5.0 Water, Wastewater, Stormwater and Village Infrastructure Plans

5.1 Coordinated Capital Investment Planning

Infrastructure plans for the City's water, wastewater, and stormwater systems, and the rural villages have been prepared based on estimated increases in capacity demands resulting from the project growth estimates. These plans address priority intensification and TOD areas, as well as sub-urban and rural development of vacant land that is slated for development.

The plans focus on growth-related projects, but are presented within an overall framework of the City's capital investments needed for system renewal, LOS improvements, legislated requirements, as well as growth. Specific major infrastructure needs - over the planning horizon and beyond - are presented for each service area in the sections which follow.

Combined, the renewal, growth, and legislated requirements form the basis of annual capital planning exercises that define the City's overall coordinated capital investment plans. These initiatives provide the inputs necessary for the City capital forecasting, long range financial forecast and inputs to longer asset renewal requirements forecasting.

Current renewal and legislated requirements (which include LOS improvements where needed) have been documented as part of the City's current LRFP for the initial 2014 to 2022 window of the IMP (*Table 5.1*). Over this horizon, there is $2,140 Million capital reinvestment directed toward existing assets. Longer term projections anticipate a significant increase in these amounts, purely as a consequence of the rapid infrastructure asset growth over the 1950 to 1980 timeframe.

The investments outlined in *Table 5.1* include major projects such as the CSO Control Storage Tunnel and the O'Connor Flood Control Works (Refer to *Section 5.3*), but exclude projects that are growth-driven. Further details on sewer and watermain asset renewal programs are provided in *Annex A*. Further information on facility renewal is provided in the following sections which summarize the Water Master Plan and Wastewater Master Plan.

Table 5.1: Long Range Financial Plan Capital reinvestment requirements (2014-2022)

Asset Category	Investment
Drinking Water Plants and Remote Facilities	$320M
Watermain Assets	$585M
Wastewater Treatment Plant	$250M
Wastewater Sewer Assets	$685M
Stormwater Facilities	$5M
Stormwater Sewer Assets	$295M

Source: City of Ottawa: Long Range Financial Plan (LRFP) 4 Assessment, 2013.

The City carries out ongoing condition and performance assessments for its existing asset base. These programs inform infrastructure needs definition and prioritization exercises that involve a validation and risk assessment process. Renewal forecast models are used to complement the information available for short to mid-term requirements to estimate the long range financial requirements for the existing asset base as it changes over time. Renewal requirements are continually being reassessed and adjusted.

The next update of renewal requirements as reflected in the current LRFP will also be influenced by emerging information on sewer system risk mitigation needs, the WW-IMP, Downtown Moves, and the implications of intensification and TOD on existing infrastructure.

It is expected that over the initial term of this IMP, the CAM Program will have yielded completion of the implementation of strategic initiatives aimed at updating and documenting customer levels of service expectations, and enhancements to capital investment prioritization processes that align with overall corporate strategic objectives.

5.2 Central Water System

5.2.1 System Overview

A population of approximately 845,000 in the urban area are currently serviced with potable water and provided with fire protection services through a City owned and operated water supply and distribution system. The system is supplied with water from the Ottawa River, which is first treated at the Lemieux Island and Britannia WPPs. From these facilities, water is pumped through a piping network comprised of approximately 2,900 km of watermains, which includes 15 high lift and booster PSs, five at-grade storage reservoirs and four elevated water storage tanks. There are a limited number of locations where the central supply service has been extended to serve small areas outside of the urban boundary. The City also operates five communal well systems, supplied by groundwater, that provide water to the communities of Vars, Richmond, Munster Hamlet, Carp and Shadow Ridge (in Greely). These village systems are covered in *Section 5.6.1.2*.

5.2.1.1 Water Purification Plants

Purification is required to treat the Ottawa River water to potable standards before delivery to its customers. The City currently treats water to meet or exceed applicable provincial and federal standards for water quality. Chloramine is currently used to maintain adequate disinfection throughout the distribution system. The nominal capacities of the WPPs are given in *Table 5.2*. There are seasonal limitations to these capacities, due to constraints imposed by sedimentation. According to the recent WPP Development Plan, the estimated de-rated combined capacity when water temperatures are low is 500 MLD —35% below the nominal capacity of 760 MLD.

Table 5.2: Nominal Water Purification Plant Capacities

Facility	Nominal Capacity
Lemieux	400
Britannia	360
Total	760

Source: Pressure Zone Operation Manuals

5.2.1.2 Water Pump Stations

Since water pressures in the distribution system generally decrease as one moves further from the WPPs (due to friction losses in the watermains) and as the ground elevations increase, booster PSs are required to ensure customers are provided with adequate water pressures. These PSs feed various water pressure zones to provide appropriate pressures to different locations. In total, there are 12 pressure zones in the city's distribution system[4].

Pressure zones with elevated storage are considered 'open' zones, and for these zones, the pump operations and the pressures are normally determined by the elevation of water in the storage facility (sometimes referred to as 'floating' storage). 'Closed' pressure zones have no elevated storage and system pressures are normally regulated

[4] Excluding a limited number of small service areas served by either a private pump station or a pressure reducing valve.

through pressure control at the PSs. The key characteristics of each pump station in the system are provided in *Table 5.3*.

Table 5.3: Existing Water Pump Station Characteristics

Pump Station	Pressure Zone	Zone Type	Nominal Discharge HGL (m)	Total Capacity (MLD)[1]	Firm Capacity (MLD)[2]
Carlington 2W	2W	Open	131	68.0	34.0
Barrhaven Reservoir	BARR	Open	155	7.5	0.0
Ottawa South	3C	Closed	151	39.7	26.2
Billings Bridge	2C	Open	134	177.5	127.0
Britannia 2W	2W	Open	134	302.0	208.0
Glen Cairn	3W	Open	160	87.5	49.5
Forest Ridge	2E	Open	134	91.5	47.0
Lemieux	1W	Open	115	456.0	308.0
Fleet	1W	Open	115	279.0	189.0
Britannia 1W	1W	Open	115	328.0	213.0
Carlington ME	ME	Closed	154	13.5	5.5
Campeau	3W	Open	160	100.0	58.0
Hurdman	1E	Open	115	286.0	204.0
Barrhaven	BARR	Open	155	104.5	57.0
Orléans	2E	Open	134	93.4	64.5
Leitrim	4C	Closed	165	33.3	19.0
Montreal	MONT	Closed	148	39.4	21.9
Brittany	MONT	Closed	148	8.1	2.6
Morgan's Grant	MG	Closed	145	17.7	12.3

Source: Pressure Zone Operation Manuals
HGL = Hydraulic Grade Line (a number that reflects both the elevation of the pump station, and the station discharge pressure)
MLD = Million Litres per Day
BARR = Barrhaven
MONT = Montreal
ME = Meadowlands
MG = Morgan's Grant

1. The nominal capacity of the station with all pumps in operation.
2. Total capacity of the station less the capacity of the largest pump. Typically, pump stations are designed to provide a firm capacity that is at least equal to the expected water system demand at the planning horizon.

5.2.1.3 Water Storage Facilities

Water storage facilities are strategically located throughout the distribution system to augment supply during high water demand periods and fire flow conditions, and to increase the reliability of water supply during system outages. During average water demand conditions, pumps are operated to allow frequent turnover of water within each facility to keep the water fresh. The key characteristics of each of the storage facilities are provided in *Table 5.4*.

Table 5.4: Water Storage Facility Characteristics

Storage Facility	Type	Volume (ML)	Maximum Water Elevation (m)	Description
Ottawa South	Reservoir	8.0	112.6	Ground storage supplying Zone 3C
Glen Cairn	Reservoir	34.0	131.0	Zone 2W floating ground storage
Barrhaven	Standpipe	18.0	131.0	Zone 2W Controlled inflow facility
Carlington Heights	Reservoir	109.0	112.0	Zone 1W floating ground storage
Orléans	Reservoir	81.0	114.0	Zone 1E Floating ground storage
Stittsville	Elevated tank	4.5	131.0	Zone 3W elevated storage
Moodie	Elevated tank	6.8	155.0	Zone BARR elevated storage
Conroy	Elevated tank	9.0	131.0	Zone 2C elevated storage
Innes	Elevated tank	4.5	131.0	Zone 2E elevated storage

Source: Pressure Zone Operation Manuals
BARR = Barrhaven

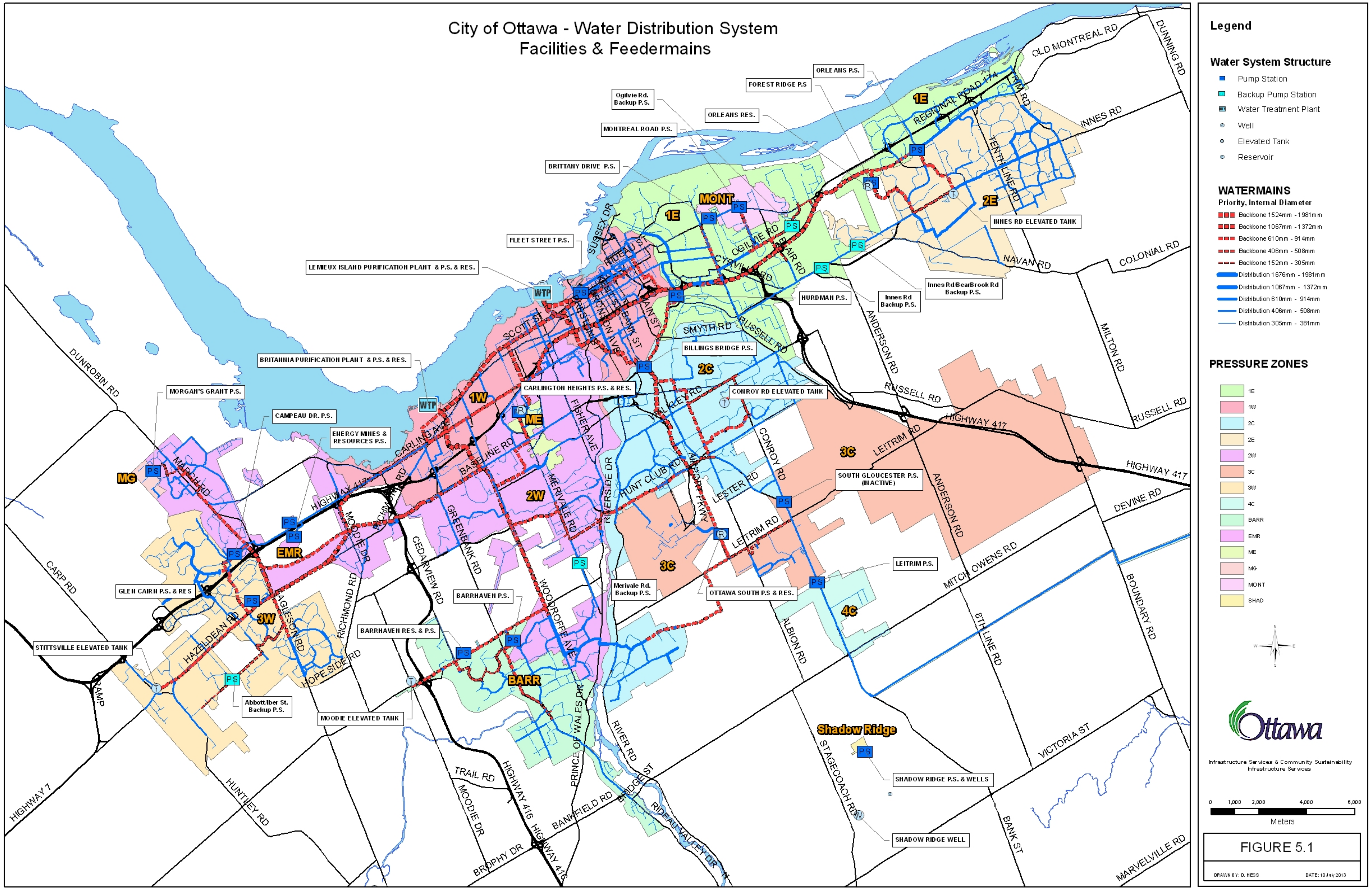
5.2.1.4 Watermain Network

The City recently completed an assessment of the water system to establish the 'backbone' of the central distribution system – the bulk delivery system that distributes water to PSs and/or storage facilities to meet system demand objectives. A plan showing the backbone infrastructure, and the facilities described previously, is provided in *Figure 5.1*.

