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Copy:	**Dave Eadie, P.Eng**	Date:	**March 23, 2023**
Subject:	**Guelph WWSMP – Executive Summary**		

City of Guelph
Water and Wastewater Servicing Master Plan

Executive Summary

C3 WATER INC.
STANTEC CONSULTING LTD.

March 23, 2023

Executive Summary

E-1. Introduction and Background

E-1.1 Master Planning Process and Purpose Statement

The Water and Wastewater Servicing Master Plan (WWSMP) was initiated to identify servicing requirements for existing and growth areas to 2051+ and consider the impact of potential intensification and greenfield growth. A focus of the WWSMP was to maintain the City's efforts of developing of a Smart City with the innovative use of technologies for improved water and wastewater level of service.

Growth projections were developed for 2031, 2041 and 2051+ planning horizons with input from the City's ongoing Municipal Comprehensive Review (Shaping Guelph) and the Water Supply Master Plan (WSMP). The existing water and wastewater systems were assessed to identify opportunities and constraints. Water and wastewater servicing alternative solutions were then developed and evaluated using criteria established by the project team. The preferred solutions were assessed and built out to develop the basis for the City's water and wastewater capital plans. Public consultation was incorporated throughout the process.

This Master Plan is being undertaken in accordance with Approach #1 of the Master Planning Process, as outlined in Appendix 4 of the Municipal Class Environmental Assessment document (October 2000, as amended), using a broad level of assessment. Detailed investigations at the project-specific level will be required in order to fulfil the Municipal Class EA documentation requirements for the specific Schedule B and C projects identified within this Master Plan. This Master Plan will become the basis for, and be used in support of, future investigations for the specific Schedule B and C projects identified within it. Schedule B projects would require the filing of the Project file for public review while Schedule C projects would have to fulfil Phases 3 and 4 prior to filing an Environmental Study Report (ESR) for public review. The schedules for future projects identified as part of this master plan were reviewed utilizing the 2023 MCEA amendments.

E-1.2 Public Engagement

As part of the EA process the public was kept up to date on the project progress through the City's "Have Your Say" community engagement platform. A Notice of Study Commencement was published on January 20th, 2019.

Public feedback was solicited during two public information centres (PICs). The first PIC was held October 28th to November 30th 2020. The second PIC was held on November 29th to December 20th, 2022. Project update letters were provided to Indigenous communities via email on October 31, 2022.

The final Master Plan Report will be provided for public comment for 30 days in April of 2023.

E-1.3 Planning Horizons

The areas of planned development were established based on information from the planning department and secondary studies. A summary of the equivalent population for each planning horizon is shown in Table E. 1-1.

Table E. 1-1 Planning Horizon Projected Reference Populations

Horizon	2031	2041	2051 (WSMP)*	2051+
Population	164,852	183,926	203,000	239,770
Employment	94,906	105,453	116,000	126,198

**Not used for this WWSMP*

The reference populations for 2031 and 2041 horizons are consistent with the WSMP, while the 2051+ horizon is based on the Shaping Guelph ultimate buildout population.

When assessing underground infrastructure and its life expectancy, it is important to consider that new infrastructure will be in use past 2051 and should be sized to service growth that occurs after 2051. As such, the City has projected the maximum allowable growth that could be supported in each of the Strategic Growth Areas to create a 2051+ Ultimate Buildout population distribution for the purpose of this study. This scenario was established by applying the maximum densities across land uses for strategic growth areas and incorporating established populations for greenfield development (i.e. Clair-Maltby) within the existing urban boundary. This maximum growth scenario was used for the WWSMP to evaluate the largest impact on water and wastewater linear infrastructure.

E-1.4 Criteria

Establishing appropriate design criteria and levels of service (LOS) is a crucial step in the development of solutions and establishing cost-effective infrastructure investment. Relevant water and wastewater servicing design criteria and LOS from Regional Guidelines, City guidelines and previous studies completed for the City and neighboring municipalities were reviewed to develop recommendations for the WWSMP.

Key performance indicators that were used for assessing the water distribution system are pressure and available fire flow. The pressure criteria used were 40 – 100 psi allowable with a preferred operating range of 50 – 80 psi where applicable. Development specific fire flow requirements were established for a number of land-use types. Thirty litres per second (30 L/s) was used as a minimum fire flow requirement throughout the existing system. Additionally, through discussions with City staff, it was established that future upgrades to the system should be planned such that maximum day demand (MDD) can be met if the Arkell Aqueduct or F.M. Woods Water Treatment Plant (Woods WTP) is unavailable. This was found to be the most critical existing piece of infrastructure for the water distribution system.

The wastewater collection system was analyzed for both existing and future conditions in consideration of the City's current Engineering and Transportation Services Development Engineering Manual (2019). These City guidelines were compared to regional and provincial guidelines, and through consultation with the City, an updated approach to the assessment was established. The update to this approach provides renewed alignment with the regional and provincial guidelines. The City's "no surcharge" performance target was maintained.

E-1.5 Existing Systems

E-1.5.1 Water Distribution System

The Guelph water distribution system consists of approximately 600 km of watermains throughout three pressure zones. The primary water source is the Arkell wells and the Glen Collector system which feed into the Woods WTP via the Arkell Aqueduct. The Woods WTP and pump station (PS) supplies approximately 60-80% of the City's drinking water. There are also a number of groundwater supply wells throughout the City. The Paisley, Robertson and Clythe PSs boost water from Zone 1 into Zone 2. The Clair PS boosts water from Zone 1 into Zone 3. The system has three elevated tanks (ETs), Verney and Clair ET located in Zone 1 and the Speedvale ET in Zone 2. There are four (4) in-ground storage reservoirs, Woods and University in Zone 1 and Paisley and Clythe in Zone 2.

Figure E. 1 below shows the minimum pressure results under existing MDD conditions. Areas of high elevation fell below the minimum pressure criteria of 40 psi.

Figure E. 2 below shows the available fire flow results under existing MDD conditions. Areas of low fire flow (less than 30 L/s) were generally a result of localized constraints due to old, small diameter, cast iron watermains with high roughness.

