CITY OF BRANTFORD

# Water, Wastewater and Stormwater Master Servicing Plan Update – 2051 Amendment

November 2021

# Volume II – Plan and Policy

GM BluePlan ENGINEERING

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## TABLE OF CONTENTS

**APPENDICES**

# Key Acronyms and Definitions

**EA (Environmental Assessment)**

An Environmental Assessment, or in the context of this document the MEA Municipal Class EA, is an approved planning process for municipal infrastructure that can be used to meet the requirements of the EAA. The Municipal Class EA process was revised and updated in 1993, 2000, 2007, 2011, 2015, and 2020.

**EAA (Environmental Assessment Act)**

Environmental Assessment Act is a planning and design process that proponents must follow to examine and document the environmental effects that could result from major projects or activities.

**MCR (Municipal Comprehensive Review)**

Municipal Comprehensive Review is a process undergone by municipalities within Ontario to ensure that their official plans conform to policies within A Place to Grow: Growth plan for the Greater Golden Horseshoe. The MCR will complete background review, public consultation, and development of policies necessary for input into a new or amended official plan.

**MEA (Municipal Engineers Association)**

Municipal Engineers Association is an association of Ontario public sector Professional Engineers performing various roles within the field of municipal engineering.

**MSP (Master Servicing Plan)**

The Master Servicing Plan is a comprehensive document that provides a review, evaluation, and development of water, wastewater, and stormwater servicing strategies to support existing needs and projected growth forecasts to 2051.

**VSA (Vulnerable Scoring Area)**

Vulnerable Scoring Area, as it relates to source water protection plans, is the area surrounding surface water intakes and municipal wells.

**WTP (Water Treatment Plant)**

Water Treatment Plant is a facility which contains a treatment process to clean water, passing through many steps to meet water quality requirements, before it enters the water distribution system.

**Wastewater Treatment Plant (WWTP)**

Wastewater Treatment Plant is a facility which contains a treatment process to clean wastewater, passing through many steps to meet treatment requirements, before it is discharged into the Grand River.

# 1. Introduction and Background

## 1.1 City of Brantford Context

The City of Brantford is located in southwest Ontario along the banks of the Grand River and is within proximity of the City of Hamilton and the County of Brant. The City of Brantford is a single tier municipality, which owns and is responsible for the planning, construction, and management of the municipal water, wastewater, and stormwater infrastructure.

The City owns and operates its water system, which includes water treatment, storage facilities, pumping stations, and trunk and distribution watermains. The City's water is supplied by a single surface water treatment plant (WTP) that draws water from the Grand River and distributes treated water to its residents.

The City owns and operates its wastewater system, which includes wastewater treatment, pumping stations, and collection and trunk sewers. The City's wastewater is collected and conveyed to a single wastewater treatment plant (WWTP) that treats the City's wastewater before discharging into the Grand River.

The City owns, maintains, and operates the majority of the stormwater collection and management infrastructure, which includes catch basins, storm sewers, ditches, culverts, stormwater management facilities, and other stormwater facilities and structures. The entirety of the City is located within the Grand River watershed. The majority of the City's existing stormwater sewers and managed ditches drain directly to the Grand River or the following Grand River tributaries: Phelps Creek, Mohawk Lake and D'Aubigny Creek; however, a significant portion of the City's northeast discharges to local creeks along the City's north and east before discharging into Fairchild Creek.

Readily available and accessible public infrastructure is essential to the viability of existing and growing communities. Infrastructure planning, land use planning, and infrastructure investment require close integration to ensure efficient, safe, and economically achievable solutions to provide the required water, wastewater, and stormwater infrastructure.

To balance the needs of growth with the protection and preservation of natural, environmental, and heritage resources, the City of Brantford initiated the preparation of the 2020 Master Servicing Plan Update – 2051 Amendment (2020 MSP Update) for water, wastewater, and stormwater services under the Municipal Engineers Association (MEA) Master Plan Class Environmental Assessment process.

## 1.2 Municipal Comprehensive Review

The City of Brantford started its Official Plan Review in 2013. Between 2013 and 2016, completed work included the hosting of visioning sessions, the preparation of technical background papers and the creation of a new Draft Official Plan (Version 1, issued in July 2016). The Official Plan Review was put on hold while the Municipal Boundary Adjustment Agreement, between the City of Brantford and the County of Brant, was finalized and approved by the Province, and pending updates to the Growth Plan for the Greater Golden Horseshoe to which the new Official Plan must conform.

In 2016, the municipal boundary, between the City of Brantford and the County of Brant, was adjusted to secure additional lands for the City's future growth, effective January 1, 2017. These lands are referred to as the Boundary Adjustment Lands.

The municipal boundary adjustment brought new lands into Brantford's municipal boundary; however, this did not automatically include the lands in the City's urban area boundary, also referred to as a Settlement Area boundary. To expand the City's Settlement Area boundary, the Province requires municipalities to conduct a Municipal Comprehensive Review (MCR) as input into their new or amended Official Plan. The MCR is necessary as it determines the extent to which the Settlement Area boundary is to be expanded. Following the completion of the MCR, the new or amended Official Plan can designate urban land uses within the expanded Settlement Area boundary.

The City ventured to complete the MCR and revisions to the 2016 Draft Official Plan to include the Boundary Adjustment Lands. The City of Brantford established an eight-stage study process to complete the Municipal Comprehensive Review and finalize the new Official Plan – entitled **Envisioning Our City**, and a new draft Official Plan was released to the public for review and comment in June 2020. To assist the City in completing a new Official Plan, the City retained a team of consultants led by SGL Planning & Design Inc., and includes The Planning Partnership, Cushman Wakefield, Hemson Consulting, AgPlan Limited, ASI (Archaeological Services Inc.), Ecosystem Recovery Inc., GM BluePlan Engineering, Plan B Natural Heritage, and Dillon Consulting. The new Official Plan was adopted by City Council in March 2021 and has been submitted to the Province for approval.

GM BluePlan Engineering was retained to support the MCR Study with respect to the determination of the appropriate water, wastewater, and stormwater servicing plan for the lands to be included within the Settlement Area boundary in the North Brantford and Tutela Heights Boundary Adjustment Lands.

## 1.3 Master Servicing Plan

In support of the Official Plan Review, and to ensure that infrastructure servicing recommendations to support the new urban land uses are made in a cohesive and integrated manner with the City's long-term servicing needs of the existing system, the City has undertaken an update to its MSP.

The 2020 MSP Update – 2051 Amendment provides a review, evaluation, and development of water, wastewater, and stormwater servicing strategies to support existing needs and projected growth forecasts based to 2051; including the servicing of new urban land uses within the City's new Official Plan, adopted by Council in March 2021.

The 2020 MSP Update was completed concurrently with the City's new Official Plan and the Transportation Master Plan Update to enable, where advantageous, alignment of recommended work or capital projects, minimizing potential impacts and disruptions to the public. Following the completion of the 2020 MSP Update to the 2041 growth horizon, updated growth numbers were provided by the Province's Growth Plan to the 2051 growth horizon.

The 2020 MSP Update – 2051 Amendment is a critical component of the City's planning for growth and will provide the framework and vision for the management, expansion and funding of the water, wastewater, and stormwater systems for the entire City to 2051 and beyond.

## 1.4 Master Servicing Plan Objectives

The MSP Update for water, wastewater and stormwater services comprehensively documents the development, evaluation, and selection of the preferred water, wastewater, and stormwater servicing strategies to meet the servicing needs of existing and future development to 2051 and beyond.

The 2020 MSP Update evaluates the ability of existing and planned water, wastewater, and stormwater infrastructure in the City of Brantford to efficiently and effectively service the City's existing and anticipated growth, including servicing of the new urban land uses within the City's new Settlement Area boundary in accordance with the draft Official Plan, and to evaluate and develop recommended servicing strategies.

The key objectives of the 2020 MSP Update are as follows:

- Review and integrate the servicing needs to support buildout of the new urban land within the 2017 Boundary Adjustment Lands;
- Review planning forecasts to 2051 and determine the impacts on servicing needs for the City's water, wastewater, and stormwater infrastructure;
- Consider and incorporate proposed water, wastewater, and stormwater infrastructure needs to support the full buildout lands within the new municipal boundary beyond 2051;
- Undertake a comprehensive review and analysis for the water, wastewater, and stormwater servicing requirements;
- Complete the MSP in accordance with the MEA Class EA process (further described in **Volume II**);

- Address key servicing considerations as part of the development and evaluation of servicing strategies including:
    - Level of service to existing users and approved growth
    - Operational flexibility and security of supply
    - Mitigation of impacts to natural, social, and economic environments
    - Opportunity to meet policy, policy statements, regulations and technical criteria
    - Opportunity to optimize existing infrastructure and servicing strategies
    - Ensuring the strategies are cost effective
- Consider and develop sustainable servicing solutions;
- Utilize updated industry trends and more detailed information from relevant City studies and projects to provide better capital cost estimates;
- Utilize recently completed and on-going projects to update infrastructure status, capacity and cost estimates;
- Utilize the updated water, wastewater, and stormwater hydraulic models for the analysis of servicing alternatives;
- Establish a complete and implementable water, wastewater, and stormwater capital program; and
- Extensive consultation with the public and stakeholders.

## 1.5 Master Servicing Plan Documentation Layout

The 2020 MSP Update Report, including all supporting volumes, is the documentation placed on public record for the prescribed review period. This documentation, in its entirety, describes all required phases of the planning process and incorporates the procedure considered essential for compliance with the **Environmental Assessment Act**.

The MSP Update Report is organized into six volumes as described below.

**Volume I – Executive Summary**

**Volume I** provides a brief overview of the 2020 MSP Update. It summarizes the information contained in **Volume II**, **III**, **IV**, **V** and **VI**, including problem statement, purpose of the study, significant planning, environmental and technical considerations, description of the analysis performed and final solution and recommendations.

**Volume II – Plan & Policy**

**Volume II** details the master planning process; including the Master Plan Class EA process, related studies, legislative, and policy planning context, water, wastewater, and stormwater servicing principles and policies, population and employment growth forecasts, existing environmental and servicing conditions, evaluation methodology, and future considerations.

The appendices in this volume contain relevant baseline and planning information including:

- Appendix A – Traffic Zone Population and Employment Projections
- Appendix B – Principles, Policies, and Level of Service
- Appendix C – Unit Rates

**Volume III – Water Master Plan**

**Volume III** consists of the principal document summarizing the study objectives, approach, methodologies, technical analyses, evaluation and selection of the preferred water servicing strategy. This volume outlines the water policies, design criteria and level of service needed to be achieved by the water network. In addition, **Volume III** identifies the existing water network and describes the hydraulic modelling tool used for the analysis. Further **Volume III** outlines the detailed evaluation and decision-making process as well as the preferred servicing strategy and associated capital program and implementation plan.

A significant amount of technical background information has been compiled, which is critical to the development of the Water Master Servicing Plan. This information is included as appendices in **Volume III**. The technical appendices contain relevant project, implementation, and technical analysis information including:

- Appendix A – Water System Schematic
- Appendix B – Traffic Zone Demand
- Appendix C – Expansion Lands Concepts
- Appendix D – Water Treatment Plant Concepts
- Appendix E – Evaluation Tables
- Appendix F – Capital Program Project Sheets

**Volume IV – Wastewater Master Plan**

**Volume IV** consists of the principal document summarizing the study objectives, approach, methodologies, technical analyses, evaluation and selection of the preferred wastewater servicing strategy. This volume outlines the wastewater policies, design criteria and level of service needed to be achieved by the wastewater network. In addition, **Volume IV** identifies the existing wastewater network and describes the hydraulic modelling tool used for the analysis. Further in **Volume IV** is the detailed evaluation and decision-making as well as the preferred servicing strategy and associated capital program and implementation plan.

A significant amount of technical background information has been compiled, which is critical to the development of the Wastewater Master Servicing Plan. This information is included as appendices in **Volume IV**.

The technical appendices contain relevant project, implementation, and technical analysis information including:

- Appendix A – Wastewater System Schematic
- Appendix B – Traffic Zone Flows
- Appendix C – Expansion Lands Concepts
- Appendix D – Wastewater Treatment Plant Concepts
- Appendix E – Evaluation Tables
- Appendix F – Capital Program Project Sheets

**Volume V – Stormwater Master Plan**

**Volume V** consists of the principal document summarizing the study objectives, approach, methodologies, technical analyses, evaluation and selection of the preferred stormwater servicing strategy. This volume outlines the stormwater policies, design criteria and level of service needed to be achieved by the stormwater network. In addition, **Volume V** identifies the existing stormwater network and describes the hydraulic modelling tool used for the analysis. Further, **Volume V** outlines the detailed evaluation and decision-making as well as the preferred servicing strategy and associated capital program and implementation plan.

A significant amount of technical background information has been compiled, which is critical to the development of the Stormwater Master Servicing Plan. This information is included as appendices in **Volume V**. The technical appendices contain relevant project, implementation, and technical analysis information including:

- Appendix A – Key Existing Stormwater Infrastructure Facility Details
- Appendix B – Expansion Lands Subwatershed Study
- Appendix C – Evaluation Tables
- Appendix D – Implementation Plan Detailed Study Overview Sheets
- Appendix E – Capital Program Project Sheets

**Volume VI – Public and Agency Consultation**

**Volume VI** contains all relevant documentation of the public consultation process including notices, comments and responses, and distribution information. Presentation material from all Public Information Centres (PICs) held during this process is included. Other presentation material and discussion information from workshops held with relevant agencies, approval bodies and other stakeholders are also included within the appendices:

- Appendix A – Study Stakeholder List
- Appendix B – Study Commencement
- Appendix C – Public Information Centres
- Appendix D – Comments Received
- Appendix E – Study Completion

# 2. Master Planning Process

A Master Plan is typically subject to approval by the municipality but does not normally require approval under the Environmental Assessment Act (EAA); however, any specific project within a Master Plan must fulfill the Class Environmental Assessment (EA) requirements. At a minimum, Master Plans address Phases 1 and 2 of the Class EA process.

This section describes the class environmental assessment process and the specific requirements for the preparation of Master Plans.

## 2.1 Class Environmental Assessment Process

Ontario's 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 a 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). It is the objective of EAA proponents to ensure that decisions result from a rational, objective, transparent, replicable, and impartial planning process.

As set out in Section 6.1(2) of the EAA, an EA document must include the following:

- A description of the purpose of the undertaking;
- A description of and a statement of the rationale for,
    - 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 reasonably 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;
- 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); and,
- A description of any consultation about the undertaking by the proponent and the results of the consultation.

## 2.2 The Principles of Environmental Planning

The EAA sets a framework for a systematic, rational and replicable environmental planning process that is based on five key principles, as follows:

- 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 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. This includes 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.

## 2.3 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, 2015, and 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 Environmental Assessment, prepared by the Municipal Engineers Association (MEA) (October 2000, as amended in 2007, 2011, 2015, and 2020), 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: Identification of the Problem or Opportunity;
- 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 based on the existing conditions and anticipated environmental effects, 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.

Projects subject to the Class EA process are classified into the 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. Projects of this class do not usually have the potential for adverse environmental impacts. Typical projects that fall in this category are within existing road allowance, and utility corridors.

**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. Provided that no significant impacts are identified and no requests for a Part II Order to a Schedule C or Individual Environmental Assessment 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 Environmental Study Report (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 Environmental Assessment are received, Schedule C projects are then approved and may proceed directly to implementation.

**Figure 1** illustrates the Municipal Class EA planning and design process with the phases required for each schedule.

It is noted that at the time of completion of this 2020 MSP Update, the COVID-19 Economic Recovery Act, 2020, S.O. 2020, C.18 and corresponding EAA amendments are in full effect.

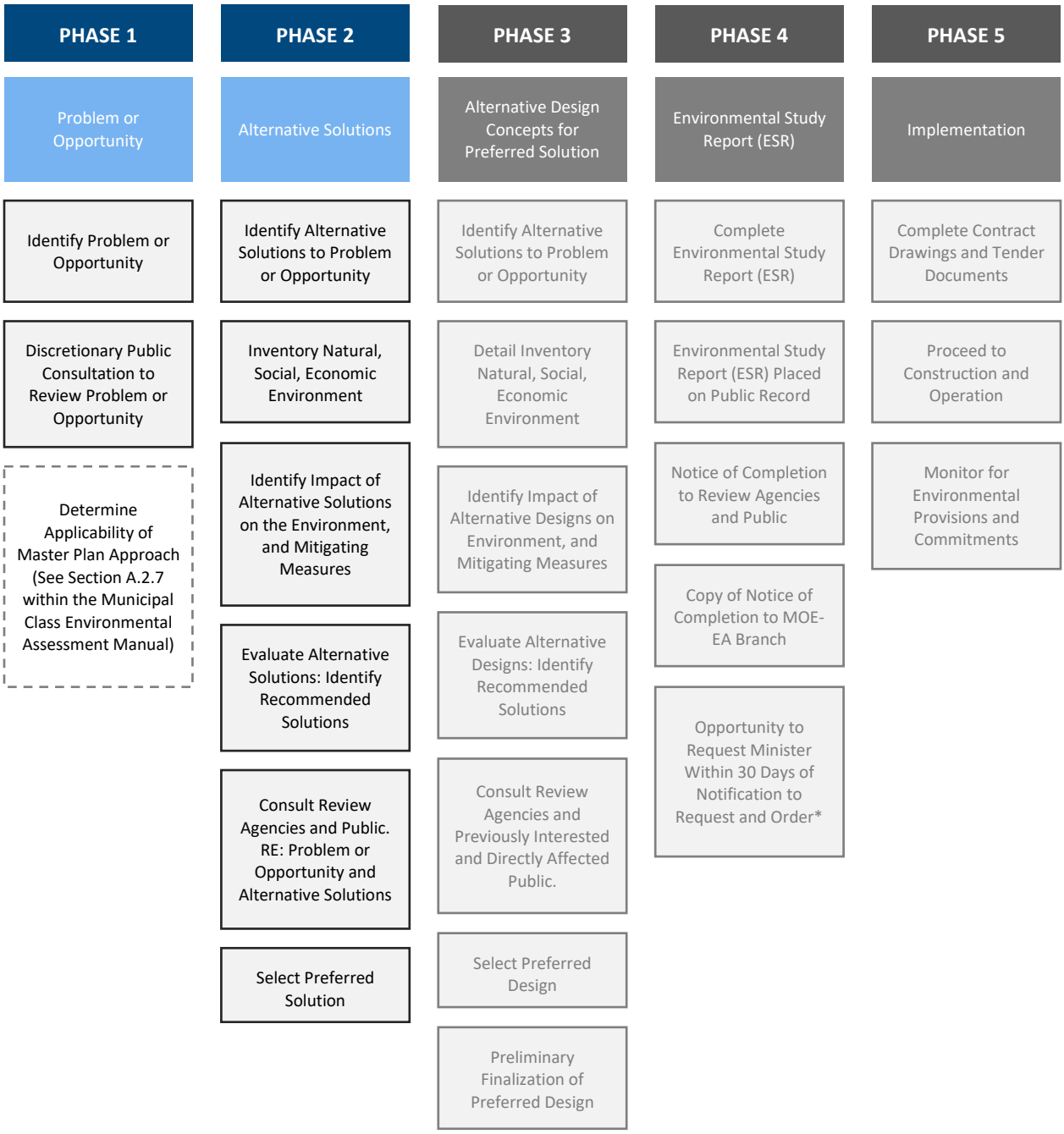



**Figure 1: Municipal Class EA Planning and Design Process**

## 2.4 Master Planning Process

Municipalities recognize the benefits of comprehensive, long-range planning exercises that examine problems and solutions for an overall system of municipal services. The Municipal Class EA for water and wastewater (including stormwater) projects recognizes the importance of master plans as the basis for sound environmental planning. The Class EA defines master plans as:

> "Long range plans which integrate infrastructure requirements for existing and future land use with environmental assessment planning principles. These plans examine an infrastructure system(s) or group of related projects in order to outline a framework for planning for subsequent projects and/or developments."

Master plans have distinguishing features that set them apart from project specific studies. These features include the following:

- Master plans are broad in scope and focus on the analysis of a system for the purpose of outlining a framework for the provision of future works and developments.
- Specific projects recommended in a master plan are part of a larger management system and are distributed geographically throughout the study area. The implementation of specific projects may occur over an extended time frame.

In accordance with the MEA Class EA document, a Master Plan must at least satisfy the requirements of Phases 1 and 2 of the Class EA process and incorporate the five key principles of environmental planning. The Master Plan must document public and agency consultation at each phase of the process and a reasonable range of alternative solutions must be identified and systematically evaluated.

The approach for the Master Plan is to confirm existing planned projects and where applicable, evaluate and develop any new components. This approach would also be scrutinized through a public and agency consultation process and be fully documented.

There are generally four approaches to undertaking Master Plans under the Class EA process as follows:

- **Approach 1**: Under this approach, the master plan document is completed through a conceptual and strategic level study where detailed investigations would be required at the project-specific level for individual Schedule B and C projects or developer led requirements identified though the master plan.
- **Approach 2**: This approach allows for Schedule A, A+ and specific Schedule B projects identified in the master plan to move forward to implementation. The master plan provides evaluation and documentation to support identified Schedule B Class EA requirements with applicable review agency commitments prior to the respective implementation. As well the master plan document identifies Schedule B or C projects that will proceed with separate studies to fully meet the Class EA requirements and allow for greater detail in the evaluation of alternatives and design concepts. Schedule C projects will continue to Phase 3 and 4 of the Class EA process with an Environmental Study Report filed for public review.
- **Approach 3**: This approach allows for Schedule for Schedule A, A+, B, and C projects identified in the master plan to move forward to implementation. The master plan completes Phases 1 to 4 of the Class EA process, necessary to for Schedule B (Phase 1 and 2 only) and Schedule C (Phases 1 to 4) projects.
- **Approach 4**: Under this approach, the master plan is completed and integrated with the Planning Act. This approach is necessary in studies where context and justifications are necessary on a broad scale. For example, a master plan completed alongside long-term planning studies (i.e. Official Plan) where the recommendations are dependent and integrated. The master plan document will satisfy the early stages of Phases 1 and 2 for Schedule B projects and Phases 3 and 4 for Schedule C projects.

This study follows Approach 1 of the approved master planning Class EA process.

## 2.5 Public Consultation

Public and agency consultation are integral to the Class EA planning process. The public consultation process is essential for informing and obtaining input from potentially interested and affected parties during the study process.

Objectives of Phase 1 of the MEA Municipal Class EA process with respect to public consultation are as follows:

- Present clear and concise information to stakeholders at key stages of the study process;
- Solicit community, regulatory and Municipal staff input;
- Meet Municipal Class EA consultation requirements;
- To fulfill the consultation requirements of the MEA Municipal Class EA document:
    - Build on past communication protocols and consultation plans from previous Class EA and municipal planning initiatives, to ensure consistency and continuity.
    - Meet public and agency notification and consultation requirements for Phases 1 and 2 of the MEA Municipal Class EA; and
    - Complete additional tasks to enhance the proposed consultation program and overall Class EA process.

As part of the current project, a communication and consultation plan was developed. The main objective of the plan was to proactively engage the community, regulatory agencies, and City staff. More specifically, the plan was designed to:

- Ensure the general public, Municipal Councillors, stakeholders, external agencies (including federal and provincial) and special interest groups had an opportunity to participate in the study process;
- Ensure that factual information was provided to interested and affected stakeholders early and often throughout the study process; and
- Contact external agencies to obtain legislative or regulatory approvals, or to collect pertinent technical information.

The complete public and agency consultation process is documented in **Volume VI – Public and Agency Consultation.**

# 3. Relevant Studies and Background Information

The following completed studies have been reviewed and considered throughout the master planning process and selection of preferred servicing strategies.

## 3.1 Transportation Master Plan

The Transportation Master Plan (TMP) Update was completed alongside the MSP Update as the outcomes and recommendations directly relate to the MCR and new Official Plan. The TMP considered strategies for the existing and future transportation networks.

## 3.2 Official Plan Update

The 2020 Official Plan was updated following the completion of the MCR and is entitled **Envisioning Our City**, see **Section 1.2**.

# 4. Problem and Opportunity Statement

Through the Municipal Class EA process, Phase 1 requires the identification of a problem or opportunity statement that guides the development and evaluation of alternative strategies to address the deficiencies identified in the water, wastewater, and stormwater systems.

The 2020 MSP Update has been initiated to:

- Review and integrate the servicing needs to support buildout of the new urban land within the 2017 Boundary Adjustment Lands;
- Review planning forecasts to 2051 and determine the impacts on servicing needs for the City's water, wastewater and stormwater infrastructure;
- Re-evaluate growth needs and water supply and wastewater treatment capacities;
- Review approach and ability to support responsible development and coordinate integrated solutions with growth areas;
- Plan for Buildout that includes flexibility in servicing strategy and understanding of servicing impacts and costs; and,
- Update the long-term financial planning that includes a capital forecast to service existing and support growth and can be used as basis for development charges and rate updates.

## 4.1 2020 Master Servicing Plan Update Vision and Problem and Opportunity Statement

Through the Municipal Class EA process, Phase 1 requires the identification of the problem and opportunity statement that guides the process of establishing preferred strategies to address the deficiencies observed in the water, wastewater, and stormwater systems. The following vision statement is a driver for the 2020 MSP Update where problems and opportunities are clearly identified through the desire to provide an adequate level of service to users and improve system performance under both current and future conditions.

The Problem and Opportunity Statement is as follows:

**Supporting a Strong and Growing Brantford**

"To establish a preferred servicing plan for the City's water, wastewater, and stormwater systems that, meets current needs, supports growth and expansion of the City's urban boundary, maintains or improves service levels, considers priority areas of climate change, infrastructure optimization and renewal, and system resiliency."

# 5. Study Area

The City of Brantford is located in southwestern Ontario, 40 km from the City of Hamilton and 120 km from the City of Toronto. The City is situated in the west portion of the Greater Golden Horseshoe, as shown in **Figure 2**.

The City of Brantford is strategically connected to Cambridge to the north and Simcoe to the south by Highway 24, and to Woodstock in the west and Hamilton to the east by Highway 403. The City is well situated with respect to the industrialized portions of Southern Ontario and the large agricultural industry.

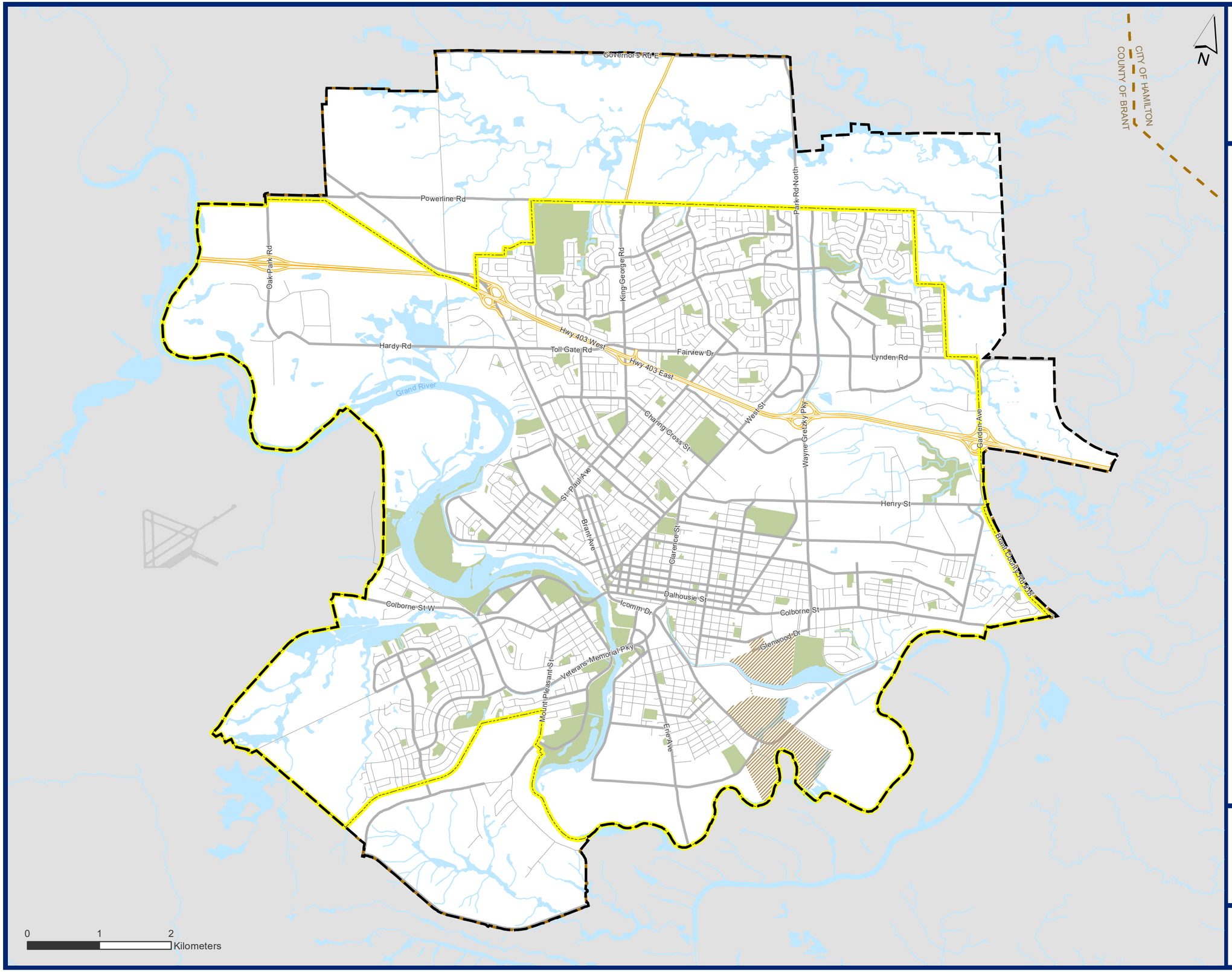
The City of Brantford has a total area of 102.5 $km^2$, including the Boundary Adjustment Lands, with a population of 101,700 people and 44,890 jobs in 2016. The study area covers the water, wastewater, and stormwater systems within the limits of the City.