There is a total of approximately 2,900 km of watermain in the city's water distribution system. The majority of pipes were constructed between 1950 and 2010. Up until 1970, cast iron (unlined and then lined) was the primary pipe material used in new construction. Between, 1950 and 1970, concrete pressure pipe was the second choice of pipe after cast iron, primarily for the larger diameter backbone pipes. From 1970 to 1990, ductile iron was the prevalent pipe material installed and beyond 1990, PVC became the most prevalent pipe material.

Watermains 152 mm and 203 mm in diameter represent about 63% of the total length of pipe in the system.

The backbone of the system generally includes watermains with a diameter of 600 mm or more. Pipes of this size total 223 km in length with over 98% installed after 1950. Over 85% of these pipes were constructed of concrete material while the remainder is comprised of ductile iron, polyethylene, steel, and unlined cast iron.



Source: City of Ottawa GIS infrastructure database

Figure 5.1: City of Ottawa Water Distribution System, Facilities and Feedermains

5.2.1.5 Pressure Zones

This section provides a brief overview of each of the City's 12 main pressure zones. *Table 5.5* indicates the approximate residential unit counts, and employment for each zone, as of 2012.

Table 5.5: Employment by Pressure Zone (2012)

Zone	Units			Jobs
	SDD	MDU	APT	
1E	14,678	22,616	14,159	85,820
1W	19,900	29,339	43,534	214,154
2C	16,010	18,388	9,742	58,363
2E	20,459	11,116	436	12,757
2W	24,249	23,149	9,564	105,982
3C	1,282	481	44	9,443
3W	16,897	10,772	769	27,447
4C	87	63	0	2,331
BARR	9,769	5,765	76	11,205
ME	1,175	2,193	1,336	2,502
MG	529	560	1	137
MONT	743	3,069	1,883	6,359
Totals	**125,778**	**127,511**	**81,544**	**536,500**

Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit.
SDD = Single Detached Dwellings
MDU = Multiple Dwelling Units
APT = Apartment
BARR = Barrhaven
MONT = Montreal
ME = Meadowlands
MG = Morgan's Grant

Descriptions of the major infrastructure components of each pressure zone in the system are provided in the 2013 Water Master Plan, referenced in *Annex B.1*.The zones are illustrated in *Figure 5.1*.

5.2.2 Water Infrastructure Asset Management

As part of the CAM Program, and to help guide investment in the city's infrastructure, a baseline condition review of all the City's assets was completed in 2012, as documented in the city's State of Assets Report (SOAR). This was the City's first comprehensive look at the state of the City's physical assets. In terms of water infrastructure, 59% of the assets were determined to be in good to very good condition, 28% were determined to be in fair condition, and 13% were determined to be in poor to very poor condition. Overall, the average asset condition rating for water infrastructure is considered good but, as is the case for all City assets, water infrastructure continues to deteriorate in spite of current levels of renewal investment. The estimated replacement value of the City's water infrastructure is over $6.6 billion.

In general, the backbone of the system is considered to be in better condition than the local distribution infrastructure. However, most of the City's water pump station facilities are considered to be in poor or fair condition. Furthermore, a small percentage of transmission mains are considered to be in poor to very poor condition. Average ratings for each category of drinking water asset category follow:

Table 5.6: Average Ratings for Each Category of Drinking Water Asset Category

Drinking Water Asset Category	Replacement Value ($M)	Condition Rating
Water Purification Plants	$503	Good
Transmission mains	$440	Good
Distribution pipes	$5,500	Good
Pump Stations	$94	Fair
Storage Facilities	$66	Good-Fair
Communal Well Systems	$20	Fair-Good
TOTAL	**$6,623**	**Good**

Source: City of Ottawa, Infrastructure Services Department, Asset Management Branch: State of the Asset Report, 2012.

It should be noted that the ratings for buried transmission and distribution mains are highly uncertain, given the difficulty to access the infrastructure, and the need to use indirect methods of assessment. The City employs the latest technologies to enhance condition assessments of large diameter, highest risk transmission infrastructure. However, for the purposes of the 2012 SOAR, existing watermain condition ratings are simply based on age and material indicators. The average age of watermains is 30 years with pipes expected to have service lives in the range of 80 to 100 years.

In terms of managing water supply assets, there is currently a focus on improving the reliability of the system through secondary mains. Major projects that will improve the reliability of water supply at a pressure zone level of analysis are identified as part of the Water Master Planning process. Other projects aimed at improving the reliability of supply to Vulnerable Service Areas have been identified as part of the City's Critical Infrastructure Identification Studies. There is also focus on improving the management of the purification plant assets to ensure the continued production of high quality, safe, drinking water.

5.2.3 Existing Systems Operations

5.2.3.1 Drinking Water Quality Management

Under the *Safe Drinking Water Act*, 2002, the MOE requires all owners of municipal drinking water systems to obtain a license for the operation of each of their systems. The Municipal Drinking Water License (MDWL) comprises five elements:

- A Drinking Water Works Permit
- A Permit to Take Water
- An Operational Plan
- An Accredited Operating Authority
- A Financial Plan

To satisfy the third requirement for the MDWL program, the City's Operational Plan documents the QMS developed by the City to meet the requirements of the Ministry's Drinking Water Quality Management Standard (DWQMS). In 2008, City Council endorsed the Operational Plan. By endorsing the plan, City Council and senior management acknowledged the need for (and expressed support for) the provision of sufficient resources to maintain and continually improve the QMS, in order to meet the requirements of the DWQMS. Under the *Safe Drinking Water Act*, the Statutory Standard of Care came into force on December 31, 2012. This section of the Act expressly extends legal responsibility to people with decision-making authority over municipal drinking water systems, potentially including but not limited to members of municipal councils.

The City's QMS policy is articulated as follows:

The City of Ottawa is committed to consistently delivering drinking water of high quality to the people of Ottawa. In particular, the City makes the following commitments:

1. To provide a reliable supply of safe drinking water to the consumer;
2. To meet or exceed applicable legislation and regulations;
3. To implement, maintain and continually improve the QMS, infrastructure and technology;
4. To deliver excellent customer service through responsiveness, accountability and innovation.

The DWQM Standard was developed based on the ‘Plan’, ‘Do’, ‘Check’ and ‘Improve’ concept of many other Quality Management Standards. The DWQMS contains 21 elements covering the broad spectrum of service delivery including system operations, risk assessment, testing and monitoring, infrastructure renewal and rehabilitation, emergency management and personnel coverage and competencies.

The Operational Plan documents the QMS that applies to all six of the City’s drinking water systems, including:

- The Central System (including the Britannia and Lemieux Island WPPs and the Central Distribution System); and
- Five communal well systems (Carp, Kings Park, Munster Hamlet, Shadow Ridge, and Vars).

The City is constantly striving to improve drinking water quality, and to optimize the processes used to treat and distribute water to customers. On-going work is being carried out on a number of process studies and experiments to optimize existing treatment processes. Currently, new water purification technologies are being evaluated at the City's Pilot Plant Research Facility, located in the Britannia WPP. At present, there are 22 projects being carried out in partnership with several Canadian universities and agencies such as Health Canada, and the Research Foundation of the American Water Works Association. This research allows the City to be proactive in implementing new technologies, ensuring drinking water of the highest quality while at the same time, reducing operating costs.

5.2.3.2 Supervisory Control and Data Acquisition

Generally the water system has been designed to operate with minimal operator input using a sophisticated SCADA system. The WPPs, as well as each of the PSs and storage facilities in the system are operated using the SCADA system. This system provides operators with the ability to monitor the flow rate through each individual pump unit, the total flow rate through each PS, the levels in each storage facility, the position of key valves, and other key system information. Most of the system operations are automated with the SCADA system, using pressure set points and reservoir levels to determine the individual pump operations.

5.2.3.3 Pump Control

For ‘open’ pressure zones, pumps are generally turned on and off automatically depending on the water level within the appropriate storage facility. In ‘closed’ zones, pump station discharge pressures must be maintained at constant levels, and individual pump units may need to be turned on and off more frequently than typical for ‘open’ zones. Variable speed pump units are normally used to help regulate water pressures in ‘closed’ zones. In addition to more straightforward pressure regulation in ‘open’ zones with storage, storage provides peak balancing which reduces peak pumping needs for high hourly demands and for aiding in the provision of fire flows.

5.2.3.4 Reliability and Redundancy

With any large complex system with multiple components, changing operational conditions and needs are expected, and can present difficulties for the operators depending on the severity of any individual event. A robust system, which provides operators with flexibility to deal with a variety of conditions, provides a higher level of reliability than one that is vulnerable to single points of failure, and thus difficult to manage. Considering the value of providing a continuous supply of potable water to the public, it is important that the water distribution network continue to be planned and designed as a robust system.

Redundant components are fundamental to ensuring reliability of water supply. In the event of a failure or outage of a critical system component, secondary (backup) infrastructure is needed to maintain the supply of water. The concept of redundancy applies to the planning and design of treatment systems, pumping and transmission facilities, as well as local pipe networks. Where secondary systems are not available, operational changes and contingency plans can normally be implemented to provide a high level of emergency service to virtually all its customers. In some cases, operator intervention may involve manual valve or portable pumping operations at strategic locations in the network. System planning seeks to limit this type of intervention, through upgrades that provide cost-effective redundancy.

5.2.4 Design Criteria and Levels of Service

Infrastructure assets only exist to support the delivery of the City’s services to its customers. A key objective of the CAM program is to optimize between the competing objectives of customer service, risk, and cost with the aim of meeting LOS at the lowest lifecycle costs. To achieve this objective, a thorough understanding of customer expectations is required in consideration of the affordability of services. It is therefore important to define and quantify the LOS for each service. These defined LOS then become the driver for the identification of asset needs and the basis for investment decisions.