Figure E. 1 Existing MDD Minimum Pressure

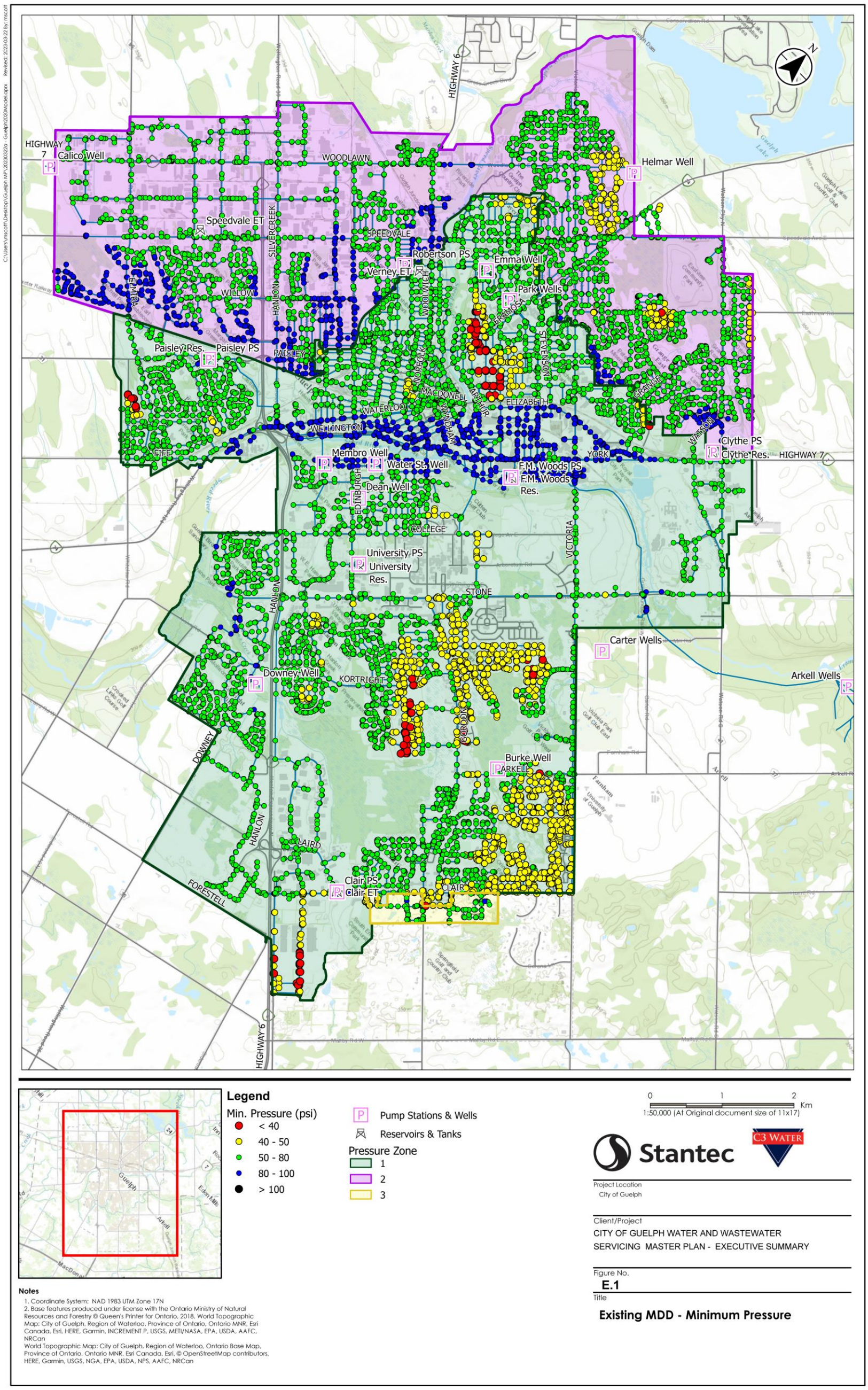
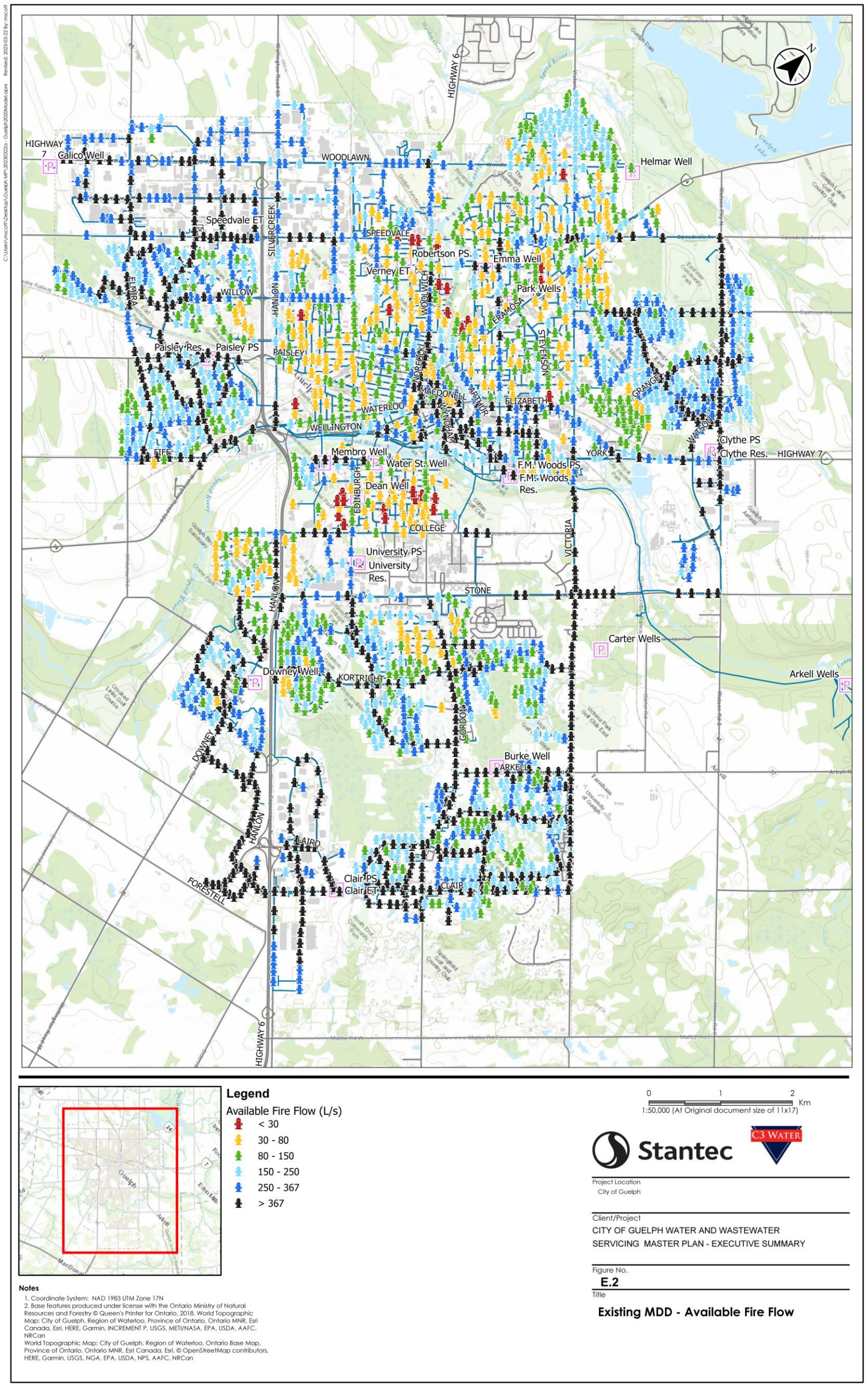


Figure E. 2 Existing MDD Available Fire Flow



E-1.5.2 Wastewater Conveyance System

The City's sanitary sewer system is primarily gravity-based. There are approximately 520 km of gravity sanitary sewers within the study area, with pipe diameters ranging from 200 mm to 1650 mm. Over 85% of the sanitary system has pipe diameters of 375 mm or less. The sanitary sewer system discharges into the Guelph Water Resource Recovery Centre (WRRC) located in the central west end of the City adjacent to the Speed River.

The York Trunk is the main trunk of the sanitary sewer system centrally located along the Speed and Eramosa Rivers. It flows east to west to the treatment plant. Several collectors discharge into this main trunk**.**

Figure E. 3 and Figure E. 4 provide an overview of the City's existing wastewater collection system for both dry and wet weather conditions.