The water, wastewater, and stormwater study areas, including limits of existing infrastructure, are shown in **Figures 3**, **4**, and **5** respectively.

## 5.1 Tutela Heights Existing Water and Wastewater System

Existing residents within the Tutela Heights area are currently serviced by the County of Brant's Mount Pleasant water system. To allow for the servicing of the anticipated intensification and growth in the area, the existing Tutela Heights water system will be separated from the County's existing water system and integrated into the City of Brantford's existing water system.

Existing residents within Tutela Heights are serviced by private on lot septic systems. New growth within the Tutela Heights area will need to be serviced by the municipal wastewater system via an extension of the City's existing wastewater system. The existing septic areas can continue to remain as such; however, the sizing of any existing wastewater infrastructure should consider the future servicing of these septic areas.




THE CORPORATION OF THE CITY OF BRANTFORD

**Water, Wastewater and Stormwater Master Servicing Plan Update**

**General Features**

- Expressway / Highway
- Arterial and Collectors
- Local Streets
- Waterbody
- Parks
- 2016 Municipal Boundary
- New Municipal Boundary
- Six Nations of the Grand River Territory
- Outside Municipalities

Figure 2
**Study Area**

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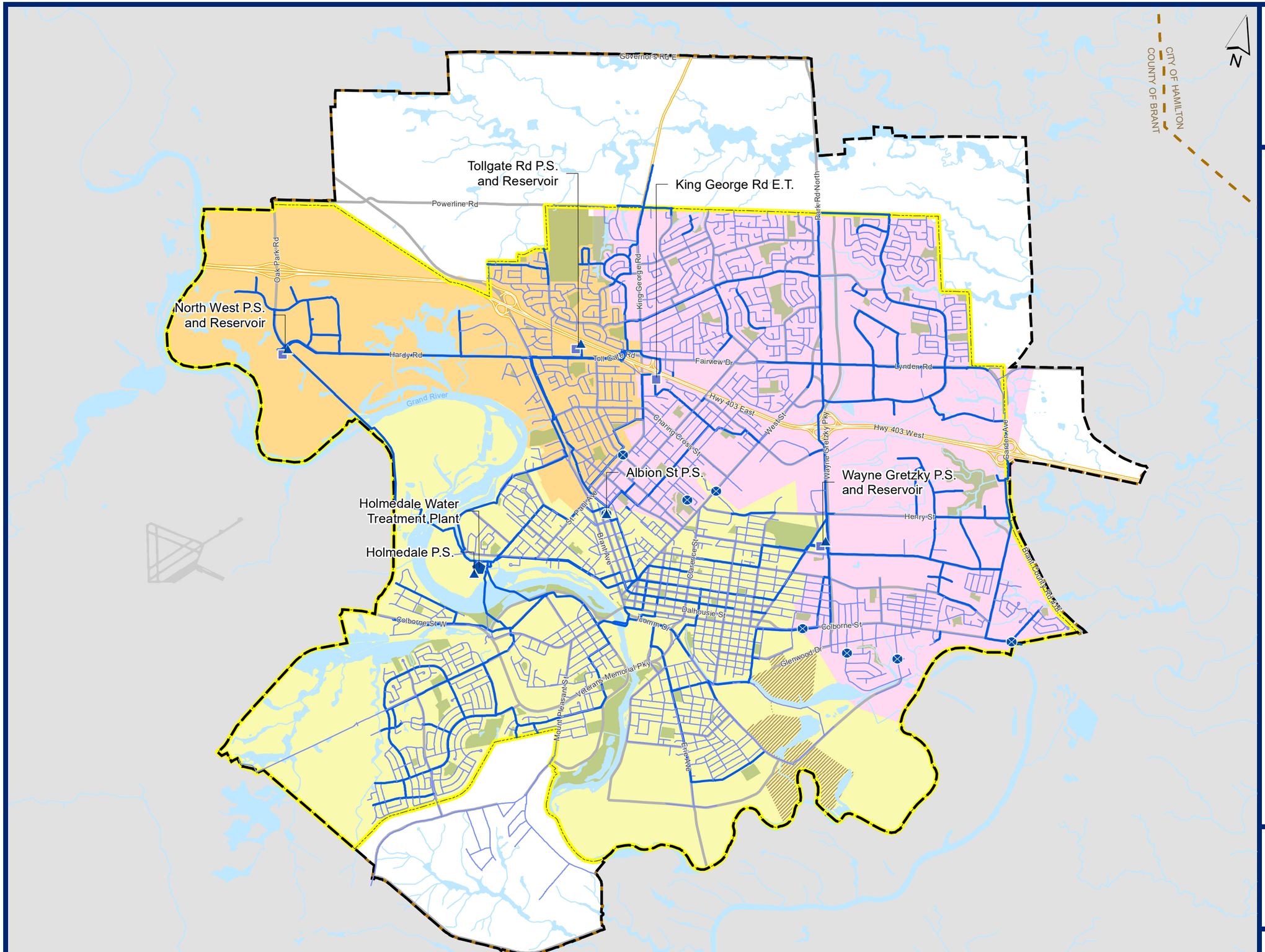
November 2020
717036-G-001
NAD 1983 CSRS UTM Zone 17N




THE CORPORATION OF THE CITY OF BRANTFORD

**Water, Wastewater and Stormwater Master Servicing Plan Update**

**Water Network**

- Water Treatment Plant
- Pumping Station
- Elevated Tank / Reservoir
- Pressure Reducing Valve
- Watermains (< 250 mm)
- Transmission (>= 250 mm)

**Water Pressure Districts**

- Pressure District 1
- Pressure District 4
- Pressure District 2/3

**General Features**

- Expressway / Highway
- Arterial and Collectors
- 2016 Municipal Boundary
- New Municipal Boundary
- Six Nations of the Grand River Territory
- Outside Municipalities
- Parks
- Waterbody

Figure 3

**Existing Water System**

BluePlan ENGINEERING

November 2020
717036-W-001
NAD 1983 CSRS UTM Zone 17N

THE CORPORATION OF THE CITY OF BRANTFORD

**Water, Wastewater and Stormwater Master Servicing Plan Update**

N

CITY OF HAMILTON
COUNTY OF BRANT

Lawren S. Harris Dr WWPS
Woodlawn Rd WWPS
Somerset Rd WWPS
St. Andrews WWPS
Alexander Dr WWPS
Henry Street Flow Split
Johnson Rd WWPS
Empey St WWPS
Wastewater Treatment Plant
Greenwich St WWPS
Fifth Ave WWPS

Governors Rd E
Powerline Rd
Oak Park Rd
Hardy Rd
Grand River
Toll Gate Rd
Hwy 403 West
Hwy 403 East
Fairview Dr
King George Rd
Park Rd North
Lynden Rd
Garden Ave
Wayne Gretzky Pkwy
West Brant Trail
Charing Cross St
Henry St
Brant County Rd #18
St Paul Ave
Brantford
Clarence St
Dalhousie St
Colborne St W
Colborne St
Terrace Hill St
Glenwood Dr
Veterans Memorial Pkwy
Mount Pleasant St
Fifth Ave

0 1 2 Kilometers

## Wastewater Network

- Wastewater Pumping Station
- Wastewater Treatment Plant
- Flow Split
- Sanitary Mains (<= 300 mm)
- Sanitary Trunks (> 300 mm)
- Forcemains

## WWPS Catchment

- Empey St WWPS
- Lawren S. Harris Dr WWPS
- Woodlawn Rd WWPS
- Johnson Rd WWPS
- Somerset Rd WWPS
- Alexander Dr WWPS
- Greenwich St WWPS
- Upstream of Henry Street Flow Split
- Fifth Ave WWPS
- WWTP
- St.Andrew's Ave WWPS

## General Features

- Expressway / Highway
- Arterial and Collectors
- Outside Municipalities
- Waterbody
- 2016 Municipal Boundary
- New Municipal Boundary
- Six Nations of the Grand River Territory

Figure 4
**Existing Wastewater System**

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THE CORPORATION OF THE CITY OF BRANTFORD

**Water, Wastewater and Stormwater Master Servicing Plan Update**

**Stormwater Network**

- Ditches
- Detention Ponds
- Wetlands
- Stormwater Pipes (< 450 mm)
- Stormwater Pipes (>= 450 mm)

**General Features**

- Expressway / Highway
- Arterial and Collectors
- 2016 Municipal Boundary
- New Municipal Boundary
- Six Nations of the Grand River Territory
- Outside Municipalities
- Parks
- Waterbody

Figure 5

**Existing Stormwater System**

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November 2020
717036-SW-001
NAD 1983 CSRS UTM Zone 17N

0 1 2 Kilometers

# 6. Planning Context

## 6.1 Provincial and Federal Legislation and Policy Context

### 6.1.1 Provincial Policy Statement

The Provincial Policy Statement sets the policy foundation for land use planning and development in Ontario. The Provincial Policy Statement provides guidance and support for appropriate land use planning and development while protecting resources of provincial interest, public health and safety, and the quality of the natural and built environment.

The Provincial Policy Statement applies to land use planning decisions made under the Planning Act by provincial ministers, municipal councils, local boards and planning boards, among other approval authorities. All municipal decisions affecting planning matters shall be consistent with the policies outlined in the Provincial Policy Statement.

The Provincial Policy Statement contains policies relevant to water, wastewater, and stormwater infrastructure planning included, but not limited to:

- Requirement that infrastructure be provided in a coordinated, efficient and cost-effective manner with considerations to climate change.
- Planning for infrastructure should be financially viable over their lifecycle and available to meet current and projected needs.
- Optimization of the use of existing infrastructure and public service facilities before developing new infrastructure.

More specifically, the Provincial Policy Statement recommends that water, wastewater, and stormwater services should:

- Direct and accommodate expected growth in a manner that promotes the efficient use and optimization of existing municipal water and wastewater services.
- Ensure that these systems are provided in a manner that:
    - Can be sustained by the water resources upon which such services rely;
    - Is feasible, financially viable and complies with all regulatory requirements; and
    - Protects human health and the natural environment.
- Promote water conservation and water-use efficiency.
- Integrate servicing and land use considerations at all stages of the planning process.

### 6.1.2 A Place to Grow

Ontario's A Place to Grow: Growth Plan for the Greater Golden Horseshoe (2006) provides a 25-year framework for implementing the Province's vision for managing growth. The plan was prepared under the Province's Place to Grow Act (2005) and has the following guiding principles:

- Build compact, vibrant and complete communities;
- Plan and manage growth to support a strong and competitive economy;
- Protect, conserve, enhance and wisely use the valuable natural resources of land, air and water for current and future generations;
- Optimize the use of existing and new infrastructure to support growth in a compact, efficient form;
- Provide for different approaches to managing growth that recognize the diversity of communities in the Greater Golden Horseshoe; and,
- Promote collaboration among all sectors – government, private and non-profit – and residents to achieve the vision.

The Growth Plan was updated in 2016 with a final release in 2017. The 2020 update extends the Growth Plan's vision, policies and population and employment forecasts to 2051 to help communities across the region better plan for growth and development in a sustainable way.

### 6.1.3 Planning Reform Act

The Planning Act establishes the rules for land use planning in Ontario. It describes how land uses may be controlled in communities. Changes to the planning system were introduced in 2006 by the Planning and Conservation Land Statute Law Amendment Act. Key changes are as follows:

- Municipalities must now update their official plan every ten years or ever five years after an update done through an amendment to the plan, followed by an update of the accompanying zoning by-law within three years after the new official plan is in effect;
- There are more opportunities for public input before local decisions are made;
- Municipalities have enhanced ability to plan for a range and mix of housing types and densities; and,
- Municipalities have additional ability to have the final say on whether designated employment lands can be changed to other uses.

### 6.1.4 Bill 13, Sustainable Water and Wastewater Systems Improvement and Maintenance Act, 2010

This Bill enacts the Sustainable Water and Wastewater Systems Improvement and Maintenance Act, 2010 and repeals the Sustainable Water and Sewage Systems Act, 2002. The Bill had it first reading on March 23rd, 2010. Key points of the Bill are as follows:

- Sets out the purposes of the Act, which include ensuring that public ownership of water services and wastewater services is maintained;
- Establishes the Ontario Water Board as an agent of the Crown and sets out the Board's objectives, powers and duties which relate to the regulation of water services and wastewater services;
- Sets out the responsibilities of municipalities or groups of municipalities that are designated as regulated entities by regulation; and,
- Regulated entities must prepare business plans for the provision of water services or wastewater services. The plan must contain, among other things, an assessment of the full cost of providing water services or wastewater services to the public and a description of how the regulated entity intends to pay this full cost.

### 6.1.5 Water Opportunities and Conservation Act

The Ontario Government passed the Water Opportunities and Conservation Act in 2010. The purposes of the Act are as follows:

- To foster innovative water, wastewater, and stormwater technologies, services and practices;
- To create opportunities for economic development and clean-technology jobs in Ontario; and,
- To conserve and sustain water resources for present and future generations.

To further the purposes of the Act, the Minister of the Environment, Conservation, and Parks may establish aspirational targets in respect of the conservation of water and other matters.

The Act requires certain municipalities, persons and entities to prepare, approve and submit to the Minister of the Environment, Conservation, and Parks municipal water sustainability plans for municipal water services, municipal wastewater services and municipal storm water services under their jurisdiction. The Minister may establish performance indicators and targets for these services. The Act also authorizes the making of regulations requiring public agencies to prepare water conservation plans, achieve water conservation targets, and consider technologies, services and practices that promote the efficient use of water and reduce negative impacts on Ontario's water resources.

### 6.1.6 Safe Drinking Water Act

The Safe Drinking Water Act was adopted in 2002. The Act provides for the protection of human health and the prevention of drinking water hazards through the control and regulation of drinking water systems and drinking water testing. Key features of the Act include the following:

- Legally binding standards for contaminants in drinking water;
- Requirement to use licensed laboratories for drinking water testing;
- Requirement to report any results that do not meet the standards to the Ministry of the Environment, Conservation, and Parks and the local Medical Officer of Health and to undertake corrective action;
- All operators of municipal drinking water systems must be trained and certified;
- Establishment of a licensing regime for drinking water systems; and,
- Inspections and enforcement to determine compliance with the Act.

### 6.1.7 Clean Water Act

The Clean Water Act was adopted in 2006 with the objective to protect existing and future sources of drinking water including rivers, lakes, and underground aquifers. The Act requires the following:

- That local communities assess existing and potential threats to their water, and that they set out and implement the actions needed to reduce or eliminate these threats;
- Empowers communities to take action to prevent threats from becoming significant;
- Public participation on every local source protection plan – the planning process for source protection is open to anyone in the community; and,
- That all plans and actions be based on sound science.

#### 6.1.7.1 Source Water Protection

Under the Clean Water Act, O. Reg. 287/07, on-site sewage systems and sewage works may be considered a threat to drinking water. These activities may be deemed significant under certain conditions. The applicable source protection plan policies have been considered throughout this Master Servicing Plan Update.

Source Water Protection (SWP) Plans were prepared for the 19 watershed-based Source Protection Regions (SPR) across Ontario to protect existing and future sources and to identify areas of significant drinking water threats. The City of Brantford falls within the Lake Erie Source Protection Area.

The Source Water Protection Plans identify vulnerable areas that have been delineated under the Clean Water Act including Wellhead Protection Areas (WHPA), Intake Protection Zones (IPZ), Highly Vulnerable Aquifers (HVA), Significant Groundwater Recharge Areas (SGRA), and

Vulnerable Scoring Areas for Groundwater and Surface Water (VSA) as well as water quantity vulnerable areas. According to the Source Protection Plan;

- WHPAs are areas on the land around a municipal well, the size of which is determined by how quickly water travels underground to the well, measured in years.
- IPZs are the areas on the water and land surrounding a municipal surface water intake.
- SGRAs are areas characterized by porous soils that allow the water to seep easily into the ground and flor to an aquifer.
- HVAs are aquifers that can be easily changed or affected by contamination from both human activities and natural processes as a result of (a) its intrinsic susceptibility, as a function of the thickness and permeability of overlaying layers, or (b) by preferential pathways to the aquifer.

As the City of Branford's water supply is from the Grand River, it is located within an IPZ.

### 6.1.8 CCME Strategic Vision for Water

In 2009, the Canadian Council of Ministers of the Environment (CCME) provided a framework for future actions and activities related to water through the development of a vision and action plan, such that Canadians have access to clean, safe and sufficient water to meet their needs in ways that also maintain the integrity of ecosystems. The goals and rationale developed as part of the vision includes the following:

**Goal 1: Aquatic ecosystems are protected on a sustainable watershed basis.**

- Rationale: Enhance understanding and application of Integrated Water Resource Management to improve ecosystem health.

**Goal 2: The conservation and wise use of water is promoted.**

- Rationale: Improve understanding of the full value of water to achieve behavioral change.

**Goal 3: Water quality and water quantity management is improved, benefitting human and ecosystem health.**

- Rationale: Promote nationally consistent approaches to water quality and quantity monitoring, guidelines and multi-jurisdictional public reporting. Encourage research and networks to enhance knowledge and understanding of ground and surface waters.

**Goal 4: Climate change impacts are reduced through adaptive strategies.**

- Rationale: Enhance water quality and quantity monitoring networks to support water and adaptation needs.

**Goal 5: Knowledge about Canada's water is developed and shared.**

Rationale: Help to spearhead value added information on water quality and quantity by supporting jurisdictional reporting efforts to Canadians in a systematic and consistent fashion.

### 6.1.9 Canada-wide Strategy for the Management of Municipal Wastewater Effluent

This 2009 Strategy was developed by the CCME and it requires that all facilities achieve minimum National Performance Standards and develop and manage site-specific Effluent Discharge Objectives. The Strategy requires that overflow frequencies for sanitary sewers not increase due to development or redevelopment. The same applies for combined sewers, unless occurring as part of an approved combined sewer overflow management plan. Neither should occur during dry weather, except during spring thaw and emergencies. Source control of pollutants is recommended, and monitoring and reporting on effluent quality required. The 2014 Progress Report outlined the progress made by signatory federal, provincial and territorial jurisdictions on the commitments made in the 2009 Strategy.

### 6.1.10 CCME Wastewater Systems Effluent Regulations

The proposed CCME Wastewater System Effluent Regulations were published in March 2010, with the final Regulations published on June 29, 2012 and was amended January 2015. These Regulations are the primary instrument that Environment Canada is using to implement the CCME Canada-wide Strategy for the Management of Municipal Wastewater Effluent.

The proposed Regulations apply to any wastewater system that has a capacity to deposit a daily volume of effluent of 100 $m^3$ or more from its final discharge point. The effluent from the applicable wastewater systems would be compared against “national effluent quality standards”, which are as follows:

- Average carbonaceous biochemical oxygen demand (cBOD) due to the quantity of BOD matter in the effluent of less than or equal to 25 mg/L;
- Average concentration of suspended solids in the effluent of less than or equal to 25 mg/L;
- Average concentration of total residual chlorine in the effluent of less than or equal to 0.02 mg/L; and,
- Maximum concentration of un-ionized ammonia in the effluent of less than 1.25 mg/L, expressed as nitrogen, at 15°C ± 1°C.

### 6.1.11 Canadian Environmental Protection Act – Inorganic Chloramines and Chlorinated Wastewater Effluents in Municipal Wastewater Effluent

The Canadian Environmental Protection Act (CEPA) required the elimination of toxic chlorine residuals from municipal wastewater effluent. All owners and operators of wastewater systems with daily volumes greater than 5,000 $m^3$ of effluent were required to lower their total residual chlorine (TRC) levels to less than 0.02 mg/L or lower by December 15, 2009.

### 6.1.12 Ministry of the Environment, Conservation, and Parks Procedure F-5-1

Procedure F-5-1 outlines the treatment requirements for municipal and private sewage treatment works discharging to surface waters. Effluent requirements are established on a case-by-case basis considering the characteristics of the receiving water body. All sewage treatment works shall provide secondary treatment or equivalent as the "normal" level of treatment, unless individual receiving water assessment studies indicate the need for higher levels of treatment. Existing works not complying with the guideline are required to upgrade as soon as possible. The Procedure stipulates effluent design objectives for biological oxygen demand (BOD), suspended solids, total phosphorus and ammonia and provides guidelines for BOD and suspended solids. It is the responsibility of the City to ensure sewage treatment works are designed according to the guidelines and should be able to meet the objectives on an average annual basis and not exceed the guidelines.

## 6.2 Conservation Authority Regulation and Policy

The legislative mandate of the Conservation Authority, as set out in Section 20 of the Conservation Authorities Act, is to establish and undertake programs designed to further the conservation, restoration, development and management of natural resources.

Conservation Authorities are local agencies that protect and manage water and other natural resources at the watershed level. These agencies have a number of responsibilities and functions in the land use planning and development process.

The study area falls entirely within the boundaries of Grand River Conservation Authority (GRCA). GRCA is a commenting agency on development applications under the Planning Act based on regulations approved by their Board of Directors and the province. These Conservation Authorities have agreements with partnering municipalities to provide technical services regarding matters associated with natural heritage protection, hazardous land management and water resources (e.g., stormwater management).

In addition, Conservation Authorities have the delegated responsibility from the Ministries of Natural Resources and Forestry and the Ministry of Municipal Affairs and Housing to implement Section 3.1 (Natural Hazards) of the Provincial Policy Statement (2014), consistent with the Provincial one-window planning initiative.

The GRCA also administers Ontario Regulation 150/06, under Section 28 of the Conservation Authorities Act. In general, these regulations prohibit altering a watercourse, wetland, or shoreline and prohibit development in areas adjacent to river and stream valleys, hazardous lands and wetlands, without the prior written approval from the Conservation Authority (i.e., issuance of a permit).

## 6.3 City of Brantford Legislation and Policy

### 6.3.1 Land Swap

A Place to Grow is a growth plan for the Greater Golden Horseshoe within Ontario. It is a 25-year plan, released in 2006, that has the following aims:

- Promote economic growth;
- Prioritize intensification in strategic growth areas;
- Increase housing supply;
- Improve integration of land use planning with planning and investment in infrastructure and public service facilities;
- Protect and enhance natural heritage, hydrologic and landform systems, features and functions;
- Create jobs; and
- Build communities that make life easier, healthier and more affordable for people of all ages.

Amendment 2 to the Province's Growth Plan came into effect on June 17, 2013. This amendment updated Schedule 3 population and employment forecasts to 2031 and extended forecasts to a 2041 horizon and subsequently a 2051 horizon. As such, to accommodate increased growth needs and population densities forecasted through this plan to the City, additional lands were necessary to acquire.

Through a Municipal Boundary Adjustment Agreement between the City of Brantford and the County of Brant, 2,719 hectares of lands was transferred from the County to the City effective January 1, 2017. These lands are known as the Boundary Adjustment Lands.

### 6.3.2 Municipal Comprehensive Review

In 2016, the municipal boundary between the City of Brantford and the County of Brant was adjusted in order to secure additional lands in the City for future growth. The boundary adjustment brought new lands into Brantford's municipal boundary. To determine the extent that the Settlement Area can to be expanded, the City was required to undertake an MCR as input into their new or amended Official Plan. Once completed, the new or amended Official Plan can designate urban land uses within the expanded Settlement Area boundary.

The MCR identified both growth and intensification targets as well as Settlement Area boundary expansion needs. The Settlement Area Boundary Expansion Lands are further subdivided into the following sub-areas:

- North Expansion Lands;
- East Expansion Lands; and,
- Tutela Heights.

Both the East Expansion Lands and Tutela Heights include lands previously within the Settlement Area boundary of the County of Brant and through the boundary adjustment became part of the City's Settlement Area; however, as these areas require municipal servicing infrastructure, they are included as part of the three expansion sub-areas listed above.

The proposed land use designations, as shown in **Figure 6**, for the Settlement Area boundary expansion areas are presented in Schedule 4: Designated Greenfield Area Structure of the Official Plan and generally include a variation of residential, intensification, and employment areas. Portions of the Settlement Area Boundary Expansion are within the Grand River Conservation Authority (GRCA) floodplain and Natural Heritage System; as such, urban development is not permitted in these portions of the new urban land uses due to their environmental sensitivity and the importance of maintaining existing land uses. Additionally, beyond the Settlement Area Boundary Expansion are Trigger Lands, which are lands held for future Settlement Area expansion following substantial development of the current proposed Settlement Area Boundary Expansion areas.

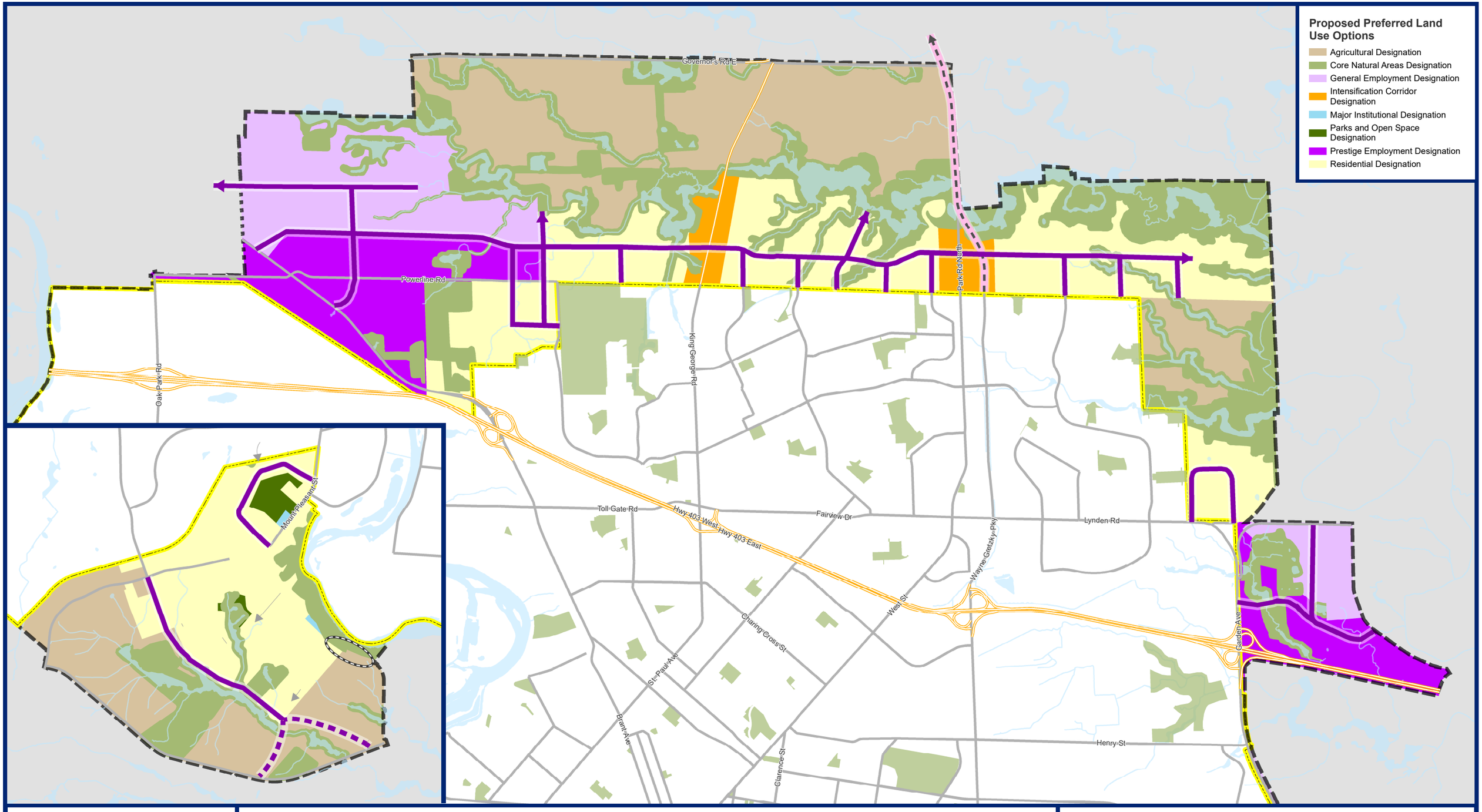
The population projections to 2051 for the Expansion Lands within the Settlement Area Boundary are provided in **Table 1**.

**Table 1: Expansion Lands Population Projections**

| Settlement Area Boundary Expansion Lands | Area (ha) | Population | | |
|---|---|---|---|---|
| | | Residential[(1)] | Employment[(2)] | Total |
| North Expansion Lands | 1,883 | 21,789 | 12,383 | 34,172 |
| East Expansion Lands | 240 | 2,772 | 2,666 | 5,438 |
| Tutela Heights | 581 | 7,386 | 278 | 7,664 |

(1) Inclusion of 3% undercount and secondary suite residential population growth distributed within the expansion lands

(2) Inclusion of employment with no fixed place of work and work from home employment growth distributed within the expansion lands




THE CORPORATION OF THE CITY OF BRANTFORD

**Water, Wastewater and Stormwater Master Servicing Plan Update**

**Proposed Preferred Road Options**

- Collector Roads
- Major Arterial Roads
- Controlled Access Major Arterial

**General Features**

- Expressway / Highway
- Arterial and Collectors
- 2016 Municipal Boundary
- Existing Municipal Boundary
- Six Nations of the Grand River Territory
- Outside Municipalities
- Parks
- Waterbody
- Future Road Closure and Implementation of Alternative Access in Accordance with the Tutela Heights Road and Slope Stability Municipal Class EA

Figure 6

# Preferred Land Uses

N

0 0.5 1 Kilometers

April 2021
717036-SP-002
NAD 1983 CSRS UTM Zone 17N

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### 6.3.3 County Agreements

As part of the 2016 Boundary Adjustment Agreement, the City committed to allowing the County to connect to the City's servicing infrastructure for areas referred to as the Airport Lands and the Cainsville Lands. The services to be connected were wastewater for the Airport Lands and water and wastewater for the Cainsville Lands. This was subject to a number of terms and conditions including that the City would provide adequate capacity to service the areas based on the City's design criteria and subject to both parties entering into a Servicing Agreement.

