The Corporation of the City of London

Core Area Servicing Study (CASS): Stormwater

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Executive Summary

In general, the redevelopment of central areas of the City of London will require growth needed infrastructure to be placed in neighborhoods that already have some pre-existing services. Typically, these redevelopment zones are characterized by congested right-of-ways, old buildings and require new infrastructure designed for higher density population loadings with additional impervious areas associated with buildings and parking facilities that are prepared using contemporary Design Criteria. Applying Council adopted policy direction of "growth paying for growth" these infill areas will have infrastructure needs that should be recoverable from the Development Charges Bylaw & Fund.

This report lists the infrastructure projects required to facilitate intensification of the City's core area, explains the modelling of the stormwater drainage system required to meet infill growth needs over the next 20 years, estimates costs of projects, reviews amendments to current growth policies that may be undertaken by the City of London, assigns a financial benefit to existing (BTE) to growth for service replacements, and distributes cost over different growth sectors (Residential, Institutional, Commercial and Industrial; commonly referred to as Res ICI).

Prior to undertaking the creation of the modelling work to estimate the growth impacts of this intensification, the City of London requested AECOM and Watson Associates review how other municipalities have planned and organized the payment for redevelopment in their central core areas. Specifically, we reviewed current City of London technical design parameters and Growth Policies with eight comparator municipalities to ensure best management practices are followed, analyzed other jurisdictions level of service for stormwater distribution systems, and summarized emergent policy needs and requirements for asset management principles laid out within Bill 73. This information is presented in **Tables 1, 2a** and **2b** in **Appendix A**.

Generally, the City of London is similar to comparator municipalities for technical parameters used for design standards and design criteria of the stormwater system and London provides a level of service consistent with other municipalities throughout Ontario with two exceptions:

- The Major system allows for greater maximum ponding depth on roads (therefore, less conservative than other municipalities).
- The runoff coefficient (C) is more sophistically discretized and allows for greater flexibility, with no minimum C for predevelopment conditions (therefore, more conservative than other municipalities)

In review of these variations and comparison to current City of London practices, no significant changes to the existing technical standards have been recommended for adoption by this study.

However, changes to Development Charge and Growth Policies may be undertaken if Municipal Council chooses to:

- Create partitions breaking the City into two or more zones;
- Recognize different levels for local servicing definition for application of funding eligibility under the DC bylaw; and
- Develop a more refined formula for BTE definition to recognize an asset condition of an existing infrastructure element that is not purely aged based are all possible refinements.

Council may wish include these possible refinements when they make amendments during the next DC by-law update study (2019). The proposed 2019 DC by-law amendments are presented in **Table 5** in **Appendix A**.

Our analysis suggested that work performed in the core area trends above other Greenfield projects, based on several City of London tenders for both downtown and Greenfield projects and the 2014 DC estimates by at least 20-50%. This suggests a short fall in funding compared to the mostly Greenfield 2014 DCBS projects. For this reason, we recommend the application of 30% contingency over the traditional 20%, and increasing the Engineering Fee from 15% to 20% used in Greenfield project. Unit rate costs are presented in **Table 3** in **Appendix A**.

An existing conditions storm water model was developed for the study area through this study and existing deficiencies identified. The impact of new growth in built up areas on the existing storm sewer system was then modelled using growth assumptions provided by the City of London Planning staff based on Draft Plan and Site plan applications, development inquires, the Vacant land Inventory and developer assembled parcels.

The modelling exercise provided a comprehensive evaluation of existing and future stormwater infrastructure needs to accommodate the future growth of the Core Area and allows the City of London to identify storm sewer infrastructure upgrades associated with the future residential and non-residential growth in the Core Area for inclusion in the City's Growth Management Implementation Strategy (GMIS), 2019 DC By-Law update study and for capital budgeting purposes; as provided in **Table 4** in **Appendix A**.

In keeping with a focus on Asset Management a new methodology to assign a value to an existing pipe in situ was developed for use as a measure of Benefit to Existing (BTE). Condition ratings were taken from the City of London Asset Management ratings which are compiled based on age, visual inspection of defects, performance factors for pipe pressure and flow.

In the 2014 stormwater DCBS, an age based formula was presented to "value an existing in situ pipe" that was predicated on the assumption that a typical pipes life expectancy is 80 years. However, given the nature of infill development, growth works in the core area will likely replace or supplement existing utilities to meet intensification loading needs. This is different from previous Greenfield growth projects that installed new services in typically unserved areas that were considered in the 2014 DCBS study.

The maximum usable life assumption of 80 years can be exceeded by 20 to 40 years, and a fairly new pipe may have performance issues leading to its premature replacement prior to it reaching 80 years of age. The new valuation uses performance factors that better evaluate the condition of an existing pipe.

The BTE represents an advantage that the City would realize by reduction of future cost by a pipe replacement. The better the condition of the existing pipe the lower the BTE and less of an advantage is assigned. Conversely, the loss of pipe residual life is greater for a pipe in good condition and is represented by (1-BTE). This then captures the fact that a poor performing pipe would have a low condition rating, high BTE and low residual life.

The infrastructure works were reviewed holistically on a system wide basis with alternate routes considered and an implementation plan was developed that coordinates needs of Water Servicing, Sanitary Servicing, Storm Servicing, infrastructure renewal, the Rapid Transit Project and other downtown initiatives (e.g. Dundas Place) that is financially responsible and viable. This staging plan is consistent with the London Plan in terms of development of growth areas.

This report and study is intended to provide the policy changes required for update in the 2019 Development Charge Background Study. Whereby City-staff can apply growth and non-growth splits to projects currently funded by the DC14-WD01002 Infill and Intensification Nodes Storm Servicing noted in the 2014 Development Charge Background Study. Amendment in the 2019 update study is subject to a formal public review process and council adoption.

There are distinct cost savings to both the rate payer and DC reserve funds by undertaking one construction project that is sized appropriately for both growth and the existing user. The extent of Local Servicing policy changes recommended for immediate project funding allocations and for the 2019 DC Study are outlined **Appendix A - Table 5**.

As a means of showing relevancy of the study and potential impacts of draft policy on future developments .A review of several potential on-going publically declared development applications without current status or draft status in the development process (subdivision or site plan) was undertaken. This report estimated the trigger servicing thresholds of these perceived developments on the infrastructure needs suggested by this report. It being noted that exact servicing requirements for these large towers will be submitted by the proponents and reviewed in detail by City staff and will be based on exact size, location zoning and usage of the built form. Variation in servicing needs is expected between the actual development and our servicing need estimated in this is report. The proponent developers are expected not rely upon our work which is solely provided as an illustrative example of how policies, and procedures may be applied and subject to changes and, amendments of the upcoming 2019 Development Charge Background Study.

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Appendices

1. Introduction

The City of London is undertaking the Core Area Servicing Studies (CASS) to determine the infrastructure servicing requirements that will support the City's vision and official plan objectives for the core area of the City. The CASS is the City's first servicing study to evaluate growth-related infrastructure needs associated with infill and intensification in the downtown core area.

CASS comprises of a family of servicing studies that includes water, wastewater and stormwater. These studies will be a critical component in the delivery of the City of London's growth aspirations. AECOM was retained to undertake the stormwater and water components of the CASS. Coordination with the wastewater CASS consultant and several other ongoing/planned City initiatives has been undertaken.

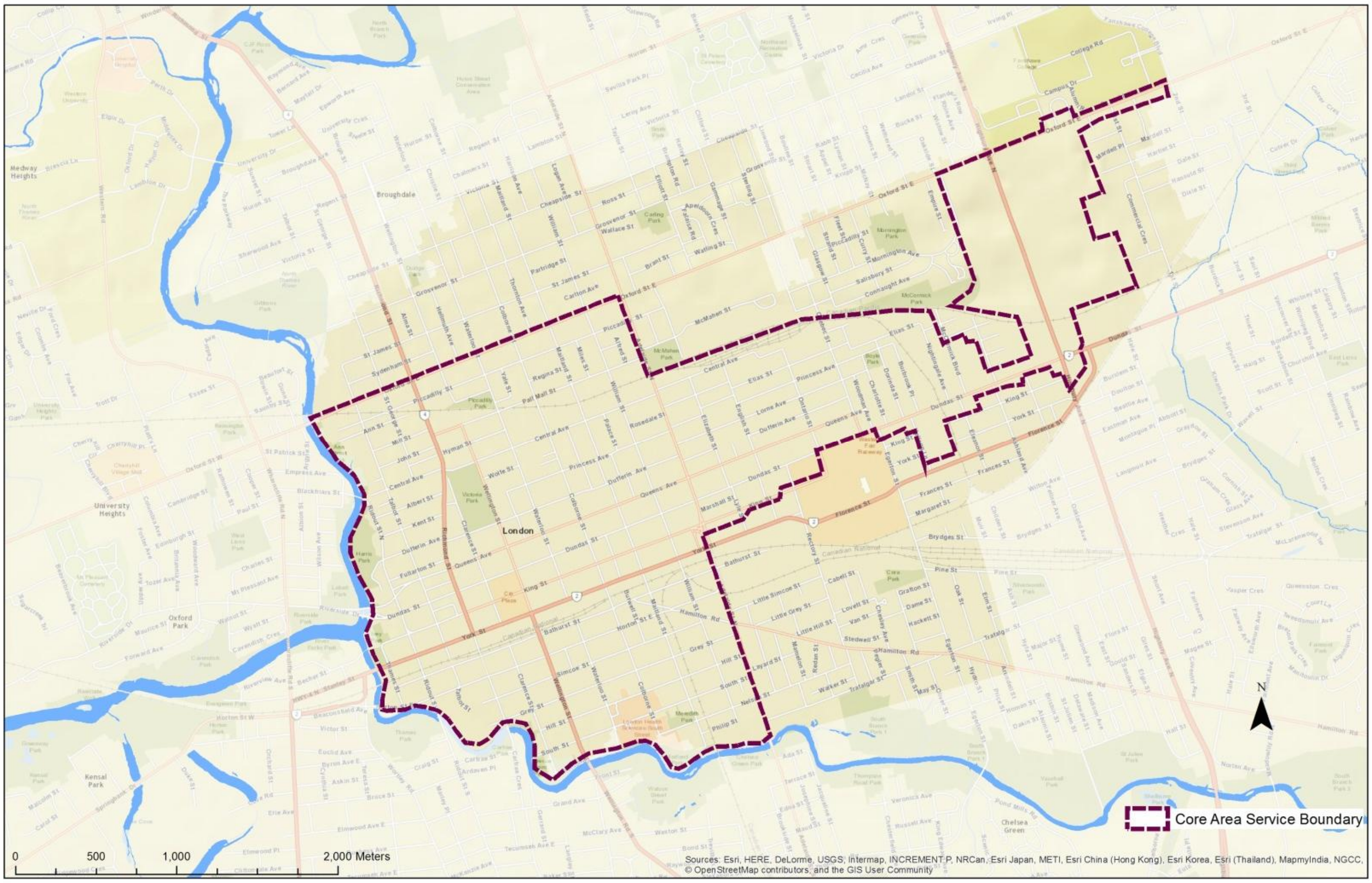
Relevant provincial guidelines and municipal stormwater design criteria have been reviewed as best practice and compared with City of London practices.

To analyze the City of London's Core Area existing stormwater system and recommend improvements, a comprehensive hydraulic model was developed for the study area.

Works required to satisfy future stormwater flow contributions driven by growth over a 20 year period have been identified. Costs have been developed and growth / non-growth determination and Res/ICI allocations have been completed.

Initially, this study was envisioned to cover growth requirements with in a discrete central area defined by certain geographical road and river boundaries as shown in **Figure 1**. Through discussion with stakeholders it was decided to recommend that the suggested amendments to the Development Charges Bylaw & Fund policies could be applied to the existing built boundary. Further refinement of those specific policy changes will be reviewed during the 2019 Development Charges Bylaw which will likely begin in the spring of 2018.

Figure 1: Study Area (Terms of Reference)



1.1 Background

The City of London, like other cities in North America, is undergoing several societal and demographical changes. These changes are leading to a shift in the way it lives, grows, travels, works and plays. The development of new transportation choices both inside, between adjacent cities and new "Smart Growth" design philosophies are changing patterns of development.

On December 3, 2015, the Ontario Ministry of Municipal Affairs and Housing passed Bill 73, "Smart Growth for Our Communities Act, 2015". According to the Ministry, the intent of Bill 73 is to give Ontario's residents a greater say in how their communities grow, provide municipalities with more opportunities to fund growth-related infrastructure and community services, give municipalities more independence to make local decisions and make it easier to resolve disputes. These amendments include the following:

- Requiring municipalities to follow reporting requirements that reflect best practices and detail to the community how money from development charges is spent;
- Requiring municipalities to better integrate how development charges fit with long-term planning;
- Creating clearer reporting requirements for the collection and use of money paid by developers for higher and denser developments, as well as for parkland;
- Making development charges payable at the time the first building permit was issued for a building, or at the beginning of each stage in the case of multi-phased development, so that developers can be certain of the cost;
- Helping municipalities identify and share their best practices on using development charges to address local planning and financial objectives; and,
- Providing for more stringent reporting and greater oversight of any funds or municipal charges on new developments.

Additionally, Bill 73 proposed changes under Section 2 of the Planning Act, in that decision-makers must have regard for matters of provincial interest, including the protection of ecological systems and agricultural resources, the supply, efficient use and conservation of energy and water, and the protection of public health and safety. Bill 73 adds the promotion of built form that is "well-designed, encourages a sense of place, and provides for public spaces that are of high quality, safe, accessible, attractive and vibrant" to this list of matters of provincial interest. This essentially is "Smart Growth" or intensification.

In London, Municipal Council has provided significant direction to staff to embrace these changes to the City's built form and supporting infrastructure through the acceptance of several planning and engineering plans, policies, and programs. As a result, the City of London is well positioned to manage this transition of future growth as it has undertaken the necessary background studies and created policies to ensure that this intensification adheres to a common vision, shaped to enhance the quality of life, health sustainability, and the economic future of its citizens.

This supportive strategic direction of policy change started with:

- 2009 and 2014 Development Charges Background Studies;
- The London Plan;
- The annual update to the Growth Management Implementation Strategy;
- Smart Moves 2030 Transportation Master Plan;
- The Rapid Transit Business Case; and
- The Strategic Plan 2015 to 2019.

The City of London 2015 to 2019 Strategic Plan sets out tangible actions and auditable projects/programs that will be coupled to the new multi-year budget to bring about a higher quality of life in the City. The strategies for Building a Sustainable City set out the City's mandate to manage and improve servicing infrastructure through water and wastewater business plans, and to build new infrastructure as London expands based on the policies of the GMIS and the London Plan. Growing the City's economy is defined in the Strategic Plan through investment in downtown core as the heart of the City, through various design and development plans and infrastructure upgrades.

This CASS stormwater report and two other companion reports are an integral part of this migration towards "smart growth" into the 21st century. These studies will ensure that the existing water, wastewater, and stormwater management systems can accept new loadings brought about by higher growth densities and ensure that growth pays for growth.

1.2 Study Objectives

The primary objectives of the Core Area Servicing Study Stormwater (CASS) is to determine the necessary infrastructure to deliver stormwater servicing for the Core Area of the City, based on ultimate build-out population projections. Subsequently, using the City's growth allocation for the Core Area, establish the phased infrastructure costs for a 20 year period, to 2034. This objective is being achieved through:

- Review Current City of London Policy and design criteria with comparator municipalities to ensure best management practices are followed;
- Provide a comprehensive evaluation of stormwater infrastructure needs to accommodate the future growth of the Core Area in order to provide a basis for future capital budgets;
- Identify Stormwater infrastructure upgrades associated with the future residential and non-residential growth in the Core Area for inclusion in the City's Growth Management Implementation Strategy (GMIS) and for capital budgeting purposes;
- Develop an implementation plan which coordinates needs of water servicing, wastewater servicing, and stormwater servicing with ongoing City initiatives that is financially responsible and viable.
- Assign DC funding to growth-related stormwater infrastructure; and
- Serve as a foundation document/background data for review as part of the City's 2019 Development Charge Master Plan Update and Development Charge Background Study (DCBS), meeting the statutory requirements of the Development Charges Act.

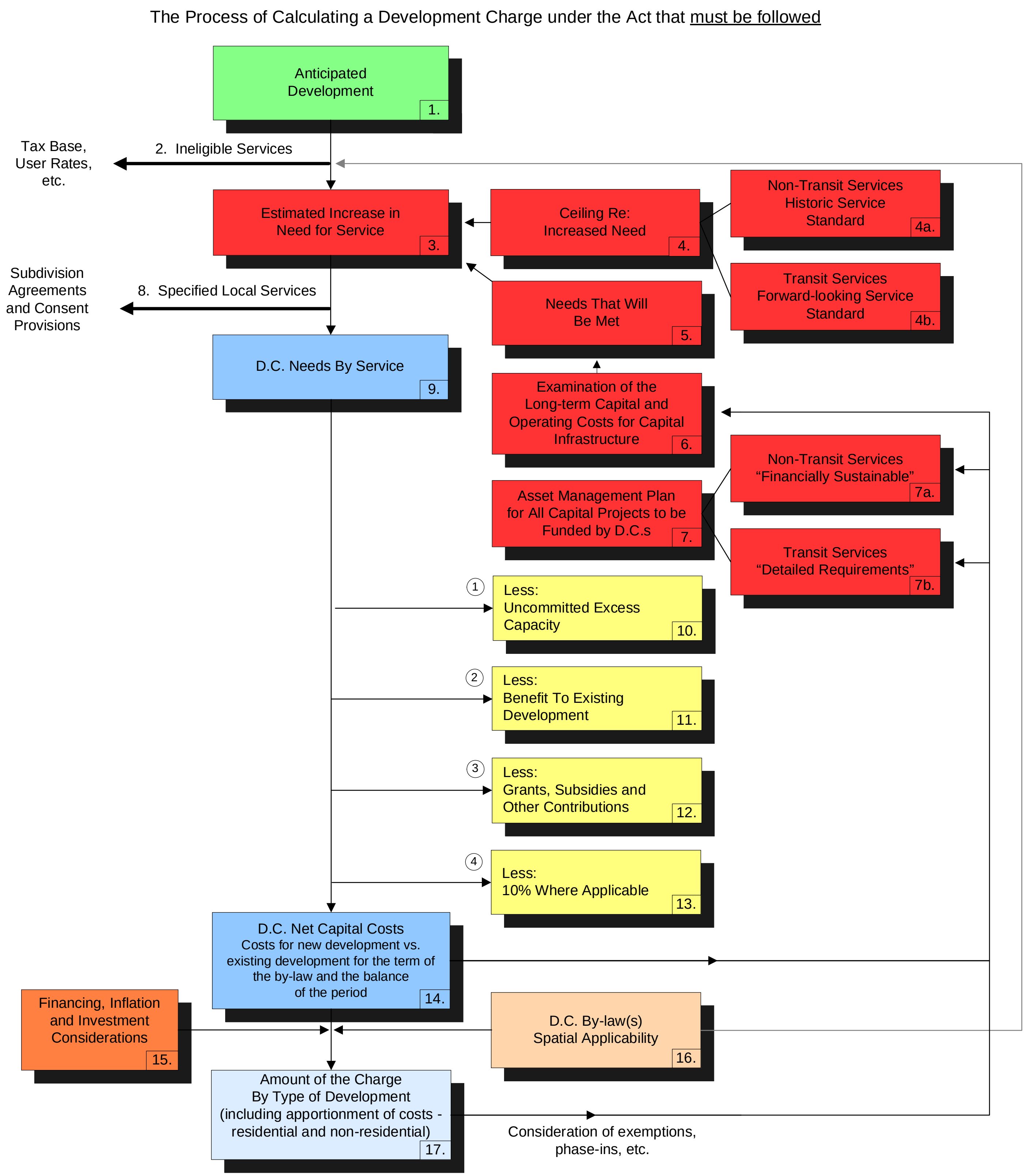
2. Policy Review

2.1 Introduction

The Development Charges Act (DCA) has been in place since 1997 and lays out the regulatory and legislative framework that municipalities in Ontario must follow to levy Development Charges (DC). DC are the primary tool in ensuring that "growth pays for growth" in an equitable manner. The legislation is the result of many years of negotiation with municipalities and developers.

Figure 2 below from the Guelph 2014 Development Charges Background Study (DCBS) outlines the general procedure for calculating a DC under the DCA. The structure guides the municipality through the process, and sets aside areas for definition of municipal policy such as: local servicing, benefit to existing, future growth benefits, and levels of service.

Figure 2: Guelph General Procedure for Calculating DCBS (Watson Associates 2014)



2.2 Existing Development Charges By-law

London specifies its policies or rules in a DCBS and DC By-Laws explicitly. A brief summary of the elements relevant to CASS is provided below.

2.2.1 Local Servicing

A "local service" is defined as an infrastructure asset that is:

- Internal to a development, or
- External to a development, but is needed to support or link to a specific development

Local services are not to be included in the calculation of development charge rates and are considered to be the direct responsibility of the developer (s.59 of the DCA) and shall be recovered under other agreements with the landowner or developer.

In the case of the City of London, all storm sewers required to service growth greater or equal to 1050mm diameter pipe and satisfy a regional benefit are eligible for DCs. If a sewer is identified by the City as strategic and provides regional benefit then any size storm sewer can be considered eligible for DCs. In other cases where storm sewers are not providing regional benefit then storm sewers greater or equal to 1050mm Ø are eligible for DCs.

2.2.2 Growth / Non Growth (benefit to existing)

Municipalities must account for the benefit of growth-related infrastructure to existing development but the DCA does not prescribe a methodology of how this impact is to be calculated. Each municipality develops a different rationale / formulae for defining DC benefit to existing (non-growth splits). The primary considerations involved in establishing an appropriate benefit to existing development deduction include:

- Is the project a capacity expansion, necessary to maintain the existing level of municipal service?
- Is the primary service area municipal-wide, large area or small area and how much growth is located in the relevant area?
- Was the project included in previous DC studies and with what level of deduction?
- Is the capital program well beyond the service level cap and to what extent do these projects benefit existing development (rather than representing oversizing for post period recovery)?
- Does the capital expenditure simply represent more of what is already being provided or does it instead offer a broader range of service?
- What is the estimated value of the service change being provided regarding user proximity, for example?
- Does the project involve a new facility or an existing replacement plus expansion?

Clause .s.5(1) of the Development Charge Act (and associated Regulations) Commentary 6. Requires that a DCBC must have regard for "The increase in the need for service must be reduced by the extent to which an increase in service to meet the increased need would benefit existing development."(BTE)

Most municipalities recognize that existing development benefits from growth via four basic principles brought about by the placement of new services:

- The repair or unexpanded replacement of existing assets;
- An increase in average service level or existing operational efficiency;
- The elimination of a chronic servicing problem not created by growth; and

- Providing services where none previously existed (e.g. stormwater collection service).

In the City of London growth has previously been focused in Greenfield locations and BTE issues were very limited as existing services were not available. The 2014 DCBS was the first study to recognize the potential shift of growth from Greenfield into pre-existing growth areas in the form of intensification

In the previous 2014 DCBS the city brought forward a formula below to consider residual life expectancy, as shown below.

$$\text{Unused Life Credit} = \frac{80 - \text{Age}}{80} \text{ x (Cost of pipe) } [\textit{minimum value} = 0]$$

2.2.3 Residential / Non-Residential Cost Splits

Growth can trigger a requirement for stormwater servicing through changes in or intensification of landuse that could be residential or non-residential (institutional, commercial, and industrial business activity). The changes could increase the imperviousness nature of surfaces resulting in an increase in run-off peak flow rates and volumes that must be managed.

In London the apportionment of cost across each specific growth sector is done using a population and employment growth study. The study predicts the total average demand of each sector and future growth in population and institutional, commercial and industrial business activity. The growth is discretely populated into the City's transportation planning zones.

In general stormwater projects required to meet growth needs are split accordingly across Residential/ Industrial/ Commercial/Institutional sectors as per geographic or service area where changes in impervious values are anticipated.

2.3 Review of Planning Policies

As described previously London specifies its policies or rules in the DCBS and DC By-Laws explicitly; other municipalities provide tables defining the eligible works without explicitly defining the rules of claims. If all works undertaken are City managed tenders then adjustments may not be necessary. However, if some works are developer tendered and constructed then explicit definitions will be an administrative necessity.

To help the City of London compare its DC rationale / formulae a review of how comparator municipalities administer their DC By-Laws has been completed by Watson Associates. The findings of the review are summarized below, further details can be found in Appendix A.

Although a lot of information exists for DC policies and rates within the GTA these were avoided due to the complexity of upper and lower tier responsibility issues and the need to compare overlapping infrastructure networks. Windsor, Ottawa, Barrie, Hamilton, Kitchener, Waterloo, Guelph, and Brantford have been selected as comparator municipalities to London.

2.3.1 Development Charges Incentives

On a province wide basis, there is significant interest in using development charges more strategically. A number of municipalities use local development charges as an incentive for directing land and building development to locations where higher-density growth is desired. This can be achieved through:

- Reductions and exemptions of development charges in areas such as downtown cores, industrial and commercial areas and in transit nodes and corridors; and
- Area-rated development charges that reflect the higher cost of infrastructure needed to service lands that are distantly located outside of higher density, serviced areas.

In a recent consultation exercises undertaken by the province of Ontario, questions were raised over whether this strategy is being fully utilized to achieve intensification in areas such as transit, nodes and corridors. There is general concern that levying development charges halts growth in areas targeted for intensification and that waiving development charges in these areas should be considered to stimulate development.

Of the eight municipalities studied four had subdivided their urban growth areas. Kitchener subdivided into two areas, Ottawa into three, Windsor into two and Barrie into two. Reduction of DC rate is specifically mentioned in their By-law text as follows:

Kitchener

Kitchener is divided using mapping within the DC By-Law into three areas with varying charges applicable to each. Water and Stormwater DC rates are not calculated in the central area, and an industrial subsidy is being phased in, charging 50% of the non-residential rate until 2019. The rate is also subdivided further for outlying rural areas with: 1) Partial Services Suburban Area (no sanitary sewer services) and 2) Partial Services Suburban Area (no sanitary sewer services and no water service).

Ottawa

The Ottawa DC By-Law is subdivided into three areas categories. The categories are: Inside Greenbelt, Outside Greenbelt, and Rural. Additional stormwater charges are included in the City Wide Calculation to cover Area Specific Charges for stormwater works.

Windsor

DC exemption areas are mapped in the DC By-Law. Exemptions exist for industrial development, a brownfield subsidy up to a maximum of 60%, and a residential infill subsidy that provides an incremental subsidy of 25%, 50% and 75% on the linear component of engineered services (i.e. roads, sewers, etc.).

Barrie

The subdividing of the DC By-Law adds an additional stormwater charge to the City Wide Calculation. This covers Area Specific Charges in Greenfield areas for ponds and other stormwater management works.

2.3.2 Local Servicing Definitions

Of the eight municipalities sampled, Hamilton, Guelph, Windsor, and Ottawa specifically provided a Local Servicing policy cutoff for DC funding eligibility with in the DCBS. The DCBS for Kitchener, Waterloo, Brantford and Windsor did not specifically note a local minimum pipe size. However, review of the lists of stormwater infrastructure works in the DCBS showed only regionally strategic trunks mentioned with stream restorations.

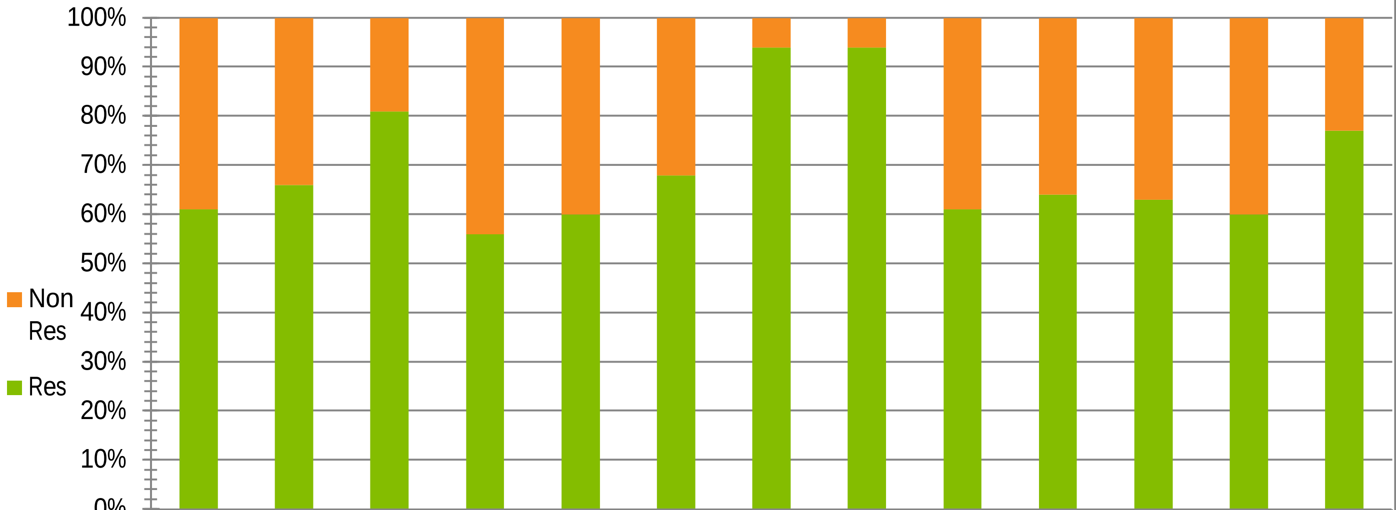
If the intention of the By-Law is to only collect and build what is specifically listed in the tables of the DCBS then an explicit local service definition may not be required. However, if substitution of works or like for like works with overbuilding is expected then a local service definition will be an essential component of and DCBS.

2.3.3 Residential / Non-Residential Cost Splits

Each municipality has its own distinct growth prediction, pipe system and existing patterns of growth for each sector. Direct comparison is somewhat problematic as each municipality is defining its own needs in different ways.

Figure 3: Comparison of Residential / Non-Residential

The City of London's methodology, as described in **Section 2.2.3**, is more sophisticated than most with allocations of specific pipe rationalized as to use.



	London	Hamilton	Kitchener	Waterloo	Guelph	Brantford	Windsor	Windsor Area 1	Ottawa	Ottawa	Ottawa	Barrie Area 1	Barrie Area 2
Non Res	39	34	19	44	40	32	6	6	39	36	37	40	23
Res	61	66	81	56	60	68	94	94	61	64	63	60	77

Municipality

2.3.4 Growth / Non Growth (benefit to existing)

In the current 2014 DC By-Law, the adopted formula assumes a typical pipe life expectancy of 80 years. This approach is commonly used across Ontario by other municipalities. However, there are cases where the maximum usable life assumption can be exceeded by 20 to 40 years. Conversely, a fairly new pipe may have performance issues leading to its premature replacement prior to it reaching 80 years of age.

Given the nature of infill development, growth works in the CASS will likely replace or supplement existing utilities to meet intensification needs. This is different from Greenfield growth projects that install new services in unserved areas. This creates an opportunity to review amendments to the methodologies for assigning benefit to existing (BTE).

Benefit to Existing Factor (BTE Factor)

By using the asset value of a pipe to calculate BTE many different measurement factors, including residual life, are taken into account to establish the performance of a pipe. This approach also aligns more closely with best practices for asset management. **Table 1** below represents a new methodology to assign an asset value to an existing pipe in situ. Condition ratings are taken from the City of London Asset Management ratings and are compiled based on age, visual inspection of defects, and performance factors for the pipe.

The residual life expectancy represents an advantage to the City by the reduction in future pipe replacement costs. The better the condition of the existing pipe, the lower the BTE 1 and less of an advantage is assigned. Conversely, the loss of pipe residual life is greater for a pipe in good condition and is represented by (1 - BTE). This then captures the fact that a poor performing pipe would have a low condition rating, high BTE and low residual life.

Table 1: BTE Factor

Condition	Condition Rating	BTE	Inverse Condition Credit
Very Good	1	0.1	0.9
Good	2	0.25	0.75
Fair	3	0.5	0.5
Poor	4	0.75	0.25
Very Poor	5	0.9	0.1

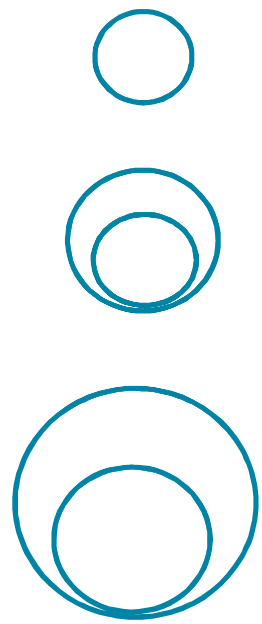
Growth Need (Upsizing)

When service expansion requires pipe upsizing growth needs will be compared with existing system needs. The beneficial contribution of a pipe upsizing due to a growth need is defined as being the removal of an existing deficiency diameter (D2) from the growth need diameter (D3).

Existing – D1 (BTE Factor)

Existing System Improvement (G/ NG) - D2

Growth Need (G/NG) - D3



This approach conservatively does not account for the greater relative flow capacity provided by D3 over D2, thereby assigning more costs as BTE.

Total servicing cost is calculated utilizing the formulas below including pipe, construction, and restoration costs for each portion:

- Total servicing cost = Growth need for service expansion
- Existing system improvement cost = Existing need service expansion

There is a growth and non-growth component for each of the above elements:

- Existing system improvement cost (Non Growth) = Existing system improvement x BTE
- Existing system improvement cost (Growth) = Existing system improvement – Existing Improvement NG
- Upsizing (Growth) = Total servicing cost - Existing System Improvement cost

Combined Sewers

When service improvements to a combined sewer are required BTE will be considered as above but individually applied to the sanitary and storm functions separately and then summed together.

2.4 Recommendations

The nature of the CASS area will require some amendments to the DC-Bylaw. The following suggested edits are recommended for City staff consideration.

- Continued reductions and exemptions of development charges in areas such as downtown cores, industrial and commercial areas and in transit nodes and corridors;
- It is proposed to calculate a residual life expectancy based on asset rating (BTE);
- It is proposed to calculate upsizing by removal of the existing system improvement diameter from the growth need diameter; and
- It is proposed to calculate the total non-growth by considering both residual life expectancy and upsizing.

See **Table 5** in **Appendix A** for proposed DC by-law amendments.

3. Level of Service Review

3.1 Introduction

Stormwater modeling developed through the CASS project will facilitate a greater understanding of flood behaviour in the downtown core area. The modelling will enable the existing conveyance systems response to design storms to be determined. The level of service can then be evaluated for the achievement of City of London and best practice design standards.

3.2 Design Criteria

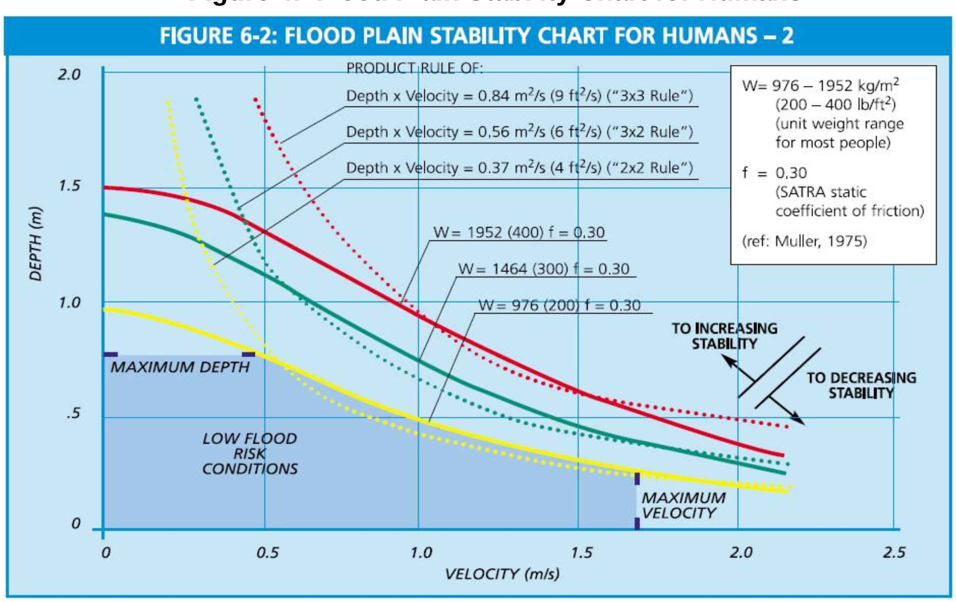
Relevant provincial guidelines and municipal stormwater design criteria have been reviewed as best practice and compared with the City of London practices. Stormwater design guidelines are issued at a provincial level by the Ministry of Natural Resources (MNR), and the Ministry of Environment and Climate Change (MOECC). The City of Toronto and City of Mississauga have been selected for review as they have relatively advanced policies. The findings are outlined below and summarized in **Table 2** in **Appendix A.**

3.2.1 Provincial Agencies

Ministry of Natural Resources (MNR)

The MNR's Technical Guide – River & Stream Systems: Flooding Hazard Limit (2002), flood hazards are reviewed for flood depth (100-year and Regional), as well as for the product of depth x velocity. The depth x velocity product is a standard used to evaluate safe or hazardous access and egress conditions, and generally describes the ability of flow to knock over people attempting to stand in the flow path. **Figure 4** below illustrates describes this flood hazard index.

Figure 4: Flood Plain Stability Chart for Humans



In **Figure 4**, there are several depth and velocity instability rule references. The following points describe these references:

- 3x3 line (Velocity x Depth = 0.84 m2/s) represents a region of instability for most individuals;
- 3x2 line (Velocity x Depth = 0.56 m2/s) represents a region of instability for many individuals; and
- 2x2 line (Velocity X Depth = 0.37 m2/s) represents a region of low risk, and has limits of a maximum depth of 0.8 m and maximum velocity of 1.7 m/s.

Ministry of Environment and Climate Change (MOECC)

MOECC's Stormwater Management Planning & Design Manual (MOE at the time of publication in 2003) provides stormwater management guidelines. Guidance is included for the provision of water quantity control, erosion control, water quality protection and water balance. Guidance is also provided on the selection and design of SWM practices.

Three levels of water quality protection are identified. In addition, the manual recommends the preparation of an Infill Development Plan or Subwatershed Rehabilitation Plan in addressing stormwater quality and quantity concerns associated with infill developments. The applicability of various lot level/source controls, end-of-pipe controls and off-site systems options are also explored in relation to the different kinds of infill development projects.

The MOECC have issued an interpretation bulletin Re: Stormwater Management in February 2015 indicating that:

- Conventional stormwater management practices (pipe and pond) that focus on peak flow mitigation and water quality, do not fully achieve watershed protection due to increased volume of runoff and water balance requirements; and
- Going forward, the Ministry expects that stormwater management plans and Environmental Compliance Approvals (ECAs) will employ LID or other source controls, where practical, feasible and applicable.

The Ministry of the Environment and Climate Change are producing a LID stormwater management guidance document that will:

- Update the 2003 SWM Manual; and
- Specify expectations on water balance, and the role of low impact development within a treatment train approach.

A draft of the document has been circulated that suggest a runoff volume control target equivalent to the 29 mm rainfall event for London will be applied. The preferred hierarchy of controls will include infiltration, filtration, and end of pipe measures.

3.2.2 Combined Sewer Overflows

A combined sewer is designed to collect and convey wastewater and stormwater flows to a pollution control plant for treatment prior to discharge. During wet weather flow conditions the capacity of a combined sewer can be exceeded and untreated flows may be discharged directly to rivers and streams at combined sewer overflow (CSO) locations.

The Ministry of the Environment and Climate Change (MOECC) regulates the permissible volume of CSO discharges through its F-5-5 procedure. Requiring capture and treatment of all dry weather flow for an average year plus 90% of the Wet Weather flow during the April to October season.

No new combined sewers are being constructed in the City of London. The City of London has a program to separate storm and sanitary sewer through local improvement works and to address MOECC F-5-5 requirements.

3.2.3 Municipalities

Municipalities generally provide specific stormwater management design criteria and level of service targets applicable to municipally owned property and infrastructure and development applications.

City of London

City of London's Design Specifications and Requirements Manual (2017) provides the basis for the design of municipal construction projects and works intended for assumption by the City of London. It includes the design criteria and requirements for storm sewer collection systems and stormwater management facilities. **Table 2** in **Appendix A** summarizes selected design requirements outlined in the manual.