Figure E. 3 Existing Conditions DWF Results

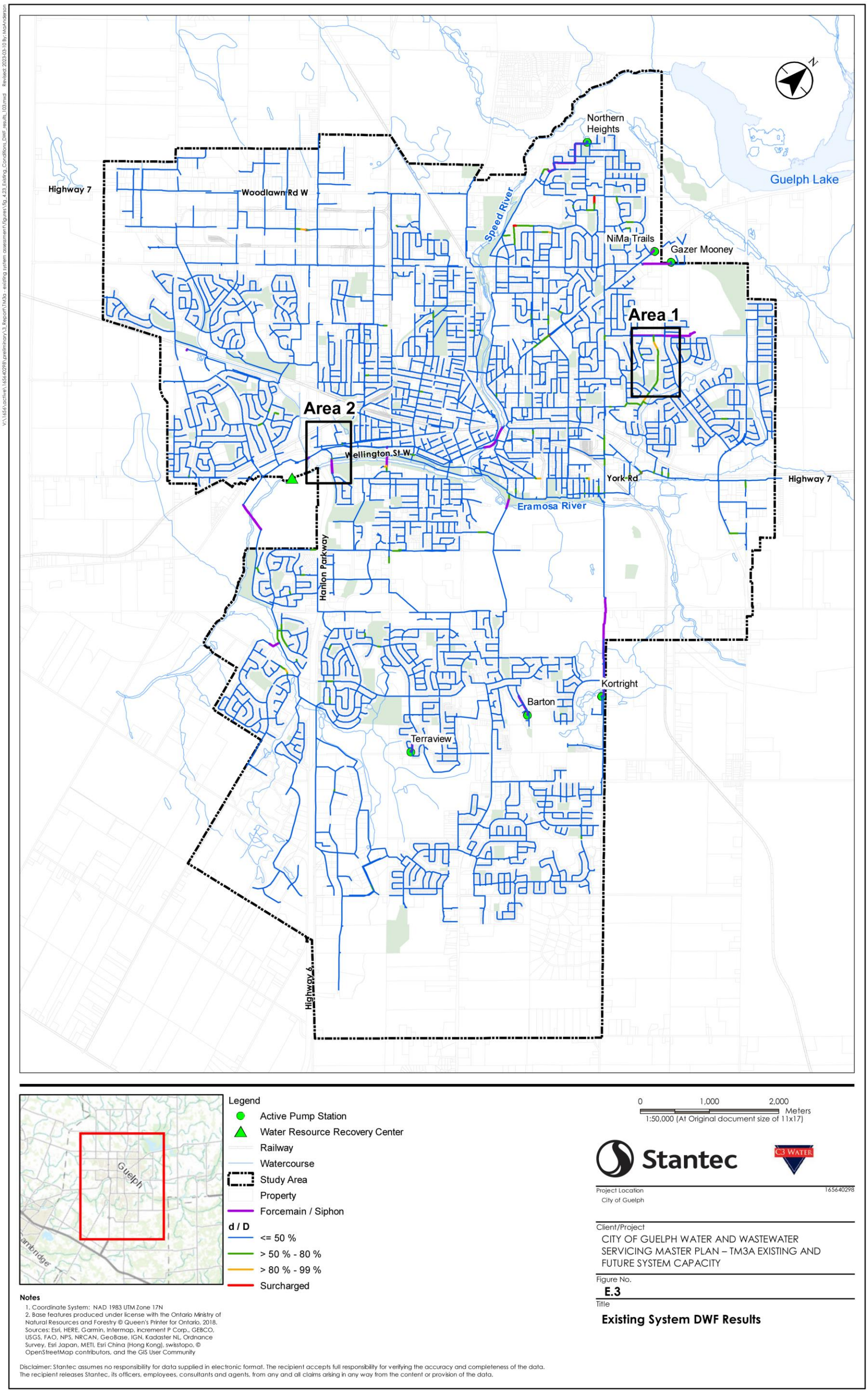
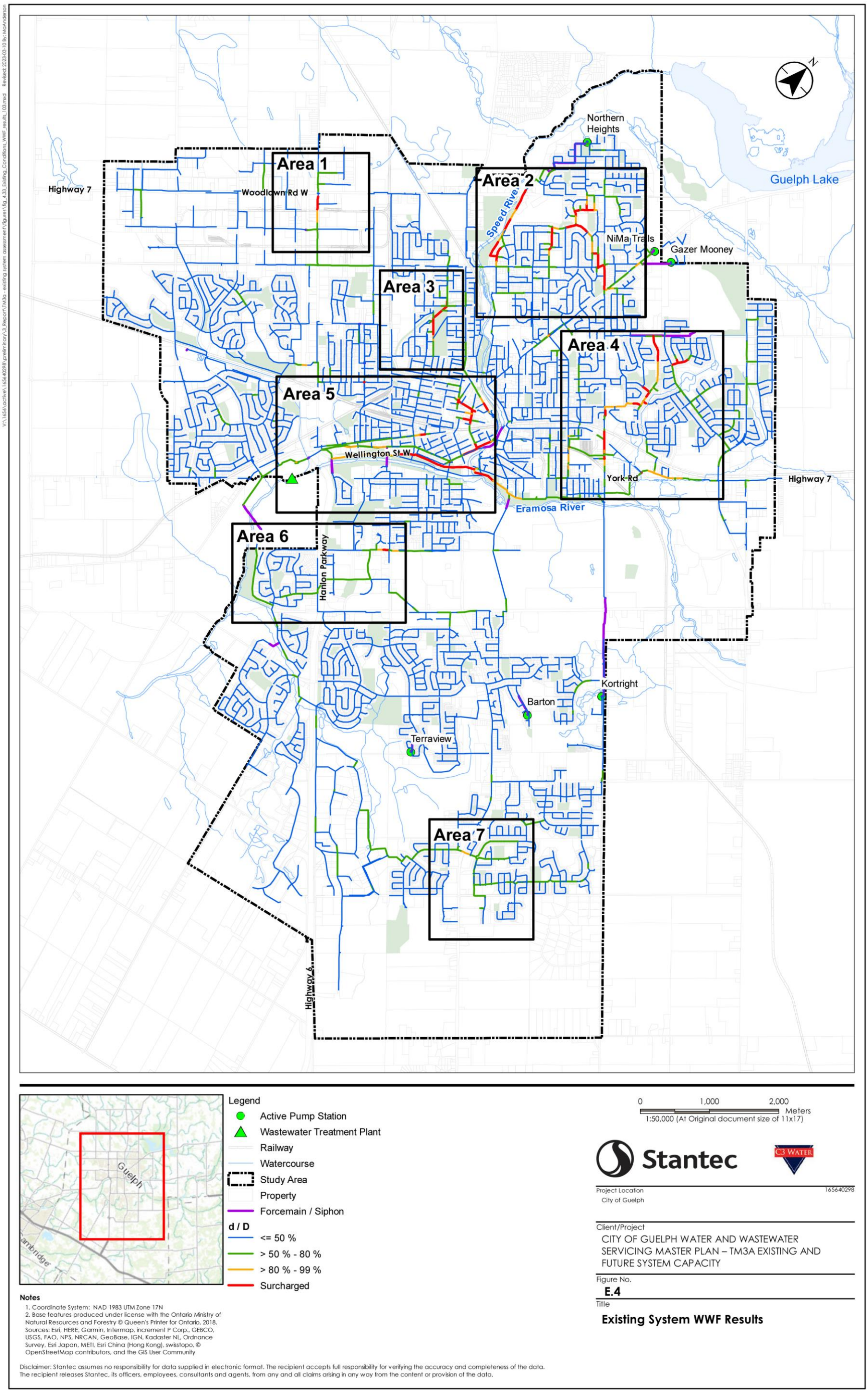


Figure E. 4 Existing Conditions WWF Results



E-2. Development and Evaluation of Alternatives

Analysis was completed to identify deficiencies in the existing system within the planning horizon. To satisfy the Class EA Process, an evaluation framework was established to assess the alternative servicing strategies for addressing deficiencies. The evaluation criteria considered included the following categories:

1. Environmental
2. Social/Cultural
3. Economic
4. Technical

E-2.1 Water Alternatives Development and Evaluation

E-2.1.1 Water Distribution System Assessment

The existing water distribution system was modelled under 2051+ demand conditions to identify deficiencies. Modelling was completed using the City's InfoWater Pro model which was updated and calibrated as part of this project. Future supply sources established through the WSMP were taken into consideration when assessing the water system under 2051+ demand conditions.

E-2.1.2 Assessment Results

The minimum pressure results under existing infrastructure conditions with 2051+ MDD is shown in Figure E. 5 below. The available fire flow under 2051+ MDD conditions is shown in Figure E. 6.

Some of the key deficiencies identified for the water distribution system were:

- High criticality of the Woods PS and Arkell Aqueduct.
- Insufficient infrastructure to transfer water from Woods PS to the south end of the system.
- Limited east-west transmission capacity in Zone 2.
- Localized fire flow constraints.