Under the 2016 Boundary Adjustment Agreement, the County would be responsible for constructing the infrastructure to connect to the City's water and wastewater system.

The existing Cainsville water system is currently supplied by the City through an existing 300 mm watermain while the existing wastewater system is serviced by an existing collection and treatment system owned and operated by the County.

The County of Brant undertook a review to evaluate the infrastructure required to service the Airport and Cainsville Lands in line with the 2016 Boundary Adjustment Agreement. The results of the study were presented at the August 14, 2018 County of Brant Public Works Committee meeting (PW-18-69 – Airport and Cainsville Servicing Strategy). The study recommendations were as follows:

- Connecting the Airport lands to the City's wastewater system will be costly and is not recommended over the next 5-10 years
- To connect the Cainsville wastewater system to the City's existing 675mm trunk sewer on Colborne Street.
- There are two potential options to support the expansion of the Cainsville water system consisting of:
    - Maintaining the existing single connection on Colborne Street, and construction of a new elevated tank; or
    - Securing a second connection to the City of Brantford system.

As per the County report Phase 1 of the Cainsville Service Area was identified as the first priority for the County. This involves connecting Cainsville wastewater to the City's collection and treatment system and ensuring that the existing water connection to the City's distribution system is adequate. The Airport connection phases were identified as a lower priority.

## 6.4 Planning Forecasts

Growth projections for the City of Brantford were provided by SGL based on the City's Official Plan, as per the Growth Plan. SGL distributed the population and employment forecasts and allocated the projections based on Traffic Survey Zone distribution, factoring projected detailed planning information within designated Greenfield Areas, Intensification Corridors, and the Settlement Area Boundary Expansion Lands. **Table 2** and **Table 3** present the population and employment breakdowns and **Table 4** outlines the 2016 and 2051 totals as per the Growth Plan forecast and as distributed to the Traffic Zones. Variation between the overall forecast and its distribution to the Traffic Zones is due primarily to the allocation of 2016 and growth, 2051 populations by the Traffic Zone data. The MSP considers existing and growth populations by the Traffic Zone data for its analysis. **Appendix A** provides a detailed breakdown of 2016 and 2051 population and employment projections by Traffic Zone.

**Table 2: Growth Population Estimates**

| Land Use Type | 2051 Population |
|---|---|
| In existing 2016 units | 84,598 |
| In new units in built up and intensification areas | 26,151 |
| In new greenfield units in existing urban area | 16,503 |
| In new greenfield units in expansion area(1) | 30,541 |
| In secondary suites | 2,000 |
| Total population | 159,794 |
| **Existing 2016 population** | **97,110** |
| **Total population +3% undercount** | **164,736** |
| **Growth population** | **67,626** |

(1) Exclusion of secondary suite residential population distributed within the expansion lands.

**Table 3: Growth Employment Estimates**

| Land Use Type | 2051 Employment |
|---|---|
| Existing 2016 employment(1) | 37,158 |
| Vacant employment lands in existing urban area | 8,738 |
| Additional employment in intensification areas | 10,534 |
| Vacant employment lands in existing greenfield areas | 603 |
| Employment in expansion area(1) | 12,311 |
| No fixed place of work | 10,067 |
| Work from home | 3,954 |
| **Existing 2016 employment(2)** | **37,158** |
| **Total employment** | **83,365** |
| **Growth employment** | **46,207** |

(1) Exclusion of no fixed place of work and work from home employment growth distributed within the expansion lands

(2) Existing employment undercounted due to StatCan employment suppression

**Table 4: Population and Employment Estimates**

| Growth Scenario | | 2016 | 2051 |
|---|---|---|---|
| Growth Plan | Population | 101,700 | 165,000 |
| | Employment | 44,890 | 80,000 |
| | **Total** | **146,590** | **245,000** |
| Traffic Zone Data | Population | 97,110 | 164,736 |
| | Employment | 37,158(1) | 83,365 |
| | **Total** | **134,268** | **248,100** |

(1) Existing employment undercounted due to Statscan employment suppression.

# 7. Servicing Principles and Policy

Execution of reasonable Policies and Level of Service (LOS) objectives are essential in ensuring that the proper planning and design principles are followed in the development of detailed servicing strategies, implementation of system capital program, and operations and maintenance practices.

In the context of the MSP Update, these Policies and LOS objectives provide guidelines and direction to the master planning process, in addition to ensuring demands and flows are adequately representative to support the decision making for sizing and timing of future infrastructure.

Through the MSP Update, draft Policies and LOS objectives were established and used to guide future investment in the water, wastewater, and stormwater systems. The MSP Update Policies and LOS objectives and recommendations are included in **Appendix B**.

## 7.1 Servicing Principles and Policies

Specific servicing principles and policies have been developed to guide the development of water, wastewater, and stormwater servicing strategies. In general, the City of Brantford is looking to build and maintain efficient, reliable, sustainable, and well-managed infrastructure systems that provide a high level of service to the public. The servicing policies which impact the water, wastewater, and stormwater servicing are summarized in **Appendix B**.

## 7.2 Design Criteria and Hydraulic Performance Criteria

A guiding principle of design criteria is to ensure that the demand and flows projections are adequately predicted with an appropriate factor of safety and risk management. This overall principle also ensures that infrastructure has sufficient capacity to meet the growing needs of the City and does not impede the approved/planned growth.

The design criteria were reviewed as part of this MSP Update to ensure that they are accurate and will support sizing and timing of future infrastructure.

# 8. Environment Existing Conditions

## 8.1 Natural Environment Policy Context

The Official Plan of the City of Brantford includes a set of policies to protect and enhance Brantford's natural heritage resources. Within the City, there exists a system of natural areas of varying significance. Development is carefully controlled in these areas to ensure that the various significant features are protected.

The City of Brantford's diverse natural features perform numerous ecological functions essential to life processes, including the conservation of biological diversity. These functions include: maintaining and improving air and water quality; controlling and mitigating the effects or erosion; and providing habitat for a variety of plant and animal species. Natural features also provide many recreational, aesthetic, and economic benefits to our human communities.

Significant natural features in the City of Brantford include wetlands, ravines, forests and rare or high-quality plant or wildlife communities. When making decisions concerning the environment, various components are considered. Factors such as the environment, social aspects, and the economy are all discussed in order to make fully informed decisions.

The City of Brantford's natural heritage system is shown in **Figure 7**.

### 8.1.1 Environmental Protection Policy Area

Environmental Protection Policy Areas have the highest level of protection. To receive this designation, the area must have been identified as significant. Some examples of areas that would receive this classification are: land with natural or scientific interest, habitats for endangered and threatened species, provincially significant savannah or wetland, ravines with watercourses, and significantly forested areas. Specifically, the vegetative buffer zone for Grand River is one important area that has been delineated as an Environmental Protection Policy Area.

### 8.1.2 Environmental Control Policy Area

Environmental Control Policy Areas contain sensitive natural features. This includes steep slopes, streams, wetlands, areas of groundwater discharge, and areas with representative tree cover. The areas are given this designation if the land is being comprised of fish habitat, significant woodlands, significant wildlife habitat, significant Areas of Natural and Scientific Interest, natural linkages, or locally significant prairies and savannahs.

Development may be permitted on these lands, but only if it is demonstrated in an Impact Assessment that there will be no negative impact on natural features or ecological functions.

### 8.1.3 Adjacent Lands

Adjacent lands refer to all areas within 50 m of an Environmental Protection Policy Area or Environmental Control Policy Area (except for fish habitat where all areas within 30 m are adjacent lands, and provincially significant wetlands where distance varies). Development in these areas must first be evaluated to ensure that there will be no negative impact on the natural features, ecological functions, or groundwater quality and quantity.

### 8.1.4 Wetlands

Lands containing a wetland area, or that drain into any abutting lands which contain a wetland area, must be evaluated to determine its wetland classification prior to development. The Province, City, and Grand River Conservation Authority must all approve the evaluation of the wetland to ensure that there will be no negative impact on the natural features or on their ecological function.

### 8.1.5 Mineral Resource Areas

Mineral Resource Areas are licensed by the Province and have the potential for extraction of mineral resources. The licensing of new Mineral Resource Areas or expansion of existing licenses, however, require an amendment of the Zoning By-law. Concurrent to the resource extraction, progressive rehabilitation will also be encouraged. Development in the Mineral Resource Areas is controlled so as not to impact existing or future extraction.

### 8.1.6 Watersheds

The Grand River watershed is the largest watershed in southern Ontario and is of great importance to the natural environment. The Grand River is the predominant feature within Brantford, flowing from the northwest portion of the City in a southeasterly direction. The Grand River is a dendritic river (tree shape) with many tributaries or branches that join along the way. D'Aubigny Creek is the tributary that runs through Brantford. It has been identified as significant for various reasons including its cold-water fishery.

## 8.2 Cultural Heritage and Archaeology

The City of Brantford encourages and supports heritage preservation. The City's atmosphere has a great sense of continuity between the past and the present as defined by its cultural heritage resources, which include: built heritage resources, cultural heritage landscapes, and archaeological resources. The Grand River in particular is important as it has played a central role in the history of both First Nations and Euro-Canadian people.

The City of Brantford has a strong belief that heritage conservation is a wise investment for the future as it makes neighborhoods even more attractive which in return increases its value. The City has therefore established additional policies to conserve its cultural heritage. For any matters relating to the heritage resources of the municipality, the Brantford Heritage Committee must be consulted to ensure the best conservation for the resources.

### 8.2.1 Built Heritage Resources and Cultural Heritage Landscapes

The Ontario Heritage Act gives municipal council the authority to designate heritage properties that have cultural heritage value or interest based on their historical, contextual, and/or architectural significance in the community. Under the Act, designated heritage properties are protected from demolition and a Heritage Permit is required to make changes to a designated property. There are over 200 designated heritage properties in Brantford.

The Brantford Heritage Committee is a citizen volunteer committee that meets monthly to advise Council on heritage matters in the City. In accordance with the Ontario Heritage Act, Council must consult with the Committee before designating a property. The Committee is also responsible for identifying properties that warrant designation for Council's consideration, and for reviewing Heritage Permit applications and Heritage Grant applications.

### 8.2.2 The Grand River as a Canadian Heritage River

The Grand River watershed has a very important cultural heritage landscape and has been granted Canadian Heritage River status.

### 8.2.3 Archaeology Resources

Before approving land development project regulated by legislation, the City – like all Ontario municipalities – is required to undertake an archaeological assessment of all lands that are part of the project. Assessments are required when the land is known to have an archaeological site on it or has the potential to have archaeological resources.

Public development projects such as highway or road construction, or sewer construction require an archaeological assessment under the Environmental Assessment Act directly or through a Class Environmental Assessment. In many cases, an Environmental Assessment determines the need for an archaeological assessment, which is completed as part of the overall environmental assessment process. Upon completion, the archaeological assessment must be sent to the Ministry of Heritage, Sport, Tourism, and Culture Industries for review to ensure the terms and conditions of the archaeological assessment were met and that any archaeological sites found were properly conserved.

THE CORPORATION OF THE CITY OF BRANTFORD

**Water, Wastewater and Stormwater Master Servicing Plan Update**

## General Features

- Expressway / Highway
- Arterial and Collectors
- Local Streets
- Waterbody
- Parks
- Natural Heritage Systems
- 2016 Municipal Boundary
- New Municipal Boundary
- Six Nations of the Grand River Territory
- Outside Municipalities

Figure 7
**Natural Heritage System**

BluePlan ENGINEERING

September 2020
717036-G-017
NAD 1983 CSRS UTM Zone 17N

0 1 2 Kilometers

N

CITY OF HAMILTON
COUNTY OF BRANT

Governor's Rd E
Powerline Rd
Park Rd North
Oak Park Rd
King George Rd
Hardy Rd
Toll Gate Rd
Hwy 403 West
Hwy 403 East
Fairview Dr
Lynden Rd
Grand River
Chatham Cross St
West St
Wayne Gretzky Pky
Garden Ave
St Paul Ave
Brant Ave
Clarence St
Henry St
Brant County Road 18
Colborne St W
Icomm Dr
Dalhousie St
Colborne St
Glenwood Dr
Veterans Memorial Pky
Mount Pleasant St
Erie Ave

# 9. Evaluation Methodology

The development and evaluation of alternatives, with the ultimate goal of determining the recommended servicing strategy, generally follows the approach outlined below for each infrastructure group:

1. Define opportunities and constraints within the study area, by evaluating existing and future system performance and facility needs, such that high-level servicing concepts are developed. These high-level servicing concepts address key system deficiencies and servicing considerations to best satisfy the previously defined principles, policies, and levels of service. The appropriateness and feasibility of these servicing concepts will be assessed through consultation with the City staff and a high-level evaluation to determine which servicing concepts will be carried forward.
2. Determine the servicing alternatives, through the refinement of the high-level servicing concepts, which fully detail necessary projects, impacts, and costing. These servicing alternatives will undergo detailed evaluation using criteria and process defined in the following sections. The intent of the detailed evaluation is to objectively assess and compare each alternative such that the recommended strategy exhibits the most positive benefits while minimizing its negative impacts.

The following sections detail the process and criteria which will be used to evaluate both the high-level concepts and the detailed alternatives. This is applicable for water, wastewater, and stormwater infrastructure.

## 9.1 Evaluation Process

The evaluation process, undertaken for the development and selection of a preferred servicing strategy, is outlined in **Figure 8**.

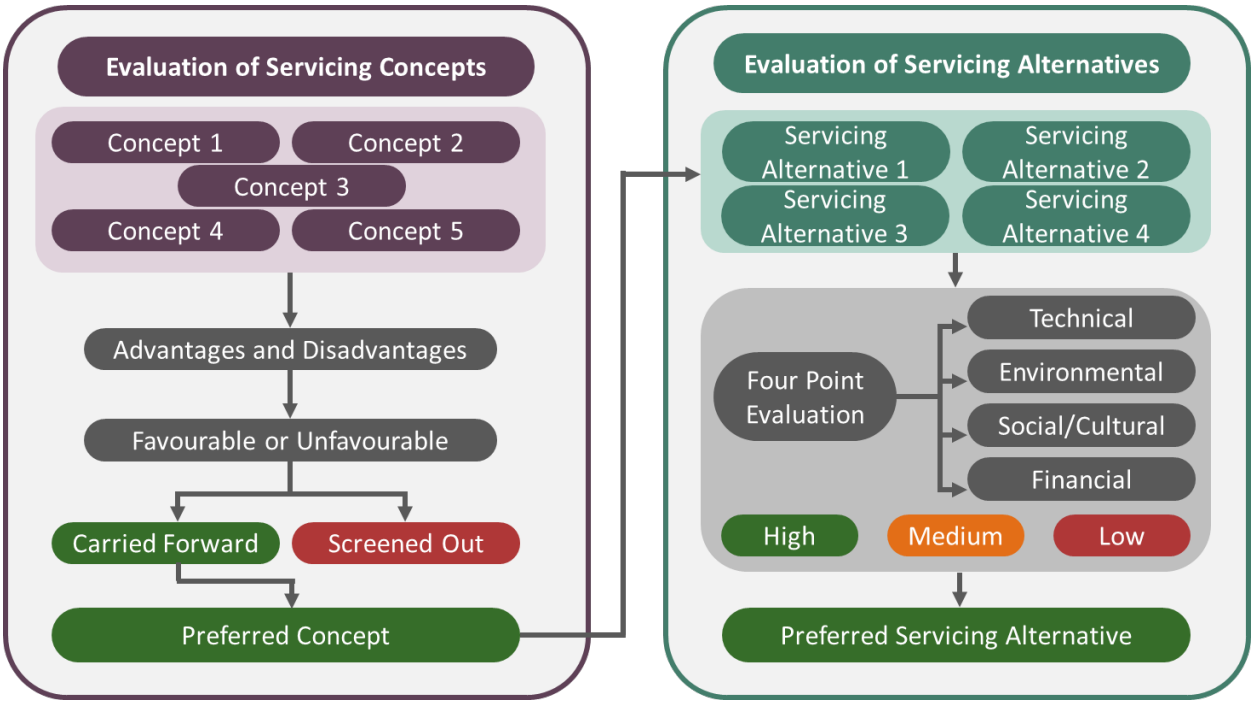



**Figure 8: Evaluation Methodology Flow Diagram**

### 9.1.1 Evaluation of Servicing Concepts

The first step in determining the preferred servicing strategy is to determine the feasibility of the high-level servicing concepts. The overall advantages and disadvantages of these concepts will define which concepts are "favourable" vs. "unfavourable" to subsequently screen out concepts which are deemed unfavourable. The favourable concepts will be carried forward and further refined into servicing alternatives and undergo a more stringent evaluation. Further, it should be noted that all servicing concepts were presented to City staff to confirm the further refinement and evaluation.

### 9.1.2 Evaluation of Servicing Alternatives

The second step in determining the preferred servicing solution is to evaluate the detailed servicing alternatives. This process uses the reasoned argument approach to provide a clear and thorough rationale of trade-offs among each alternative based on the anticipated impacts caused by the evaluation criteria. The basis of this approach is to qualitatively evaluate the relative advantages, disadvantages, and impacts of each alternative against the established criteria.

Further to the qualitative evaluation, the following criteria score will be assigned to each criteria for each servicing alternative:

- "High" concepts generate beneficial impacts and/or has no substantial technical challenges; these are depicted in green within the evaluation tables.
- "Medium" concepts present a mix of positive and negative elements with some impacts; these are depicted in yellow within the evaluation tables.
- "Low" concepts present negative impacts and/or presents significant technical challenges; these are depicted in red within the evaluation tables.

This process is intended to highlight the preferred alternative through the evaluation of technical, environmental, social/cultural, and financial categories.

## 9.2 Evaluation Criteria

The evaluation matrices, which outline both the qualitative reasoning and score for each servicing alternative, will be used in selecting the preferred servicing strategy. The servicing alternatives will be subject to a four-point evaluation which includes technical, environmental, social/cultural, and financial impacts categories. The detailed criteria within each category are outlined in **Table 5**.

**Table 5: Evaluation Categories and Criteria**

| Category | Criteria | Description |
|---|---|---|
| **Technical Impacts** | 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. This includes capacity to meet existing level of service and capacity to support future growth. |
| | Provides a reliable service | To assess the overall system configuration's ability to: support flexibility in system operations, provide system redundancy, minimize the risk related to single element failure, perform under power outage, and adapt to the potential impacts of climate change. Includes the feasibility, maintenance, and flexibility of the alternative's implementation (i.e. length of linear needs associated operation and maintenance, additional pumping due to hydraulic conditions, or regular maintenance requirements). |
| | Minimizes and manages construction risk | To assess the alternative's constructability including scope of infrastructure upgrades including maximizing existing infrastructure, 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. |
| | Supports phased expansion of the system | To assess whether the proposed servicing strategy minimizes the total system upgrades, maximizing the capacity/use of existing facilities, and provides flexibility in servicing of growth areas. |
| | Operational Complexity | To assess whether the proposed servicing strategy will result in a system which is difficult to operate and maintain. |
| | Resiliency to climate change | To assess the alternative's resiliency to maintain the desired system level of service objectives due to climate changes impacts. This includes assessment of system resiliency and/or the facility and network vulnerability to climate related failures such as flooding. |
| **Environmental Impacts** | Protects environment features | To assess, monitor and ensure the preservation and protection of aquatic resources and other natural features. This includes minimizing any impact to wetlands (Locally or Provincially Significant, identified by Conservation Authority and Province), wildlife habitat, or valley lands, which may be identified by Conservation Authorities, Municipalities, or Province. |
| | Protects wildlife and species at risk | To assess any potential species at risk. The implementation should maintain the function of habitat for locally significant wildlife, including endangered or threatened species. |
| | Minimizes climate change impacts | Uses technology and 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. |
| **Social and Cultural Impacts** | Protects resident quality of life | To assess the proposed alternative's ability to maintain or improve upon the existing level of service. Further, to assess any impacts to existing residents due to the long-term operation of any new/modified linear infrastructure and/or facilities including aesthetic impacts. |
| | Manages and minimizes construction impacts | To assess any impact 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 and archeological features | To assess impacts to a structure, property or district which has been previously identified to be of cultural heritage or archeological value or interest. Impacts may be deemed as temporary (i.e. site access) or permanent (i.e. altering the existing conditions). |
| **Financial Impacts** | Capital and life-cycle costs | To minimize the capital and lifecycle costs of the new/upgraded infrastructure and maximizes use of existing infrastructure. Outlines costs required for phasing of growth. |
| | Operation and maintenance costs | To minimize the operational costs of the new infrastructure and impacts on existing operational and maintenance cost of the existing infrastructure. Life cycle costing to consider greenhouse gas emissions and carbon pricing. |
| | Aligns with approval and permitting process | To assess the impact any required property/approvals may have on the implementation process (expropriation of land/land purchase, temporary/permanent easements, or land leasing fees) and compatibility with surrounding land use. |

# 10. Project Costing

The cost estimation approach used for the MSP Update, uses a classification system to categorize different cost estimate classes. These classes represent different phases of planning and design, and subsequently different methods of cost estimation and levels of accuracy. This framework complements the generic approach developed by the Association of Advancement in Cost Estimating (AACE) International and has similarities to the Government of Canada (GOC) approach. For the purposes of the 2020 MSP Update it is expected that all the cost estimates will follow a Class 4 estimate; however, it is important to establish the level of accuracy that can be expected and as the project matures through planning to design, how the higher-class estimates refine the costs. Each of the key components is described below, including:

- Cost Estimate Classes
- Project Complexity
- Area Condition
- Estimate Accuracy Range
- Construction and Project Contingency
- Construction Provisional and Allowance
- Additional Costs

The unit costs and all the above components are contained in the 2020 MSP Update Capital Program spreadsheets which also include standard project details sheets. The spreadsheets are the working tool that brings all the cost components together to create a project cost estimate and are include in **Volume III**, **Volume IV** and **Volume V** for each program area.

## 10.1 Unit Rates

Suggested unit rates, detailed in **Appendix C**, are based on supplier material costs, tender analysis, and historic project costs from multiple municipalities across southern Ontario. In this recommended approach the unit rates are the starting point or base for a cost estimate. Many other factors and criteria are applied to the unit rates. As such, caution is advised when comparing recommended unit rates in isolation with those used for previous studies. Only full and complete costs estimates should be compared.

## 10.2 Cost Estimate Classes

**Table 6** provides a description of the proposed estimate classes and their end usage or deliverables.

**Table 6: Cost Estimation Classes**

| Estimate Class | Estimate Class Description | End Usage / Major Deliverables |
|---|---|---|
| Class 4 | Planning Cost Estimate | Infrastructure Planning/Master Planning. Justification for project planning funding. Minimum information requirements. |
| Class 3 | Concept Design Cost Estimate | Basis for budgeting and approvals. |
| Class 2 | Preliminary Design Cost Estimate | Used for project cost control during design; initial detailed estimate. |
| Class 1 | Detailed Design Cost Estimate | Final cost review in preparation for construction; tender ready. |

## 10.3 Project Complexity

**Table 7** provides a general definition of project complexity.

**Table 7: Project Complexity Descriptions**

| Project Complexity | Complexity Description |
|---|---|
| High Complexity | Projects with high cost, broad scope of work, multiple alternatives/alignments, etc. |
| Low Complexity | Projects with low cost, defined scope of work, few if any alternatives |

## 10.4 Area Condition

Area Condition provides an allowance for the increased cost of constructing in built-up areas, applied to the base construction cost. **Table 8** below provides a general definition and the construction uplift cost percentage of the area condition.

**Table 8: Area Condition Descriptions**

| Construction Environment | Environment Description | Construction Cost Uplift % |
|---|---|---|
| Rural | Greenfield construction with no environmental constraints | 0% |
| Suburban | Developed built up environment | 20% |
| Urban | Heavily developed built up environment – downtown area | 30% |

## 10.5 Estimated Accuracy Range

The accuracy range is defined by the cost estimate class and the project complexity. **Figure 9** shows how the estimate varies based on the two input criteria. The accuracy percentage applies to the total base cost plus all allowances and contingencies.

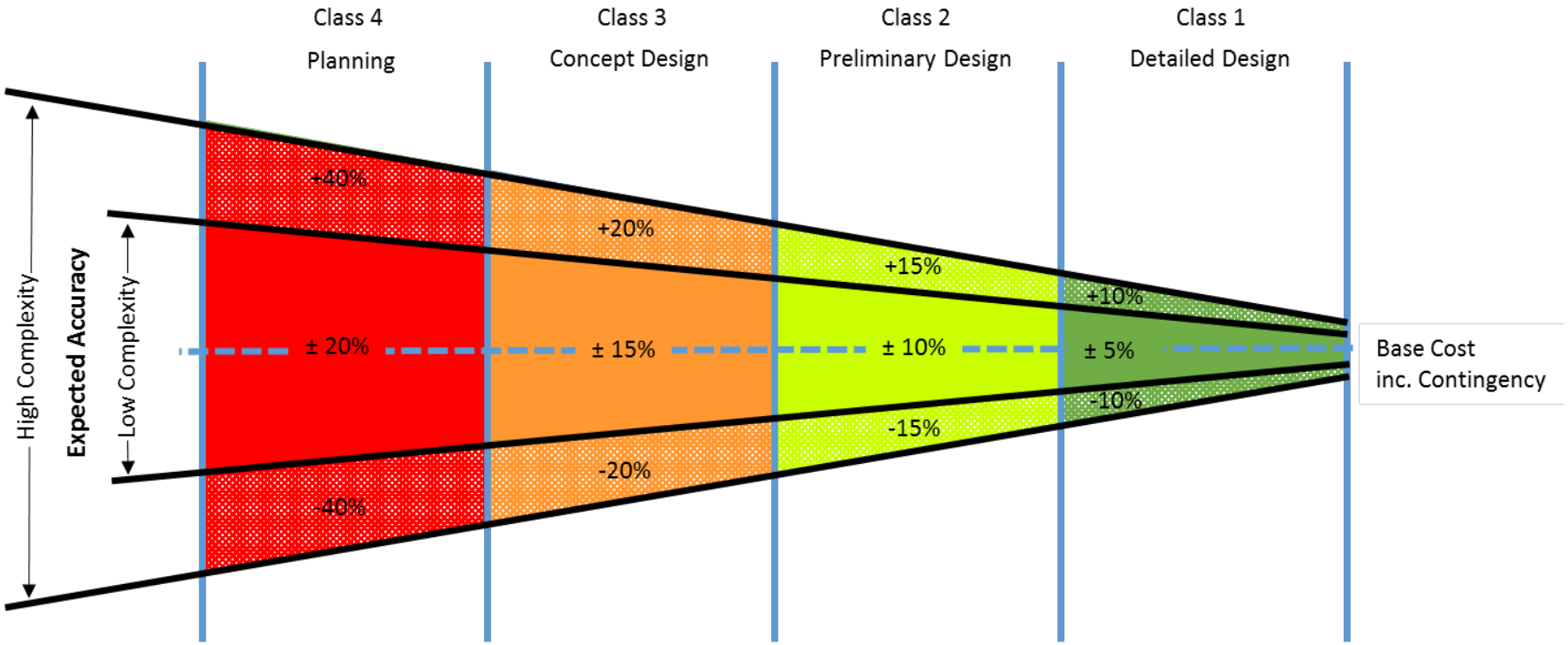



**Figure 9: Cost Estimate Accuracy Ranges**

An accuracy range is an acknowledgment that even with a formal cost estimation framework, and appropriate contingencies, actual costs may still vary because of 'unknown unknowns', such as changes in the economy or new future innovative technologies. These unknowns can just as easily result in a lower final cost as a higher one, even with the application of an appropriate contingency. A recent example is the value of the Canadian dollar. In 2013, the Canadian dollar was at par with the American dollar, and in 2018 it was $0.77. If an American supplier is being used for the project, a final cost in 2020 will significantly vary from that estimated in 2013. This variance should not be associated with the contingency amount.

The accuracy range is not an additional contingency and should not be used for budgeting or funding purposes but rather be a representation of the level of confidence or vulnerability associated with a cost estimate (base + contingency). The concept of an accuracy range is that after the inclusion of an appropriate contingency, it is just as likely that the final cost will be below the estimate as above and it is therefore expected that the long-term aggregate of cost estimates (base + contingency), within each class, will balance out.

The accuracy range for each class is comprised of a high and low value to provide flexibility with respect to the project complexity and corresponding levels of cost estimating confidence.

In summary, as the class and project details increase (left to right in **Figure 9**), or as the project complexity decreases (top to bottom in **Figure 9**), the cost estimate is less vulnerable to 'unknown unknowns' and therefore the extent of the accuracy range will be narrower.

### 10.5.1 Construction and Project Contingency

There is a certain amount of risk and uncertainty associated with each class of cost estimation. The associated risk and uncertainty are minimized with the addition of a contingency. Contingencies are an allowance for risks that are known or anticipated at early stages of the project definition, i.e. they represent probable events that are 'known unknowns' and experience has shown are likely to occur. They cannot be attributed to specific items in the base estimate but need to be considered in addition to the base cost. It should be noted that a project contingency does not cover changes in scope, which are dealt with on their own and should be defined in the project management plan.

Two types of contingency are recommended for use; construction contingency and project contingency.

### 10.5.2 Construction Contingency

Construction contingency is a percentage contingency amount applied to the base construction costs. It accounts for any additional construction costs not included in the unit rates, valves, and crossings. It includes Mobilization/Demobilization, connections, inspection, hydrants, signage, traffic management, bonding, and insurance. Construction contingency changes with project complexity, as follows:

- Low Complexity Construction Contingency: 10%
- High Complexity Construction Contingency: 20%

### 10.5.3 Project Contingency

Project contingency is a percentage applied to the entire project cost inclusive of all soft costs and fees. It accounts for any additional cost associated to any part of the project including soft cost such as consultant engineering and design, geotechnical and property costs. As such the project contingency changes with project complexity as well as project estimate class, as shown in **Figure 10**.