City of Toronto

Storm sewer and stormwater management facility targets and design criteria are outlined in two policy documents: Design Criteria for Sewers and Watermains (2009) and Wet Weather Flow Management (WWFM) Guidelines (2006). The former provides design criteria for storm sewer systems, whereas the latter is more focused on stormwater management. The WWFM Guidelines also include specific stormwater management requirements regarding infill and re-development projects. **Table 2** in **Appendix A** summarizes selected design requirements outlined in these documents.

City of Mississauga

The City of Mississauga's Development Requirement Manual (2009) provides general design requirements for storm sewers and stormwater management. **Table 2** in **Appendix A** summarizes selected design requirements outlined in the manual.

3.2.4 Comparing Levels of Service

The findings of the level of service review are contained in **Table 2** in **Appendix A** and the most pertinent elements are summarized below.

Storm Conveyance Design Criteria

The Cities of Mississauga and Toronto both have variable design standards for the minor system, varying from the 2-year to 10-year event for local storm sewers and up to the 25-year for trunk storm sewers. The City of London applies the 2-year design event utilizing synthetic IDF curves that approximates a 5-year historical IDF design event.

The Rational method is universally used across all three. Each has their own set of Intensity, Duration, Frequency (IDF) curves, and a slight variation in runoff coefficients. The City of London requirement of "no minimum C" and matching to pre-development peak runoff rates is the most stringent standard.

London has a less stringent standard for maximum ponding depth at 0.3 m for the major system, however it is noted that the design storm is greater.

Stormwater Management Design Criteria

Various different models are used by each of the Cities for stormwater management design. The selection of storm distributions and modelling methodology appear to be more prescriptive in the City of London standards. However, based on AECOM's experience with the City of Toronto, in practice their requirements for InfoWorks modelling and specification of parameters are the most stringent.

Stormwater management targets are specified for control of quantity, water balance, water quality, and erosion. In the City of London and Mississauga these targets are set at a subwatershed study or master drainage plan level and the requirements are consistent with provincial policy. The City of Toronto also defers to subwatershed and sewershed level guidance, however in the absence of those studies more stringent generic requirements are in place.

The City of London Private Permanent Systems (PPS) policy requires the use of on-site stormwater management controls that is consistent with the City of Toronto. However, the City of Toronto strongly encourages LID and includes requirements that can only be achieved through LID practices such as infiltration. The MOECC are moving in the direction of water balance and filtration requirements that will require the incorporation of LID and treatment trains to facilitate ECA approvals. The City of London may consider revamping the PPS policy to align with the MOECC guidance and new manual when it is issued. The City of London design criteria will need to consider LID where it affects, road cross-sections, utility allocations, landscaping and maintenance.

3.3 Development Charges

The Development Charges Act provides guidance on the allocation of the increase in the level of service attributed to growth or non-growth (benefit to existing). The existing level of service is defined as the average level of that service provided in the Municipality over the 10-year period immediately preceding the preparation of the background study.

Historic ten-year average service levels thus form the basis for development charges. A review of the City's capital service levels for infrastructure has been prepared in many previous DCBS for the calculation so that the portion of future capital projects that may be included in the development charge can be determined.

Work within the CASS is no different functionally than previous DCBS undertakings. Water mains and appurtenances, road work, sanitary sewers, stormwater management facilities and storm pipes have long been undertaken. A review of comparator municipalities shows similar trends in calculation of Levels of service.

3.4 Recommendations

The level of service policy review determined that the City of London has a comprehensive set of guidelines. The guidelines are relatively consistent with the City of Toronto and City of Mississauga and defer to subwatershed criteria for specific guidance.

The City may consider:

- Revamping the PPS policy to align with the MOECC guidance and new LID design manual when it is issued; and
- The City may wish to seek further guidance from the province on an appropriate strategy for the consideration of climate change.

4. Cost Review

4.1 Introduction

The cost of CASS stormwater projects were generated using three independent sources. Namely, first principles for pipes using supplier information, previous City tenders, and historic benchmark costs from previous DC master plan and Growth studies.

Past City of London and area tenders, including 2014 / 2015 projects were provide by Wastewater and Drainage Engineering (WADE) Division. Unit costs for linear infrastructure where isolated from other items such as: large lump sum items, architectural elements, road works, sewers, bonding, mobilization, and insurance. Front ending and weighted bias was also removed from individual tenders.

Comparison to historical DC tender unit items were made in a graphical manner, isolating high and low statistical outliers and increase to proposed Unit Rates were compared to relevant Statscan Indices to show reasonability.

Independent cost estimates were created by aggregating items using RSMeans data bases and publications. This data came from construction costs in other similar Canadian markets.

Technically this study reviewed the applicability of a variable unit rate table to predict cost based upon components such as; pipe material, pipe size, depth, restoration, engineering fees, construction contingencies, construction complexity, availability of contractors within the labor market, need for shoring, vibration studies, pedestrian protection, night work and working around other utilities requiring support, relocation and / or isolation.

For consistency with the future DCBS, cost were prorated to 2017 prices using an extrapolation of 3% for Q3, and Q4 of 2016. Unit rate costs for storm sewers are presented in **Table 3** in **Appendix A.**

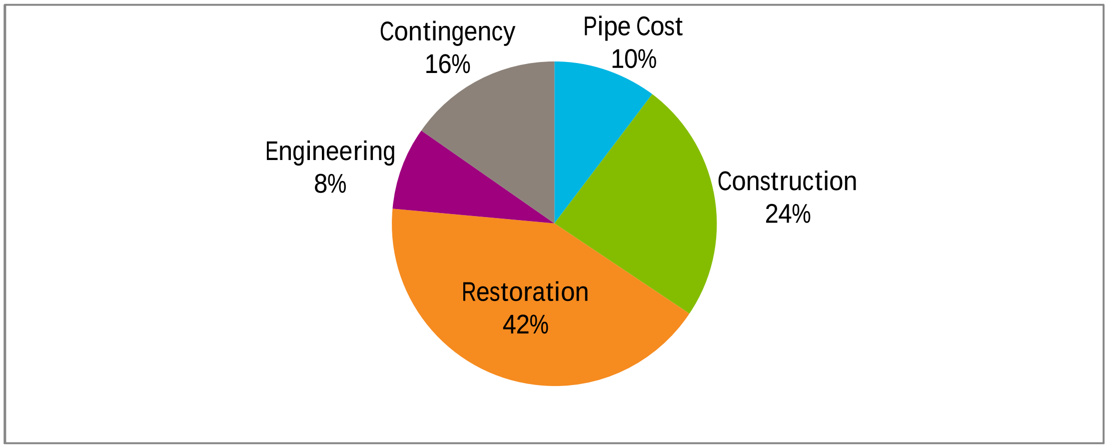
4.2 Previous Studies

Previous servicing studies, master plans and development charge studies have generated the cost of projects based on a combination of six factors;

- Raw pipe sizing used to convey theoretical flows;
- Pipe Material;
- Construction depth;
- Restoration simplified into 5 types (open, landscaped, rural, urban, ecosystem);
- Engineering; and
- Contingency.

In the 2014 Stormwater Servicing DCBS the costs range from between $905 / m to $3,140 / m and are individually generated based upon each projects location. Typically, the impact of the six cost inputs fall within the range as shown in **Figure 5** below. Variation in cost distribution occurs from site to site. In this example the raw pipe cost of a 400 mm concrete pipe in an urban setting contributes less than 10% to the total cost of projects. However, it is noted that the cost of a larger diameter storm sewer would slightly modify the relative contribution of the pipe costs.

Figure 5: Typical Cost Breakdown for a 400mm Concrete Pipe in Urban Setting in the Previous DC Study



It can also be seen in **Figure 5** that restoration and construction costs are the two most significant factors contributing to a combined 66% share of the typical project cost in an urban setting. The cost of construction for "new" services in the Downtown Core specifically at intersections may be significantly more expensive than similarly sized previously envisioned "Greenfield" situations.

4.3 Tenders

Ten tender submissions have been used for the comparison as listed below:

Greenfield in Nature Outside of Downtown: Hyde Park Phase 2, Local Improvement from Eastgate Crescent and Perkins Road (T16-69 2016), Sarnia/Wonderland/Sleightholme Road

Downtown & Similar to CASS : Dufferin Avenue between Wellington and Richmond (T15-21), Life Cycle Renewal Contract D Adelaide St South of Dundas, Wellington Road /Hill / South Street, Nelson / Colborne, Bond Street (T16-08), Raywood Avenue, Alexandra Street and Lincoln Place, and T16-69 Phyliss & Rachel Street.

Approximately 14,000 m of piped network was used in the analysis and comparison graphs prepared for stormwater and water costs per meter of pipe. These graphs have not been used to justify a specific unit rate increase, but to illustrate the presence of the additional complexities in downtown projects and associated cost impacts. The followings assumptions have been incorporated into the generation of the graphs:

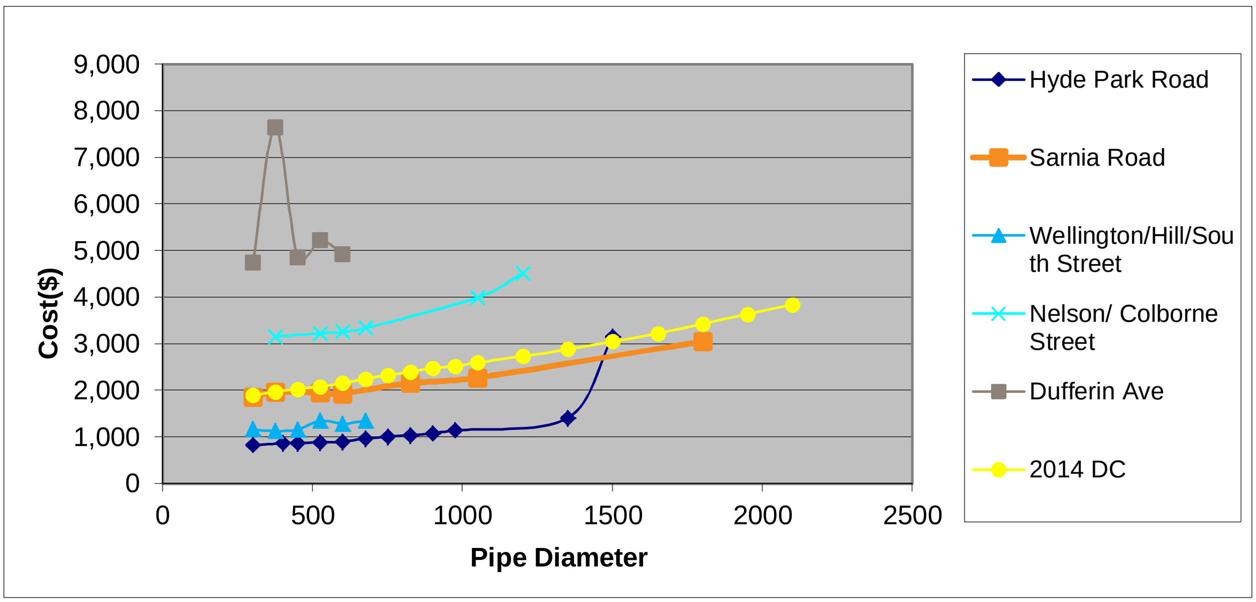
- Restoration costs were reduced and split 50/50 with transportation when additional road widenings were under taken;
- Electrical and pump station costs were removed from tenders with no distribution;

- Sanitary, stormwater and water utility splits for residual restoration cost is based upon length of service on each construction project;
- Each individual pipe size was attributed a restoration cost within its service based upon its total accumulated length; and
- The depth of each individual pipe was not considered. However, this would have been a significant factor and is considered in the 2014 DCBS and will be considered in the CASS.

Review of the comparison graphs suggests that most of the projects studied are more expensive than the 2014 DCBS rate. Two significant projects that fall below the 2014 DCBS on the graphs are Wellington/Hill/South and Hyde Park Road. These projects are likely lower in cost due to the fact that one was built outside the CASS and both had large economies of scale with combination of roadworks and underground services leading to the sharing of restoration costs across multiple services.

For the other eight projects the graph suggests a short fall in funding compared to the mostly “green field“ 2014 DCBS numbers and reinforces **Figure 5** graphics with restoration approximating 50 to 60% of the total project costs.

Figure 6: Stormwater Comparison



4.4 Contingency

Cost estimates prepared in the master planning and DC phase of project development are typically in a time range of 10 to 20 years from project award. The projects are usually characterized by a great deal of uncertainty due to low scope definition. Typically these cost estimates include an amount as contingency in the project cost estimate to cover costs due to unidentified or unquantified risks during project development.

Many technical papers and studies that have been developed by federal agencies and road authorities recommend a sliding scale for estimating contingency on projects taking into consideration the effect of major factors, such as project complexity. Sliding scale contingencies are typically developed for three levels of project complexity: noncomplex (minor), moderately complex, and most complex (major) projects.

Given the amount of uncertainty and complexity of working with within the CASS. We recommend that a 30% contingency be applied across all projects in CASS.

4.5 Engineering Fees

The changes brought about by undertaking the works above in a congested urban environment will require more engineering effort. The increase in cost due to the each individual item increases the allowance through application of a 15% engineering fee will likely not be enough to capture the total required. Application of a 20% engineering fee to the projects total cost is suggested.

4.6 Recommendations

The cost of construction for "new" services in the downtown core specifically will likely significantly more expensive than similarly sized previously envisioned "greenfield" situations. The increase in costs is due to greater uncertainty and complexity. It is recommended that staff consider:

- Application of a 30% contingency to the projects total cost; and
- Application of a 20% engineering to the projects total cost.

5. Modelling

5.1 Introduction

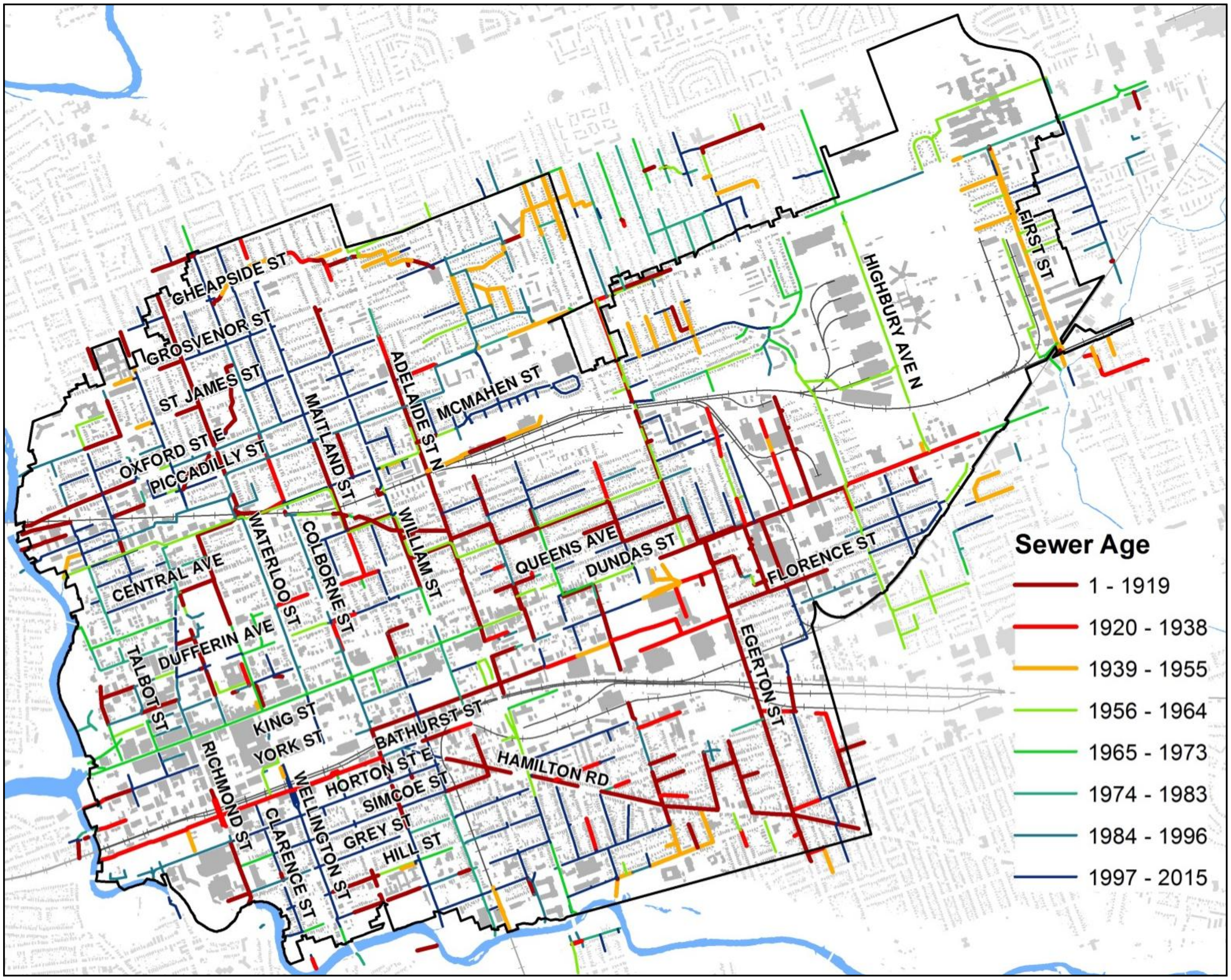
To analyze the City of London's Core Area existing stormwater system and recommend improvements, a comprehensive model was developed for the study area. This model provides an understanding of the hydrologic response to rainfall within the area and the hydraulics associated with the collection and overflow systems. The Innovyze InfoWorks model was used for this analysis.

The extent of the modeled storm sewers and the study area are shown in **Figure 7**.

Figure 7: Study Area Stormsewers

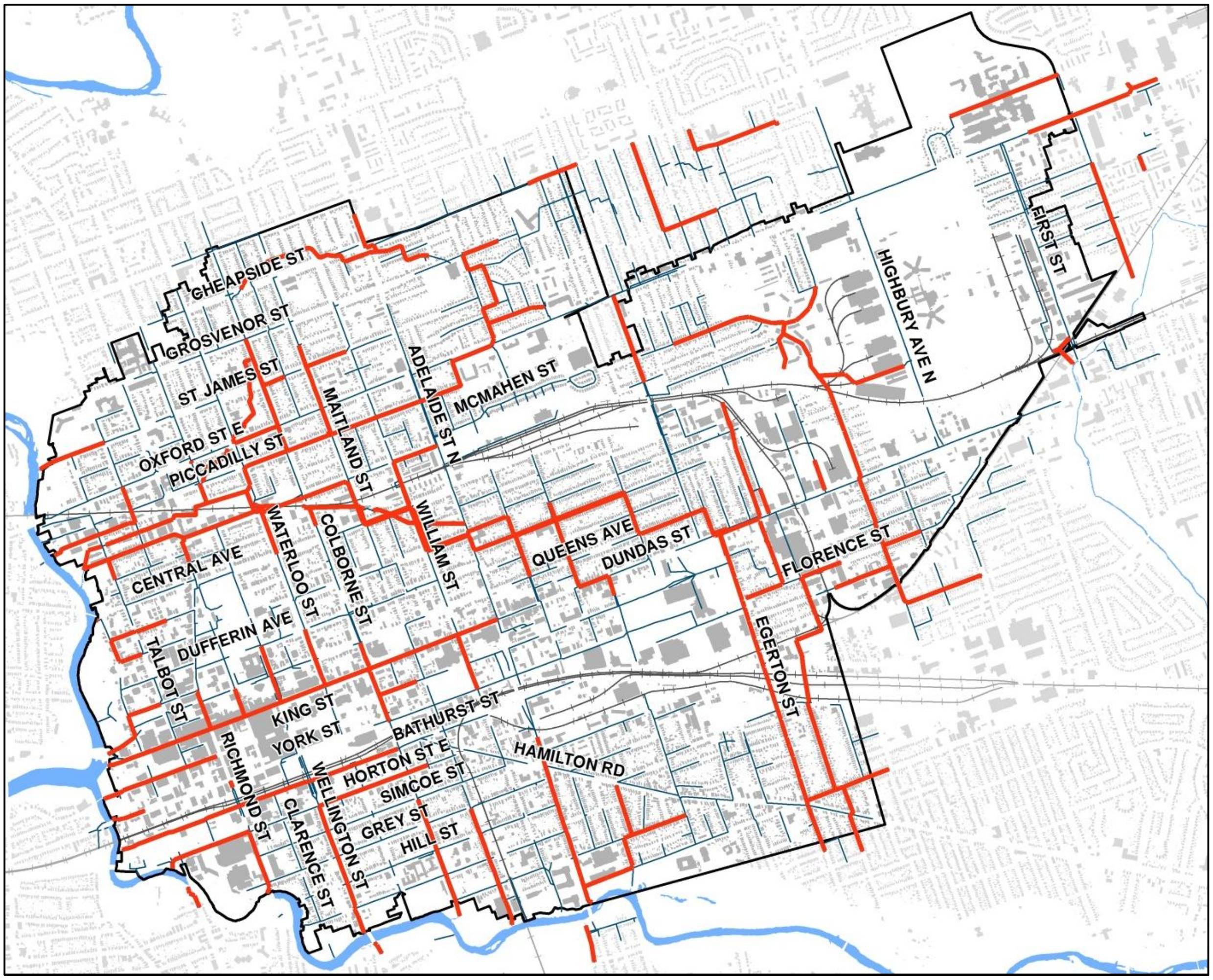
The age of storm sewers in the CASS was reviewed to provide context with respect to residual life expectancy, refer to **Figure 8**. The storm sewers highlighted in red are approximately 100 years old and may have exceeded an expected life of 80 years.

Figure 8:Storm Sewer Age



Storm sewers greater than 900 mm diameter where reviewed to consider the applicability of current DC oversizing policy for sewers 1050 mm and greater, refer to **Figure 9**.

Figure 9: Storm Sewer Trunks greater than 900 mm



5.2 Model Development

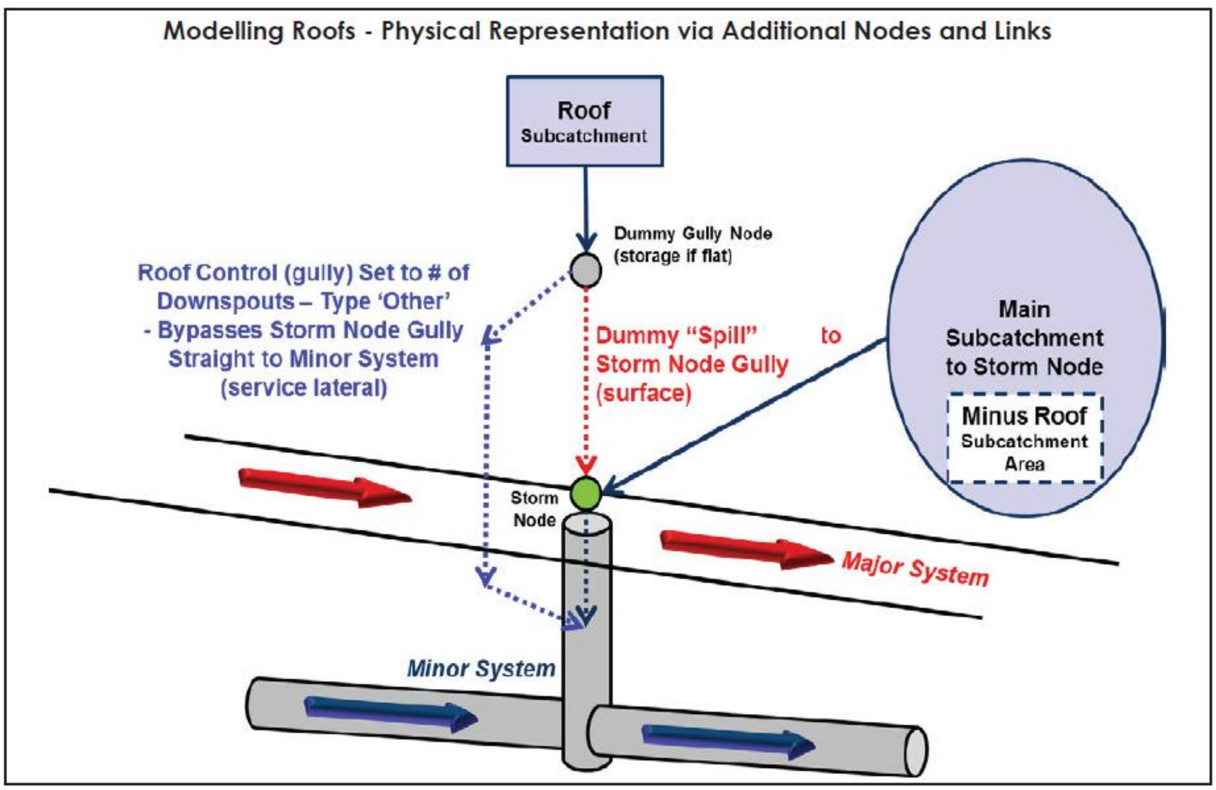
The development of the InfoWorks model consisted of the following phases:

- Collection of data to support model construction;
- Hydraulic model construction, including pipes, maintenance holes, catchbasins, and roof direct connections; and
- Hydrologic model construction including catchment surface runoff characteristics (imperviousness, soil conditions).

A "dual drainage" model was constructed, using all existing storm pipes in the model. Storm runoff originates in the defined catchments, which typically drain to the road surface. From the road, a portion of the overland flow is captured by catchbasins, represented as 'gullies' in the InfoWorks model. The captured flow is conveyed by the gullies to the storm sewers in the model, while the portion of the surface flow that exceeds the catchbasin inlet capacity continues to flow along the overland flow network to the next downstream node.

AECOM further defined the model hydrology by splitting the storm catchments into roof areas, and non-roof areas. This is especially important, given the prevalence of flat roofs in the core area; flat roofs are directly connected to storm sewers, while sloped roofs drain to the surface, where drainage is eventually directed to gullies on the road.

Figure 10: InfoWorks Modeling Strategy



5.3 Data Collection

5.3.1 Level Monitoring

This section summarizes the assessment and conclusions for level gauges installed in the study area, including evaluation of nearby rainfall gauges and identification of storm events suitable for verifying flow in the model vs. actual flow in the storm sewers.

Level monitoring was completed at several sites in the study area as part of this study to determine flow in the storm sewers for observed rainfall events. The monitoring program was performed during the period of August 2016 to January 2017 with pressure transducers (recording level) mounted in manholes in the storm sewers to measure depth relative to the pipe invert. Recorded data, in conjunction with the physical pipe characteristics (e.g. shape, size, slope), were used to calculate average velocity and flow rate. This data is used to:

- Monitor water depths in the stormwater collection system for service improvement; and
- Provide data to verify the CASS's stormwater model.

In total, AECOM measured depth at 6 specific and useful locations in the core area. The location and drainage area of the monitoring stations are shown in **Table 2** and **Figure 11**.

These sites were selected from the core area to be significant for development and calibration of the model. A total of approximately 490 hectares of Core Area was gauged in this study.

Three level gauges were located downstream of one of the other monitors:

- Talbot Street-8G266 was located downstream of Richmond-8G199;
- Mill Street-8G139 was located downstream of Pall Mall-8G0031 ; and
- Ridout-6G83 was located downstream of Fullarton-6G135.

Therefore, drainage area of station Talbot Street-8G266 includes the drainage area of station Richmond-8G199. This improved the peak flow estimate by providing a measured hydraulic gradient in each reach.

5.3.2 Monitoring Results

The results of the flow monitoring are provided in **Table 2**. **Table 2** summarizes the peak runoff rates and volumetric runoff calculated based on the rating curve from InfoWorks at each of the six storm monitoring stations for the selected storm events.

The monitoring stations yield higher runoff volumes during larger events, as expected. Smaller events, however, show greater variability due to the impacts of antecedent moisture conditions. Larger events are more predictable in terms of runoff response and were used for model validation.

Depth measurements suggest the following system capacity constraints that start to manifest during large rainfall events:

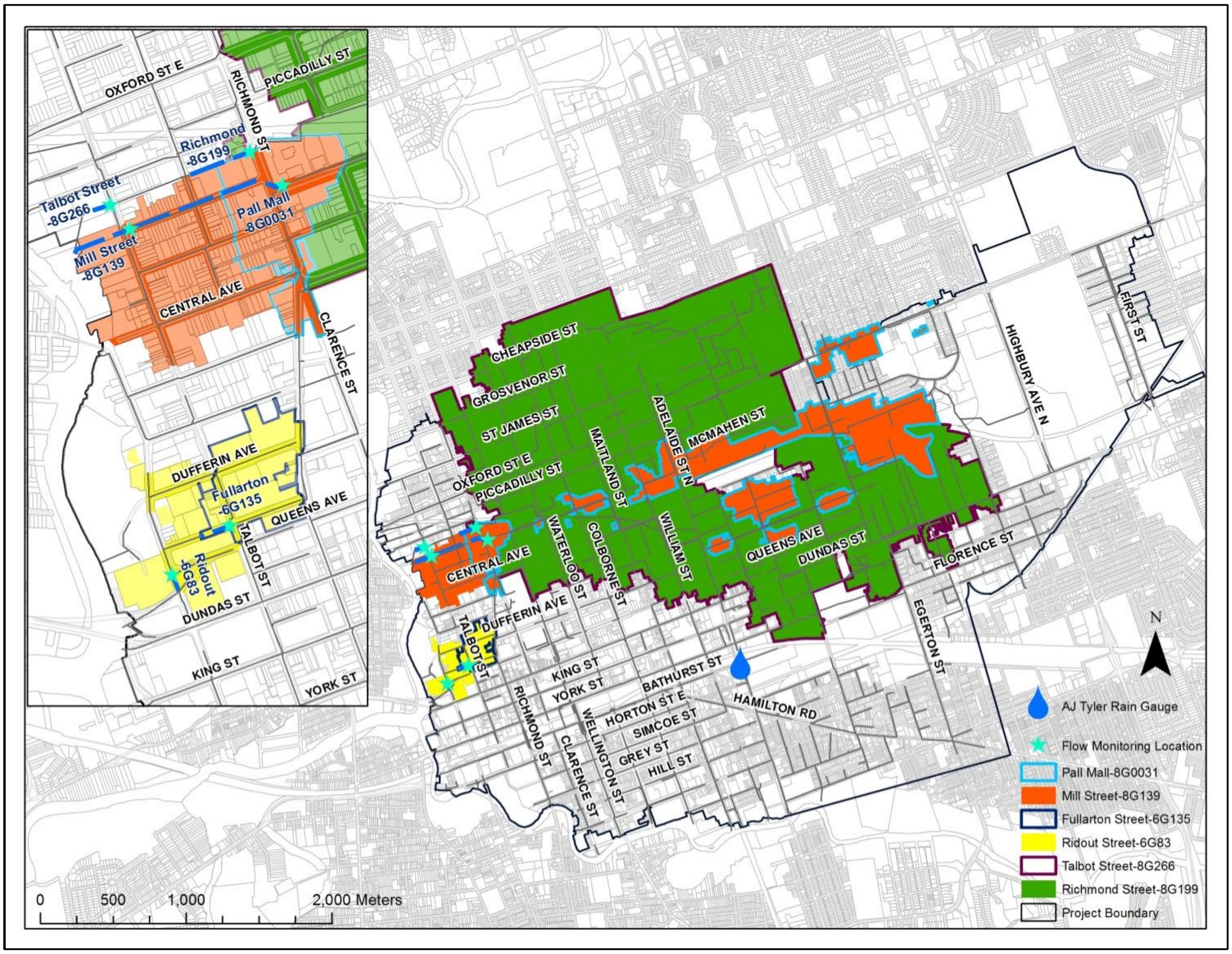
- Talbot Street-8G266 monitor measured depth and was located on Talbot Street. Surcharges during the August 13 event, with a maximum surcharge depth of 0.4 m above the obvert of the 1.5 m storm sewer.

- Mill Street-8G139 surcharges during the August 13 event, with a maximum surcharge depth of 0.2 m above the obvert of the 1.8 m storm sewer.
- Richmond-8G199 surcharges during both the August 13 and 25 events, with a maximum surcharge depth of 0.2 m above the obvert of the 2.4 m storm sewer.
- Pall Mall-8G0031 monitor results show no surcharge occurred during the monitoring period. The capacity of the 1.8 m pipe is 9.5 m3/s, which exceeds all the monitored flow.
- Ridout-6G83 monitor results show no surcharge occurred during the monitoring period. The capacity of the 1.2 m pipe is 2.7 m3/s, which greatly exceeds all the monitored flow.
- Fullarton-6G135 monitor results show no surcharge occurred during the monitoring period. The capacity of the 0.9 m pipe is 1.6 m3/s, which greatly exceeds all the monitored flow.

Table 2: Summary of Flow Monitoring Data

Gauge Location	Catchment Area (ha)	Catchment Imperviousness (%)	Pipe Characteristics	Date	Rainfall Depth (mm)	Measured Maximum Depth (m)	Peak Flow from Observed Depth and Rating Curve (m3/s)	Observed Runoff Volume (m3)
			Diameter (m): 1.5	11-Aug	21	1.2	8.8	41988
			Slope: 3.4%	12-Aug	14.25	1.2	9.1	52869
				13-Aug	13.5	1.9	11.7	12461
					25.75			
				25-Aug	39			
Talbot Street-8G266	490	47			11.5		Data Gap	
			Diameter (m): 1.8	11-Aug	21	0.5	1.9	7747
			Slope: 0.66%	12-Aug	14.25	1.2	7.8	11317
				13-Aug	13.5	2.0	10.6	11521
					25.75	0.4	1.4	5542
				25-Aug	39	1.8	10.0	27835
Mill Street-8G139	104	44			11.5	0.5	1.9	9426
			Diameter (m): 2.4	11-Aug	21	1.4	8.3	25776
			Slope: 0.15%	12-Aug	14.25	1.5	9.6	30406
				13-Aug	13.5	2.6	12.6	31286
					25.75	0.9	3.9	16333
				25-Aug	39	2.6	12.6	64102
Richmond-8G199	490	47			11.5	1.6	10.3	32625
			Diameter (m): 1.8	11-Aug	21	0.4	1.9	5982
			Slope: 0.8%	12-Aug	14.25	0.6	3.5	9081
				13-Aug	13.5	0.9	5.9	10584
					25.75	0.4	1.8	4902
				25-Aug	39	1.1	7.4	27686
Pall Mall-8G0031	89	43			11.5	0.6	2.8	9817
			Diameter (m): 1.2	11-Aug	21	0.4	0.9	2367
			Slope: 0.58%	12-Aug	14.25	0.5	1.5	2468
				13-Aug	13.5	0.7	2.1	1881
					25.75	0.4	0.8	1393
				25-Aug	39	0.6	1.9	4722
Ridout-6G83	12	75			11.5	0.2	0.3	1717
			Diameter (m): 0.9	11-Aug	21	0.2	0.2	269
			Slope: 0.94%	12-Aug	14.25	0.3	0.3	220
				13-Aug	13.5	0.3	0.5	279
					25.75	0.2	0.1	66
				25-Aug	39	0.3	0.3	510
Fullarton-6G135	6	80			11.5	0.1	0.05	58

Figure 11: 2016 Flow Monitor Locations and Catchments.



5.3.3 Rainfall Data

City of London maintains a rain gauge network, which provides historic rainfall records. Five- minute interval rainfall data was obtained from AJ Tyler Center Rain Gauge station to evaluate the spatial and temporal variation of selected storms events. This gauge is located at the center of the study area and is appropriately situated to characterize rainfall over the subject catchment.

167 mm of rain fell at AJ Tyler Center Rain Gauge during Aug 10-31 2016, with a maximum of 39.2 mm on a single day (August 13 2016). **Figure 12** shows the total precipitation for five-minute intervals. For the purpose of storm selection and classification for flow monitoring, a minimum depth of 10 mm for a single event were selected.

Table 3 shows the six significant rainfall events recorded during the flow monitoring period and available for calibrating the model. Of these events, the August 11, August 12, August 13, August 24 and August 25 events for 2016 were selected as the most suitable for calibration. The rainfall events were selected based on the size of the storm event and the peak rainfall intensity. The two largest storm events were recorded on August 13 and August 24, 2016, with a total rainfall depth of 39.2 and 39 mm, respectively. These two events generally produced the highest peak flows.

Table 3: Summary of Flow Monitoring Data

Date	Storm Duration	Total Rainfall (mm)	Peak Rainfall Intensity (mm/hr)
11-Aug	11:10-13:15	21.0	51
12-Aug	17:45-20:40	14.2	63
13-Aug	3:35-3:50	13.5	111
	10:00-18:15	25.7	120
16-Aug	3:40-8:30	23.5	30
24-Aug	20:40-23:20	39.0	105
25-Aug	12:40-16:50	11.5	30

A rainfall intensity-duration-frequency (IDF) analysis was performed on rainfall records to determine the probability that a storm of a given size or larger will occur in any given year. This analysis was used to determine the return period for the storm events.