Figure E. 5 2051+ MDD – Existing Infrastructure – Minimum Pressure

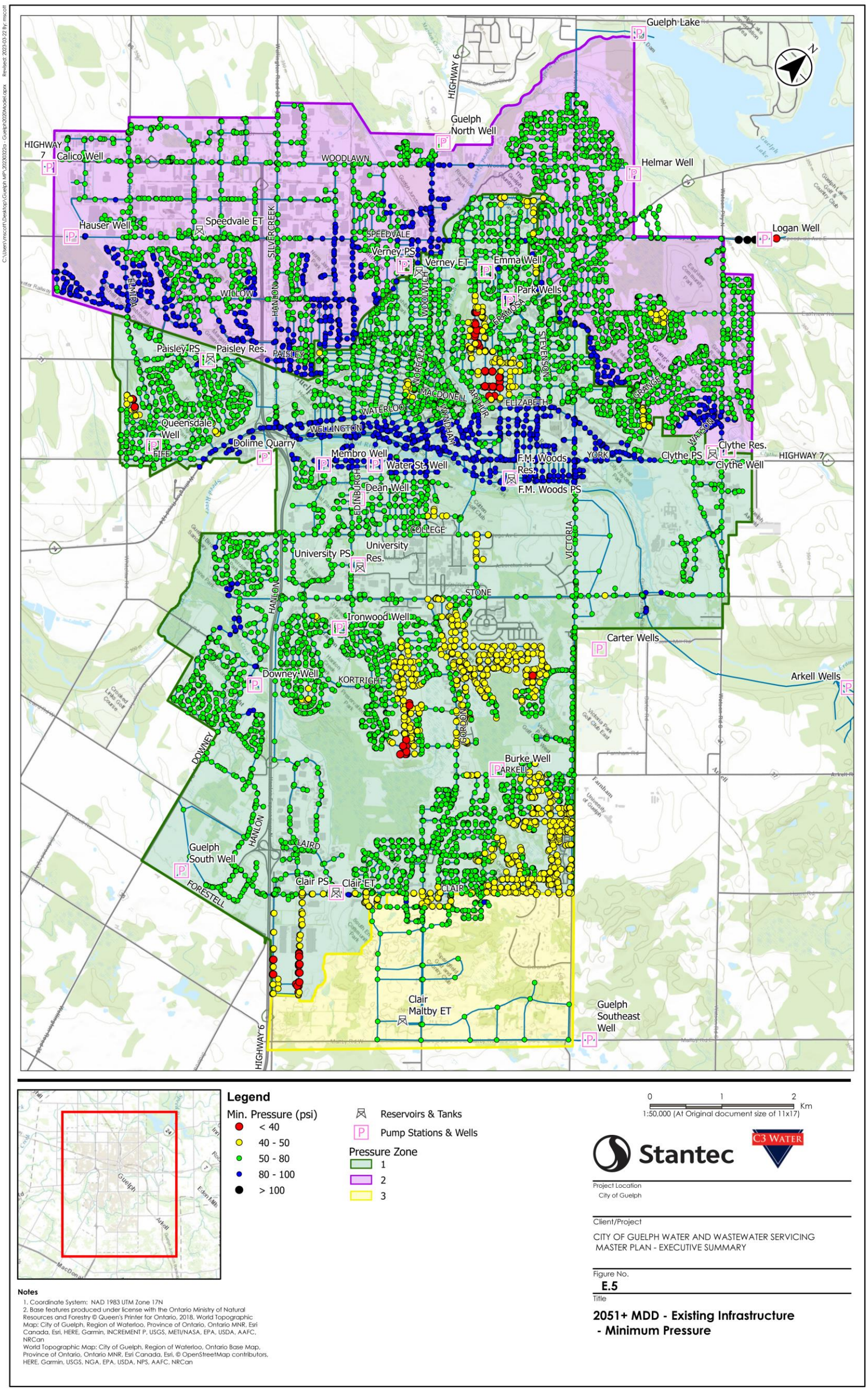
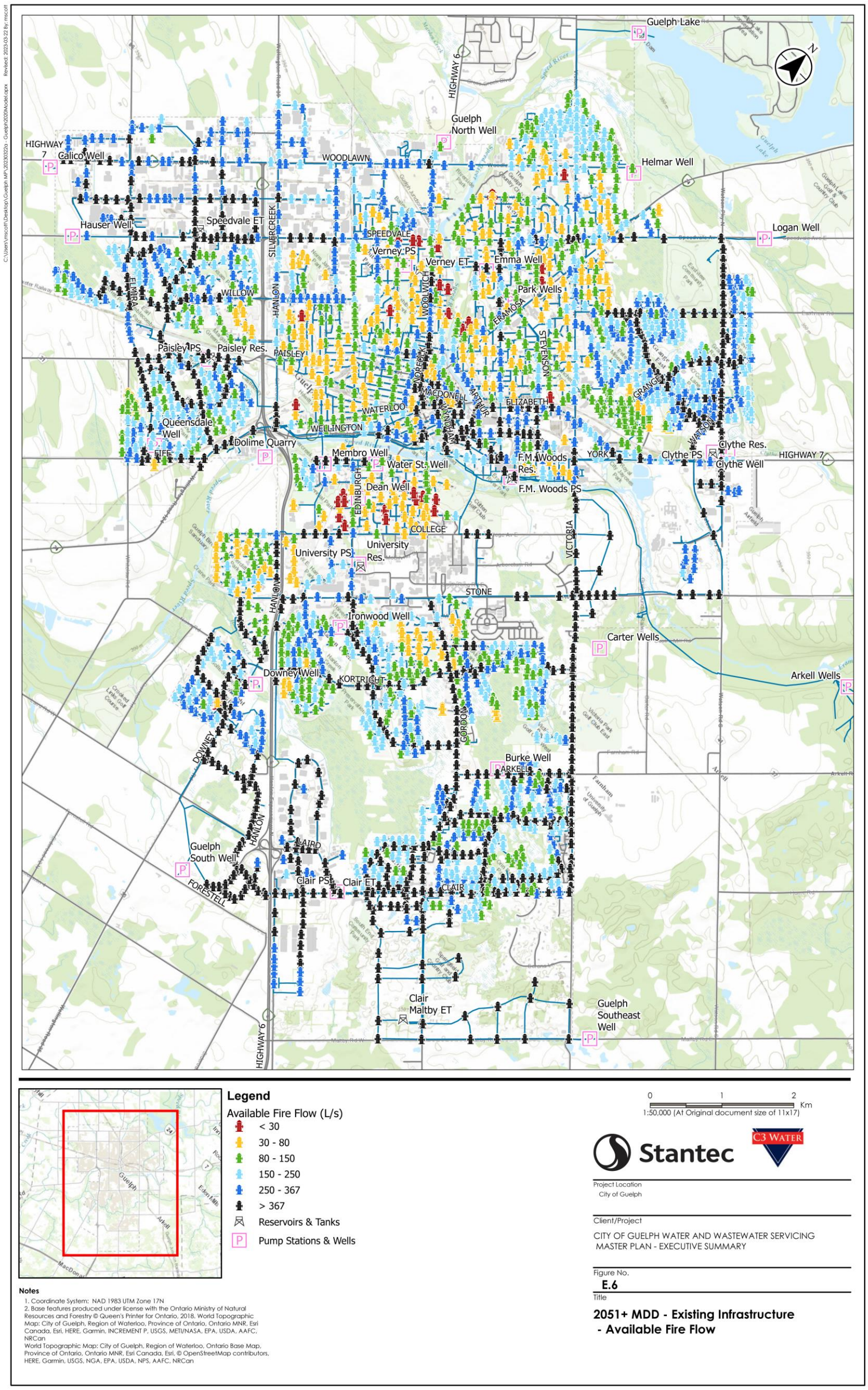


Figure E. 6 2051+ MDD – Existing Infrastructure – Available Fire Flow



E-2.1.3 Development of Alternatives and Evaluation

To address the water distribution system deficiencies identified, the following water servicing alternatives were considered:

1. Do Nothing
2. Limit Community Growth
3. Water Conservation/Demand Management
4. Improvements to Existing System: New Facilities and Watermains

Alternative 4 involves implementation of capital projects such as watermains, reservoirs and pump facilities to both address existing constraints and meet the needs for future growth. The Arkell Aqueduct and resiliency of supply of the Arkell sources was an area of focus for considering upgrades to the existing system because it supplies approximately 60-80% of the City's drinking water on any given day. The aqueduct is approximately 6 km long and a single non-redundant pipe, making this a critical piece of infrastructure. Therefore, under Alternative 4, two sub-alternatives were considered for providing improved redundancy and resiliency of the City's largest supply:

A. Twin Existing Arkell Aqueduct – FM Woods WTP point of entry (POE),
B. New Watermain, Reservoir and Pump Station (South end POE).

The first sub-alternative (Alternative 4A) considered was to twin the existing aqueduct along the existing alignment. This would reduce the criticality of the existing aqueduct and improve operational flexibility as one aqueduct could remain operational while the other is isolated for maintenance. This alternative does not provide resiliency of supply for the Arkell sources in the event of an emergency failure or planned shutdown at the Woods WTP and PS. Under this failure event, the City would run out of water in less than 24-hours.