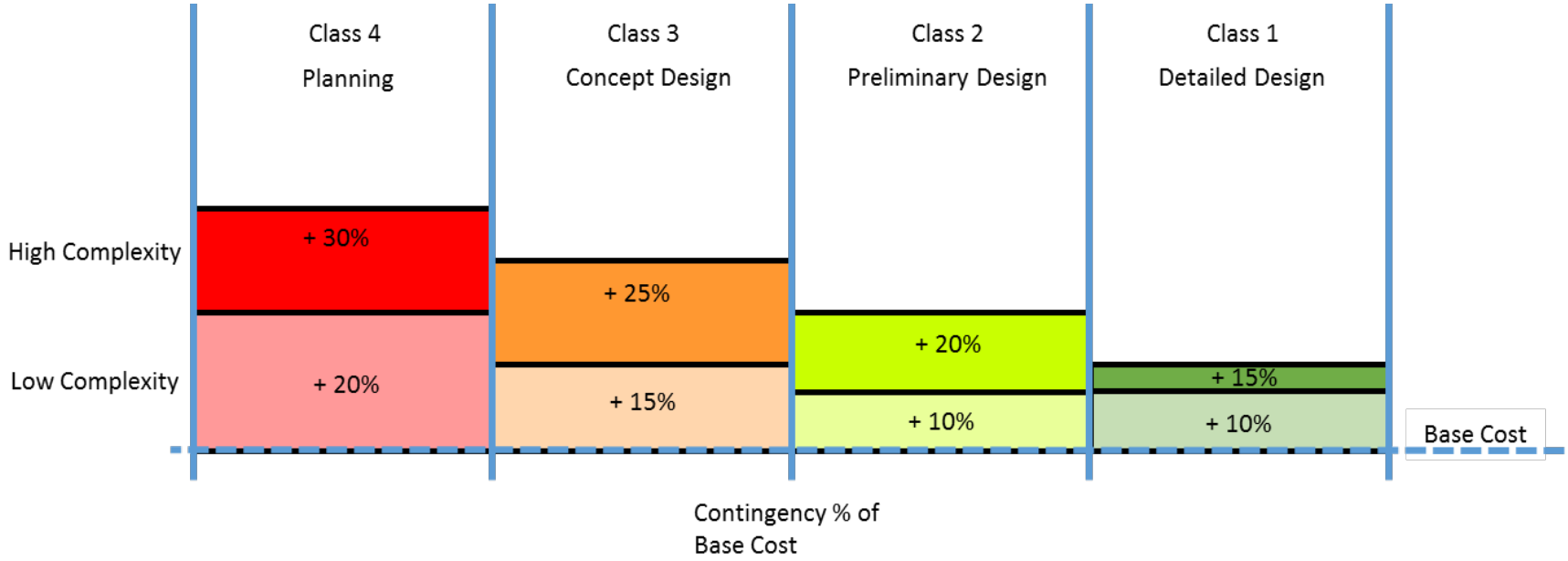



**Figure 10: Cost Estimate Contingency Amounts**

## 10.6 Construction Provisional and Allowance

It is recommended that a provisional amount be applied to the base construction costs in the event of increased construction labour and or material costs. Provisional Project Costs remain separate from the primary project cost but must be included for budgeting purposes. Regardless of estimate class or project complexity it is recommended that 10% of the base construction cost is applied as a Provisional Allowance.

## 10.7 Additional Costs

Additional Costs capture all soft costs associated with the project. If available, actual quoted costs should be used. In the absence of actual costs, percentage amounts, applied to the base construction costs, are recommended. Such costs are related to project complexity and total project cost, as such percentages vary accordingly. **Table 9** shows the percentages to be applied for high and low complexity and different value projects.

**Table 9: Additional Cost Components**

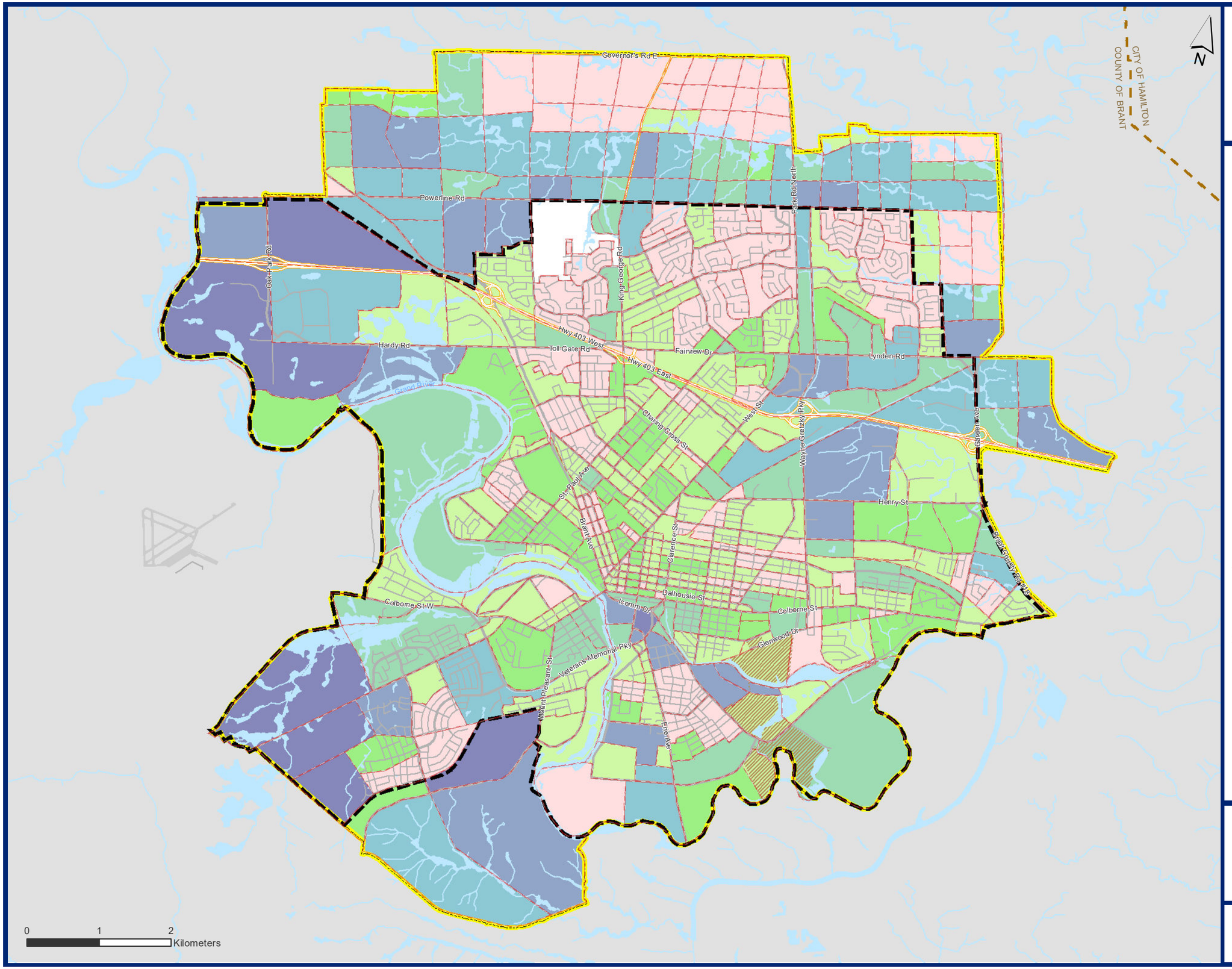
| Cost Component | | High Complexity | Low Complexity |
|---|---|---|---|
| **Geotechnical / Hydrogeological / Materials** | | 2% of construction cost | 0.5% of construction cost |
| **Property Requirements (including property acquisition)** | | 2% of construction cost | 1% of construction cost |
| **Consultant Engineering/Design** | Total Construction Cost <$10M | 15% of construction cost | |
| | Total Construction Cost $10M to $50M | 12% of construction cost | |
| | Total Construction Cost >$50M | 10% of construction cost | |
| **In House Labour/Engineering/ Wages/CA** | Total Construction Cost <$10M | 8% of construction cost | |
| | Total Construction Cost $10M to $50M | 6% of construction cost | |
| | Total Construction Cost >$50M | 4% of construction cost | |
| **Non-refundable HST** | | 1.76% of Total costs | |

# A

City of Brantford

# APPENDIX A

TRAFFIC ZONE POPULATION AND EMPLOYMENT PROJECTIONS




THE CORPORATION OF THE CITY OF BRANTFORD

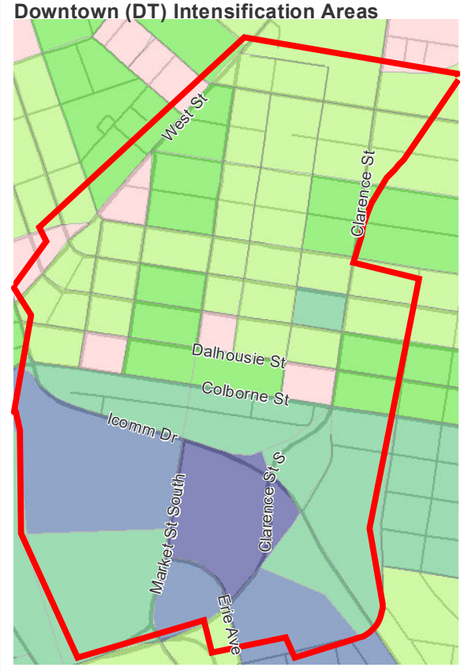
**Water, Wastewater and Stormwater Master Servicing Plan Update**

- Expressway / Highway
- Arterial and Collectors
- 2016 Municipal Boundary
- New Municipal Boundary
- Six Nations of the Grand River Territory
- Parks
- Waterbody

**Growth**

- No growth
- 1 - 100
- 101 - 200
- 201 - 500
- 501 - 1000
- 1001 - 2500
- 2501 - 4510

**Downtown (DT) Intensification Areas**




Appendix A - Figure 1
**Growth**

BluePlan ENGINEERING

June 2021
717036-G-009
NAD 1983 CSRS UTM Zone 17N

| Traffic Zone Name | MCR-2016-POP-RES | MCR-2021-POP-RES | MCR-2026-POP-RES | MCR-2031-POP-RES | MCR-2036-POP-RES | MCR-2041-POP-RES | MCR-2051-POP-Res | MCR-2016-POP-EMP | MCR-2021-POP-EMP | MCR-2026-POP-EMP | MCR-2031-POP-EMP | MCR-2036-POP-EMP | MCR-2041-POP-EMP | MCR-2051-POP-EMP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1001 | 0 | 164 | 328 | 491 | 655 | 819 | 819 | 735 | 772 | 809 | 845 | 882 | 919 | 919 |
| 1002 | 0 | 81 | 162 | 244 | 325 | 406 | 406 | 320 | 336 | 352 | 367 | 383 | 399 | 399 |
| 1003 | 15 | 12 | 9 | 6 | 3 | 0 | 0 | 1037 | 1068 | 1098 | 1129 | 1159 | 1190 | 1190 |
| 1004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1340 | 1356 | 1372 | 1387 | 1403 | 1419 | 1419 |
| 1005 | 5 | 4 | 3 | 2 | 1 | 0 | 0 | 355 | 377 | 400 | 422 | 445 | 467 | 467 |
| 1006 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 5 | 8 | 10 | 13 | 13 |
| 1007 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 525 | 553 | 581 | 610 | 638 | 666 | 666 |
| 1008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 59 | 119 | 178 | 237 | 296 | 296 |
| 101 | 1675 | 1654 | 1633 | 1612 | 1591 | 1570 | 1570 | 0 | 29 | 58 | 86 | 115 | 144 | 144 |
| 102 | 465 | 374 | 283 | 192 | 101 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 103 | 85 | 110 | 136 | 161 | 187 | 212 | 212 | 0 | 62 | 123 | 185 | 246 | 308 | 308 |
| 104 | 870 | 849 | 827 | 806 | 785 | 763 | 763 | 0 | 13 | 27 | 40 | 54 | 67 | 67 |
| 105 | 960 | 936 | 912 | 888 | 863 | 839 | 839 | 0 | 12 | 25 | 37 | 49 | 61 | 61 |
| 106 | 630 | 615 | 601 | 586 | 571 | 556 | 556 | 0 | 9 | 17 | 26 | 34 | 43 | 43 |
| 107 | 410 | 401 | 391 | 382 | 372 | 363 | 363 | 0 | 8 | 17 | 25 | 33 | 41 | 41 |
| 108 | 270 | 306 | 341 | 377 | 412 | 448 | 448 | 95 | 104 | 113 | 122 | 131 | 140 | 140 |
| 109 | 200 | 267 | 334 | 401 | 469 | 536 | 536 | 665 | 693 | 721 | 749 | 777 | 805 | 805 |
| 110 | 70 | 78 | 86 | 94 | 102 | 110 | 110 | 150 | 156 | 162 | 168 | 174 | 180 | 180 |
| 1101 | 30 | 24 | 18 | 12 | 6 | 0 | 0 | 0 | 2 | 4 | 6 | 8 | 10 | 10 |
| 1102 | 45 | 36 | 27 | 18 | 9 | 0 | 0 | 0 | 3 | 6 | 9 | 11 | 14 | 14 |
| 1103 | 35 | 32 | 29 | 27 | 24 | 21 | 21 | 0 | 1 | 2 | 2 | 3 | 4 | 4 |
| 1104 | 425 | 431 | 436 | 442 | 448 | 454 | 454 | 0 | 6 | 11 | 17 | 22 | 28 | 28 |
| 1105 | 140 | 139 | 138 | 137 | 136 | 135 | 135 | 160 | 169 | 178 | 187 | 196 | 205 | 205 |
| 1106 | 200 | 267 | 333 | 400 | 467 | 533 | 533 | 110 | 126 | 142 | 158 | 174 | 190 | 190 |
| 1107 | 315 | 308 | 301 | 293 | 286 | 279 | 279 | 0 | 11 | 22 | 34 | 45 | 56 | 56 |
| 1108 | 330 | 325 | 321 | 316 | 311 | 307 | 307 | 0 | 5 | 11 | 16 | 21 | 26 | 26 |
| 1109 | 455 | 451 | 447 | 443 | 439 | 436 | 436 | 0 | 5 | 10 | 15 | 20 | 25 | 25 |
| 111 | 30 | 29 | 28 | 27 | 26 | 24 | 24 | 0 | 1 | 2 | 3 | 4 | 5 | 5 |
| 1110 | 575 | 569 | 563 | 557 | 551 | 546 | 546 | 0 | 6 | 12 | 17 | 23 | 29 | 29 |
| 1201 | 55 | 81 | 107 | 134 | 160 | 186 | 186 | 135 | 146 | 157 | 169 | 180 | 191 | 191 |
| 1202 | 150 | 164 | 179 | 193 | 207 | 221 | 221 | 0 | 4 | 9 | 13 | 18 | 22 | 22 |
| 1203 | 155 | 199 | 244 | 288 | 333 | 377 | 377 | 530 | 588 | 647 | 705 | 763 | 822 | 822 |
| 1204 | 75 | 71 | 68 | 64 | 60 | 57 | 57 | 225 | 240 | 254 | 269 | 283 | 298 | 298 |
| 1205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 170 | 180 | 190 | 200 | 209 | 219 | 219 |
| 1206 | 5 | 136 | 268 | 399 | 531 | 662 | 662 | 0 | 6 | 12 | 19 | 25 | 31 | 31 |
| 1301 | 365 | 379 | 393 | 407 | 422 | 436 | 436 | 0 | 5 | 11 | 16 | 21 | 26 | 26 |
| 1302 | 190 | 189 | 188 | 186 | 185 | 184 | 184 | 0 | 3 | 5 | 8 | 11 | 13 | 13 |
| 1303 | 25 | 20 | 15 | 10 | 5 | 0 | 0 | 0 | 10 | 20 | 31 | 41 | 51 | 51 |
| 1304 | 600 | 616 | 633 | 649 | 666 | 682 | 682 | 0 | 10 | 20 | 30 | 40 | 50 | 50 |
| 1305 | 60 | 48 | 36 | 24 | 12 | 0 | 0 | 0 | 1 | 2 | 3 | 4 | 5 | 5 |
| 1306 | 120 | 121 | 122 | 123 | 124 | 125 | 125 | 0 | 2 | 4 | 6 | 8 | 9 | 9 |
| 1307 | 240 | 236 | 233 | 229 | 226 | 222 | 222 | 0 | 5 | 10 | 14 | 19 | 24 | 24 |
| 1308 | 65 | 61 | 58 | 54 | 50 | 47 | 47 | 0 | 1 | 2 | 2 | 3 | 4 | 4 |
| 1309 | 25 | 42 | 59 | 76 | 93 | 110 | 110 | 110 | 115 | 120 | 125 | 131 | 136 | 136 |
| 1310 | 345 | 407 | 470 | 532 | 595 | 657 | 657 | 0 | 4 | 8 | 12 | 16 | 20 | 20 |
| 1311 | 205 | 201 | 197 | 193 | 188 | 184 | 184 | 145 | 156 | 167 | 178 | 189 | 200 | 200 |
| 1312 | 60 | 48 | 36 | 24 | 12 | 0 | 0 | 0 | 2 | 3 | 5 | 6 | 8 | 8 |
| 1401 | 245 | 257 | 269 | 282 | 294 | 306 | 306 | 210 | 223 | 235 | 248 | 260 | 273 | 273 |
| 1402 | 305 | 298 | 292 | 285 | 279 | 272 | 272 | 0 | 3 | 6 | 10 | 13 | 16 | 16 |
| 1403 | 305 | 302 | 299 | 296 | 293 | 290 | 290 | 0 | 5 | 9 | 14 | 19 | 24 | 24 |
| 1404 | 145 | 148 | 151 | 154 | 156 | 159 | 159 | 0 | 3 | 6 | 10 | 13 | 16 | 16 |
| 1405 | 320 | 315 | 311 | 306 | 301 | 296 | 296 | 0 | 5 | 10 | 15 | 20 | 25 | 25 |
| 1406 | 240 | 235 | 231 | 226 | 221 | 217 | 217 | 0 | 4 | 7 | 11 | 14 | 18 | 18 |
| 1407 | 440 | 438 | 435 | 433 | 431 | 429 | 429 | 0 | 8 | 17 | 25 | 33 | 42 | 42 |
| 1408 | 465 | 457 | 448 | 440 | 431 | 423 | 423 | 245 | 268 | 292 | 315 | 338 | 361 | 361 |
| 1501 | 100 | 109 | 119 | 128 | 138 | 147 | 147 | 1505 | 1560 | 1614 | 1669 | 1723 | 1778 | 1778 |
| 1502 | 415 | 430 | 446 | 461 | 476 | 492 | 492 | 0 | 6 | 12 | 18 | 23 | 29 | 29 |
| 1503 | 105 | 111 | 117 | 123 | 129 | 135 | 135 | 0 | 1 | 2 | 4 | 5 | 6 | 6 |
| 1504 | 245 | 244 | 243 | 242 | 241 | 240 | 240 | 0 | 4 | 7 | 11 | 15 | 19 | 19 |
| 1505 | 30 | 26 | 23 | 19 | 15 | 12 | 12 | 0 | 0 | 1 | 1 | 1 | 2 | 2 |
| 1506 | 115 | 123 | 131 | 139 | 147 | 154 | 154 | 0 | 1 | 2 | 3 | 4 | 5 | 5 |
| 1507 | 240 | 241 | 242 | 243 | 243 | 244 | 244 | 0 | 4 | 8 | 12 | 16 | 20 | 20 |
| 1508 | 200 | 215 | 229 | 244 | 259 | 273 | 273 | 225 | 236 | 246 | 257 | 268 | 278 | 278 |
| 1509 | 355 | 366 | 377 | 388 | 399 | 410 | 410 | 120 | 129 | 139 | 148 | 157 | 167 | 167 |
| 1510 | 720 | 741 | 762 | 784 | 805 | 826 | 826 | 225 | 243 | 262 | 280 | 299 | 317 | 317 |
| 1511 | 315 | 312 | 310 | 307 | 304 | 301 | 301 | 0 | 5 | 10 | 15 | 20 | 25 | 25 |
| 1512 | 50 | 49 | 49 | 48 | 48 | 47 | 47 | 180 | 187 | 194 | 201 | 208 | 215 | 215 |
| 1601 | 485 | 484 | 483 | 481 | 480 | 479 | 479 | 0 | 14 | 27 | 41 | 54 | 68 | 68 |
| 1602 | 560 | 596 | 631 | 667 | 702 | 738 | 738 | 100 | 113 | 126 | 139 | 152 | 165 | 165 |
| 1603 | 520 | 507 | 494 | 481 | 468 | 455 | 455 | 0 | 11 | 21 | 32 | 42 | 53 | 53 |
| 1604 | 315 | 307 | 299 | 291 | 283 | 275 | 275 | 280 | 300 | 320 | 340 | 360 | 380 | 380 |
| 1605 | 125 | 122 | 120 | 117 | 115 | 112 | 112 | 0 | 3 | 5 | 8 | 10 | 13 | 13 |
| 1606 | 720 | 705 | 689 | 674 | 659 | 644 | 644 | 0 | 12 | 24 | 36 | 49 | 61 | 61 |

| Traffic Zone Name | MCR-2016-POP-RES | MCR-2021-POP-RES | MCR-2026-POP-RES | MCR-2031-POP-RES | MCR-2036-POP-RES | MCR-2041-POP-RES | MCR-2051-POP-Res | MCR-2016-POP-EMP | MCR-2021-POP-EMP | MCR-2026-POP-EMP | MCR-2031-POP-EMP | MCR-2036-POP-EMP | MCR-2041-POP-EMP | MCR-2051-POP-EMP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1607 | 185 | 198 | 211 | 224 | 237 | 250 | 250 | 265 | 278 | 292 | 305 | 318 | 331 | 331 |
| 1608 | 635 | 620 | 605 | 590 | 575 | 559 | 559 | 0 | 13 | 25 | 38 | 50 | 63 | 63 |
| 1609 | 255 | 252 | 249 | 246 | 242 | 239 | 239 | 0 | 6 | 11 | 17 | 22 | 28 | 28 |
| 1610 | 330 | 328 | 326 | 324 | 322 | 320 | 320 | 0 | 6 | 12 | 17 | 23 | 29 | 29 |
| 1611 | 420 | 412 | 405 | 397 | 390 | 382 | 382 | 0 | 7 | 15 | 22 | 29 | 37 | 37 |
| 1612 | 155 | 152 | 148 | 145 | 142 | 138 | 138 | 0 | 5 | 10 | 15 | 20 | 25 | 25 |
| 1701 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 226 | 452 | 678 | 904 | 1131 | 1131 |
| 1702 | 5 | 12 | 18 | 25 | 31 | 38 | 38 | 480 | 1065 | 1650 | 2235 | 2821 | 3406 | 3406 |
| 1703 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 589 | 1177 | 1766 | 2354 | 2943 | 2943 |
| 1704 | 5 | 4 | 3 | 2 | 1 | 0 | 0 | 2185 | 2302 | 2419 | 2536 | 2653 | 2771 | 2771 |
| 1801 | 315 | 308 | 301 | 294 | 287 | 279 | 279 | 0 | 16 | 33 | 49 | 66 | 82 | 82 |
| 1802 | 465 | 458 | 451 | 443 | 436 | 429 | 429 | 115 | 150 | 185 | 220 | 256 | 291 | 291 |
| 1803 | 130 | 128 | 125 | 123 | 120 | 118 | 118 | 0 | 4 | 7 | 11 | 15 | 19 | 19 |
| 1804 | 475 | 464 | 453 | 442 | 431 | 420 | 420 | 0 | 8 | 16 | 25 | 33 | 41 | 41 |
| 1805 | 110 | 110 | 110 | 109 | 109 | 109 | 109 | 325 | 350 | 376 | 401 | 427 | 452 | 452 |
| 1806 | 410 | 412 | 413 | 415 | 416 | 418 | 418 | 0 | 6 | 12 | 18 | 24 | 30 | 30 |
| 1901 | 285 | 308 | 330 | 353 | 376 | 399 | 399 | 130 | 178 | 226 | 275 | 323 | 371 | 371 |
| 1902 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 385 | 404 | 423 | 441 | 460 | 479 | 479 |
| 1903 | 370 | 363 | 355 | 348 | 341 | 333 | 333 | 245 | 264 | 282 | 301 | 319 | 338 | 338 |
| 1904 | 205 | 201 | 198 | 194 | 190 | 186 | 186 | 0 | 4 | 7 | 11 | 14 | 18 | 18 |
| 1905 | 725 | 738 | 751 | 764 | 776 | 789 | 789 | 0 | 10 | 19 | 29 | 38 | 48 | 48 |
| 2001 | 865 | 846 | 827 | 808 | 789 | 770 | 770 | 0 | 21 | 42 | 62 | 83 | 104 | 104 |
| 2002 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 27 | 40 | 54 | 67 | 67 |
| 2003 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 8 | 11 | 15 | 19 | 19 |
| 2004 | 85 | 68 | 51 | 34 | 17 | 0 | 0 | 705 | 738 | 771 | 804 | 837 | 870 | 870 |
| 2005 | 0 | 12 | 24 | 35 | 47 | 59 | 59 | 145 | 153 | 161 | 170 | 178 | 186 | 186 |
| 2006 | 45 | 36 | 27 | 18 | 9 | 0 | 0 | 0 | 5 | 9 | 14 | 19 | 24 | 24 |
| 2007 | 175 | 185 | 195 | 205 | 215 | 225 | 225 | 0 | 3 | 6 | 10 | 13 | 16 | 16 |
| 2008 | 295 | 306 | 317 | 327 | 338 | 349 | 349 | 0 | 4 | 9 | 13 | 18 | 22 | 22 |
| 201 | 225 | 367 | 508 | 650 | 792 | 934 | 934 | 800 | 836 | 873 | 909 | 946 | 982 | 982 |
| 202 | 390 | 380 | 370 | 361 | 351 | 341 | 341 | 0 | 8 | 15 | 23 | 30 | 38 | 38 |
| 203 | 240 | 241 | 243 | 244 | 246 | 247 | 247 | 0 | 4 | 8 | 13 | 17 | 21 | 21 |
| 204 | 270 | 264 | 258 | 251 | 245 | 239 | 239 | 0 | 4 | 8 | 13 | 17 | 21 | 21 |
| 205 | 5 | 20 | 35 | 49 | 64 | 79 | 79 | 155 | 161 | 168 | 174 | 180 | 187 | 187 |
| 206 | 425 | 424 | 423 | 422 | 421 | 420 | 420 | 0 | 8 | 16 | 24 | 32 | 40 | 40 |
| 207 | 880 | 858 | 836 | 814 | 792 | 771 | 771 | 0 | 15 | 30 | 45 | 61 | 76 | 76 |
| 2101 | 130 | 128 | 126 | 124 | 121 | 119 | 119 | 0 | 7 | 14 | 21 | 27 | 34 | 34 |
| 2102 | 795 | 808 | 821 | 834 | 847 | 860 | 860 | 0 | 14 | 27 | 41 | 54 | 68 | 68 |
| 2103 | 305 | 306 | 306 | 307 | 308 | 308 | 308 | 0 | 4 | 8 | 12 | 16 | 20 | 20 |
| 2104 | 130 | 131 | 132 | 134 | 135 | 136 | 136 | 0 | 1 | 3 | 4 | 6 | 7 | 7 |
| 2105 | 30 | 25 | 19 | 14 | 8 | 3 | 3 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 2106 | 310 | 310 | 309 | 309 | 308 | 308 | 308 | 320 | 346 | 373 | 399 | 425 | 452 | 452 |
| 2201 | 195 | 204 | 214 | 223 | 232 | 242 | 242 | 0 | 2 | 4 | 6 | 8 | 10 | 10 |
| 2202 | 80 | 65 | 49 | 34 | 18 | 3 | 3 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 2203 | 80 | 64 | 48 | 32 | 16 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 2204 | 45 | 36 | 27 | 18 | 9 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 2205 | 55 | 45 | 35 | 24 | 14 | 4 | 4 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 2206 | 85 | 68 | 51 | 34 | 17 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | 4 | 4 |
| 2207 | 55 | 44 | 33 | 22 | 11 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 3 | 3 |
| 2208 | 135 | 156 | 178 | 199 | 220 | 241 | 241 | 0 | 6 | 11 | 17 | 22 | 28 | 28 |
| 2209 | 75 | 61 | 46 | 32 | 18 | 3 | 3 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 2210 | 65 | 52 | 39 | 26 | 13 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 2211 | 25 | 20 | 15 | 10 | 5 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 2212 | 55 | 44 | 33 | 22 | 11 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 2213 | 135 | 141 | 147 | 152 | 158 | 164 | 164 | 0 | 2 | 4 | 6 | 7 | 9 | 9 |
| 2214 | 130 | 133 | 135 | 138 | 141 | 144 | 144 | 0 | 2 | 4 | 6 | 8 | 10 | 10 |
| 2215 | 230 | 238 | 247 | 255 | 264 | 272 | 272 | 0 | 3 | 6 | 9 | 12 | 15 | 15 |
| 2216 | 405 | 425 | 444 | 464 | 483 | 503 | 503 | 0 | 5 | 10 | 16 | 21 | 26 | 26 |
| 2217 | 50 | 42 | 33 | 25 | 17 | 8 | 8 | 0 | 1 | 1 | 2 | 2 | 3 | 3 |
| 2218 | 50 | 40 | 30 | 21 | 11 | 1 | 1 | 0 | 1 | 2 | 2 | 3 | 4 | 4 |
| 2301 | 50 | 43 | 36 | 28 | 21 | 14 | 14 | 0 | 11 | 21 | 32 | 42 | 53 | 53 |
| 2302 | 85 | 95 | 105 | 114 | 124 | 134 | 134 | 0 | 11 | 22 | 33 | 44 | 55 | 55 |
| 2303 | 35 | 28 | 21 | 14 | 7 | 0 | 0 | 0 | 6 | 12 | 18 | 24 | 30 | 30 |
| 2304 | 175 | 188 | 202 | 215 | 229 | 242 | 242 | 0 | 17 | 34 | 52 | 69 | 86 | 86 |
| 2305 | 80 | 73 | 67 | 60 | 53 | 47 | 47 | 0 | 8 | 16 | 25 | 33 | 41 | 41 |
| 2306 | 55 | 55 | 54 | 54 | 53 | 53 | 53 | 0 | 8 | 17 | 25 | 33 | 42 | 42 |
| 2307 | 45 | 36 | 27 | 18 | 9 | 0 | 0 | 0 | 12 | 24 | 36 | 48 | 60 | 60 |
| 2308 | 65 | 58 | 51 | 44 | 37 | 30 | 30 | 305 | 328 | 350 | 373 | 395 | 418 | 418 |
| 2309 | 120 | 123 | 126 | 130 | 133 | 136 | 136 | 0 | 13 | 25 | 38 | 50 | 63 | 63 |
| 2310 | 195 | 207 | 219 | 231 | 244 | 256 | 256 | 0 | 13 | 26 | 39 | 52 | 65 | 65 |
| 2401 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 5 | 7 | 10 | 12 | 12 |
| 2402 | 5 | 10 | 15 | 21 | 26 | 31 | 31 | 0 | 5 | 10 | 15 | 20 | 24 | 24 |
| 2403 | 15 | 20 | 24 | 29 | 33 | 38 | 38 | 0 | 8 | 16 | 24 | 32 | 40 | 40 |

