UTILITIES KINGSTON

CITY OF KINGSTON WASTEWATER MASTER PLAN

ALTERNATIVES ANALYSIS AND REVIEW

JANUARY, 2017

WSP

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ALTERNATIVES ANALYSIS AND REVIEW

Utilities Kingston

Final Report

Project nº : 151-02944-00
Date : January, 2017

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January, 30 2017

Mr. Mike Fischer
Utilities Kingston
1211 John Counter Blvd
Kingston, ON, K7L 4X7

Subject : City of Kingston Wastewater Master Plan

Dear Mr. Fischer:

We are pleased to provide the Wastewater System Alternatives Analysis for the City of Kingston service areas. The purpose of this report is to present a review of the infrastructure gaps identified in the GAP Analysis report and establishes alternatives to address both existing and projected deficiencies in the wastewater system. The developed alternatives are based on the desired level of service, identified design criteria and the capacity requirements as a result of growth and development.

A capital improvement plan detailing the costs as well as an update to the Pollution Control Plan (PCP) based on the Alternative Solutions for the Master Plan report will be completed in a separate reports. Details pertaining to full Gap Analysis and the hydraulic model construction and loading are documented separately in the Gap Analysis Report and Hydraulic Modeling report respectively.

We would be happy to discuss this report with you at your convenience.

Yours truly,

Matt Morkem, P. Eng
Manager, Infrastructure, Kingston

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VERSION	DATE	DESCRIPTION
1	OCTOBER 17, 2016	Draft Report
2	JANUARY 30, 2017	Final Report

SIGNATURES

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1 INTRODUCTION

WSP was retained by Utilities Kingston to complete a Master Plan to establish servicing strategies for wastewater infrastructure for the next 20 years. The Master Plan will identify potential projects to address the servicing needs of planned growth and development within the Urban Boundary. The Master Plan is being conducted in accordance with the requirements set out in the Municipal Class Environmental Assessment (Class EA) document (Municipal Engineers Association, Amended 2011).

This report presents a review of the infrastructure gaps identified in the Gap Analysis Report (WSP 2016) and establishes alternatives to address both existing and projected deficiencies in the wastewater system. The developed alternatives are based on the desired level of service, identified design criteria and the capacity requirements as a result of growth and development.

1.1 ANALYSIS APPROACH

Alternatives have been developed based on the infrastructure deficiencies identified in the Gap Analysis Report (WSP, 2016) that are based on the existing and projected growth scenarios being used in the Master Plan Study. Condition and Level of Service (LOS) results from the 2036 scenario were used as the primary scenario for planned improvements and upgrades for the infrastructure, with the Full Build-Out scenario serving as a check and balance for the recommended upgrades. The results from the 2021 and 2026 scenarios were used to identify the timing and urgency of the upgrades. The Ultimate scenario has been primarily used to develop an overall strategy to help guide the servicing of these development areas with the analysis reviewing high-level servicing recommendations.

The wastewater system was reviewed starting with the upstream branches of the system, working downstream. Discussions regarding the developed alternatives has been divided up into the three main collection systems:

1. West Collection System
2. Central Collection System
3. East Collection System

The review of alternative solutions for each collection system included programming of alternative scenarios into the wastewater InfoSWMM model where scenarios are used to stream line the review of alternatives and to demonstrate the effectiveness of proposed recommendations

The subsequent sections further detail the development of the alternatives as well as the applied evaluation criteria. It should be noted that the evaluation of the recommended alternatives have been tailored to suit the nature and complexity of the alternative with additional detail given to the Central collection systems which experiences the effects of significant Combined Sewer Areas resulting Combined Sewer Overflows (CSO).