The second sub-alternative (Alternative 4B) considered was a new POE into the distribution system at Arkell Road and Victoria Road from the Arkell Wellfield. This alternative includes a new watermain, Reservoir and PS. Sources from the Arkell Wellfield could be directed to a new Arkell reservoir and WTP facility. The water would then be pumped to the south end of Zone 1. This alternative allows the Arkell sources to be directed to either the new reservoir and PS or the existing Woods Reservoir. This alternative allows for complete redundancy of supply of all of the Arkell sources in the event of a failure of either the existing Aqueduct or the Woods WTP, allowing max day demands to continue to be met. This alternative also reduces the need for improved north/south watermain capacity within pressure Zone 1 as water could be supplied directly to the south end, where growth is expected to occur. Secondary benefits of this alternative include the opportunity to supply other potential users, such as Arkell Village along the watermain route. Consultation should be conducted with Puslinch and Wellington County to discuss the needs or interest to service Arkell.

Of the alternatives assessed, Improvements to the Existing System (Alternative 4) is the only one that can meet the future requirements for the system while aligning with

Shaping Guelph requirements. Therefore, this was carried forward as the preferred alternative.

Of the two Arkell Sub-Alternatives assessed, only Alternative 4B (New Watermain, Reservoir and PS) reduces the criticality of both the existing Aqueduct and the F.M. Woods PS, improves resiliency of supply of the Arkell Sources and provides of redundancy of the Arkell Wellfield. Alternative 4B is the only one that allows the City's maximum day demand to be met in the event of the Woods PS or Arkell Aqueduct being out of service. The hydraulic performance associated with Alternative 4B was also superior to the other alternatives. Therefore, Alternative 4B was carried forward as the preferred alternative to build out the distribution system.

E-2.2 Wastewater Alternatives Development and Evaluation

E-2.2.1 Wastewater Collection System Assessment

The City's wastewater collection system was represented in a hydraulic model (PC-SWMM). This hydraulic model was updated using City provided GIS information and the tool was also calibrated to sewer flow monitoring data provided by the City. The City's existing and growth projected flows are distributed throughout the model to facilitate the assessment of the wastewater collection system's ability to maintain the targeted level of service under both dry and wet weather flow conditions.

E-2.2.1.1 Assessment Results

Figures E.7 and E.8 provide 2051+ DWF and WWF results, respectively, under existing infrastructure conditions.

The updated hydraulic model results showed that there are no capacity constraints in the City's wastewater collection system under dry weather conditions for either the existing or future scenarios. Multiple locations (7 general areas) are identified as being under capacity (i.e., upgrades of modifications required) for the wet weather flow conditions for both the existing and future scenarios. The City has reviewed these results and have also identified operational interests to consider in the development of alternatives to address the constraints.

Of note, the City's wastewater pumping stations appear to have adequate capacity for the dry and wet weather flow conditions for both the existing and future scenarios.

Figure E. 7 2051+ DWF Results – Existing Infrastructure

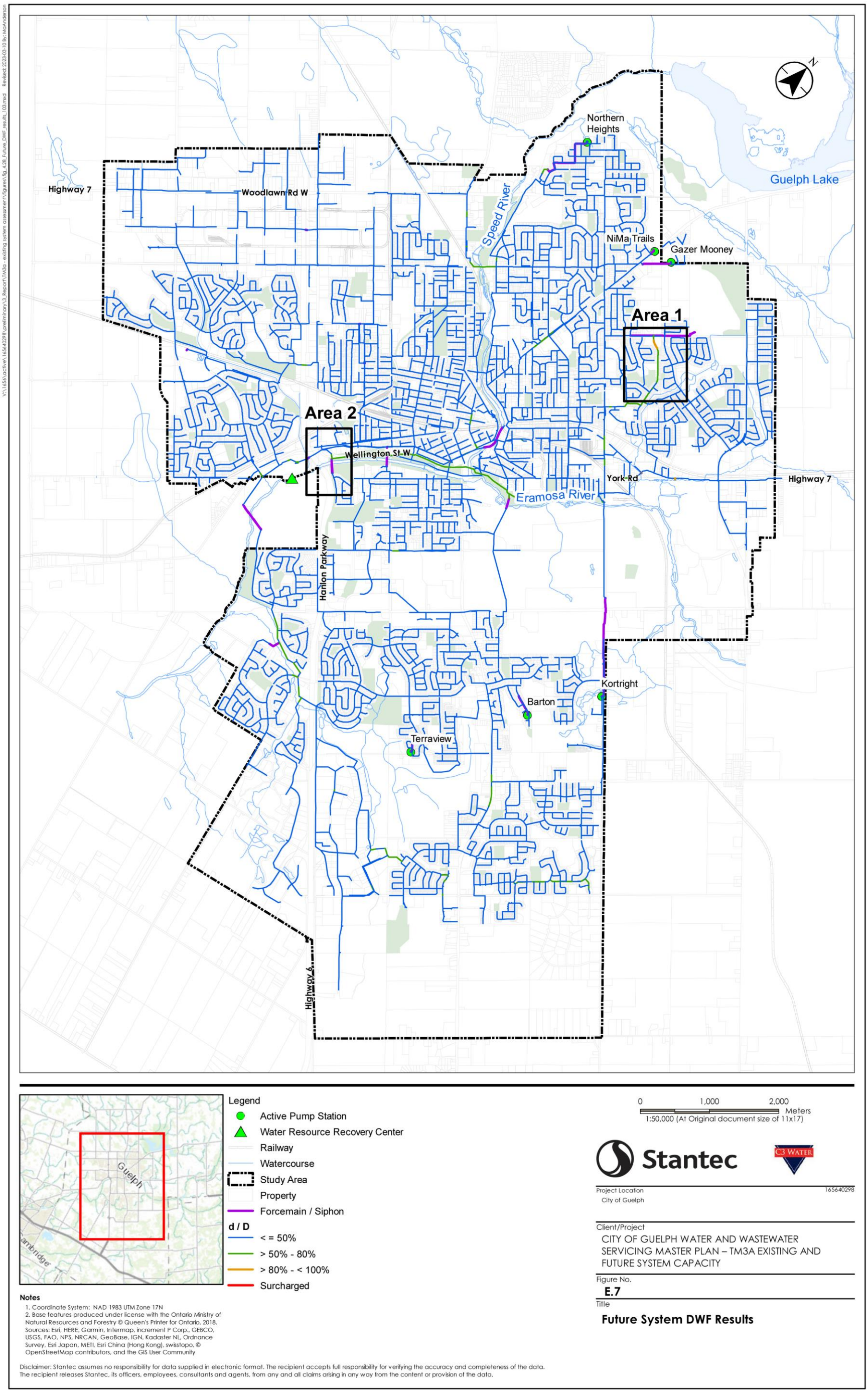
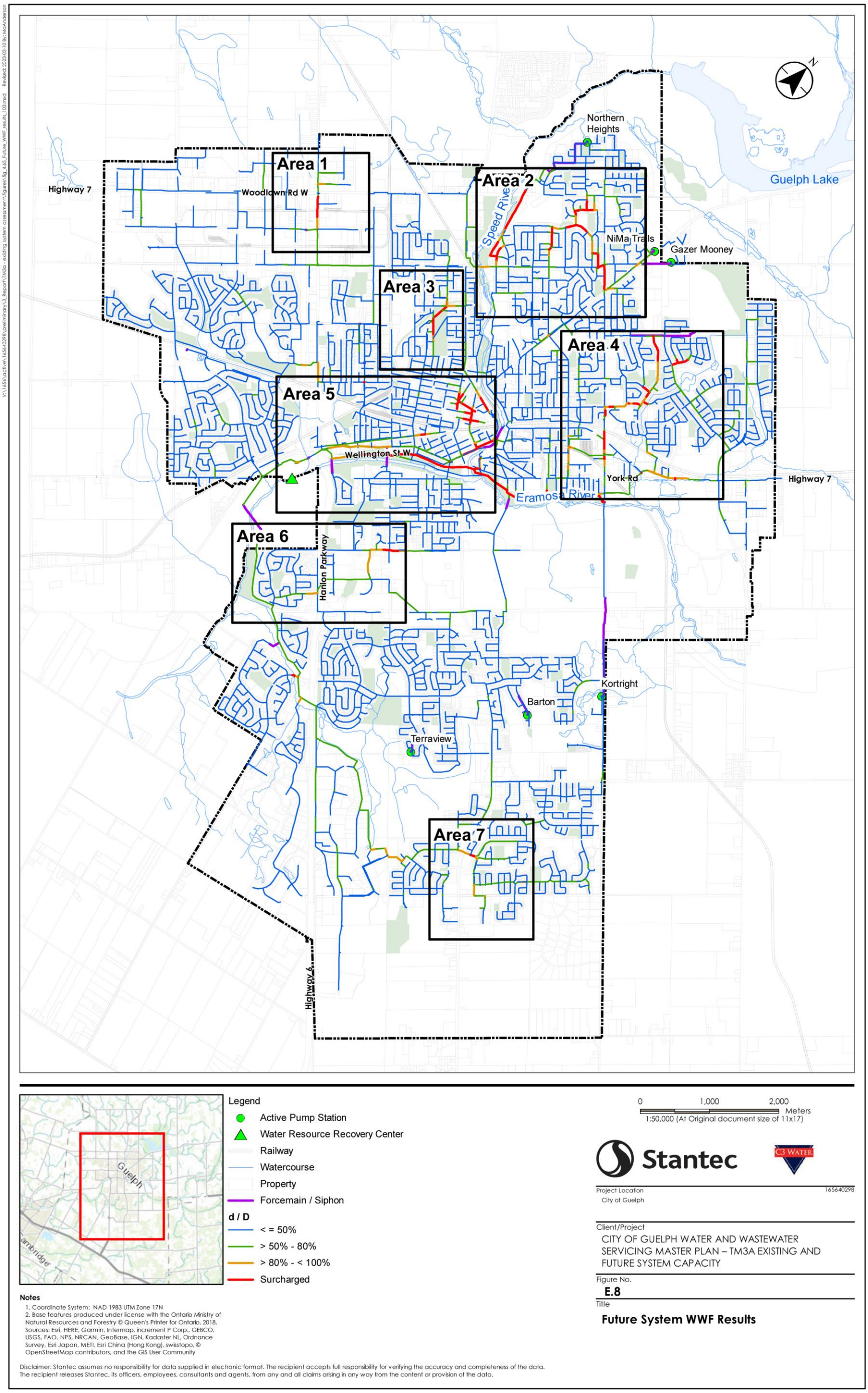