| Traffic Zone Name | MCR-2016-POP-RES | MCR-2021-POP-RES | MCR-2026-POP-RES | MCR-2031-POP-RES | MCR-2036-POP-RES | MCR-2041-POP-RES | MCR-2051-POP-Res | MCR-2016-POP-EMP | MCR-2021-POP-EMP | MCR-2026-POP-EMP | MCR-2031-POP-EMP | MCR-2036-POP-EMP | MCR-2041-POP-EMP | MCR-2051-POP-EMP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2404 | 20 | 23 | 25 | 28 | 31 | 34 | 34 | 0 | 7 | 13 | 20 | 26 | 33 | 33 |
| 2405 | 5 | 26 | 47 | 69 | 90 | 111 | 111 | 620 | 645 | 671 | 697 | 723 | 749 | 749 |
| 2406 | 20 | 24 | 27 | 31 | 34 | 38 | 38 | 0 | 5 | 10 | 16 | 21 | 26 | 26 |
| 2407 | 25 | 28 | 30 | 33 | 35 | 38 | 38 | 0 | 5 | 10 | 14 | 19 | 24 | 24 |
| 2408 | 40 | 39 | 38 | 37 | 36 | 34 | 34 | 100 | 109 | 117 | 126 | 135 | 143 | 143 |
| 2409 | 60 | 54 | 48 | 41 | 35 | 29 | 29 | 0 | 5 | 10 | 15 | 20 | 25 | 25 |
| 2410 | 5 | 12 | 18 | 25 | 32 | 39 | 39 | 0 | 8 | 15 | 23 | 31 | 38 | 38 |
| 2411 | 0 | 9 | 18 | 27 | 36 | 45 | 45 | 125 | 137 | 149 | 161 | 173 | 185 | 185 |
| 2412 | 30 | 34 | 38 | 42 | 46 | 50 | 50 | 355 | 375 | 396 | 416 | 436 | 457 | 457 |
| 2413 | 120 | 138 | 156 | 174 | 192 | 210 | 210 | 185 | 200 | 216 | 231 | 246 | 262 | 262 |
| 2414 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 105 | 113 | 121 | 128 | 136 | 144 | 144 |
| 2415 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 8 | 12 | 16 | 20 | 20 |
| 2416 | 45 | 38 | 32 | 25 | 18 | 12 | 12 | 0 | 4 | 8 | 12 | 16 | 21 | 21 |
| 2417 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 195 | 208 | 221 | 234 | 247 | 260 | 260 |
| 2418 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 230 | 244 | 259 | 273 | 287 | 301 | 301 |
| 2419 | 0 | 7 | 15 | 22 | 30 | 37 | 37 | 0 | 6 | 13 | 19 | 25 | 31 | 31 |
| 2420 | 0 | 14 | 28 | 42 | 55 | 69 | 69 | 265 | 284 | 304 | 323 | 343 | 362 | 362 |
| 2421 | 5 | 13 | 21 | 29 | 38 | 46 | 46 | 0 | 6 | 12 | 18 | 24 | 30 | 30 |
| 2422 | 460 | 508 | 557 | 605 | 654 | 702 | 702 | 145 | 160 | 174 | 189 | 204 | 219 | 219 |
| 2423 | 10 | 16 | 23 | 29 | 35 | 42 | 42 | 0 | 6 | 12 | 18 | 23 | 29 | 29 |
| 2424 | 40 | 32 | 24 | 16 | 8 | 0 | 0 | 0 | 6 | 12 | 17 | 23 | 29 | 29 |
| 2425 | 145 | 168 | 191 | 214 | 237 | 260 | 260 | 145 | 172 | 199 | 226 | 252 | 279 | 279 |
| 2501 | 35 | 28 | 21 | 14 | 7 | 0 | 0 | 0 | 11 | 21 | 32 | 43 | 54 | 54 |
| 2502 | 465 | 468 | 471 | 474 | 476 | 479 | 479 | 0 | 15 | 30 | 45 | 60 | 75 | 75 |
| 2503 | 480 | 495 | 510 | 525 | 540 | 555 | 555 | 0 | 8 | 17 | 25 | 34 | 42 | 42 |
| 2504 | 230 | 236 | 241 | 247 | 252 | 258 | 258 | 0 | 6 | 13 | 19 | 25 | 32 | 32 |
| 2505 | 145 | 155 | 164 | 174 | 183 | 193 | 193 | 0 | 9 | 19 | 28 | 38 | 47 | 47 |
| 2506 | 255 | 271 | 287 | 303 | 319 | 335 | 335 | 0 | 10 | 21 | 31 | 41 | 52 | 52 |
| 2507 | 125 | 143 | 160 | 178 | 195 | 213 | 213 | 0 | 9 | 18 | 26 | 35 | 44 | 44 |
| 2508 | 130 | 127 | 124 | 121 | 118 | 115 | 115 | 0 | 2 | 3 | 5 | 6 | 8 | 8 |
| 2509 | 355 | 356 | 357 | 357 | 358 | 359 | 359 | 0 | 4 | 8 | 12 | 17 | 21 | 21 |
| 2510 | 300 | 298 | 296 | 294 | 292 | 290 | 290 | 0 | 4 | 7 | 11 | 15 | 19 | 19 |
| 2511 | 175 | 173 | 171 | 169 | 166 | 164 | 164 | 0 | 2 | 4 | 6 | 8 | 11 | 11 |
| 2512 | 190 | 193 | 197 | 200 | 204 | 207 | 207 | 0 | 2 | 5 | 7 | 9 | 12 | 12 |
| 2513 | 155 | 158 | 161 | 164 | 167 | 170 | 170 | 0 | 2 | 4 | 6 | 9 | 11 | 11 |
| 2514 | 155 | 167 | 179 | 191 | 203 | 215 | 215 | 0 | 2 | 3 | 5 | 7 | 8 | 8 |
| 2601 | 65 | 54 | 43 | 32 | 21 | 10 | 10 | 0 | 1 | 2 | 4 | 5 | 6 | 6 |
| 2602 | 280 | 275 | 270 | 266 | 261 | 256 | 256 | 0 | 4 | 8 | 12 | 16 | 20 | 20 |
| 2603 | 245 | 244 | 242 | 241 | 240 | 238 | 238 | 0 | 3 | 6 | 10 | 13 | 16 | 16 |
| 2604 | 110 | 107 | 104 | 101 | 98 | 95 | 95 | 0 | 1 | 2 | 4 | 5 | 6 | 6 |
| 2605 | 95 | 76 | 57 | 38 | 19 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | 4 | 4 |
| 2606 | 30 | 24 | 18 | 12 | 6 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 2607 | 0 | 2 | 4 | 7 | 9 | 11 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2608 | 95 | 76 | 57 | 38 | 19 | 0 | 0 | 0 | 1 | 3 | 4 | 6 | 7 | 7 |
| 2609 | 335 | 333 | 332 | 330 | 329 | 327 | 327 | 0 | 5 | 11 | 16 | 21 | 27 | 27 |
| 2610 | 445 | 436 | 426 | 417 | 407 | 398 | 398 | 0 | 6 | 13 | 19 | 26 | 32 | 32 |
| 2611 | 120 | 120 | 121 | 121 | 122 | 122 | 122 | 0 | 2 | 4 | 6 | 8 | 10 | 10 |
| 2612 | 520 | 559 | 598 | 637 | 676 | 715 | 715 | 0 | 6 | 11 | 17 | 22 | 28 | 28 |
| 2613 | 15 | 20 | 25 | 30 | 35 | 40 | 40 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 2614 | 105 | 104 | 103 | 102 | 100 | 99 | 99 | 0 | 2 | 4 | 6 | 7 | 9 | 9 |
| 2615 | 70 | 88 | 105 | 123 | 140 | 158 | 158 | 0 | 3 | 5 | 8 | 11 | 13 | 13 |
| 2701 | 485 | 477 | 468 | 460 | 452 | 444 | 444 | 115 | 125 | 135 | 145 | 155 | 165 | 165 |
| 2702 | 35 | 34 | 34 | 33 | 32 | 31 | 31 | 365 | 381 | 397 | 413 | 429 | 444 | 444 |
| 2703 | 200 | 198 | 196 | 194 | 193 | 191 | 191 | 0 | 4 | 8 | 12 | 16 | 19 | 19 |
| 2704 | 95 | 76 | 57 | 38 | 19 | 0 | 0 | 0 | 3 | 5 | 8 | 11 | 13 | 13 |
| 2705 | 85 | 90 | 94 | 99 | 103 | 108 | 108 | 0 | 2 | 3 | 5 | 7 | 9 | 9 |
| 2706 | 475 | 474 | 472 | 471 | 469 | 468 | 468 | 110 | 121 | 133 | 144 | 156 | 167 | 167 |
| 2707 | 635 | 672 | 709 | 747 | 784 | 821 | 821 | 0 | 8 | 15 | 23 | 31 | 38 | 38 |
| 2708 | 900 | 923 | 945 | 968 | 990 | 1013 | 1013 | 0 | 12 | 24 | 36 | 48 | 61 | 61 |
| 2709 | 145 | 158 | 171 | 183 | 196 | 209 | 209 | 0 | 4 | 9 | 13 | 18 | 22 | 22 |
| 2710 | 620 | 677 | 733 | 790 | 846 | 903 | 903 | 0 | 11 | 23 | 34 | 46 | 57 | 57 |
| 2801 | 70 | 56 | 42 | 28 | 14 | 0 | 0 | 0 | 8 | 15 | 23 | 30 | 38 | 38 |
| 2802 | 90 | 73 | 55 | 38 | 21 | 3 | 3 | 0 | 2 | 4 | 5 | 7 | 9 | 9 |
| 2803 | 345 | 372 | 398 | 425 | 452 | 478 | 478 | 0 | 5 | 10 | 15 | 20 | 25 | 25 |
| 2804 | 770 | 757 | 744 | 731 | 718 | 704 | 704 | 0 | 17 | 34 | 51 | 68 | 85 | 85 |
| 2805 | 75 | 61 | 47 | 33 | 19 | 5 | 5 | 0 | 1 | 2 | 2 | 3 | 4 | 4 |
| 2806 | 195 | 209 | 222 | 236 | 250 | 264 | 264 | 0 | 12 | 25 | 37 | 50 | 62 | 62 |
| 2807 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 2808 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 11 | 16 | 21 | 26 | 26 |
| 2901 | 0 | 21 | 42 | 63 | 83 | 104 | 104 | 0 | 3 | 5 | 8 | 10 | 13 | 13 |
| 2902 | 0 | 31 | 62 | 93 | 124 | 155 | 155 | 0 | 1 | 2 | 3 | 4 | 5 | 5 |
| 2903 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 4 | 5 | 5 |
| 2904 | 350 | 395 | 439 | 484 | 529 | 574 | 574 | 170 | 183 | 197 | 210 | 224 | 237 | 237 |

| Traffic Zone Name | MCR-2016-POP-RES | MCR-2021-POP-RES | MCR-2026-POP-RES | MCR-2031-POP-RES | MCR-2036-POP-RES | MCR-2041-POP-RES | MCR-2051-POP-Res | MCR-2016-POP-EMP | MCR-2021-POP-EMP | MCR-2026-POP-EMP | MCR-2031-POP-EMP | MCR-2036-POP-EMP | MCR-2041-POP-EMP | MCR-2051-POP-EMP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3001 | 735 | 766 | 796 | 827 | 858 | 889 | 889 | 140 | 154 | 169 | 183 | 198 | 212 | 212 |
| 3002 | 385 | 392 | 399 | 406 | 413 | 420 | 420 | 0 | 6 | 12 | 18 | 24 | 31 | 31 |
| 3003 | 930 | 955 | 979 | 1004 | 1028 | 1053 | 1053 | 95 | 110 | 125 | 140 | 155 | 170 | 170 |
| 3004 | 545 | 547 | 549 | 551 | 553 | 555 | 555 | 120 | 133 | 146 | 159 | 172 | 185 | 185 |
| 301 | 585 | 585 | 586 | 586 | 587 | 587 | 587 | 0 | 12 | 24 | 37 | 49 | 61 | 61 |
| 302 | 520 | 513 | 506 | 499 | 492 | 485 | 485 | 115 | 130 | 145 | 159 | 174 | 189 | 189 |
| 303 | 820 | 799 | 779 | 758 | 737 | 717 | 717 | 0 | 13 | 26 | 40 | 53 | 66 | 66 |
| 304 | 55 | 51 | 46 | 42 | 38 | 33 | 33 | 0 | 3 | 5 | 8 | 11 | 14 | 14 |
| 305 | 80 | 64 | 48 | 32 | 16 | 0 | 0 | 335 | 354 | 373 | 392 | 411 | 429 | 429 |
| 306 | 495 | 511 | 528 | 544 | 560 | 576 | 576 | 195 | 208 | 221 | 234 | 247 | 260 | 260 |
| 3101 | 0 | 63 | 125 | 188 | 250 | 313 | 313 | 0 | 4 | 8 | 12 | 16 | 19 | 884 |
| 3102 | 5 | 124 | 244 | 363 | 482 | 602 | 1383 | 0 | 6 | 11 | 17 | 23 | 29 | 501 |
| 3103 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 3104 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 195 | 209 | 223 | 237 | 251 | 265 | 265 |
| 3105 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 57 | 115 | 172 | 230 | 287 | 287 |
| 3201 | 1450 | 1426 | 1401 | 1377 | 1352 | 1328 | 1328 | 85 | 107 | 130 | 152 | 175 | 197 | 197 |
| 3202 | 685 | 711 | 737 | 762 | 788 | 814 | 814 | 105 | 118 | 131 | 143 | 156 | 169 | 169 |
| 3203 | 165 | 233 | 302 | 370 | 439 | 507 | 507 | 0 | 14 | 28 | 42 | 56 | 70 | 70 |
| 3204 | 10 | 44 | 78 | 112 | 146 | 180 | 180 | 0 | 3 | 7 | 10 | 14 | 17 | 17 |
| 3205 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 5 | 7 | 9 | 9 |
| 3301 | 730 | 1146 | 1561 | 1977 | 2393 | 2808 | 3008 | 0 | 30 | 60 | 90 | 120 | 150 | 155 |
| 3302 | 1500 | 1480 | 1459 | 1439 | 1419 | 1399 | 1399 | 0 | 19 | 39 | 58 | 78 | 97 | 97 |
| 3401 | 0 | 133 | 266 | 400 | 533 | 666 | 666 | 825 | 911 | 997 | 1082 | 1168 | 1254 | 1254 |
| 3402 | 0 | 25 | 50 | 74 | 99 | 124 | 124 | 0 | 43 | 85 | 128 | 171 | 213 | 213 |
| 3403 | 0 | 711 | 1423 | 2134 | 2846 | 3557 | 3557 | 345 | 413 | 481 | 548 | 616 | 684 | 684 |
| 3404 | 0 | 0 | 0 | 0 | 0 | 0 | 1031 | 321 | 333 | 346 | 359 | 371 | 384 | 409 |
| 3405 | 0 | 5 | 9 | 14 | 18 | 23 | 23 | 0 | 11 | 22 | 32 | 43 | 54 | 402 |
| 3406 | 75 | 65 | 54 | 44 | 33 | 23 | 370 | 0 | 37 | 74 | 111 | 148 | 185 | 193 |
| 3407 | 0 | 261 | 523 | 784 | 1046 | 1307 | 393 | 0 | 18 | 37 | 55 | 74 | 92 | 70 |
| 3501 | 430 | 426 | 423 | 419 | 415 | 411 | 411 | 0 | 8 | 16 | 23 | 31 | 39 | 39 |
| 3502 | 5 | 4 | 3 | 3 | 2 | 1 | 1 | 0 | 3 | 5 | 8 | 11 | 13 | 13 |
| 3503 | 425 | 414 | 404 | 393 | 382 | 372 | 372 | 0 | 6 | 12 | 18 | 23 | 29 | 29 |
| 3504 | 135 | 134 | 133 | 133 | 132 | 131 | 131 | 0 | 1 | 3 | 4 | 6 | 7 | 7 |
| 3505 | 550 | 560 | 571 | 581 | 591 | 601 | 601 | 0 | 8 | 15 | 23 | 31 | 38 | 38 |
| 3506 | 505 | 517 | 528 | 540 | 551 | 563 | 563 | 0 | 9 | 17 | 26 | 34 | 43 | 43 |
| 3507 | 205 | 464 | 723 | 981 | 1240 | 1499 | 1507 | 0 | 13 | 27 | 40 | 53 | 67 | 67 |
| 3508 | 10 | 8 | 6 | 4 | 2 | 0 | 0 | 0 | 4 | 8 | 12 | 16 | 20 | 20 |
| 3509 | 30 | 134 | 238 | 342 | 447 | 551 | 552 | 0 | 3 | 7 | 10 | 13 | 17 | 17 |
| 3510 | 10 | 15 | 19 | 24 | 28 | 33 | 33 | 320 | 333 | 346 | 359 | 372 | 384 | 384 |
| 3511 | 10 | 8 | 6 | 4 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 3512 | 10 | 132 | 255 | 377 | 500 | 622 | 626 | 0 | 4 | 7 | 11 | 14 | 18 | 18 |
| 3601 | 295 | 291 | 287 | 282 | 278 | 274 | 274 | 0 | 9 | 18 | 27 | 36 | 45 | 45 |
| 3602 | 320 | 314 | 307 | 301 | 294 | 288 | 288 | 0 | 7 | 15 | 22 | 29 | 37 | 37 |
| 3603 | 50 | 58 | 66 | 74 | 82 | 90 | 90 | 0 | 6 | 13 | 19 | 25 | 32 | 32 |
| 3604 | 5 | 4 | 3 | 2 | 1 | 0 | 0 | 0 | 16 | 31 | 47 | 62 | 78 | 78 |
| 3701 | 0 | 644 | 1288 | 1933 | 2577 | 3221 | 3225 | 0 | 18 | 36 | 55 | 73 | 91 | 91 |
| 3702 | 405 | 1171 | 1937 | 2703 | 3469 | 4235 | 4243 | 65 | 101 | 136 | 172 | 207 | 243 | 243 |
| 3703 | 845 | 832 | 818 | 805 | 792 | 778 | 778 | 0 | 4 | 9 | 13 | 18 | 22 | 22 |
| 3704 | 465 | 664 | 864 | 1063 | 1262 | 1462 | 1466 | 0 | 33 | 67 | 100 | 134 | 167 | 168 |
| 3705 | 165 | 158 | 152 | 145 | 139 | 132 | 132 | 215 | 230 | 244 | 259 | 274 | 288 | 288 |
| 3706 | 925 | 956 | 988 | 1019 | 1051 | 1082 | 1083 | 0 | 7 | 13 | 20 | 26 | 33 | 33 |
| 3707 | 1400 | 1364 | 1329 | 1293 | 1258 | 1222 | 1222 | 0 | 19 | 38 | 57 | 76 | 94 | 94 |
| 3708 | 2120 | 2188 | 2255 | 2323 | 2390 | 2458 | 2462 | 85 | 122 | 158 | 195 | 231 | 268 | 268 |
| 3709 | 1620 | 1581 | 1542 | 1503 | 1464 | 1425 | 1425 | 0 | 31 | 63 | 94 | 126 | 157 | 157 |
| 3710 | 310 | 308 | 306 | 305 | 303 | 301 | 301 | 0 | 5 | 9 | 14 | 18 | 23 | 23 |
| 3901 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 134 | 201 | 268 | 335 | 335 |
| 401 | 490 | 478 | 465 | 453 | 441 | 428 | 428 | 140 | 156 | 173 | 189 | 205 | 221 | 221 |
| 402 | 245 | 240 | 234 | 229 | 224 | 219 | 219 | 0 | 5 | 10 | 14 | 19 | 24 | 24 |
| 403 | 270 | 281 | 292 | 303 | 314 | 326 | 326 | 140 | 150 | 160 | 170 | 180 | 190 | 190 |
| 404 | 165 | 162 | 158 | 155 | 152 | 149 | 149 | 0 | 5 | 10 | 15 | 20 | 25 | 25 |
| 405 | 5 | 210 | 416 | 621 | 827 | 1032 | 1032 | 455 | 479 | 502 | 526 | 549 | 573 | 573 |
| 406 | 0 | 92 | 184 | 277 | 369 | 461 | 461 | 1058 | 1072 | 1085 | 1098 | 1112 | 1125 | 1125 |
| 407 | 115 | 165 | 216 | 266 | 317 | 367 | 367 | 275 | 288 | 300 | 313 | 326 | 339 | 339 |
| 4501 | 5 | 514 | 1023 | 1531 | 2040 | 2549 | 2561 | 0 | 65 | 130 | 195 | 261 | 326 | 326 |
| 4502 | 475 | 556 | 638 | 719 | 801 | 882 | 884 | 0 | 8 | 16 | 23 | 31 | 39 | 39 |
| 4503 | 2780 | 2804 | 2829 | 2853 | 2877 | 2901 | 2903 | 585 | 647 | 708 | 770 | 832 | 893 | 894 |
| 4601 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 41 | 61 | 82 | 102 | 102 |
| 4602 | 30 | 242 | 455 | 667 | 880 | 1092 | 1092 | 0 | 26 | 52 | 79 | 105 | 131 | 131 |
| 4603 | 0 | 11 | 21 | 32 | 43 | 53 | 53 | 0 | 1 | 1 | 2 | 2 | 3 | 3 |
| 4701 | 450 | 438 | 426 | 414 | 402 | 390 | 390 | 0 | 21 | 42 | 62 | 83 | 104 | 104 |
| 4702 | 255 | 248 | 241 | 233 | 226 | 219 | 219 | 0 | 5 | 9 | 14 | 18 | 23 | 23 |
| 4703 | 420 | 413 | 406 | 399 | 392 | 385 | 385 | 0 | 5 | 10 | 16 | 21 | 26 | 26 |
| 4704 | 95 | 244 | 393 | 543 | 692 | 841 | 842 | 0 | 5 | 11 | 16 | 22 | 27 | 27 |