Figures 13-14 show the magnitude of these events relative to the City of London IDF curves. The assessment shows that the August 11, 12 and August 25 events were far less than a 2-year event across small time scales (less than 1 hour). For large time scales (1 hour to 24 hour), August 24 is the only event close to 2-year event. The shorter durations are more relevant in the catchment, given the fast response time between rainfall and peak flow evident from the flow monitor data

Figure 12: AJ Tyler Center Rain Gauge Rainfall for August 2016

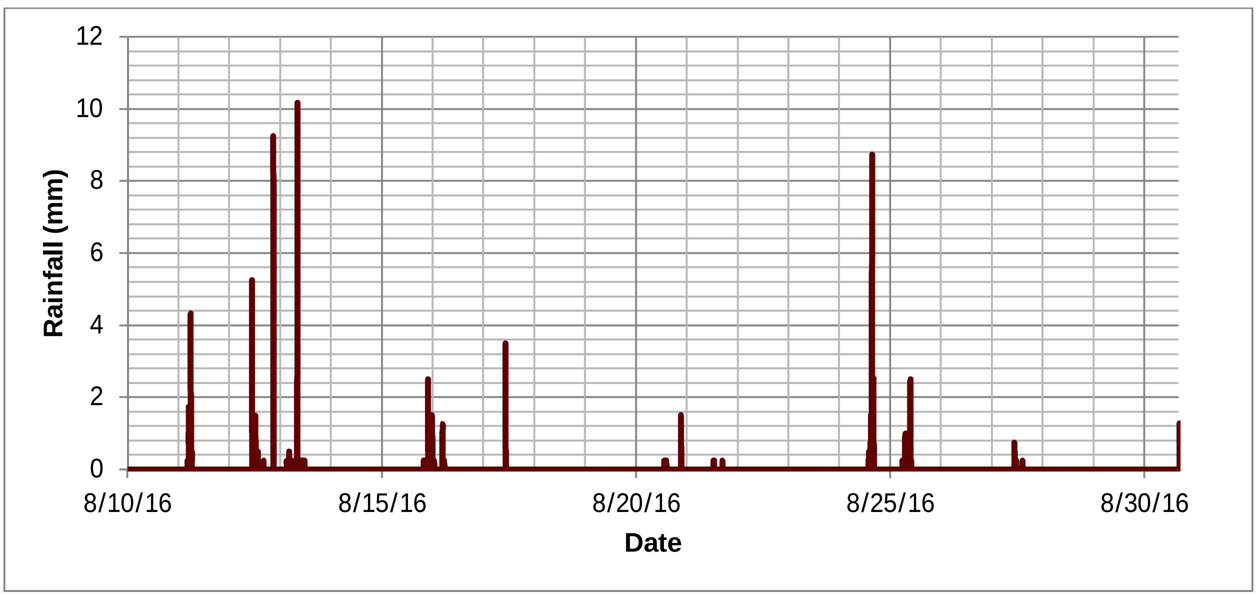
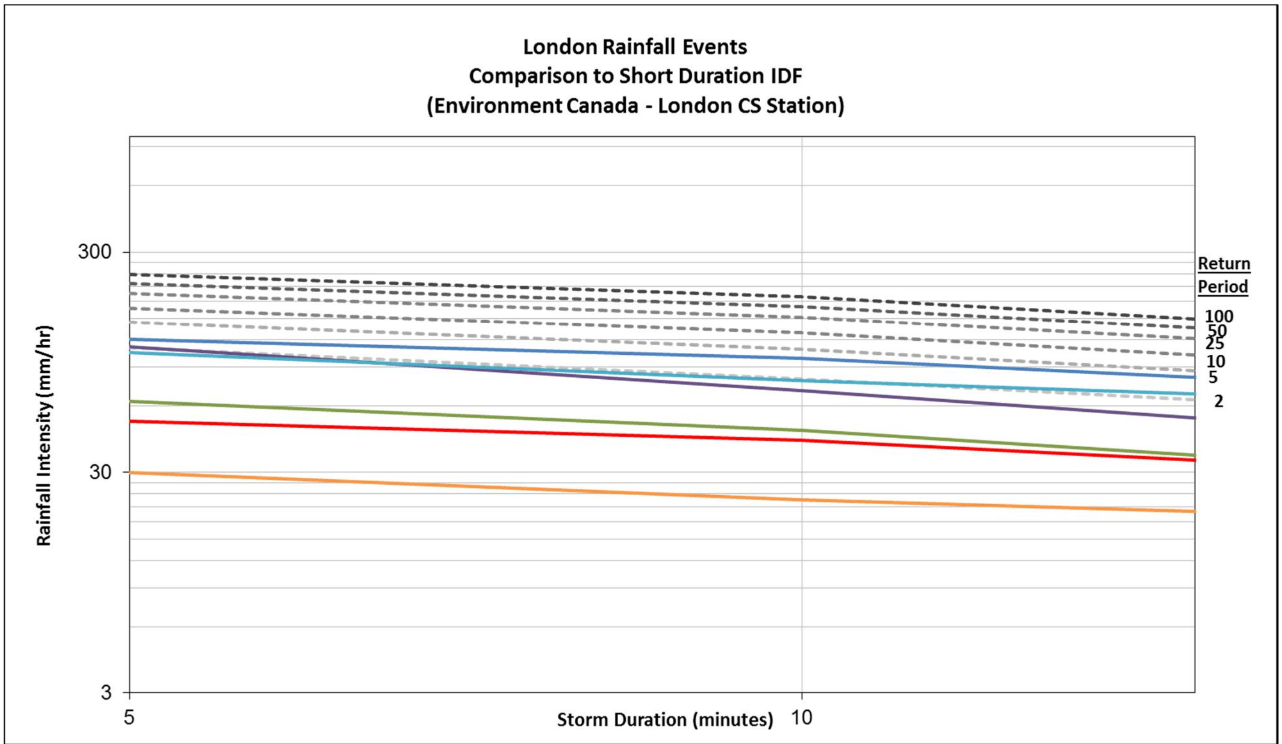


Figure 13: Return Period of Recorded Rainfall Events for Short Duration IDF



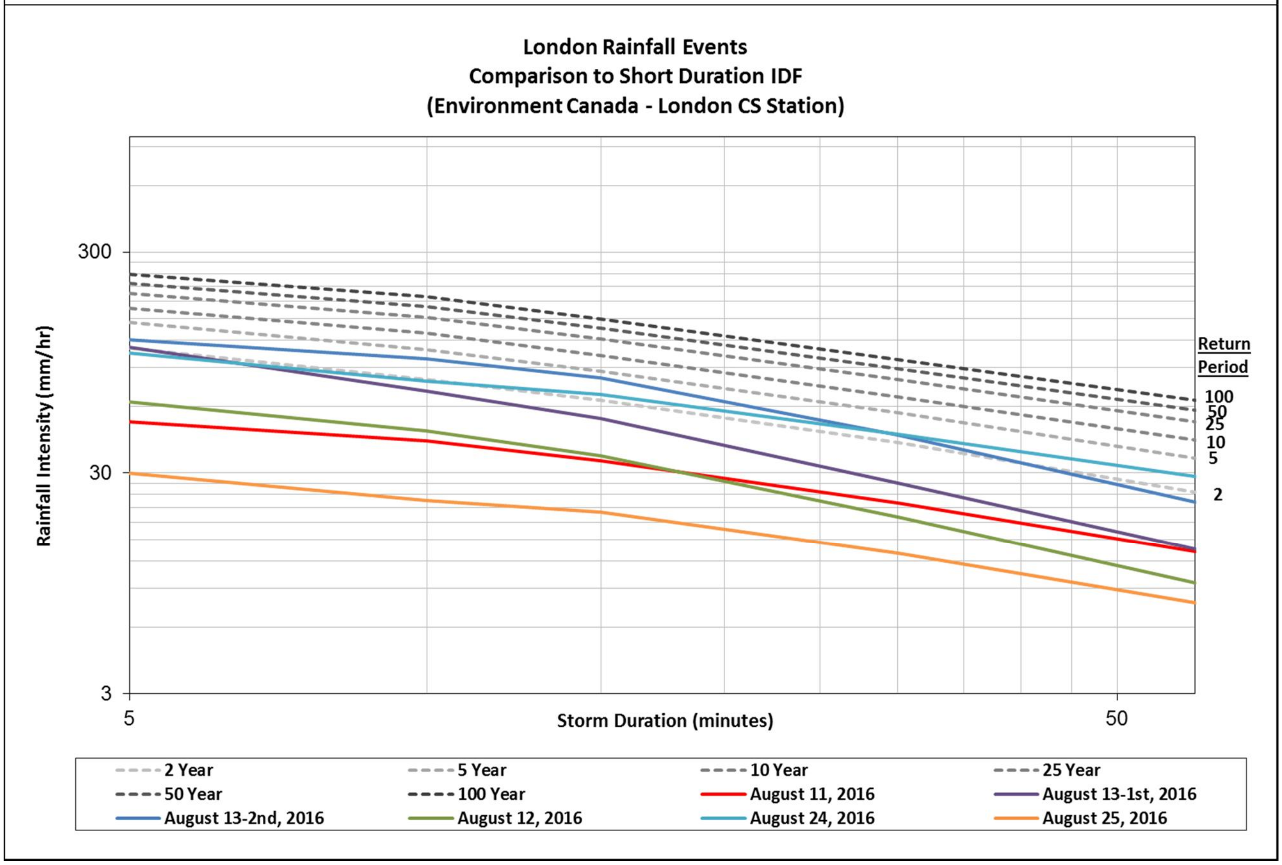
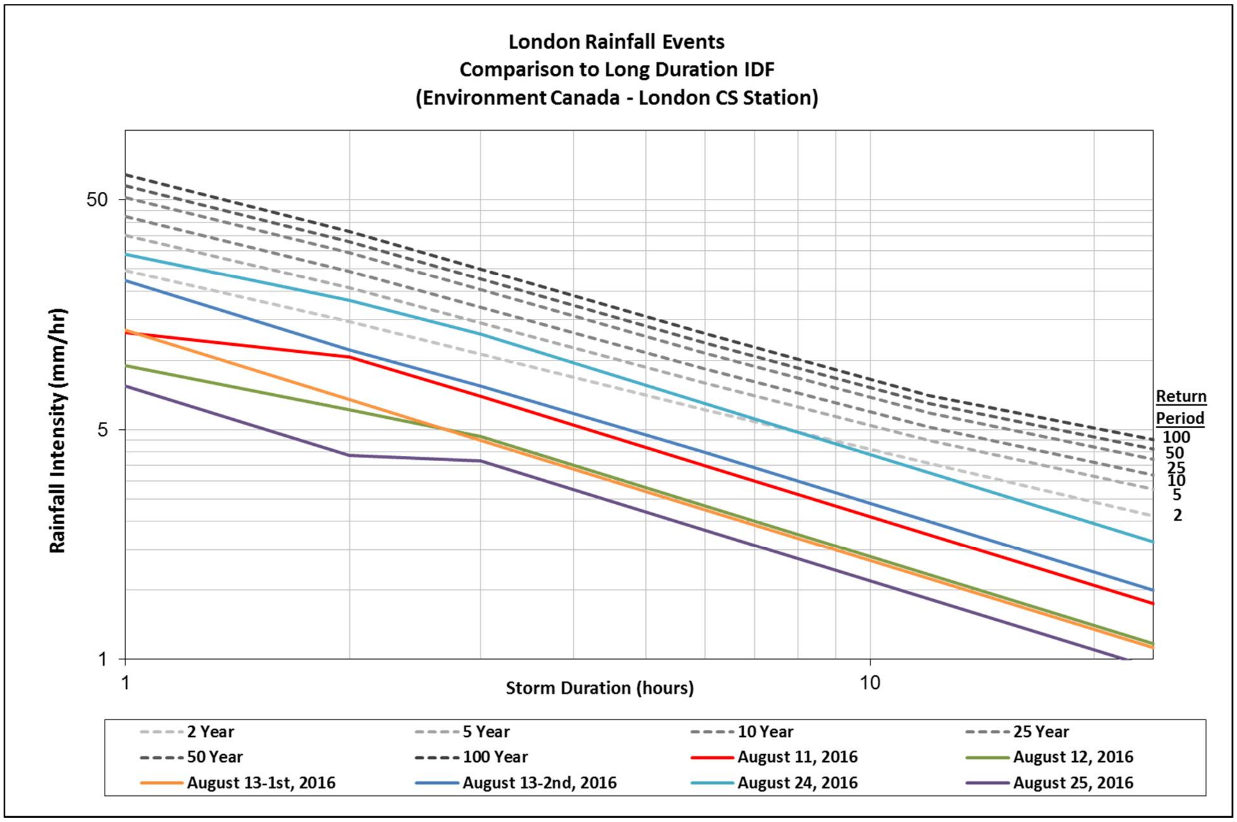


Figure 14: Return Period of Recorded Rainfall Events for Long Duration IDF



5.4 Model Hydraulics

5.4.1 Minor Piped Storm System

The layout and characteristics of the minor piped storm sewer system were added to the model from available GIS data. Physical characteristics obtained from the GIS include: pipe diameter and slope, pipe roughness (based on type and of pipe material), sewer invert elevation, and pipe network connectivity.

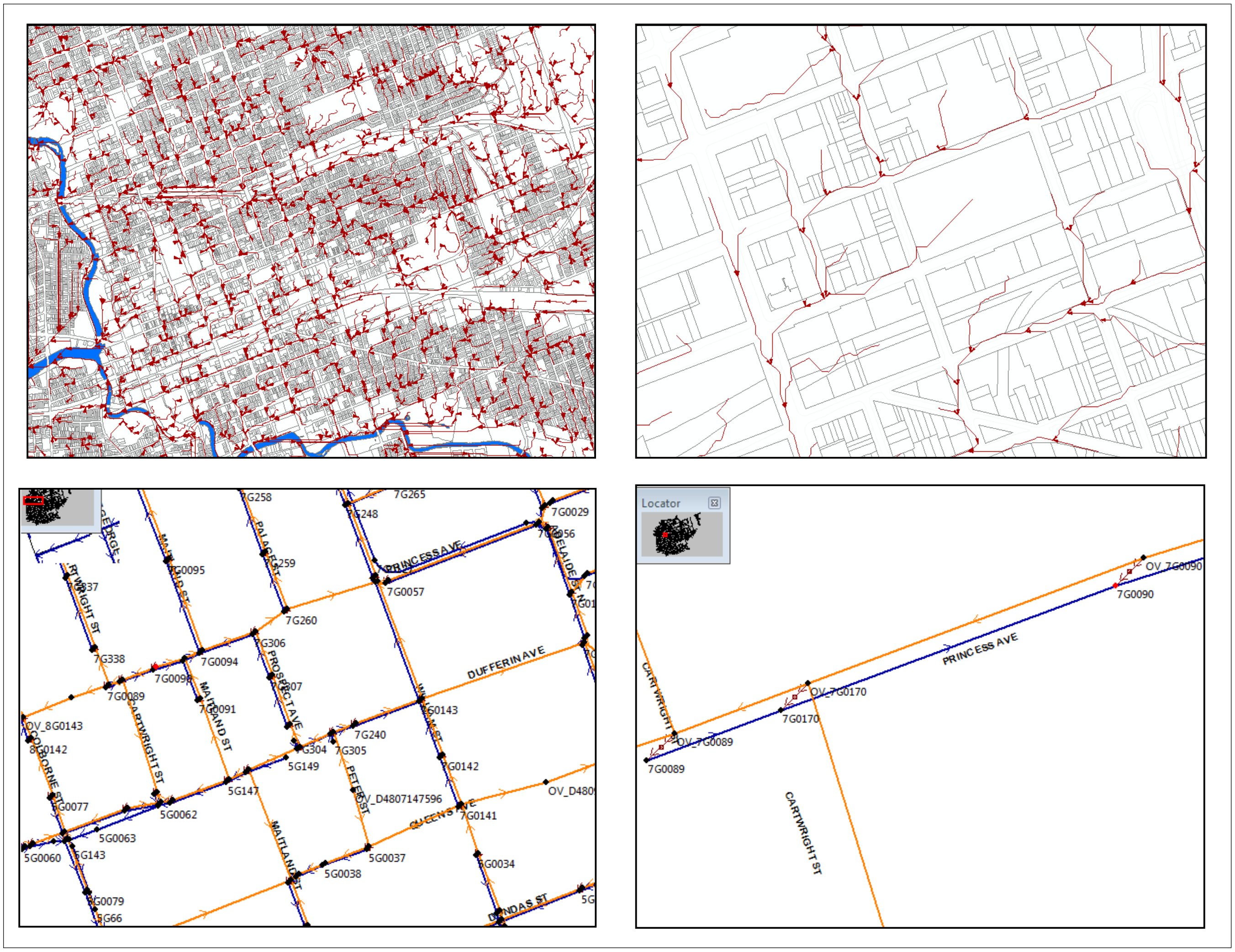
- The City's conduit shapefile was used to populate the model with all stormwater links; and
- 126 upstream and 116 downstream invert elevations are missing in the pipe shapefile, which was estimated from US and DS pipe elevations and flagged as "ES" (i.e. 'estimated') in the model.

5.4.2 Major Storm System

Performance of the major storm system was analyzed based on DEM created using best available topo data. Major system elements within the model include: streets and overland flow paths. In some instances, the major system layout and connections mirrored the layout and direction of the minor system, while in other instances, the major drainage systems did not. This could occur, for example, in locations where the streets slope in the opposite direction of the sub-surface sewer pipe systems. The following is a summary of the procedure that AECOM used to create the overland network:

- Initially, copy of STM links;
- Added overland links where STM doesn't exist to create a complete overland network;
- Assigned flow direction based on flow paths;
- Checked, corrected flow direction, assigned IDs; and
- Offset from STM, so both are visible.

Figure 15: Creation of Overland Network



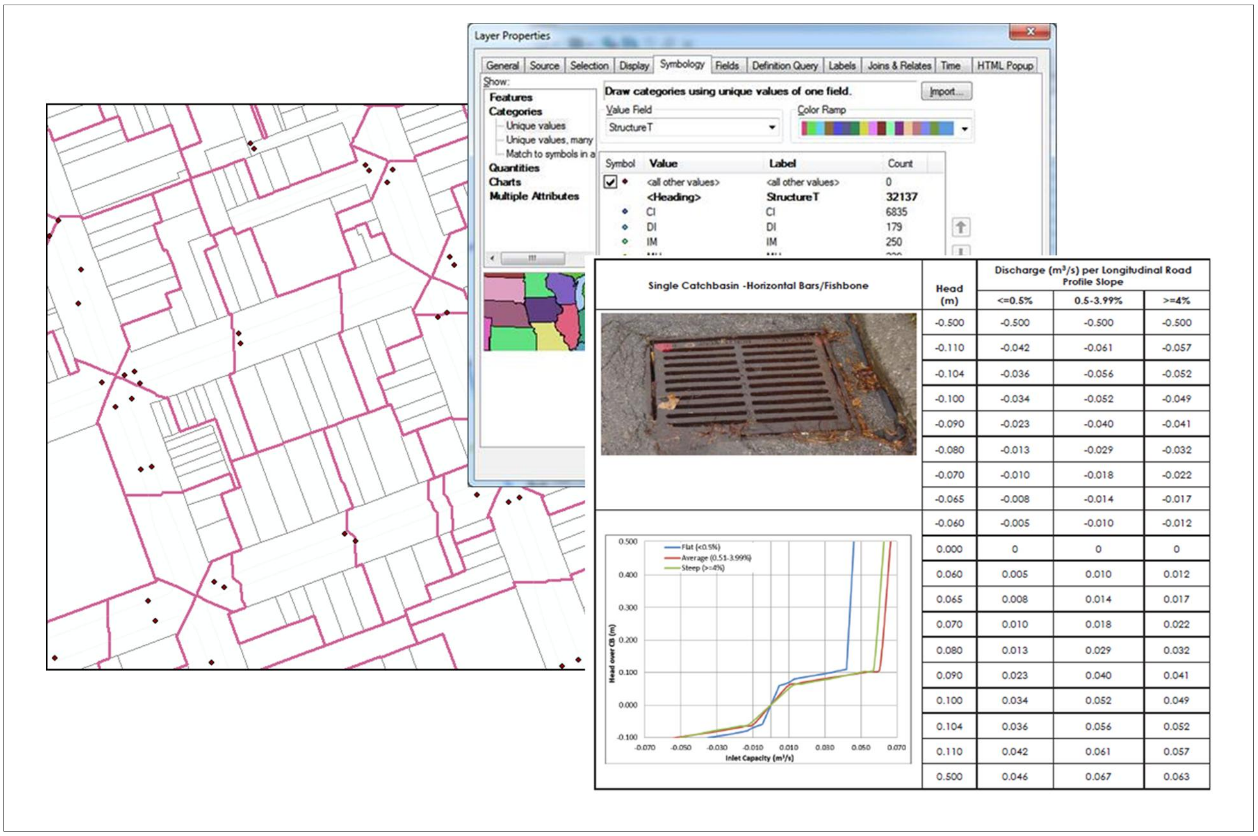
5.4.3 Linkage between Minor and Major Storm System

A typical storm drainage system in an urban area comprises both a minor system and a major system.
The minor storm drainage system, the storm sewer system, receives the runoff from the more frequent rainfall events, typically up to a 1-in-2 year return rain storm.
Runoff from larger, more infrequent rain storms that cannot be accommodated in the minor storm system is conveyed on the road surface in the major drainage system. The major system conveys runoff from storm events larger than the 1-in-2 year storm and up to and including the 1-in-100 year storm. Minor and major drainage systems should convey the peak runoff from all design storm events without flooding private property

In the model:

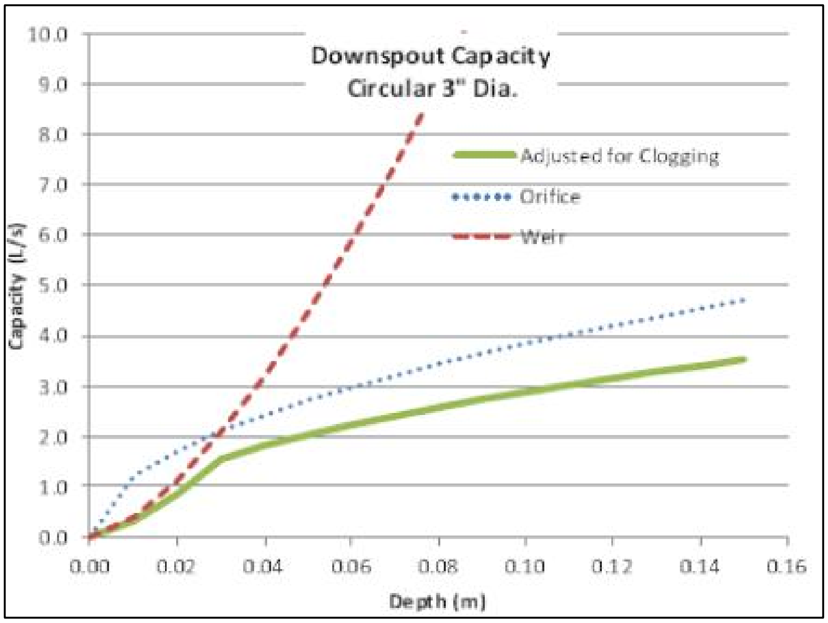
- Each storm catchment drains to a 'gully' on the road surface, representing catchbasins;
- Each gully has an inlet capture curve;
- Inlet capture curves are based on the number and type of CBs in each catchment; and
- This information is taken from city GIS database for CBs.

Figure 16: Linkage between Minor and Major Storm System



Head (m)	Discharge (m³/s) per Longitudinal Road Profile Slope		
	<=0.5%	0.5-3.99%	>=4%
-0.500	-0.500	-0.500	-0.500
-0.110	-0.042	-0.061	-0.057
-0.104	-0.036	-0.056	-0.052
-0.100	-0.034	-0.052	-0.049
-0.090	-0.023	-0.040	-0.041
-0.080	-0.013	-0.029	-0.032
-0.070	-0.010	-0.018	-0.022
-0.065	-0.008	-0.014	-0.017
-0.060	-0.005	-0.010	-0.012
0.000	0	0	0
0.060	0.005	0.010	0.012
0.065	0.008	0.014	0.017
0.070	0.010	0.018	0.022
0.080	0.013	0.029	0.032
0.090	0.023	0.040	0.041
0.100	0.034	0.052	0.049
0.104	0.036	0.056	0.052
0.110	0.042	0.061	0.057
0.500	0.046	0.067	0.063

Figure 17: Downspout Discharge Capacity



Depth (m)	Downspout Discharge Capacity (L/s): Downspout Capture[1] – Orifice	Weir	Control	Adjusted for Clogging
0.00	0.0	0.0	0.0	0.0
0.01	1.2	0.4	0.4	0.3
0.02	1.7	1.1	1.1	0.8
0.03	2.1	2.1	2.1	1.6
0.04	2.4	3.2	2.4	1.8
0.05	2.7	4.5	2.7	2.0
0.06	3.0	5.9	3.0	2.2
0.07	3.2	7.4	3.2	2.4
0.08	3.4	9.0	3.4	2.6
0.09	3.6	10.8	3.6	2.7
0.10	3.8	12.6	3.8	2.9
0.11	4.0	14.6	4.0	3.0
0.12	4.2	16.6	4.2	3.1
0.13	4.4	18.7	4.4	3.3
0.14	4.5	20.9	4.5	3.4
0.15	4.7	23.2	4.7	3.5

Parameters			
Orifice Parameters			
Orifice Invert	0.0 m	Perimeter	0.24 m
Dimensions HxW (m)	0.0762 0.0762	Area	0.005 m^2
Orifice Centre	0 m	Orifice Coeff.	0.6
Orifice Shape	Circular	Orientation	Horizontal
Weir Coeff.	1.670	Max Head (m)	0.127
Roof Characteristics			
Area (m^2)	65	# Downspouts	1.0
Slope (m/m)	0.330	Blockage Factor	25%
Adjusted # of Downspouts per Roof			1.0
Gutter Characteristics			
Width (m)	0.127	Slope (m/m)	0.00521
Depth (m)	0.150	$Area_x$ (m^2)	0.019
Mannings	0.013	Capacity (L/s)	13.3

1. Conventional uncontrolled straight drop pipe assumed to act as a sharp crested weir or orifice whichever limits Q

5.4.4 Model Nodes

Nodes represent manholes and outfalls in the model. The City's manhole and outfall shapefile was used to import the nodes in the model, and provide ground elevations and manhole depths.

- A surface based on the City's points and breaklines shapefile and additional survey data provided by City for BRT were used to populate missing manhole ground elevations.
- AECOM performed QA/QC checks on the pipe, invert, and ground data, and found a number of ground elevations from the database that were incorrect. AECOM corrected these values, using the same procedure that was used to populate the missing ground elevations.

- 1325 missing MH lid elevations in manhole shapefile, which were taken from elevation of surface (DEM) at the MH location, and flagged in InfoWorks

5.5 Model Hydrology

5.5.1 Subcatchment Delineation

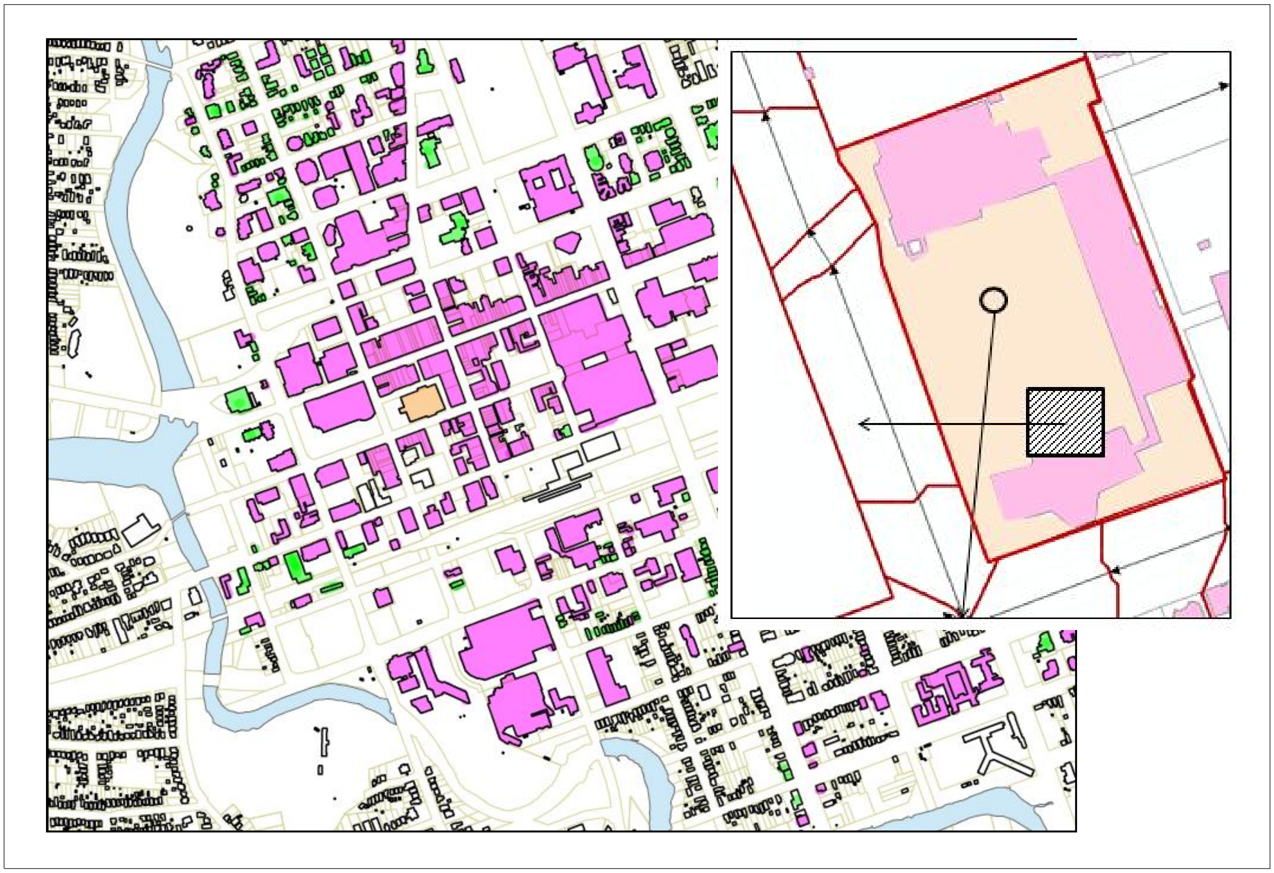
The City's parcels shapefile was used to create stormwater subcatchments in the model. Parcels were spatially joined to the closest manhole in GIS, and the resulting allocation was then reviewed, and any errors were corrected.

Figure 18: Subcatchment Delineation

5.5.2 Flat Roofs in the Model

AECOM defined separate catchments for all flat roof areas, in order to facilitate directing these roofs directly to either the storm sewer or sanitary sewer.

Figure 19: Separate Catchments for the Flat Roofs



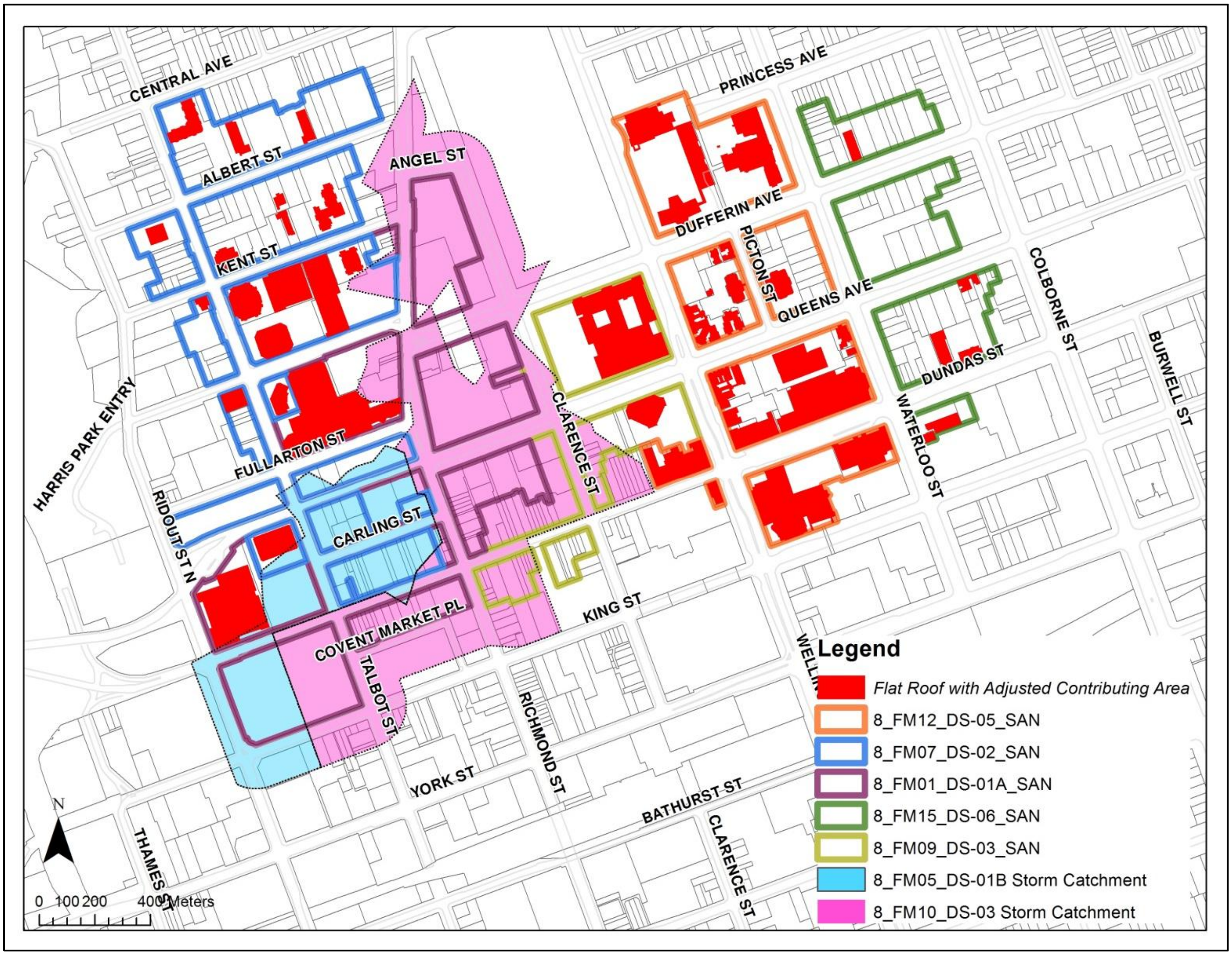
Flat roof contributing area were adjusted based on the CASS sanitary model, to provide consistency between the storm and sanitary model in terms of roof drainage assumed to be connected to storm or sanitary sewers.

- If the flat roofs are within the "stormwater" catchments in the sanitary model, the flat roofs were 100% connected to storm sewers.
- If the flat roofs are only within the "sanitary" flow monitoring catchments, the a portion of the roof areas were adjusted to contribute to the sanitary sewers, based on the sanitary model calibration results, in order to produce the correct volume of wet weather flow.

Table 4: Percent of Flat Roofs Connected to the Sanitary Sewer

Sanitary Flow Monitoring Location	Total Flat Roof Area (ha)	Percent of Flat Roofs Connected to the Sanitary Sewer (%)
8_FM09_DS-03_SAN	2.7	<23
8_FM15_DS-06_SAN	0.3	<65
8_FM01_DS-01A_SAN	5.4	<2
8_FM07_DS-02_SAN	4.0	<4
8_FM12_DS-05_SAN	4.1	<6

Figure 20: Flat Roofs with Adjusted Contributing Area Based on Sanitary Flow Calibration



5.5.3 Runoff Surfaces

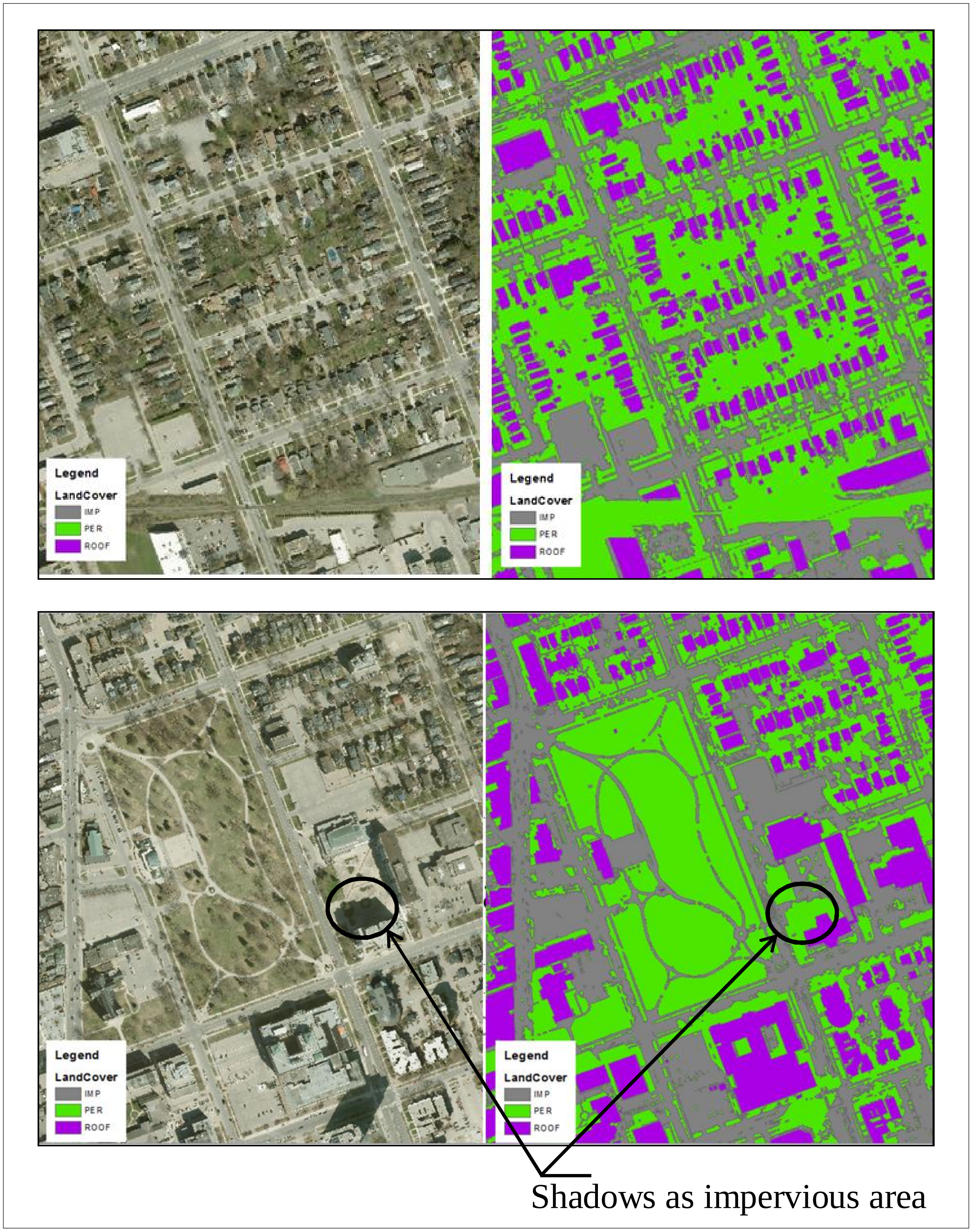
Runoff surfaces are used to generate a runoff volume that is routed through the system. The volume and timing of runoff depend on the types of surfaces generating runoff. Two general categories for these surface types are impervious and pervious. Impervious surfaces typically generate faster and larger runoff than pervious surfaces. Within each subcatchment, surfaces were delineated into the following runoff surface types:

Table 5: Runoff Surfaces Classification

No.	Runoff Surface Type	Description
10	Impervious-General	Roads, Sidewalks, Parking Lots, Patios, etc
20	Roofs-Disconnected	Sloped roof area, not connected to collection system
30	Flat Roofs	Flat Roof Area
40	Pervious Surface-HSG C-D	Pervious With poorly-draining soils (clays, silts)
41	Pervious Surface-HSG A-B	Pervious With poorly-draining soils (sandy, loamy)

Aerial images were used to quantify the contributing areas for each runoff surface.

Figure 21: Runoff Surface Classification from Processed Aerial Image



5.6 Runoff Volume Model

The runoff volume model defines how much precipitation falling on each runoff surface type (buildings, roads, driveways, etc., as listed above) becomes surface runoff that enters the stormwater system. The impervious surface types were set to use the Fixed Runoff Volume model, which calculates runoff as a fixed percentage of rainfall (in the case of impervious surfaces, 100%) minus surface depression storage. For the pervious surface type, the Horton Infiltration model was used, which calculates runoff via the Horton equation based on the infiltration capacity and an exponential decay constant dependent on soil type and vegetation.

5.6.1 Runoff Routing Model

InfoWorks provides five different potential models for routing stormwater runoff. AECOM used the SWMM hydrograph routing for the CASS stormwater model. This routing method uses a combination of a non-linear reservoir and kinematic wave routing to move the runoff over the ground surface to the inlet node.

Figure 22: Schematic Representation of Storm Model Catchments

Table 6: Model Parameters

InfoWorks Parameter	Description	Runoff Surface Number				
		10	20	30	40	41
Runoff Routing Value	Manning's Roughness	0.013	0.015	0.015	0.41	0.41
Runoff Volume Type	Runoff Volume Model	Fixed	Fixed	Fixed	Horton	Horton
Surface Type	Impervious vs. Pervious	Imp.	Imp.	Imp.	Perv.	Perv.
Ground Slope	Surface Slope (m/m)	0.01	0.33	0.001	0.01	0.01
Initial Loss Value	Initial Abstraction (m)	0.002	0	0	0.005	0.005
Fixed Runoff Coefficient	Proportion of Surface Area	1	1	1	-	-
Horton Initial	Initial Infiltration (mm/hr)				75	200
Horton Limiting	Limiting Infiltration (mm/hr)				5	20
Horton Decay	Exponential Decay (1/hr)				2	2
Horton Recovery	Dry Recovery (1/hr)				2	2

5.7 Model Verification

Monitored depth with corresponding precipitation were the primary data used to assess the accuracy of the model and to verify the model results.

5.7.1 Verification Process

After model construction was finished, the model was reviewed for completeness. This review included an initial verification of the model. The purpose of the initial verification was to review minor and major system flows, tracing flow through portions of the system to verify model connectivity, overland flow directions, and inlet capture. The model development consisted of iterative adjustment of model elements affecting both hydraulic and hydrologic responses. These adjustments included:

- Identifying whether the catchment areas upstream of the flow monitoring locations were reasonable, generating approximately correct runoff volume, or whether surface catchment areas or runoff parameters needed to be adjusted to properly represent this runoff volume
- Identifying overland flow and ponding locations, at each ponding location, AECOM closely assessed the topography in the area, and the model was adjusted to properly represent any surface storage and spill outside of the right of way.
- Storage was added to simulate surface flooding due to overland flow at all locations with significant ponding.

5.7.2 Calibration Events

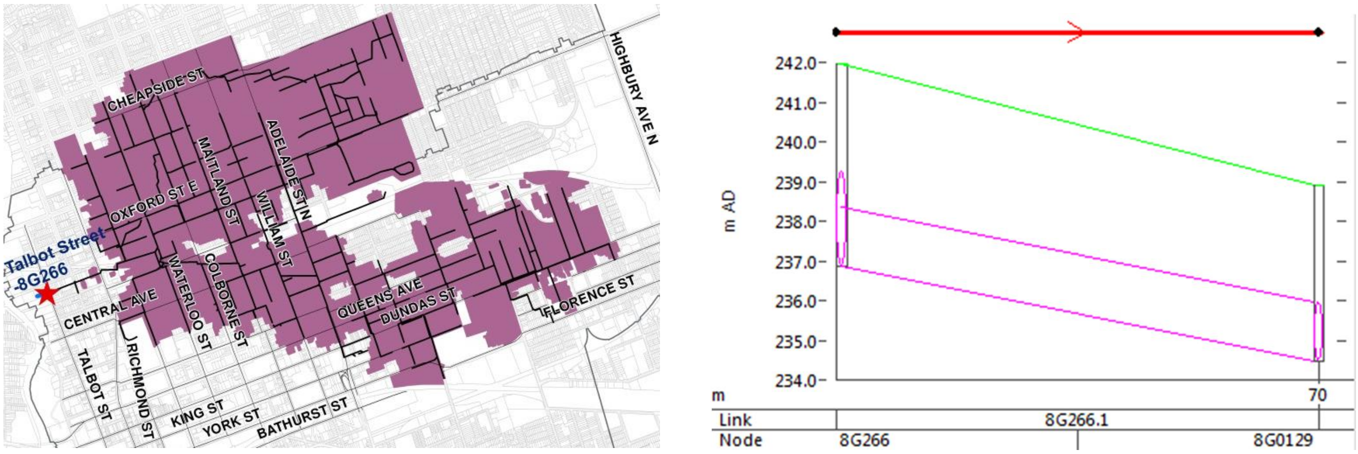
Precipitation data gathered at AJ Tyler Center rain gauge for the duration of the flow-monitoring period were used to generate flow in the model. Events captured between August 11-13, 2016, and August 24-25, 2016 was used to calibrate the model.