Figure E. 8 2051+ WWF Results – Existing Infrastructure



E-2.2.2 Development of Alternatives & Evaluation

To address the wastewater collection system deficiencies identified, the following wastewater servicing alternatives were considered:

1. Do Nothing
2. Sewer Replacement
3. Sewer Twinning / Storage
4. Flow Diversion

The “Do-Nothing” approach is generally discounted for all of the system deficiencies as the City has adopted a “no-surcharge” LOS in the wastewater collection system. Capacity constraints have been identified under both existing conditions as well as future growth (2051+) conditions. Not addressing them would result in the City accepting a lower LOS than that targeted.

Sewer Replacement is the preferred improvement alternative for most of the system deficiencies as they are primarily discrete sections of local sewers with diameters ranging from 200 mm to 450 mm (with some exceptions) with few downstream implications or constraints.

Sewer Twinning and/or Storage can achieve similar improvements as Sewer Replacement but generally are less preferred. Flow Diversion options were considered to determine if the required residual capacity in nearby adjacent sewers may be available.

E-3. Preferred Water Servicing Alternative

Based on the preferred water servicing alternative of “Improvements to Existing System”, watermain and facility upgrades were developed and are shown in Figure E.9. An estimated capital cost summary by time horizon is presented in Table E. 3-1.

Table E. 3-1 Summary of Water Cost Estimates by Time Horizon

Horizon	Short-Term (2031)	Mid-Term (2041)	Long-Term (2051+)	Total
Major Linear (> 300mm)	$23,800,000	$14,000,000	$19,600,000	**$57,400,000**
Minor Linear (<= 300mm)	$14,300,000	$2,200,000	$0	**$16,500,000**
CI Replacement	$31,900,000	$32,000,000	$32,000,000	**$95,900,000**
Facilities	$10,200,000	$10,900,000	$0	**$21,100,000**
Arkell PS, Res & Watermain (4B)	$110,400,000	$0	$0	**$110,400,000**
Total	**$190,600,000**	**$59,100,000**	**$51,600,000**	**$301,300,000**

Facility projects include upgrades to the Woods WTP (F-1) and the new Clythe WTP, reservoir and PS (F-2). Costs for these projects have been previously approved by Council and are not included in Table E.2. Other facility projects include replacement of the existing Robertson PS with a new Verney PS (F-3) and a new Park Zone 2 PS (F-4), both of which improve servicing and reduce criticality for Pressure Zone 2. F-5 involves retrofitting the existing Clair PS, once the Clair Maltby ET is online, to improve efficiency of the station. W-S-1 involves the replacement of the existing Speedvale ET with a new Pressure Zone 2 ET on the north end of the system to improve the Pressure Zone hydraulics and increase floating storage volume.

Major watermains were defined as pipes greater than or equal to 400mm. In Zone 1, a focus for the upgrades was to improve watermain capacity in the downtown area and create looping between the Wellington Feedermain and the Verney Feedermain. Another area of focus was improved transmission between the proposed new Arkell POE and the Clair ET.

A primary focus for watermain upgrades in Zone 2 was to improve east/west transmission and overall looping throughout the Zone to reduce the criticality of any one of the three pump stations.

Proposed watermain upgrades in Zone 3 have been established through the Clair Maltby MESP and were not revisited through this project as no servicing concerns were identified through the analysis.

Minor watermains were defined as those less than 400mm. Two areas of focus for minor watermain projects were the downtown core and the University area. Proposed watermain projects improve localized capacity to support growth and meet fire flow requirements.

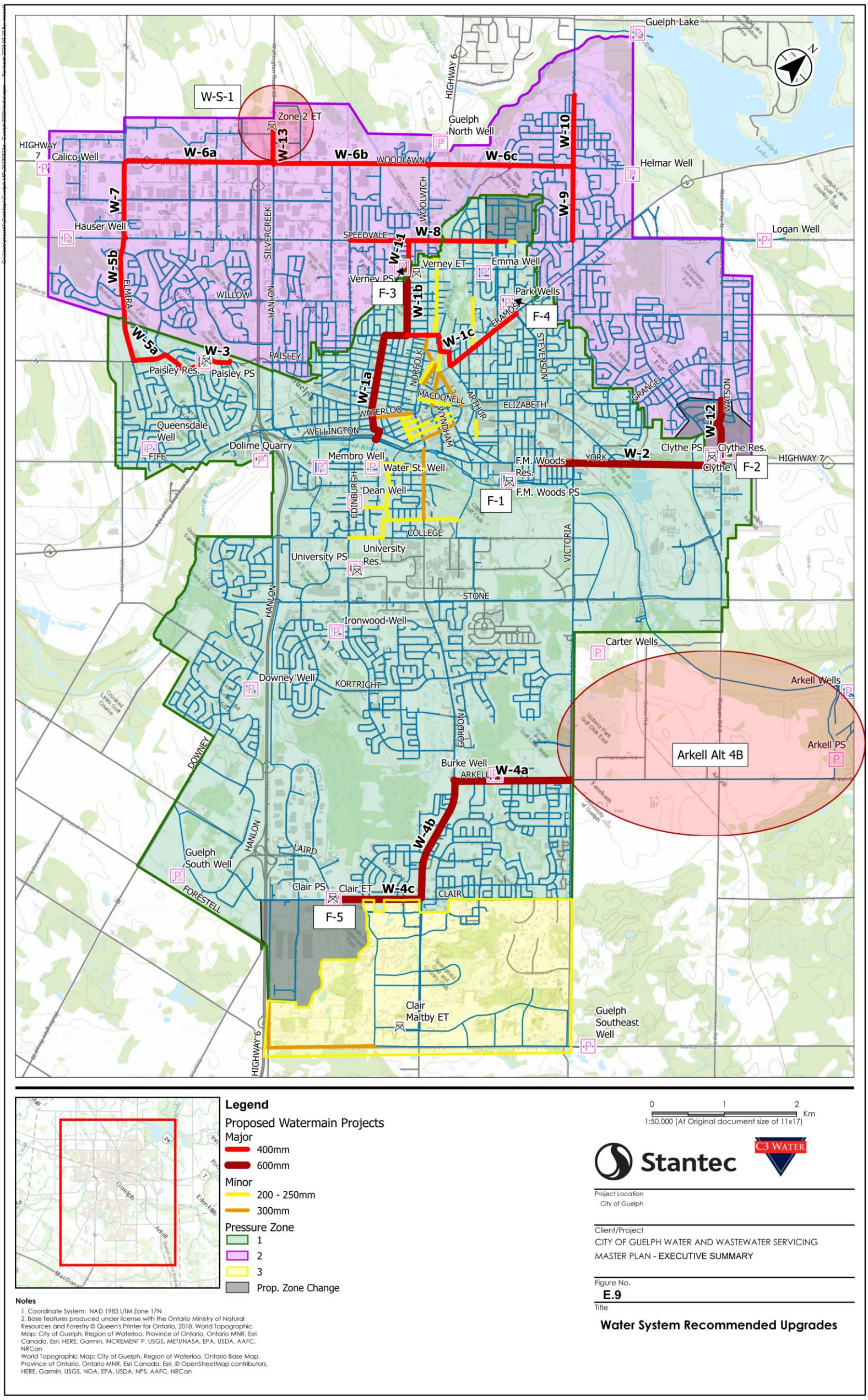
A cast iron watermain replacement program has been recommended with the intent of replacing all 100mm-150mm cast iron pipe within the 30-year planning horizon. Although many CI pipes are in very good condition structurally, CI pipe is subject to tuberculation of the inner pipe walls over time, leading to high roughness and reduced capacity.