While the City strives to maintain a high LOS that will meet the expectations of residents and businesses, specific targets, such as normal service pressures, are not guaranteed. In terms of fire protection, local watermain networks and hydrant densities are generally engineered to allow high enough flow to protect adjacent structures from fire damage, but not necessarily to limit damage at the source of the fire. Fire flow needs are highly variable and depend on a range of improvements in fire fighting technologies and construction standards, as well as trends in development characteristics, such as spacing between structures. The City is currently reviewing the methodologies used to determine fire flow needs.

The City is currently establishing a consistent approach to document and measure LO S across all areas of service. This will be followed by a comprehensive LOS review, including the formalization of specific targets where appropriate, considering best practices in other jurisdictions, and historic expectations.

In the interim, a cursory review of LOS objectives and design criteria was carried out to support the Master Planning process. These LOS objectives address system performance under normal and emergency operating conditions. It should be noted that the LOS objectives are not strict targets – they are subject to cost-benefit considerations. Design criteria and LOS objectives are described in detail the 2013 Water Master Plan, referenced in *Annex B.1*.

In general, the design criteria comply with the City's Water Design Guidelines (WDG). However, some key guidelines in the WDG (i.e. unit water demands) are only relevant to development areas that are 50 ha in size or less. Application of these guidelines to the pressure zone or system-wide scale would suggest excessively high capacity upgrade needs. System-level planning requires assessment of actual demands based on SCADA system monitoring and water billing information. The design criteria in the 2013 Water Master Plan, referenced in *Annex B.1*, reflect this assessment.

Action:

- The City will, on a regular basis, confirm system demands and performance through monitoring and analysis, and update design criteria and allowances based on the results of the monitoring, as appropriate.

5.2.5 Urban Growth by Water Supply Pressure Zone

The projected growth to 2031 within areas connected to the central system is provided in *Table 5.7* by water pressure zone.

Table 5.7: Projected Growth by Pressure Zone to 2031

Future Zone Configuration	New Units			New Jobs
	SDD	MDU	APT	
1W	136	826	19,769	37,180
2W	1,230	1,089	1,936	16,229
3W	12,177	11,668	2,592	9,942
2C	32	138	2,950	10,810
3C	19,612	16,562	322	10,507
4C	0	0	0	0
1E	864	1,089	12,396	36,159
2E	6,129	5,580	1,695	9,237
BARR	752	885	153	5,848
MONT	282	671	4,594	613
ME	5	8	690	905
MG	459	284	82	198
UPLANDS	0	0	0	2,234
Total	**41,678**	**38,800**	**47,179**	**139,863**
IGB	568	1,922	40,003	92,826
OGB	41,110	36,878	7,176	47,037

Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit.
IGB = Inside Greenbelt
OGB = Outside Greenbelt
SDD = Single Detached Dwellings
MDU = Multiple Dwelling Units
APT = Apartment
BARR = Barrhaven
MONT = Montreal
ME = Meadowlands
MG = Morgan's Grant

It should be noted that pressure zone BARR, as it currently exists, includes part of the Village of Manotick, and thus *Table 5.7* includes growth within this rural village. *Table 5.7* also reflects the creation of the Uplands Pressure Zone as part of a reconfiguration of zones in the South Urban Community (SUC) as described later in this section.

5.2.6 Water Demand Projections

Water system planning must account for the projected distribution of changes in population and employment across the city. Planning projections are covered in *Section 2*.

Future water demand estimates were calculated based on these projections for each pressure zone. These demands consider the basic day (BSDY) demands that are expected every day of the year, including all normal indoor water use in all City households and businesses. The demands also consider projected outdoor water use, which tends to occur from mid-spring to early fall. The combination of BSDY demand and high rates of outdoor water use results in a MXDY demand condition that is the primary basis for system capacity planning. Diurnal demand patterns can be used to derive peaking factors that, in turn, can be applied to the MXDY demands in order to estimate 'peak hour' demands.

In addition to the basic and outdoor water components of demand, system planning and design must also consider potential demands for fire fighting, in addition to water that can be lost through factors such as leakage and system flushing. Demand projections also considered the trends in unit water demands over time. These trends are discussed in *Section 4.1.1*. Detailed projections supporting the demand estimates were developed for the years 2031 and beyond to 2060. Projections for intermediate years (2015 and 2021) were developed based on linear interpolation between 2012 and 2031. The associated demands for each of these years are presented in *Table 5.8*.

Table 5.8: Water Demand Projections

Zone	2012		2015		2021		2031		2060	
	BSDY	MXDY	BSDY	MXDY	BSDY	MXDY	BSDY	MXDY	BSDY	MXDY
1E	42.4	61.5	43.6	62.9	45.9	65.5	52.8	72.9	67.6	88.3
1W	75.0	101.9	77.5	104.5	82.6	109.6	87.7	114.7	100.9	128.2
2C	40.4	57.4	40.3	57.4	40.2	57.3	41.9	59.0	49.2	66.6
2E	20.3	43.1	21.4	45.3	23.4	49.5	26.8	56.0	33.7	69.1
2W	51.2	82.6	41.5	66.4	43.3	67.9	44.9	70.1	55.4	83.0
3C	4.3	6.0	19.0	39.9	29.9	55.4	43.0	78.7	61.4	107.6
3W	22.0	50.6	24.4	55.2	29.2	64.2	36.9	78.3	41.2	84.8
4C	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4	1.4	2.6
BARR	10.8	22.5	5.5	11.5	5.9	12.0	6.3	12.8	6.4	12.9
ME	2.8	4.1	2.8	4.2	2.9	4.3	3.0	4.3	3.4	4.8
MG	0.7	1.7	0.8	1.8	0.9	2.2	1.1	2.6	4.0	8.4
MONT	5.7	6.7	6.2	7.2	7.1	8.2	8.6	9.9	10.8	12.8
Upland	0.0	0.0	1.3	1.3	1.3	1.3	1.4	1.4	1.9	1.9
Russel	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8	11.8
Totals	**287.7**	**450.4**	**296.4**	**324.8**	**324.8**	**509.4**	**366.5**	**572.9**	**448.9**	**682.6**

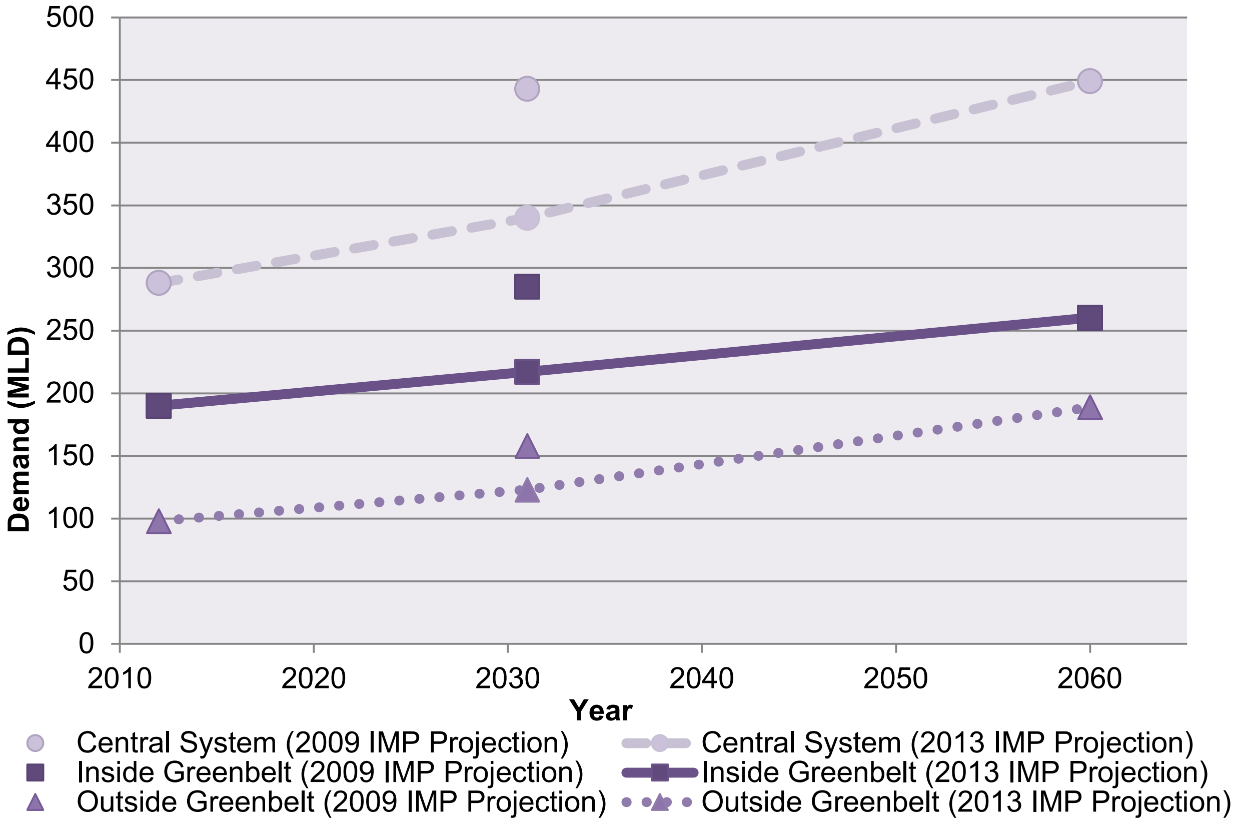
Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit: Ottawa Official Plan 2031 Projections. City of Ottawa SCADA and AQUACIS database.