For some events and some monitors, flow-monitoring data did not correspond with recorded precipitation, likely due to spatial variability of the rainfall.

Model calibration results are show in Figures below. The results show:

- For some events, there is not good agreement between observed and modeled depth—(dashed red line is perfect agreement)-
- This shows the variability in the data for maximum depth between individual events—with no clear trend; the model overestimates depth for some events, and underestimates for others.
- A depth vs flow rating curve, developed from the InfoWorks model, was used to translate depth to volume. Model calibration results for overall volume is slightly better than the depth calibration
- The second August 13 events should be considered an outlier, since the applied rainfall data is clearly not represented in the observed flow response.
- The results show the model and monitor agreeing closer for total volume. While peak flow is still not matching particularly well, this can be attributed to the large variability inherent in high intensity short duration rainfall within the catchment.
- The inferred HGL based on level data shows that the 2400 mm STM pipe was flowing full twice during the monitoring period. The rainfall associated with each of these events is between a 2-year and a 5-year storm. The model results also show that this pipe starts to surcharge for the 2-year to 5-year design storm, which is a consistent result. Since the rainfall during these two events, Aug 13 and 25, 2016 exhibited similar return period as the 1 or 5-year storms, these surcharge conditions would be expected.

Figure 23: Talbot Street (8G266) Calibration Summary



Events	Rainfall Depth (mm)	Measured Maximum Depth (m)	Model Maximum Depth (m)	Peak Flow from Observed Depth and Rating Curve (m3/s)	Peak Flow in Model (m3/s)	Observed Runoff Volume (m3)	Modeled Runoff Volume (m3)
11-Aug	21.0	1.2	1.1	8.8	8.3	41988	38532
12-Aug	14.3	1.2	0.8	9.1	6.3	52869	28429
13-Aug	13.5	Data Gap					
13-Aug	25.8						
24-Aug	39.0						
25-Aug	11.5						

Figure 24: Observed Depth vs. Modeled

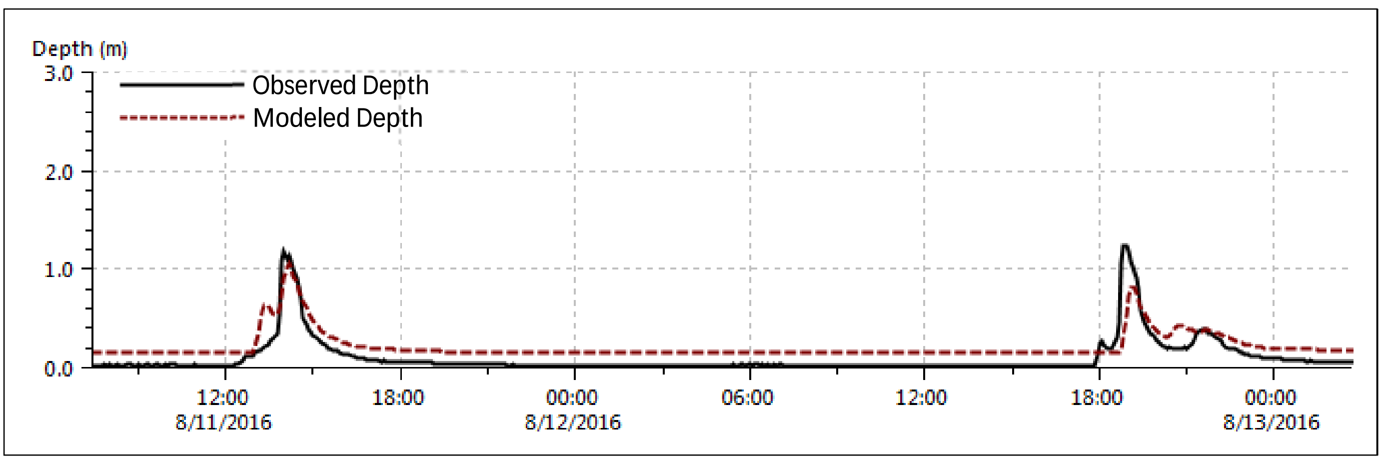
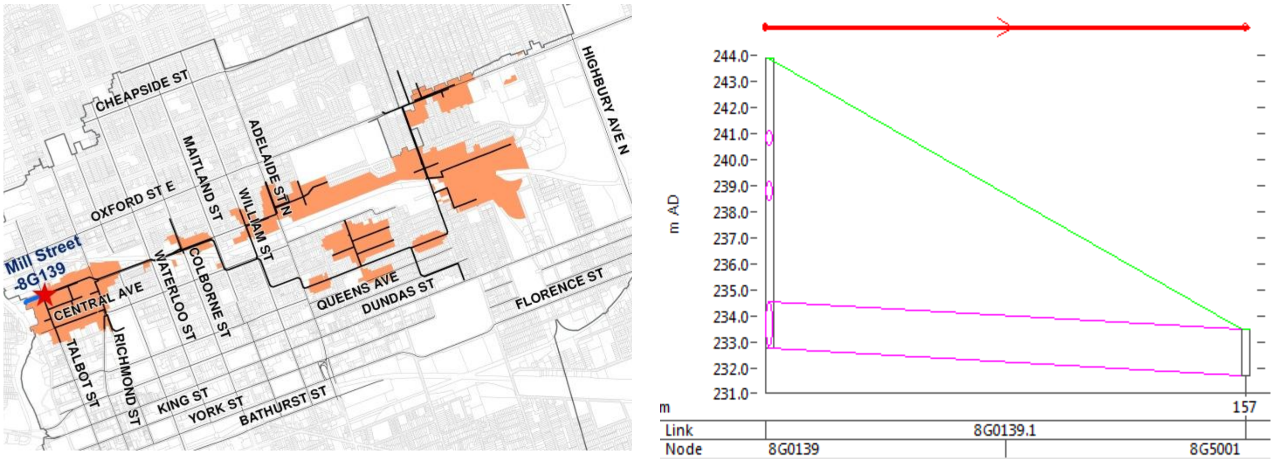


Figure 25: Mill Street (8G139) Calibration Summary



Events	Rainfall Depth (mm)	Measured Maximum Depth (m)	Model Maximum Depth (m)	Peak Flow from Observed Depth and Rating Curve (m3/s)	Peak Flow in Model (m3/s)	Observed Runoff Volume (m3)	Modeled Runoff Volume (m3)
11-Aug	21.0	0.5	0.6	1.9	2.4	7747	9700
12-Aug	14.3	1.2	0.5	7.8	1.7	11317	6090
13-Aug	13.5	2.0	0.7	10.6	2.9	11521	7162
13-Aug	25.8	0.4	0.9	1.4	4.7	5542	15060
24-Aug	39.0	1.8	1.0	10.0	5.3	27835	26086
25-Aug	11.5	0.5	0.4	1.9	1.0	9426	4727

Figure 26: Observed Depth vs. Modeled

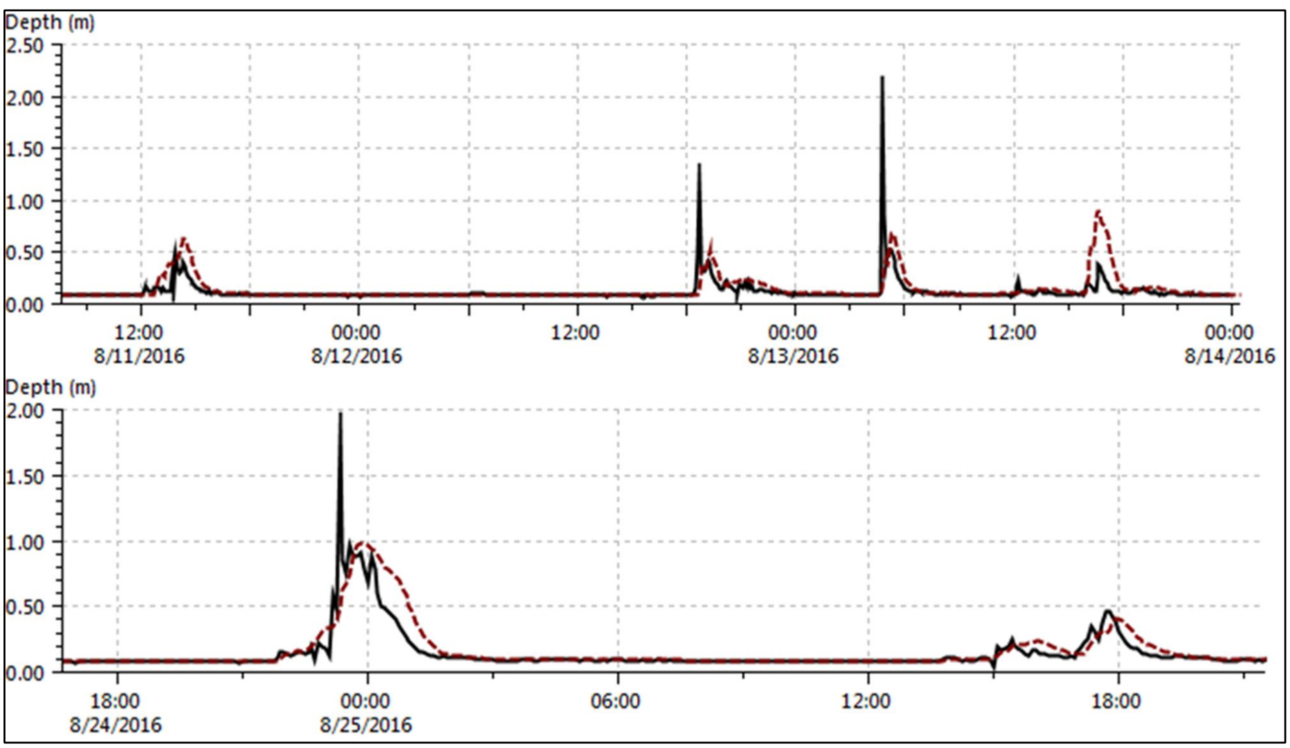
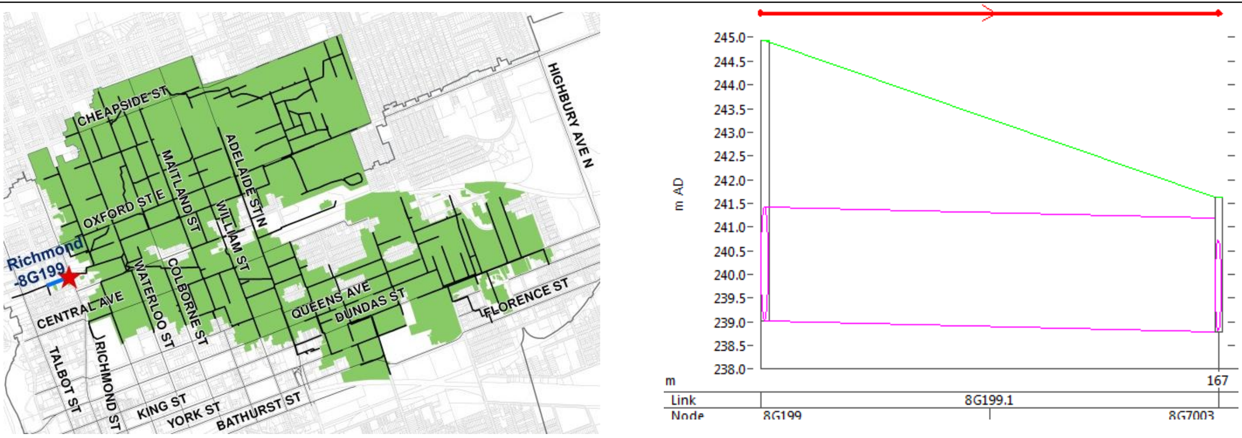


Figure 27: Richmond (8G199) Calibration Summary



Events	Rainfall Depth (mm)	Measured Maximum Depth (m)	Model Maximum Depth (m)	Peak Flow from Observed Depth and Rating Curve (m3/s)	Peak Flow in Model (m3/s)	Observed Runoff Volume (m3)	Modeled Runoff Volume (m3)
11-Aug	21.0	1.4	0.1	8.3	8.4	25776	38510
12-Aug	14.3	1.5	1.2	9.6	6.4	30406	28404
13-Aug	13.5	2.6	1.4	12.6	9.6	31286	26081
13-Aug	25.8	0.9	2.1	3.9	13.2	16333	45659
24-Aug	39.0	2.6	2.4	12.6	13.4	64102	72705
25-Aug	11.5	1.6	1.0	10.3	4.5	32625	23679

Figure 28: Observed Depth vs. Modeled

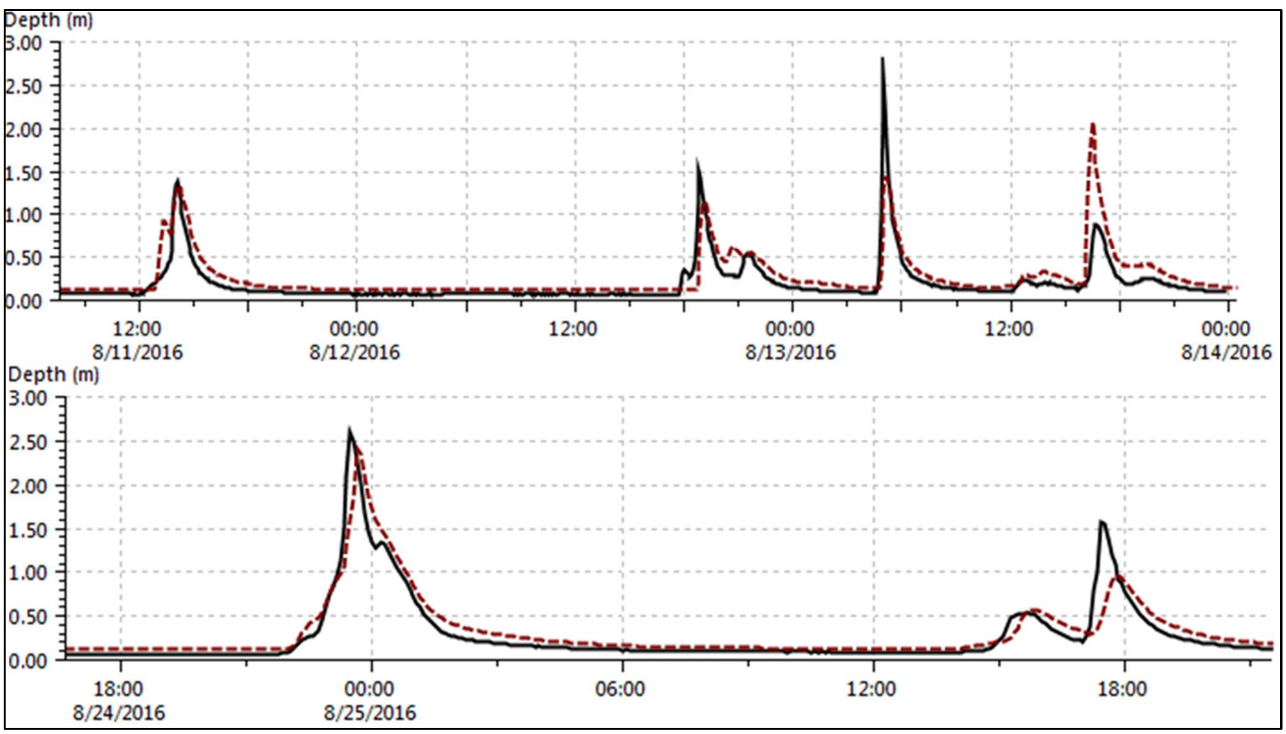
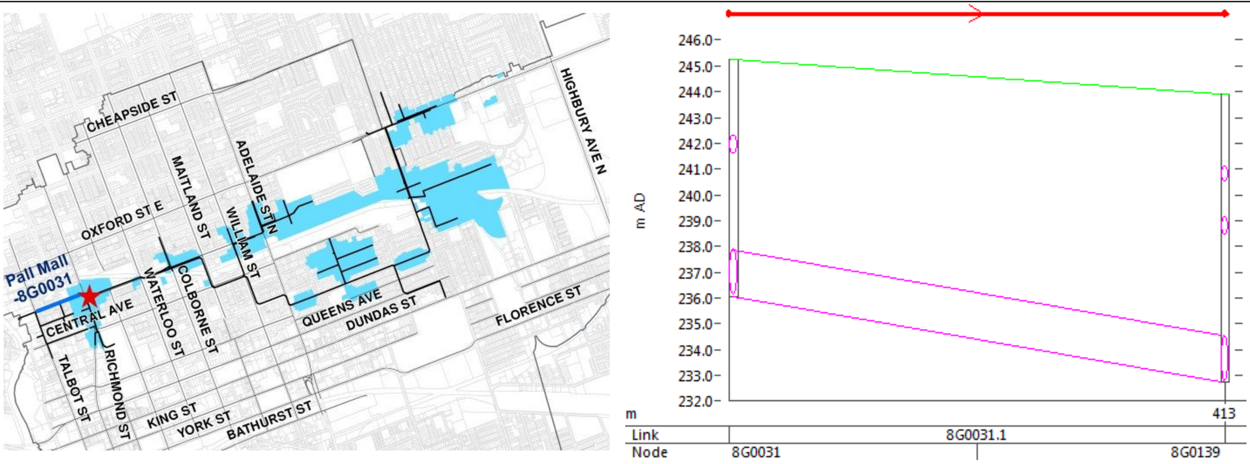


Figure 29: Pall Mall (8G0031) Calibration Summary



Events	Rainfall Depth (mm)	Measured Maximum Depth (m)	Model Maximum Depth (m)	Peak Flow from Observed Depth and Rating Curve (m3/s)	Peak Flow in Model (m3/s)	Observed Runoff Volume (m3)	Modeled Runoff Volume (m3)
11-Aug	21.0	0.4	0.6	1.9	2.3	5982	8290
12-Aug	14.3	0.6	0.5	3.5	1.6	9081	5073
13-Aug	13.5	0.9	0.7	5.9	2.8	10584	6284
13-Aug	25.8	0.4	0.9	1.8	4.6	4902	13584
24-Aug	39.0	1.1	1.0	7.4	5.0	27686	23504
25-Aug	11.5	0.6	0.4	2.8	1.0	9817	3858

Figure 30: Observed Depth vs. Modeled

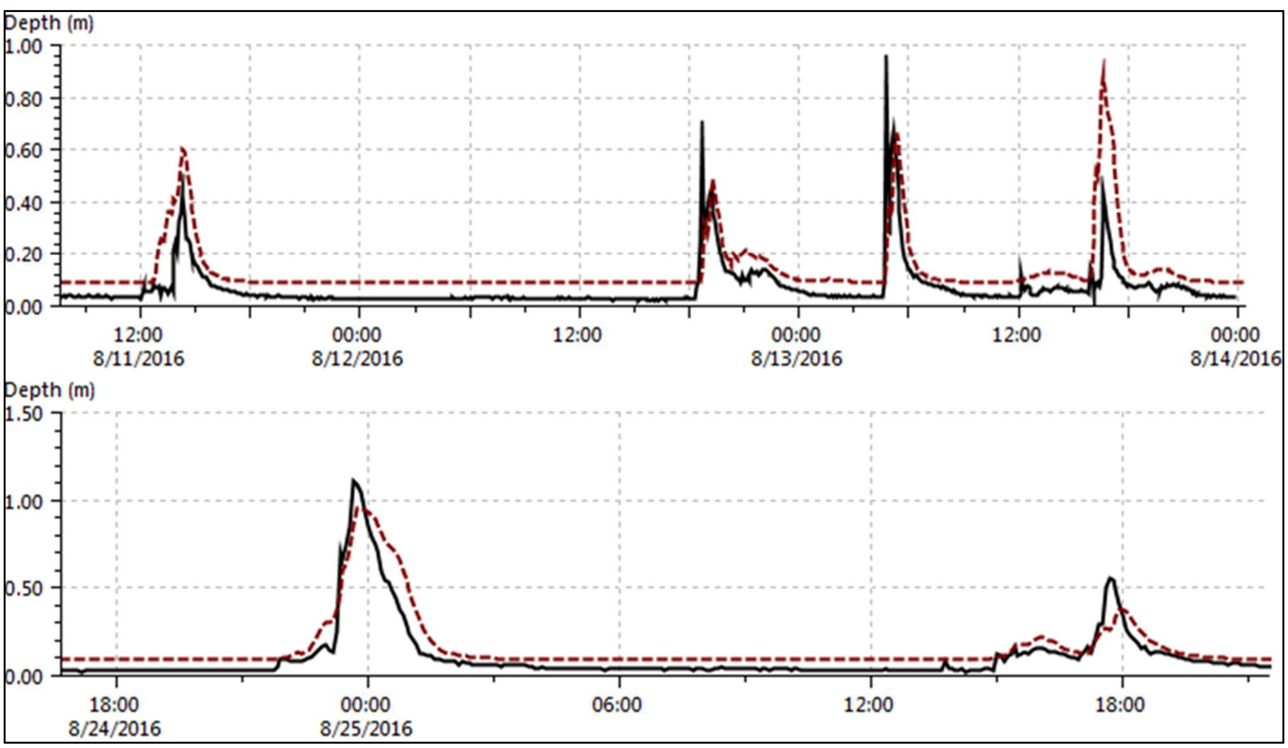
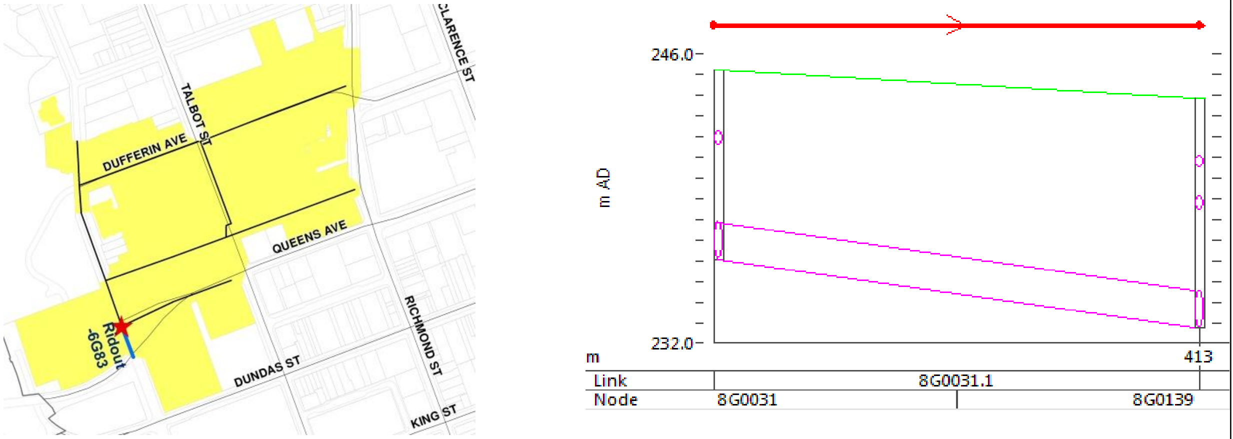


Figure 31: Ridout (6G83) Calibration Summary



Events	Rainfall Depth (mm)	Measured Maximum Depth (m)	Model Maximum Depth (m)	Peak Flow from Observed Depth and Rating Curve (m3/s)	Peak Flow in Model (m3/s)	Observed Runoff Volume (m3)	Modeled Runoff Volume (m3)
11-Aug	21.0	0.4	0.4	0.9	0.6	2367	1754
12-Aug	14.3	0.5	0.4	1.5	0.6	2468	1276
13-Aug	13.5	0.7	0.5	2.1	0.9	1881	1171
13-Aug	25.8	0.4	0.6	0.8	1.5	1393	2066
24-Aug	39.0	0.6	0.6	1.9	1.3	4722	3381
25-Aug	11.5	0.2	0.3	0.3	0.4	1717	1031

Figure 32: Observed Depth vs. Modeled

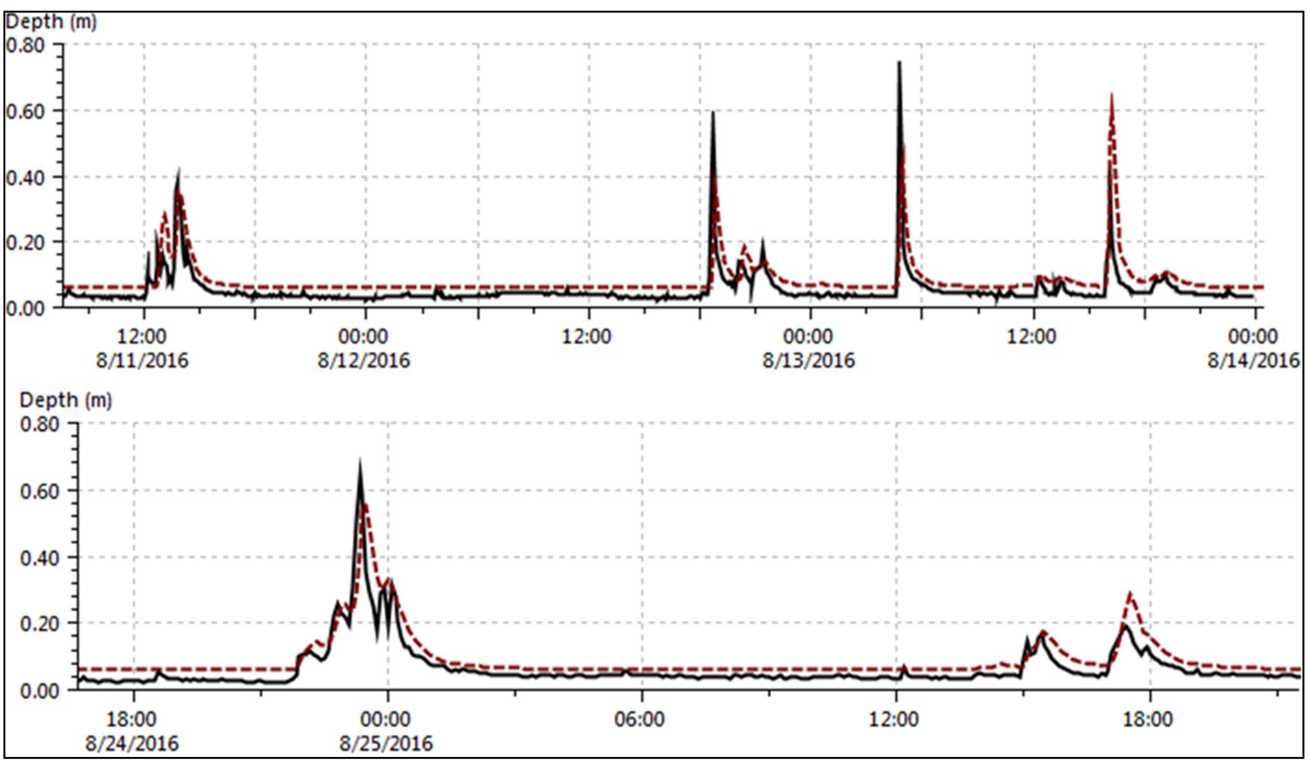
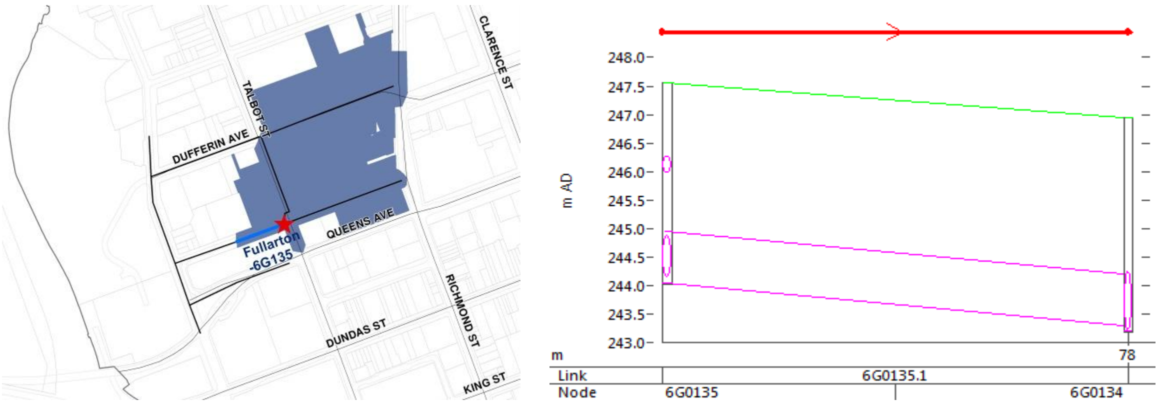
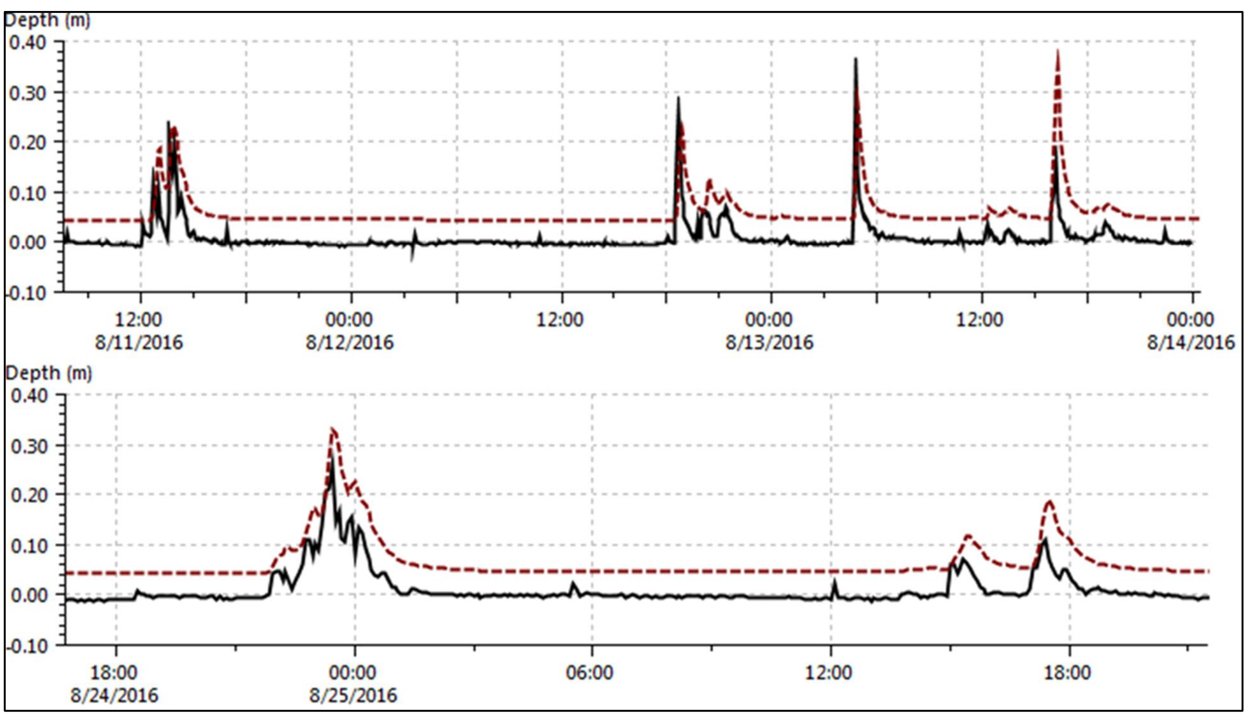


Figure 33: Fullarton (6G135) Calibration Summary



Events	Rainfall Depth (mm)	Measured Maximum Depth (m)	Model Maximum Depth (m)	Peak Flow from Observed Depth and Rating Curve (m3/s)	Peak Flow in Model (m3/s)	Observed Runoff Volume (m3)	Modeled Runoff Volume (m3)
11-Aug	21.0	0.2	0.2	0.2	0.2	269	837
12-Aug	14.3	0.3	0.2	0.3	0.2	220	585
13-Aug	13.5	0.3	0.3	0.5	0.3	279	512
13-Aug	25.8	0.2	0.4	0.1	0.5	66	836
24-Aug	39.0	0.3	0.3	0.3	0.4	510	1476
25-Aug	11.5	0.1	0.2	0.0	0.2	58	489

Figure 34: Observed Depth vs. Modeled



5.8 Future Growth Projection

The study area is essentially completely developed with respect to the percentage imperviousness within the catchment. Growth will largely consist of re-development or intensification in some portions of the study area. In many instances, growth may result in a large increase in population for specific parcels, but have a negligible change in storm runoff due to a negligible increase in impervious area (for example, construction of a high rise apartment on an existing parking lot). From a storm drainage perspective, there are two primary ways that growth associated with re-development or intensification will typically result in a significant increase to runoff to the storm sewers:

- By increasing imperviousness in the identified growth parcels; or
- By facilitating improvements to internal storm drainage, such as redirecting roof drainage from sanitary sewers to storm sewers

In order to identify potential growth related increases to storm runoff, AECOM completed a detailed review of forecast growth within the study area, both in terms of overall magnitude and specific locations. The source of growth information is:

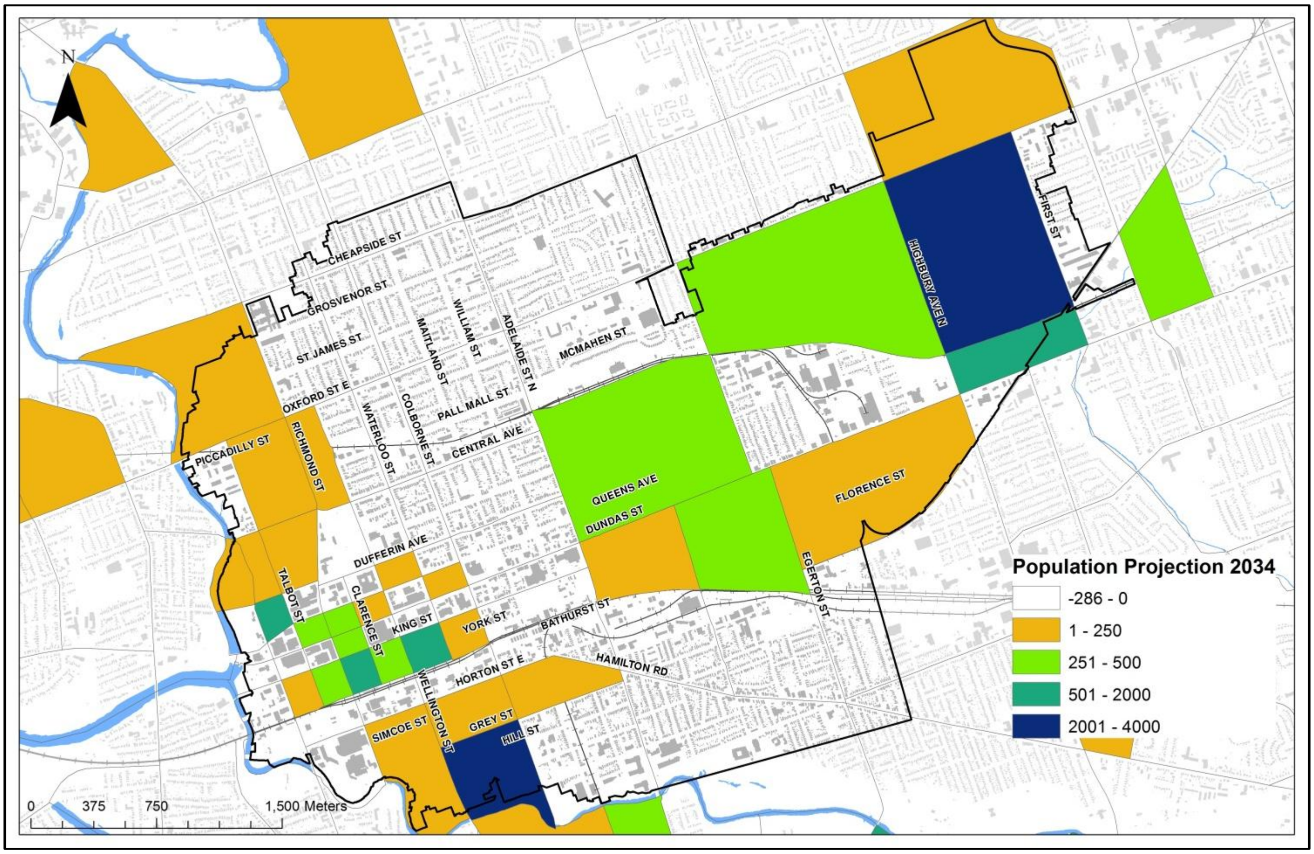
- The City traffic zone database, for general areas of growth; and
- New development applications and planning areas, identifying growth in specific parcels.

While this will not necessarily accurately predict all locations where development eventually takes place, it is used as the best modelling assumption to understand the impacts of the sewer network to growth.

AECOM used the following shape files in identifying growth scenarios:

- The City parcel database, with a field identifying the % imperviousness and land cover, which AECOM calculated from ortho photography;
- The City's traffic zone database (GrowthBySGU.shp); and
- Specific growth parcel allocations and new development applications (shape files from City):
  - Traffic zones (CASS_TZs_allocations_VLIparcels.shp)
  - London Psychiatric Hospital Lands (LPHLands.shp)
  - The former South Hospital lands (SOHO.shp)

Figure 35: Future Growth Prediction from Traffic Zone



AECOM then assigned growth to specific areas as described below.

In downtown area growth from Traffic Zone were assigned to specific parcels by either:

- **New Development Applications (shape file from City); or**
- ***CASS_TZs_allocations_VLIparcels.shp* (shape file from City).**

Figure 36: Identify Growth Parcels

Example-all growth in each of these Traffic Zones is assigned to specific parcels witin the traffic zone

If no growth was determined in the Traffic Zone, a parcel was assumed to be developed if it was flagged by either of the two shape files:

- **New Development Applications; or**
- ***CASS_TZs_allocations_VLIparcels.shp*.**

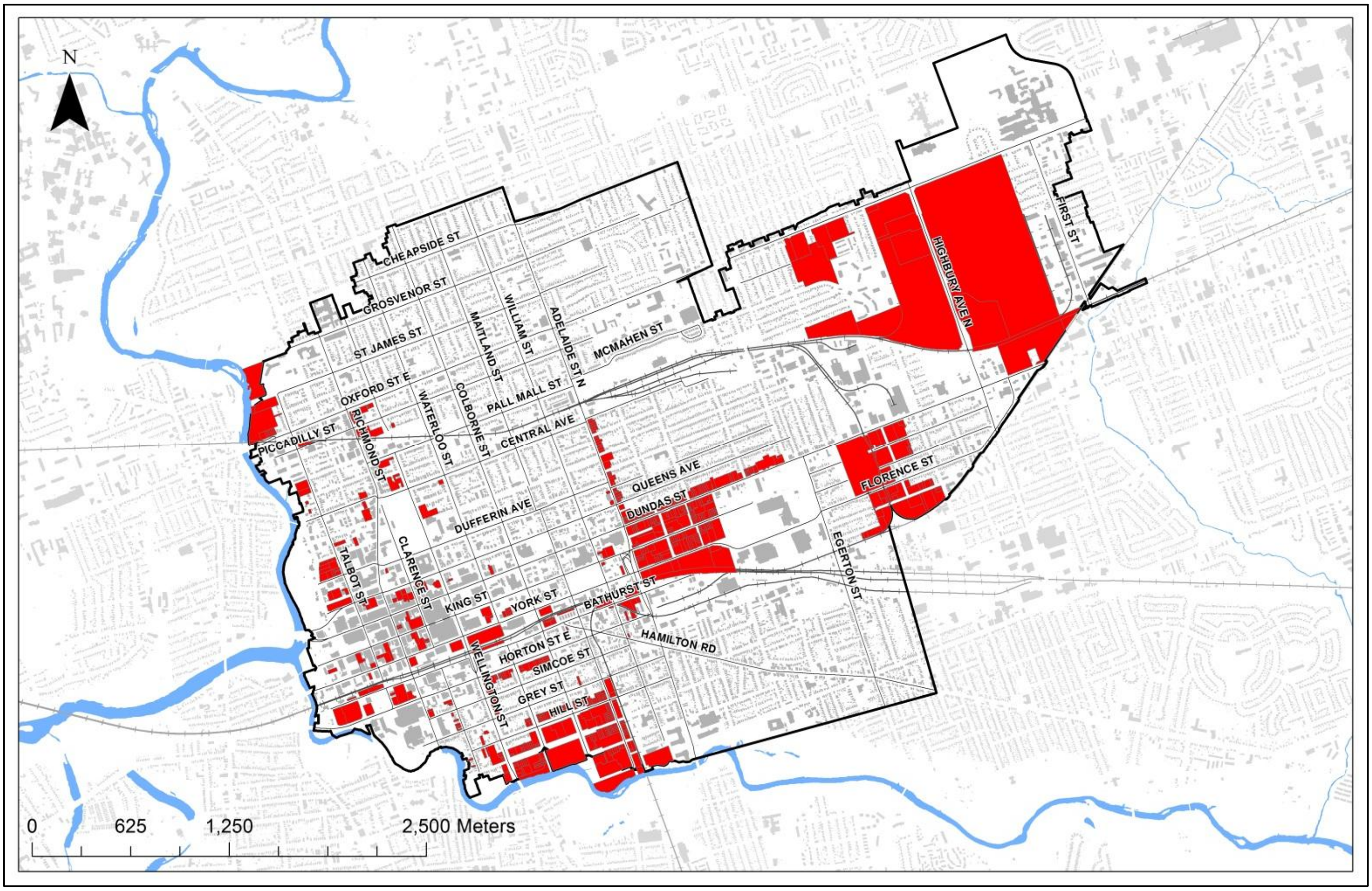
Even if no specific parcels were allocated for growth, AECOM assigned growth in some areas to specific parcels within the traffic zone based on feasibility for development or redevelopment.