There are areas of the system that experience operating pressures outside of the preferred range of 50-80 psi as a result of the group elevations. A number of areas of concerns were identified and were assessed to determine if there was an overall benefit to adjusting the pressure zone boundary in these areas.

The following Zone boundary adjustments are recommended, as shown in Figure E.9 below:

- Southgate Dr area from Zone 1 to Zone 3. Timing based on Clair Maltby ET.
- Fleming Rd area from Zone 2 into Zone 1. Timing based on Clythe PS upgrades.
- Waverly Dr area from Zone 1 to Zone 2. Timing based on Speedvale feedermain.

Figure E. 9 Water System Recommended Upgrades



E-4. Preferred Wastewater Collection Alternative

In total there are 20 projects identified for the wastewater system to address capacity constraints, eliminate system surcharge, and address operational issues. Alternate improvements concepts were identified and tested in 7 general areas (see Figure E.10). These projects are intended to take advantage of existing/planned City works, improve operational efficiency / flexibility, and to move existing sewers/trunks into transportation right of ways and out of easements. Of note, the City's wastewater pump stations all have adequate capacity for both the dry and wet weather conditions under the existing and future scenarios – no upgrades are anticipated to be required based on current understanding. An overall system improvement summary, including sewer lengths, diameters and cost estimates is provided in Table E. 4-1, visually identified in Figure E.10.

Table E. 4-1 Summary of Wastewater Cost Estimates by Time Horizon

Horizon	Short-Term (2031)	Mid-Term (2041)	Long-Term (2051+)	Total
Major Linear (> 300mm)	$57,740,000	$14,420,000	$3,680,000	**$75,840,000**
Minor Linear (<= 300mm)	$4,260,000	$0	$0	**$4,260,000**
Capital Works (Siphons)	$5,500,000	$0	$14,170,000	**$19,670,000**
Total	**$67,500,000**	**$14,420,000**	**$17,850,000**	**$99,770,000**

The recommended upgrades per area are summarized as follows:

Area 1 includes two (2) reaches. Gravity sewer replacements are recommended for both reaches.

Area 2 includes four (4) reaches. Gravity sewer replacements are recommended for 3 of the 4 reaches. For the remaining location (reach 2-3), the recommended upgrade includes the installation of a new sewer south on Riverview Drive to provide front of lot servicing. The existing 225 mm sewer on Kitchener Avenue could be abandoned.

Area 3 includes one (1) reach. Sewer realignment is recommended for this reach for the sewers from Exhibition Park. The realignment would reroute flow south on Exhibition Street and London Road. This would provide the required capacity upgrades while also eliminating sewers through the park. A new 450 mm sewer from the intersection of Division Street and Exhibition Street to London Road and Kathleen Street is included.

Area 4 includes five (5) reaches. Gravity sewer replacements are recommended for 4 of the 5 reaches. For the remaining location (reach 4-2), sewer upgrades along York Road and Victoria Road are identified that would eliminate the easement required with the current alignment. The City has identified that further review is required before

proceeding with this recommendation (in full) to investigate the feasibility of crossing existing culverts and storm sewers.

Area 5 includes six (6) reaches. Gravity sewer replacements are identified for all reaches. Further study of this area is recommended however due to the following:

- Recent emergency works completed to stabilize the existing trunk sewer should be incorporated in a long-term solution. A long-term solution which results in these recent mitigative investments being replaced are to be avoided.
- There appears to be available elevation for lowering of the connection(s) to the WRRC. This provides the opportunity to consider lowered trunk infrastructure to satisfy the servicing needs for the area. This also provides a potential opportunity to explore modifications to the City's existing siphons.
- Gravity solutions may benefit from use of adjacent parallel roads/easements for alleviation of surcharge. These alignment options warrant further consideration.
- A diversion structure may be of benefit. This might be used to convey flow above the existing system's capacity to the WRRC. The diversion could be to a lowered trunk sewer, or to a new bypass pump station.

The findings of the WWSMP for Area 5 should be considered as preliminary and used to help form the basis for further study.

Area 6 includes one (1) reach. Gravity sewer replacement is recommended.

Area 7 includes one (1) reach. The construction of a new sewer along Clair Road is recommended. This would address the capacity issues while avoiding construction in deeper sewers. This upgraded is to be timed to concur with the road widening associated with the Clair Maltby Secondary Plan (Phase 2).

