 • Improves security of supply within north Cam 3 in the event of a watermain failure 	<ul style="list-style-type: none"> • Reduced ability to supplement fire flows due to reduced Cam 1 hydraulic grade line • Is not able to support fire flows within Cambridge West Lands Development in the event of a watermain failure
Decommission Bismark	<ul style="list-style-type: none"> • Reduced operation and maintenance needs as replaced valve will be a boundary valve 	<ul style="list-style-type: none"> • Reduces security of supply within north Cam 3 in the event of a watermain failure

7 Evaluation of Alternatives

This section presents the evaluation of each of the Schedule B and Schedule A/A+ components. The full evaluation is detailed in **Appendix E** (Technical Memorandum #6).

- For both the Schedule B components, construction of a new Cam 3 ET and increasing the supply from Wells G4/G4A above the existing PTTW, the full Phase 2 process of Identification and Evaluation of Alternative Solutions, in line with the MEA Class EA process, was undertaken using the methodology further outlined in this section.
- For the remaining Schedule A/A+ components, recommended upgrades were determined following the identification of the preferred new ET location and Water Supply alternatives.

7.1 Evaluation of Elevated Tank Alternatives

Table 16 summarizes the results of the preliminary evaluation of the ET alternatives. It is noted that the magnitude and impact of supporting watermain and system upgrades needed to support the operational viability was considered when evaluating each ET alternative.

Based on the preliminary ET alternative evaluation, Location A – Cedar Creek Road (along Cedar Creek Road, approximately 300-1,200 m from the municipal boundary) has the highest scores for technical factors, environmental factors, and social and cultural factors and is tied for the highest score for financial factors, as the Cedar Creek Road alternative generally has:

- High technical factors score due to the optimal location for system hydraulics and supporting infrastructure needs
- The highest environmental factors score due to the limited proximity of significant environmental features, limited presence of significant wildlife or species at risk, and limited impact on wildlife migration
- High social and cultural factors score, due to its separation from existing/ future residences, limited construction impacts, and limited impacts to the residential landscape

- An equal financial viability score due to its similar overall life cycle costs to other ET alternatives
- The Spragues Road alternative generally scored lower than the Cedar Creek Road alternative due to the following reasons:
 - Some lower technical factors score due to the reduced system efficiencies, the greatest infrastructure upgrade needs
 - Lower environmental factors score due to their proximity to significant environmental features and increased presence of species at risk
 - Lower social and cultural factors score due to the increased construction impacts related to the increased supporting watermain upgrade needs
 - An equal financial viability score due to its similar overall life cycle costs to other ET alternatives
- The CWLD alternative generally scored the lowest due to the following reasons:
 - Lower technical factors score due to the reduced system efficiencies, increased infrastructure upgrade needs, and increased timing risk due to the dependency on developer led watermain infrastructure
 - Lower environmental factors score due to their proximity to significant environmental features and increased presence of species at risk
 - The lowest social and cultural factors score due to their placement within a future residential subdivision, and the expected future impacts to residents and impacts to the developers
 - An equal financial viability score due to its similar overall life cycle costs to other ET alternatives

A sensitivity analysis, provided in **Appendix E** (Technical Memorandum #6), demonstrated how potentially doubling the category weighting of each of the technical factors, environmental factors, social and cultural factors, and financial viability categories affects overall alternatives scoring and ranking of the ET alternatives.

Based on this sensitivity analysis, the general ranking of Cedar Creek Road, CWLD, and Spragues Road alternatives relative to each other remains unchanged as Cedar Creek Road remains ranked first.

Table 16: Elevated Tank Alternative Preliminary Evaluation

Evaluation Criteria		Cedar Creek Road (Location A)	Cambridge West Lands Development (Location B)	Spragues Road (Location C)
Technical Factors	Meets existing and future servicing needs	3	2	3
	Aligns with existing system and strategy	4	3	2
	Provides a reliable water supply	3	3	2
	Minimizes and manages construction risk	2	3	3
	Aligns with existing and future land use	1	1	2
	Ability to adapt to climate change	4	4	4
	Total Score	17	16	16
	Weighted Score	17.7	16.7	16.7
Environmental Factors	Protects environmental features	4	2	3
	Protects wildlife and species at risk	3	3	3
	Protects groundwater and well supplies	4	4	4
	Minimizes climate change impacts	4	3	2
	Total Score	15	12	12
	Weighted Score	23.4	18.8	18.8
Social and Cultural Factors	Minimizes impacts to residents related to noise, traffic, and aesthetics	3	0	3
	Minimizes impacts to businesses	2	1	3
	Manages and minimizes construction impacts	3	2	1
	Protects cultural heritage features	3	3	3
	Protects archaeological features	3	4	3
	Total Score	14	10	13
	Weighted Score	17.5	12.5	16.3
Financial Viability	Low lifecycle costs	3	3	3
	Total Score	3	3	3
	Weighted Score	18.8	18.8	18.8
Alternative Score Out of 100		77.4	66.7	70.4
Alternative Rank		1	3	2

Based on the evaluation, the recommended new ET alternative is **Location A – Cedar Creek Road (along Cedar Creek Road, approximately 300-1,200 m from the municipal boundary)**. A summary of the key benefits for the recommended location are provided below:

- A mid-system location (Cedar Creek Road) requires the least amount of supporting infrastructure upgrades while providing improved long-term system operational flexibility and efficiency relative to north system (CWLD) and south system (Spragues Road) ET placement
- The recommended location is not in close proximity to significant environmental features or wildlife migration routes and produces the least amount of greenhouse gas due to hydraulic configuration and long-term operational needs
- The recommended location has a greater separation distance from existing/future residences, limited construction impacts, and limited impacts to the local landscape
- The recommended location has similar life cycle costs as the other alternatives

Potential constraints, as they relate to the recommended ET alternative, are as follows:

- The existing and previous land use as an aggregate extraction pit leads to:
 - Potential impacts to the existing aggregate extraction business and higher land acquisition costs or potential construction complexities related to filling a previously extracted area
 - Construction and implementation risks related to potential schedule delays
- Identified species at risk and cultural heritage structures within the Cedar Creek Road location, resulting in mitigation measures that will be required

These factors were accounted for in the evaluation process; however, the benefits of the remaining criteria still resulted in the Cedar Creek Road location being the highest overall scoring ET location.

7.2 Evaluation of Water Supply Alternatives

Table 17 summarizes the results of the preliminary evaluation of the water supply alternatives. Based on the preliminary evaluation of the water supply alternatives, the following is noted:

- The alternative to increase supply from Wells G4/G4A has the highest technical factors score, as it increases the water supply in Cambridge to meet the objectives of the WSMP (Stantec, 2014), improves the water system’s operational flexibility, and enhances the systems ability to adapt to climate change
- The alternative to increase the reliance on the St. Andrews PS does not increase the water supply in Cambridge. As water demands for the system increase, additional supply will still be necessary, therefore, the evaluation of alternatives assumed an additional supply of 20 L/s would need to be secured at a new location (which would need to be identified through future studies).
- The associated impacts related to increasing the water supply by 20 L/s elsewhere in the system are, at this time, unknown; as such:
 - All environmental and social and cultural factors were not scored higher than three (3) due to the uncertainty of future impacts related to securing the additional 20 L/s supply
 - There is a need to account for the future costs related to securing the additional 20 L/s supply including: studies, land acquisition, and construction
- The Wells G4/G4A wellhouse and process piping need rehabilitation based on the current asset conditions to maintain the existing supply capacity; as such, the near-term cost associated with the rehabilitation at the Wells G4/G4A site needs to be accounted for in the costing of both alternatives

Table 17: Water Supply Alternatives Preliminary Evaluation

Water Supply Alternative Evaluation		Increase Supply from Wells G4/G4A	Increase Reliance on St. Andrews Pumping Station
Technical Factors	Meets existing and future servicing needs	4	1
	Aligns with existing system and strategy	3	1
	Provides a reliable water supply	4	0
	Minimizes and manages construction risk	3	2
	Aligns with existing and future land use	4	4
	Ability to adapt to climate change	4	0
	Total Score	22	8
	Weighted Score	22.9	8.3
Environmental Factors	Protects environment features	3	3
	Protects wildlife and species at risk	4	3
	Protects groundwater and well supplies	3	3
	Minimizes climate change impacts	3	3
	Total Score	13	12
	Weighted Score	20.3	18.8
Social and Cultural Factors	Minimizes impacts to residents related to noise, traffic, and aesthetics	4	3
	Minimizes impacts to businesses	4	3
	Minimizes source water protection impacts	3	2
	Manages and minimizes construction impacts	2	3
	Protects cultural heritage features	4	3
	Protects archaeological features	4	3
	Total Score	21	17
	Weighted Score	21.9	17.7
Financial Viability	Low lifecycle costs	4	2
	Total Score	4	2
	Weighted Score	25.0	12.5
Total Score out of 100		90.1	57.3
Alternative Rank		1	2

Based on the evaluation of alternatives, the recommended water supply alternative is **Increase Supply from Wells G4/G4A**, based on:

- The highest technical factors score, as it increases the water supply to meet the long-term water supply needs, as identified in the Region’s WSMP (Stantec, 2014)
- If water supply is not increased at Wells G4/G4A, an additional 20 L/s water supply will need to be secured elsewhere. The associated impacts related to increasing the water supply by 20 L/s elsewhere in the system are unknown at this time; however, it can be assumed that developing a new supply well, rather than increasing the supply from an existing well with good water quality, will have a greater impact for technical, environmental, social, and financial considerations.
- The Wells G4/G4A wellhouse and process piping need rehabilitation based on the current asset conditions to maintain the existing supply capacity. The additional cost related to increasing the PTTW at Wells G4/G4A represent a minor increase in the total cost at the site, and represent a lower system wide life-cycle cost.
- Watermain needs associated with the upgrades at Wells G4/G4A are subject to further investigations during detailed design to confirm the preferred alignment based on constructability considerations and opportunities to coordinate with planned projects. Both alignment options identified to accommodate an increase in flow from Wells G4/G4A are within existing road right-of-way or utility easements (refer to **Section 7.3** for details).