Figure 37: Assigned Growth in Some Areas to Specific Parcels

Increases in imperviousness to growth parcels were determined as follows:

- **If growth parcel existing imperviousness is below 70%, it was assumed to increase to 70% under growth condition;**
- **If growth parcel existing imperviousness is above 70%, it was assumed to not change under growth conditions; and**
- **In downtown areas, growth parcels were assumed to be 90% imperviousness instead of 70%. Most areas to be redeveloped in the downtown core area are already completely impervious (e.g. parking lots).**

Figure 38: Future Growth Parcels



5.9 Existing System Performance

5.9.1 Minor Stormwater System

The InfoWorks model of the existing stormwater system was run for a range of design storms events. For each design event, AECOM identified sewer pipes in the systems that were operating at or over their full capacity. AECOM also reviewed the resulting surcharging of the system and if any manholes were overflowing, causing ponding of stormwater in the vicinity of the overflow.

The 2 to 100 year rainfall hyetographs used for runoff calculations follow the 3-hour Chicago Distribution as outlined in the 2017 Design Specifications and Requirement Manual (February 2017, City of London). **Table 7** summarizes the rainfall parameters (A, B, and C) for 2-year up to 100 year return periods design storms used by the City of London.

Table 7: Rainfall Parameters used by the City of London

Return Period	A	B	C
2yr	1290.000	8.500	0.860
5yr	1330.310	7.938	0.855
10yr	1497.190	7.188	0.850
25yr	1455.000	5.000	0.820
50yr	1499.060	4.188	0.809
100yr	1499.530	3.297	0.794

Generally, during a 1 in 2 year, 3 hour design storm, many of the storm pipes in the Core Area are operating at or near their full capacity. Results are shown in the following Figures.

Figure 39: 2 Year Design Storm Depth of Water and Surcharge state

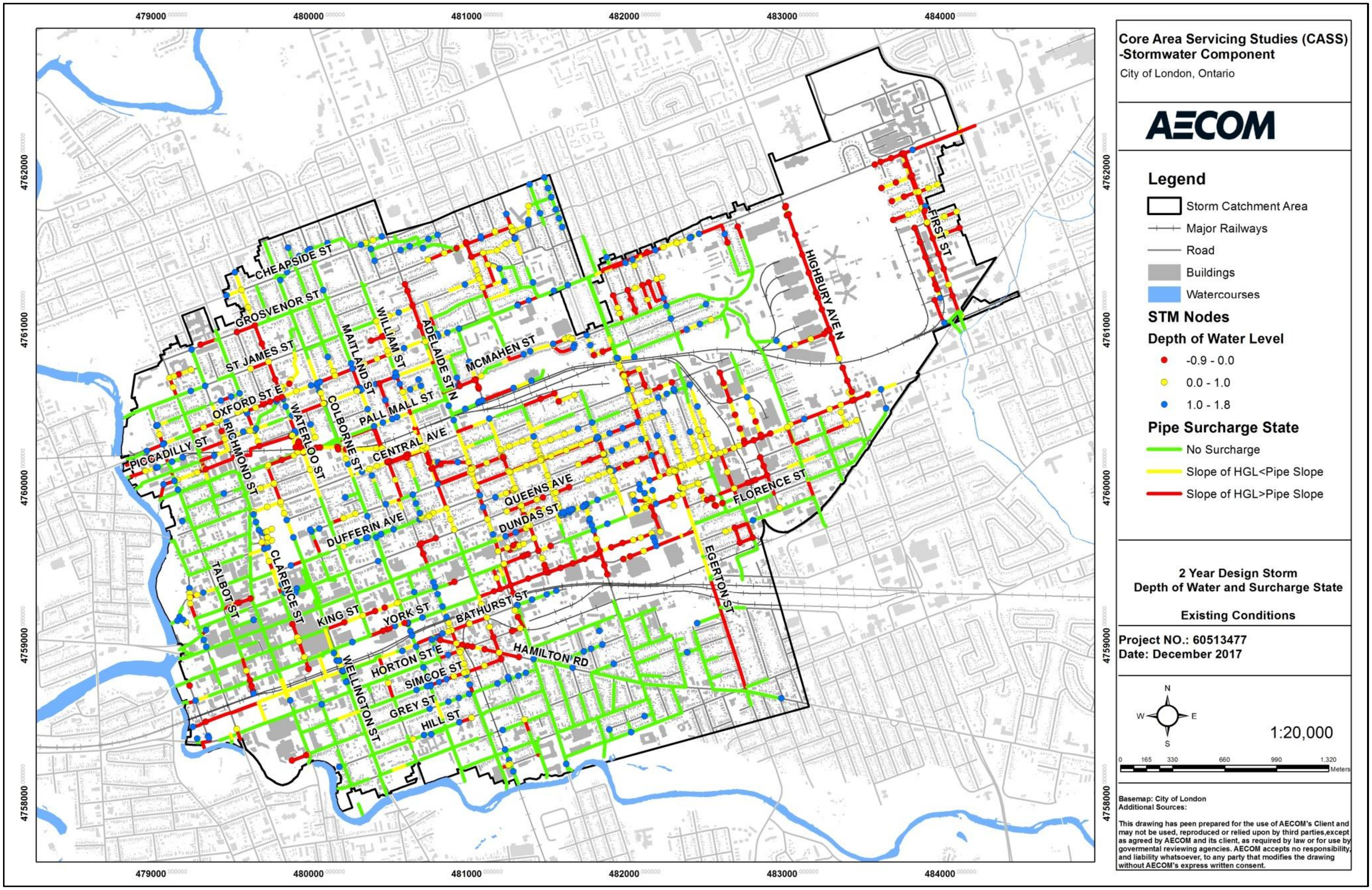


Figure 40: Surcharged Pipes, 2-year London Storm

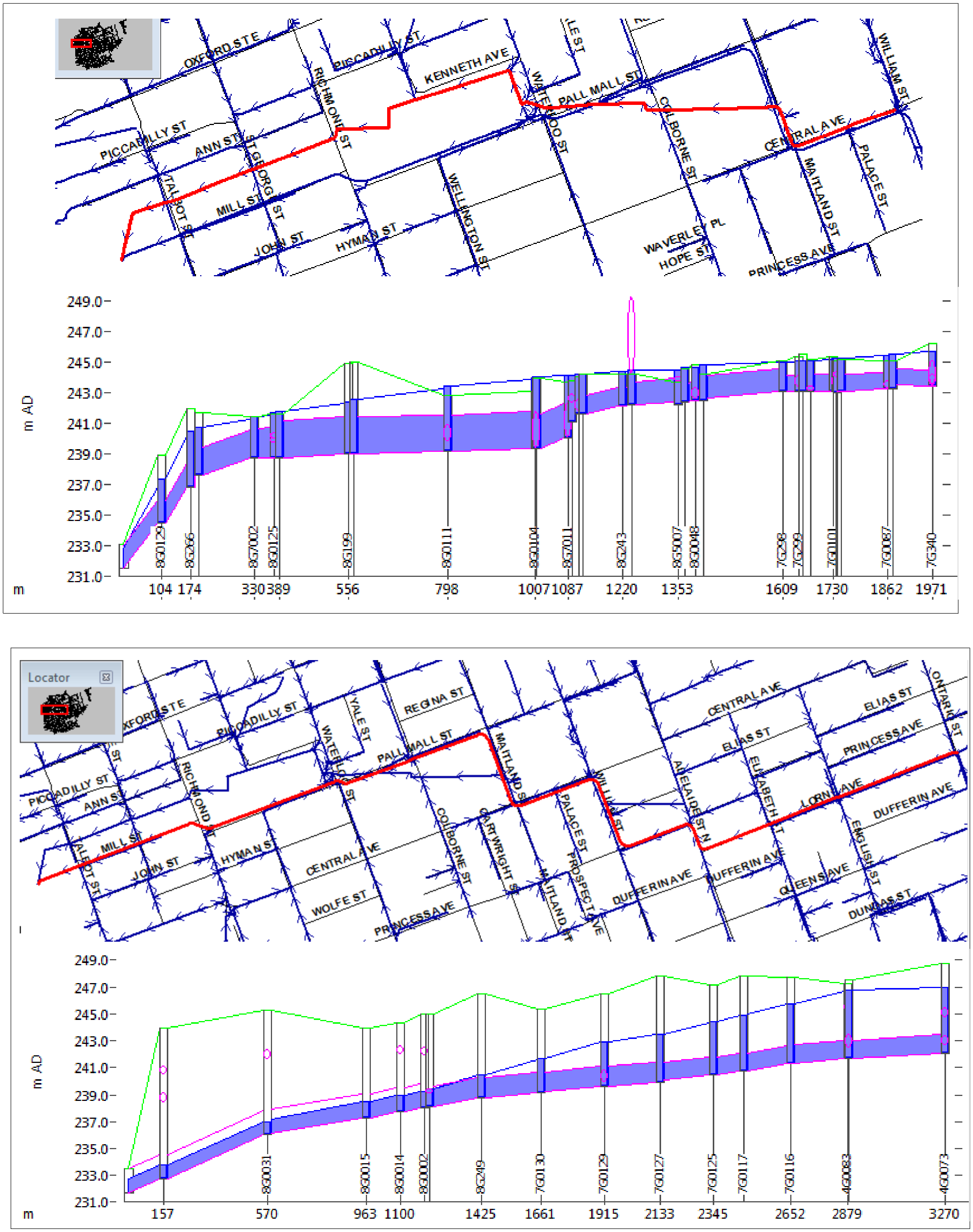
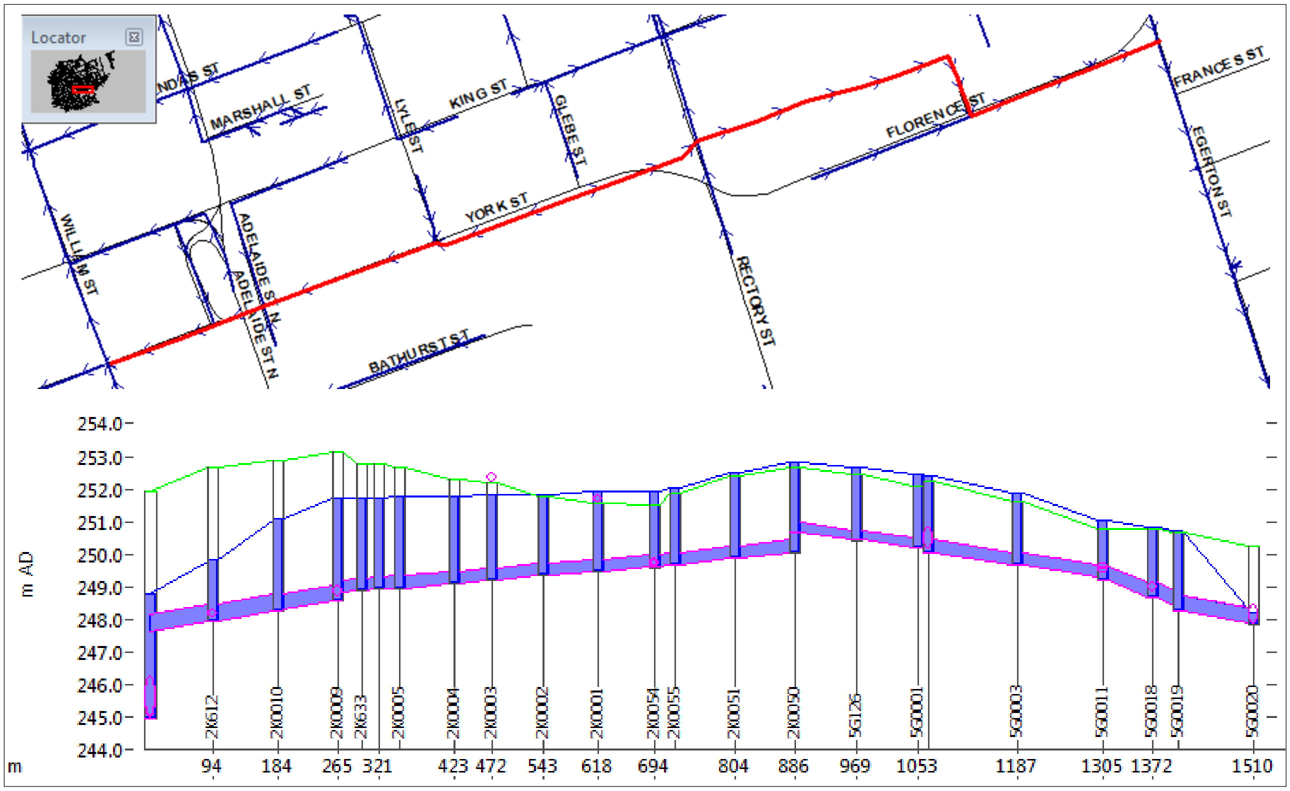


Figure 41: Surcharged Pipes, 2-year London storm



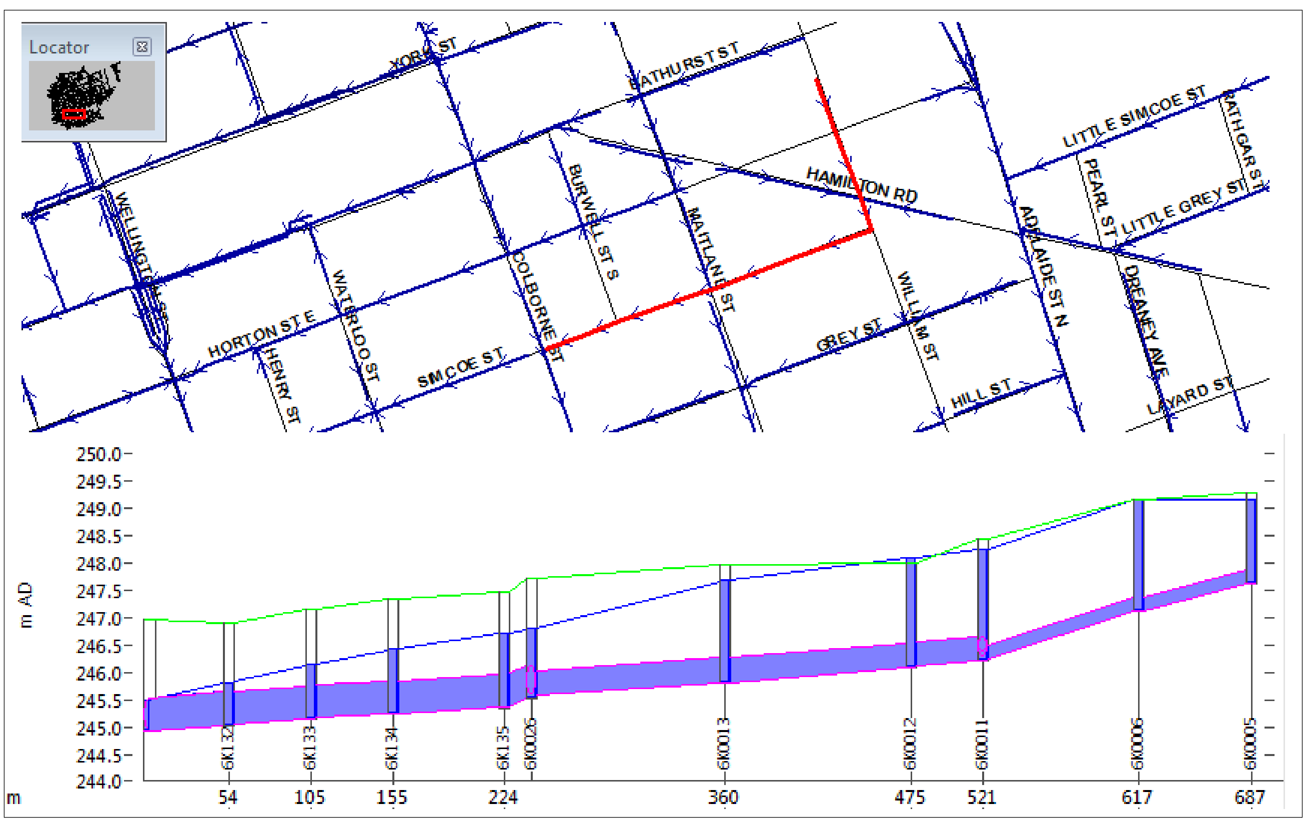
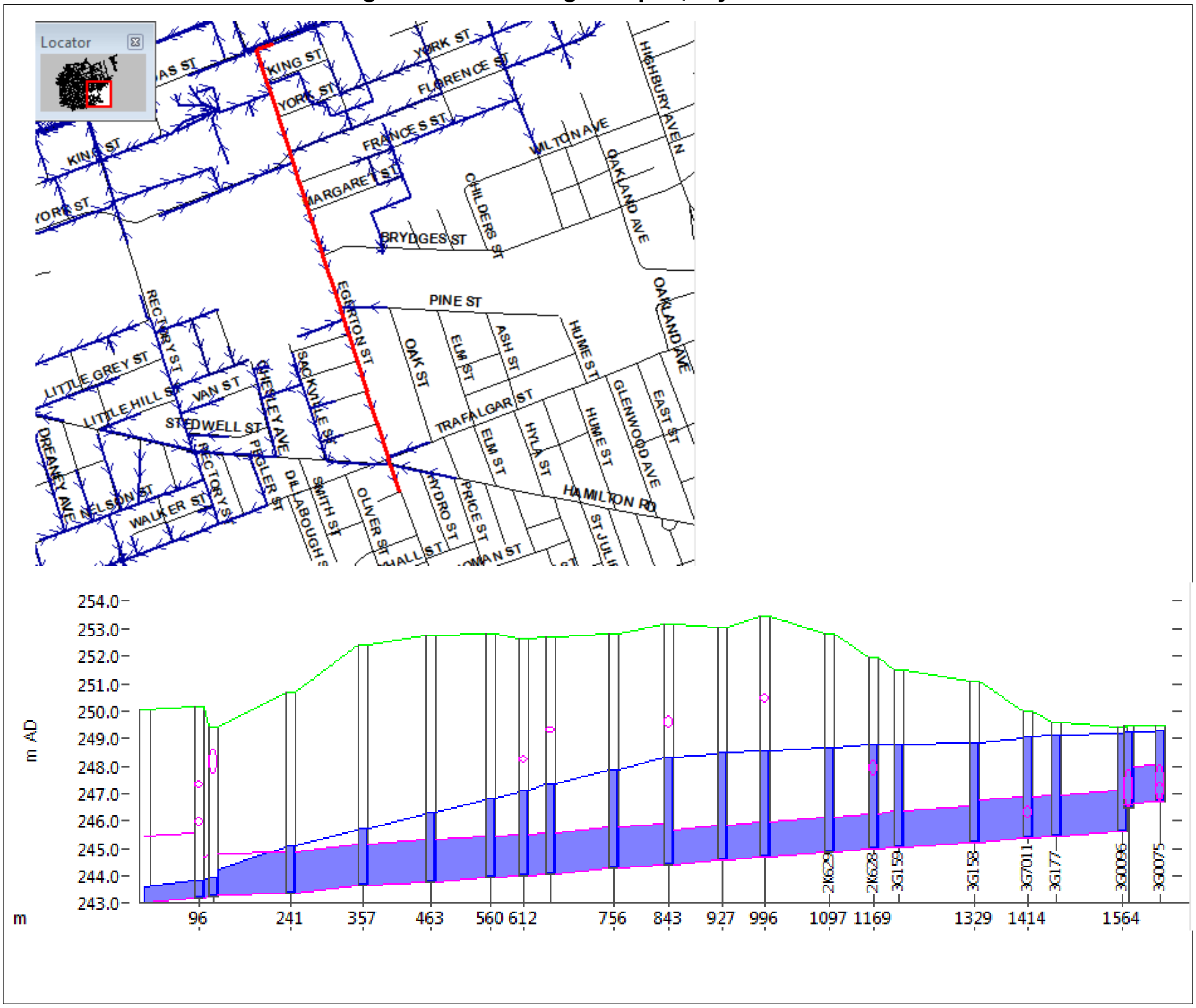
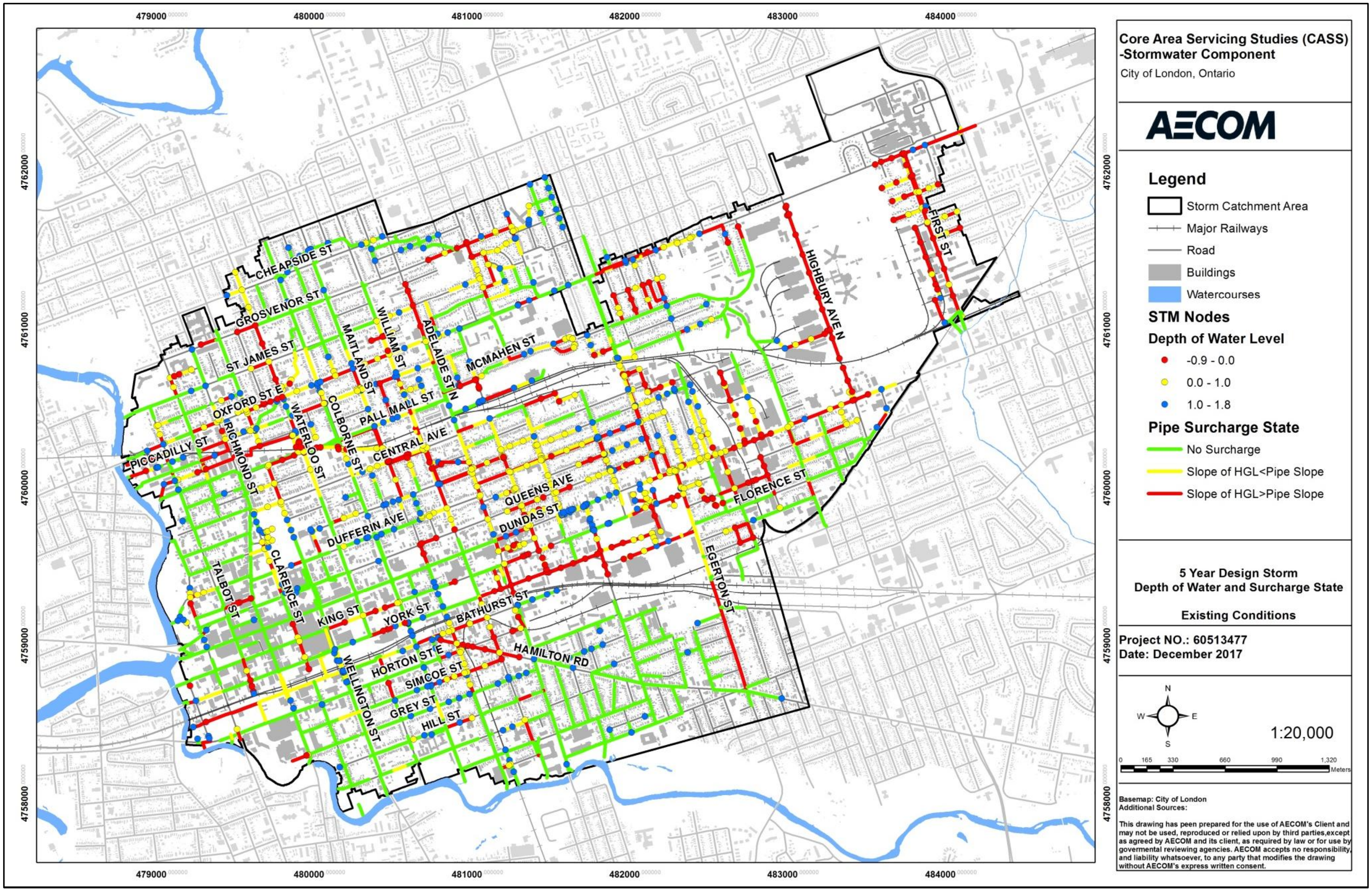


Figure 42: Surcharged Pipes, 2-year London storm



During the 1-in-5 year, 3-hour storm, many of the storm pipes in the Core Area are operating at or near their full capacity and flooding of the ground surface are observed at many locations. This condition is expected since the minor system is has typically been designed to accommodate runoff for the 1-in-2 year storm event. **Figure 43** highlights the storm sewer pipes surcharged and junctions flooded during the 1-in-5 year, 3-hour design storm.

Figure 43: 5 Year Design Storm Depth of Water and Surcharge State



5.10 Major Stormwater System

There are many areas in the Core Area, where deficiencies in the major drainage system have been identified. AECOM identified numerous sag locations in the overland drainage system, where ponding would occur if flows exceeded the catchbasin inlet capacity. At each of these locations, the model included storage volumes characteristic of ponding in the area, and identified spill elevations/directions. Once the capacity of the minor system is exceeded, stormwater will pond up to the threshold ponding elevation and potentially spill outside the road right of way. This local ponding can result in flooding of neighboring properties, damage to private property and represent a safety hazard or barrier to the passage of vehicles. Typically, the water level in the ponded area will decline as hydraulic capacity becomes available in the minor piped system or through evaporation or infiltration into the soils.

The following Figures identify sag locations, overland spill directions, and 100-year model results showing ponding limits and potential flooding concerns.