BSDY = basic day
MXDY = maximum day
BARR = Barrhaven

ME = Meadowlands
MG = Morgan's Grant
MONT = Montreal

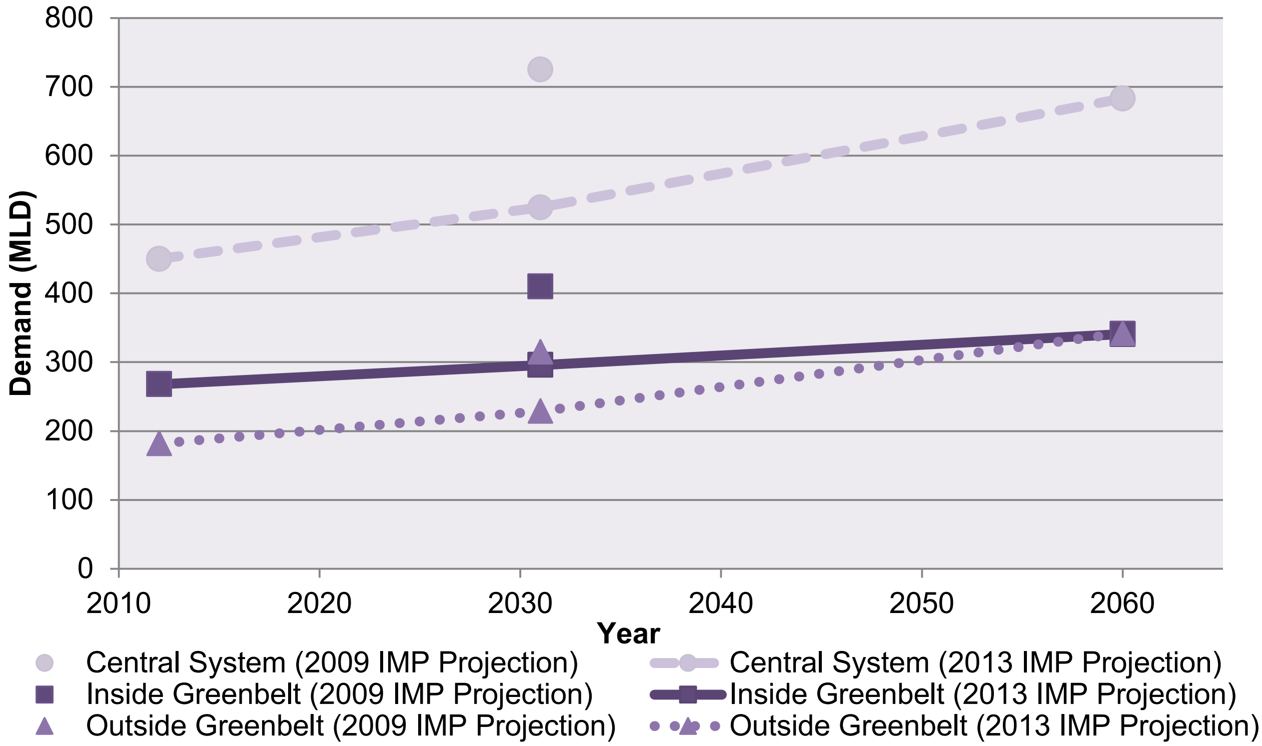
The projections presented in *Table 5.8* represent a significant drop in the future demands as projected previously. This drop, which is illustrated in *Figure 5.2* and *Figure 5.3*, is a result of a number of factors including, the declining trend in both indoor and outdoor water use, reductions in water loss, and reductions in occupancy, a shift from SDD to townhome and other types of MDU, and somewhat lower population and employment projections.

As noted in *Figure 5.2*, basic demands are not expected to reach the 2031 levels predicted in the 2009 IMP until almost 2060. This is in large part due to the slow growth in demand inside the Greenbelt, in spite of the significant intensification development that is expected. The key factors here are occupancy and unit demand reduction. The reduction in maximum day demand, relative to 2009 projections, is even more striking, due to the continuing reductions in outdoor water use, which is related to the projected shift in new dwelling types, and development characteristics.



Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit: Ottawa Official Plan 2031 projections. City of Ottawa SCADA and AQUACIS databases.

Figure 5.2: Basic Day Demand Projections



Source: City of Ottawa, Planning and Growth Management, Research and Forecasting Unit: Ottawa Official Plan 2031 projections. City of Ottawa SCADA and AQUACIS databases.

Figure 5.3: Maximum Day Demand Projections

5.2.7 Water Master Plan Development Approach

The preparation of the 2013 Water Master Plan Update involved significant analytical rigour to ensure a cost-effective plan that will meet LOS expectations as the City continues to grow. The approach involved a two-stage process of analysis.

The first stage was to develop a comprehensive spreadsheet model that established preliminary infrastructure needs. The model facilitated comparison of existing infrastructure capacities with projected demands on a year by year basis to identify when capacity improvements would be required. This analysis addressed the following components:

- Calculation of basic treatment, pumping and storage needs to meet peak demands by pressure zone and service area.
- Calculation of system redundancy needs for treatment, pumping, and storage for major component failures or outages.
- Calculation of back-up power needs.

The second stage of analysis was to complete hydraulic modeling to confirm and/or refine the required treatment, pumping, storage, piping and redundancy needs, in addition to understanding how the system would operate under various conditions.

To support the second stage of analysis, a detailed hydraulic model of the existing water distribution system was prepared by the City. This model includes every pipe, pump, and storage facility in the public system, as of 2012. Individual water demands were allocated to the model pipes, based on the City's entire water meter dataset. Outdoor water use and non-revenue water demands were calculated and allocated based on pressure zone level data available from the City's SCADA system. Pump duty tables and operational experience were used to establish pump and valve controls. Results generated by the model were verified by comparing results to current SCADA information.

Various future scenario models were developed based on the existing system model. These models cover the full range of future demand, infrastructure, and operating conditions.

The hydraulic model was used to evaluate the LOS that would be available under the MXDY demand in 2031 conditions, if no infrastructure upgrades were implemented to address the projected increase in water demand. Results indicate that, without significant water use restrictions, several of the City's storage facilities would empty completely, and peak hour pressures would drop to well below the LOS objectives. In some areas, the system would depressurize completely, creating significant water quality and public health risks.

The detailed methodology that was followed to establish the infrastructure recommendations is described in the 2013 Water Master Plan, referenced in *Annex B.1*.

5.2.7.1 Consideration to Growth Beyond 2031

The life cycle of municipal infrastructure extends beyond the City's Official Planning horizon of 2031. For example, the expected life span of piped infrastructure is in the order of 80 to 100 years. It is important to consider the impact of potential post-2031 growth on infrastructure performance. Depending on the nature of these impacts, it may be appropriate to over-size infrastructure or include provisions that will allow for cost-effective post-2031 expansion of facilities. These considerations will reduce the risk that the City will build infrastructure that does not meet long-term performance expectations, and/or be faced with higher post-2031 infrastructure costs than would otherwise be needed.

To consider needs beyond 2031, modeling and analysis were carried out for the 2060 scenario to predict the performance of the 2031 infrastructure beyond the planning horizon, and to identify what adjustments to the 2031 infrastructure recommendations may be appropriate. Further, additional projects that would be required to meet the 2060 projections were identified to provide a longer-term view of potential infrastructure requirements.

5.2.7.2 Transit-Oriented Development and other Intensification Area Considerations

As described in *Section 2*, the growth projections include a significant degree of urban intensification. In developing the projections, particular consideration has been given to TOD in the vicinity of the future OLRT stations. However, the projections do not reflect the much longer term vision for these areas, which will only fully develop according to the TOD vision until many years beyond 2031 planning horizon. Servicing studies were undertaken to support the TOD planning exercises and, as a result of the long-term nature of the plan, would be expected to identify infrastructure needs that would not otherwise be required to support the current IMP. Nonetheless, the TOD study results were examined to determine if they should influence the plan for growth, reliability, and renewal projects as determined by the Water Master Planning process.

5.2.7.3 Infrastructure Renewal Considerations

Long-term projections of major infrastructure renewal were examined to identify opportunities to integrate these needs with the growth and reliability driven projects identified by hydraulic analysis.

5.2.7.4 Climate Change Adaptation

A review of climate change issues related to water supply was carried out to identify related considerations for the master planning process. While local climate trends (*Section 4.3*) are of interest for the City's village systems which rely on groundwater supplies (refer to *Section 5.6*), climate trends over the much larger Ottawa River basin are of interest for the central water supply system (only 2% of the 146,300 km^2 basin is within City jurisdiction). Previous analyses have suggested potentially lower flows in the river due primarily to increased evaporation. Potential long term reductions in flow are estimated to be in the range of 1% to 8%. The seasonal distribution of these potential reductions are of particular interest, in terms of the security of supply during the low flow period (typically August and September), when river flows are typically about 53% of the annual average. While potential reductions are unlikely to put the City's central water supply at risk (in terms of water availability), impacts could include changes in water quality, which could impact treatment processes, or problems at raw water intake structures due to reduced water levels. In fact, potential issues related to raw water intake capacity (which is influenced by river water levels) have already been identified.

River flow data for Britannia Station, from 1961 to 2011, was analyzed to identify any trends. The river is highly regulated, with 43 hydroelectric stations and dams involved in the management of flows. Thus, the analysis considered annual and seasonal averages, in addition to the lowest flow month (September).

The results of this analysis do suggest a slight downward trend in annual flow minima based on monthly averages. This trend is statistically significant (at the 95% confidence level), but caution should be exercised in interpreting apparent trends because possible changes in how the river is regulated over time are not accounted for. There is no statistically significant trend in the data for the annual or low quarter, average flows.

Other studies have suggested that climate change could result in an increase in the occurrence of frazil ice (concentration and suspension of ice crystals in turbulent, supercooled water), and ice jamming (due to increased frequent freeze-thaw cycles throughout the winter and early spring periods). This could pose significant problems for the City's raw water intake and screening structures. In fact, in the winter of 2012, the City experienced unprecedented challenges associated with frazil ice, which required the construction of a temporary alternate raw water intake system, and 24-hour clearing of travelling screens.

Action:

- The City will continue to monitor trends in Ottawa River water level conditions over time, and identify adaptive measures and related water infrastructure improvements as required.

5.2.8 System Reconfiguration

The 2013 analysis included recommendations that came out of a 2008 study "Water Supply System Optimization Study, Final Report". This study recommended a reconfiguration of the water pressure zones serving the SUC. The assessment of zone configuration was triggered by the need for a new pump station, and a number of operational complexities that would have arisen as a result of the project. The assessment was also motivated by the recognition that zone configuration could be improved to increase the number of customers that experience maximum and minimum water pressures that fall within the ideal range as promoted in the city's WDGs. The zone reconfiguration, which considered several fundamental alternatives, will involve significant changes to Zones BARR, 2W, and 3C. These changes are summarized as follows:

1. Expand Zone 3C to include the majority of Zone 2W that lies within the SUC (Zone 2W-S), and the lower elevation areas within existing Zone BARR. The reconfigured Zone 3C will be supplied with water from the existing Ottawa South PS and a modified Barrhaven PS.
2. Isolate the Uplands area (Ottawa International Airport) of Zone 3C to create a separate pressure zone dedicated to the lands controlled by the Ottawa International Airport Authority. The LOS in the Uplands Zone will not change as a result of this project.
3. Reduce the Zone 3C hydraulic grade line (HGL) by approximately 8 m, or the equivalent of 11 psi (78 kPa). The adjusted Zone 3C pressure will be higher than Zone 2W but lower than the Barrhaven Zone. Pressures within the new Uplands zone will remain as per existing conditions.
4. The Barrhaven PS will be modified to include two sets of pumps: one to feed Zone BARR and one to feed Zone 3C.
5. Pumps at Ottawa South will also be replaced with different pump sets: one to feed Zone 3C and one to feed the Uplands Zone.

The planned zone reconfiguration is illustrated in *Figure 5.4*. The following benefits are expected as a result of the reconfiguration initiative:

1. Avoids the need for a new pump station serving the SUC.
2. Minimizes system fragmentation (dead-end watermains at zone boundaries).
3. Best distribution of zone elevations (minimum and maximum pressures) compared to the alternatives.
4. Major increase in system reliability and operational ease.

The individual projects that are needed to implement the zone changes are included in the following Section.