As the **Increase Supply from Wells G4/G4A** scores the highest in all four (4) evaluation categories, a sensitivity analysis was not needed.

7.3 Evaluation of Supporting Project Elements

The evaluation and recommendation of the preferred solutions for the remaining Schedule A/A+ projects are based on the following recommended ET alternative and water supply alternative:

- **Location A – Cedar Creek Road (along of Cedar Creek Road, approximately 300-1,200 m from the municipal boundary)**
- **Increase Supply from Wells G4/G4A**

7.3.1 Watermain Upgrades

Based on the recommended strategy for Cam 3 the following watermain are required:

- 450 mm watermain connecting the new ET to the existing system
- Increased watermain capacity from Wells G4/G4A to Bismark Drive
- Increased watermain capacity between Bismark Road and Blenheim Road to support peak flow needs, this upgrade is in addition to the already proposed 300 mm CWLD watermain connecting the existing watermain on Freure Drive and Westcliff Way

7.3.1.1 Watermain Upgrades to Support New Elevated Tank

Based on the recommended ET alternative, a 450 mm watermain connecting the new ET is recommended along the existing Cedar Creek Road, which is to connect to the existing 300 mm watermain on Grand Ridge Drive.

7.3.1.2 Watermain Upgrades to Support Increased Supply from Wells G4/G4A

Two potential watermain alignments to support the increased PTTW capacity at Wells G4/G4A were identified. **Table 18** summarizes the project capital costs and advantages and disadvantages of the two (2) alternatives. Note that for both watermain alignment options, the long-term operational and maintenance costs are proportional to the capital costs; as such, only the capital cost was considered in the evaluation.

Based on a review of the upgrade alternatives, additional investigations are required to confirm the preferred alignment based on constructability considerations and opportunities to coordinate with other planned projects.

Table 18: Watermain Alignment Alternatives

Watermain Alignments	Advantages	Disadvantages	Capital Costs
Morva Rouse Park Easement	<ul style="list-style-type: none"> • Existing easement through Morva Rouse Park • Watermain upgrades can be combined with future planned replacement of the existing watermain • Reduced impacts to local residents • Shorter distance of upgrades required (250 m) 	<ul style="list-style-type: none"> • Alignment under Devil’s Creek and through Grand River Conservation Authority (GRCA) regulated area • Potential constructability and approval challenges due to location 	\$560,000
Dianne Avenue and Leslie Avenue	<ul style="list-style-type: none"> • Reduced construction risk 	<ul style="list-style-type: none"> • Longer distance of upgrades required (590 m) • Future replacement of Morva Rouse Park Easement watermain still needed • Increased construction impacts to local residents 	\$690,000

7.3.1.3 Watermain Upgrades to Support the Increased Capacity between Bismark Road and Blenheim Road

A review of the watermain upgrade alternatives needed to support the increased capacity between Bismark Road and Blenheim Road is detailed in **Table 19**. Note that for the watermain alignment options the long-term operational and maintenance costs are proportional to capital costs; as such, only the capital cost was considered in the evaluation.

Further, a third option, upsize watermain through the CWLD to 450 mm, was considered as an additional watermain alternative to strengthen the connection between Bismark Road and Blenheim Road. This watermain upgrade alternative was not carried forward into the watermain evaluation as it does not meet the Study's objectives. The Study's problem and opportunity statement outlined a need to increase overall efficiency, reliability, and flexibility which are not achieved through the upsizing of the development watermain as there is a dependency on a single watermain. This dependency results in an increased system risk and consequence of failure.

At the time of this analysis, further investigations are needed to make a recommendation on the preferred watermain alignment; as such, the final recommendation is that one of the following two alignments (i.e. only one alignment is necessary) be implemented to provide a secondary north-south connection and provide improved redundancy in supply for the northern area of Cam 3:

- **Alignment through Cemetery** – Upgrade along the existing watermain alignment through Mount View Cemetery and install a new watermain along Blenheim Road to the new CWLD 300 mm watermain
- **Alignment along Blair Road** – Install a new watermain along Blair Road and Blenheim Road to the new CWLD 300 mm watermain

Either of these alternatives can be implemented at any time and the final alignment should be completed alongside the City of Cambridge or RoW's State of Good Repair (SOGR) program.

In addition to the SOGR repair projects, new 300 mm watermains will be installed through the Cambridge West Development extending the existing Bismark Drive and Hardcastle Drive watermains and along the realigned Blenheim Road.

Table 19: Watermain Alignment Alternatives

Watermain Alignments	Advantages	Disadvantages	Capital Costs
Through Cemetery	<ul style="list-style-type: none"> • Existing easement through City owned land • Provides security of supply • Medium distance of upgrades required (2.7 km) 	<ul style="list-style-type: none"> • Alignment through cemetery may have negative social and consequence of failure impacts • Potential constructability challenges due to location • One (1) creek and two (2) rail crossings required 	\$6,200,000
Along Blair Road	<ul style="list-style-type: none"> • Reduced construction risk compared to Cemetery alignment • Provides security of supply 	<ul style="list-style-type: none"> • Longest distance of upgrades required (3.3 km) • Potential for high traffic impacts due to collector road • One (1) creek and two (2) rail crossings required Increased internal watermain pressures for the portion of Cam 3 watermain alignment within Cam 1 (~120 psi) 	\$6,700,000

7.3.2 St. Andrews Pumping Station Upgrades

Based on a review of the upgrade alternatives, detailed in **Table 20**, it is recommended that the St. Andrews PS **Supply MDD** by reconfiguring St. Andrews PS to have three (3) equally sized pumps, with a firm pumping station capacity capable of meeting future MDD as:

- A fire pump is not required as the new ET will be sized to provide adequate fire protection to Cam 3. Timing of future ET maintenance work will be infrequent and for short duration; as such, there are other operational alternatives to manage fire risk during ET maintenance periods
- Use of three (3) equally sized pumps will improve the operational efficiency and flexibility of the station
- Existing pumps will not be capable of meeting MDD under the proposed reconfiguration of Cambridge

Table 20: St. Andrews Pumping Station Upgrade Alternatives

St. Andrews Pumping Station Upgrades	Advantages	Disadvantages	Lifecycle Costs
Maintain Existing Duty Pumps	<ul style="list-style-type: none"> • Can achieve Average Day Demand (ADD) • Minimal upgrades needed to existing facility 	<ul style="list-style-type: none"> • Cannot achieve future Maximum Day Demand (MDD) • Larger pumps are more difficult to maintain under normal operating conditions • Difficulty removing the Elevated Tank (ET) and/or Wells G4/G4A from operations during necessary maintenance • Potential for impeller replacement; however, will likely require motor upgrades 	\$1,710,000
Supply MDD	<ul style="list-style-type: none"> • Optimizes pump sizing based on normal operating conditions • Three (3) equally sized pumps will allow increased operating flexibility 	<ul style="list-style-type: none"> • Available fire flow would be reduced when ET is offline for maintenance 	\$2,390,000
Supply MDD + Fire Flow	<ul style="list-style-type: none"> • Allows ET to be taken offline for maintenance with minimal impacts to fire flows • Similar costs as Supply MDD alternative 	<ul style="list-style-type: none"> • Larger pumps are more difficult to maintain under normal operating conditions 	\$2,470,000

7.3.3 St. Andrews Standpipe Upgrades

Based on a review of the upgrades alternatives, detailed in **Table 21**, it is recommended that the Region maintain the existing SP until such time that major rehabilitation work is needed, at which time the existing SP be replaced with a new smaller SP as:

- Full removal of storage at St. Andrews is not desired from an operational standpoint, as storage facilitates the operation of the St. Andrews PS during pump start up and shut down and provides local stabilization of pressures in Cam 1
- Due to the age and size of the existing SP, it is expected that more frequent and costly rehabilitation works are needed, as compared to a new smaller SP, to maintain the existing facility
- Phased implementation of the new smaller SP allows for the Region to potentially defer capital costs and maximize the usable life of the existing SP

Table 21: St. Andrews Standpipe Upgrade Alternatives

St. Andrews Standpipe Upgrades	Advantages	Disadvantages	Lifecycle Costs
Maintain Existing Standpipe (SP)	<ul style="list-style-type: none"> Upgrade costs limited to foundation rehab No alterations are needed to the SP 	<ul style="list-style-type: none"> High life cycle costs as the SP will likely need to be recoated every 15 years due to humidity of the primarily hollow SP 	\$3,140,000
Remove SP	<ul style="list-style-type: none"> Low life cycle costs as there is no SP to operate or maintain 	<ul style="list-style-type: none"> Difficult operating the St. Andrews PS due to potential pressure surges in Cam 1, increasing risk due to transient pressures Costs associated with new transient reducing valves 	\$50,000
Modify existing SP	<ul style="list-style-type: none"> Lower life cycle costs than maintaining the existing SP height as it will need to be recoated less frequently and would have a smaller surface area 	<ul style="list-style-type: none"> High capital costs associated with the modification and foundation rehab 	\$1,440,000
New SP	<ul style="list-style-type: none"> Lowest life cycle costs as new steel SP would only need to be recoated once Optimize necessary height and volume Existing SP does not need to be removed to site new SP 	<ul style="list-style-type: none"> Highest capital costs due to new SP 	\$1,340,000

7.3.4 Existing Inverness Elevated Tank

Based on a review of the Inverness ET alternatives, detailed in **Table 22**, it is recommended that the existing Inverness ET be decommissioned as:

- The new ET will be sized to provide adequate storage for Cam 3; as such the Inverness ET is not required to meet the Cam 3 storage needs
- Two ETs within one pressure zone typically leads to increased operational complexity and reduced efficiency
- Due to the age of the Inverness ET, ongoing rehabilitation and maintenance activities would be needed to support the continued operation

Further, future use of the Inverness Water Tower property will be determined at a future date.