| Traffic Zone Name | MCR-2016-POP-RES | MCR-2021-POP-RES | MCR-2026-POP-RES | MCR-2031-POP-RES | MCR-2036-POP-RES | MCR-2041-POP-RES | MCR-2051-POP-Res | MCR-2016-POP-EMP | MCR-2021-POP-EMP | MCR-2026-POP-EMP | MCR-2031-POP-EMP | MCR-2036-POP-EMP | MCR-2041-POP-EMP | MCR-2051-POP-EMP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4705 | 300 | 292 | 284 | 276 | 269 | 261 | 261 | 0 | 3 | 5 | 8 | 11 | 14 | 14 |
| 4706 | 770 | 766 | 762 | 758 | 754 | 751 | 751 | 0 | 4 | 9 | 13 | 18 | 22 | 22 |
| 4801 | 980 | 974 | 969 | 963 | 957 | 952 | 952 | 590 | 634 | 679 | 723 | 767 | 812 | 812 |
| 4802 | 1605 | 1649 | 1693 | 1736 | 1780 | 1824 | 1824 | 135 | 160 | 186 | 211 | 237 | 262 | 262 |
| 4803 | 760 | 805 | 851 | 896 | 941 | 987 | 987 | 0 | 12 | 24 | 36 | 48 | 60 | 60 |
| 4901 | 545 | 540 | 535 | 530 | 525 | 520 | 520 | 0 | 9 | 18 | 27 | 36 | 45 | 45 |
| 4902 | 370 | 361 | 353 | 344 | 335 | 326 | 326 | 0 | 6 | 13 | 19 | 25 | 32 | 32 |
| 4903 | 895 | 873 | 851 | 829 | 807 | 785 | 785 | 0 | 12 | 25 | 37 | 50 | 62 | 62 |
| 4904 | 655 | 642 | 629 | 615 | 602 | 589 | 589 | 0 | 10 | 20 | 31 | 41 | 51 | 51 |
| 4905 | 1280 | 1404 | 1528 | 1652 | 1777 | 1901 | 1901 | 0 | 14 | 28 | 41 | 55 | 69 | 69 |
| 4906 | 415 | 410 | 405 | 399 | 394 | 389 | 389 | 0 | 6 | 12 | 19 | 25 | 31 | 31 |
| 5001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 131 | 263 | 394 | 526 | 657 | 657 |
| 5002 | 5 | 4 | 3 | 2 | 1 | 0 | 0 | 0 | 102 | 204 | 306 | 407 | 509 | 509 |
| 5003 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 65 | 129 | 194 | 258 | 323 | 323 |
| 5004 | 20 | 16 | 12 | 8 | 4 | 0 | 0 | 0 | 213 | 426 | 639 | 852 | 1065 | 1065 |
| 501 | 720 | 713 | 706 | 699 | 692 | 685 | 685 | 0 | 10 | 20 | 30 | 40 | 50 | 50 |
| 502 | 990 | 969 | 947 | 926 | 904 | 883 | 883 | 0 | 12 | 25 | 37 | 49 | 61 | 61 |
| 503 | 520 | 508 | 496 | 484 | 472 | 460 | 460 | 0 | 9 | 19 | 28 | 38 | 47 | 47 |
| 504 | 275 | 393 | 511 | 630 | 748 | 866 | 869 | 105 | 115 | 124 | 134 | 144 | 153 | 153 |
| 505 | 525 | 512 | 499 | 485 | 472 | 459 | 459 | 0 | 9 | 18 | 27 | 36 | 45 | 45 |
| 506 | 880 | 861 | 842 | 823 | 804 | 785 | 785 | 145 | 164 | 182 | 201 | 220 | 239 | 239 |
| 507 | 475 | 466 | 456 | 447 | 438 | 428 | 428 | 0 | 6 | 11 | 17 | 23 | 29 | 29 |
| 508 | 725 | 708 | 690 | 673 | 655 | 638 | 638 | 0 | 12 | 24 | 35 | 47 | 59 | 59 |
| 509 | 895 | 873 | 852 | 830 | 808 | 786 | 786 | 0 | 11 | 23 | 34 | 45 | 56 | 56 |
| 510 | 545 | 534 | 523 | 512 | 501 | 490 | 490 | 0 | 10 | 19 | 29 | 38 | 48 | 48 |
| 5101 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 5102 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5103 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | 4 | 4 |
| 5104 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5105 | 0 | 130 | 261 | 391 | 521 | 651 | 652 | 0 | 4 | 7 | 11 | 14 | 18 | 18 |
| 5106 | 0 | 45 | 89 | 134 | 179 | 223 | 223 | 0 | 1 | 3 | 4 | 5 | 6 | 6 |
| 5107 | 0 | 378 | 757 | 1135 | 1514 | 1892 | 1896 | 0 | 17 | 35 | 52 | 70 | 87 | 87 |
| 511 | 1050 | 1027 | 1005 | 982 | 960 | 937 | 937 | 0 | 11 | 22 | 33 | 45 | 56 | 56 |
| 512 | 350 | 405 | 460 | 515 | 570 | 625 | 625 | 425 | 449 | 472 | 496 | 519 | 543 | 543 |
| 513 | 445 | 482 | 518 | 555 | 591 | 628 | 628 | 0 | 4 | 9 | 13 | 18 | 22 | 22 |
| 514 | 930 | 944 | 959 | 973 | 988 | 1002 | 1002 | 0 | 12 | 23 | 35 | 46 | 58 | 58 |
| 515 | 1145 | 1142 | 1139 | 1136 | 1133 | 1129 | 1129 | 120 | 140 | 160 | 180 | 200 | 221 | 221 |
| 516 | 195 | 228 | 262 | 295 | 329 | 362 | 362 | 0 | 2 | 5 | 7 | 10 | 12 | 12 |
| 5201 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5202 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5203 | 0 | 41 | 81 | 122 | 162 | 203 | 356 | 0 | 1 | 3 | 4 | 5 | 7 | 16 |
| 5204 | 0 | 0 | 0 | 0 | 0 | 0 | 224 | 0 | 0 | 0 | 0 | 0 | 1 | 6 |
| 5205 | 5 | 187 | 369 | 551 | 733 | 916 | 810 | 0 | 6 | 12 | 18 | 23 | 29 | 67 |
| 5206 | 40 | 32 | 24 | 16 | 8 | 0 | 759 | 0 | 0 | 1 | 1 | 2 | 2 | 21 |
| 5301 | 0 | 12 | 24 | 36 | 49 | 61 | 61 | 0 | 0 | 1 | 1 | 1 | 2 | 2 |
| 5302 | 0 | 11 | 22 | 32 | 43 | 54 | 54 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| 5303 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5401 | 0 | 36 | 73 | 109 | 145 | 182 | 183 | 0 | 45 | 90 | 136 | 181 | 226 | 226 |
| 5402 | 0 | 113 | 225 | 338 | 451 | 563 | 564 | 0 | 6 | 13 | 19 | 25 | 32 | 32 |
| 5403 | 0 | 118 | 236 | 354 | 472 | 590 | 591 | 0 | 4 | 9 | 13 | 17 | 22 | 22 |
| 5404 | 0 | 111 | 222 | 332 | 443 | 554 | 555 | 0 | 13 | 25 | 38 | 51 | 64 | 64 |
| 5405 | 10 | 94 | 177 | 261 | 344 | 428 | 430 | 0 | 144 | 287 | 431 | 574 | 718 | 718 |
| 5406 | 0 | 236 | 471 | 707 | 943 | 1178 | 1182 | 0 | 11 | 23 | 34 | 46 | 57 | 57 |
| 5407 | 0 | 100 | 201 | 301 | 402 | 502 | 503 | 0 | 4 | 9 | 13 | 18 | 22 | 22 |
| 5408 | 15 | 140 | 265 | 389 | 514 | 639 | 640 | 0 | 6 | 12 | 17 | 23 | 29 | 29 |
| 5501 | 0 | 211 | 422 | 633 | 844 | 1055 | 1059 | 0 | 55 | 110 | 165 | 220 | 275 | 275 |
| 5502 | 0 | 188 | 375 | 563 | 751 | 938 | 939 | 0 | 7 | 14 | 22 | 29 | 36 | 36 |
| 5503 | 0 | 85 | 170 | 255 | 340 | 425 | 425 | 0 | 3 | 5 | 8 | 10 | 13 | 13 |
| 5504 | 0 | 41 | 82 | 123 | 165 | 206 | 206 | 0 | 2 | 4 | 6 | 8 | 10 | 10 |
| 5505 | 0 | 27 | 55 | 82 | 109 | 137 | 137 | 0 | 2 | 4 | 6 | 8 | 10 | 10 |
| 5506 | 0 | 89 | 179 | 268 | 357 | 447 | 448 | 0 | 18 | 35 | 53 | 71 | 88 | 88 |
| 5507 | 45 | 193 | 340 | 488 | 636 | 783 | 786 | 0 | 32 | 65 | 97 | 130 | 162 | 162 |
| 5508 | 5 | 152 | 300 | 447 | 594 | 741 | 744 | 0 | 9 | 18 | 26 | 35 | 44 | 44 |
| 5509 | 0 | 99 | 198 | 298 | 397 | 496 | 498 | 0 | 7 | 14 | 21 | 28 | 35 | 35 |
| 5510 | 5 | 87 | 169 | 250 | 332 | 414 | 416 | 0 | 6 | 12 | 19 | 25 | 31 | 31 |
| 5511 | 0 | 140 | 280 | 420 | 561 | 701 | 703 | 0 | 17 | 34 | 51 | 68 | 85 | 85 |
| 5512 | 5 | 163 | 321 | 479 | 636 | 794 | 798 | 0 | 31 | 62 | 93 | 124 | 154 | 155 |
| 5601 | 15 | 12 | 9 | 6 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5602 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5603 | 15 | 12 | 9 | 6 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5604 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5605 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5606 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Traffic Zone Name | MCR-2016-POP-RES | MCR-2021-POP-RES | MCR-2026-POP-RES | MCR-2031-POP-RES | MCR-2036-POP-RES | MCR-2041-POP-RES | MCR-2051-POP-Res | MCR-2016-POP-EMP | MCR-2021-POP-EMP | MCR-2026-POP-EMP | MCR-2031-POP-EMP | MCR-2036-POP-EMP | MCR-2041-POP-EMP | MCR-2051-POP-EMP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5607 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5608 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5609 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5610 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5611 | 15 | 16 | 18 | 19 | 21 | 22 | 22 | 165 | 172 | 179 | 186 | 193 | 200 | 200 |
| 5612 | 0 | 1 | 3 | 4 | 6 | 7 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5613 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5614 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5615 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5701 | 25 | 20 | 15 | 10 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5702 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5703 | 30 | 24 | 18 | 12 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5704 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5705 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5706 | 10 | 9 | 8 | 7 | 6 | 5 | 5 | 0 | 0 | 1 | 1 | 2 | 2 | 2 |
| 5707 | 0 | 97 | 195 | 292 | 389 | 487 | 489 | 0 | 6 | 12 | 18 | 24 | 30 | 30 |
| 5708 | 0 | 106 | 213 | 319 | 426 | 532 | 534 | 0 | 6 | 12 | 19 | 25 | 31 | 31 |
| 5709 | 0 | 121 | 242 | 364 | 485 | 606 | 609 | 0 | 43 | 85 | 128 | 170 | 213 | 213 |
| 5710 | 5 | 188 | 371 | 554 | 736 | 919 | 922 | 0 | 19 | 39 | 58 | 78 | 97 | 97 |
| 5711 | 0 | 157 | 315 | 472 | 629 | 787 | 789 | 0 | 9 | 17 | 26 | 35 | 44 | 44 |
| 5712 | 0 | 72 | 144 | 216 | 288 | 360 | 361 | 0 | 16 | 32 | 48 | 64 | 80 | 80 |
| 5801 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 | 83 | 125 | 167 | 209 | 209 |
| 5802 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5803 | 10 | 8 | 6 | 4 | 2 | 0 | 0 | 0 | 169 | 337 | 506 | 675 | 844 | 844 |
| 5804 | 0 | 46 | 93 | 139 | 185 | 232 | 232 | 0 | 92 | 185 | 277 | 370 | 462 | 462 |
| 5805 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 96 | 191 | 287 | 382 | 478 | 478 |
| 5806 | 15 | 53 | 91 | 129 | 166 | 204 | 206 | 0 | 75 | 150 | 225 | 300 | 375 | 375 |
| 5900 | 20 | 16 | 12 | 8 | 4 | 0 | 0 | 0 | 149 | 299 | 448 | 598 | 747 | 747 |
| 5901 | 10 | 8 | 6 | 4 | 2 | 0 | 0 | 0 | 162 | 324 | 486 | 648 | 810 | 810 |
| 5902 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 113 | 225 | 338 | 450 | 563 | 563 |
| 5903 | 15 | 257 | 499 | 741 | 983 | 1225 | 1227 | 0 | 9 | 18 | 27 | 36 | 44 | 44 |
| 5904 | 0 | 437 | 874 | 1311 | 1748 | 2186 | 2190 | 0 | 18 | 37 | 55 | 74 | 92 | 92 |
| 6001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 4 | 5 | 6 | 196 |
| 6002 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 5 | 6 | 8 | 169 |
| 6003 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 4 | 5 | 6 | 156 |
| 6004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 15 | 23 | 30 | 38 | 391 |
| 6005 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 85 | 170 | 255 | 340 | 425 | 425 |
| 6006 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 157 | 315 | 472 | 629 | 786 | 1152 |
| 6007 | 5 | 4 | 3 | 2 | 1 | 0 | 0 | 0 | 174 | 349 | 523 | 697 | 872 | 1089 |
| 6008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 8 | 13 | 17 | 21 | 21 |
| 6009 | 10 | 8 | 6 | 4 | 2 | 0 | 0 | 0 | 136 | 272 | 409 | 545 | 681 | 681 |
| 601 | 355 | 346 | 337 | 327 | 318 | 309 | 309 | 0 | 9 | 18 | 27 | 36 | 45 | 45 |
| 6010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 110 | 219 | 329 | 439 | 548 | 548 |
| 602 | 545 | 534 | 522 | 511 | 499 | 488 | 488 | 0 | 12 | 24 | 36 | 48 | 60 | 60 |
| 603 | 955 | 930 | 905 | 880 | 855 | 831 | 831 | 0 | 12 | 24 | 37 | 49 | 61 | 61 |
| 604 | 915 | 891 | 867 | 843 | 819 | 795 | 795 | 0 | 10 | 20 | 30 | 40 | 49 | 49 |
| 605 | 725 | 707 | 689 | 671 | 653 | 635 | 635 | 0 | 10 | 20 | 30 | 40 | 50 | 50 |
| 606 | 1000 | 973 | 947 | 920 | 894 | 867 | 867 | 0 | 15 | 30 | 44 | 59 | 74 | 74 |
| 7001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 701 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 610 | 642 | 674 | 705 | 737 | 769 | 769 |
| 702 | 0 | 35 | 69 | 104 | 139 | 174 | 174 | 480 | 504 | 529 | 553 | 578 | 602 | 602 |
| 703 | 0 | 28 | 56 | 85 | 113 | 141 | 141 | 1427 | 1440 | 1453 | 1466 | 1480 | 1493 | 1493 |
| 704 | 0 | 53 | 107 | 160 | 213 | 267 | 267 | 875 | 890 | 905 | 920 | 936 | 951 | 951 |
| 705 | 5 | 144 | 283 | 422 | 562 | 701 | 701 | 805 | 846 | 887 | 927 | 968 | 1009 | 1009 |
| 706 | 0 | 71 | 143 | 214 | 286 | 357 | 357 | 335 | 357 | 379 | 401 | 423 | 445 | 445 |
| 707 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 135 | 206 | 277 | 347 | 418 | 489 | 489 |
| 708 | 0 | 250 | 500 | 751 | 1001 | 1251 | 1251 | 780 | 815 | 849 | 884 | 919 | 954 | 954 |
| 7901 | 145 | 141 | 137 | 133 | 129 | 125 | 125 | 0 | 1 | 1 | 2 | 3 | 4 | 4 |
| 801 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1795 | 1906 | 2017 | 2128 | 2239 | 2351 | 2351 |
| 8501 | 40 | 159 | 278 | 397 | 517 | 636 | 636 | 0 | 4 | 7 | 11 | 15 | 19 | 19 |
| 8502 | 530 | 868 | 1206 | 1544 | 1882 | 2220 | 2220 | 0 | 14 | 28 | 41 | 55 | 69 | 69 |
| 8600 | 70 | 936 | 1802 | 2668 | 3533 | 4399 | 4403 | 0 | 36 | 72 | 109 | 145 | 181 | 181 |
| 8701 | 35 | 53 | 72 | 90 | 109 | 127 | 127 | 0 | 2 | 4 | 5 | 7 | 9 | 9 |
| 901 | 5 | 134 | 263 | 392 | 521 | 649 | 649 | 1605 | 1875 | 2144 | 2414 | 2684 | 2953 | 2953 |
| 902 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 445 | 465 | 484 | 504 | 524 | 544 | 544 |
| 903 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 280 | 298 | 317 | 335 | 353 | 372 | 372 |

# B

City of Brantford

# APPENDIX B

PRINCIPLES, POLICIES, AND LEVEL OF SERVICE

# TABLE OF CONTENTS

# 1 INTRODUCTION

The City of Brantford retained GM BluePlan to complete a Master Servicing Plan Update. The City's Master Servicing Plan Update consists of a comprehensive Infrastructure Plan that addresses existing and growth-related needs for the City's water, wastewater, and stormwater services; including addressing the trunk and local servicing needs to support the new areas within the City's recently expanded municipal boundary.

The Master Servicing Plan Update is a critical component in the City's planning for growth and will provide the framework and vision for the management, expansion and funding of the water, wastewater, and stormwater servicing needs for the City to support growth to 2051.

The purpose of this report is to summarize the recommended water, wastewater, and stormwater Policies, Level of Service Objectives, and Design Criteria that will be used to effectively evaluate the existing and future performance of the water, wastewater, and stormwater systems and further, as rationale in the development of a long-term servicing strategy which meets infrastructure capacity needs and details necessary upgrades.

## 1.1 Background and Objectives

Execution of reasonable Policies and Level of Service (LOS) objectives are essential in ensuring that the proper planning and design principles are followed in the development of detailed servicing strategies, implementation of system capital program, and operations and maintenance practices.

Through the Master Servicing Plan; draft Policies and LOS objectives will be established and used to guide future investment in the water, wastewater, and stormwater systems.

The development of water, wastewater, and stormwater Policies and LOS objectives have been based on existing documentation and related sources, and an assessment of the City's existing infrastructure condition and performance, including:

- The City's Official Plan
- Federal and Provincial Policies and Legislation
- Existing design criteria
    - Criteria required by the Ministry of Environment, Conservation, and Parks (MECP)
    - City of Brantford current design criteria, updated in 2017
    - Design criteria utilized in the 2014 Master Servicing Plan
    - Other local municipal design criteria
- Existing system performance
    - Historic and existing system operations and performance
    - Resiliency to climate change
- Stakeholder feedback
    - City of Brantford staff
- Financially feasible objectives

The objectives of the Principles, Policies, and Level of Service Document include, but are not limited to the following:

- Providing direction for planning and identifying water, wastewater, and stormwater servicing issues that may impact growth options
- Providing direction for normal operation and maintenance of the water and wastewater systems (the policies do not replace normal operation and maintenance procedures or best practices)
- Providing direction for development and evaluation of servicing strategies for the Master Servicing Plan Update
- Ensuring appropriate design and costing criteria are utilized for developing and evaluating servicing strategies for the Master Servicing Plan Update
- Setting policies and Level of Service Objectives that are reasonably implemented
- Setting policies and Level of Service Objectives that are robust, sustainable, and measurable

Although best management practices, criteria, and key performance indicators are updated over time, the context, intent and validity of the Policies and LOS objectives should remain intact.

Policy is the overall guiding principle. Criteria are the tactical implementation of policy.

## 1.2 Approach

The Policies and LOS discussion is split into four main categories and aims to link the analysis of system needs and replacement triggers with the customer experience.

- **Policy Statements:** communicate the overall guiding principles and objectives of the infrastructure systems.
- **Customer Level of Service objectives**: communicate and translate technical Levels of Service into terminology relevant to customers.
- **Technical Level of Service objectives (Criteria)**: quantitatively measure the system performance and are used to compare potential strategies and solutions.
- **Key performance indicator:** measures the relative system performance against the Technical and Customer Level of Service objectives and validate the beneficial impact of any given investment.

The system performance goals are intended to be used in the medium to long-term and will form the basis of a continuous improvement program by which each system investment is measured.

This approach is in line with the Ontario Regulation 588/17 made under the Infrastructure for Jobs and Prosperity Act, 2015, S.O. 2015.

Through the MSP, initial development of the LOS framework will be completed; however, the focus of MSP will be on achieving the Technical Level of Service Objectives (Criteria). Refinement and final development of the LOS framework will be completed under future Asset Management Plans, and will require further discussion with Senior Staff and Council to finalize.

## 2 MSP VISION STATEMENT

Through the Municipal Class EA process, Phase 1 requires the identification of the problem and opportunity statement that guides the process of establishing preferred strategies to address the deficiencies observed in the water, wastewater, and stormwater systems. The following vision statement is a driver for the Brantford Master Servicing Plan Update where problems and opportunities are clearly identified through the desire to provide an adequate level of service to users and improve system performance under both current and future conditions.

The Vision Statement is as follows:

**Supporting a Strong and Growing Brantford**

To establish a preferred servicing plan for the City's water, wastewater, and stormwater systems that:

- Meets current needs
- Supports growth and expansion of the City's urban boundary
- Maintains or improves service levels
- Considers priority areas of climate change, infrastructure optimization and renewal, and system resiliency

## 3 POLICY STATEMENTS

Specific servicing principles and policies have been developed to guide and provide direction for the development and evaluation of servicing strategies. In general, the City of Brantford is looking to build and maintain efficient, effective, well managed water, wastewater, and stormwater systems that provide a high level of service to the end users. In order to clearly capture these goals, the servicing principles have been categorized into 4 categories – general, water, wastewater, and stormwater.

**Table B-1** presents the general servicing policies which impact water, wastewater, and stormwater servicing. While **Table B-2** to **Table B-4** present the servicing policies for the water, wastewater, and stormwater systems.

**Table B-1: General Servicing Principles**

| Policy No. | Policy Area | Policy Statement | Servicing Implications |
|---|---|---|---|
| G.01 | Municipal Servicing | "The City of Brantford shall provide adequate municipal servicing for water, wastewater and stormwater in accordance with the population and employment projections in the time horizon of the Official Plan." | • Planning and design of servicing strategies will optimize use of existing infrastructure where possible.<br>• Infrastructure will be planned and designed in accordance of growth projections in the Official Plan.<br>• Timing of growth will be reviewed with consideration to a reasonable implementation schedule for infrastructure required to meet the projected growth.<br>• Municipal servicing will be implemented under typical standards (MECP Guidelines). |
| G.02 | Environmental Protection | "The City of Brantford shall consider, and endeavour to minimize, the impact to the natural, built and cultural environment and heritage of the community; due to municipal servicing policies and projects." | • Servicing studies shall consider the City's Official Plan Environmental and Heritage Policies<br>• Services will be planned through the appropriate Environmental Assessment process to ensure full regard for the natural and cultural heritage |
| G.03 | Planning Horizon | "The City of Brantford shall ensure that the design of water, wastewater and stormwater infrastructure recognizes the potential for growth beyond the time horizon of the Official Plan." | • Recognize that the service life of infrastructure may be 60 years or more[1].<br>• Consider, where appropriate, potential for growth beyond the time horizon of the Official Plan for the planning and sizing of infrastructure. |
| G.04 | Reserve Capacity | "The City of Brantford will endeavour to maintain sufficient reserve capacity in its water, wastewater and stormwater infrastructure and facilities to provide operational flexibility and meet potential changes in servicing conditions." | • Recognize the time frame required to implement expansion of the infrastructure and facilities and initiate planning, the Environmental Assessment process, design and construction for expansion with consideration of the in-service date.<br>• Maintain plant operating capacity close to its rated capacity. Inability to maintain adequate operating capacity will trigger future expansions or upgrades of the infrastructure. |
| G.05 | System Reliability and Security | "The City of Brantford shall endeavour to provide reliability, redundancy and security in its water, wastewater and stormwater systems with attention to high risk and critical areas." | • Recognize that all systems are susceptible to some level of failure or breakdown or need to be taken out of service for regular maintenance. It is reasonable to provide a level of reliability to ensure an acceptable level of service is maintained. |

[1] While linear infrastructure such as watermains and sewer have an estimated service life of 60-100 years depending on material, location, and construction practices, other infrastructure such as pump station mechanical equipment have an estimated service life of 25 years

| Policy No. | Policy Area | Policy Statement | Servicing Implications |
|---|---|---|---|
| G.06 | Location of Municipal Services and Facilities | "The City of Brantford shall locate all of its services and facilities on public property or on municipally-owned easements." | • The City will ensure that any new and existing infrastructure be located within road right-of-ways, or on City-owned property (including designated lots and easements, subject to City By-Law property encumbrance rules). Where existing infrastructure is not located within a road right-of-way or on City owned property, the City will look to secure appropriate working easements to facilitate ongoing operation and maintenance and/or look to relocate infrastructure when major rehabilitation and/or upgrades works are required.<br>• Adequate property size will be maintained to facilitate all day-to-day activities and emergency response.<br>• Adequate property will be acquired to meet future infrastructure requirements. |
| G.07 | Climate Change | "The City of Brantford shall be aware of and consider the potential impact of climate change on planning and sizing of infrastructure." | • Water, wastewater and stormwater facilities will be designed with consideration to the potential impacts of climate change. |
| G.08 | Energy Efficiency | "The City of Brantford shall design water, wastewater and stormwater facilities with consideration to energy use." | • Facilities will be planned and designed with consideration to Net Present Value (Capital and Operating Costs) as they relate to energy use (i.e. minimize pumping where possible). |
| G.09 | Integrated Infrastructure Program | "The City of Brantford shall coordinate and integrate the MSP program with City planning, programs and policies where appropriate." | • Coordination and integration will ensure servicing policies and strategies are aligned |
| G.10 | Level of Service | "The City of Brantford shall outline the Level of Service Objectives through the Master Servicing Plan and endeavour to meet/exceed the minimum requirements as outlined in the objectives." | • The City will review and evaluate alternatives developed through the Master Servicing Plan based on their ability to meet requirements outlined in the Level of Service Objectives. |
| G.11 | Sustainability | "The City will endeavor to undertake sustainable planning, operation and maintenance of the water, wastewater, and stormwater." | • The City will strive to plan, operate and maintain Water, Wastewater, and Stormwater Systems that are environmentally, financially, operationally, legislatively, and socially sustainable<br>• Financial Sustainability shall consider and utilize appropriate funding mechanisms including but not limited to Development Charges, local cost to development and rate reserves to provide a long term balanced and equitable plan to fund the delivery of servicing |

**Table B-2: Water Servicing Principles**

| Policy No. | Policy Area | Policy Statement | Servicing Implications |
|---|---|---|---|
| W.01 | Health & Safety | "The City of Brantford will promote health, productivity and safety of the community through design, construction and maintenance of the City's potable water infrastructure" | • The City will prepare a comprehensive strategy to manage existing and future water servicing needs<br>• Ensure that planning and implementation of the potable water systems are consistent with legislative policies and guidelines<br>• Municipal servicing will be implemented under typical standards (MECP Guidelines). |
| W.02 | Sustainability | "The City of Brantford will endeavour to undertake sustainable planning, operation and maintenance of the Water System." | • The City will strive to plan, operate and maintain a water system that is environmentally, financially, operationally, legislatively, and socially sustainable<br>• Financial Sustainability shall consider and utilize appropriate funding mechanisms including but not limited to Development Charges, local cost to development and rate reserves to provide a long term balanced and equitable plan to fund the delivery of servicing |
| W.03 | Demand Projections | "The City of Brantford shall consider existing water consumption trends when identifying long-term water system needs." | • When estimating long-term water demand needs, existing water consumption rates will be used to account for existing customer demands and future demands will be estimated using the per capita rates identified in the Master Servicing Plan. |
| W.04 | Raw Water Source | "The City of Brantford shall endeavor to enhance, protect and maintain quality, quantity and safety of its raw water source" | • Monitoring of water sources is required to ensure safe yield limit of the water taking is occurring<br>• The City's current Raw Water Source is the Grand River<br>• Consideration should be given to the impacts of short-term raw water intake closures on trunk infrastructure needs |
| W.05 | Treatment & Distribution Water Quality | "The City of Brantford shall meet or exceed legislated water quality criteria" | • Water quality will meet, at a minimum, all legislated criteria<br>• Ensure regularly testing and monitoring for chlorine residual in the system<br>• Implement industry best practices to ensure water quality is maintained<br>• Review the economics, reliability and water quality impacts of implementing new technology |
| W.06 | Distribution Requirements | "The City of Brantford shall provide potable water at adequate pressure and flow to its customers" | • Provide pressures which meet current design criteria and standards.<br>• MECP Guidelines identify a typical recommended operating range of 275-700 kPa (40-100 psi).<br>• Review existing Pressure District Boundaries.<br>• Have an adequate combination of reservoir capacity, pumping capacity, and stand-by power to meet the desired level of service under emergency conditions. |
| W.07 | Fire Flow Requirements | "The City of Brantford shall consider the MECP Guidelines and the Fire Underwriters Guidelines for establishing the acceptable level of fire flow." | • Provide pressures and flows which meet current design criteria and standards. |

| Policy No. | Policy Area | Policy Statement | Servicing Implications |
|---|---|---|---|
| W.08 | Storage Requirements | "The City of Brantford shall consider the MECP Guideline as the minimum acceptable level of water storage." | • Provide adequate level of storage which meets current design criteria and standards, and considers the operational requirements and impacts to pumping firm capacity requirements.<br>• Consider level of storage required under floating versus pumped conditions. |
| W.09 | Operational Flexibility | "The City of Brantford shall consider levels of storage beyond MECP Guidelines where appropriate in order to provide operational flexibility, energy management, and system security" | • Water storage can provide opportunities for optimization of pumping strategies, to consider the operational requirements and impacts to storage capacity requirements.<br>• Water storage can provide additional level of service and security under emergency conditions, particularly for any areas across the City with limited redundancy and/or to protect against a temporary closure of the City's raw water intake<br>• Consideration should be given to optimizing lifecycle costs for the water system as storage can minimize pumping energy costs |
| W.10 | Water Efficiency and Consumption Trends | "The City of Brantford shall be aware of the impacts water efficiency and conservation has on the water network." | • Continue to assess water demand conditions and determine reasonableness of trends (potential lower water use and consumption)<br>• Utilize water efficiency studies where available.<br>• Apply where appropriate demand trends (efficiency) into future design criteria and growth forecasts.<br>• Apply awareness to how it will impact alternatives and scheduling of future infrastructure. |
| W.11 | Water Supply and Distribution Security | "The City of Brantford shall plan, design, construct, operate, and maintain the water system to balance level of service and security of supply to the customers" | • The City shall continue to implement standards, criteria, and standard operating procedures for the water system<br>• There is an awareness and integration between the City water system, local distribution system and water services on private property<br>• The City will maintain appropriate standards for the City water system to protect the public and private infrastructure |

**Table B-3: Wastewater Servicing Principles**

| Policy No. | Policy Area | Policy Statement | Servicing Implications |
|---|---|---|---|
| WW.01 | Health & Safety | "The City of Brantford will promote health, productivity and safety of the community through design, construction and maintenance of the City's wastewater infrastructure" | • The City will prepare a comprehensive strategy to manage existing and future wastewater servicing needs<br>• Ensure that planning and implementation of the wastewater systems are consistent with legislative policies and guidelines<br>• Municipal servicing will be implemented under typical standards (MECP Guidelines). |
| WW.02 | Sustainability | "The City of Brantford will endeavour to undertake sustainable planning, operation and maintenance of the Wastewater System." | • The City will strive to plan, operate and maintain a Wastewater System that is Environmentally, Financially, Operationally, Legislatively, and Socially Sustainable<br>• Financial Sustainability shall consider and utilize appropriate funding mechanisms including but not limited to Development Charges, local cost to development and rate reserves to provide a long term balanced and equitable plan to fund the delivery of servicing |
| WW.03 | Sewer Use Criteria | "The City of Brantford shall maintain a sewer use program that sets the appropriate limits and procedures to control discharge." | • Review and maintain the sewer use by-law, which is supported by Council.<br>• Maintain a monitoring program to ensure the discharges meet the limits set out in the by-law |
| WW.04 | Receiving Water Bodies | "The City of Brantford shall endeavour to enhance, protect, and maintain quality, quantity, and safety of its receiving water bodies." | • Wastewater effluent discharges will meet, at a minimum, all legislated criteria<br>• The City shall seek to minimize and/or eliminate untreated overflows to the environment<br>• The City shall consider policies related to the International Joint Commission on the Great Lakes |
| WW.05 | Wastewater Treatment and Collection Requirements | "The City of Brantford shall meet as a minimum the requirements of the Environmental Compliance Approvals set out by governing bodies and the appropriate legislated treatment and collection criteria." | • Wastewater quality (air and effluent) will meet as a minimum all legislated criteria.<br>• Manage inflow / infiltration through asset management programs to minimize extraneous flows and maximize efficient use of available wastewater infrastructure.<br>• Review the economics, reliability and water quality impacts of implementing new technology.<br>• Have an adequate combination of pumping capacity and stand-by power to meet the desired level of service under emergency conditions. |
| WW.06 | Wastewater Flow Projections | "The City of Brantford shall utilize a wastewater flow projection methodology that recognizes recent wastewater flow and treatment data and current consumption trends" | • Forward-looking wastewater flow projections in the Master Servicing Plan must appropriately identify future wastewater needs to ensure the best estimate for infrastructure capacity and timing<br>• The City will utilize a starting point methodology based on recent wastewater flow conditions<br>• The City will establish current wastewater design criteria and standards for new growth |
| WW.07 | Overstrength – Discharge | "The City of Brantford shall ensure that all new users adhere to the City's allowable discharge criteria as outlined in the City's existing sewer use by-law" | • All users shall plan and design to meet the sewer by-law.<br>• Where over strength discharge are anticipated, onsite pre-treatment in order to achieve the City's allowable discharge criteria as outlined in the City's sewer use by-law will be required. |

| Policy No. | Policy Area | Policy Statement | Servicing Implications |
|---|---|---|---|
| WW.08 | Separated Wastewater and Stormwater Systems | "The City of Brantford shall plan and maintain separate wastewater and stormwater systems" | • The City will continue to build, maintain, and operate separated wastewater and stormwater systems<br>• The City will endeavor to ensure that new wastewater systems are constructed in a manner that minimize new Inflow and Infiltration contributions<br>• The City will endeavor as part of Inflow and Infiltration reduction measures to identify and remediate existing sanitary sewer cross connections and implement a strategy to prevent future cross connections |
| WW.09 | Wet Weather Flow Criteria | "The City of Brantford shall utilize current wet weather flow criteria to determine peak wet weather flows and size wastewater infrastructure" | • The City will continue to manage system performance under wet weather conditions<br>• The level of service under wet weather conditions will be established through the Master Servicing Plan design criteria<br>• Consideration to environmental, social and financial factors as well as the feasibility for implementation should be given when determining the wet weather criteria<br>• As additional flows from growth are added to the system, the City should look for opportunities to not make overflow conditions worse than the current baseline conditions |
| WW.10 | Wet Weather Strategies | "The City of Brantford shall review a combination of servicing strategies including infrastructure and non infrastructure (i.e. i/i reduction) solutions to meet wet weather level of service and provide sufficient wastewater capacity to support existing users and future growth." | • The City Master Servicing Plan will develop and evaluate a comprehensive list of alternatives against multiple-bottom-line criteria including lifecycle costs<br>• The most cost-effective and beneficial strategy may include not providing additional infrastructure but creating additional capacity through flow reduction methods such as inflow/infiltration control<br>• Where inflow/infiltration control programs secure growth capacity, program cost should be recoverable through Development Charges |
| WW.11 | Capacity Allocation | "The City of Brantford shall review opportunities to allocate capacity gained through implementation of wet weather strategies and system optimization for growth and non growth benefit in compliance with the City's Wastewater Allocation Policy" | • Provision of additional capacity within the wastewater system will need to consider the desired benefit<br>• Additional capacity may be required to meet regulatory requirements or to improve level of service in the system |

**Table B-4: Stormwater Servicing Principles**

| Policy No. | Policy Area | Policy Statement | Servicing Implications |
|---|---|---|---|
| SW.01 | Health and Safety | "The City of Brantford will prioritize the health and safety of the public and property by implementing a strategy to provide sufficient conveyance and control infrastructure to safely manage stormwater runoff." | • The City will prepare a comprehensive strategy to manage existing and future stormwater related impacts<br>• Ensure that planning and implementation of stormwater management systems are consistent with legislative policies and guidelines<br>• Stormwater Management (SWM) strategies will need to be coordinated with flood plain management strategies and the Grand River Conservation Authority<br>• Municipal servicing will be implemented under typical standards (MECP Guidelines) |
| SW.02 | Sustainability | "The City of Brantford will endeavour to undertake sustainable planning, operation and maintenance of the Stormwater System." | • The City will strive to plan, operate and maintain a Stormwater System that is Environmentally, Financially, Operationally, Legislatively, and Socially Sustainable<br>• Financial Sustainability shall consider and utilize appropriate funding mechanisms including but not limited to Development Charges, local cost to development and rate reserves to provide a long term balanced and equitable plan to fund the delivery of servicing |
| SW.03 | Natural Environment and Hydrologic Cycle | "The City of Brantford, through stormwater servicing strategy and policy implementation, will endeavour to preserve and/or re-establish a more natural hydrologic cycle." | • The City will promote the utilization of facilities and low impact development techniques that mimic the existing hydrologic cycle<br>• Promote and facilitate strategies within existing service areas that implement retrofit programs and no net increase in runoff for infill and redevelopment sites<br>• The City will strive to develop sustainable stormwater management practices |
| SW.04 | Natural Environment and Erosion Control | "The City of Brantford will endeavour to reduce impacts to the natural environment and protect against erosion." | • Require the implementation of stormwater management measures to mitigate the impacts of urban runoff on existing streams' stability and to minimize erosion |
| SW.05 | Water Quality | "The City of Brantford, through its stormwater servicing strategy and implementation, endeavours to improve runoff water quality." | • Require the implementation of stormwater management measures to improve storm water runoff quality<br>• The City is to implement operational activities to improve storm water runoff quality |
| SW.06 | Management Responsibility | "The City of Brantford will develop and implement a stormwater management strategy and program that promotes and implements shared responsibility between the City and property owners." | • Stormwater Management is a Shared Responsibility<br>• The City's Future Development Manual and Linear Design Manual set land use restrictions and specify minimum levels of onsite measures and controls |
| SW.07 | Integrated Planning Approach | "The City of Brantford will improve Management of the Stormwater System through Integrated Stormwater Management Planning." | • The City will agree to a comprehensive stepped approach to developing a robust understanding and delivery plan for stormwater management including: development of master drainage plans, subwatershed studies, area specific stormwater management plan, and storm water management reports.<br>• The City will strive to develop sustainable stormwater management practices |

| Policy No. | Policy Area | Policy Statement | Servicing Implications |
|---|---|---|---|
| SW.08 | Separated Wastewater and Stormwater Systems | "The City of Brantford shall plan and maintain separate wastewater and stormwater systems." | • The City will continue to build, maintain and operate separated wastewater and stormwater systems<br>• The City will endeavor, as part of Inflow and Infiltration reduction measures, to identify and remediate existing sanitary sewer cross connections and implement strategies to prevent future Inflow and Infiltration. |

# 4 WATER SYSTEM

## 4.1 Water Level of Service Framework

Based on the MSP vision statement and the identified Policy statements, the following customer service statement for the City's water system was developed to guide the selection of Level of Service objectives and design criteria:

**"To provide an efficient, sustainable, and safe water system that meets regulatory requirements, minimizes service disruptions, and is capable of accommodating growth"**

**Table B-6** outlines the draft water system level of service framework, outlining the water system in terms of technical and customer key performance indicators.