5.2.9 Growth and Reliability Driven Projects

The results of the hydraulic analysis and planning efforts yielded various conceptual alternatives for system upgrades that will be required to meet growth and reliability needs. Alternatives were subject to technical evaluation and review. A final list of projects required to meet LOS objectives to 2031 was prepared, as detailed in *Annex A.1*. These projects are illustrated in *Annex A.3*.

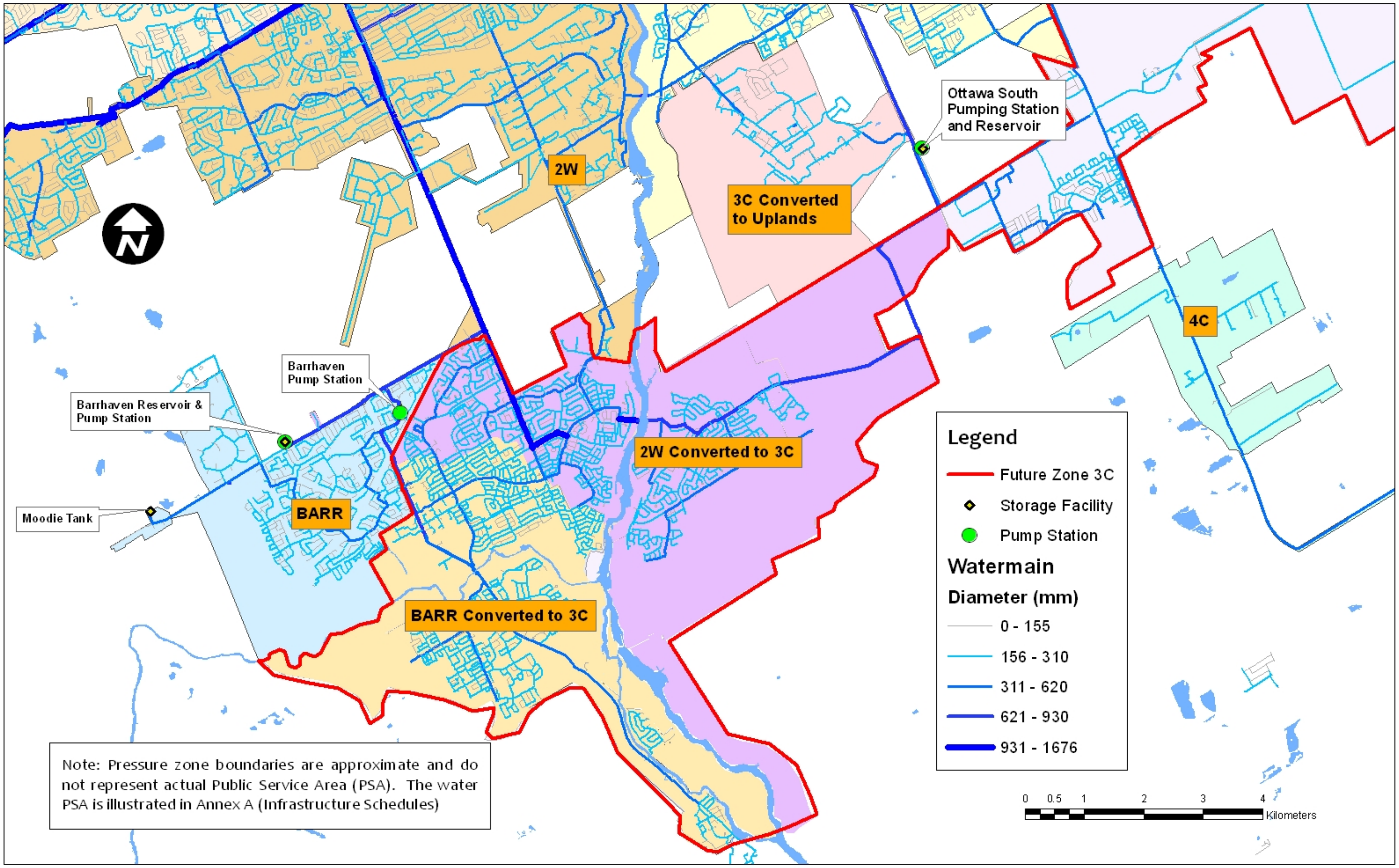
The project plan considers the servicing study results for the recent TOD studies, which provide a very long term vision of development which extends beyond the 2031 planning horizon.

The recommended water projects will be subject to further development, assessment and evaluation within the context of separate Class EAs and/or functional design assignments for each individual project.

The total project costs indicated include all costs to the City, including contributions from Development Charges. Each project cost assumes 2013 construction costs. These costs include allowances for engineering, utility relocation, property needs, City staff time, and contingencies.

Total project costs for all Development Charges and/or Rate funded growth and reliability driven projects to 2031 are estimated at approximately $324M. Of this amount, $193M is estimated for facility projects, and $131M is estimated for major watermains. The total cost estimate for major water infrastructure projects, including renewal, growth, and reliability-driven projects to the year 2031 is approximately $770M. This includes costs associated with eliminating the existing cold water treatment constraints (refer to *Section 5.2.1.1*), as identified in the recent WPP Development Plan (refer to *Annex B.5* for more details). However, this number does not include minor (<$500,000) facility renewal projects.

A number of potential additional post-2031 facility projects have been identified to provide a longer-term view of potential infrastructure needs. These projects are also listed in *Annex A.1*.



Source: City of Ottawa GIS infrastructure database. City of Ottawa, Planning and Growth Management, Infrastructure Policy Unit: Water Infrastructure Master Plan, 2013.

Figure 5.4: South Urban Community Pressure Zone Reconfiguration

5.2.10 Renewal Projects

As noted previously, the City anticipates significant investment to maintain or replace existing infrastructure to meet long-term operational needs. Priorities, timing, and scope of these renewal projects are highly uncertain, and subject to future condition assessment efforts. Condition assessment of buried pipe infrastructure is particularly challenging, costly, and can pose significant operational risks in the case of high pressure transmission mains. Condition assessment technology is evolving with recent and on-going increases in sophistication and accuracy. As such, there is a high level of uncertainty regarding long-term plans for infrastructure renewal.

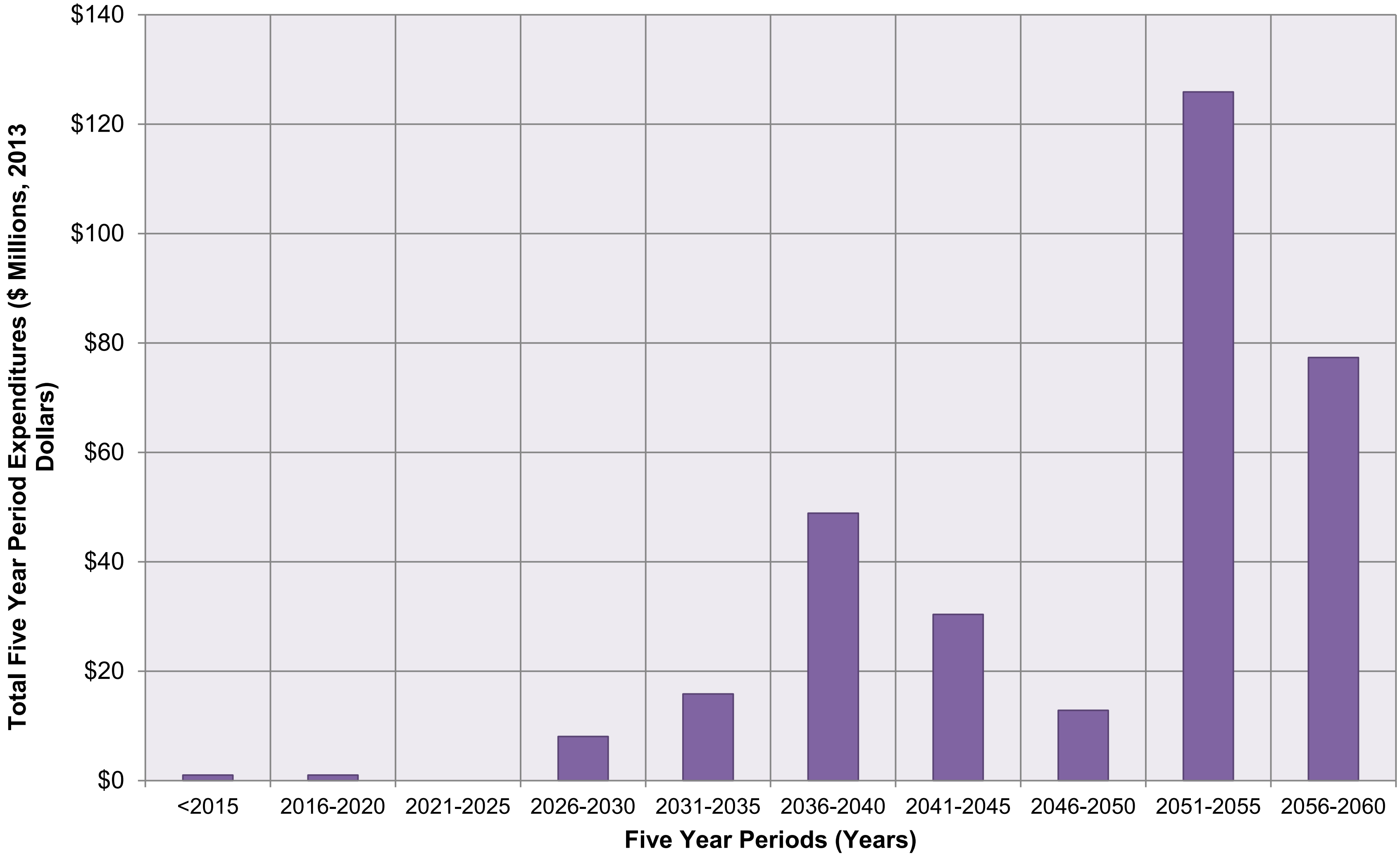
The potential costs of backbone watermain renewal over time are illustrated in *Figure 5.5*. This figure is simply based on the assumption that renewal is required when pipe age reaches 80 years. This information suggests limited short-term needs that will rise very rapidly shortly after the 2031 planning horizon, up to about $10 M /year, then varying widely thereafter, reaching a peak of roughly $25 M /year after 2050. While useful for long-term planning purposes, these costs are highly uncertain. Actual project needs will be based on the City's evolving Transmission Main Condition Assessment Program described in *Section 4.2.3*.

Long-term facility renewal costs are estimated periodically by City staff, based on facility-specific considerations. Project descriptions and estimates of renewal costs are provided in *Annex A.1*. Only projects exceeding $500,000 are identified in these tables.

5.2.11 Integrated Water Project Recommendations

The growth, reliability, and renewal driven facility projects to 2031 have been integrated as presented in *Annex A.1*. The locations and limits of these projects are illustrated in *Annex A.3*. This schedule also includes Development Charges and Rate funded watermain projects that are expected to be implemented by 2031.

Owing to the uncertainty associated with the timing and scope of renewal projects, these recommendations will be subject to frequent review and change. At this time, cost efficiencies related to combining renewal efforts with projects related to reliability and growth have not been considered. As part of the annual planning for infrastructure requirements, opportunities for further integration and cost efficiencies will be assessed and evaluated. This may affect the implementation timing of either the growth or renewal projects.