Table 22: Inverness Elevated Tank Alternatives

Inverness Elevated Tank Alternatives	Advantages	Disadvantages	Lifecycle Costs
Maintain Inverness	<ul style="list-style-type: none"> • Provides redundancy of floating storage during future major rehabilitation work for the new Elevated Tank 	<ul style="list-style-type: none"> • Higher life cycle cost • Increases operational complexity of the system 	\$5,200,000
Decommission Inverness	<ul style="list-style-type: none"> • Lower life cycle cost • Reduced operational complexity 	<ul style="list-style-type: none"> • Complicated removal due to proximity to existing residential homes 	\$250,000

7.3.5 Bismark Check Valve

Based on a review of the Bismark CV alternatives, detailed in **Table 23**, it is recommended that the existing Bismark CV be maintained as:

- The Bismark CV supplements fire flows and provide security of supply within north Cam 3, generally north of Bismark Drive

Note that neither option was found to have a substantial capital investment and the annual operational and maintenance cost of both alternatives is minimal.

Table 23: Bismark Check Valve Alternatives

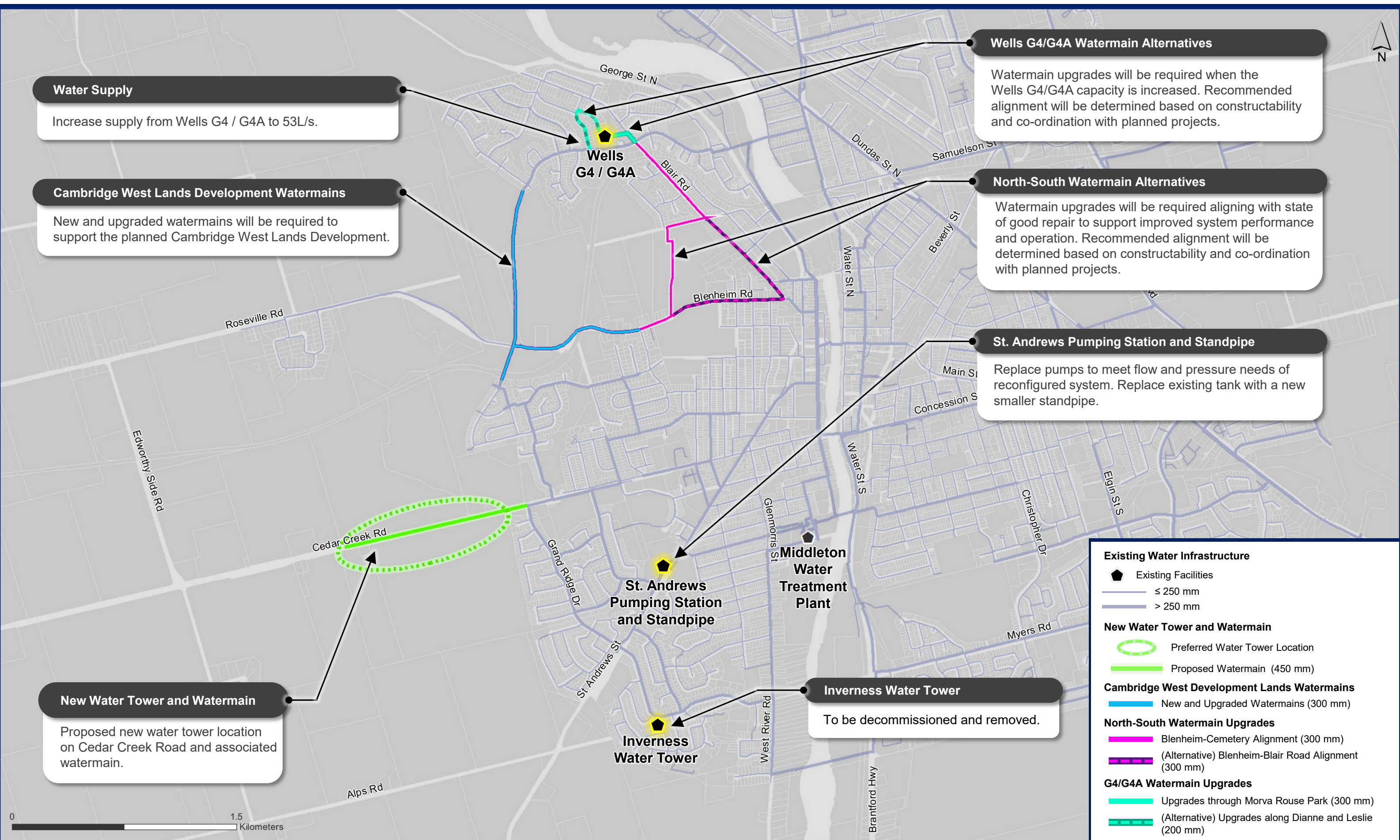
Bismark Check Valve Alternatives	Advantages	Disadvantages	Capital Costs
Maintain Bismark	<ul style="list-style-type: none"> • Provides supplemental fire flow to the adjacent area in Cam 3 • Improves security of supply within north Cam 3 in the event of a watermain failure 	<ul style="list-style-type: none"> • Reduced ability to supplement fire flows due to reduced Cam 1 hydraulic grade line • Is not able to support fire flows within Cambridge West Lands Development in the event of a watermain failure 	\$0
Decommission Bismark	<ul style="list-style-type: none"> • Reduced operation and maintenance needs as replaced valve will be a boundary valve 	<ul style="list-style-type: none"> • Reduces security of supply within north Cam 3 in the event of a watermain failure 	\$0

8 Final Recommendations and Implementation

Through comprehensive analysis, consultation with key stakeholders, and feedback received through the virtual Public Consultation Centres (PCC) #3 (December 9th, 2020 to January 8th, 2021), the following recommendations were identified for the Regional Water System Upgrades in Cambridge and North Dumfries:

- A new elevated tank located at **Location A – Cedar Creek Road (along Cedar Creek Road, approximately 300-1,200 m from the municipal boundary)**;
 - **New 450 mm watermain along Cedar Creek Road** to connect the new elevated tank to the existing distribution system;
- **Increase Supply from Wells G4/G4A**, consisting of a maximum PTTW to 53 L/s with an average annual taking of 42 L/s, to meet the long-term water supply strategy for Cambridge;
 - Watermain upgrade from Wells G4/G4A to Bismark Drive to accommodate increased flows from Wells G4/G4A by **upsizing the Morva Rouse Park Easement watermain to 300 mm or upsizing the Dianne Avenue and Leslie Avenue watermains to 200 mm**;
- Watermain upgrades, to improve the Cam 3 north-south watermain conveyance capacity, should align with the City of Cambridge's or RoW's SOGR as either:
 - **Upgrade along the existing watermain alignment through Mount View Cemetery and install a new 300 mm watermain along Blenheim Road to the new CWLD 300 mm watermain**; or
 - **Install a new 300 mm watermain along Blair Road and Blenheim Road to the new CWLD 300 mm watermain**
- St. Andrews PS upgrades to install three (3) equally sized pumps with a station firm capacity that can **Supply MDD**;
- Maintain the existing St. Andrews SP until such time that major rehabilitation work is needed, at which time the existing standpipe should be **replaced with a new smaller SP**;
- **Decommission (remove) the existing Inverness ET** after the new elevated storage tank is constructed;
- **Maintain the existing Bismark CV**

The recommendations summarized above are illustrated in **Figure 10**.



Water Supply

Increase supply from Wells G4 / G4A to 53L/s.

Cambridge West Lands Development Watermains

New and upgraded watermains will be required to support the planned Cambridge West Lands Development.

Wells G4/G4A Watermain Alternatives

Watermain upgrades will be required when the Wells G4/G4A capacity is increased. Recommended alignment will be determined based on constructability and co-ordination with planned projects.

North-South Watermain Alternatives

Watermain upgrades will be required aligning with state of good repair to support improved system performance and operation. Recommended alignment will be determined based on constructability and co-ordination with planned projects.

St. Andrews Pumping Station and Standpipe

Replace pumps to meet flow and pressure needs of reconfigured system. Replace existing tank with a new smaller standpipe.

Inverness Water Tower

To be decommissioned and removed.

New Water Tower and Watermain

Proposed new water tower location on Cedar Creek Road and associated watermain.

Existing Water Infrastructure

- Existing Facilities
- ≤ 250 mm
- > 250 mm

New Water Tower and Watermain

- Preferred Water Tower Location
- Proposed Watermain (450 mm)

Cambridge West Development Lands Watermains

- New and Upgraded Watermains (300 mm)

North-South Watermain Upgrades

- Blenheim-Cemetery Alignment (300 mm)
- (Alternative) Blenheim-Blair Road Alignment (300 mm)

G4/G4A Watermain Upgrades

- Upgrades through Morva Rouse Park (300 mm)
- (Alternative) Upgrades along Dianne and Leslie (200 mm)



Figure 10: Recommended Options

8.1 Implementation Plan

An implementation plan, detailing implementation steps and dependant infrastructure, is outlined in the following sections and detailed in **Table 24**. Further, implementation and triggers by each watermain segment is detailed in **Appendix E** (Technical Memorandum #6).