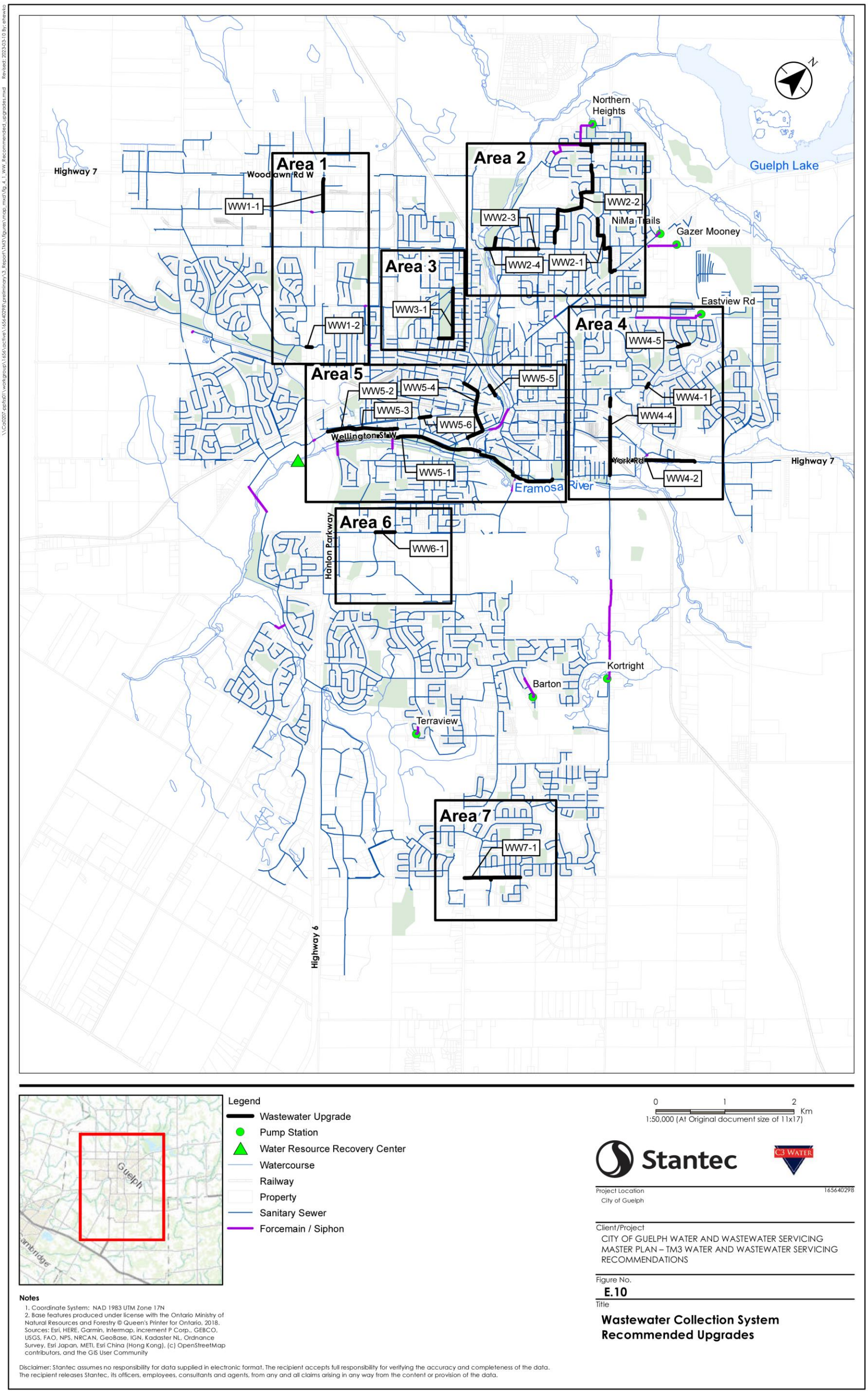
E-4.1 Siphons

The City's siphons were also assessed in consideration of City, regional, and provincial guidelines. In summary, the City's siphons are not currently achieving minimum velocity requirements. In addition, the Ontario Ministry of the Environment, Conservation and Parks 2019 Design Guidelines for Sewage Works (MECP) provincial guideline suggests two (2) barrels be provided for all siphons. This minimum barrel guideline is not satisfied for five (5) of the 13 City siphon crossings.

Based on available information from City Operations, the siphons are not currently experiencing major performance issues. The suggested approach is to inspect and track the performance of these hydraulic structures. Tactical maintenance may be sufficient to maintain their operation. Replacement and/or modification when concurrent opportunities arise may also be explored. For example, the cost estimates presented include the recommendations from the Manor Park siphon feasibility study ($1.5M

planned for 2028) and the Municipal Street siphon feasibility study ($2.7-$4.0M – timing to be confirmed).

Figure E. 10 Wastewater System Recommended Upgrades



E-5. Other Programs and Studies

A number of studies were recommended under the planning horizon of this WWSMP including 5-year updates to the WWSMP itself. Additional water studies include the Integrated Water Management study, a conceptual design and Schedule C EA for the Arkell Alternative and Schedule B EA for the Zone 2 ET. Recommended wastewater studies include preliminary studies for system improvements in specific areas and annual flow monitoring and I&I studies.

The WWSMP included the development of an Innovation Strategy for the City. To support the City's vision and align with the Future-Ready Strategic Plan (2019-2023) and the Future Ready-Action Plan, the innovation initiatives explored and rated in collaboration with the City are summarized in Table E. 5-1.

Table E. 5-1 Evaluation Summary of Innovation Initiatives

Innovation	System(s)	Score
Build on the existing leak detection program with extension of leak detection devices.	Water	38
Establish a common/integrated data & analytics platform for all one-water related business functions (gis, scada, and cloud-based).	Water & Wastewater	37
Establish a long-term flow and level monitoring program.	Wastewater	36
Develop a business case for advanced meter infrastructure.	Water	35
Establish a capacity assurance program with the development of a growth management tool.	Water & Wastewater	33
Develop an automated demand prediction tool.	Water	33
Establish a strategic I/I remediation program with cost-effectiveness and innovation as key guiding principles to achieve program objectives.	Wastewater	32
Develop an automated water supply availability prediction model.	Water	32
Develop flow prediction tools based on weather forecasts and system digital twin.	Wastewater	29
Establish an integrated green infrastructure program as a multi-functional infrastructure solution.	Wastewater	28
Develop a water system *digital twin.*	Water	28
Develop wastewater energy transfer (WET) applications.	Wastewater	27
Integrate real time GIS information in hydraulic models.	Water	22

The cost estimates for the studies and pilot programs are summarized in Table E. 5-2.

Table E. 5-2 Studies and Pilot Projects Cost Estimates

Horizon	Short-Term (2031)	Mid-Term (2041)	Long-Term (2051+)	Total
Studies	$3,750,000	$3,200,000	$2,800,000	**$9,750,000**
Innovation Pilot Programs	$575,000	$0	$0	**$575,000**

E-6. Summary Recommendations

The WWSMP update includes recommended infrastructure upgrades to satisfy the City's targeted level of service and growth projections. These recommendations are based on the results of calibrated hydraulic models which consider the existing and projected growth needs and build on the WSMP.

There are several ongoing activities that are recommended to continue in an effort to refine the findings from the system assessments and maintain and increase the confidence in the results of the developed models:

- Regularly update the City's hydraulic models as field data is collected and GIS systems are updated. The City's models should also be updated with growth and infrastructure updates as these occur.
- Continue annual strategic sewer flow monitoring. The focus of these efforts should be to further understand how the City's wastewater collection system responds to rainfall and ongoing growth. Additional interest in obtaining data adjacent to areas where upgrades are identified is also strategic. This data may help confirm the timing and/or actual need for these upgrades.
    - Sewer flow monitoring data analysis also allows the City to understand its I/I profile and where any leakier areas may be present in the City. The sewer flow monitoring analysis completed as part of this WWSMP showed minimal to null I/I in the data collected. It is valuable to continue with similar analysis to ensure this is representative of the entire City. This could be achieved by continuing the City's existing I/I program and expanding the effort to include a city-wide strategy.
- Correlation of basement flooding reports to the results of the City's hydraulic modelling findings. Combined with an understanding of the return period of the corresponding rainfall, this correlation can help validate the model's predictive findings, or identify that additional calibration is warranted. This data is also valuable in establishing and confirming project prioritization.

- Confirm the location and distribution of building lateral connections to the City's sewers through field measurements/inspections. Currently the City's design/development guidelines do not allow any surcharging of sewers. This may be overly conservative depending on the building lateral connection details. The City's sewers are also known to be shallow in certain areas, notably the City Centre / core area. An understanding of where there are basements and associated lateral connection to the shallow network would allow an understanding of the risk of allowing surcharging and possibly allow the City to allow surcharge in certain areas.
- Align the City's development review tracking methods to use the hydraulic model and track cumulative demands.
- Continuation and further refinement of the City's leak detection program.
- Take further advantage of the City's data collection system by providing performance metrics.

Additional recommendations pertaining to City procedures, policies, and non-capital upgrade initiatives were provided. These include recommendations relating to the City's Development Engineering Manual (DEM). The City's existing DEM was reviewed and compared to both regional and provincial comparable guidelines. Guidelines from nearby municipalities were also consulted. Recommendations for the City's DEM are provided in the WWSMP report Volume II *TM5 Design Criteria, Level of Service, and Sensitivity Analysis (TM5).*

A cost summary per time horizon for the recommended capital projects, studies and pilot programs is summarized in Table E. 6-1.

Table E. 6-1 Cost Estimates Summary

Horizon	Short-Term (2031)	Mid-Term (2041)	Long-Term (2051+)	Total
Capital Works - Water	$190,600,000	$59,100,000	$51,600,000	**$301,300,000**
Capital Works - Wastewater	$67,500,000	$14,420,000	$17,850,000	**$99,770,000**
Studies	$3,750,000	$3,200,000	$2,800,000	**$9,750,000**
Innovation Pilot Programs	$575,000	$0	$0	**$575,000**
Total	**$262,425,000**	**$76,720,000**	**$72,250,000**	**$411,395,000**