## 4.2 Water System Technical Level of Service Criteria

**Table B-5** summarizes the draft water system technical level of service criteria that will be utilized as the decision-making rationale rated to water system capacity needs and triggers for upgrades.

**Table B-5: Summary of Water Design Criteria**

| Criteria | | Draft Targets |
|---|---|---|
| Water Use | Per Capita Rate | 270 Litres/capita/day (residential and employment) |
| | Max Day Peaking Factor | 1.8 |
| System Performance | Pressures | 40-100 psi |
| | Fire flow | Land use/FUS-lite approach |
| | Velocities | Flag velocities >1.5 m/s<br>Maintain peak velocities <2.0 m/s |
| Facility Capacity | Facility Triggers (supply and pumping) | 80% Planning and Design<br>90% Construction |
| | Water Storage | Total Storage Needs = Balancing + Fire + Emergency<br>Balancing = 25% MDD<br>Fire = Greater of MECP population-based calculation or the highest landuse based FF needs<br>Emergency = 50% of Balancing + Fire<br>* Each PD to be storage self-sufficient |
| | Pumping | Firm capacity = largest pump out of service<br>Firm capacity provides MDD if sufficient storage within PD<br>Firm capacity provides largest of MDD+FF or PHD if insufficient storage within PD<br>*FF needs based on highest landuse based FF within the PD |

**Table B-6: Water Level of Service Objectives**

| Service Objective | Supporting Policy Statements | Technical Objective | Key Performance Indicators - Technical | Key Performance Indicators - Customer |
|---|---|---|---|---|
| Efficient | G.08 W.03 W.10 | • Full life-cycle costing<br>• Renewal of aging infrastructure<br>• Optimization of system operations<br>• Increased water conservation<br>• Non-revenue water is at a reasonable rate | • Water use including non-revenue water rate, per capita rate, peaking factor<br>• Energy consumption<br>• State of Good Repair (SOGR) program<br>• Watermain headlosses and velocities<br>• Facility needs (supply, storage, and pumping) | • Number of complaints (water bills, cost, pressure, quality etc.)<br>• Default rates<br>• Service interruptions<br>• Compliance with MECP Standards |
| Sustainable | G.07 G.11 W.02 | • Full life-cycle costing<br>• Renewal of aging infrastructure<br>• Resiliency to climate change<br>• Costs associated with water servicing fees | • SOGR program<br>• Age of infrastructure<br>• Number of watermain breaks<br>• Replacement/ rehab costs<br>• O&M costs | |
| Safe | G.10 W.01 W.05 W.07 | • Reliability of the distribution system<br>• Safe Drink Water Act requirements<br>• Maintain chlorine residual in distribution system<br>• Provide adequate fire protection | • Water quality including water age, chlorine residuals, flushing rates, and watermain velocities<br>• Water turnover rate in storage facilities<br>• Available fire flow<br>• Emergency storage | |
| Reliable | G.04 G.05 G.10 W.04 W.06 W.07 W.08 W.09 | • Ability to supply adequate pressures and flows, uninterrupted to the distribution system<br>• Ability to meet daily demands<br>• Minimal service interruptions<br>• Facilities have backup power available | • Water system performance including pressures and fire flows<br>• Facility needs (supply, storage, and pumping)<br>• Backup power at facilities<br>• System redundancies | |
| Capacity | G.04 W.06 W.07 W.08 | • Provide adequate, uninterrupted pressures and flows, to the existing and future distribution system<br>• Ability to meet daily demands<br>• Minimal service interruptions | • Water system performance including pressures and fire flows<br>• Facility needs (supply, storage, and pumping | |
| Regulatory | W.04 W.05 W.06 W.11 | • Safe Drinking Water Act<br>• MECP<br>• Ontario Water Resources Act | • Pressure and emergency pressure<br>• Chlorine residuals<br>• Supply capacity | |
| Growth | G.03 W.04 W.07 W.08 | • Rated capacity of facility can support growth<br>• Pressures, fire flow, and water quality are maintained at or above current performance<br>• Projected demands are applied to areas of planned growth | • Water system performance including pressures and fire flows<br>• Facility needs (supply, storage, and pumping)<br>• Water use including rate, per capita rate, peaking factor | |

## 4.3 Water Technical Level of Service Criteria Context

### 4.3.1 Water Use Design Criteria

The basis of the growth water system evaluation relies heavily on water per capita consumption and maximum day demand peaking factors as these design criteria will be used to estimate growth demands. An analysis of historic water treatment plant production and water billing records (2008-2016), as detailed in **Table B-7**, confirmed both a declining trend and that historic values are less than current City of Brantford Linear Design and Construction Manual (2018). In addition to a historic water use analysis, benchmarking, and comparison with municipalities of similar population and geographic location was made for per capita rates and peaking factors. Generally, the existing and revised design criteria are within an acceptable range with other municipalities.

### Table B-7: Historic Water Use

| Year | ADD (MLD) [1] | MDD (MLD) [2] | Per Capita Rate (L/c/d) | Peaking Factor |
|---|---|---|---|---|
| 2008 | 34.3 | 53.6 | 247 | 1.62 |
| 2009 | 33.3 | 48.0 | 238 | 1.49 |
| 2010 | 33.5 | 50.7 | 239 | 1.57 |
| 2011 | 34.2 | 57.5 | 243 | 1.78 |
| 2012 | 36.3 | 56.8 | 256 | 1.68 |
| 2013 | 33.0 | 47.0 | - | 1.42 |
| 2014 | 32.5 | 41.8 | 225 | 1.31 |
| 2015 | 32.2 | 45.2 | 221 | 1.43 |
| 2016 | 32.1 | 46.1 | 218 | 1.47 |
| 2017 | 31.5 | 46.6 | 227 | 1.48 |
| 2018 | 32.9 | 44.7 | 230 | 1.36 |
| 2019 | 33.1 | 47.6 | 225 | 1.44 |
| **Average** | **33.3** | **49.0** | **233** | **1.51** |
| **Historic Design Criteria (2019)** | **-** | **-** | **300** | **2.0** |

[1] Average Day Demand
[2] Maximum Day Demand

The recommended design criteria to be utilized for water use is as follows:

- Growth related per capita rate of 270 L/c/d
    - This represent a decrease in the existing design criteria per capita rates of 10% and is in line with the recommended wastewater per capita rate decrease.
    - The recommended per capita rate remains above the observed historic per capita rate; providing reasonable flexibility in the criteria to accommodate potential changes in future usage rates.
    - While there is an observed decreasing trend in per capita rates, a stepped approach to lowering per capita rates is recommended with the next MSP to ensure water conservation measures are maintained.
- Peaking factor of 1.8
    - This represents a decrease in the existing design criteria maximum day demand peaking factor of 10%.
    - The recommended peaking factor remains above the observed historic 10-year maximum day peaking factor, and above the MECP recommended maximum day peaking factor of 1.65 for a population base between 75,001 to 150,000 or 1.5 for a population based greater than 150,000 (2051 Population); providing reasonable flexibility in the criteria to accommodate potential changes in future usage rates.

### 4.3.2 Starting Point Methodology

The five-year rolling average of average day demands will be used to establish baseline system average day demands. Baseline system max day demand will be calculated using a peaking factor of 1.8.

### 4.3.3 Growth Demand Projections

Future system demands were developed using a starting point methodology, the standard approach within Southern Ontario for projecting future growth demands. Expected demand due to growth was added to the starting point demand to establish future demands. Example is provided below.

2051 ADD = Baseline ADD + (2051 total equ.pop.[2] – 2016 total equ.pop) * 270 L/c/d

[2] Equ. Pop – Total of the combined people and employment population.

### 4.3.4 Hydraulic Performance Criteria

An updated and calibrated hydraulic water model (2019) was utilized in the analysis of existing water system performance. This process detailed existing system performance without the application of growth demands and could be used as a guideline for potential system upgrades.

#### 4.3.4.1 Pressures

Pressures within the existing system, detailed as a percent of the system in **Table B-8**, are typically between 40-100 psi under both average day demand (ADD) and maximum day demand (MDD) scenarios.

Recommended design criteria to be utilized for pressure are as follows:

- Maintain pressure design criteria between 40-100 psi, consistent with the MECP Criteria
- Reduction of the pressure bounds would require system operations modifications and water system upgrades with minimal to moderate benefit

**Table B-8: Existing System Pressures**

| Pressure (psi) | ADD | MDD |
|---|---|---|
| <40 | <1% | <1% |
| 40-50 | <1% | 1% |
| 50-60 | 2% | 25% |
| 60-80 | 44% | 53% |
| 80-90 | 30% | 20% |
| 90-100 | 22% | 1% |
| >100 | 2% | 0% |

#### 4.3.4.2 The Fire Flow – Network Capacity

There is currently an opportunity to define fire flow targets within the existing system and future network as the 2014 MSP did not evaluate fire flows on a local basis and the current design criteria relies on the Fire Underwriters Survey (FUS) for new development only and does not consider impacts on the existing system. Further, the intent of defining these targets:

- Commits a certain level of service for a typical property of a specific land use,
- Provides guidance in the prioritization of the City's State of Good Repair (SOGR) program and clearly identifies upsizing needs, and
- Requires developers to meet City's fire flow targets should they require a higher fire flow based on FUS evaluation

The recommended process of defining fire flow targets is as follows:

- FUS and land use-based approach
- Fire flow at a hydrant is governed by land use with the highest fire flow target
- Due to current uncertainties on the magnitude of water system upgrades as a result of fire flow targets, a sensitivity analysis is to be performed to ensure reasonable targets can be met.

**Table B-9** summarizes the range of recommended fire flows, including typical FUS ranges and hydrants used in the event of a fire, which was subjected to a further sensitivity analysis. In consultation with the City, the High Fire Flow (FF) Scenario target will be used as the Fire Flow target when assessing system capacity.

**Table B-9: Range of Recommended Fire Flow Targets**

| Landuse | Typical FUS Range (L/s) | # of Hydrants | Low FF Scenario(L/s) | High FF Scenario(L/s) |
|---|---|---|---|---|
| Dead End Residential | 27-100 L/s | - | 50 | 50 |
| Single/ Semi Family | 27-162 L/s | 1 | 75 | 75 |
| Townhouse/ Row House | 82-167 L/s | 1-2 | 90 | 125 |
| Multi Family | 117-368 L/s | 2 | 100 | 150 |
| Commercial | 111-185 L/s | 2-3 | 125 | 175 |
| Institutional | 96-334 L/s | 2-3 | 125 | 175 |
| Industrial | 133-299 L/s | 3-4 | 150 | 250 |
| City Center | - | 3 | 150 | 225 |

#### 4.3.4.3 Peak Velocities

The current Design criteria require new watermains to maintain peak velocities, under peak hour conditions, less than 1.5 m/s with peak velocities exceeding 2.0 m/s to be flagged for review. This methodology is to be used to evaluate the existing system. The majority of the system is currently within these bounds, as detailed in **Table B-10**.

**Table B-10: Existing System Peak Velocities**

| Peak Velocity (m/s) | Distribution (<400 mm) | Transmission (≥400 mm) |
|---|---|---|
| <0.5 | 84% | 3% |
| 0.5-1.0 | 9% | 1% |
| 1.0-1.5 | 1% | 1% |
| 1.5-2.0 | <1% | <1% |
| ≥2.0 | <1% | <1% |

#### 4.3.4.4 Water Quality

Based on MECP requirements, the City must maintain total chlorine residuals at 0.25 mg/L; however, as discussed with City staff, there are no existing low residual issues within the City system; as potential problem area are being effectively managed through the City's existing flushing program. The recommended approach to water quality is:

- Water age, as evaluated by the hydraulic water model, is correlated to chlorine residuals
- Areas with high water ages (greater than 98 percentile) will be flagged and reviewed with City staff to confirm any water quality constraints

### 4.3.5 Water Facilities

Evaluation of facility capacities and future needs was assessed first by historic conditions max day demands and further by growth demands using the per capita rate and peaking factor outlined in **Section 2.3.1**. The evaluation of facility capacity using a starting point methodology and applying varying per capita rates and peaking factor to fully assess the sensitivity and impacts of facility needs by changing these criteria.

#### 4.3.5.1 Facility Upgrade Triggers

Industry best practice and recommended methodology for supply and pumping stations facility upgrade triggers are as follows:

- At 80% utilization of a facility's capacity the planning process will begin to assess upgrade capacity needs.
- At 90% utilization of a facility's capacity the construction process begins through either an upgrade to an existing facility or construction of a new facility.

#### 4.3.5.2 Storage Capacity

Potential short-term loss of City raw water supply due to upstream overflow or spill events has been identified as a risk and is a significant concern based on the following high-risk factors:

- Single supply source for the entire City of Brantford
- Frequency of intake closures due to upstream contaminant spill
- Limited raw water storage capacity

As such, evaluated through the Water Treatment Plant Emergency Water Supply and Canal Upgrades Study (AECOM, 2019), a raw storage capacity of two (2) days will be achieved through upgrades to the Holmedale Canal and raw/partially treated tank storage at the WTP was recommended. Further, system storage will be supplemental to raw storage in the event of the listed high-risk factors occurring.

System (treated) storage will be evaluated on a pressure district by pressure district basis using the approach of:

Total Storage = Fire Storage (A) + Equalization Storage (B) + Emergency Storage (C)

- Fire storage (A) needs for water reservoirs will be sized to be the greater of:
  - FUS fire storage need based on the highest land use needs as identified within the pressure district; or,
  - MECP population-based storage requirement
- Equalization Storage (B) to be based on the MECP 25% of maximum day demand to meet peak demands
- Emergency Storage (C) to be based on the 50% of Fire Storage (A) + Equalization Storage (B)

To mitigate against the interruption of supply capacity each Pressure District Fire Storage is to be calculated independently. Storage capacity can supplemented by a second pressure district; however, the City shall maintain enough storage volume in the system to support each pressure district as if it was independently supplied.

#### 4.3.5.3 Pumping Firm Capacity

The evaluation of pumping firm capacities, at both pumping stations and water treatment plant high lift pumps, considered historic and future pumping needs, current firm capacity definition, and storage within a pressure district. The recommended approach in determination of pumping firm capacities is as follows:

- Firm capacity is defined as the largest pump out of service
- The pump capacity shall be sized to provide
  - Max day demands where sufficient elevated storage is available
  - The greater of peak hour demand or max day demand + fire flow where no/insufficient elevated storage is available; further, fire flow needs are based on the highest land use-based fire flow target within the Pressure District

# 5 WASTEWATER SYSTEM

## 5.1 Wastewater Level of Service Framework

Based on the MSP vision statement and the identified Policy statements, the following customer service statement for the City's wastewater system was developed to guide the selection of Level of Service objectives and design criteria:

**"To provide an efficient, sustainable, and reliable wastewater system that minimizes environmental impacts and is capable of accommodating growth"**

**Table B-12** details objectives intended to evaluate the existing and future performance of the wastewater system in terms of technical and customer key performance indicators.

## 5.2 Wastewater System Technical Level of Service Criteria

**Table B-11** summarizes the draft wastewater system technical level of service criteria that will be utilized as the decision-making rationale rated to wastewater system capacity needs and triggers for upgrades.

**Table B-11: Summary of Wastewater Design Criteria**

| Criteria | | Draft Targets |
|---|---|---|
| Wastewater Flows | Per Capita Rate | 245 Litres/capita/day (residential)<br>270 Litres/capita/day (employment) |
| | Peaking Factor | Harmon's Peaking Factor |
| | I/I Allowance | 0.3 L/s/ha |
| Facility Capacity | Facility Triggers | 80% Planning and Design<br>90% Construction |
| | Pumping | Firm capacity<br>• Largest pump out of service (pump capacity); and<br>• Largest forcemain out of service (when multiple forcemains are present)<br>SPS to convey peak 100-year flows<br>New SPS or upgraded SPS, which support growth, to also provide storage to detail 10-year flows for 1 hour |
| System Performance | Peak Wet Weather Design Flows | 10 Year Design Storm |
| | Existing Infrastructure | HGL Target 2.1 m below ground level or d/D <= 1.0 |
| | New/Upgraded Infrastructure | d/D = 0.7 |
| Extraneous Flow Program | | Requirement of the flow monitoring of new developments to ensure development is achieving design flows |

**Table B-12: Wastewater Level of Service Objectives**

| Service Objective | Supporting Policy Statements | | Technical Objective | Key Performance Indicators - Technical | Key Performance Indicators - Customer |
|---|---|---|---|---|---|
| Efficient | G.08 | WW.05<br>WW.08<br>WW.10 | • Full life-cycle costing<br>• Renewal of aging infrastructure<br>• Optimization of system operations<br>• Reduction of inflow and infiltration | • Energy consumption<br>• State of Good Repair (SOGR) program<br>• Pumping capacity (actual vs. design)<br>• Inflow and Infiltration (I/I) flows<br>• Performance of treated sewage<br>• Sewer surcharging during wet weather event | • Number of complaints (water bills, cost, odour, etc.)<br>• Basement flooding (due to extraneous flows)<br>• Default rates<br>• Service interruptions<br>• Compliance with MECP Standards |
| Sustainable | G.07<br>G.11 | WW.02 | • Full life-cycle costing<br>• Renewal of aging infrastructure<br>• Resiliency to climate change<br>• Costs associated with Wastewater servicing fees | • SOGR program<br>• Age of infrastructure<br>• Replacement/rehab costs<br>• O&M costs | |
| Safe | G.10 | WW.01<br>WW.04 | • Compliance with Provincial Water Quality Objectives<br>• Canadian Council of Ministers of the Environment (CCME) Wastewater Effluent Regulations<br>• MECP Guideline F-5-5 & F-5-1 (compliance with Effluent Criteria)<br>• Sewer system meeting capacity targets | • I/I flows<br>• Treatment Plant Capacity<br>• System Combined Sewer Overflow (CSO) Volumes | |
| Reliable | G.04<br>G.05<br>G.10 | WW.05 | • Condition of sewer system (CCTV)<br>• Capacity to meet wastewater production<br>• Minimal service interruptions<br>• Facilities have backup power available | • System capacity is compliant with PACP scores<br>• Percent of system meeting capacity needs<br>• Sewer surcharging during wet weather event | |
| Capacity | G.04 | WW.05<br>WW.06<br>WW.09<br>WW.11 | • Availability to service Urban Boundaries<br>• Minimal service interruptions<br>• Ability to convey growth wastewater production | • Treatment Plant Capacity<br>• Pump Station Capacity<br>• Percent of system meeting capacity needs<br>• Sewer surcharging during wet weather event | |
| Regulatory | | WW.03<br>WW.04<br>WW.07 | • Compliance with Provincial Water Quality Objectives<br>• CCME Wastewater Effluent Regulations<br>• MECP Guideline F-5-5 & F-5-1 (compliance with Effluent Criteria) | • System CSO Volumes<br>• Sewer and forcemain velocities<br>• Pump Station Capacity<br>• Treatment Plant Capacity<br>• Sewer surcharging during wet weather event | |
| Growth | G.03 | WW.06<br>WW.09 | • Rated capacity of facility can support growth (treatment, pumping)<br>• Sewers system can support growth (gravity sewers)<br>• Projected demands are applied to areas of planned growth | • Pump Station Capacity<br>• Treatment Plant Capacity<br>• I/I allowance<br>• Per capita rate<br>• Percent of system meeting capacity needs<br>• Sewer surcharging during wet weather event | |

## 5.3 Wastewater Technical Level of Service Criteria Context

### 5.3.1 Wastewater Use Design Criteria

Wastewater flows are assessed by means of dry weather flows and peak wet weather flow with growth design flows calculated using the following formula:

Peak Design Flow = Dry Weather Flow × Peaking Factor + Infiltration Allowance

To estimate the growth flow per capita rates, extraneous flow allowance, and peaking factors must be defined.

#### 5.3.1.1 Per Capita Rate

Per capita average dry weather flows, as detailed in **Table B-13**, was assessed on a system scale with further analysis using 2017 flow monitoring data. The per capita rates indicate that typical residential and employment per capita rates are generally lower than the existing design criteria on a catchment scale and a system wide scale.

**Table B-13: Historic Wastewater Per Capita Rates**

| Year | Residential Per Capita Rate (L/c/d) | Employment Per Capita Rate (L/c/d) | Combined Per Capita Rate (L/c/d) |
|---|---|---|---|
| 2012 | 219 | 259 | 232 |
| 2013 | - | - | 238 |
| 2014 | 239 | 268 | 244 |
| 2015 | 197 | 227 | 201 |
| 2016 | 214 | 250 | 218 |
| 2017 | 243 | 243 | 263 |
| 2018 | 224 | 244 | 244 |
| 2019 | 222 | 236 | 234 |
| **Average** | **223** | **247** | **234** |
| **Current Design Criteria** | **270** | **300** | **-** |

The recommended design criteria to be utilized for per capita dry weather flows is as follows:

- Growth related residential per capita rate of 245 L/c/d and employment per capita rate of 270 L/c/d
    - This represents a decrease in the existing design criteria per capita rates of 10% and is in line with the recommended water per capita rate decrease.
    - The recommended per capita rate remains above the observed historic per capita rate; providing reasonable flexibility in the criteria to accommodate potential changes in future usage rates.
    - While there is an observed decreasing trend in per capita rates, a stepped approach to lowering per capita rates is recommended with the next MSP to ensure water conservation measures are maintained as wastewater flows are directly correlated with water consumption.

#### 5.3.1.2 Peaking Factor

The City presently utilizes the Harmon's peaking factor approach in their current design criteria, and it is recommended that this approach be maintained. Using 2017 flow monitoring data, observed and design guideline peaking factors were compared where observed peaking factors were lower than design guideline methodology, as detailed in **Table B-14**. Harmon's peaking factor will be used to estimate growth related peak dry weather flows as it provides an additional safety factor in the evaluation of the local system.

**Table B-14: Observed and Harmon's Peaking Factors**

| Flow Monitor | Observed Peaking Factor | Design Guidelines Peaking Factor (Residential) | Design Guidelines Peaking Factor (Employment) |
|---|---|---|---|
| SA03 | 1.95 | 2.86 | 2.97 |
| SA04 | 1.85 | 2.63 | 2.82 |
| SA10 | 1.67 | 3.72 | 3.43 |
| SA11 | 2.19 | 3.65 | 3.59 |
| SA12 | 1.83 | 2.83 | 3.24 |
| SA13 | 1.63 | 2.82 | 2.71 |
| SA14 | 1.83 | 2.85 | 3.15 |
| SA15 | 1.81 | 3.03 | 3.16 |
| SA16 | 1.93 | 3.80 | 3.58 |

#### 5.3.1.3 Extraneous Flow Allowance

Observed wet weather flows, by means of extraneous flows entering the wastewater system, were evaluated based on the 2017 flow monitoring data. This process extrapolated observed extraneous flows to design storms, as detailed in **Table B-15**, such that the performance of the existing wastewater system could be assessed.

**Table B-15: Observed Extraneous Flows**

| Design Storm | Average I/I (L/s/ha) | Min I/I (L/s/ha) | Max I/I (L/s/ha) |
|---|---|---|---|
| 2-Year | 0.22 | 0.08 | 0.41 |
| 5-Year | 0.31 | 0.10 | 0.55 |
| 10-Year | 0.38 | 0.11 | 0.67 |
| 25-Year | 0.46 | 0.13 | 0.81 |
| 50-Year | 0.52 | 0.15 | 0.93 |
| 100-Year | 0.59 | 0.17 | 1.05 |
| **Current Design Criteria** | **0.26** | | |

The recommended design criteria to be utilized for extraneous flow allowance are as follows:

- Recommend extraneous flow allowance for new greenfield and infill development be increased to 0.3 L/s/ha.
- Capacity assessment for existing infrastructure to utilize actual existing peak wet weather flow based on the hydraulic model results.

### 5.3.2 Starting Point Methodology

The five-year rolling average of average day flows will be used to establish baseline system average daily flows.

### 5.3.3 Growth Flow Projections

Future system demands were developed using a starting point methodology, the standard approach within Southern Ontario for projecting future growth flows. Expected flows due to growth were added to the starting point demand to establish future flows. Example below:

2051 ADF = Baseline ADF + (2051 total equ.pop. – 2016 total equ.pop) * 245 L/c/d [3]

[3] Equ. Pop – Total of the combined people and employment population.

### 5.3.4 Wastewater Facility Capacity

Evaluation of facility capacities and future needs were assessed first utilizing peak wet weather flows under historic conditions and further growth demands utilizing the per capita rate, peaking factor, and extraneous flow allowance outlined in **Section 3.1.1**.

#### 5.3.4.1 Facility Upgrade Triggers

Industry best practice, and recommended methodology, for treatment and sewage pumping stations facility upgrade triggers are as follows:

- At 80% utilization of a facility's capacity the planning process will begin to assess upgrade capacity needs.
- At 90% utilization of a facility's capacity the construction process begins through either an upgrade to an existing facility or construction of a new facility.

#### 5.3.4.2 Sewage Pumping Station Capacity

The evaluation of pumping needs considered the inflow to each pumping station for each design storm using the hydraulic wastewater model. The recommended approach in determination of pumping capacities is as follows:

- Firm capacity is defined as the largest pump out of service, utilizing pump performance data where available, and largest forcemain out of service where there are dual forcemains
- 100-year level of service for existing and new sewage pumping facilities – capable of conveying peak 100-year design storm flows.
- 10-year level of service for new facilities and upgraded facilities – capable of providing 1 hour of onsite storage for the 10-year design storm flows.

### 5.3.5 Hydraulic Performance Criteria

An updated and calibrated hydraulic wastewater model (2017) was utilized in the analysis of existing wastewater system performance. This process detailed existing system performance without the application of growth demands and could be used as a guideline for potential system upgrades.

#### 5.3.5.1 Gravity Sewer System Capacity

Sewer surcharging conditions will be defined and assessed when peak system hydraulic grade line (HGL) within a pipe satisfies the following conditions under the 10-year design storm:

- Existing Infrastructure
  - The Hydraulic Grade Line (HGL) in the pipe if the pipe obvert is more than 2.1 meters below grade; or
  - The depth of flow in pipe is equal to or less than the obvert elevation (d/D <= 1) [4];
- New/Upgraded Infrastructure
  - Gravity sewers will achieve a d/D target of 0.7

**Table B-16** details the existing gravity sewer performance.

**Table B-16: Gravity Sewer Performance**

| Design Storm | d/D | | | | |
|---|---|---|---|---|---|
| | <0.5 | 0.5-0.8 | 0.8-1 | >1 | Surcharging <2.1 m |
| DWF | 99% | 0.8% | 0.1% | 0.3% | 0% |
| 2-Year | 90% | 8.2% | 0.6% | 1% | 0% |
| 5-Year | 84% | 12.0% | 1.5% | 2% | 0% |
| 10-Year | 81% | 13.0% | 2.2% | 4% | 0% |
| 25-Year | 78% | 12.4% | 2.9% | 7% | 1% |
| 50-Year | 74% | 12.5% | 3.1% | 10% | 2% |
| 100-Year | 72% | 12.1% | 3.3% | 13% | 3% |

[4] Depth of flow in pipe (d) is equal to or less than the obvert elevation (D)

# 6 STORMWATER SYSTEM

## 6.1 Stormwater Level of Service Framework

Based on the MSP vision statement and the identified Policy statements, the following customer service statement for the City's stormwater system was developed to guide the selection of Level of Service objectives and design criteria:

**"To provide an efficient, sustainable, and reliable stormwater management system that minimizes environmental impacts and protects public health and property"**

**Table B-17** details objectives intended to evaluate the existing and future performance of the stormwater system in terms of technical and customer key performance indicators.