8.1.1 New Cam 3 Elevated Tank

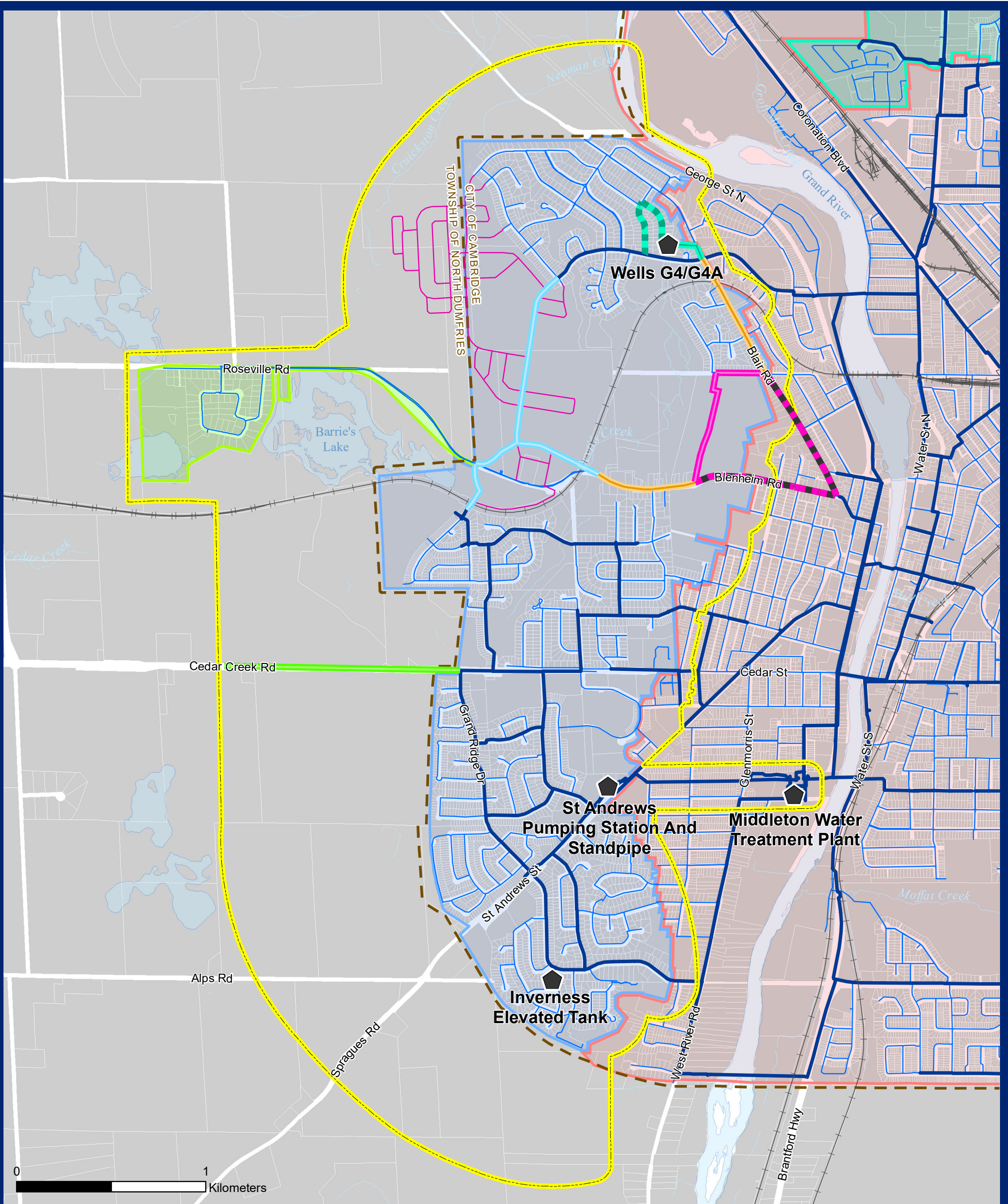
The construction of the new ET at the Cedar Creek Road location can begin following the completion of this EA, detailed design, and acquisition of land. To support the construction of the new ET, the 450 mm watermain connecting the ET to the existing water system must be constructed. The existing Inverness ET can be decommissioned following the construction of the new ET and 450 mm watermain; however, the decommissioning is dependant on first constructing the 300 mm watermain which extends through the CWLD and along the realigned Blenheim Road.

8.1.2 Increase Supply from Wells G4/G4A

Increasing supply at Wells G4/G4A is not dependant on the other project elements, including the construction of the new ET; however, updates to the Grand River Source Protection Plan are necessary, prior to the amendment of the PTTW, to accommodate new wellhead protection area. To support the increased taking from the Blair Wellfield including the updated PTTW, upgrades are necessary to the existing facility including replacement of the existing well pump, process piping, monitoring equipment, and chlorination equipment. To accommodate the additional process equipment, the existing wellhouse will need to be expanded or a new wellhouse will need to be constructed. Flow from Wells G4/G4A will be increased incrementally and prior to exceeding 32 L/s, watermains from Wells G4/G4A to Blair Road must be upsized to 300 mm. The alignment of these upgrades is reliant on further investigations to confirm constructability considerations and opportunities to coordinate with planned projects.

8.1.3 Watermain Upgrades

Additional watermain upgrades, independent of the construction of the new ET and increasing supply from Wells G4/G4A, will be constructed as part of the City of Cambridge or RoW's SOGR program. These upgrades will facilitate the north-south watermain capacity and the final alignment will be determined following additional stakeholder consultation and investigations. **Figure 11** presents the watermain upgrades needs and the associated triggers further outlined in **Appendix E** (Technical Memorandum #6).



0 1 Kilometers



Regional Water System Upgrades in Cambridge and North Dumfries

Figure 11: Watermain Upgrades - Implementation Triggers

Water Infrastructure	Pressure Zone	Implementation Triggers
Existing Facilities	Cam 1	Priority 1: Construction of ET
≤ 250 mm	Cam 1A	Priority 2: 250 L/s in CWLD
> 250 mm	Cam 2E	Priority 3a: Flow of 32 L/s at G4/G4A (Easement Option)
Local development	Cam 3	Priority 3b: Flow of 32 L/s at G4/G4A (Dianne/Leslie Option)
Study Area	North Dumfries/Lloyd Brown	Priority 4: Align with SOGR
Municipal Boundary	North Dumfries/Lloyd Brown	Priority 4a: Align with SOGR (Cemetery Option)
		Priority 4b: Align with SOGR (Blair Road Option)



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NAD 1983 UTM Zone 17N



8.1.4 St. Andrews Pumping Station and Standpipe

Upgrades to the St. Andrews PS are dependant on the implementation of the Cam 1W booster pumping station and subsequent lowering of the Cam 1 HGL. Following lowering of the HGL, pumping station upgrades must be completed prior to Cam 3 MDD exceeding 58 L/s. There is potential for variation in the staging of the Cambridge water system upgrades and operational adjustments; as such, the design of the St. Andrews PS upgrades will need to accommodate the operation under the Cam 1 HGL of 332 m and 324-326 m. Further assessment, under a separate study, is required to review and confirm the staging requirements of the St. Andrews PS upgrades in relation to the planned lowering of the Cam 1 HGL and other Cambridge water system upgrades.

Upgrades to the St. Andrews SP are dependent on the implementation of the Cam 1W booster pumping station and subsequent lowering of the Cam 1 HGL. The new SP can be constructed prior to the existing SP scheduled recoating.

Table 24: Implementation Plan

Independent Project Element	Step	Infrastructure Element	Infrastructure Description	Implementation Dependency
New Cam 3 Elevated Tank (ET) at Cedar Creek Road and Decommission Inverness ET	1	Construction of new ET at the Cedar Creek Road location	New 5.4 ML ET	Completion of new watermains to connect new ET to existing water system
		Construction of new watermains to connect new ET to existing water system	450 mm watermain from the new ET at Cedar Creek Road to Grand Ridge Drive	-
	2	Construction of new watermain through Cambridge West Lands Development (CWLD)	300 mm watermain through CWLD extending from the existing Bismark Drive watermain to the existing Hardcastle Drive watermain	Construction of the CWLD
		Construction of new watermain along realigned Blenheim Road through CWLD	300 mm watermain along the realigned Blenheim Road from CWLD west property boundary to CNR Rail Crossing (CWLD east boundary)	
	3	Decommissioning of Inverness ET	Inverness ET is taken offline and removed from existing location	Completed commissioning of new ET at Cedar Creek Road and construction of the CWLD watermains
Increase Supply from Wells G4/G4A	1	Amendment to existing permit to take water (PTTW)	Amended PTTW to increase water taking from Wells G4/G4A to 53 L/s	-
	2	Update to Grand River Source Protection Plan	Update to the Grand River Source Protection Plan to include new Wellhead Protection Area necessary for increased water taking	-
	3	Upgrades at Wells G4/G4A to accommodate increased flow rate up to 53 L/s	Upgrades to existing well pump, process piping, monitoring equipment, chlorination equipment, and expansion of existing wellhouse/ construction of new wellhouse	Amendment to existing PTTW and update to Grand River Source Protection Plan
	4a	Upsize existing watermains to accommodate increased flows from Wells G4/G4A	300 mm watermain from Wells G4/G4A through Morva Rouse Park Easement and along Blair Road from the Morva Rouse Park Easement to Bismark Drive	Flow from Wells G4/G4A is increased to or exceeds 32 L/s
	4b		300 mm watermain from Wells G4/G4A along Dianne Avenue and along Leslie Avenue from Dianne Avenue to Bismark Drive	
Watermain Upgrades	1a		300 mm watermain along Blair Road from Bismark Drive Grant Street, along Grant Street from Blair Road to the	

Independent Project Element	Step	Infrastructure Element	Infrastructure Description	Implementation Dependency
	1b	Upsize existing watermains to improve the Cam 3 north-south watermain conveyance capacity	Mount View Cemetery, through the Mount View Cemetery, and along Blenheim Road to the CWLD east boundary 300 mm watermain along Blair Road from Bismark Drive to Blenheim Road, and along Blenheim from Blair Road to the CWLD east boundary	Aligned with City of Cambridge or Region of Waterloo's State of Good Report Program
	1	Implementation of Cam 1W pressure zone and decrease of existing Cam 1 hydraulic grade line (HGL)	Cam 1 pressure zone boundary adjustment is complete and HGL is lowered	Currently Ongoing
St. Andrews Pumping Station	2	Replacement of existing pumps to supply maximum day demand (MDD) to Cam 3	Three (3) pump configuration (duty, lag, and standby) capable of providing ultimate build out (2031) MDD (firm capacity of 66 L/s)	Cam 3 maximum day demand is increased to or exceeds 58 L/s
St. Andrews Standpipe (SP)	1	Implementation of Cam 1W pressure zone and decrease of existing Cam 1	Cam 1 pressure zone boundary adjustment is complete and HGL is lowered	Currently Ongoing
	2	Construction of new smaller SP	Optimized new SP for both volume and height based on revised Cam 1	Existing St. Andrews SP requires scheduled recoating
	3	Decommissioning of existing St. Andrews SP	Existing St. Andrews SP is taken offline and removed from existing location	Completed commissioning of the new St. Andrews SP

8.2 Permitting and Approvals

Key permits and approvals that may be required in advance of the construction activities (to be confirmed following land acquisition and detailed design) are provided as follows:

- Ministry of Environment, Conservation, and Parks
 - Amendment to the Drink Water Works Permit is required for all changes to the drinking water system
 - Update to the Grand River Source Protection Plan is required with revision to the Wells G4/G4A wellhead protection areas
 - Amendment to the existing Wells G4/G4A PTTW (1224-88MK7Q)
 - Environmental Compliance Approval may be required as it relates to the new standby generator at St. Andrews PS
 - Completion of Form 1 Record of Watermain Authorizes as a Future Alteration for watermain upgrade projects
- Ministry of Natural Resources and Forestry
 - Permit or other authorization may be required, based on the final location of the ET within the Cedar Creek Road location, due to the potential impacts to an endangered or threatened animal or its habitat
- Ministry of Heritage, Sport, Tourism, and Culture
 - Approval may be required, based on the final location of the ET within the Cedar Creek Road location, for fieldwork and reporting completed as part of a Stage 2 archaeological assessments, and must be deemed compliant with the Ministry's 2011 Standards and Guidelines for Consultant Archaeologists
- Fishers and Oceans Canada
 - Approval may be required should the watermain upgrades to facilitate the increased supply from Wells G4/G4A be through the Morva Park Easement which crosses Devil's Creek, to show construction methodology and watermain upsize do not impact existing surface water conditions

- Grand River Conservation Authority
 - Permit (O. Reg. 150/06) may be required, dependant on final watermain alignment, to comply with the Regulation of Development, Interference with Wetlands and Alterations to Shoreline and Watercourses
 - Permit (O. Reg. 166/06) may be required, dependant on final watermain alignment, to traverse all areas regulated by the GRCA
 - Update WHPA, based on increased PTTW from Wells G4/G4A, as required by the Clean Water Act and Safe Drinking Water Act
- Region of Waterloo
 - Road permits along associated right-of-way for the installation of new watermains
- Township of North Dumfries
 - Site plan approval and building permit to accommodate the new ET, and the new or expanded wellhouse at Wells G4/G4A
 - Based on the final location of the ET within the Cedar Creek Road location, cultural heritage committee approval may be required to address any impacts to existing cultural heritage structures
 - Approval for rezoning the parcel with the new ET
- Technical Standards and Safety Authority
 - Communications on removal of existing diesel pump at St. Andrews PS and license for the installation of new standby power generator

9 Potential Effects and Mitigations

An overview of the mitigation measures required to avoid or minimize impacts to the study area based on the recommended servicing solution is provided in the following section.

9.1 Elevated Tank at Cedar Creek Road

9.1.1 Impacts to Species at Risk

Breeding bird field investigations completed at the preferred ET location, Cedar Creek Road, observed two (2) SARs forging, bank swallow and barn swallow designated as threatened. Further, the barn structure at the most westerly portion of the Cedar Creek Road location is a potential habitat for barn swallows as well as chimney swifts and little brown myotis, both of which were not observed during field investigations but have a high potential of occurring.

The destruction of the barn swallow, chimney swift, or little brown myotis habitat or harm to the individual is prohibited under the ESA. As such, additional surveys should be conducted to confirm the presence of barn swallows or chimney swifts using the barn to nest. If nesting is confirmed within the barn, authorization under the ESA must be obtained in the form of a registration. These actions would be required if the demolition of the barn is required to accommodate the construction of the ET.

The removal of the habitat can be registered through the online Notice of Activity process, as per Section 23.5 (barn swallow) and Section 23.8 (chimney swift) of the ESA. Registration of the activity allows proponents to remove habitat with certain conditions, including minimizing effects to SAR individuals, creation of compensation habitat, preparation of a mitigation plan, and monitoring and reporting on the success of the mitigation measures.

To avoid harm to individuals, the structure must be removed outside of the breeding season for barn swallow (May 1 – August 31) and chimney swift (April 1 – October 31). Compensation habitat must also be provided prior to the next breeding season. For barn swallow, compensation habitat consists of a new structure containing nest cups within 1 km of the existing structure and within 200 m of foraging habitat. Nest cups must be provided in a 1:1 ratio of nests destroyed/removed. Compensation habitat must be monitored for three (3) years following creation. For chimney swift, compensation habitat consists of a new structure (built to specific dimensions) that provides more habitat than was provided in the existing chimney and is within 2 km of the existing habitat. Compensation habitat must be monitored for three (3) years following creation.

There is no registration process for little brown myotis. Consultation with the MECP is recommended to confirm the requirements of a permit for removal of habitat. The conditions of the permit may require creation of compensation habitat, such as bat boxes/houses and development of a mitigation plan. To avoid adverse impacts to individuals, the structures must be removed outside of the maternity roost season for little brown myotis (April 30 – July 31).

9.1.2 Impacts to Natural Environment

The Gilholm-Salisbury PSW, within the Blair-Bechtel-Cruickston ESL, is located within proximity of a portion of the Cedar Creek Road location. A minimum 30 m setback from the edge the PSW, erosion and sedimentation plan, and confirmation of the regulation limits from the GRCA (O.Reg. 150/06) is needed.

Site drainage, if the ET is located north of Cedar Creek Road, will drain towards the GRCA regulated area and Gilholm Salisbury PSW; as such, stormwater quantity and quality management is required onsite.

Further, appropriate de-chlorination infrastructure and procedures would be required to ensure any potential ET overflows are appropriately captured and de-chlorinated before discharging to the environment. This will be accomplished through the construction of an onsite overflow pond and an appropriate outlet structure.

9.1.3 Impacts to Wildlife and Wildlife Habitat

Two (2) species designated as special concern under the ESA, monarch and yellow-banded bumble bee, were assessed to have a moderate potential to occur within the Cedar Creek Road location as farm field edges and roadsides may provide suitable foraging habitat and host plants. It is expected that minimal areas of suitable habitat will be directly removed as a result of the proposed ET. In addition, these types of habitats are abundant in the local landscape, and removal of a small amount of habitat is not expected to have any adverse impacts to the regional populations.

9.1.4 Impacts to Migratory Birds

Anthropogenic structures can pose a collision risk for migrating birds and are a significant cause of avian mortality (Gehring et al. 2009; Erickson et al. 2005). Accurately estimating avian mortality resulting from collisions with the project infrastructure is not possible due to large uncertainties associated with bird populations and flight altitude variability (Erickson et al. 2005). Numerous studies have been conducted on avian mortality with buildings and similar structures. Fatalities are usually the result of collisions with tall buildings or windows (Erickson et al. 2005), due to use of materials such as glass or mirrored surfaces which reflect back the landscape and confuse birds (FLAP 2019). Because the project infrastructure will be below the typical flight altitude of migrating birds, and will not include reflective surfaces, the risk of avian mortality from collision with the project infrastructure is not expected to be significant.

The majority of birds migrate during the night (FLAP 2019; Ducks Unlimited 2019), outside of the period for construction activities, and adverse impacts associated with deterring waterfowl from landing in the adjacent wetland habitats are not expected. To further minimize the potential for noise-related impacts on migrating birds, site preparation and construction activities should be avoided or minimized during peak migration periods (April-May and August – October).

Artificial lighting, especially the use of spotlights, may also lead to bird collisions with structures, as lights appear to either confuse or attract birds (Lincoln and Peterson 1979; FLAP 2019). The risk of collision due to lights is higher during poor weather conditions (e.g., rain or fog) when birds migrate at lower altitudes (FLAP 2019). Turning off, or minimizing the number of, artificial light sources used between dusk and dawn, and avoiding use of spotlights during the migration season (March-May and August-October), will also benefit migratory birds (FLAP 2019). In addition, light fixtures used during construction, on the structure itself, or on the site should be shielded to minimize glare and spill light (Sheppard and Phillips 2015). If navigation lighting is required to be installed on the ET, it is recommended to avoid steady-burn (non-flashing) red lights, as these lights have been shown to increase the risk of avian collision (Gehring et al. 2009).

9.1.5 Impacts to Areas with Archeological Potential

Within the Cedar Creek Road location, only 1233 Cedar Creek Road is anticipated to possess archaeological potential based on its presence of a historic structure (timbre barn) within its limits, and its proximity to a historic transportation route, a watercourse, cultural heritage resources, registered archaeological sites, and soils that were conducive to human settlement. As such, a Stage 2 archeological assessment is recommended on areas which have not been previously disturbed which includes a test pit survey at 5 m intervals in accordance with Section 2.1.2 of the Ministry of Heritage, Sport, Tourism, and Culture Industries (2011).

Further, it can be noted that the Stage 1 assessment identified parts of the 1233 Cedar Creek Road, and the remaining parcels within the Cedar Creek Road location, to have been extensively disturbed due to existing aggregate extraction operations, and do not possess any archeological potential.

9.1.6 Impacts to Cultural and Built Heritage Features

Within the Cedar Creek Road location, the following properties have cultural heritage significance:

- One property of cultural heritage value or interest (CHVI) listed on the Township of North Dumfries Register of Listed Properties (1286 Cedar Creek Road);
- Two properties the RoW considers to have “built heritage resources of interest” (1180 Cedar Creek Road and 1038 Cedar Creek Road)
- One property of potential CHVI (1233 Cedar Creek Road).

9.1.6.1 Impacts to 1286 Cedar Creek Road

1286 Cedar Creek Road is adjacent to the Cedar Creek Road ET location; however, this property exceeds 100 m from the proposed location and adverse impact, primarily due to shadowing, are not expected to occur. As such, no mitigation measures are necessary for 1286 Cedar Creek Road.

9.1.6.2 Impacts to 1180 Cedar Creek Road

Construction of the ET within proximity of 1180 Cedar Creek Road will introduce a cumulative effect and the magnitude of this potential direct impact is low as the property is extensively altered through the previous aggregate extraction operations. The built heritage resource of interest at 1180 Cedar Creek Road has design or physical value as a representative vernacular expression of the Classic Revival style executed in coursed rubble masonry to a high degree of craftsmanship. The farmhouse also has contextual value since it maintains the rural agricultural character of the roadscape.