Source: City of Ottawa GIS infrastructure database.

Figure 5.5: Backbone Watermain Replacement Costs (5-year increments): 2013 Opinion of Probable Total Five Year Expenditures Assuming 80 Year Life Cycle

An integrated watermain project list has not been prepared at this time, due to the particularly high uncertainties regarding the timing and scope of the potential backbone watermain renewal projects. It is expected that this will be prepared as part of the Condition Assessment Program, and completed prior to the next IMP.

5.3 Central Wastewater System

5.3.1 System Overview

5.3.1.1 Wastewater System Generation

The design and configuration of the wastewater system in the city is governed by the flows that the sewer system must collect, convey, pump and treat. There are two major components contributing to wastewater flows in the system including:

- Dry Weather Flows (DWF): Sanitary wastewater flows resulting from the use and discharge of water from residential, commercial, institutional and industrial areas and groundwater flows that enter the sewer system from sources such as cracks in pipes, leaky joints and maintenance holes in a period with an absence of rainfall and snowmelt.
- Wet Weather (Extraneous) Flows: DWF plus surface runoff and groundwater infiltration which enters the sanitary system during periods of rainfall and snowmelt. The amount of inflow and infiltration (I/I) that enters the sewer will vary depending on the characteristics of the catchment areas, i.e. age of sewer, condition, sewer type, and severity of the rainfall and snowmelt event. In older areas of the city, sources of inflow include foundations drains, sump pumps, roof and driveway drains.

5.3.1.2 Wastewater Collection System Sewer Types

The City's wastewater collection system has developed since the late 1800s. Over 2,740 km of sanitary and combined sewers are maintained. The collection system includes the following sewer types:

- **Combined sewers**, initially constructed between the late 1860s and 1950, and are designed to collect DWF and primarily runoff through a single pipe to the sewage treatment plant. Originally in Ottawa, combined sewer flows were conveyed by gravity to the Ottawa River, Rideau River and possibly the Rideau Canal without receiving treatment. Today, older parts of the city, specifically the downtown core, remains serviced by combined sewers however they discharge to larger collector sewers, which in turn convey flows to ROPEC. Under certain conditions, the combined sewer system overflows into the Ottawa River. Such overflows are monitored and controlled by the City. The Provincial government in turn regulates the frequency of overflow occurrences to the receiving watercourse.

- **Partially separated sewers** date from 1951 to 1961, and are designed to collect DWF and some runoff primarily from foundation drains and in some cases from flat roofs, sump pumps and driveway drains. These types of systems are typically found in older areas of the city where the storm sewer system is often too shallow to receive the extraneous flow contribution.
- **Separated sanitary sewers** have been constructed since 1961 and constitute the majority of the City's sanitary sewer system. These sewers are designed to collect sanitary flows only, with a small allowance made for extraneous flows.

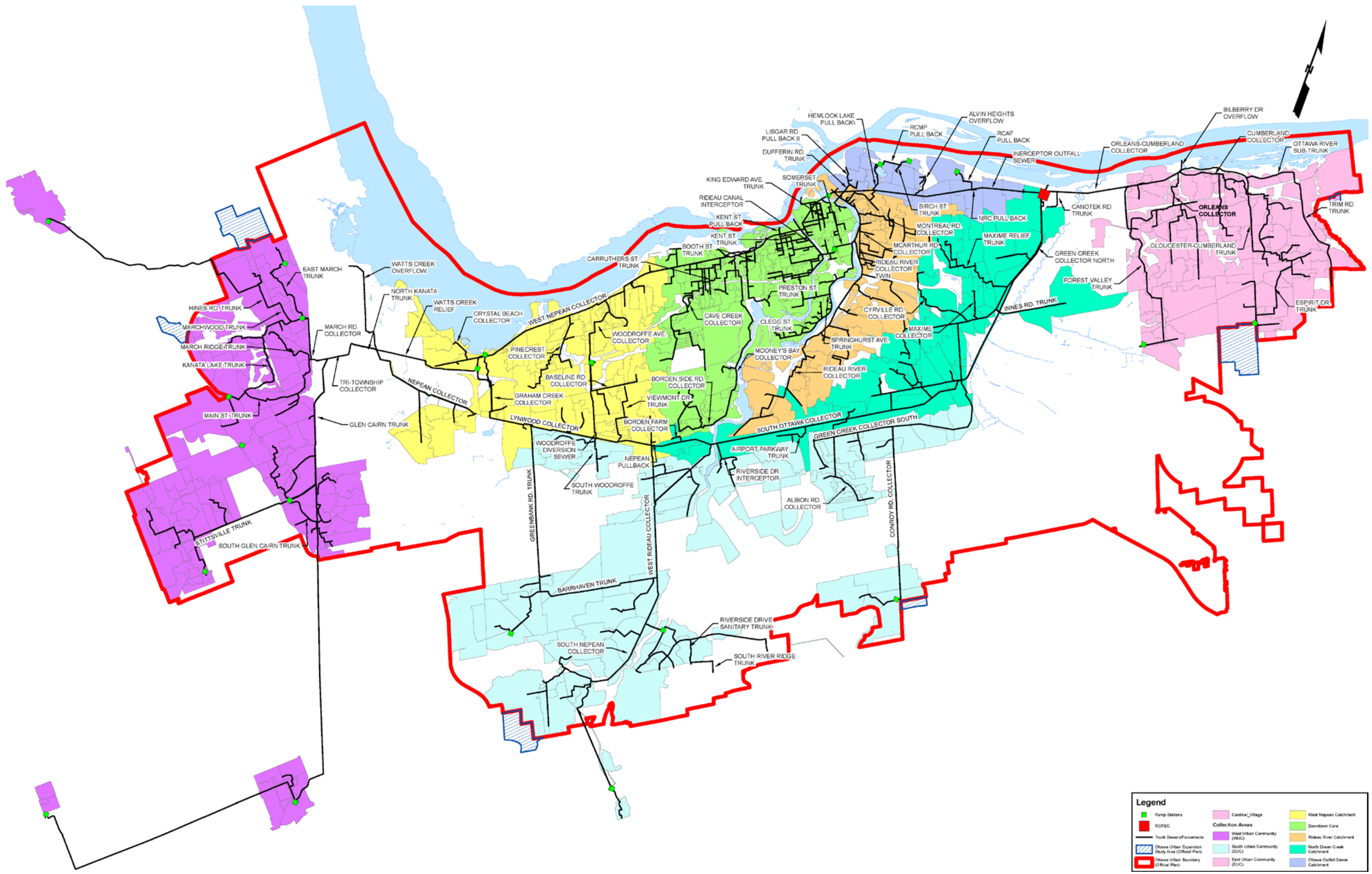
5.3.1.3 Wastewater Collection System Components

The wastewater collection system in the city conveys wastewater to be treated at ROPEC which has a capacity to treat 545 MLD and can sustain peak flows up to 1362 MLD. Septage from private systems is also transported via trucks directly to ROPEC for treatment.

The major components of the wastewater system include collector sewers, pump stations and forcemains that convey flows to ROPEC. The City's wastewater system is broken down into collection areas as follows:

- West Urban Community;
- South Urban Community;
- East Urban Community;
- West Nepean Community;
- Downtown Core;
- Rideau River Catchment;
- North Green's Creek Catchment; and
- Ottawa Outfall Sewer Catchment.

The central wastewater system including trunk sewers/forcemains, pump stations and collection areas are shown on *Figure 5.6*.



Source: City of Ottawa GIS infrastructure database. City of Ottawa, Planning and Growth Management, Infrastructure Policy Unit: Wastewater Collection System Assessment, 2013.

Figure 5.6: The City of Ottawa Central Wastewater System

5.3.2 Wastewater Infrastructure Asset Management

A comprehensive state of the assets review was completed in 2012 as part of the CAM Program. In terms of wastewater infrastructure, 60% of the assets were determined to be in good to very good condition, 28% were determined to be in fair condition, and 13% were determined to be in poor to very poor condition. Overall, the average asset condition rating for wastewater infrastructure is considered good to fair. As is the case for all City assets, wastewater infrastructure continues to deteriorate at current levels of renewal investment. The estimated replacement value of the City's wastewater infrastructure is over $5.7 billion.

In general, the collection pipes are considered to be in slightly better condition than the wastewater trunk sewers. The sewer pump station and odour control facilities are considered to be in fair condition while flow regulator chambers are considered to be in very good condition.

In terms of managing wastewater collection assets, WWF management is currently considered a major focus for improvement. This includes reducing threats to human health and property damage from flooding; reducing infrastructure capacity restrictions that could limit planned growth and intensification; and minimizing adverse impacts on the water environment from combined and SSOs. Adding redundancy to trunk sewers and renewal of major equipment at ROPEC are also a priority.

5.3.3 Wastewater System Growth Challenges

Management of the existing wastewater system is undertaken through operational reviews, on-going rehabilitation and other City programs aimed at maintaining the wastewater collection and treatment systems.

5.3.3.1 Treatment Plant

Planning studies, separate from the IMP, are required to direct the timing and scope of future treatment facility modifications or expansions. For the 2013 IMP, a preliminary assessment of treatment facility needs, including modifications and expansions, has been undertaken. These needs have been included as part of the IMP affordability analysis. A more comprehensive R. O. Pickard Development Plan will be developed over the next few years which will serve to inform the next IMP update.

5.3.3.2 Peak Flow Management

Peak wastewater flows need to be managed in the system and must be factored into system design and planning. During wet weather events, the amount of extraneous inflow greatly exceeds the DWF which contributes to the overall peak wastewater flow. Substantial allowances are made to transport and treat these extraneous flows. In some cases, extreme wet weather events may result in surcharging within the collection system. Reduction of extraneous inflow in existing systems and control of potential for extraneous inflow in new systems can provide opportunities to accommodate growth, particularly growth through intensification, through more efficient use of the existing system infrastructure.

Wet-weather flow and its management also affect the combined sewer system and the frequency and volume of overflows. As part ORAP, the City is moving towards the goal of the system to release zero CSOs for an average rainfall year. This involves the provision of storage and operational monitoring and control systems to optimize the available capacity.

Actions:

- The City will work toward the goal of achieving zero CSOs during the swimming season for the ‘design year’ (which represents an average precipitation year).
- The City will continue to investigate options for creating wastewater capacity such as extraneous flow removal and flow diversions, as alternatives to upgrading or constructing new infrastructure.
- The City, as part of its ORAP Communications Plan, will continue to inform the community of requirements to eliminate household and business practices that negatively impact the wastewater collection and treatment systems.

5.3.3.3 Intensification Inside the Greenbelt

Intensification inside the Greenbelt will create challenges to the provision of wastewater infrastructure capacity as it can take place where there is a lack of detailed information regarding the local collection system capacities. Intensification will need to be assessed, as some older local collection systems already operate at or near maximum capacities.