Figure 44: 100 Year Design Storm Depth of Water on Road Surface

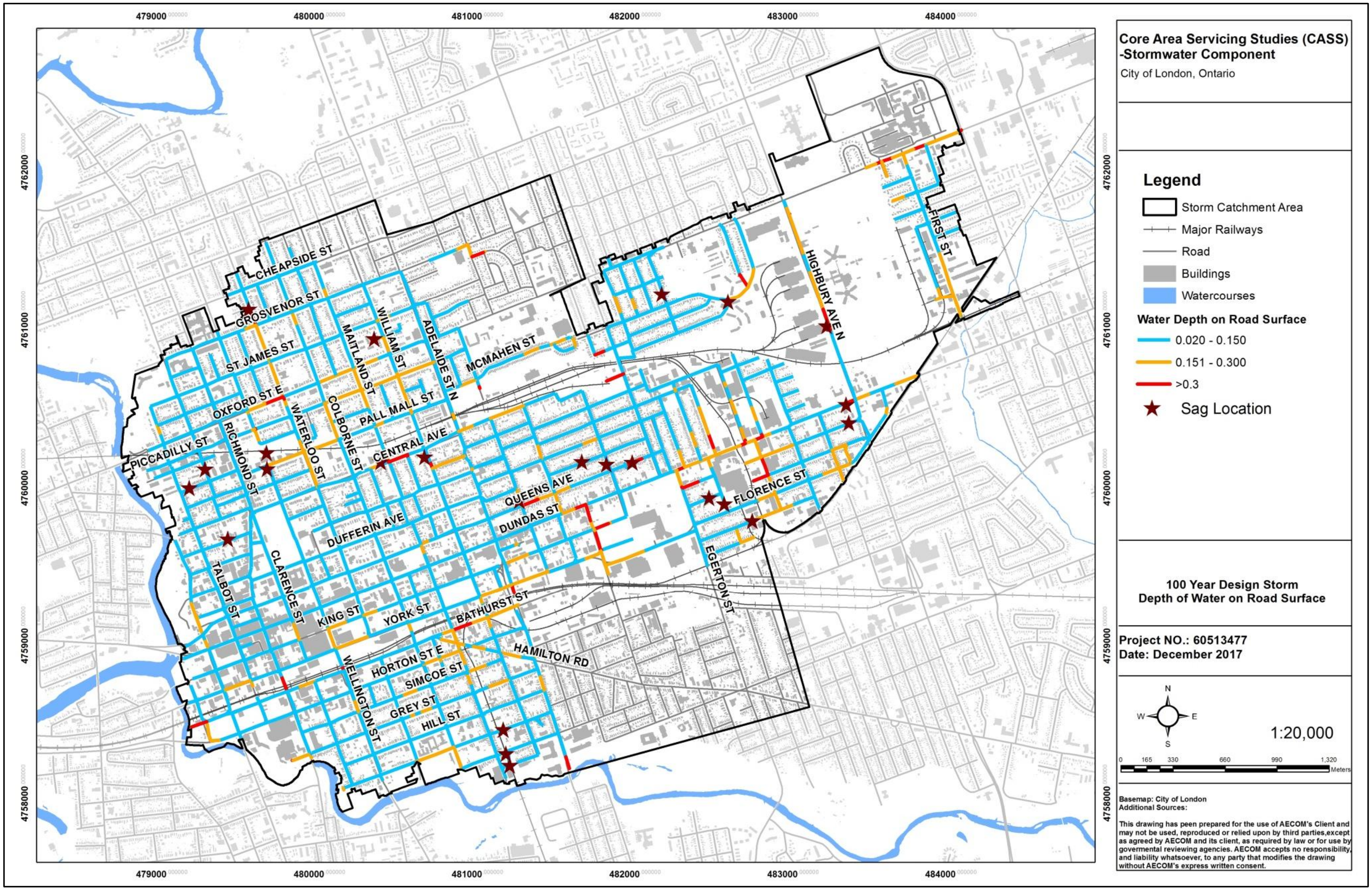


Figure 45: Overland Ponding Areas Identified

Figure 46: Overland Ponding Areas Identified

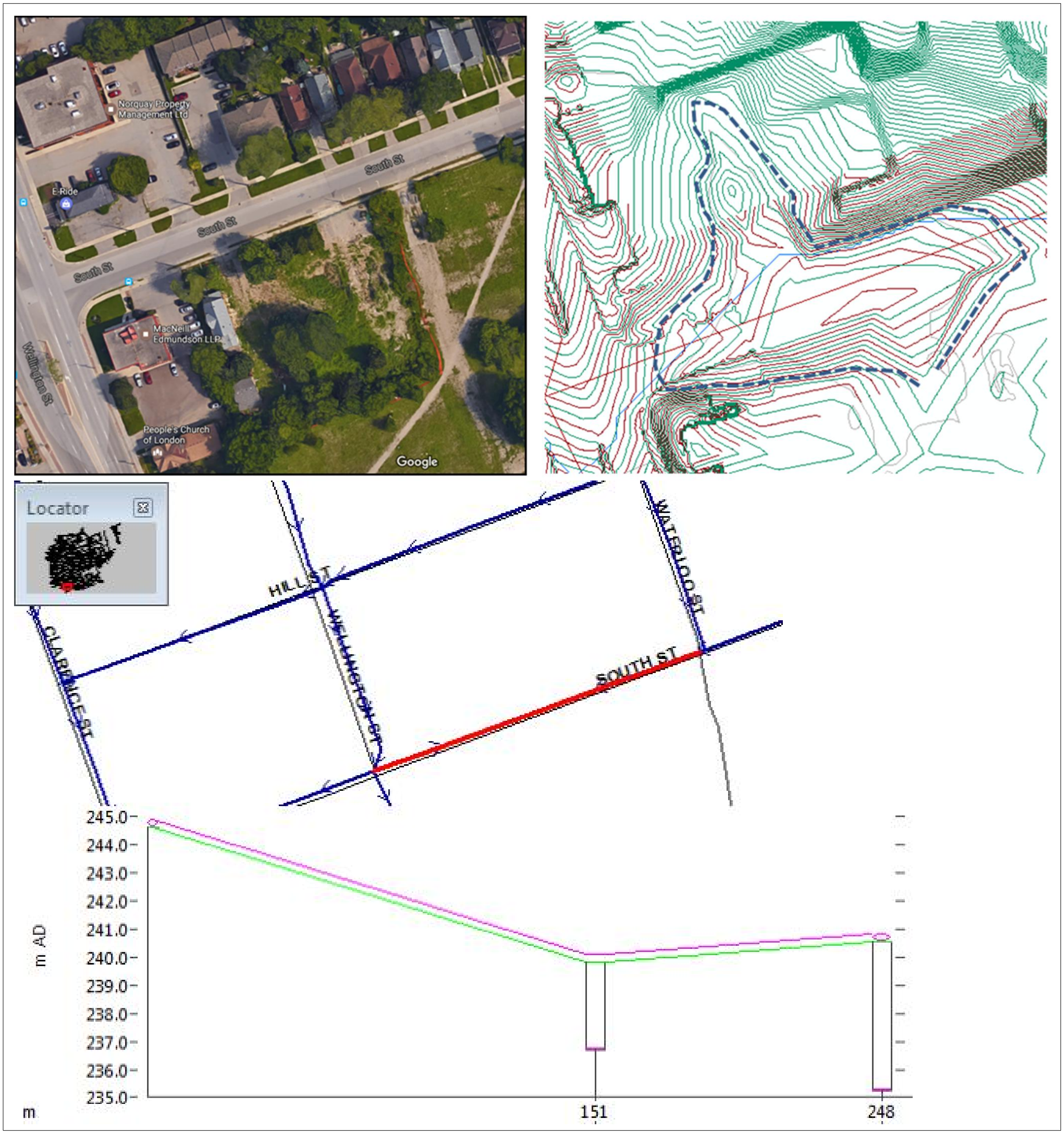


Figure 47: Overland Ponding Areas Identified

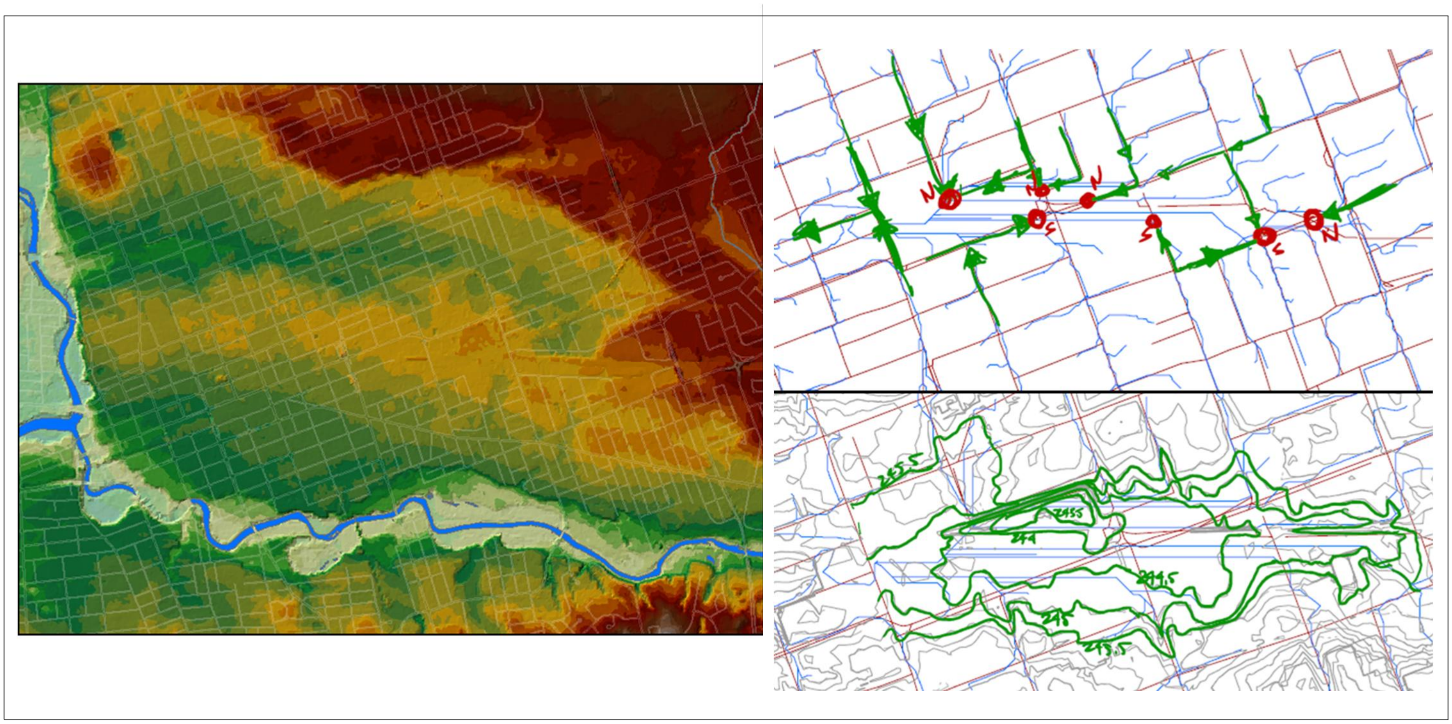


Figure 48: 100 year Flooding

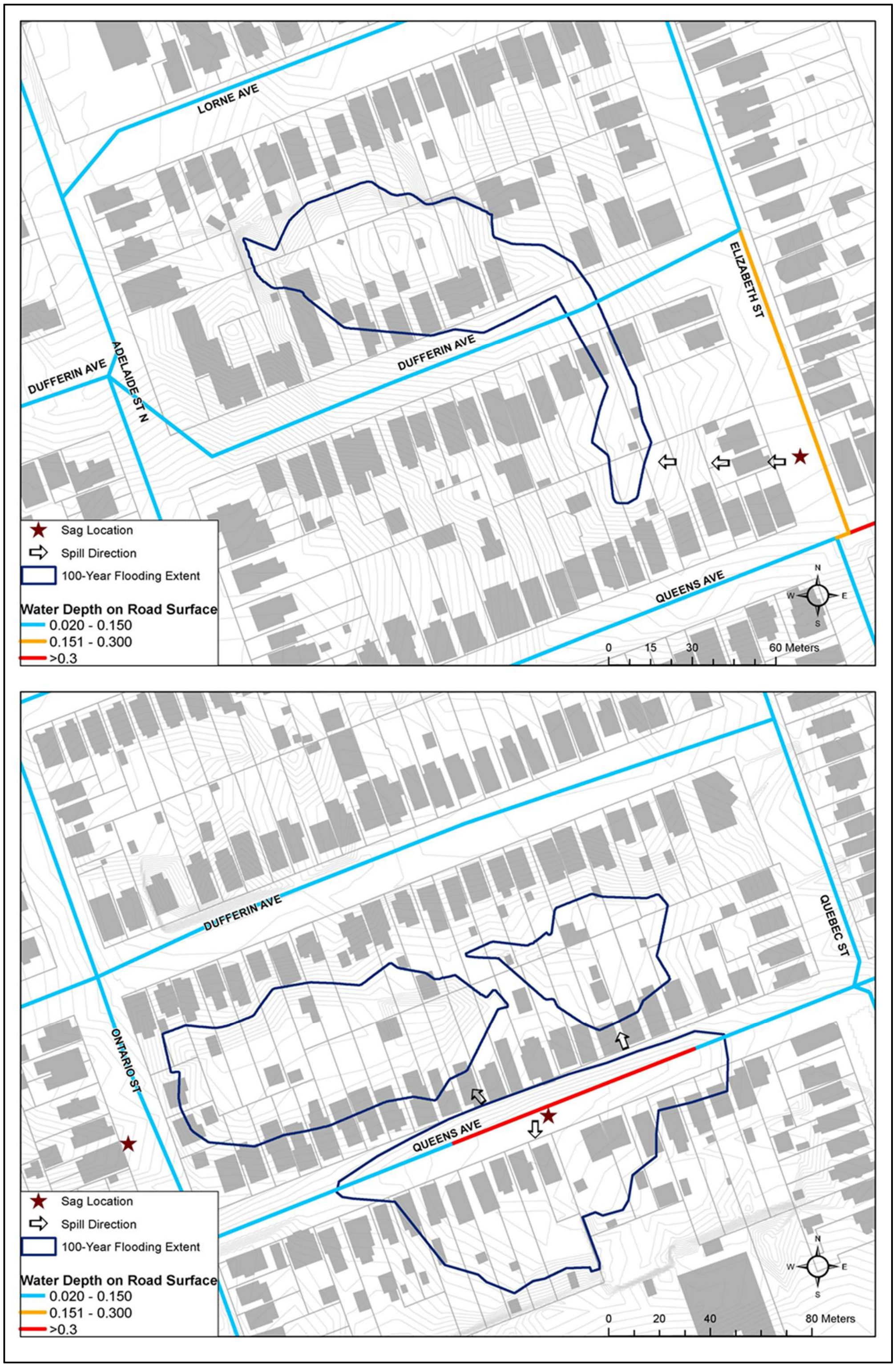


Figure 49: 100 year Flooding

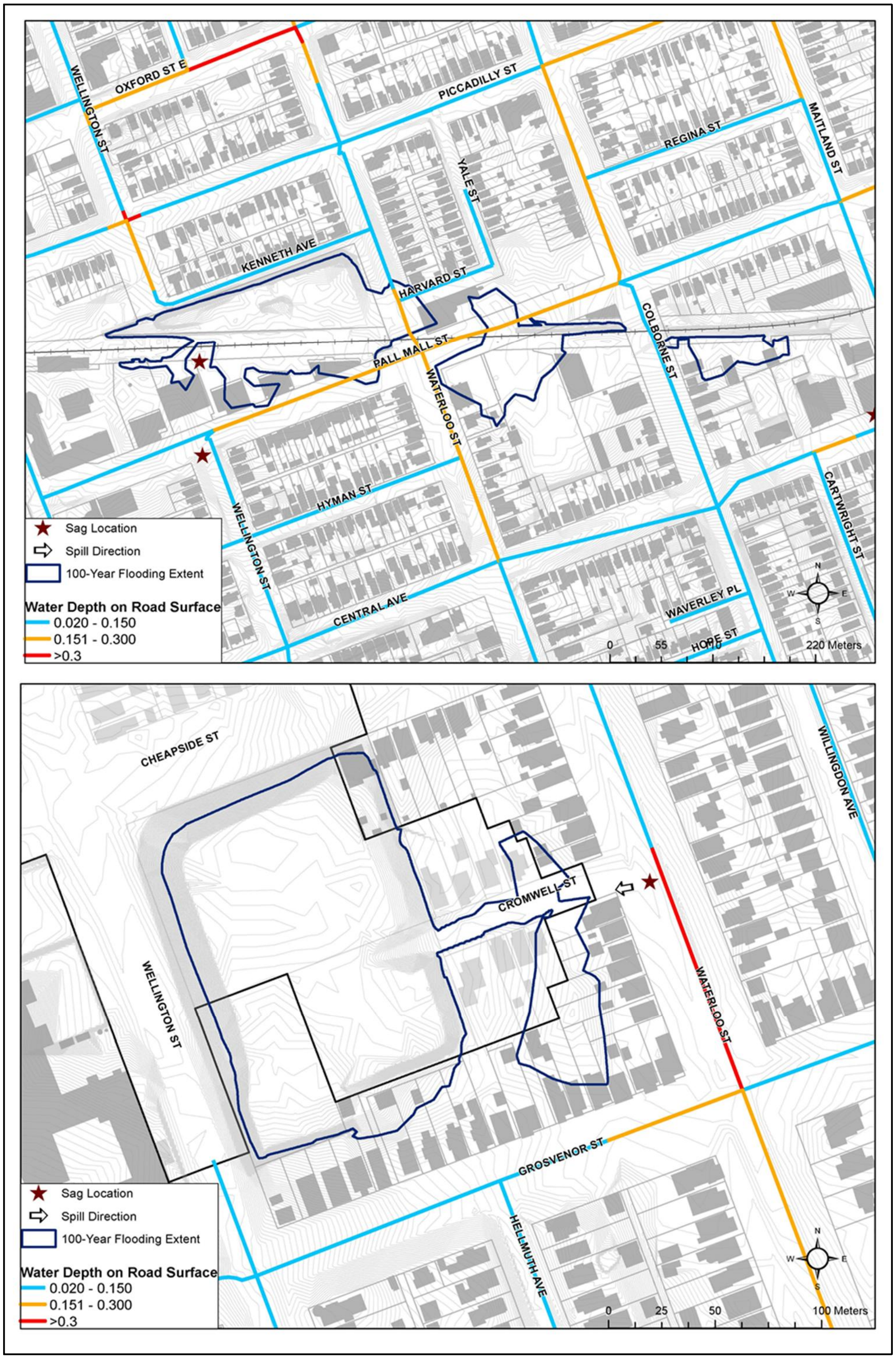
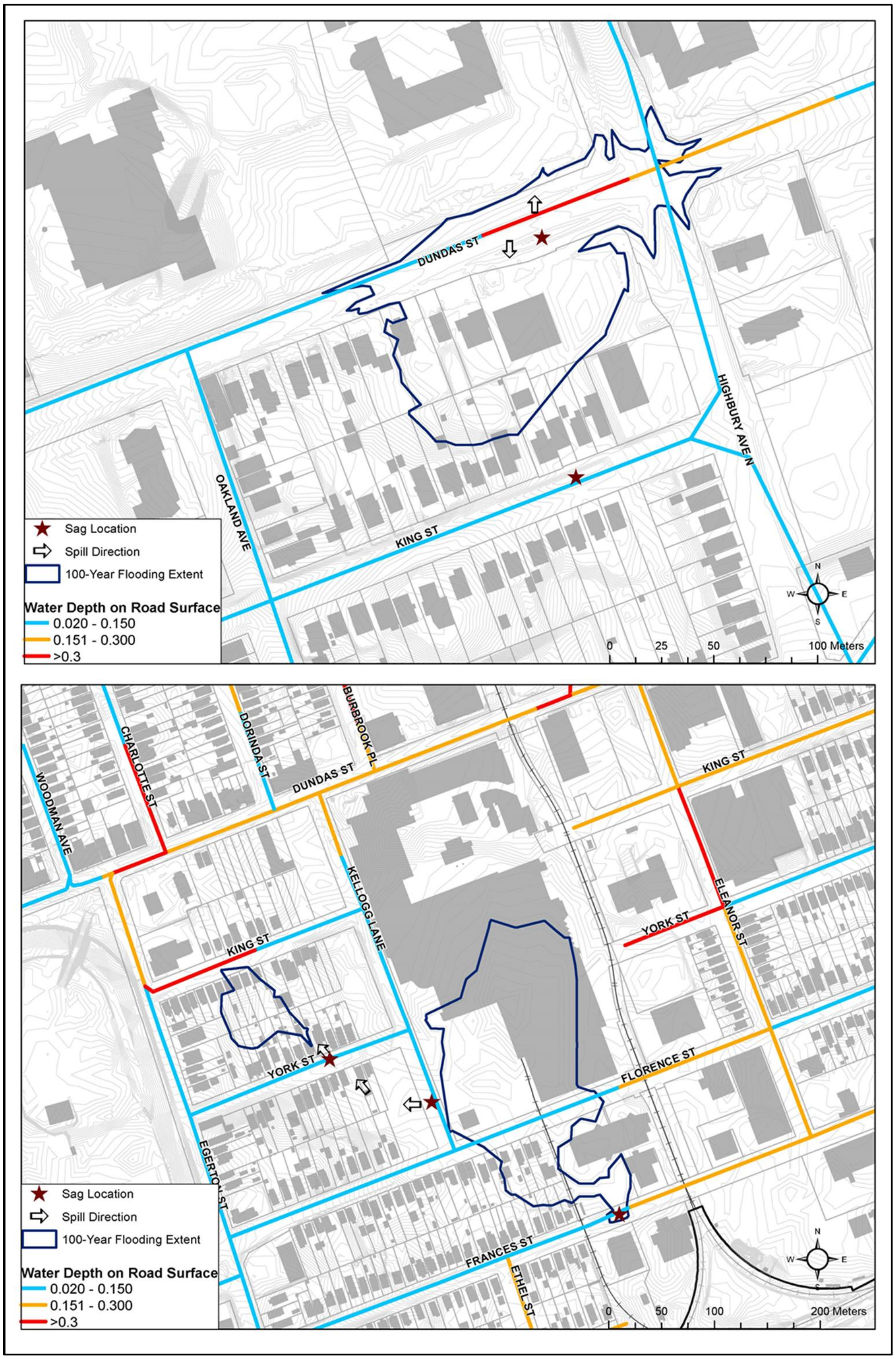


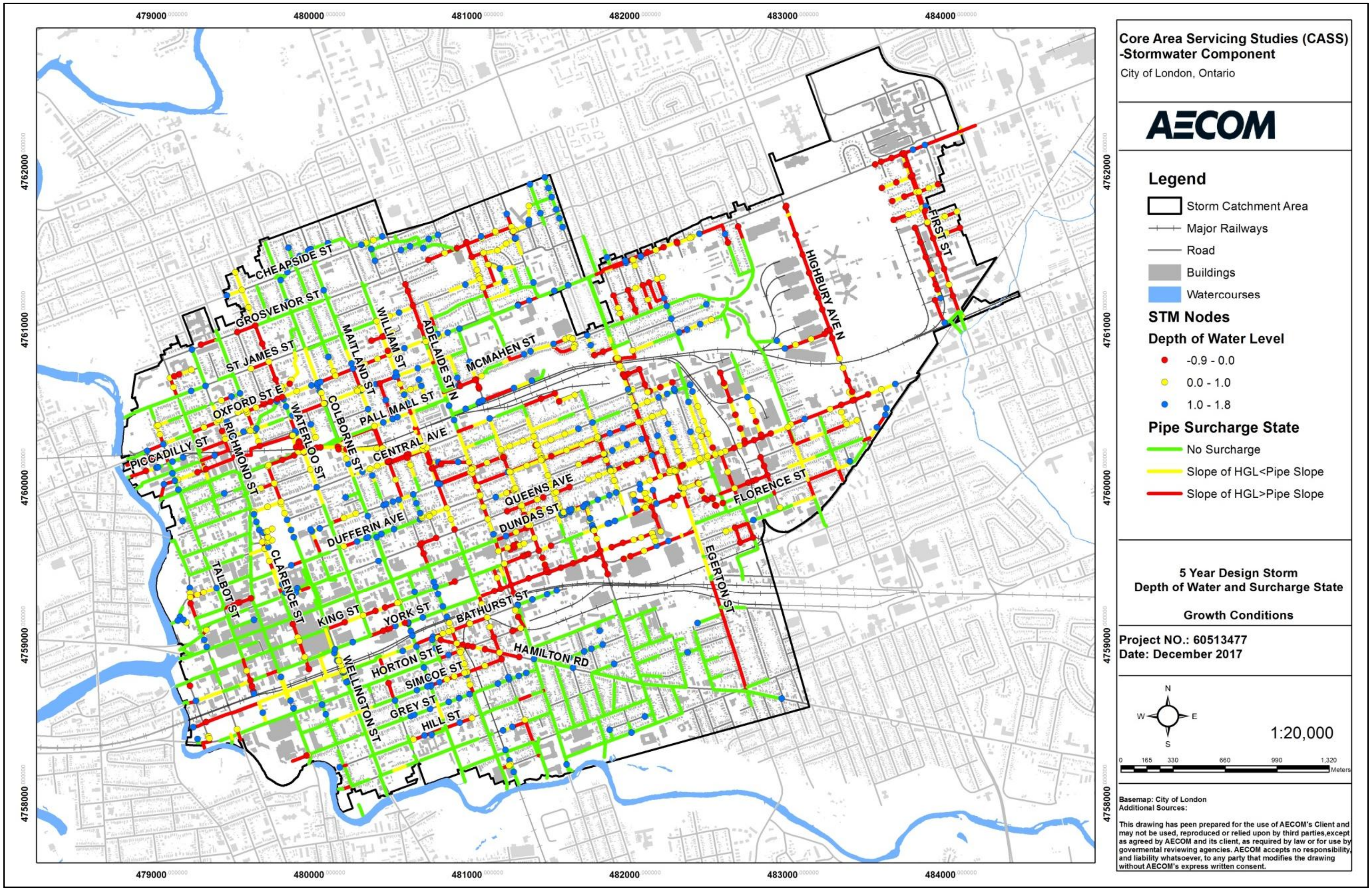
Figure 50: 100 year Flooding



5.11 Existing System Performance with Future Growth

The InfoWorks model of the existing stormwater system with additional future flows was run for a range of design storms events. The Figure below highlights the storm sewer pipes surcharged and junctions flooded during the 5-year, 3-hour design storm under growth conditions. This Figure, compared with the similar Figure for existing conditions, shows a minor reduction in the level of service for the storm sewers servicing growth.

Figure 51: 5 Year Design Storm Depth of Water and Surcharge State under Growth Condition



5.12 Specific Areas of Concern

- There is no overland outlet for old Carling Creek catchment area;
- Existing storm sewers are unable to convey entire 100-year flow;
- Opportunities to replace storm sewers, reroute, increase capacity to reduce risk of flooding upstream; and
- Opportunity to service upstream grade separation with new deeper storm sewer.

Figure 52: Historic Carling Creek

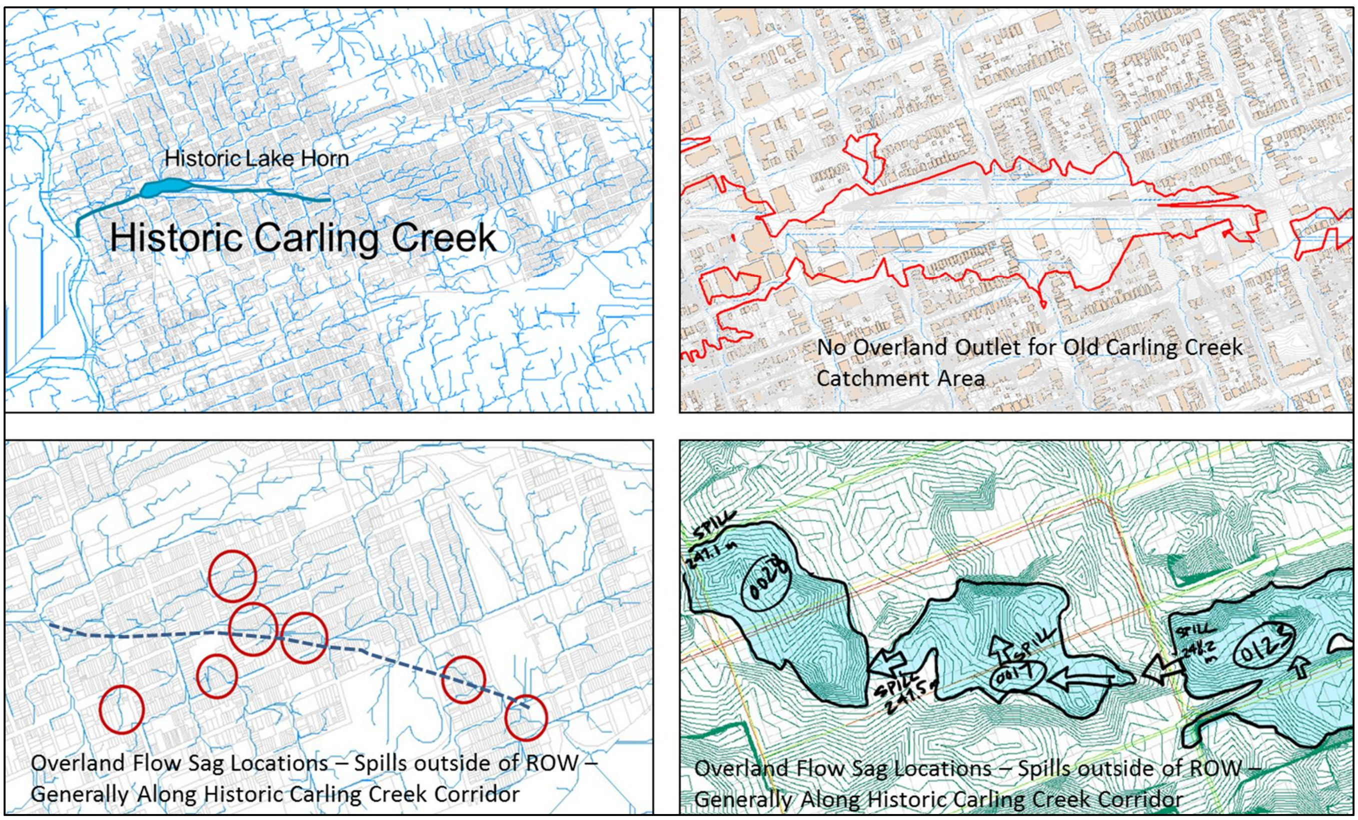


Figure 53: Carling Creek Strom Sewer and Pall Mall Storm Relief Sewer

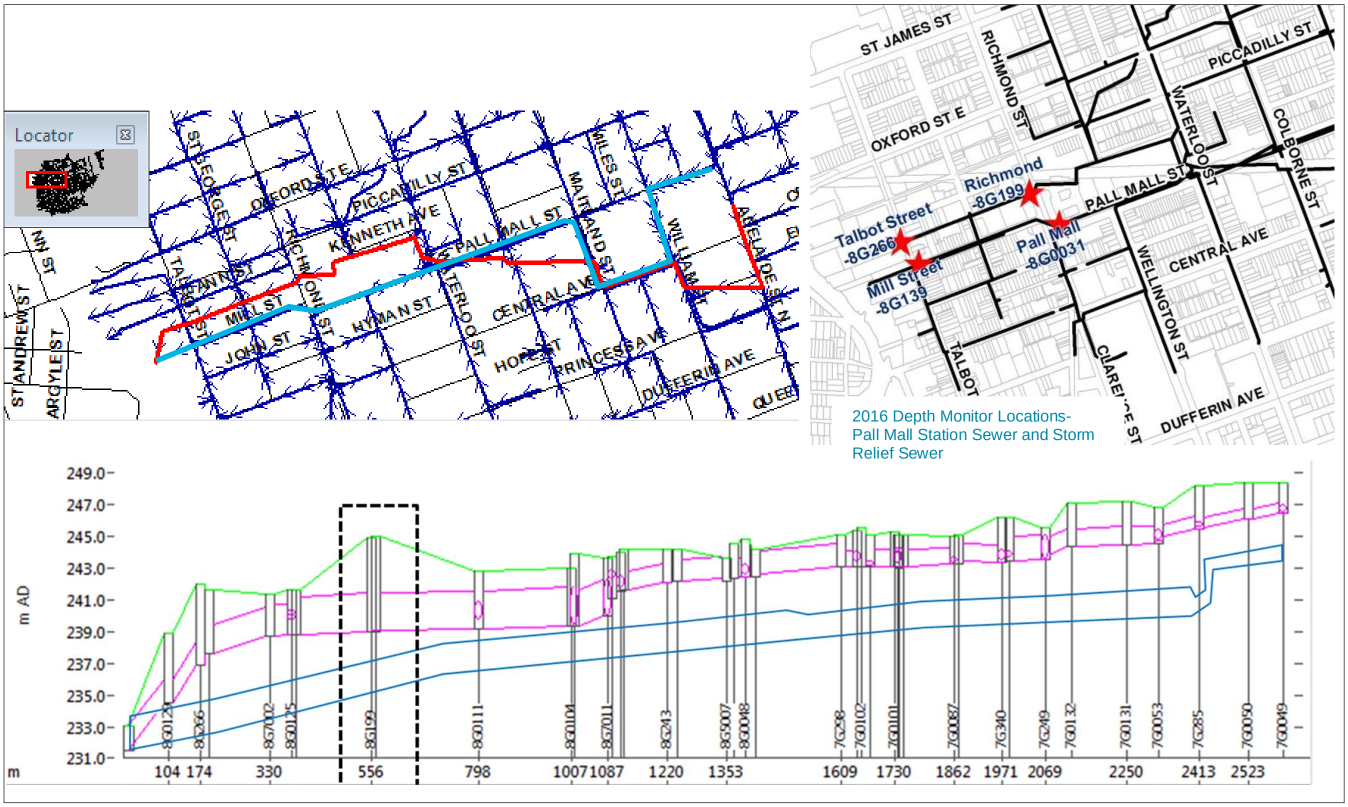


Figure 54: 2016 Monitored Depths- Storm Pipes

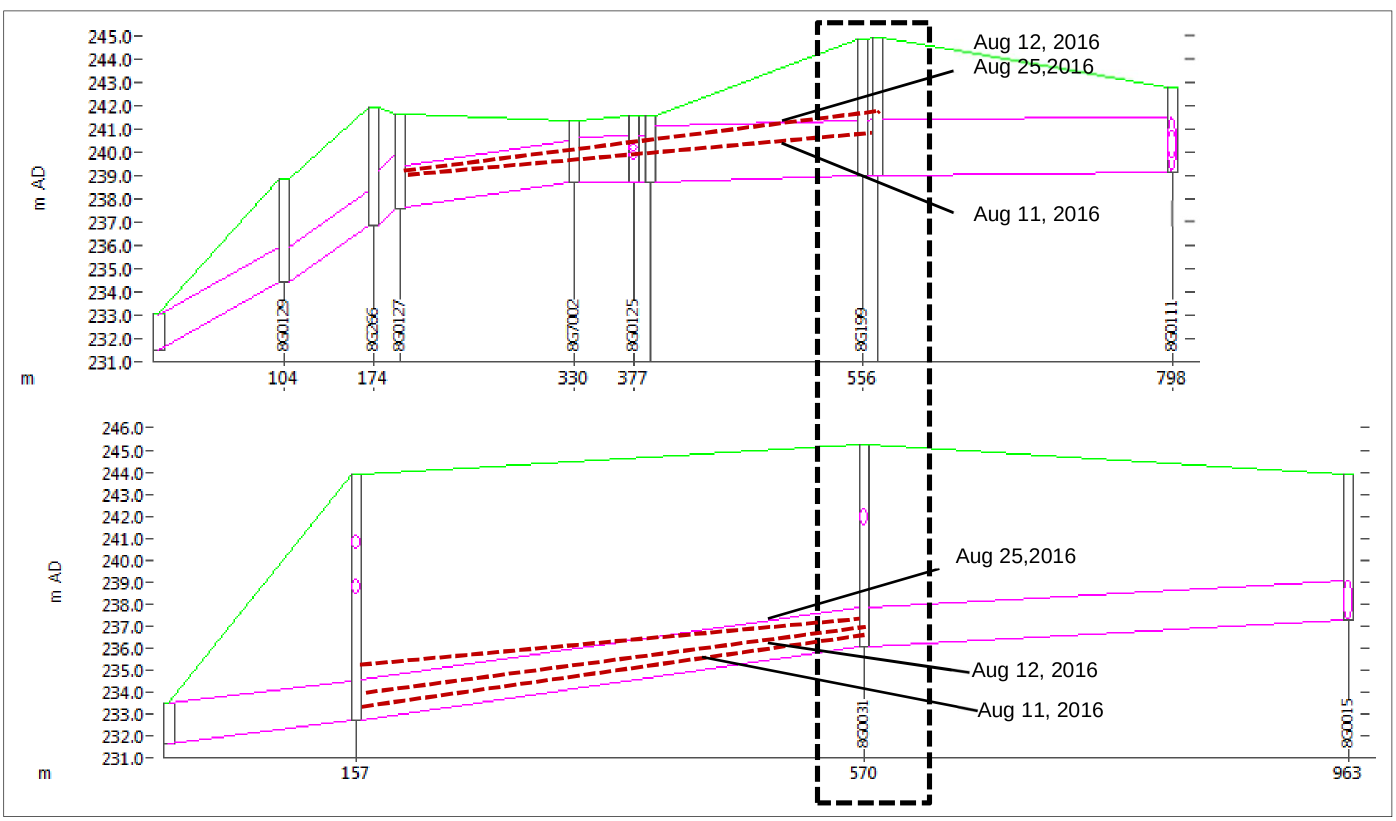


Figure 55: 100-year Surcharge Levels-Storm Pipes

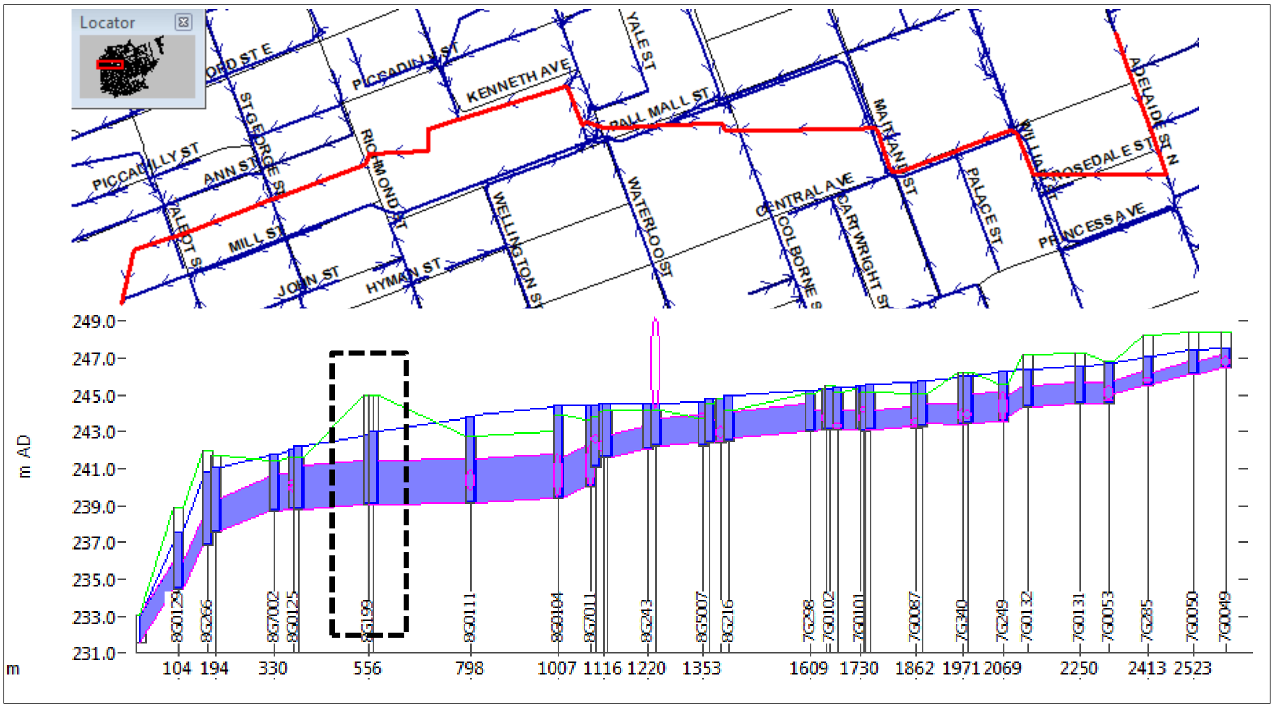
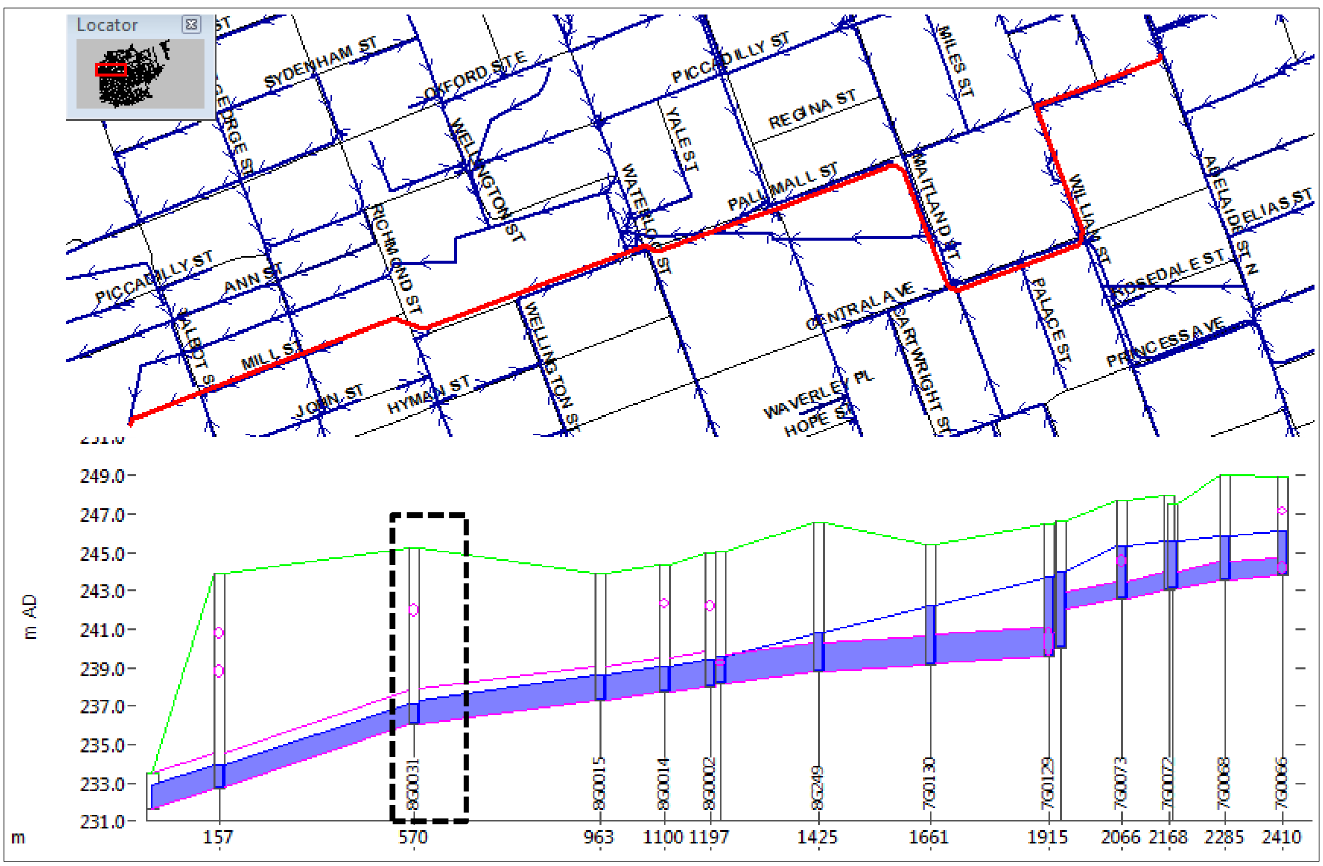


Figure 56: 100-year Surcharge Levels-Storm Pipes



5.13 Findings

Stormwater flows vary in different regions of the core area. The York Street and King Street corridors are serviced by combined sewers; these sewers receive extremely large volumes of wet weather flows through catchbasin connections. These corridors are almost completely impervious in the downtown area; roof drainage is also typically connected to the sewer, leading to extremely large flow volumes.

In the area north of King Street, the sanitary sewers are largely separated from the storm sewers. The storm sewers receive drainage from most of the directly connected impervious areas and roof drains. The portion of roof area that appears to be directly connected to the sanitary sewer has been calibrated in the concurrent core area sanitary model. The Dundas Street storm sewer is the major storm trunk (2,100 to 2,400 mm diameter), collecting storm drainage from most of the study area between Victoria Park and Dundas Street. Importantly, the Dundas Street storm sewer also serves as an overflow relief sewer for the sanitary sewers in the same area, which exhibit high levels of wet weather flows.

In the Pall Mall catchment to the north, land use is a mix of commercial and residential uses, and the sewers are essentially separated. The sanitary sewers, however, still receive a large contribution of wet weather flows, which overflow to the Pall Mall storm relief sewer at numerous locations. The Carling Creek storm trunk sewer and the Pall Mall storm relief sewer flow parallel to each other. Most of the storm flow from the catchment is directed to the storm trunk, while the storm relief trunk largely serves only to collect overflows from the sanitary sewers; however, approximately 10% of the storm catchment drains directly to the storm relief sewer.

6. Works

Coordination of recommended stormwater works was considered with other infrastructure improvements, including wastewater, water and roadwork projects. An overlay map including CASS stormwater, wastewater, water and 2018-2022 downtown capital projects is provided in **Appendix C**.

As the review of the future servicing requirements progressed, all alternative solutions were presented graphically (e.g., location/concept plans) and described to a level of detail that allowed for an understanding of potential impacts from construction and operations and an assessment of those impacts based on evaluation and mitigation.

Alternative solutions were also presented graphically and described to a level of detail that allows for an understanding of impacts from construction and operations and an assessment of those impacts based on evaluation and mitigation. Each servicing alternative was developed in sufficient detail to be able to have an acceptable level of accuracy in terms of:

- Capital costs;
- Phasing;
- System redundancy;
- Existing system utilization;
- Future growth potential;
- Community impacts; and
- Ability to meet implementation schedule.

Based on a thorough review of these parameters, the completion of the modelling analysis and through consultation with City staff, AECOM developed a system upgrade plan, including cost estimate and schedule. Discrete project limits were provided for each project.

A summary of the infrastructure needs and costs is provided in **Table 8** below. These projects are listed as **Table 4 List of CASS Storm Projects** in **Appendix A.** A listing and written description of the works is provided as CASS Project Description Record (PDR's) in **Appendix B**.

Table 8: Summary of Infrastructure Costs

Project	Location	Total ($000s)	Growth ($000s)	Non Growth ($000s)	Growth (%)	Non Growth (%)
1	Carling STM Trunk from Adelaide to Thames/Outlet	$25,268	$0	$25,268	0.0%	100.0%
2	York St from Rectory to William	$2,940	$1,748	$1,192	59.5%	40.5%
3	Bathurst St from Talbot to Thames/Outlet	$2,683	$2,028	$655	75.6%	24.4%
4	William/Simcoe St from Hamilton to Colborne	$2,483	$1,735	$747	69.9%	30.1%
5	Highbury Ave from Oxford to Rail Line	$4,562	$2,548	$2,014	55.9%	44.1%
6	Eggerton St from Brydges to Hamilton	$11,165	$3,475	$7,690	31.1%	68.9%
7	Florence Ave from WFG to Eggerton	$1,195	$742	$453	62.1%	37.9%
8	Wellington St from Central to Pall Mall	$1,078	$539	$539	50.0%	50.0%
9	Waterloo St from Grovener to Oxford	$2,540	$1,025	$1,516	40.3%	59.7%
11	Adelaide St from Grovener to Oxford	$2,097	$1,013	$1,083	48.3%	51.7%
12	Dundas St from Highbury to Ashland	$2,085	$808	$1,277	38.8%	61.2%
13	Dundas St from McCormich to Kellogg	$3,921	$2,335	$1,586	59.5%	40.5%
14	Easement from Highbury to S of Mornington	$3,975	$1,229	$2,746	30.9%	69.1%
15	Lorne St from Quebec to Adelaide	$8,085	$6,295	$1,790	77.9%	22.1%
16	Elliot/Falaise from Grovener to Brant	$4,032	$3,024	$1,008	75.0%	25.0%
17	Ashland Ave from Dundas to Wilton	$5,623	$3,198	$2,425	56.9%	43.1%
18	Quebec St. from Glasgow to Quebec	$3,105	$2,342	$762	75.5%	24.5%
23	Curry St from Piccadilly to Mornington	$716	$489	$227	68.3%	31.7%
		$87,552	$34,574	$52,978	39.5%	60.5%

As a means of showing relevancy of the study and potential impacts of draft policy on future developments, a review of several potential on-going publically declared development applications without current status or draft status in the development process (subdivision or site plan) was undertaken. This report estimated the trigger servicing thresholds of these perceived developments on the infrastructure needs suggested by this report listed in **Table 8** above.

Table 9: Summary of Infrastructure Costs Applied to Emergent Development Applications

Development	Associated Projects	Comment	Draft Non -Growth Cost ($000)	Draft Growth Cost ($000)
560 Wellington Rd	1, 8	Existing issue	$25,807	$539
809 Dundas Street	1, 15	Existing issue	$1,790 *	$6,295*

It is assumed that project 1 has been built as part of 560 Wellington Road prior to the completion of 809 Dundas Street to avoid double counting. Should the reverse occur the additional $25,269,000 would be removed from one and applied to the other. Note that exact servicing requirements for these large towers will be submitted by the proponents and reviewed in detail by City staff and will be based on exact size, location, zoning and usage of the built form.

Variation in servicing needs is expected between the actual development and our servicing needs estimated in this is report. The proponent developers are expected to not rely upon our work, which is solely provided as an illustrative example of how policies and procedures may be applied and are subject to changes and amendments of the upcoming 2019 Development Charge Background Study. Exact cost sharing splits will also depend upon the final development submission servicing needs.