Although the property at 1180 Cedar Creek Road will be directly impacted if the ET is located within this site, a Cultural Heritage Evaluation Report (CHER) is not recommended as most of the parcel is previously developed as an aggregate extraction operation and the property’s potential CHVI is linked only to the stone residence, which will not be demolished or altered.

9.1.6.3 Impacts to 1038 Cedar Creek Road

Construction of an ET within proximity to 1038 Cedar Creek Road could result in vibration impact to the stone entrance pillars during construction of the ET, and shadow impact may occur from the ET to the built heritage resource of interest at 1038 Cedar Creek Road. Views to the south from 1038 Cedar Creek Road of the surrounding agricultural setting will also be affected, although 1107-1157 Cedar Creek Road is approved for aggregate extraction. The property at 1038 Cedar Creek Road has design or physical value for its relatively rare or unique example of an ashlar stone, two-storey Regency farmhouse executed to high degree of craftsmanship, and for its historical association with Robert Gilholm Jr., a former mayor of Galt. The property also has contextual value as it maintains and supports the rural agricultural character of the area and is visually and historically linked to its agricultural surroundings and to the Gilholm Marsh. The mitigation measures are as followed:

- If possible, the ET and associated infrastructure should be at least 100 m from the southwest corner of 1038 Cedar Creek Road to avoid indirect impacts to its built heritage resource (stone residence and gateposts) through shadowing, obstructed views, and construction vibration.
- If it is not feasible to place the ET and associated infrastructure at least 100 m distant from the southwest corner of 1038 Cedar Creek Road, monitor the built heritage resources (stone residence and gateposts) at 1038 Cedar Creek Road for vibration impact during all construction within 60 m of the structures.

9.1.6.4 Impacts to 1233 Cedar Creek Road

Locating the ET within proximity of 1233 Cedar Creek Road, a two-level, timber frame, three-bay, and gable-type barn, may require that the barn be demolished, resulting in destruction of a structure of cultural heritage value or interest. If placed adjacent to the barn, the ET will result in an alteration to existing conditions, shadowing, a change in existing land use and potential vibration impact during construction. The barn has design or physical value as a representative and increasingly rare example of a gable type Central Ontario Barn built to a high degree of craftsmanship, and it has contextual value as it maintains and supports the area's rural agricultural character and is visually linked to the surrounding agricultural land use and former farmhouses.

However, as the barn is no longer part of an outbuilding complex with associated farmhouse and is currently near late 20th century residences and an active quarry operation, construction of the ET adjacent to the structure is not predicted to result in a significant adverse visual impacts nor alteration to the barn's heritage attributes. Vibration impacts are probable during construction is the ET is located within 60 m of the barn's footprint.

The following mitigation measures are as follows:

- If possible, the ET and associated infrastructure should be placed to avoid demolishing the barn and reduce indirect impacts from shadow to the barn. If this option is feasible, monitor the barn for vibration impact during construction within 60 m of the structure. A Cultural Heritage Impact Assessment (CHIA) is not recommended for this option as a majority of the parcel is currently being developed as a quarry operation and the property's CHVI is linked only to the barn, which will not be demolished or altered.
- If it is not feasible to avoid demolishing the barn, conduct a CHIA for 1233 Cedar Creek Road in compliance with the Township of North Dumfries Official Plan to determine the appropriate conservation or mitigation measures.

9.1.7 Climate Change and Mitigations

Climate change impacts, as they relate to the new ET, will be observed primarily through a change in water use demographics, further emphasizing peak demands. This will have an impact on equalization storage utilization and can be mitigated through modified operations at the St. Andrews PS to maintain appropriate levels within the ET.

The overflow storage pond, located on the ET site, will need to be sized to accommodate two (2) hours of overflow storage as well as provide stormwater management. Climate change has the potential to increase the intensity and frequency of these storm events; as such, the sizing of the combined overflow storage and stormwater management pond should account for these potential storm events.

9.1.8 Property Acquisition

A 100 m x 100 m parcel of land will need to be acquired, within the Cedar Creek Road location, by the RoW to site the new ET. The Cedar Creek Road ET location south of Cedar Creek Road is currently licenced for aggregate extraction. The Cedar Creek Road ET location north of Cedar Creek Road is an aggregate extraction site which has previously been excavated. Coordination with the landowners will be critical in both areas to determine an exact location for the new ET to minimize potential impacts to on-going business and future land uses.

9.1.9 Construction Impacts to Natural Environment

Activities related to site preparation and development such as grading, filling, and presence of heavy machinery can cause soil erosion and compaction, while machinery can destroy over-hanging vegetation. Encroachment into the natural areas can also occur by machinery, foot traffic, and discarding or storage of construction materials outside of the construction envelope. Standard construction practices should be implemented to mitigate damage to the adjacent natural features.

Generally, noise generated by construction activities represents a short-term disturbance to wildlife using the adjacent natural areas. It is expected that with the completion of construction, wildlife will quickly return to their normal use patterns within the natural areas adjacent to the development.

As the majority of construction activities (i.e., site clearing) would occur in active agricultural fields, fallow meadows, or residential properties, loss of biodiversity is expected to be minimal.

The following best management practices should be followed during construction:

- Clearly demarcate and maintain the construction boundaries shown on the site plan;
- Avoid removal of vegetation during the active season for breeding birds (April 15 – August 31);
- Avoid or minimize site preparation and construction activities during peak bird migration periods (April-May and August – October);
- Ensure all equipment is cleaned prior to transportation and use on the site to avoid the spread or introduction of invasive species seed on the site;
- Implement standard best management practices, including sediment and erosion controls, spill prevention, etc. during the construction phase of the project;
- Implement standard best management practices to mitigate noise and dust on the site during the construction phase of the project;
- General Best Management Practices to consider when planning landscaping and planting activities include:
 - Use natural, indigenous landscaping wherever possible;
 - Avoid the use of chemical pesticides. Landscaping with native species reduces the need for pesticides and fertilizers because native species are adapted to the local climate, insects and diseases;
 - Consider using natural landscaping techniques: Natural landscaping involves the use of plants that are native to a region to replicate a natural landscape that reflects indigenous vegetation communities. Native plants are adapted to the local environment and typically require less maintenance and are less likely to be invasive than non-native species traditionally sold at garden centres. Native plants are also more likely to provide wildlife habitat; and,
 - Avoid species that are known to escape garden settings and colonize adjacent natural areas (often referred to as ‘invasive species’). A good source for learning what species to avoid planting in yards is the Ontario Invading Plant Species Awareness Program’s website (<http://www.invadingspecies.com/invaders/plants-terrestrial/>).

Natural areas are already limited or non-existent on, or within, the Cedar Creek Road location containing only two (2) narrow areas of sparsely vegetated hedgerows. Due to the restricted width and cover of these hedgerows, they have limited function as wildlife corridors. The function of these hedgerows may be improved through enhancement plantings following construction. Plantings should consist of native, non-invasive species that are common to the planning region (i.e., ecoregions 6E and 7E) and/or forest region (i.e., Deciduous Forest and the Great Lakes – St. Lawrence Forest). A list of native tree, shrub and herbaceous species suitable for planting in ecoregions 6E and 7E can be found in Credit Valley Conservation's (CVC) Plant Selection Guideline (CVC 2018). Plants should also be selected based on site-specific ecological conditions (e.g., soil type and moisture level).

9.1.10 Construction Impacts to Utilities

Construction of a new ET at the Cedar Creek Road location, including the installation of new watermain along Cedar Creek Road to connect to the existing water system, will require communication with all existing utilities. Notices will be sent prior to construction to hydro (Energy+ Inc), gas (Union Gas), and telecommunication companies. Further, it can be noted that impedance to the existing utilities is not anticipated.

9.2 Increased Permit to Take Water from Wells G4/G4A

9.2.1 Impacts to Groundwater

Impacts to local groundwater users including existing WWR and PTTW, local surface water resources, and water quality as a result of increasing the water taking from Wells G4/G4A were observed through field testing or modelled to have minimal or no effect.

9.2.2 Wellhead Protection Areas

The revised and expanded WHPAs, as a result of the proposed increased PTTW to 42 L/s, results in a larger area experiencing high vulnerability scores of eight (8) to ten (10). Properties within the high vulnerability areas will be subject to restrictions on activities performed on the property as well as storage/use of various chemicals and pathogens. The following list provides a brief overview of limitations on the potential activities which may impact existing and future use, with varying vulnerability scores, noting that the Grand River Source Water Protection Plan provides a more detailed and comprehensive list:

- Application of nitrogen and phosphorous for livestock and agricultural use
- Use and storage of pesticides for agricultural and commercial lands
- Storage, transmission, treatment, and disposal of sewage including restrictions on septic tanks
- Storage (above or below grade), handling, and/or use of various chemicals including fuel
- Storage of industrial or chemical waste (above or below grade)
- Storage of snow
- Application and storage of road salt
- Discharge from stormwater management facilities

It should be noted that the majority of the properties within the expanded eight (8) to ten (10) vulnerable areas are municipally serviced, reducing their potential threat, and may not be subject to increased regulations. Further, the existing single-family residential dwellings within the expanded eight (8) to ten (10) vulnerable areas will be exempted from implementing risk management plans for salt.

The number of additional properties which coincide into the new eight (8) to ten (10) vulnerable areas are summarized in **Table 25** by land use type. While the majority of the properties within the expanded high vulnerability areas are residential, additional agricultural, commercial, open space, and institutional properties are added to the new high vulnerable area.

Table 25: Vulnerability of 8 to 10 by Land Use

Land Use	Vulnerability Score of 8		Vulnerability Score of 10	
	Number of Properties at 20 L/s	Number of Properties at 42 L/s	Number of Properties at 20 L/s	Number of Properties at 42 L/s
Agricultural	1	2	0	0
Commercial	0	1	0	1
Industrial	0	0	1	1
Institutional	0	2	1	1
Open Space	3	10	7	9
Residential	216	579	140	173

A new, delineated WHPA is necessary for the PTTW increase application and the update to the Grand River Source Protection Plan and as part of this process, the Region may need to contact the new properties within the revised WHPA areas:

- To confirm no site contamination and/or ensure the proper abatement has occurred
- To ensure that appropriate operating procedures and risk management plans are in place where applicable

9.2.3 Well Rehabilitation

Well capacity of Well G4A should be monitored over time to establish the frequency of ongoing rehabilitation required at this well to maintain capacity.