## 6.2 Stormwater System Technical Level of Service Criteria

**Table B-17** summarizes the draft stormwater system technical level of service criteria that will be utilized as the decision-making rationale rated to stormwater system capacity needs and triggers for upgrades.

**Table B-17: Summary of Stormwater Technical Criteria**

| Criteria | | Draft Targets |
|---|---|---|
| Stormwater Flows | Imperviousness % | Parks, Open Space – 35%<br>Low and Medium Density Residential – 65%<br>Downtown, High Density- Residential – 75%<br>Institutional, Commercial – 80%<br>Industrial – 90% |
| | Depression Storage | 1.5 mm for impervious areas<br>3.5 mm for pervious areas |
| | Synthetic Design Storm | 3-hour Chicago (minor system) |
| Sewer System Performance | Design Return Period | 2 or 5 Year – catchment dependent |
| | HGL Target (existing) | Below ground level |
| | d/D Target (new) | $d/D \leq 0.7$ |
| Facility Assessment – Quantity Control/ Erosion Control | Coverage | 100% of outfalls to sensitive watercourses have upstream control or downstream control measures. – All new development to implement appropriate controls to manage post development runoff volumes to the greater of:<br>• Match pre development flows under both minor flow system level of service objective (2 year or 5 year design storm) and 100 year design storm<br>• Capture and manage the first 25 mm of site runoff for erosion control.<br>Meet other water quality obligations applicable to the sub-catchment. |
| Facility Assessment – Quality Control | Coverage (existing) | Minimum 50% of impervious area drains to water quality facility |
| | Coverage (new) | 100% of impervious area drains to water quality facility |
| | Target | 80% Total Suspended Solids (TSS) removal (Typical)<br>70% Total Suspended solids removal (Direct Outfall to Grand River) |
| | Thermal Mitigation | Per Subwatershed Studies or individual studies if a subwatershed study is not available |
| Facility Assessment – Water Balance | | Per Subwatershed Studies or individual studies if a subwatershed study is not available |

**Table B-18: Stormwater Level of Service Objectives**

| Service Objective | Supporting Policy Statements | | Technical Objective | Key Performance Indicators - Technical | Key Performance Indicators - Customer |
|---|---|---|---|---|---|
| Efficient | G.08 | SW.02<br>SW.08 | • Full life-cycle costing<br>• Renewal of aging infrastructure<br>• Optimization of system operations<br>• Source control<br>• Minimize directly connected downspouts | • State of Good Repair (SOGR) program<br>• Performance of existing conveyance and treatment infrastructure<br>• Prevalence of on-site Stormwater Water Management (SWM) controls<br>• Percent of direct connected rooftops | • Number of complaints (cost, flooding, etc.)<br>• Number of basements flooded<br>• Number of road flooding events with or without road closures<br>• Emergency relief cost<br>• Regular cost (property tax) |
| Sustainable | G.07<br>G.11 | SW.02 | • Full life-cycle costing<br>• Renewal of aging infrastructure<br>• Costs associated with obtaining funding | • SOGR program<br>• Age of infrastructure<br>• Replacement/rehab costs<br>• O&M costs | |
| Safe and Reliable | G.04<br>G.05<br>G.07<br>G.10 | SW.01 | • Capacity to meet specified design storm (major and minor systems)<br>• Minimal flooding events<br>• Resiliency to climate change<br>• Condition of sewer system (CCTV)<br>• Minimize cross-connections | • Percent of system meeting capacity needs under minor storm<br>• Percent of system meeting capacity needs under major storm<br>• System's ability to meet performance targets under existing and climate change scenarios<br>• Sufficiency of outlets<br>• Number of cross connections to sanitary system | • Number of complaints (cost, flooding, etc.)<br>• Number of basements flooded<br>• Number of road flooding events with or without road closures<br>• Amount of damage and insurance claims<br>• Emergency relief cost<br>• Regular cost (property tax) |
| Environmental and Regulatory | G.02 | SW.03<br>SW.04<br>SW.05<br>SW.07 | • Compliance with Provincial Water Quality Objectives<br>• Ontario Water Resources Act<br>• MECP Stormwater Planning and Design Guidelines, Future LID Guidelines<br>• Adaptability to the effect of climate change<br>• Water balance and provision of baseflow to streams<br>• Protecting aquatic habitat | • Percent of system with adequate flooding and erosion control practices (stabilization or retention/detention)<br>• Percent of system with adequate water quality treatment<br>• Imperviousness<br>• Prevalence of LIDs/ recharge areas<br>• Pond and OGS sediment removal needs<br>• Critical receiver water quality<br>• Critical receiver stability<br>• Critical receiver ecological changes | • Compliance with MECP Standards<br>• Alignment with Grand River Integrated Water Management Plan<br>• Number of complaints: park/trail and watercourse cleanliness, water quality, sport fisheries<br>• Number of severe weather events |

## 6.3 Climate Change Consideration

Several different approaches have been undertaken by municipalities to account for climate change when evaluating or planning their stormwater management system, including the following:

- Undertake a statistical study to update local intensity-duration-frequency (IDF) parameters based on the most up-to-date precipitation data to determine the current impact of climate change. Where old IDF parameters have been found to be more conservative than the updated parameters (which may occur if the old parameters were calculated form a shorter data set including an extreme storm event), old parameters are retained to implicitly account for future climate change.
- Apply an increase factor (e.g. 15%) to existing IDF parameters based on assumptions regarding the effect of climate change on rainfall depths.
- Utilize modified IDF parameters based on specific local predictions of a global climate model, if available.
- Utilize a more conservative return period when designing new infrastructure (e.g. 10 year storm instead of 5 year storm).

Due to the inherent uncertainty and lack of site-specific information regarding the current and future impact of climate change on the City of Brantford, the recommended approach is as follows:

- Conservative IDF parameters (as included in the new Linear Design Guidelines) and design storms will be used to assess existing storm sewer capacity and design new storm sewers
- Target level of service for storm sewer capacity in existing areas will consider financial and technical feasibility of upgrading deficiencies, and major system evaluation study will be recommended to ensure that storms exceeding minor system capacity can be adequately conveyed to outlets
- During MSP process, alternative approaches will be evaluated based on resiliency to climate change by assessing the solutions capacity to accommodate more conservative return period storms.

## 6.4 Stormwater Technical Level of Service Context

There is no prescribed level of service in the MECP design manual for minor system (storm sewer and ditch) performance. The manual notes that storm sewers are generally sized to convey runoff from storms ranging from 2 year to 10-year return periods, and that during the design phase the Rational Method is typically used to calculate the required capacity of sewers.

The recommended approach to evaluate the existing stormwater system performance is as follows:

- Utilize all-pipes model with catchment characteristics calibrated to observed flow monitoring data and apply 3-hour Chicago design storm of various return periods in existing and post-development scenarios. For growth and intensification areas, subcatchment parameters typical to the type of land use will be applied.
- Recommend major system evaluation study to ensure that storms exceeding minor system capacity can be adequately conveyed to outlets.

New infrastructure in greenfield areas should follow the City of Brantford Linear Design Standards.

### 6.4.1 Flood Plain Areas

A special case for minor system performance involves low lying areas near the Grand River which are protected from high river levels by means of a dike system owned and operated by the Grand River Conservation Authority (GRCA). A system of gates at each storm sewer outlet are manually closed at prescribed water levels according to an internal City protocol to prevent water from the Grand River from passing through the dike. However, the storm sewers in these areas have no outlet during periods when the gates are closed. Level of service during these time periods will be investigated as part of the MSP.

### 6.4.2 Stormwater Hydraulic Performance Criteria

An updated and calibrated hydraulic stormwater model (2017) was utilized in the analysis of existing stormwater system performance. This process detailed existing system performance without the application of growth or climate change and could be used as a guideline for potential system upgrades.

### 6.4.3 Storm Sewer System Capacity

Storm sewer capacity conditions will be defined and assessed when peak system HGL within a pipe satisfies both of the following conditions:

- The depth of flow in pipe is equal to or less than 70% full (d/D<0.7); and,
- The HGL is maintained below the ground surface elevation (i.e. stormwater system surcharges to the road) at either end of each storm sewer.

Level of service, in terms of design storm return period, for the assessment of upgrade triggers is to be subcatchment specific and based on observed performance/ characteristics, providing an appropriate balance of risk and financial feasibility:

- 2 Year level of service selected where poorer performance observed in the model; typically, older areas constructed to older design standards.
- 5 Year level of service selected where better performance observed, so higher level of service is more reasonably achieved; typically, newer areas with more modern design standards and practices and for existing and greenfield employment areas.

However, wherever feasible and does not negatively impact the downstream system performance, the design of new sewers should strive to achieve the 5 Year level of service.

### 6.4.4 Stormwater Facilities

There are several types of stormwater management facilities within the City of Brantford:

- End-of-pipe detention ponds, including dry ponds, wet ponds, and wetlands. Typically designed for quantity control (flooding and/or erosion control) and quality control.
- Oil grit separator (OGS) units; quality control only.
- Infiltration facilities designed to promote groundwater recharge. Implicit quantity and quality control benefits.

The recommended approach is to evaluate the existing stormwater system in terms of coverage, with the required amount of coverage and design criteria for various stormwater management objectives to be subcatchment specific depending on the characteristics of the receiver. 100% of outfalls to sensitive watercourses are to have upstream or downstream control measures unless the subwatershed study confirms that they are not required. Further, direct outfalls to Grand River or Mohawk Lake do not require quantity control, however they do require quality control.

- Existing system coverage requires a minimum of 50% of the impervious areas to be captured and treated via a water quality facility
- New system coverage requires 100% of the impervious area drains to have a water quality facility

Further, each quality control facility is to target an 80% suspended solids removal (to be confirmed by subwatershed studies) and 70% suspended solids removal into the Grand River.

### 6.4.5 New Development Sites

Servicing of new development with the MSP was evaluated using the Standards as outlined below (based on the 2019 version of the City's Linear Design Manual). Approval of future development applications will be subject to the City criteria and policy in place at the time of the application and may differ to those outlined below.

#### 6.4.5.1 Stormwater Runoff and Imperviousness

**Table B-19** details the percent impervious, by land use, that was used by the MSP to evaluate the potential runoff rated from greenfield and infill development.

**Table B-19: Stormwater Perviousness**

| Land use | Percent Impervious |
|---|---|
| Parks and Open Space | 35% |
| Low and Medium Density Residential | 65% |
| Downtown, High Density Residential | 90 |
| Institutional, Commercial | 80% |
| Industrial | 90% |

#### 6.4.5.2 Depression Storage

**Table B-20** summarizes the depression storage that was used by the MSP.

**Table B-20: Depression Storage Recommendation**

| Perviousness | Depression Storage |
|---|---|
| Pervious | 3.5 mm |
| Impervious | 1.5 mm |

#### 6.4.5.3 Flow Control Targets

Unless otherwise stated under area specific stormwater planning studies, new development / redevelopment areas will be expected to manage stormwater runoff to the following criteria:

- Post development peak flow to match pre development peak flow under both minor flow system level of service objective (2 year or 5 year design storm) and 100 year design storm
- Manage post development runoff volumes to the greater of:
    - Match pre development flows under both minor flow system level of service objective (2 year or 5 year design storm) and 100 year design storm
    - Capture and manage the first 25 mm of site runoff for erosion control.
    - Meet other water quality obligations applicable to the sub-catchment.

Further, allowable peak flows will be subject to the available capacity in the downstream minor and major stormwater conveyance systems.

#### 6.4.5.4 Major Flow System

Unless otherwise stated under area specific stormwater planning studies, new development / redevelopment area will require a clearly defined major storm outlet, with adequate capacity, discharging to the City's riverine system, the Grand River, or Mohawk Lake.

C

City of Brantford

# APPENDIX C

UNIT RATES

**Appendix C Table 1:Trenchless construction unit rates for watermains or sanitary sewers**

| Diameter (mm) | Total Unit Cost ($/m) | Diameter (mm) | Total Unit Cost ($/m) | Diameter (mm) | Total Unit Cost ($/m) |
|---|---|---|---|---|---|
| **150** | $1,300 | **500** | $6,450 | **1200** | $10,600 |
| **200** | $1,350 | **525** | $6,500 | **1350** | $11,500 |
| **250** | $1,400 | **600** | $8,000 | **1500** | $12,000 |
| **300** | $1,450 | **675** | $8,100 | **1650** | $12,500 |
| **325** | $1,500 | **750** | $8,200 | **1800** | $13,000 |
| **350** | $1,550 | **825** | $9,800 | **2100** | $14,000 |
| **375** | $6,300 | **900** | $10,000 | **2400** | $14,500 |
| **400** | $6,350 | **975** | $10,200 | **3000** | $16,000 |
| **450** | $6,400 | **1050** | $10,400 | | |

**Anticipated trenchless methodology is as follows:**

- 1350 mm – 3000 mm: Microtunnel or TBM
- 825 mm – 1200 mm: Microtunnel, Auger Boring, Guided Auger Boring
- 375 mm – 750 mm: Axis Guided Boring, Auger Boring, Guided Auger Boring
- 150 mm – 350 mm: Axis Guided Boring, Horizontal Directional Drilling

**Note**: Trenchless Cost estimate table provides estimated high level cost for tunnelling, pipe installation and shafts for ranges of diameter. Tunnelling project costs can vary widely depending on project details that are not fully known at the Master Plan / DC stage (e.g., number of shafts, subsurface conditions, site conditions, contractor preferred tunnelling method, depth, location (urban, greenfield) etc.).

**Appendix C Table 2: Facilities**

| Facility | Total Unit Cost | Unit |
|---|---|---|
| **Reservoirs** - New Construction | $900,000 | ($/ML) |
| **New Water / Sewage Pumping Stations** ≤ 150L/s | $23,000 | ($/L/s) |
| **New Water / Sewage Pumping Stations** > 150 L/s ≤ 600 L/s | $13,000 | ($/L/s) |
| **New Water / Sewage Pumping Stations** > 600 L/s | $11,000 | ($/L/s) |

**Notes**: Unit rate is intended to provide the base construction cost for a basic pumping facility. These costs are not assumed to account for force mains (for WWPS) or overflow storage tanks (WWPS) or unique items such as deep wet wells (WWPS), extensive architectural features or extensive site works.

**Appendix C Table 3: Sanitary sewer unit rates for 5-meter deep open cut construction**

| Diameter | Excavation | | | Granular Bedding | | | Pipe | | | Backfill | | | Subtotal Unit Cost | Restoration (2020 $) | Manhole Allowance | Total Unit Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Volume | Cost | Unit Cost | Volume | Cost | Unit Cost | Supply Cost | Installation (2020 $) | Pipe Supply +Install | Vol | Cost | Unit Cost | | | | |
| (mm) | (m3/m) | ($/m3) | ($/m) | (m3/m) | ($/m3) | ($/m) | ($/m) | ($/m) | ($/m) | (m3/m) | ($/m3) | ($/m) | ($/m) | ($/m) | ($/m) | (2020$/m) |
| **300** | 5.0 | 32 | $ 160 | 1.0 | 67.2 | $ 67 | $ 95 | $ 48 | $ 143 | 4.0 | 14 | $ 56 | $ 427 | $ 115 | $ 110 | $ 651 |
| **375** | 5.5 | 32 | $ 176 | 1.0 | 67.2 | $ 67 | $ 117 | $ 48 | $ 165 | 4.5 | 14 | $ 63 | $ 472 | $ 115 | $ 110 | $ 697 |
| **450** | 6.0 | 32 | $ 192 | 1.1 | 67.2 | $ 74 | $ 151 | $ 48 | $ 199 | 4.9 | 14 | $ 69 | $ 534 | $ 116 | $ 110 | $ 760 |
| **525** | 6.5 | 32 | $ 208 | 1.2 | 67 | $ 81 | $ 182 | $ 48 | $ 230 | 5.3 | 14 | $ 75 | $ 593 | $ 117 | $ 110 | $ 820 |
| **600** | 7.0 | 32 | $ 224 | 1.4 | 67 | $ 94 | $ 240 | $ 48 | $ 288 | 5.6 | 14 | $ 79 | $ 684 | $ 117 | $ 250 | $ 1,052 |
| **675** | 8.5 | 32 | $ 272 | 1.9 | 67 | $ 128 | $ 363 | $ 57 | $ 420 | 6.6 | 14 | $ 93 | $ 912 | $ 132 | $ 250 | $ 1,295 |
| **750** | 9.0 | 32 | $ 288 | 2.0 | 67 | $ 134 | $ 479 | $ 57 | $ 536 | 7.0 | 14 | $ 98 | $ 1,057 | $ 134 | $ 250 | $ 1,440 |
| **825** | 9.5 | 32 | $ 304 | 2.2 | 67 | $ 148 | $ 556 | $ 57 | $ 613 | 7.3 | 14 | $ 103 | $ 1,167 | $ 135 | $ 250 | $ 1,552 |
| **900** | 9.5 | 32 | $ 304 | 2.4 | 67.2 | $ 161 | $ 666 | $ 57 | $ 723 | 7.1 | 14 | $ 100 | $ 1,289 | $ 136 | $ 400 | $ 1,824 |
| **975** | 10.0 | 32 | $ 320 | 2.5 | 67.2 | $ 168 | $ 767 | $ 57 | $ 824 | 7.5 | 14 | $ 105 | $ 1,418 | $ 150 | $ 400 | $ 1,968 |
| **1050** | 11.5 | 32 | $ 368 | 3.1 | 67 | $ 208 | $ 878 | $ 57 | $ 935 | 8.4 | 14 | $ 118 | $ 1,629 | $ 151 | $ 400 | $ 2,181 |
| **1200** | 12.5 | 32 | $ 400 | 3.4 | 67 | $ 228 | $ 1,100 | $ 57 | $ 1,157 | 9.1 | 14 | $ 128 | $ 1,913 | $ 153 | $ 400 | $ 2,467 |
| **1350** | 13.5 | 32 | $ 432 | 3.9 | 67 | $ 262 | $ 1,413 | $ 64 | $ 1,477 | 9.6 | 14 | $ 135 | $ 2,306 | $ 156 | $ 333 | $ 2,795 |
| **1500** | 14.0 | 32 | $ 448 | 4.2 | 67 | $ 282 | $ 1,729 | $ 64 | $ 1,794 | 9.8 | 14 | $ 138 | $ 2,662 | $ 171 | $ 333 | $ 3,166 |
| **1800** | 16.0 | 32 | $ 512 | 5.1 | 67 | $ 343 | $ 2,504 | $ 64 | $ 2,568 | 10.9 | 14 | $ 153 | $ 3,576 | $ 176 | $ 333 | $ 4,085 |
| **2100** | 17.5 | 32 | $ 560 | 6.0 | 67 | $ 403 | $ 3,328 | $ 64 | $ 3,393 | 11.5 | 14 | $ 162 | $ 4,517 | $ 179 | $ 400 | $ 5,097 |
| **2400** | 19.5 | 32 | $ 624 | 7.0 | 67 | $ 470 | $ 4,427 | $ 64 | $ 4,491 | 12.5 | 14 | $ 176 | $ 5,761 | $ 184 | $ 400 | $ 6,345 |
| **3000** | 23.0 | 32 | $ 736 | 9.0 | 67 | $ 605 | $ 6,783 | $ 64 | $ 6,848 | 14.0 | 14 | $ 197 | $ 8,385 | $ 192 | $ 400 | $ 8,977 |

**Appendix C Table 4: Sanitary sewer unit rates for 10-meter deep open cut construction**

| Diameter | Excavation | | | Granular Bedding | | | Pipe | | | Backfill | | | Subtotal Unit Cost | Restoration (2020 $) | Manhole Allowance | Total Unit Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Volume | Cost | Unit Cost | Volume | Cost | Unit Cost | Supply Cost | Installation (2020 $) | Pipe Supply +Install | Vol | Cost | Unit Cost | | | | |
| (mm) | (m3/m) | ($/m3) | ($/m) | (m3/m) | ($/m3) | ($/m) | ($/m) | ($/m) | ($/m) | (m3/m) | ($/m3) | ($/m) | ($/m) | ($/m) | ($/m) | (2020$/m) |
| **300** | 35.0 | 45 | $ 1,575 | 1.0 | 67.2 | $ 67 | $ 95 | $ 48 | $ 143 | 34.0 | 14 | $ 478 | $ 2,263 | $ 211 | $ 200 | $ 2,674 |
| **375** | 36.0 | 45 | $ 1,620 | 1.0 | 67.2 | $ 67 | $ 117 | $ 48 | $ 165 | 35.0 | 14 | $ 492 | $ 2,345 | $ 211 | $ 200 | $ 2,756 |
| **450** | 37.0 | 45 | $ 1,665 | 1.1 | 67.2 | $ 74 | $ 151 | $ 48 | $ 199 | 35.9 | 14 | $ 505 | $ 2,443 | $ 217 | $ 200 | $ 2,860 |
| **525** | 38.0 | 45 | $ 1,710 | 1.2 | 67.2 | $ 81 | $ 182 | $ 48 | $ 230 | 36.8 | 14 | $ 517 | $ 2,538 | $ 217 | $ 200 | $ 2,955 |
| **600** | 39.0 | 45 | $ 1,755 | 1.4 | 67 | $ 94 | $ 240 | $ 48 | $ 288 | 37.6 | 14 | $ 529 | $ 2,665 | $ 219 | $ 350 | $ 3,234 |
| **675** | 42.0 | 45 | $ 1,890 | 1.9 | 67 | $ 128 | $ 363 | $ 57 | $ 420 | 40.1 | 14 | $ 564 | $ 3,001 | $ 221 | $ 350 | $ 3,573 |
| **750** | 43.0 | 45 | $ 1,935 | 2.0 | 67 | $ 134 | $ 479 | $ 57 | $ 536 | 41.0 | 14 | $ 576 | $ 3,182 | $ 225 | $ 350 | $ 3,757 |
| **825** | 44.0 | 45 | $ 1,980 | 2.2 | 67 | $ 148 | $ 556 | $ 57 | $ 613 | 41.8 | 14 | $ 588 | $ 3,328 | $ 233 | $ 350 | $ 3,912 |
| **900** | 44.0 | 45 | $ 1,980 | 2.4 | 67 | $ 161 | $ 666 | $ 57 | $ 723 | 41.6 | 14 | $ 585 | $ 3,450 | $ 236 | $ 600 | $ 4,285 |
| **975** | 45.0 | 45 | $ 2,025 | 2.5 | 67.2 | $ 168 | $ 767 | $ 57 | $ 824 | 42.5 | 14 | $ 598 | $ 3,615 | $ 238 | $ 600 | $ 4,453 |
| **1050** | 48.0 | 45 | $ 2,160 | 3.1 | 67.2 | $ 208 | $ 878 | $ 57 | $ 935 | 44.9 | 14 | $ 631 | $ 3,935 | $ 241 | $ 600 | $ 4,776 |
| **1200** | 50.0 | 45 | $ 2,250 | 3.4 | 67 | $ 228 | $ 1,100 | $ 57 | $ 1,157 | 46.6 | 14 | $ 655 | $ 4,291 | $ 244 | $ 600 | $ 5,134 |
| **1350** | 52.0 | 45 | $ 2,340 | 3.9 | 67 | $ 262 | $ 1,413 | $ 64 | $ 1,477 | 48.1 | 14 | $ 676 | $ 4,755 | $ 244 | $ 567 | $ 5,566 |
| **1500** | 53.0 | 45 | $ 2,385 | 4.2 | 67 | $ 282 | $ 1,729 | $ 64 | $ 1,794 | 48.8 | 14 | $ 686 | $ 5,147 | $ 244 | $ 567 | $ 5,957 |
| **1800** | 57.0 | 45 | $ 2,565 | 5.1 | 67 | $ 343 | $ 2,504 | $ 64 | $ 2,568 | 51.9 | 14 | $ 730 | $ 6,205 | $ 252 | $ 567 | $ 7,024 |
| **2100** | 60.0 | 45 | $ 2,700 | 6.0 | 67 | $ 403 | $ 3,328 | $ 64 | $ 3,393 | 54.0 | 14 | $ 759 | $ 7,255 | $ 266 | $ 733 | $ 8,254 |
| **2400** | 64.0 | 45 | $ 2,880 | 7.0 | 67 | $ 470 | $ 4,427 | $ 64 | $ 4,491 | 57.0 | 14 | $ 801 | $ 8,643 | $ 274 | $ 733 | $ 9,651 |
| **3000** | 71.0 | 45 | $ 3,195 | 9.0 | 67 | $ 605 | $ 6,783 | $ 64 | $ 6,848 | 62.0 | 14 | $ 872 | $ 11,519 | $ 295 | $ 733 | $ 12,548 |

## Appendix C Table 5: Watermain and forcemain unit rates for open cut construction

| Diameter | Excavation | | | Granular Bedding | | | Pipe | | | Backfill | | | Subtotal Unit Cost | Restoration (2020 $) | Total Unit Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Volume | Cost | Unit Cost | Volume | Cost | Unit Cost | Supply Cost | Installation (2020 $) | Pipe Supply +Install | Volume | Cost | Unit Cost | | | |
| (mm) | (m3/m) | ($/m3) | ($/m) | (m3/m) | ($/m3) | ($/m) | ($/m) | ($/m) | ($/m) | (m3/m) | ($/m3) | ($/m) | ($/m) | ($/m) | ($/m) |
| **150** | 2.3 | 32 | $ 72 | 1.0 | 67 | $ 67 | $ 227 | $ 59 | $ 285 | 1.3 | 14 | $ 18 | $ 442 | $ 115 | $ 557 |
| **200** | 3.3 | 32 | $ 104 | 1.0 | 67 | $ 67 | $ 227 | $ 60 | $ 287 | 2.3 | 14 | $ 32 | $ 489 | $ 115 | $ 604 |
| **250** | 4.3 | 32 | $ 136 | 1.1 | 67 | $ 74 | $ 227 | $ 61 | $ 288 | 3.2 | 14 | $ 44 | $ 542 | $ 115 | $ 657 |
| **300** | 5.3 | 32 | $ 168 | 1.2 | 67 | $ 81 | $ 227 | $ 62 | $ 289 | 4.1 | 14 | $ 57 | $ 594 | $ 115 | $ 709 |
| **350** | 5.3 | 32 | $ 168 | 1.4 | 67 | $ 94 | $ 312 | $ 62 | $ 374 | 3.9 | 14 | $ 54 | $ 690 | $ 115 | $ 805 |
| **400** | 5.3 | 32 | $ 168 | 1.9 | 67 | $ 128 | $ 352 | $ 62 | $ 414 | 3.4 | 14 | $ 47 | $ 757 | $ 116 | $ 873 |
| **450** | 5.3 | 32 | $ 168 | 2.0 | 67 | $ 134 | $ 438 | $ 62 | $ 500 | 3.3 | 14 | $ 46 | $ 848 | $ 116 | $ 964 |
| **500** | 6.3 | 32 | $ 202 | 2.2 | 67 | $ 148 | $ 550 | $ 62 | $ 612 | 4.1 | 14 | $ 58 | $ 1,019 | $ 117 | $ 1,136 |
| **600** | 6.3 | 32 | $ 202 | 2.4 | 67 | $ 161 | $ 626 | $ 176 | $ 802 | 3.9 | 14 | $ 55 | $ 1,220 | $ 117 | $ 1,337 |
| **750** | 8.9 | 32 | $ 286 | 2.5 | 67 | $ 168 | $ 680 | $ 176 | $ 856 | 6.4 | 14 | $ 90 | $ 1,399 | $ 134 | $ 1,533 |
| **900** | 13.3 | 32 | $ 426 | 3.1 | 67 | $ 208 | $ 733 | $ 176 | $ 909 | 10.2 | 14 | $ 143 | $ 1,686 | $ 136 | $ 1,822 |
| **1050** | 14.4 | 32 | $ 461 | 3.4 | 67 | $ 228 | $ 940 | $ 205 | $ 1,145 | 11.0 | 14 | $ 155 | $ 1,990 | $ 151 | $ 2,141 |
| **1200** | 16.9 | 32 | $ 542 | 3.9 | 67 | $ 262 | $ 1,148 | $ 239 | $ 1,387 | 13.0 | 14 | $ 183 | $ 2,374 | $ 153 | $ 2,528 |
| **1350** | 20.6 | 32 | $ 660 | 4.2 | 67 | $ 282 | $ 1,418 | $ 328 | $ 1,747 | 16.4 | 14 | $ 231 | $ 2,920 | $ 156 | $ 3,076 |
| **1500** | 22.1 | 32 | $ 706 | 3.1 | 67 | $ 207 | $ 1,689 | $ 376 | $ 2,065 | 19.0 | 14 | $ 267 | $ 3,245 | $ 171 | $ 3,416 |
| **1650** | 23.6 | 32 | $ 756 | 5.1 | 67 | $ 343 | $ 2,024 | $ 411 | $ 2,435 | 18.5 | 14 | $ 260 | $ 3,794 | $ 171 | $ 3,966 |
| **1800** | 27.6 | 32 | $ 882 | 3.5 | 67 | $ 233 | $ 2,359 | $ 431 | $ 2,790 | 24.1 | 14 | $ 339 | $ 4,244 | $ 176 | $ 4,419 |
| **2100** | 30.6 | 32 | $ 980 | 6.0 | 67 | $ 403 | $ 2,658 | $ 431 | $ 3,090 | 24.6 | 14 | $ 346 | $ 4,819 | $ 179 | $ 4,998 |