7. References

1. Technical Guide – River & Stream Systems: Flooding Hazard Limit (MNR, 2002)
2. Stormwater Management Planning & Design Manual (MOE, 2003)
3. Design Specifications and Requirements Manual (City of London, 2017)
4. Design Criteria for Sewers and Watermains (City of Toronto, 2009)
5. Wet Weather Flow Management Guidelines (City of Toronto, 2006)
6. Development Requirements Manual (City of Mississauga, 2016)

Appendix A

Tables

TABLE 1

London CASS Survey of Policies - Stormwater Development Charge

Municipality	DC Rate Effective Date	Residential Singles/Semis Stormwater DC	Non-Residential Commercial Stormwater DC (per sq.ft)	Non-Residential Industrial Stormwater DC (per sq.ft)	Notes Regarding DC Rates	Res/Non-Res Split %	Res/Non-Res Split Basis	Items Included in the DC	Local Service Policy Inclusions and Comments
London - Inside Urban Growth Area	January 1, 2016	$ 5,228	$ 3.88	$ -	Industrial development exempt from DCs per DC by-law and Industrial Lands Community Improvement Plan.	82% Res/ 12% Commercial / 6% Institutional	Allocations are weighted using the "Net Amount Eligible for DC rate" for Urban Works Reserve Fund (UWRF)	Storm Sewers with all of the following attributes: - The sewer services external developable areas, and - The sewer is greater than 1050mm in diameter. The oversizing subsidy amounts cover the cost per metre of all associated eligible costs including engineering, manholes, restoration, etc. - Open Channels with all of the following attributes: - An open channel design is required for the reason of inherent site drainage constraints and the design has been accepted by the City Engineer, - The open channel services external developable areas, and - The open channel has a 2-year storm design flow cross-sectional area greater than a 1050mm sewer using the City's minimum design standards. The oversized portion represents the cross-sectional area required in excess of a 1050mm sewer for a 2-year storm design. - Land will be reimbursed at a specific rate, with different land values assigned to different categories as outlined in the Development Charges By-law. - Any storm sewers within a Major SWM Facility block that are either upstream or downstream of a facility. - Any major SWM facility outlet sewer that extends outside the SWM block facility is considered to satisfy a regional benefit to growth.	- Any pipe or portion of a larger pipe that is less than or equal to 1050 mm in diameter are referred to as local works, and undertaken at the Developer's expense. - Costs of all storm sewer systems that are temporary or not defined in the DC Background Charge Study shall be borne by the Developer. - Any temporary works or works not included in the approved Development Charges Background Study are at the sole expense of the Developer including operation, maintenance and decommissioning.
Hamilton	June 6, 2016	$ 6,658	$ 0.67	n/a	New Commercial/Institutional Development - 1st 5,000 sq.ft. - 50% of total DC charge	Stormwater (except facilities): 50%Res / 50% Non-Res Facilities: 100% Res / 0% Non-Res	The costs for all stormwater services except facilities are shared 50%/50% between residential and non-residential based on the benefitting lands associated with the stormwater management works over the 18-year forecast period. For stormwater facilities, the costs identified are attributable 100% to residential development. Non-residential development is required to provide facilities as part of the local service policy	- Storm Sewer mains greater than 1200mm in diameter. - Storm sewers 1350mm diameter in size and larger are considered trunk sewers for the purposes of oversizing and are eligible for DC contribution based flat rates outlined in the City's Financial Policies for Development. - Centralized stormwater management facilities (e.g. wet ponds and dry ponds) identified through the City's Stormwater Master Plan, a Master Plan, a Master Drainage Plan, or a Watershed/Subwatershed Study. - For stormwater facilities which benefit both residential and non-residential only the residential portion will be eligible for DC contributions. - DC contributions allocated to land costs for stormwater management facilities shall be the lesser of the footprint area identified in DC Background Study or the approved design. - Stormwater management facilities	- Storm Sewer mains up to and including 1200mm diameter - Temporary storm sewers. - Installation of private drain connections or private systems . - The construction of on-site open watercourse and overland flow routes for conveyance Internal to a Development. - A stormwater management facility not identified in an approved Master Plan or Subwatershed Study is deemed a local service component. - For stormwater facilities which benefit both residential and non-residential, the portion servicing the nonresidential land uses shall be the financial responsibility of the developer. - The Developer is responsible to acquire lands for stormwater management facilities External to a Development.
			$ 1.00	n/a	New Commercial/Institutional Development - 2nd 5,000 sq.ft. - 75% of total DC charge				
			$ 1.33	n/a	New Commercial/Institutional Development - 10,000+ sq.ft. - 100% of total DC				
			$ -	n/a	Existing Commercial/Institutional Development as of July 6, 2009 - 1st 5,000 sq.ft.of expansion is exempt				
			$ 1.33	n/a	Existing Commercial/Institutional Development as of July 6, 2009 - 5,000+ sq.ft.of expansion - 100% of total DC				
			n/a	$ 1.00	New Industrial development - under 10,000 sq.ft				
			n/a	$ 1.33	New Industrial development - 10,000+ sq.ft				
			n/a	$ -	Existing Industrial development - exempt up to 50% of existing floor area				
			n/a	$ 1.33	Existing Industrial development - over 50% of existing floor area				
Kitchener - Central	January 1, 2016	$ -	$ -	$ -	Stormwater DC was not calculated for the Central Area				Local Service Policy not included in Background Study
Kitchener - Suburbs	January 1, 2016	$ 145	$ 0.27	$ 0.14	For the period of July 1, 2014 to March 1, 2019, industrial development will be charged 50% of the non-residential development charge rate. After March 1, 2019, industrial development will be charged the non-residential development charge rate.	81% Res / 19% Non-res for all projects except Schneider Creek. 60% res / 40% non-res for Schneider Creek	All projects except for the Schneider Creek project is allocated 81 per cent against residential development and 19 per cent against non-residential development. The development-related net capital cost of the Schneider Creek project has been allocated 60% residential and 40% non-residential development in accordance with the above noted Ontario Municipal Board ruling.	- Creek Improvements	Local Service Policy not included in Background Study
Waterloo	January 1, 2016	$ 1,046	$ 0.87	$ 0.87	Charge has been converted from sq.m to sq.ft.	56% Res / 44% Non-Res	This ratio is based on forecast changes in population in new housing units and employment over the planning period	- Storm sewer upgrades - Channel improvements	Local Service Policy not included in Background Study
Guelph	March 2, 2016	$ 125	$ 0.05	$ 0.05	For certain residential plans of subdivision, development charges for water, wastewater, stormwater, roads and related services are required to be paid upon entering into the subdivision agreement.	60% Res / 40% Non-res	The costs for Stormwater Services are shared 60%/40% between residential and nonresidential based on the population to employment ratio over the 19-year forecast period	- Pipe sizes greater than 900mm	The costs of the following items shall be direct developer responsibilities as a local service: - providing all underground services internal to the development, including storm services; - providing service connections from existing underground services to the development; - providing new underground services or upgrading existing underground services external to the development if the services are required to service the development, and if the pipe sizes do not exceed 900 mm for stormwater services. If external services are required by two or more developments, the developer for the first development will be responsible for the cost of the external services and may enter into frontending/cost-sharing agreements with other developers independent of the City; - providing stormwater management ponds required by the development including all associated features such as landscaping and fencing;
Brantford	January 1, 2016	$ 323	$ 0.17	$ 0.17	The charge for industrial developments will be calculated on the basis of gross floor area to a maximum of 25% building coverage multiplied by the non-residential development rate. For example, an application for 20% industrial lot coverage would be calculated based on 20% lot coverage. However, an application for 30% lot coverage would be charged based on the maximum charge of 25% lot coverage.	80% Res / 20% Non-Res	allocated to residential (80%) and nonresidential (20%) development based on population in new units and employment shares calculated in the Analysis of Intensification Opportunities in the City of Brantford Report (to 2031).	- The costs of stormwater studies, with the exception of area-specific local studies, are included in the development charges calculation. These include all required studies as outlined in the City's Official Plan or in other City stormwater management studies. - The cost of new or upgrades to existing stormwater management facilities utilized to manage peak flows, water quality, and/or erosion resulting from a development and that are external to the development are to be included in the development charge calculation. - For development connecting to existing stormwater conveyance system that have identified deficiencies, upgrading of these system are deemed necessary to service the proposed development and are to be included in the development charge calculation.	Local SWM facilities would typically include: - Stormwater management facilities servicing local drainage areas; - Storm sewer oversizing associated with local drainage areas; - Storm sewer works on existing roads. - The cost of local area-specific studies such as Stormwater Area Management Plan studies and/or Site Management reports as outlined in the City's Official Plan are deemed to be a local service and are a direct funding responsibility of the developer. - The cost of stormwater management facilities internal or directly adjacent to the development necessary to manage peak stormwater discharges rates and/or water quality to the existing stormwater system are deemed to be a local service and are a direct funding responsibility of the developer. - Connections to trunk mains and stormwater management facilities to service specific areas are to be a direct developer responsibility.

London CASS Survey of Policies - Stormwater Development Charge

Municipality	DC Rate Effective Date	Residential Singles/Semis Stormwater DC	Non-Residential Commercial Stormwater DC (per sq.ft)	Non-Residential Industrial Stormwater DC (per sq.ft)	Notes Regarding DC Rates	Res/Non-Res Split %	Res/Non-Res Split Basis	Items Included in the DC	Local Service Policy Inclusions and Comments
Windsor - City-Wide	June 1, 2016	$ 6,060	$ 2.49	$ -	Industrial is exempt Windsor also has a designated DC exemption area, see link below for a map of the exemption area: http://www.citywindsor.ca/residents/building/Building-Permits/Documents/SCHEDULE%20A%20TO%20SCHEDUL	94% Res / 6% Non-Res	94 per cent to new residential development and 6 per cent to non-residential development based on shares of population in new units and employment growth in new space to 2024	- Storm Pond expansion - Storm drainage - Storm sewers	Local Service Policy not included in Background Study
Windsor - Area 1	August 2, 2016	$ 4,545	$ 1.87	$ -					Local Service Policy not included in Background Study
Ottawa - Area 1 - Inside the Greenbelt	August 1, 2016	$ 44	$ 0.04	$ 0.02	City Wide Calculation plus: Area Specific Charges for the following areas (ponds and other SW management works) Cardinal Creek Erosion Works Gloucester Urban Centre Inner Greenbelt Ponds Leitrim - South Urban Centre Monahan Drain N5 and Channelization Nepean Ponds in Parks Nepean South Urban Centre Riverside - South Urban Centre Shirley's Brook Range of $744 to $6,811 per Single detached unit Range of $0.63 to $7.52 per Sq.ft. for Non-residential	Cardinal Creek Erosion Works (70%/30%) Gloucester Urban Centre (63%/37%) Inner Greenbelt Ponds (41%/59%) Leitrim - South Urban Centre (83%/17%) Monahan Drain (92%/8%) N5 and Channelization (81%/19%) Nepean Ponds in Parks (18%/82%) Nepean South Urban Centre (55%/45%) Riverside - South Urban Centre (58%/42%) Shirley's Brook (50%/50%)	The benefiting area comprising each recovery area has been measured with respect to the development potential in terms of the land area, number of residential units by type and the floor area of non-residential development. The costs have been allocated to residential vs. non-residential development based on the background Stantec report.	The development charge benchmark for pipe size and flow is based on a 30 ha town house development. - Only over-sizing costs for trunk storm sewers meeting the combined criteria of having a nominal pipe diameter being equal to or greater than 1800 mm and having a flow greater than 3600 l/s are considered to be development charges projects. The contribution towards 'over-sizing' through development charges for pipes equal to or greater than 1800 mm and having a flow greater than 3600 l/s shall be the cost in excess of the cost of a 1650 mm storm sewer and shall increase as the pipe size increases as follows: Size of Storm Sewer Charged to DCs 1650 mm NIL 1800 mm (cost of 1800mm less cost of 1650mm) 1950 mm (cost of 1950mm less cost of 1650mm) 2100 mm (cost of 2100mm less cost of 1650mm) 2250 mm (cost of 2250mm less cost of 1650mm) Larger pipe sizes (cost of larger pipe less cost of 1650mm) Storm Water Management Facilities - Where the City deems, through an approved study, that it is preferable to provide centralized facilities to serve growth-related projects controlled by multiple owners, they are considered development charges projects.	Storm Pipe Sizes of 1650mm and smaller. - Where conditions of a particular development require on-site over-sizing, the onsite over-sizing shall be the developer's responsibility. - Unless identified as a development charges project, all storm sewers are considered to be the developer's responsibility. Storm Water Management Facilities - Where the City deems, through an approved study, that it is preferable to provide centralized facilities to serve growth-related projects controlled by multiple owners, they are considered development charges projects. - Quality and quantity works benefitting the owner on whose lands the works are located will be responsible for their proportionate share of the work. - All other stormwater quality and quantity works are a direct developer responsibility.
Ottawa - Area 2 - Outside the Greenbe	August 1, 2016	$ 44	$ 0.04	$ 0.02					
Ottawa - Area 3 - Rural Serviced	August 1, 2016	$ 44	$ 0.04	$ 0.02					
Barrie - Former City Municipal Boundary Areas	January 1, 2016	$ 3,627	$ 1.03	$ 1.24	City also has one area specific charge which was to facilitate a front ending agreement	70% Res / 30% Non-Res	The residential/non-residential share is based on respective land area within the Former City Municipal Boundary Areas and is calculated as follows: Residential Gross Land Needs (acres) / [Residential Gross Land Needs (acres) + Non-residential Gross Land Needs (acres)] = 2,117.84 ÷ (2,117.84 + 900.18) = 70% Residential / 30% Non-residential	Former City Municipal Boundary Areas – Stormwater drainage and control services are included in the DC calculation as listed in this study.	Former City Municipal Boundary Areas – All other stormwater management requirements, including oversizing, are considered a "local service".
Barrie - Salem & Hewitt's Secondary Plan Areas (Annexation Lands)	January 1, 2016	n/a	n/a	n/a	New annexation lands will require developers to build all works 100% Direct Developer Responsibility			Salem & Hewitt's Secondary Plan Areas – Stormwater drainage works associated with arterial roads included in the DC calculation as part of the road project.	Salem & Hewitt's Secondary Plan Areas – All other stormwater drainage works are a "local service" and will be the responsibility of the developing landowners to provide.

Table 2a Storm Conveyance System Design Criteria Comparison between Municipalities

		City of London	City of Toronto	City of Mississauga
Design Storm		City of London IDF curves	City of Toronto IDF curves	City of Mississauga IDF curves
Level of Protection	**Minor System**	• 2-year McLaren (Synthetic IDF approximates 5-year historical IDF)	Existing Separated Areas [1] • General: 2-year without surcharge • Urban Arterial Roads: 10-year free flow • Road Underpasses: 10-year – 25-year free flow Greenfield Development • Max. hydraulic grade line 0.5 m below basement floor elevation or > 1.8 m below crown of road for 100-year event • Local roads: 2-year free flow • Collector roads: 5-year free flow	• Local sewer: 10-year • Trunk sewer: 25-year
	Major System	• 100 year storm for conveyance in ROW • 250 year storm provision for safe conveyance	Existing Separated Areas No negative impact on an existing major system Greenfield Development 100-year	• Regional storm or the 100 year storm
Flow Calculations		Rational Method on standard design chart	• Rational Method (if area < 40 ha and outlet isn't submerged) • Dynamic Computer Models (if area > 40 ha, SWM or risk of experiencing surcharge), with calibration recommended	• Rational Method (only if < 10 ha) • Computer Models (> 10 ha)
Runoff Coefficient (C)		No minimum C restriction for pre-development peak run-off rates. Applies the following C values for proposed development: • Parks, open space and playgrounds 0.20 • Single family/ semidetached 0.50 • Townhouse/ row house 0.65 • Apartments 0.65 - 0.70 • Commercial, institutional and industrial 0.70 - 0.90 • Densely built, paved 0.90	A maximum value of C used in calculating the predevelopment peak runoff rate is limited to of 0.5	Minimum C for undeveloped upstream area external to the subdivision of: • Future residential development: 0.55 • Future industrial or commercial development: 0.75
Max. Major System Ponding Depth		300 mm	• Local Road: < 15 cm above crown of road or water level up to the right-of-way • Collector: < 10 cm above crown of road or water level up to the right-of-way • Arterial: No barrier curb overtopping	• All classes of roads: depth of water at the gutter times the velocity of flow shall not exceed 0.65 m^2/s • Arterial Roads: < 0.15 m at road crown • For minor storm (1:10 year), flow across road intersection is not permitted.
Storm Sewer Outlet to Watercourse		Headwalls are required	Obvert of sewer must be above the 25 year storm elevation of the creek	Obvert of sewer must be above the 25 year storm elevation of the creek
Flow Spread Specifications		×	✓	×

Note:

1. Existing separated areas are defined as all currently developed areas other than combined sewer areas that have been designed and constructed with minor drainage systems only

Table 2b Stormwater Management (SWM) Design Criteria Comparison between Municipalities

	City of London	City of Toronto	City of Mississauga	MOECC
Design Storm Distribution	3-hr Chicago/AES	Specified for each watershed	SCS/Chicago	Specified for each watershed
Modeling Method	• SCS • Horton • Green-Ampt	• Rational Method (only if < 2 ha and outlet isn't submerged) • Computer Modeling otherwise	• Modified rational method or equivalent • Recommends following the M.T.O. Drainage Management Technical Guidelines	• Computer simulation modelling • Transpose a frequency analysis of measured peak flow rates on a unit area basis
Design Storm	Specific to each watershed/sewershed	Specific to each watershed/sewershed	Specific to each watershed/sewershed	Specific to each watershed/sewershed
Quantity Target	Specific to each watershed/sewershed	Discharge to Municipal Infrastructure • All infill development or re-development • All rezoning application • All commercial, institutional and industrial site plan applications Discharge to Specific Watercourse • TRCA Flood Flow Criteria [3]	Specified in master drainage or Subwatershed plans	Maximum peak flow rates must not exceed pre-development values for storms with return periods ranging from 2 to 100 years
Water Balance	Specific to each watershed/sewershed	• Annual volume of overland runoff allowable from the development site under pre-development[1] conditions • Minimum on-site runoff retention of 5 mm	×	×
Water Quality Target	• Ref. MOE standard • Addition requirement identified in applicable Subwatershed studies	<u>TSS</u> 80% removal <u>E-Coli</u> • < 1000/100 mL for wet weather periods • < 100/100 mL for dry weather periods	Specified in master drainage or Subwatershed plans and the City storm water quality study	Three levels of protection are identified based on long-term S.S. removal rate
Erosion Control Target	• Minimum of 40 m^3/ha of extended detention storage • Addition requirement identified in applicable Subwatershed studies	• Specific to each watershed/sewershed • Erosion control in the form of stormwater detention is not required for small infill/redevelopment sites < 2 ha	×	×
Roof Drain/Downspout	×	• All roof drain will discharge to the surface away from the foundation wall • No new connection to sewers are allowed	Roof leaders must not be connected directly to the storm sewer system	Opportunity to discharge to ponding areas or soakaway pits
Foundation Drain	Indirect connections of foundation drain via sump pumps to storm private drain connections are permitted	Must be pumped to surface through the use of sump pump	If basement floor is at least 1.0 m above the storm sewer obvert: Connect to the storm sewer system y gravity. Otherwise, sump pump system must be installed.	Opportunity to discharge to soakaway pits
Low-Impact Development (LID)	Design Requirements for Permanent Private Stormwater Systems will apply to all locations for subdivision and site plan and condominium development applications with the following land uses: • Medium and high density residential, • Institutional, • Commercial, and • Industrial	Strongly encouraged	Not mentioned	Integrated treatment train approach recommended[2]
Infill or Redevelopments	On-site private stormwater systems located in the Central Thames Subwatershed (likely infill) must be designed and constructed based on the following design criteria: • The flow from the site must be discharged at a rate equal to or less than the existing condition flow, • The discharge flow from the site must not exceed the capacity of the stormwater	Specific requirements depending on the type of infill	×	Various SWMP options considered for different type of infill developments

	City of London	City of Toronto	City of Mississauga	MOECC
	conveyance system, • The design must account the sites unique discharge conditions (velocities and fluvial geomorphological requirements), • “normal” level water quality is required as per the MOE guidelines and/or as per the EIS field information; and • Shall comply with riparian right (common) law.			
Off Site System/Cash-in-lieu Option	×	May be considered if on-site SWM is ineffective or impractical due to physical constraints	Facility Cost Basis	May be considered if on-site SWM is ineffective or impractical due to physical constraints

TABLE 3
CITY OF LONDON
CASS STORMWATER UPDATE 2016
UNIT RATE COSTS FOR SEWERS
(Revised April 27, 2017)

PIPE COSTS

Based on 2014 Concast reinforced circular concrete pipe price list, includes pipe and gaskets.
200mm and 250 mm pipe cost was extrapolated based on other 2014 pipe prices
All pipe prices inflated to 2017 using Statistics Canada Infrastructure Construction Price Index. As it only provides data to 2015 Quantity Survey estimating resource(BTY) was used for 2016-2017 At 2.5% per annum.

	Diameter																									
Depth	**200**	**250**	**300**	**375**	**450**	**525**	**600**	**675**	**750**	**825**	**900**	**975**	**1050**	**1200**	**1350**	**1500**	**1650**	**1800**	**1950**	**2100**	**2250**	**2400**	**2550**	**2700**	**3000**	**3600**
2.5	71	77	89	100	104	114	153	234	305	354	425	469	540	676	823	1,008	1,210	1,461	1,695	1,940	2,207	2,583	2,910	3,232	3,957	4,748
5.0	71	77	89	100	104	114	153	234	305	354	425	561	649	812	992	1,057	1,270	1,537	1,782	2,038	2,322	2,709	3,052	3,390	4,153	4,983
7.5	71	77	89	100	104	131	174	267	349	452	491	561	649	812	992	1,210	1,450	1,755	2,033	2,333	2,649	3,101	3,493	3,875	4,747	5,696
10.0	71	77	89	100	104	131	174	267	349	452	491	659	752	943	1,155	1,412	1,690	2,044	2,371	2,720	3,090	3,613	4,071	4,524	5,543	6,651
12.5	71	77	89	100	131	131	207	267	349	452	491	659	752	943	1,155	1,412	1,690	2,044	2,371	2,720	3,090	3,613	4,071	4,524	5,543	6,651
15.0	71	77	89	100	131	158	207	311	409	474	572	659	752	943	1,155	1,412	1,690	2,044	2,371	2,720	3,090	3,613	4,071	4,524	5,543	6,651

CONSTRUCTION COSTS - Open Cut - Pipe Cost NOT Included

1460.6

Based on tender costs as provided by the City over the past 5 years and indexed to 2017.
Includes trenching labor and equipment, bedding, backfill, compaction, dewatering, and maintenance holes.

	Diameter																									
Depth	**200**	**250**	**300**	**375**	**450**	**525**	**600**	**675**	**750**	**825**	**900**	**975**	**1050**	**1200**	**1350**	**1500**	**1650**	**1800**	**1950**	**2100**	**2250**	**2400**	**2550**	**2700**	**3000**	**3600**
2.5	431	441	458	469	496	523	567	583	627	665	698	736	763	801	839	872	910	937	986	1,019	1,221	1,428	1,630	1,935	2,344	2,812
5.0	649	659	676	692	730	790	839	877	927	1,014	1,019	1,019	1,019	1,057	1,095	1,281	1,341	1,417	1,482	1,591	1,913	2,294	2,605	3,216	3,897	4,676
7.5	763	774	790	801	867	899	992	1,030	1,090	1,090	1,177	1,226	1,264	1,368	1,477	1,591	1,695	1,815	1,946	2,060	2,523	3,057	3,564	4,333	5,346	6,416
10.0	1,090	1,101	1,172	1,237	1,412	1,564	1,728	1,875	2,044	2,115	2,240	2,273	2,300	2,414	2,523	2,638	2,774	2,916	3,036	3,139	3,793	4,518	5,112	6,071	7,390	8,868
12.5	2,267	2,278	2,289	2,300	2,344	2,403	2,425	2,491	2,556	2,551	2,572	2,594	2,632	2,665	2,709	2,785	2,916	3,134	3,363	3,619	4,355	5,303	6,180	7,646	9,270	11,125

RESTORATION COSTS

Taken from 20-year (LSSSS) plan and updated as per 2016 tender and transportation costs for rural and urban restoration.
Open - no restoration; Landscape- minor/boulevard (no roadway restoration); Rural - cross section as per transportation cost table; Urban - cross section as per transportation cost table; Ecosystem - applies to areas adjacent to or within environmentally significant areas.

Condition	**Open**	**Landscape**	**Rural**	**Urban**	**Ecosystem**
Depth					
2.5	0	436	1,744	1,929	916
5.0	0	556	2,224	2,409	1,166
7.5	0	654	2,671	2,845	1,384
10.0	0	774	3,183	3,357	1,613
12.5	0	883	3,706	3,859	1,831

CASS Cost Factors

It is recognized that an increased cost may be encountered and applied to total cost of project due to location of works and to account for extra efforts for shoring, traffic control, additional utilities, slower construction progress, etc.
Project specific cost in CASS to include 20% Enginnering Fees and 30% Contingencies

TABLE 4

CITY OF LONDON

LIST OF CASS STORM AND SWM PROJECTS

Project	Location Detail: Street	Location Detail: From Street	Location Detail: To Street	CASS Number	Existing (A): Shape	Existing (A): Pipe Size (mm)	Existing (A): Average Rating	Existing (A): Rating Description	Existing (A): Pipe Length (m)	Existing (A): Asset value of existing Pipe only ($000s)	Existing (A): BTE Factor	Existing System Improvement (B): Shape	Existing System Improvement (B): Pipe Size (mm)	Existing System Improvement (B): Pipe Length (m)	Existing System Improvement (B): Total Cost (Pipe + Const + Rest) ($000s)	Existing System Improvement (B): 20% Engineering ($000s)	Existing System Improvement (B): 30% Contingency ($000s)	Existing System Improvement (B): Grand Total($000s)	Existing System Improvement (B): Growth ($000s)	Existing System Improvement (B): Non Growth ($000s)
1	Carling STM Trunk	Adelaide	Thames / Outlet		New Trunk					$0	1.0	CIRC	2700	1257	$8,920	$1,784	$2,676	$13,380	$0	$13,380
										$0	1.0	CIRC	3000	963	$7,925	$1,585	$2,378	$11,888	$0	$11,888
				AECOM-SWM-001										2220	$16,845	$3,369	$5,054	$25,268	$0	$25,268
2	York Street	Rectory	William		CIRC	300	3	Fair	165	$15	0.5	CIRC	675	165	$453	$91	$136	$680	$340	$340
					CIRC	300	3	Fair	15	$1	0.5	CIRC	825	15	$44	$9	$16	$69	$34	$34
					CIRC	375	3	Fair	120	$12	0.5	CIRC	825	120	$354	$71	$127	$552	$276	$276
					CIRC	375	3	Fair	118	$12	0.5	CIRC	900	118	$360	$72	$130	$562	$281	$281
					CIRC	450	2	Good	112	$12	0.3	CIRC	900	112	$342	$68	$123	$533	$400	$133
					CIRC	600	2	Good	4	$1	0.3	CIRC	975	4	$13	$3	$5	$20	$15	$5
					CIRC	450	2	Good	100	$10	0.3	CIRC	975	100	$313	$63	$113	$489	$367	$122
				AECOM-SWM-002					634	$62				634	$1,879	$376	$649	$2,904	$1,712	$1,192
3	Bathurst Street	Talbot	Thames / Outlet		CIRC	900	3	Fair	232	$99	0.5	CIRC	900	12	$37	$7	$13	$57	$29	$29
					CIRC	1050	2	Good	123	$66	0.3	CIRC	1350	354	$1,273	$255	$458	$1,986	$1,489	$496
					CIRC	1200	2	Good	98	$67	0.3	CIRC	1500	87	$333	$67	$120	$520	$390	$130
				AECOM-SWM-003					454					454	$1,642	$328	$591	$2,562	$1,907	$655
4	William / Simcoe Street	Hamilton	Colborne		CIRC	450	3	Fair	160	$17	0.5	CIRC	750	160	$457	$91	$164	$713	$356	$356
					CIRC	450	3	Fair	118	$12	0.5	CIRC	825	118	$348	$70	$125	$543	$271	$271
					CIRC	600	1	Very Good	18	$3	0.1	CIRC	825	18	$53	$11	$19	$83	$75	$8
					CIRC	600	1	Very Good	234	$36	0.1	CIRC	900	234	$715	$143	$257	$1,115	$1,003	$111
				AECOM-SWM-004					530					530	$1,591	$314	$566	$2,453	$1,705	$747
5	Highbury Avenue	Oxford	Rail line		CIRC	200	2	Good	9	$1	0.3	CIRC	675	9	$26	$5	$9	$41	$31	$10
					CIRC	300	3	Fair	49	$4	0.5	CIRC	825	49	$145	$29	$52	$225	$113	$113
					CIRC	375	3	Fair	392	$39	0.5	CIRC	825	392	$1,155	$231	$416	$1,801	$901	$901
					CIRC	375	3	Fair	171	$17	0.5	CIRC	900	171	$521	$104	$188	$813	$406	$406
					CIRC	375	3	Fair	79	$8	0.5	CIRC	1050	79	$256	$51	$92	$399	$200	$200
					CIRC	600	3	Fair	137	$21	0.5	CIRC	1350	137	$493	$99	$177	$769	$384	$384
				AECOM-SWM-005					837					837	$2,595	$519	$934	$4,048	$2,034	$2,014
6	Eggerton Street	Brydges	Hamilton		ARCH	600x 1500*[1]	3	Fair	7	$5	0.5	CIRC	1500	7	$27	$5	$10	$42	$21	$21
					ARCH	600x 1500*[1]	3	Fair	229	$155	0.5	CIRC	1950	229	$1,054	$211	$380	$1,645	$822	$822
					ARCH	1275x 1275*[2]	4	Poor	129	$87	0.8	CIRC	1950	129	$596	$119	$215	$930	$233	$698
					ARCH	1275x 1275*[2]	4	Poor	207	$227	0.8	CIRC	2100	207	$1,011	$202	$364	$1,577	$394	$1,183
					CIRC	1275*[3]	3	Fair	155	$105	0.5	CIRC	2100	155	$757	$151	$273	$1,181	$591	$591
					CIRC	1500	5	Very Poor	31	$31	0.9	CIRC	2100	31	$151	$30	$54	$236	$24	$213
					RECT	600x 1500*[2]	4	Poor	728	$492	0.8	CIRC	2100	728	$3,558	$712	$1,281	$5,551	$1,388	$4,163
				AECOM-SWM-006					1486					1486	$7,155	$1,431	$2,576	$11,162	$3,472	$7,690
7	Florence Avenue	WFG	Eggerton		CIRC	450	1	Very Good	81	$8	0.1	CIRC	750	81	$231	$46	$83	$361	$324	$36
					CIRC	525	3	Fair	90	$10	0.5	CIRC	750	90	$257	$51	$92	$400	$200	$200
					CIRC	525	3	Fair	94	$11	0.5	CIRC	825	94	$279	$56	$100	$434	$217	$217
				AECOM-SWM-007					265					265	$766	$153	$276	$1,195	$742	$453
8	Wellington Street	Central	Pall Mall		CIRC	450	3	Fair	15	$2	0.5	CIRC	600	15	$39	$8	$14	$60	$30	$30
					CIRC	500*[4]	3	Fair	238	$25	0.5	CIRC	675	238	$652	$130	$235	$1,018	$509	$509
				AECOM-SWM-008					252					252	$691	$138	$249	$1,078	$539	$539
9	Waterloo	Grovener	Oxford		CIRC	250	3	Fair	122	$9	0.5	CIRC	450	122	$307	$61	$111	$480	$240	$240
					CIRC	500*[4]	3	Fair	123	$13	0.5	CIRC	675	123	$339	$68	$122	$528	$264	$264
					CIRC	500*[4]	3	Fair	123	$13	0.5	CIRC	750	123	$353	$71	$127	$550	$275	$275
					CIRC	550*[5]	4	Poor	214	$24	0.8	CIRC	825	214	$630	$126	$227	$982	$246	$737
				AECOM-SWM-009					582					582	$1,629	$326	$586	$2,540	$1,025	$1,516
11	Adelaide Street	Grovener	Oxford		CIRC	200	4	Poor	45	$3	0.8	CIRC	300	45	$111	$22	$40	$174	$43	$130
					CIRC	300	4	Poor	99	$9	0.8	CIRC	450	99	$249	$50	$90	$389	$97	$292
					CIRC	450	4	Poor	141	$15	0.8	CIRC	450	141	$356	$71	$128	$556	$139	$417
					CIRC	375	2	Good	244	$24	0.3	CIRC	525	244	$627	$125	$226	$978	$733	$244
				AECOM-SWM-010					529					529	$1,344	$269	$484	$2,097	$1,013	$1,083

Project	Growth Improvement (C): Shape	Growth Improvement (C): Pipe Size (mm)	Growth Improvement (C): Pipe Length (m)	Growth Improvement (C): Total Cost (Pipe + Const + Rest) ($000s)	Growth Improvement (C): 20 %Engineering ($000s)	Growth Improvement (C): 30 % Contingency ($000s)	Growth Improvement (C): Grand Total($000s)	Growth Improvement (C): Growth Oversizing ($000s)	Growth / Non-Growth: Growth ($000s)	Growth / Non-Growth: Non Growth($000)	Growth / Non-Growth: Individual Project BTE Split %	Growth / Non-Growth: Individual project Growth Split %	Cost Allocation: Residential 82.6% (thousand)	Cost Allocation: Commercial 10% (thousand)	Cost Allocation: Institutional 7.4% (thousand)	Implementation: Trigger	Implementation: Date	Implementation: 2014 - 2018 (thousands)	Implementation: 2019 - 2023 (thousands)	Implementation: 2024 - 2033 (thousands)	Implementation: Build Out (thousands)
1	CIRC	2700	1257	$8,920	$1,784	$2,676	$13,380	$0	$0	$13,380						Existing Flooding Issues	2020	$ -	$ 25,268	$ -	$ -
	CIRC	3000	963	$7,925	$1,585	$2,378	$11,888	$0	$0	$11,888											
			2220	$16,845	$3,369	$5,054	$25,268	$0	$0	$25,268	100.0%	0.0%	$0	$0	$0						
2	CIRC	675	165	$453	$91	$136	$680	$0	$340	$340						Growth	2026	$ -	$ -	$ 2,940	$ -
	CIRC	825	15	$44	$9	$16	$69	$0	$34	$34											
	CIRC	900	120	$366	$73	$132	$571	$19	$295	$276											
	CIRC	900	118	$361	$72	$130	$563	$1	$282	$281											
	CIRC	900	112	$342	$68	$123	$533	$0	$400	$133											
	CIRC	975	4	$13	$3	$5	$20	$0	$15	$5											
	CIRC	1050	100	$323	$65	$116	$504	$15	$382	$122											
			634	$1,902	$380	$657	$2,940	$36	$1,748	$1,192	40.5%	59.5%	$1,444	$175	$129						
3	CIRC	900	12	$37	$7	$13	$57	$0	$29	$29						Infrastruc-ture Renewal	2020	$ -	$ 2,683	$ -	$ -
	CIRC	1500	354	$1,350	$270	$486	$2,106	$121	$1,610	$496											
	CIRC	1500	87	$333	$67	$120	$520	$0	$390	$130											
			454	$1,720	$344	$619	$2,683	$121	$2,028	$655	24.4%	75.6%	$1,675	$203	$150						
4	CIRC	750	160	$457	$91	$164	$713	$0	$356	$356						Existing Flooding Issues	2027	$ -	$ -	$ 2,483	$ -
	CIRC	825	118	$348	$70	$125	$543	$0	$271	$271											
	CIRC	825	18	$53	$11	$19	$83	$0	$75	$8											
	CIRC	975	234	$734	$147	$264	$1,145	$30	$1,033	$111											
			530	$1,591	$318	$573	$2,483	$30	$1,735	$747	30.1%	69.9%	$1,433	$174	$128						
5	CIRC	975	9	$30	$6	$11	$46	$6	$36	$10						Growth	2022	$ -	$ 4,562	$ -	$ -
	CIRC	975	49	$154	$31	$55	$240	$14	$127	$113											
	CIRC	1200	392	$1,334	$267	$480	$2,081	$280	$1,180	$901											
	CIRC	1200	171	$581	$116	$209	$907	$94	$501	$406											
	CIRC	1200	79	$270	$54	$97	$421	$21	$221	$200											
	CIRC	1650	137	$556	$111	$200	$867	$98	$482	$384											
			837	$2,924	$585	$1,053	$4,562	$514	$2,548	$2,014	44.1%	55.9%	$2,105	$255	$189						
6	CIRC	1650	7	$29	$6	$10	$45	$3	$24	$21						Existing Flooding Issues, older pipe	2023	$ -	$ 11,165	$ -	$ -
	CIRC	1950	229	$1,054	$211	$380	$1,645	$0	$822	$822											
	CIRC	1950	129	$596	$119	$215	$930	$0	$233	$698											
	CIRC	2100	207	$1,011	$202	$364	$1,577	$0	$394	$1,183											
	CIRC	2100	155	$757	$151	$273	$1,181	$0	$591	$591											
	CIRC	2100	31	$151	$30	$54	$236	$0	$24	$213											
	CIRC	2100	728	$3,558	$712	$1,281	$5,551	$0	$1,388	$4,163											
			1486	$7,157	$1,431	$2,577	$11,165	$3	$3,475	$7,690	68.9%	31.1%	$2,870	$347	$257						
7	CIRC	750	81	$231	$46	$83	$361	$0	$324	$36						Level of Service	2035	$ -	$ -	$ -	$ 1,195
	CIRC	750	90	$257	$51	$92	$400	$0	$200	$200											
	CIRC	825	94	$279	$56	$100	$434	$0	$217	$217											
			265	$766	$153	$276	$1,195	$0	$742	$453	37.9%	62.1%	$613	$74	$55						
8	CIRC	600	15	$39	$8	$14	$60	$0	$30	$30						Existing Flooding, older pipe	2027	$ -	$ -	$ 1,078	$ -
	CIRC	675	238	$652	$130	$235	$1,018	$0	$509	$509											
			252	$691	$138	$249	$1,078	$0	$539	$539	50.0%	50.0%	$445	$54	$40						
9	CIRC	450	122	$307	$61	$111	$480	$0	$240	$240						Existing Flooding Issues, older pipe	2025	$ -	$ -	$ 2,540	$ -
	CIRC	675	123	$339	$68	$122	$528	$0	$264	$264											
	CIRC	750	123	$353	$71	$127	$550	$0	$275	$275											
	CIRC	825	214	$630	$126	$227	$982	$0	$246	$737											
			582	$1,629	$326	$586	$2,540	$0	$1,025	$1,516	59.7%	40.3%	$846	$102	$76						
11	CIRC	300	45	$111	$22	$40	$174	$0	$43	$130						Existing Flooding Issues, page age and condition	2022	$ -	$ 2,097	$ -	$ -
	CIRC	450	99	$249	$50	$90	$389	$0	$97	$292											
	CIRC	450	141	$356	$71	$128	$556	$0	$139	$417											
	CIRC	525	244	$627	$125	$226	$978	$0	$733	$244											
			529	$1,344	$269	$484	$2,097	$0	$1,013	$1,083	51.7%	48.3%	$837	$101	$75						