9.2.4 Well Permitting and Monitoring

It is recommended to permit Well G4A at a maximum of 53 L/s with an average annual taking of 42 L/s. The following staged approach to increased pumping and monitoring is recommended, including enhanced monitoring as further described in the sections that follow:

- **Stage 1** – Background monitoring for a two (2) year period at up to currently permitted rate of 22 L/s.
- **Stage 2** – After the PTTW, with the increased rate in place and immediately prior to increased pumping rates, background monitoring for additional period of six (6) months at up to 22 L/s.
- **Stage 3** – Operational testing program with increased pumping to 42 L/s and monitoring for a period of two (2) to five (5) years.

It should be noted that Stage 2 was included should there be a delay in obtaining the PTTW or prior to the RoW moving forward with Stage 3; as such, Stage 2 would ensure that the six (6) months of testing was completed prior to the operational testing. In the event that the RoW would like to proceed to operational testing immediately following Stage 1 then Stage 2 would not be necessary.

Following the completion of Stage 3 operational testing and monitoring, the operation and impact of Well G4A should be reviewed to establish if the average annual taking at G4A could be increased to a higher rate beyond the 42 L/s as established as part of the hydrogeological investigation completed within this Study.

9.2.4.1 Monitoring Program

During Stage 1 and 2, the Region should continue to monitor groundwater levels in wells currently listed in the current PTTW No. 1224-8MK7Q (OW5BCDE-95; BROW1ABC-09, BROW1D-08), in addition to wells currently incorporated into the Region's ongoing groundwater monitoring program (GMP) (BROW1AB-10), new wells (OW1ABC-17, OW2ABC-17, OW3AB-17, A128186), shallow piezometers (MP2-17, MP3-17 and MP4-17) and staff gauges (SG1-17, SG2-17 and SG3-17).

Piezometer MP3-17 should also be reinstalled in the streambank adjacent to Well G4A to support the monitoring program as this piezometer was previously removed due to sustained damages.

9.2.4.2 Stages 1 and 2 – Background Monitoring

The following are general recommendations to establish background conditions:

- Groundwater should be monitored at the 19 wells (7 locations) detailed in **Appendix B** (Technical Memorandum #2 and #3). Groundwater monitoring should be completed using data loggers set to record at one (1) hour intervals for a period of two (2) years. The data loggers should be downloaded on a semi-annual basis, with manual backup measurements;
- Shallow groundwater levels should be monitored at three (3) shallow piezometers and surface water levels at three staff gauges detailed in **Appendix B** (Technical Memorandum #2 and #3). Water levels should be measured at these locations using data loggers during ice-free conditions and manual water levels should be collected at these locations on a monthly basis. Six (6) stream flow measurements should be taken annually for two years at the stream gauging stations and a rating curve should be developed for Devil's Creek. Following two (2) years of stream flow monitoring, the frequency of streamflow measurements during longer term operation monitoring should be evaluated; and,
- Manganese should be monitored on a regular basis in Well G4A to establish a range of background concentrations.

Following the collection of two years of background water level and stream flow data (Stage 1), if there is a delay in the permitting and operation of Well G4A at a higher rate, monitoring can be reduced to locations currently listed in the current PTTW No. 1224-8MK7Q (OW5BCDE-95; BROW1ABC-09, BROW1D-08) as well as BROW1AB-10.

Once well G4A is permitted at a higher rate, prior to increasing pumping rates beyond 22 L/s, the Region should reinstate the groundwater and surface water monitoring program as outlined in **Appendix B** (Technical Memorandum #2 and #3) for a period of six (6) months (Stage 2). The background monitoring data collected during Stages 1 and 2 should be reviewed to establish the frequency and locations of the Stage 3 operational testing monitoring program.

9.2.4.3 Stage 3 – Long-Term Operational Testing and Monitoring

Once six (6) months of monitoring in Stage 2 has been completed while pumping Well G4A at a rate of up to 22 L/s, the Region should increase the rate of pumping at Well G4A up to an average annual rate of 42 L/s. Following a minimum of two (2) years of monitoring during Stage 3 pumping at rate of up to 42 L/s, the frequency and locations in the monitoring program should be re-evaluated. Following a review of data and assessment of the impacts at the rate of 42 L/s, further increasing the PTTW beyond 42 L/s can be further investigated.

9.2.5 Watermain Upgrades to Accommodate Increased Flows

Watermain upgrades are proposed to accommodate increased flows from Wells G4/G4A are proposed through the existing Morva Park Easement. As this watermain transverses under Devil's Creek as well as a number of existing structures on residential parcels, geotechnical investigations should be completed to determine the feasibility of a trenchless approach (directional drilling). In the event that a trenchless approach is not feasible the alternative alignment along Dianne Avenue and Leslie Avenue can be further explored. Both alignments will require coordination between the RoW and City of Cambridge as the subject watermains are City owned.

9.2.6 Climate Change and Mitigations

Climate change impacts, as they relate to water supply, may be experienced through increase in demands due to drought and need for increased water supply in response to reduction in recharge related to drought across the entire Integrated Urban System. Through the hydrogeological investigation completed as part of this EA, a long term sustainable withdrawal rate was determined to be an annual average rate of 42 L/s and a maximum rate of 53 L/s. Increasing the capacity at Wells G4/G4A increases the flexibility to meet changes in demand and/or recharge associated with climate change.

9.3 Watermain Upgrade Construction Impacts

The proposed watermain upgrades within the existing water system will be within existing rights-of-way with existing watermains; however, it is noted that watermain ownership in the Region is a two-tiered system. As such, coordination between the RoW and City of Cambridge is necessary to confirm the strategy for implementing new watermains.

Further, a scoped Environmental Impact Study must be completed on the Mount View Cemetery Alignment watermain, submitting to the GRCA, to determine the necessary mitigation measures necessary on the surrounding wetlands should it be selected as the preferred alternative.

9.4 Inverness Elevated Tank Decommissioning Impacts

The existing Inverness ET site is constrained due to the proximity of existing residential properties; as such, typical ET removal methods cannot be used and the demolition should be completed by removing sections of the ET piecemeal. Further, residents should be informed of its removal prior to the demolition.

9.5 St. Andrews Pumping Station and Standpipe Construction Impacts

The upgrades to the existing St. Andrews PS are expected to have minimal impact, with pump refurbishment occurring one pump at a time, such that continuous conveyance from Cam 1 can be maintained.

The upgrades to the existing St. Andrews SP are expected to have minimal impact, as the new SP can be constructed at the location of the previously removed 1 ML SP, such that the existing 3 ML SP can be maintained during construction prior to its decommissioning and subsequent removal.

10 Agency and Public Consultation

Consultation is an integral component of the Class EA process enabling the RoW to inform the public about the study while eliciting input from potentially interested and affected parties during the study process. This study held three (3) PCCs: the first PCC focused on the review of the problem and opportunity, the second PCC provided further information to the public on the Schedule B projects and evaluation criteria, and the third PCC detailed the decision-making process and the preliminary preferred alternative.

The primary goals of the public consultation process were to:

- Present clear and concise information to stakeholders at key stages of the study process;
- Solicit community, regulatory and stakeholder input;
- Undertake comprehensive consultation to complete the duty to consult with Aboriginal people in Ontario;
- Consider comments received when evaluating alternative solutions and in recommending the preferred solution; and,
- Comply with Municipal Class EA consultation requirements.

At the outset of the public consultation process, the RoW developed a Communication and Consultation Plan tailored to this study. The primary objective of the plan was to encourage two-way communication with the community, regulatory agencies, and stakeholders. More specifically, the plan was designed to:

- Build on previous Class EAs communication protocols, consultation plans, and municipal planning to ensure consistency and continuity;
- Ensure the general public, regional councillors, stakeholders, external agencies (including federal, provincial and regional) and special interest groups had an opportunity to participate in the study process;
- Ensure that relevant information was provided to interested and affected stakeholders early and often throughout the planning process; and
- Make contact with external agencies to obtain legislative or regulatory approvals, and to collect pertinent technical information

Complete documentation of agency and public consultation is available in **Appendix F** (Agency and Public Consultation Report).

10.1 Contact List

A list of stakeholders, review agencies and other interested parties was developed at the outset of the study to invite participation in the EA process. The contact list was updated throughout the study as more individuals became aware of the study or provided feedback.

Through the progression of the study, key groups reached out or were consulted to provide detailed feedback on impacts and concerns as they relate to the study's components. A summary of comments received is provided in **Table 26** and full correspondence, including action and/or response taken, is provided in **Appendix F** (Agency and Public Consultation Report).

Table 26: Summary of Comments

Date Received	Comment Received
8/25/2017	Request that the study area be expanded to include the lands within the designated City Urban Area as shown in a map provided and attached in the received email. Requested that all communications associated with the study, including Notice of Public Consultation Centre (PCC), copies of staff reports, and notice of Committee and Regional Council's consideration of the project be provided.
9/6/2017	Ministry of Environment, Conservation, and Parks (MECP) confirmed receipt of Notice of Commencement. Identified Aboriginal Communities for contact.
9/8/2017	Ministry of Heritage, Sport, Tourism, and Cultural Industries (MHSTCI), confirmed receipt of Notice of Commencement. Provided overview of MHSTCI requirements and expressed interest in the archaeological resources, built heritage resources, and cultural heritage landscapes.
9/7/2017	Developer requested confirmation that the lands identified as being within the City Urban Area but located outside the study area are already within the Cam 3 pressure servicing area and that an extension of the area is not required.
11/20/2017	Request for information from the Region regarding environmental concerns, site location, and decision-making steps.
11/24/2017	Follow-up question regarding water tower which included questions on proximity of identified site locations to environmental features, proposed height of the tower, and lights required for safety.
12/4/2017	Ministry of Infrastructure (MOI) received study notification via mail. If any MOI lands are proposed for use of the project, confirmation will be provided in writing along with the reason as to why the lands are required along with a copy of a title search for the MOI lands.