Understanding the performance of existing systems and improving on it are critical when considering areas slated for intensification. Implementing the objectives of the WW-IMP in a timely manner will be extremely important in dealing with any potential capacity issues. Ongoing system assessments including camera inspections, condition rating, and flow monitoring will continue to be important activities in directing and confirming decisions related to both rehabilitation requirements as well as planning for intensification on existing systems.

Action:

- The City will provide the necessary resources to support the implementation of the WW-IMP in particular in those areas slated for intensification.

5.3.3.4 Other Issues

A particular wastewater collection issue facing an expanding city is the aging of sewage in the pipes before it reaches treatment due to the lengthy distances from the source to the WWTP. The impact of sewage age on infrastructure, odour control and methods of mitigation, and implications of the findings in the wastewater treatment master plan will need to be considered in the future for possible change in design criteria.

Another issue is the expected timing of the delivery of new wastewater infrastructure in relation to actual growth. Delivering complex infrastructure, such as PSs, without sufficient time to confirm performance may introduce unacceptable risk. Time is required to provide flexibility to deal with fluctuations in growth. On the other hand, delivering capital works too far in advance of actual growth needs, although positive in terms of removing capacity constraints to growth, will have financial and operational impact. A balanced approach is required between 'just in time' infrastructure delivery and delivering infrastructure too far in advance of actual need.

5.3.4 Wastewater Master Plan Development Approach

To accommodate anticipated growth to 2031 an analysis of the existing wastewater system components capacities and their general conditions was undertaken using growth projections for the 2031 planning horizon. A 2060 longer term planning horizon was also considered to provide a better understanding of opportunities for integration of future growth and renewal needs and to ensure that infrastructure will be able to effectively adapt to growth that may be planned in the future.

A model was created to represent the current and future city-wide trunk wastewater collection system. This allowed for a system assessment and identification of system upgrades and/or new infrastructure needs to accommodate the anticipated growth to 2031 and beyond to 2060.

Three flow generation scenarios were established and modeled to understand the existing system performance under extreme events:

1. Design event scenario – Monitored DWF + a modified September 9, 2004 Hurricane Francis event. The 100 year rainfall volume extracted from the City's Intensity/Duration/Frequency (IDF) Table was applied to the observed 24 hour Hurricane Francis rainfall distribution.
2. January 2008 event scenario – Monitored DWF + January 8, 2008 rain on snow event (WWF).
3. Hurricane Francis event scenario (climate change and adaptation scenario) – Monitored DWF + Hurricane Francis (September 9, 2004) WWF.

5.3.5 Existing System Performance

The existing collection system as of 2012 was modeled with the three scenarios listed above. The results under the various scenarios were assessed to determine the following:

- hydraulic performance of the collection system such as areas at risk of sewer surcharge and potential for basement flooding; and
- potential capacity constraints for pipes and PSs.

The existing collection system was determined to perform in an acceptable manner under the 100 year design event. The majority of neighborhoods identified as areas of risk are known as they have been identified in previous studies. Short and long term initiatives for these neighborhoods have begun to improve the LOS and reduce the potential for sewer surcharge. The Wastewater Master Plan referenced in *Annex B.2* details these areas at risk.

5.3.6 Capacity Assessment – 2031 Do Nothing Alternative

A 'do-nothing' alternative was also modeled to identify the impact on the collection system of not adding any additional wastewater infrastructure over the 2031 development horizon. The design event and the Hurricane Francis event scenarios were used for this assessment which revealed that the areas of risk to the collection system will increase from today if no planned infrastructure upgrades are implemented by 2031. The assessment also confirmed that many of the pump stations assessed will require a capacity upgrade to accommodate the projected 2031 flows.

5.3.7 Capacity Assessment and Servicing Alternatives – 2031

Flows for the projected 2031 growth conditions were assessed using the model of the existing collection system with any planned infrastructure projects, identified in previous studies, assumed to be built. The planned major infrastructure included:

- the Combined Sewage Storage Tunnel;
- the O'Connor Trunk Level Measures;
- the North Kanata Sewer Phase 2
- the Stittsville / Fernbank diversion sewer;
- the West Kanata PS ; and
- the South Nepean Collector.

The design and Hurricane Francis events scenarios were used to assess the 2031 alternative. Results were evaluated to establish residual capacities and any remaining capacity constraints within the collection system and ROPEC. Alternative infrastructure upgrades necessary to address collection system constraints were identified. Necessary upgrades were considered in conjunction with remaining service life of existing major infrastructure (refer to project list in *Annex A.1*).

Under 2031 conditions the need for the planned infrastructure was confirmed and areas were identified as needing improvement including some areas serviced by the Rideau River Collector and the Conroy Collector. Additionally, a number of PSs were identified as needing potential improvements when subjected to the 2031 projected flows. These infrastructure upgrades have been included in the planned infrastructure requirements list in *Annex A.1*.

5.3.8 Capacity Assessment and Servicing Alternatives – Longer Term Planning (2060)

Potential long term infrastructure requirements beyond 2031 to 2060 were simulated with the planned infrastructure identified for 2031 assumed to be built to demonstrate that the existing and proposed infrastructure is robust enough to accommodate future conditions and to account for the design life (up to 100 years) for major wastewater collectors.

5.3.9 Robert O. Pickard Environmental Centre WWTP Considerations

ROPEC provides a complex treatment function as there are many processes involved in treating the influent. Each treatment component can have an impact on the treatment rate. It is beyond the scope of this IMP to assess the internal workings of the plant. For purposes of this IMP, it was determined that the plant would be upgraded to manage increases in wastewater flows as a result of the 2031 growth. A preliminary capital cost estimate of $669 million was identified to address growth and renewal for the 2031 scenario. A detailed wastewater treatment master plan has been initiated to identify any specific upgrades which will be used to inform the next IMP update.

5.3.10 Flow Monitoring Program Recommendations

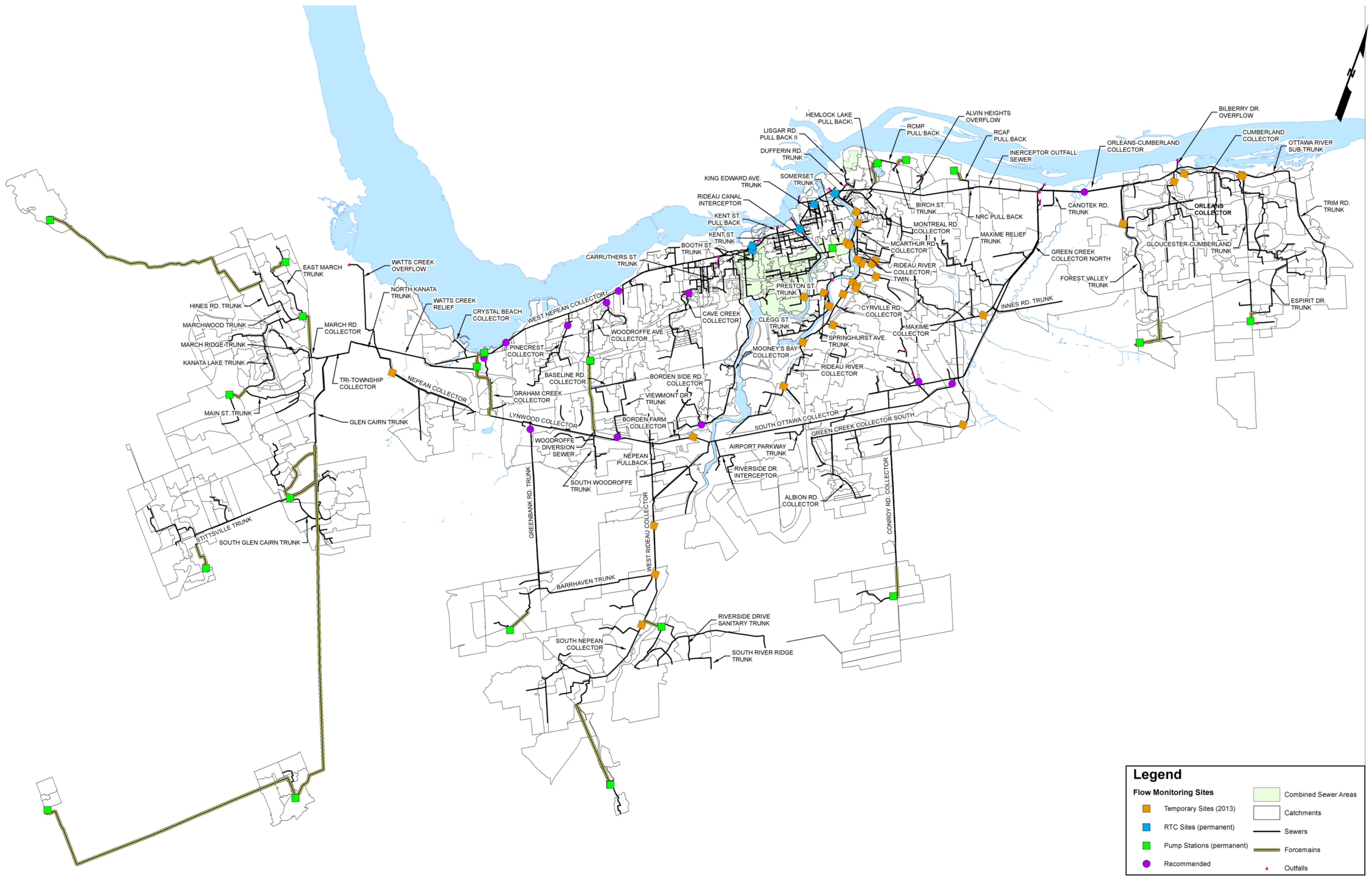
In planning for wastewater infrastructure, flow monitoring is needed to identify current conditions and project future conditions. In some instances this flow monitoring data was either non-existent or insufficient. In order to better plan for these requirements in the future, in particular for areas subject to intensification, an expanded and more comprehensive flow monitoring program is required.

A review was done of the current monitoring areas, and a recommendation for a future monitoring network is identified in *Figure 5.7*. This does not preclude additional monitoring locations which may be needed to assess site specific issues, i.e. high extraneous flow.

Several strategic trunk sewers were monitored in 2013 with the goal of further developing an understanding of existing flows and available residual capacity throughout the collection system. Details of the areas monitored can be found in the 2013 Wastewater Master Plan, referenced in *Annex B.2*.

Action:

- The City will review and update its wastewater flow monitoring requirements and its network on an annual basis.



Source: City of Ottawa GIS infrastructure database. City of Ottawa, Planning and Growth Management, Infrastructure Policy Unit: Wastewater Collection System Assessment, 2013.

Figure 5.7: Recommended Wastewater Flow Monitoring Sites

5.3.11 System Risk Assessment

In addition to capacity requirements there are other issues associated with how the LOS is met in the wastewater system. One of these issues is how facilities, pump stations in particular, are able to function under emergency situations. Undertaking a risk assessment helps determine the vulnerability of these facilities and how significant their failure might be, and consequently identify potential infrastructure upgrades.