Project	Location Detail			CASS Number	Existing (A)							Existing System Improvement (B)									Growth Improvement (C)								Growth / Non-Growth				Cost Allocation			Implementation					
	Street	From Street	To Street		Shape	Pipe Size (mm)	Average Rating	Rating Description	Pipe Length (m)	Asset value of existing Pipe only ($000s)	BTE Factor	Shape	Pipe Size (mm)	Pipe Length (m)	Total Cost (Pipe + Const + Rest) ($000s)	20% Engineering ($000s)	30% Contingency ($000s)	Grand Total($000s)	Growth ($000s)	Non Growth ($000s)	Shape	Pipe Size (mm)	Pipe Length (m)	Total Cost (Pipe + Const + Rest) ($000s)	20 %Engineering ($000s)	30 % Contingency ($000s)	Grand Total($000s)	Growth Oversizing ($000s)	Growth ($000s)	Non Growth($000)	Individual Project BTE Split %	Individual project Growth Split %	Residential 82.6% (thousand)	Commercial 10% (thousand)	Institutional 7.4% (thousand)	Trigger	Date	2014 - 2018 (thousands)	2019 - 2023 (thousands)	2024 - 2033 (thousands)	Build Out (thousands)
12	Dundas Street	Highbury	Ashland		CIRC	525	4	Poor	15	$2	0.8	CIRC	675	15	$42	$8	$15	$65	$16	$49	CIRC	675	15	$42	$8	$15	$65	$0	$16	$49						Existing Flooding Issues, older pipe	2022	$ -	$ 2,085	$ -	$ -
					CIRC	525	4	Poor	190	$22	0.8	CIRC	825	190	$559	$112	$201	$873	$218	$654	CIRC	825	190	$559	$112	$201	$873	$0	$218	$654											
					CIRC	600	3	Fair	249	$38	0.5	CIRC	825	249	$735	$147	$265	$1,147	$574	$574	CIRC	825	249	$735	$147	$265	$1,147	$0	$574	$574											
				AECOM-SWM-011					454					454	$1,336	$267	$481	$2,085	$808	$1,277			454	$1,336	$267	$481	$2,085	$0	$808	$1,277	61.2%	38.8%	$667	$81	$60						
13	Dundas Street	McCormick	Kellogg		CIRC	500[*3]	2	Good	61	$6	0.3	CIRC	1350	61	$218	$44	$78	$340	$255	$85	CIRC	1350	61	$218	$44	$78	$340	$0	$255	$85						Existing Flooding Issues, older pipe	2027	$ -	$ -	$ 3,921	$ -
					CIRC	500[*3]	2	Good	153	$16	0.3	CIRC	1500	153	$582	$116	$209	$907	$681	$227	CIRC	1500	153	$582	$116	$209	$907	$0	$681	$227											
					CIRC	600	3	Fair	95	$15	0.5	CIRC	1500	95	$363	$73	$131	$567	$283	$283	CIRC	1500	95	$363	$73	$131	$567	$0	$283	$283											
					CIRC	600	3	Fair	124	$19	0.5	CIRC	1500	124	$473	$95	$170	$737	$369	$369	CIRC	1650	124	$502	$100	$181	$784	$46	$415	$369											
					CIRC	1350	3	Fair	209	$172	0.5	CIRC	1500	209	$798	$160	$287	$1,245	$622	$622	CIRC	1650	209	$848	$170	$305	$1,323	$78	$701	$622											
				AECOM-SWM-012					642					642	$2,434	$487	$876	$3,796	$2,210	$1,586			642	$2,514	$503	$905	$3,921	$125	$2,335	$1,586	40.5%	59.5%	$1,929	$233	$173						
14	Easement	Highbury	S of Mornington		CIRC	675	2	Good	18	$4	0.3	CIRC	1950	18	$84	$17	$30	$132	$99	$33	CIRC	2100	18	$90	$18	$32	$140	$8	$107	$33						Level of Service, pipe age and condition	2024	$ -	$ -	$ 3,975	$ -
					CIRC	750	4	Poor	24	$7	0.8	CIRC	1950	24	$112	$22	$40	$175	$44	$132	CIRC	2100	24	$119	$24	$43	$186	$11	$54	$132											
					CIRC	900	4	Poor	197	$84	0.8	CIRC	1950	197	$908	$182	$327	$1,416	$354	$1,062	CIRC	2100	197	$962	$192	$346	$1,501	$85	$439	$1,062											
					CIRC	1050	4	Poor	282	$152	0.8	CIRC	1950	282	$1,299	$260	$468	$2,026	$506	$1,519	CIRC	2100	282	$1,377	$275	$496	$2,148	$122	$629	$1,519											
				AECOM-SWM-013					521					521	$2,403	$481	$865	$3,749	$1,003	$2,746			521	$2,548	$510	$917	$3,975	$226	$1,229	$2,746	69.1%	30.9%	$1,015	$123	$91						
15	Lorne Street	Quebec	Adelaide		CIRC	1450*[6]	3	Fair	280	$282	0.5	CIRC	1200	280	$954	$191	$343	$1,488	$744	$744	CIRC	1200	280	$954	$191	$343	$1,488	$0	$744	$744						Waste-water	2034	$ -	$ -	$ -	$ 8,085
					CIRC	1450*[6]	3	Fair	310	$312	0.5	CIRC	1800	310	$1,341	$268	$483	$2,093	$1,046	$1,046	CIRC	1800	310	$1,341	$268	$483	$2,093	$0	$1,046	$1,046											
					New Trunk					$0	0.0	CIRC	1800	80	$346	$69	$125	$540	$540	$0	CIRC	1800	80	$346	$69	$125	$540	$0	$540	$0											
										$0	0.0	CIRC	2100	520	$2,542	$508	$915	$3,965	$3,965	$0	CIRC	2100	520	$2,542	$508	$915	$3,965	$0	$3,965	$0											
				AECOM-SWM-014					590					1190	$5,183	$1,037	$1,866	$8,085	$6,295	$1,790			1190	$5,183	$1,037	$1,866	$8,085	$0	$6,295	$1,790	22.1%	77.9%	$5,200	$630	$466						
16	Elliot / Falaise	Grov-ener	Brant		CIRC	900	2	Good	87	$37	0.3	CIRC	1500	87	$330	$66	$119	$515	$386	$129	CIRC	1500	87	$330	$66	$119	$515	$0	$386	$129						Existing Flooding Issues	2032	$ -	$ -	$ 4,032	$ -
					CIRC	1200	2	Good	35	$24	0.3	CIRC	1500	35	$133	$27	$48	$207	$155	$52	CIRC	1500	35	$133	$27	$48	$207	$0	$155	$52											
					CIRC	1200	2	Good	524	$354	0.3	CIRC	1650	524	$2,122	$424	$764	$3,310	$2,483	$828	CIRC	1650	524	$2,122	$424	$764	$3,310	$0	$2,483	$828											
				AECOM-SWM-015					646					646	$2,585	$517	$930	$4,032	$3,024	$1,008			646	$2,585	$517	$930	$4,032	$0	$3,024	$1,008	25.0%	75.0%	$2,498	$302	$224						
17	Ahsland	Dundas	Wilton		CIRC	1800	3	Fair	11	$17	0.5	CIRC	2100	11	$56	$11	$20	$88	$44	$44	CIRC	2100	11	$56	$11	$20	$88	$0	$44	$44						Existing Flooding Issues	2028	$ -	$ -	$ 5,623	$ -
					CIRC	1800	3	Fair	351	$512	0.5	CIRC	2100	351	$1,714	$343	$617	$2,673	$1,337	$1,337	CIRC	2250	351	$1,878	$376	$676	$2,930	$256	$1,593	$1,337											
					CIRC	1800	3	Fair	188	$275	0.5	CIRC	2250	188	$1,007	$201	$363	$1,572	$786	$786	CIRC	2250	188	$1,007	$201	$363	$1,572	$0	$786	$786											
					CIRC	2100	2	Good	124	$240	0.3	CIRC	2250	124	$663	$133	$239	$1,034	$776	$259	CIRC	2250	124	$663	$133	$239	$1,034	$0	$776	$259											
				AECOM-SWM-016					674					674	$3,440	$688	$1,238	$5,366	$2,942	$2,425			674	$3,604	$721	$1,298	$5,623	$256	$3,198	$2,425	43.1%	56.9%	$2,642	$320	$237						
18	Quebec	Glasgow	Quebec		CIRC	525	2	Good	103	$12	0.3	CIRC	675	103	$284	$57	$102	$443	$332	$111	CIRC	675	103	$284	$57	$102	$443	$0	$332	$111						Existing Flooding Issues	2032	$ -	$ -	$ 3,105	$ -
					CIRC	525	2	Good	56	$6	0.3	CIRC	750	56	$159	$32	$57	$248	$186	$62	CIRC	750	56	$159	$32	$57	$248	$0	$186	$62											
					CIRC	600	2	Good	48	$7	0.3	CIRC	750	48	$137	$27	$49	$214	$161	$54	CIRC	750	48	$137	$27	$49	$214	$0	$161	$54											
					CIRC	600	2	Good	218	$33	0.3	CIRC	1050	218	$705	$141	$254	$1,099	$824	$275	CIRC	1050	218	$705	$141	$254	$1,099	$0	$824	$275											
					CIRC	600	2	Good	155	$24	0.3	CIRC	1050	207	$669	$134	$241	$1,044	$783	$261	CIRC	1200	207	$705	$141	$254	$1,100	$56	$839	$261											
				AECOM-SWM-017					580					632	$1,954	$391	$703	$3,048	$2,286	$762			632	$1,990	$398	$716	$3,105	$56	$2,342	$762	24.5%	75.5%	$1,935	$234	$173						
23	Curry Street	Piccadilly	Mornington		CIRC	250	2	Good	131	$10	0.3	CIRC	525	131	$336	$67	$121	$525	$394	$131	CIRC	525	131	$336	$67	$121	$525	$0	$394	$131						Level of Service	2035	$ -	$ -	$ -	$ 716
					CIRC	300	3	Fair	46	$4	0.5	CIRC	600	46	$122	$24	$44	$191	$96	$96	CIRC	600	46	$122	$24	$44	$191	$0	$96	$96											
				AECOM-SWM-018					177					177	$459	$92	$165	$716	$489	$227			177	$459	$92	$165	$716	$0	$489	$227	31.7%	68.3%	$404	$49	$36						

Condition	Condition Rating	BTE Factor
Very Good	1	0.10
Good	2	0.25
Fair	3	0.50
Poor	4	0.75
Very Poor	5	0.90

	Total Program Cost		Total Growth Costs	Total Non-Growth Costs		Res.	Comm.	Inst.		2014 - 2018	2019 - 2023	2024 - 2033	Build Out
Totals	$87,552		$34,574	$52,978		$28,558	$3,457	$2,558		$0	$47,859	$29,697	$9,997
Percentages			39.5%	60.5%		82.6%	10.0%	7.4%		0.0%	54.7%	33.9%	11.4%

Assumptions and Footnotes

1 Asset condition as inspected, weighted, calculated, and inventored by City of London Asset Management Office

2 A is the existing pipe capacity in the ground

3 B is the pipe capacity required to address existing deficiencies

4 C is the pipe capacity required to address growth

5 BTE is a calculation of the benefit to existing based on asset condition rating.

6 Growth split is equal to Growth total cost (C) - (Existing Upgrades (B) x BTE Factor)

7 Refinement for increase in capacity due to efficencies and more flow due to new better grade lines, new alignments, deepening, and increasing slope not considered in this study. This may be studied in future and improvements attributed to Growth.

8 Growth is the Trigger for all projects as the work is being undertaken as a result of development

9 No property impacts assumed

10 No bypass pumping assumed

11 When growth Triggered excavation paid for by growth, as lining was a potential option for deficencies

12 All pipes assumed to be open cut construction within 2.5m depth of surface

13 Combined Sewers treated as per same BTE principles for Sanitary , New storm 100% Growth

*1 use a 1200mm equivalent pipe
*2 use a 1200mm equivalent pipe
*3 use a 1200mm equivalent pipe
*4 use a 450mm equivalent pipe
*5 use a 525mm equivalent pipe
*6 use a 1500mm equivalent pipe

14 For the purpose of CASS Carling Creek is assumed to be 100% non-growth. This may be revisited in DCBS 2017.

15 The Carling Creek project has assumed to be constructed by open cut methods. The project scope and cost will be more defined in future Master Plans and may increase significantly.

TABLE 5
Proposed 2019 DC By-Law Amendments
CITY OF LONDON
2017 CASS POLICIES

GENERAL

G-1. Claimability
Any item listed as claimable, subsidizable, or eligible for funding from a development charge reserve fund must also be provided for in the approved DC rates. To the extent that specific cost sharable works and projects cannot be identified as to location or timing, there should be a contingency provided for in the estimates that is incorporated into the rates.

It is important that the City continue to monitor between DC Background Studies, the accuracy of the estimates and assumptions used to establish the rates. To the extent that substantial variations are identified, Council should be advised and will need to consider whether to increase or decrease the rates in accordance with the monitoring observations.

G-2. DC Fund reimbursements for Exempted Development
The City currently exempts Industrial development, and certain specified forms of Institutional development from the payment of development charges. These exemptions support economic development and not-for-profit development initiatives.

With respect to any non-statutory exemptions the City approves in its DC policy, the City will pay for these exemptions through non-DC supported contributions to the respective DC reserve funds. This meets the legislative requirement that exemptions or reductions to charges otherwise payable not be recovered from other, non-exempt forms of development (DCA s.5 (6)3.)

G-3. Non-Growth Works that Benefit the Existing Population (BTE)
Where minor works funded in part from the CSRF are subject to this policy and also include a non- growth component in the DC Background Study, funding of that portion of the works must wait until the City has approved sufficient funds in its Council approved capital budgets, or Council makes provision for a Reserve Fund designated for use in funding the non-growth share of DC funded works, to pay for that non-growth portion of the works. The non-growth portion of the funding shall be identified in the City's Capital Works Budget and approved by Council.

The benefit To Existing (BTE) will be calculated based on the Asset Condition of the current infrastructure element as defined by the relevant Asset Management data base as defined by condition parameters and maintained by the City of London

G-4. Use of Contingencies
Works listed as eligible in the Development Charges Background Study, or with the approval of the City Engineer, in consultation with the Director, Development Finance, drawn from a contingency and/or an alternative to a work listed in the Background Study may be funded from the CSRF. The claimability of such a work would be subject to inclusion in the development agreement (for works less than $50,000 subject to approved funding in the Capital Budget) or subject to execution of a Municipal Servicing and Financing agreement prior to commencement of the work. The works funded from the CSRF under this paragraph would be subject to rules similar to those described for minor CSRF eligible works contained in this section with respect to eligibility, tender and claim completeness and submission.

G-5. Exceptions
The Development Charge By-law allows for exceptions to projects listed in the DC Background Study for works listed as eligible in the Development Charges Background Study, or with the approval of the City Engineer, in consultation with the Director, Development Finance, drawn from a contingency and/or substituted for a work listed in the Background Study may be claimable.

G-6. Work in the Right of Way and Distribution of Costs
Given the congested nature of the ROW in the CASS study area it is unlikely for one Infrastructure element requiring a growth need upgrade can be improved without impacts upon other services in close proximity. In these cases:

- The City shall undertake the management of the required construction project (unless previous written permission by the City Engineer to do otherwise is secured)
- The claimable costs for the infrastructure upgrade will include Pipe, construction, engineering and related utility relocations with appropriate identification and deductions for Local Servicing portions(defined elsewhere in this document)) Restoration will be split between the City owned services being reconstructed (i.e. if all 3 services are impacted then restoration will be shared ,water 1/3, sanitary 1/3, stormwater 1/3) and BTE split generated using the City's asset rating is applied to corresponding portion of restoration.

G-7. Distribution of Growth Costs
The infill and intensification projects are to be considered Community Growth and a standard split is applied across several growth types in the CASS boundary as determine by the City's growth predictions and intensification policies.

G-8. Restoration and Damage
When an infrastructure upgrade is not deemed a Local Service then of any utility cuts, shoring, vibration monitoring & protection, pedestrian hoarding, signage, and or restoration of damage created by construction activities and /or construction traffic in and out of the development area. including but not limited to daily removal of mud tracking, daily dust suppression, milling and paving of deteriorated asphalt caused by construction traffic, grading of gravel shoulders to remove rutting caused by construction traffic shall be claimable as restoration;

G-9. Utility Upgrades
When an infrastructure upgrade is not deemed a Local Service then the costs related to the upgrading of any utility plant, or the relocation of the same, unless necessitated by the roadwork will not be covered by the Development Charges unless those upgrades pertain to City Owned services;

G-10. Relocation and Replacement Costs
When an infrastructure upgrade is not deemed a Local Service then the relocation and/or replacement costs of any encroachment on the City's road allowance or easement including but not limited to trees, art, signage, planters, paving stones, parking meters, bus bays, street trees, hedges, sprinklers systems and fences shall be part of the claimable work as restoration;

WATER DISTRIBUTION IN CASS AREA

CASS W-1. Major Watermains (CSRF-Water Distribution)
Claims against the CSRF Water Distribution fund may be made if:

a. the watermain is required to service future development on the Public ROW or in an Easement that are greater than or equal to 250mm in diameter are considered to satisfy a network wide benefit to growth and are identified separately as projects in the Development Charges Background Study, Growth Management Implementation Study (GMIS), or referred to in the CASS study and are eligible for a claim from the *CSRF*- Water Distribution Fund.

b. The claims shall be limited to the conditions mentioned herein, and limited to the reimbursements in the current Development Charges Background Study for oversizing are subject to reduction for Local Service components and council approval

Claims against the CSRF – Infill and Intensification Program if:

a. The works occur inside or service lands inside the CASS boundary as shown by Figure 1.1: Study Area.

b. Any watermain is deemed required to address an upgrade at a distance greater than the smallest of the following four conditions:

   1) four Hydrants on the same line;
   2) two valve chambers on the same line;
   3) one city block or;
   4) 150 m radius around the centroid of the development measured from the center of the proposed development frontage.

c. The claims shall be limited to the conditions mentioned herein, and limited to the reimbursements mention in the current Development Charges Background Study for oversizing are subject to reduction for Local Service components and council approval

CASS W-2. Watermain Oversizing (CSRF-Water Distribution)
Watermains with the all of the following attributes are eligible for a subsidy from the CSRF-Water Distribution:
- The watermain services external developable areas, and
- The watermain is greater than 250mm in diameter and less than 400mm in diameter.

The oversized portion (>250mm) is eligible for a subsidy payable based on an average oversizing cost and is stated in terms of a $/m of pipe constructed. The oversizing subsidy amounts will be identified in a schedule provided in the approved Development Charges By-law from the City Services Reserve Fund. Payment of claims from the City Services Reserve fund is subject to budget approval.

CASS W-3. Water Facilities *(CSRF*-Water Distribution*)*
Where the upgrading or construction of new public water booster pumping stations and reservoir projects are designed to increase capacity or improve service to acceptable standards and as a result of growth, these works are eligible for a claim from the CSRF-Water Distribution. These projects must also be identified in the Development Charges Background Study. This does not include privately owned water boosting devices.

CASS W-4. Temporary Facilities (Developer Cost)
Where a temporary facility precedes the construction of a permanent facility, the developer that requires the temporary facility will be required to also assist in making provision for the permanent facility (e.g. secure land for permanent facility) as a condition of approval for the temporary facility. Approval of temporary works is at the discretion of the City Engineer. In order for a temporary work to proceed there must first be provisions for the permanent work within the current Development Charge Background Study.

CASS W-5. Local Service Costs (Developer Cost)
Any watermain or portion of a larger watermain that is less than or equal to 250mm in diameter located on the public ROW is referred to as “local works”, and undertaken at the Developer’s expense in the CASS boundary if the work is required to address an upgrade, not mentioned in the CASS Master Plan, within any of the following trigger distances::

1) four Hydrants on the same line;
2) two value chambers on the same line;
3) one city block or;
4) 150 m radius around the centroid of the development measured from the center of the proposed development frontage.

WASTEWATER IN CASS AREA

CASS SS-1. Regional Trunk Sewers (CSRF- Sanitary Sewerage)
Claims against the CSRF Sanitary Sewage Fund may be made if:

a. the Sanitary Sewer is required to service future development on the Public ROW or in an Easement that are greater than or equal to 300mm in diameter are considered to satisfy a network wide benefit to growth and are to be identified separately as projects in the Development Charges Background Study, Growth Management Implementation Study (GMIS), or referred to in the CASS study.

b. The claims shall be limited to the conditions mentioned herein, and limited to the reimbursements mention in the current Development Charges Background Study for oversizing are subject to reduction for Local Service components and Municipal Council approval.

c. All sewers of any diameter required to service future development that satisfy a regional benefit to growth and are identified as a strategic need by the City Engineer are considered to satisfy a regional benefit to growth and are to be identified as separate projects in the DC Background Study and are eligible.

d. In order to be eligible for a claim as a Regional Trunk Sewer, the sewer must have no Private Drain Connections to individual residential units otherwise the "Sewer Oversizing" policy applies.

e. This work will be undertaken by the City unless authorized prior by the City Engineer in writing.

CASS SS-2. Sewer Oversizing (CSRF - Minor Sanitary Sewers)
Sanitary Sewers, which are not Regional Trunk Sewers, with all of the following attributes are eligible for a subsidy from the CSRF - Minor Sanitary Sewers:

- The sewer services external developable areas, and
- The sewer is greater than 250mm in diameter.

The oversized portion (>250mm) is eligible for a subsidy payable based on an average oversizing cost and is stated in terms of a $/m of pipe constructed. The oversizing subsidy amounts are to be reflected in an appendix of the DC Bylaw. The oversizing subsidy amounts cover the cost per meter of all associated eligible costs including engineering, manholes, restoration, etc.

CASS SS-3. CSRF – Infill and Intensification Program
Claims against the CSRF – Infill and Intensification Program if:

a. The works occur inside or service lands inside the CASS boundary.

b. Any Sanitary Sewer that is greater than 250 mm in diameter is deemed required to address a required upgrade at a distance of greater than the smallest of the following two conditions:

   1) one city block or;
   2) 150 m radius around the centroid of the development measured from the center of the proposed development frontage.

c. The claims shall be limited to the conditions mentioned herein, and limited to the reimbursements mention in the current Development Charges Background Study for oversizing are subject to reduction for Local Service components and Council approval.

d. The BTE shall be based on the City of London's asset rating of existing pipe.

e. This work will be undertaken by the City unless authorized prior by the City Engineer in writing.

CASS SS-4. Combined Sewers (CS)
Claims against the CSRF – Infill and Intensification Program for combined sewers are eligible if:

a. The work is required to service future development on the Public ROW or in an Easement and are considered to satisfy a network wide benefit to growth and outside the greater distance of either one city block or 150 m radius around the centroid of the development measured from the center of the proposed development frontage.

b. Work on CSO pipes will be similar to as noted in SS-8 for local service, however the BTE shall be based on the arithmetical sum of the individually calculated sanitary and storm BTE based on the City of London's asset rating of the existing sanitary and storm portions of the CSO pipe. This will be applied to the individual replacement costs of the new sanitary and storm pipe respectively to generate the total BTE split for the new service(s) (sanitary and storm).

c. This work will be undertaken by the City unless authorized prior by the City Engineer in writing.

CASS SS-5.
All planned works noted in the CASS study as growth needs or upgrades will use the table in the 2014 DCBS/MP –for oversizing calculation. BTE will be generated using tables based on asset rating and be applied across construction costs for pipe, construction cost, engineering, utilities, land and restoration as a DC eligible cost. If there is deemed to be a local servicing costs then an appropriate share shall be allocated by the individual contributing developers.

CASS SS-6. Regional Pumping Stations (CSRF- Sanitary Sewerage)
The upgrading or construction of new regional pumping stations are to be identified as separate projects in the DC Background Study and are eligible for a claim from the CSRF- Sanitary Sewerage. These projects must also be identified in the Development Charges Background Study. A figure showing the location of all of these pumping stations is provided in the Sanitary Master Servicing Study.

CASS SS-7. Temporary Pumping Stations (Developer Cost)
The cost of any temporary pumping stations and/or forcemains is borne by the developer. Approval of temporary works is at the discretion of the City Engineer. Where a temporary facility precedes the construction of a permanent facility, the developer that requires the temporary facility will be required to make provision for the permanent facility (e.g. provide land for permanent facility at the developer's cost) as a condition of approval for the temporary facility. In order for a temporary work to proceed there must first be provisions for the permanent work within the current Development Charge Background Study.

CASS SS-8. Local Service Costs (Developer Cost)
Any pipe or portion of a larger pipe that is less than or equal to 250mm in diameter are referred to as local works, and undertaken at the Developer's expense
Any work or portion of a larger sewer that is on the public ROW or easement and undertaken at the Developer's expense in the CAS zone if the work is required to address an upgrade not mentioned in the CASS Master Plan and within the lesser distance of either one city block or 150 m radius around the centroid of the development measured from the center of the proposed development frontage.

STORMWATER IN CASS AREA

CASS SWM-1. Regional Trunk Sewers
Claims against the CSRF Storm Sewage Fund may be made if:

a. the Storm Sewer is required to service future development on the Public ROW or in an Easement that are greater than or equal to 900mm in diameter are considered to satisfy a network wide benefit to growth and are to be identified separately as projects in the Development Charges Background Study, Growth Management Implementation Study (GMIS), or referred to in the CASS study.

b. The claims shall be limited to the conditions mentioned herein, and limited to the reimbursements mention in the current Development Charges Background Study for oversizing are subject to reduction for Local Service components and Municipal Council approval.

c. All sewers of any diameter required to service future development and that are identified as a strategic need by the City Engineer are considered to satisfy a regional benefit to growth and are to be identified as separate projects in the DC Background Study and are eligible.

d. In order to be eligible for a claim as a Regional Trunk Sewer, the sewer must have no Private Drain Connections to individual residential units otherwise the “Sewer Oversizing” policy applies.

e. This work will be undertaken by the City unless authorized prior by the City Engineer in writing

Claims against the CSRF – Infill and Intensification Program if:

a. The works occur inside or service lands inside the Built Urban Boundary January 2018.

b. Any storm sewer or combined sewer is deemed required to address a required upgrade at a distance of greater than the smallest of the following two conditions:

   1) one city block or;
   2) 50 m radius around the centroid of the development measured from the center of the proposed development frontage.

c. The claims shall be limited to the conditions mentioned herein, and limited to the reimbursements mention in the current Development Charges Background Study for oversizing are subject to reduction for Local Service components and council approval

This work will be undertaken by the City unless authorized prior by the City Engineer in writing.

CASS SWM-2. Regional Open Channels (CSRF- Major SWM Works)
Any open channel works identified through the Environmental Assessment process that are considered to satisfy a regional benefit to growth are to be identified as separate projects in the DC Background Study and are eligible for a claim from the CSRF- Major SWM Works.

CASS SWM-3. Storm Sewer Oversizing (CSRF- Minor Storm Works inside CASS)
Storm Sewers with all of the following attributes are eligible for a subsidy from the CSRF - Minor Storm Works:

- The sewer services external developable areas, and
- The sewer is greater than 900mm in diameter.

The oversized portion (>900mm) is eligible for a subsidy payable based on an average oversizing cost and is stated in terms of a $/m of pipe constructed. The oversizing subsidy amounts are to be reflected in an appendix of the DC Bylaw. The oversizing subsidy amounts cover the cost per meter of all associated eligible costs including engineering, manholes, restoration, etc.

CASS SWM-4. Open Channel Oversizing (CSRF- Minor Storm Works)
Open Channels with all of the following attributes are eligible for a subsidy from the CSRF - Minor Storm Works:
- An open channel design is required for the reason of inherent site drainage constraints and the design has been accepted by the City Engineer,
- The open channel services external developable areas, and
- The open channel has a 2-year storm design flow cross-sectional area greater than a 900mm sewer using the City’s minimum design standards.
- The oversized portion represents the cross-sectional area required in excess of a 900mm sewer for a 2-year storm design. The oversizing subsidy will be calculated based on the additional cost of oversizing beyond an area equivalent to a 900mm pipe size using the City’s minimum design standards for a 2-year storm design flow. The oversizing subsidy is payable based on an average oversizing cost in the form of a $/m of channel constructed as calculated by the Owners consulting engineer and as accepted by the City Engineer (or designate). An allowance of 15% will be added to the calculated oversizing amount to cover applicable engineering costs.

CASS SWM-5. Stormwater Management Works (CSRF- Major SWM Works)
Environmental Assessment Complete
Any municipally owned or operated stormwater management works designed to provide capacity to facilitate growth that are identified through the Environmental Assessment process and are considered to satisfy a regional benefit to growth are to be identified as separate projects in the DC Background Study and are eligible for a claim from the CSRF- Major SWM Works.

Environmental Assessment Not Complete
Stormwater Management Works for which an Environmental Assessment has not been completed that are anticipated to satisfy a regional benefit to growth are to be identified as separate area specific contingencies in the DC Background Study and are eligible for a claim from the CSRF- Major SWM Works.

Upon completion of the applicable Environmental Assessment (i.e. no outstanding Part 2 orders), a review of the related area specific contingency and the development charge rate will be undertaken and, if required, a revision to the development charge by-law will be made.

CASS SWM-6. Stormwater Management Facility Land Costs (CSRF- Major SWM Works)
Land will be reimbursed at a specific rate, with different land values assigned to different categories as outlined in the Development Charges By-law.

CASS SWM-7. Major SWM Facility Inlet and Outlet Sewers within the SWM Block(CSRF- Major SWM Works)
Any storm sewers within a Major SWM Facility block that are either upstream or downstream of a facility are considered to satisfy a regional benefit to growth and are eligible for a claim from the CSRF- Major SWM Works.

CASS SWM-8. Major SWM Facility Outlet Sewers outside the SWM Block (CSRF- Major SWM Works or CSRF- Minor Storm Works)
Any major SWM facility outlet sewer that extends outside the SWM block facility is considered to satisfy a regional benefit to growth and is eligible for a claim from the CSRF- Major SWM Works if the outlet sewer is not also used to provide drainage to a development adjacent to the outlet sewer.

In the event that all or a portion of the outlet sewer outside the SWM block is used to provide drainage to a development adjacent to the outlet sewer then the portion of the outlet sewer downstream from the adjacent development is eligible for “Storm Sewer Oversizing” as described in the DC By-law.

CASS SWM-9. Local Service Costs (Developer Cost)
Any pipe or portion of a larger pipe that is less than or equal to 900 mm in diameter are referred to as local works, and undertaken at the Developer’s expense and/or if the work is required to address an upgrade not mentioned in the CASS MP within the greater distance of either one city block or 150 m radius around the centroid of the development measured from the center of the proposed development frontage.

CASS SWM-10. Temporary Storm Sewers (Developer Cost)
Costs of all storm sewer systems that are temporary or not defined in the DC Background Charge Study shall be borne by the Developer. In order for a temporary work to proceed there must first be provisions for the permanent work within the current Development Charge Background Study.

CASS SWM-11. Temporary Stormwater Management Works (Developer Cost)

Any temporary works or works not included in the approved Development Charges Background Study are at the sole expense of the Developer including operation, maintenance and decommissioning. Approval of temporary works is at the discretion of the City Engineer. Where a temporary facility precedes the construction of a permanent facility, the developer that requires the temporary facility will be required to also assist in making provision for the permanent facility (e.g. secure land for permanent facility) as a condition of approval for the temporary facility. In order for a temporary work to proceed there must first be provisions for the permanent work within the current Development Charge Background Study.

Best management practices or private drainage systems are not claimable unless identified through the Environmental Assessment process as being required to meet a regional benefit to growth.

The construction of road side ditches, swales, and overland flow routes are not eligible for claim from the City Services Reserve Fund - Stormwater Management.

Appendix B

Project Description Records

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Carling Street Storm Trunk Sewer	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Carling Storm Trunk Sewer from Adelaide Street to Thames River Outlet. BRT utility relocation.

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$25,268.0**	AMOUNT ELIGIBLE FOR DC:	

	G	nG
G/Ng SPLIT:		

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:				

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	York Street	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

York Street from Rectory Street to William Street. (963m - 3000mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$2,940.0**	AMOUNT ELIGIBLE FOR DC:	**$1,748.0**

	G	nG
G/Ng SPLIT:	59.50%	40.50%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Bathurst Street - Talbot Street to Thames River Outlet	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

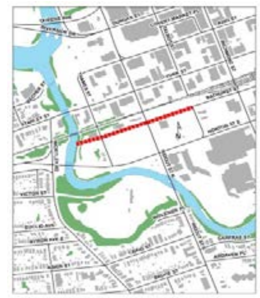
DESCRIPTION:

Bathurst Street - Talbot Street to Thames River Outlet. (12m - 900mm dia., 354m - 1350mm dia., 87m - 1500mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:



DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$2,683.0**	AMOUNT ELIGIBLE FOR DC:	**$2,028.0**

	G	nG
G/Ng SPLIT:	75.60%	24.40%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	William / Simcoe Street - Hamilton Road to Colborne Street	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

William / Simcoe Street - Hamilton Road to Colborne Street. (160m - 750mm dia., 136m - 825mm dia., 234m - 900mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$2,483.0**	AMOUNT ELIGIBLE FOR DC:	**$1,735.0**

	G	nG
G/Ng SPLIT:	69.90%	30.10%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Highbury Avenue - Oxford Street to Rail Line	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Highbury Avenue - Oxford Street to Rail Line. (9m - 675mm dia., 441m - 825mm dia., 171m - 900mm dia., 79m - 1050mm dia., 137m - 1350mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$4,562.0**	AMOUNT ELIGIBLE FOR DC:	**$2,548.0**

	G	nG
G/Ng SPLIT:	55.90%	44.10%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Egerton Street - Brydges Street to Hamilton Road	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Egerton Street - Brydges Street to Hamilton Road. (7m - 1650mm dia., 358m - 1950mm dia., 1121m - 2100mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$11,165.0**	AMOUNT ELIGIBLE FOR DC:	**$3,475.0**

	G	nG
G/Ng SPLIT:	31.10%	68.90%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Florence Street - Western Fair District to Egerton Street.	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Florence Street - Western Fair District to Egerton Street. (170m - 750mm dia., 94m - 825mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$1,195.0**	AMOUNT ELIGIBLE FOR DC:	**$742.0**

	G	nG
G/Ng SPLIT:	62.10%	37.90%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Wellington Street - Central Avenue to Pall Mall	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Wellington Street - Central Avenue to Pall Mall. (15m - 600mm dia., 238m - 675mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$1,078.0**	AMOUNT ELIGIBLE FOR DC:	**$539.0**

	G	nG
G/Ng SPLIT:	50.00%	50.00%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Waterloo Street - Grosvenor Street to Oxford Street	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Waterloo Street - Grosvenor Street to Oxford Street (122m - 450mm dia., 123m - 675mm dia., 123m - 750mm dia., 214m - 825mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$2,540.0**	AMOUNT ELIGIBLE FOR DC:	**$1,025.0**

	G	nG
G/Ng SPLIT:	40.30%	59.70%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Adelaide Street - Grosvenor Avenue to Oxford Street	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Adelaide Street - Grosvenor Avenue to Oxford Street (45m - 300mm dia., 239m - 450mm dia., 244m - 525mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$2,097.0**	AMOUNT ELIGIBLE FOR DC:	**$1,013.0**

	G	nG
G/Ng SPLIT:	48.30%	51.70%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Dundas Street - Highbury Avenue to Ashland Avenue	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Dundas Street - Highbury Avenue to Ashland Avenue (15m - 675mm dia., 439m - 825mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$2,085.0**	AMOUNT ELIGIBLE FOR DC:	**$808.0**

	G	nG
G/Ng SPLIT:	38.80%	61.20%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Dundas Street - McCormick Boulevard to Kellogg Lane	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Dundas Street - McCormick Boulevard to Kellogg Lane (61m - 1350mm dia., 248m - 1500mm dia., 334m - 1650mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$3,921.0**	AMOUNT ELIGIBLE FOR DC:	**$2,335.0**

	G	nG
G/Ng SPLIT:	59.50%	40.50%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Easement - Highbury Avenue to south of Mornington Avenue	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Easement - Highbury Avenue to south of Mornington Avenue (521m - 2100mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$3,975.0**	AMOUNT ELIGIBLE FOR DC:	**$1,229.0**

	G	nG
G/Ng SPLIT:	30.90%	69.10%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Lorne Avenue - Quebec Street to Adelaide Street	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Lorne Avenue - Quebec Street to Adelaide Street (280m - 1200mm dia., 390m - 1800mm dia., 520m - 2100mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$8,085.0**	AMOUNT ELIGIBLE FOR DC:	**$6,295.0**

	G	nG
G/Ng SPLIT:	77.90%	22.10%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

P:\60513477 CoL-CASS Stormwater\400-Technical [TECH]\480 Report\Final Draft Submission 07-07-2017\Appendix B - PDR\DC Project Description Summary - CASS - Stormwater - July10'17 update.xlsx]

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Elliott Street / Falaise Road - Grosvenor Avenue to Brant Street	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Elliott Street / Falaise Road - Grosvenor Avenue to Brant Street (122m - 1500mm dia., 524m - 1650mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$4,032.0**	AMOUNT ELIGIBLE FOR DC:	**$3,024.0**

	G	nG
G/Ng SPLIT:	75.00%	25.00%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Ashland Avenue - Dundas Street to Wilton Avenue	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

DESCRIPTION:

Ashland Avenue - Dundas Street to Wilton Avenue (11m - 2100mm dia., 662m - 2250mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:

DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$5,623.0**	AMOUNT ELIGIBLE FOR DC:	**$3,198.0**

	G	nG
G/Ng SPLIT:	56.90%	43.10%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Quebec Street - Glasgow Street to Quebec Street	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

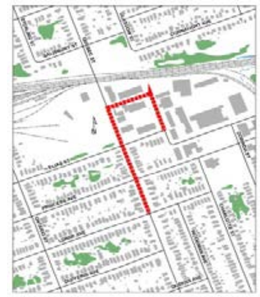
DESCRIPTION:

Quebec Street - Glasgow Street to Quebec Street (103m - 675mm dia., 104m - 750mm dia., 218m - 1050mm dia., 207m - 1200mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:



DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$3,105.0**	AMOUNT ELIGIBLE FOR DC:	**$2,342.0**

	G	nG
G/Ng SPLIT:	75.50%	24.50%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

DEVELOPMENT CHARGE PROJECT DESCRIPTION - COMPLIMENT TO PDR's

DEVELOPMENT CHARGE PROJECT SHEET

GMIS AREA:	CASS	DC PROJ #:	
PROJECT:	Curry Street - Piccadilly Avenue to Mornington Avenue	CAPITAL #:	
		DATE:	July 10, 2017
LEAD:	City, EES - WADE	SOURCE:	2014 DC
CONSTRUCTION YR:			

PROJECT SUMMARY

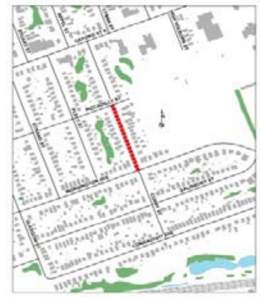
DESCRIPTION:

Curry Street - Piccadilly Avenue to Mornington Avenue (131m - 525mm dia., 46m - 600mm dia.)

LANDS IMAPCTED BY PROJECT:

CAS Area

LOCATION:



DEVELOPMENT CHARGE ESTIMATE (000's of $)

TOTAL COST:	**$716.0**	AMOUNT ELIGIBLE FOR DC:	**$489.0**

	G	nG
G/Ng SPLIT:	68.30%	31.70%

G/Ng DESCRIPTION: Growth/Non-growth derived from BTE formula defined in 2017 CASS work (asset condition and asset credit determine BTE1, BTE2 oversizing formula as per CAS studies).

	Res.	Comm.	Inst.	Ind.
RICI SPLITS:	82.7%	10.0%	9.4%	0%

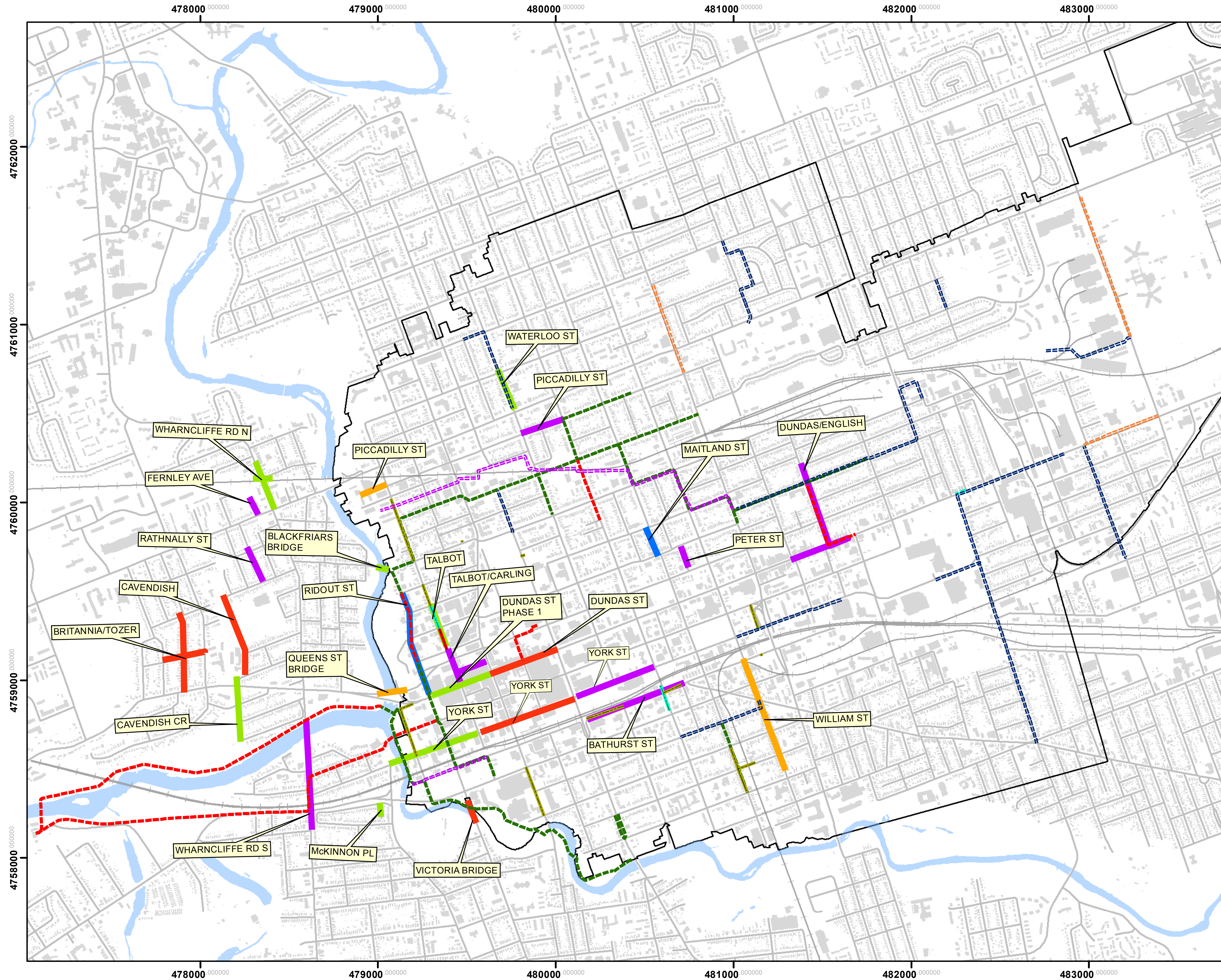
RICI DESCRIPTION: City wide basis. Industrial have own work program.

PREVIOUS STUDIES: None.

OTHER INFORMATION: None.

Appendix C

CASS and Capital Project Overlay



Core Area Servicing Studies (CASS) -Stormwater Component

City of London, Ontario

AECOM

Legend

Stormwater Project

- 2020
- 2022
- Beyond 2022

Water Project

- Immediate
- 2019
- Beyond 2022

Wastewater Project

- Commenced
- 2019
- Beyond 2022

Downtown Capital Projects (2018-2022)

- 2018
- 2019
- 2020
- 2021
- 2022

CASS and Capital Project Overlay

Project NO.: 60513477
Date: July 2017

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0 165 330 660 990 1,320 Meters

Basemap: City of London
Additional Sources:

About AECOM

AECOM (NYSE: ACM) is built to deliver a better world. We design, build, finance and operate infrastructure assets for governments, businesses and organizations in more than 150 countries.

As a fully integrated firm, we connect knowledge and experience across our global network of experts to help clients solve their most complex challenges.

From high-performance buildings and infrastructure, to resilient communities and environments, to stable and secure nations, our work is transformative, differentiated and vital. A Fortune 500 firm, AECOM companies had revenue of approximately US $19 billion during the 12 months ended June 30, 2015.

See how we deliver what others can only imagine at aecom.com and @AECOM.

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