Date Received	Comment Received
12/8/2017	Transportation Canada requested self-assessment with a federal property and/or waterway by reviewing the Directory of Federal Real Property, to determine if project will require approval and/or authorization
12/21/2017	Attachment included - Cambridge Environmental Advisory Committee (CEAC) Report. Major recommendation adopted: That the Cambridge EA Committee forward Report No. CEAC-09-17 as its comments on the West Cambridge Water System Upgrades Class Environmental Assessment as presented at Public Consultation Centre No. 1 on November 30, 2017.
1/9/2018	Request for more information on if a new water tower was a result of Cambridge West Development and why North Dumfries was being considered as part of the EA as there is sufficient space set aside in Potential Water Tower Site 8. The draft plans for the subdivision have already been submitted and appealed to the Ontario Municipal Board (OMB). Would like to know if it is possible to place a tower east of Site 10, which would place the tower in the City of Cambridge.
1/19/2018	Region informed Protecting Waters, Ministry of Municipal Affairs and Housing (MMAH) that a component of this study is to identify a preferred location for a new water tower and requested information on the potential impacts of a greenbelt expansion on the siting for a new water tower.
1/24/2018	MMAH provided two applicable policy numbers based on the current best available information.
12/13/2018	Follow-up provided regarding the Urban Design Guidelines for the Cambridge West Community along with Regional staff preliminary commentary
4/23/2019	Provided an attached correspondence on behalf of client regarding information presented at Public Consultation Centre No. 2 including evaluation criteria and methodology, short listed water tower locations and their details, and recommendation of further investigations that should be completed.

Date Received	Comment Received
4/30/2019	Provided adopted comments from the CEAC on the project for consideration. Noted that no changes were made to the draft comments sent a few weeks prior.
5/3/2019	Water tower manufacturer requested to sign up for project notifications. Received notification from employees that live in the study area. Water tower manufacturer's brochure attached for project consideration.
5/29/2019	Region provided feedback and further commentary on CEAC recommendations.
8/23/2019	Provided response to Region's response. Requests that a meeting to review submissions would be appropriate and that Hallman will follow-up to coordinate.
7/27/2020	Submission of project summary, including objectives, works completed, and preliminary recommendations, to the GRCA for review.
8/20/2020	Received response from GRCA following review of relevant project details, feedback was incorporated into reporting.
12/4/2020	Request to detail project elements requirement for green solutions.
12/6/2020	Request for details on the impacts to the ponds on both sides of Cedar Street at Grand Ridge, traffic impacts along Cedar Street, and proposed timing of construction.
12/8/2020	Region provided response in regards to completed natural heritage investigations, traffic impacts, and timing of construction.
12/8/2020	Request of information regarding use of Inverness property following the demolition of Inverness.
12/9/2020	Region provided response to resident regarding future use of the Inverness property and proposed timeline of the demolition.

Date Received	Comment Received
12/9/2020	Fisheries and Oceans Canada provided a self-screening tool to determine if a detailed review by the department is necessary.
12/15/2020	Region provided a response with regards to green technology and its considerations in the evaluation of alternatives.
12/23/2020	Transport Canada provided a self-screening tool to determine if a detailed review by the department is necessary.

10.2 Steering Committee Meetings

Four (4) steering committee meetings were hosted by the Region to provide guidance to the Project Team at key points within the study. The steering committee included representatives from the RoW, City of Cambridge, and Township of North Dumfries.

Steering Committee Meeting #1, held on October 17th, 2017, introduced the project to the steering committee as well as provided an overview of the project goals, key elements, preliminary problem/opportunity statement, and public engagement process. A preliminary screening of potential new ET locations and the preliminary ten (10) long list ET locations was presented to the committee. Consensus was obtained from the steering committee on the problem/opportunity statement.

Steering Committee Meeting #2, held on April 12th, 2018, provided a project update as well as presented the preliminary short listed ET locations. Consensus was obtained from the steering committee on the presented ET sites.

Steering Committee Meeting #3, held on February 11th, 2019, provided a project update, a revised ET short list, water supply alternatives, and evaluation criteria and methodology to be presented at PCC #2. Consensus was obtained from the steering committee on the presented ET sites, water supply alternatives, and evaluation criteria.

Steering Committee Meeting #4, held on June 23rd, 2020, provided a project update and the presented the preliminary preferred solution. Consensus was obtained from the steering committee on the preliminary preferred solution.

10.3 Project Notices

10.3.1 Notice of Commencement and Project Sheet

The Notice of Commencement indicated what the purpose of the project is, identified the general study area and provide key contact information. This was published in the Ayr Times and the Cambridge Times, distributed to the initial list of agencies and stakeholders, including Aboriginal communities, and distributed to all addresses within the study area via postal route. In addition to the Notice of Commencement, all mail-outs included a two-page project sheet highlighting the key elements of the study with high quality graphics intended to encourage interested residents to sign up for an e-newsletter. The Notice of Commencement and Project Sheet were distributed August 1, 2017. The Notice of Commencement was advertised in the Ayr News on August 1 and 8, 2017 and advertised in the Cambridge Times on August 2 and 9, 2017.

10.3.2 Project E-Newsletter

Two (2) project E-Newsletters were prepared to provide interim project updates between PCCs, provide links to current materials presented to the public including previous PCC boards, provide an additional notice of upcoming PCCs, and provide links to online surveys. These project e-newsletters were emailed to interested parties on April 31, 2018 and October 9, 2019.

10.3.3 Notice of Public Consultation Centre

The Notice of PCCs indicated where and when the PCC would take place, as well as a brief summary of the materials presented at the PCC. These notices were published in the Ayr Times and the Cambridge Times, distributed to the list of agencies and stakeholders, and distributed to all addresses within 500 m of a long-list water tower site or existing facility (Inverness Water Tower, St. Andrews Pumping Station, or Wells G4/G4A). Each notice was sent out two (2) weeks prior to the PCC. Notice of PCC #1 was advertised in the Ayr News on November 15 and 22, 2017 and advertised in the Cambridge Times on November 21 and 23, 2017. Notice of PCC #2 was advertised in the Ayr News on March 20 and 27, 2019 and advertised in the Cambridge Times on March 21 and 28, 2019. Notice of PCC #3 was advertised in the Ayr News on November 26 and December 3, 2020 and advertised in the Cambridge Times on November 25 and December 2, 2020.

10.3.4 Notice of Completion

The Notice of Completion signifies the beginning of the 30-day public review period for the Project File Report. The notice included advice to the public of their rights to request a Part II Order (or appeal). If no request is received during the review period, the RoW may proceed to design and construction of the project. This notice was advertised in the Ayr News on June 2, 2021 and June 9, 2021 and the Cambridge Times on June 3, 2021 and June 10, 2021, distributed to the list of agencies and stakeholders, and distributed to all addresses previously receiving a notice of PCC.

10.4 Public Consultation Centres and Online Surveys

Three (3) PCCs were hosted during key decision making milestones of the project to both inform the public of the study and elicit feedback on key study items (i.e. important aspects of the water system, evaluation criteria, potential challenges, etc.). In conjunction with these PCCs, online surveys were distributed via the RoW's "Engage" platform

PCC #1 was held on November 30th, 2017 and presented the following information:

- Project background and history of related projects;
- EA process and general project timeline;
- Water system overview, detailing the purpose and location of key water infrastructure within the study area;
- Problem and opportunity statement;
- Background, opportunities, and challenges of the water infrastructure components evaluated as part of this EA;
- Technical screening criteria and process used to develop a long list of water tower locations; and
- Long list of potential locations for a new water tower (10 areas).

PCC #2 was held on April 1st, 2019 and presented the following information

- Project refresher and summary of key information from PCC #1
 - Project background and history of related projects;
 - Summary of background, opportunities, and challenges of the water infrastructure components evaluated as part of this EA;
- Detailed evaluation methodology and next steps to be used in the evaluation of the preferred water tower location and water supply options;
- Short listed water tower locations and key considerations for each (3 locations);
- Background information on the existing Blair Road Wellfields;
- Short listed water supply options (2 options);
- Overview of project timelines and next steps; and
- Summary of remaining water system components and the approach for identifying the preferred alternatives.

PCC #3 was virtually held from December 9th, 2020 to January 8th, 2021, due to COVID-19, and presented the following information:

- Project refresher including key study components, evaluation methodology, and works completed to date;
- Evaluation, including advantages and disadvantages, of water tower locations (3 locations) and water supply options (2 options);
- Preliminary preferred recommendations for the new water tower location and the water supply option;
- Preliminary preferred recommendations at St. Andrews, Inverness Water Tower, and new watermains; and
- Presentation of the preliminary preferred strategy for Cam 3.

11 Next Steps

Following the completion of this EA, the following next steps should be undertaken by the RoW:

- Conceptual design of the new ET at Cedar Creek Road including the following key elements:
 - Site layout and conceptual layout, including related structural, mechanical and electrical work;
 - Preliminary plan and profile drawings for the new watermain needed to support the new ET; and
- The 100 m x 100 m parcel of land needed to construct the new ET at Cedar Creek Road should be acquired; the following additional works must be completed dependant on the final location of the ET parcel:
 - A Stage 2 Archeological Assessment should be completed if site acquired has been previously identified as requiring additional assessment
 - Additional field surveys should be conducted to confirm presence of SARs if site acquired has been previously identified as requiring additional assessment
 - Cultural heritage next steps dependant on completed CHIA, if necessary
- Application for the Wells G4/G4A PTTW amendment
 - Implementation of proposed monitoring program
 - Provide GRCA with an update of the WHPA for inclusion in an amended Grand River Source Protection Plan
- Conduct a geotechnical investigation along the Morva Rouse Park Easement watermain upgrade alignment to confirm if trenchless installation would be possible (watermain upgrades for this alignment are related to the increase in flows from Wells G4/G4A)
- Detailed design of new ET, new watermains connecting the new ET to the existing water system and upgrades to Wells G4/G4A
- Communications between the RoW and City of Cambridge to discuss the implementation of proposed watermain upgrades