An assessment was undertaken of the pump stations, and the criteria used in the assessment included: population served, flow, age, condition, construction material, ability to access, inspect and maintain, presence of backup power, rated capacity, presence of overflow and overflow level, potential failures modes, weather variations vulnerability, severity of consequences and potential public health and safety implications. This assessment was not intended to preclude any subsequent work evaluating risk and vulnerability in more detail, but was undertaken to identify non-capacity related improvements to respond to LOS objectives.

Unlike the Water system, the wastewater system has little to no redundancy in the event of problems in the sewer network. The provision of redundancy, particularly in the collection system, would be very costly to achieve, nevertheless, system redundancy must be considered as part of risk management.

5.3.11.1 Pump Station High-Level Reliability Assessment

For each PS and forcemain, risks were characterized as a function of probability and the consequence of failure. The rated capacity of the pump stations was used as a surrogate to represent the consequence of failure as it provides an indication of the potential severity of consequences such as number of people and/or critical customers affected, potential flooding, anticipated complexity and magnitude of repair costs, necessary bypass pumping effort in case of failure and potential public health and safety implications in the event of basement and/or surface flooding. The assessment includes only the pump stations that are included in the trunk level model or which are typically above 50 L/sec.

The indicators used for station reliability are summarized in *Table 5.9*.

Table 5.9: Summary of Indicators of Pump Station Reliability

Indicator of Reliability	Description
Pump Station Condition	• Provides an indication of the probability of one of the pump station's systems failing. • For simplicity, the overall pump station condition rating as documented in the *Equipment Inventory and Condition Assessment for the Wastewater Pump Stations* (Ainley Group, 2005) was used. • Planned upgrades are not considered in the current assessment.
Backup Power	• The presence of backup power or ability to easily accommodate a mobile back-up power unit provides an indication of pump station reliability.
Overflow	• The presence of an overflow and its ability to handle the rated capacity of the station provides an indication of the system reliability in avoiding impacts to customers.
Storage	• The presence and the amount of available storage provide an indication of the system reliability in providing Operations the time to respond to issues and avoiding impacts to customers.
Forcemains	• The length and age of the forcemain and the presence of redundant forcemains provides an indication of the reliability of the station. • A short forcemain is more easily bypassed for repairs.

Source: City of Ottawa, Planning and Growth Management, Infrastructure Policy Unit: Wastewater Collection System Assessment, 2013.

Based on the assessment undertaken, the highest ranked pump stations in terms of the risk of failure and ensuing consequence are:

- March
- Cumberland 4
- Delorme
- Tartan Drive
- Wessex
- Acres

The City is planning to introduce the necessary upgrades to the above stations to increase their reliability.

5.3.11.2 Risk-Based Management Plan

CAM addresses the extent, condition, and age of the infrastructure and the need to operate and maintain it over time. For the wastewater system, a key concern is that the materials and methods used to construct sewer systems have changed over time, and many that were constructed during past periods of rapid urban growth are beginning to reach the end of their life cycles. The result is significant portions of municipal sewer infrastructure will require replacement, rehabilitation, or regular maintenance and inspection within the same timeframe.

In order to prioritize which components of the wastewater system require renewal at which time, a prioritization tool is required. A risk-based management plan provides a means to prioritize efforts based on the most critical sewer segments. Such a plan identifies the critical components of the sewer system through an analysis of the consequences of failures (structural and LOS) and prioritizes action plans on the basis of the risk of failure. The focus of the management plan is to minimize the risk of social and environmental impacts resulting from infrastructure deterioration and, consequently, also maximize the return on investment within the city's CAM program.

Having completed a risk-based management plan for its large-diameter backbone watermain network, the City is proceeding to develop a similar plan for sewers within its sanitary, combined and storm sewer networks.

The next step following completion of this plan which will identify critical components in the wastewater system will be to assess the redundancies that are required.

Actions:

- The City will use the results of the wastewater risk-based management plan to establish priority needs for sewer segments.
- The City will evaluate the critical sanitary sewer segments to determine whether redundancy measures are warranted in the wastewater system.

5.3.12 Intensification / Renewal Projects

In addition to areas that were assessed for intensification as part of the overall growth of the City, specific results from the TOD studies were also assessed in more detail from an infrastructure perspective. To direct intense land development in the proximity of the OLRT stations, City Council has established priority areas for the creation of TOD plans. The TOD plans set the stage for future intense development by adding in appropriate locations, opportunities for additional land use and densities.

High level review and recommendations for wastewater servicing/infrastructure capacity needs to support the anticipated land use intensification plans were undertaken for the Blair, Cyrville, St. Laurent, Train Station, Hurdman and Lees areas. The TOD build-out population projections are included in the 2031 projections even though actual build-out will occur over a longer time frame.

The recommended upgrades related to wastewater servicing (*Figure 5.8*) from TOD studies are as follows:

- Partial replacement/upgrade of 860 m of 762 mm diameter sewer on Tremblay Road.
- Construction of a new interceptor sewer to parallel the Rideau River Collector from Riverside Transitway to Wright Street.

These two projects are included in the 2031 wastewater recommended projects list (*Annex A.1*).

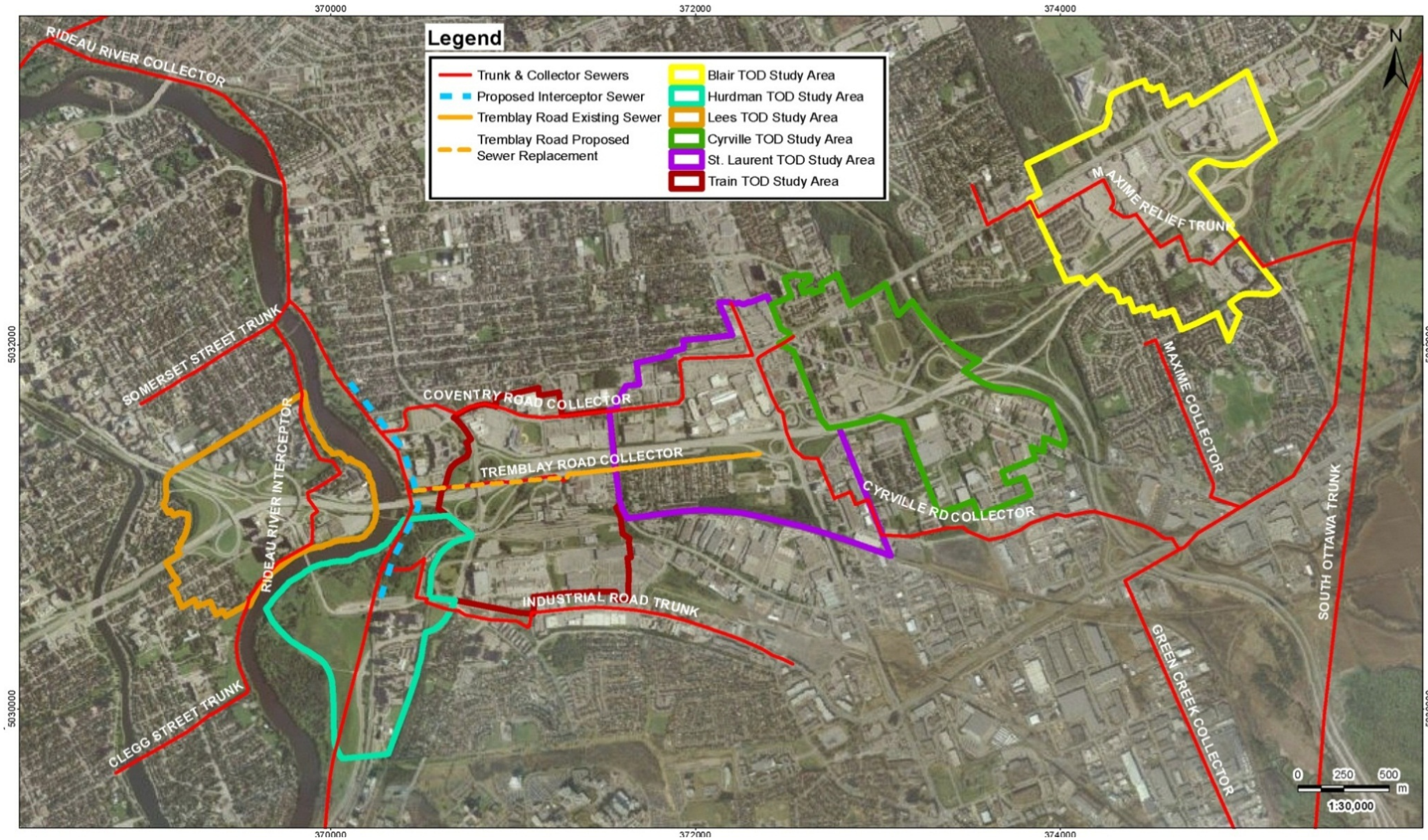
As the remaining TOD studies are completed, additional recommended upgrades may be identified. Any additions would also be subject to an affordability review.

5.3.13 Integration Opportunities (combining growth needs with renewal)

Currently, it is known that there are areas of the existing wastewater infrastructure system that are operating at levels that exceed their capacity during extreme wet weather events. New development, particularly in the form of intensification, will further aggravate this situation if not addressed. To accommodate new development in these areas, system upgrades or/or reductions in wet weather inflow will be required to gain additional capacity.

The wastewater infrastructure rehabilitation/replacement process provides opportunity to integrate the need for additional capacity for growth through the renewal program. Renewal of wastewater infrastructure, particularly piped infrastructure, as part of such an integrated program, is a cost effective way of providing capacity, as opposed to adding or replacing sewers solely for the purpose of providing capacity where needed to respond to development pressures in areas affected by intensification. Where rehabilitation involves the removal of extraneous flows and the reduction in infiltration, support for the objectives detailed in the WW-IMP will be required.

Based on the principle that an integrated approach is applied to infrastructure renewal, the growth portion of wastewater rehabilitation or replacement costs has been identified as eligible for recovery from Development Charges.



Source: City of Ottawa, Planning and Growth Management, Community Planning and Urban Design Unit: Preliminary TOD Servicing and Transportation Study, 2013.

Figure 5.8: Proposed Sanitary System Infrastructure

Actions:

- The City will, in areas with partially-separated sewers, give priority to extraneous flow removal projects that provide capacity for intensification.
- Capacity constraints that limit intensification potential will be addressed in planning and prioritizing infrastructure renewal programs.
- The City, as part of the planning for infrastructure, will continue to look at ways to integrate renewal and growth planning to achieve cost efficiencies.
- The City will maintain an internal working committee with representation from the various planning and operational City Departments, to consider opportunities to improve the integration of renewal and growth planning.

5.3.14 Summary of Proposed 2031 Wastewater Infrastructure

Projects currently proposed by the City for the 2031 planning horizon are detailed in *Annex A*. A description of the planned projects is provided, as well as their locations within the city's collection network. Also provided is the associated estimated total capital cost which includes engineering, construction cost, project management and contingency.

These projects are expected to be sized such that the predicted 2060 development planning horizon flows will be accommodated. In most cases the required over-sizing will have a negligible impact on the project capital cost comparing to 2031 development requirements. The post-2031 cost allocation details will be established as part of the 2014 Development Charges review.