2 EVALUATION AND INFRASTRUCTURE ALTERNATIVES

2.1 EVALUATION OVERVIEW

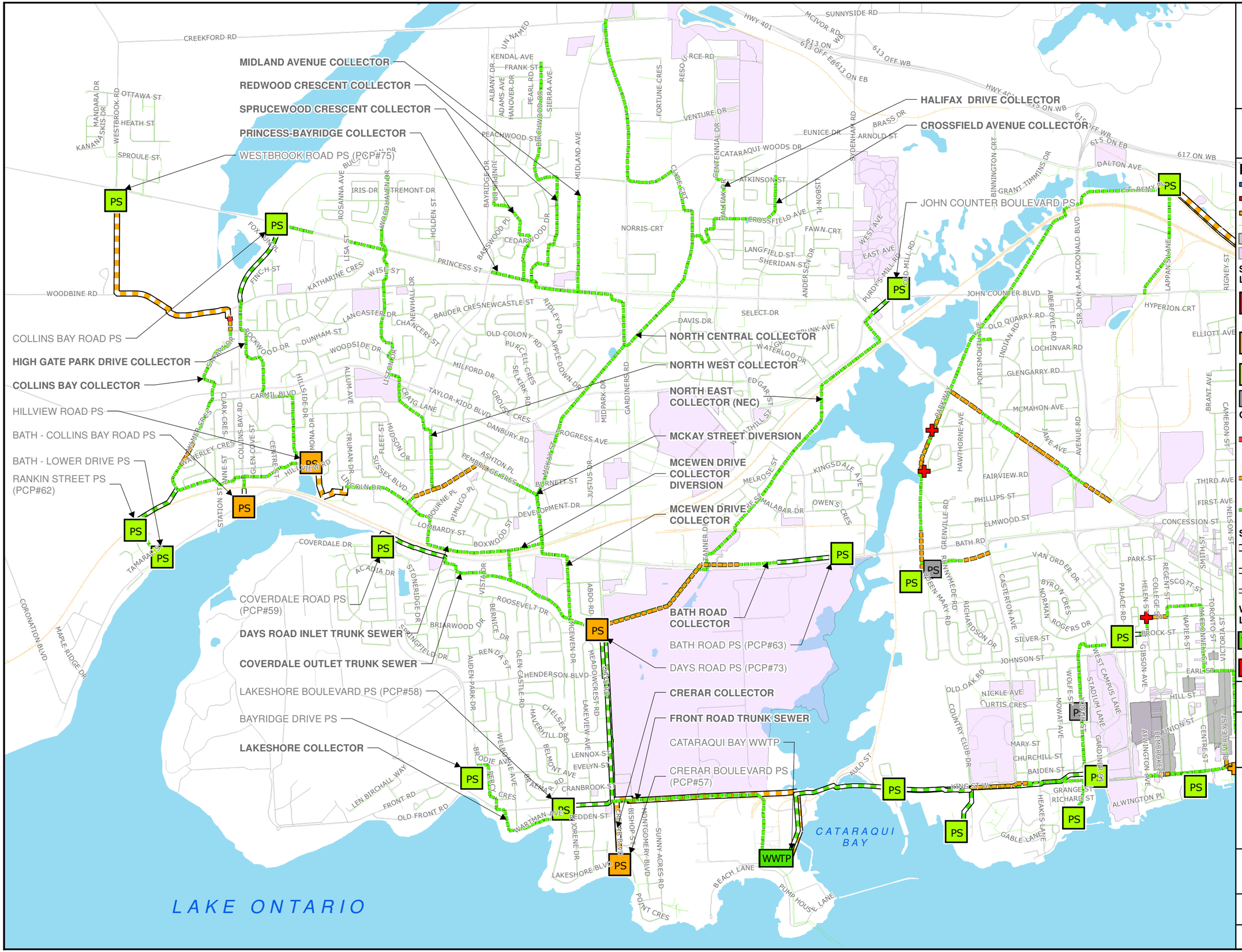
As detailed in the Gap Analysis Report (WSP, 2016) the wastewater system was evaluated using multiple scenarios to predict the effects of growth and development on the system infrastructure. The accepted approach for determining the required system upgrades is to determine the requirements in the most future study year (2036) and work backwards. In the development of alternative solutions the main principle considered was to determine if the infrastructure will be able to adequately convey projected flow from development and design storms while meeting the desired level of service for the 2036 scenario; then progressively work backwards through the other analysis periods to determine the timing of these upgrades. This ensures that the upgrades recommended for 2026 or 2021 would not need to be revised to meet the next study year requirements. Table 2-1 shows the LOS criteria for the system.

Table 2-1 Level of Service to be met for Evaluated Alternative Solutions

COLLECTION SYSTEM TYPE	SEWERS LOS	PUMPING STATION LOS	WWTP LOS	COMMENT
Wastewater System	100yr Design Storm Flows	10yr Design Storm Flows	10yr Design Storm Flows	Includes West and East Collections System

Figure 2-1 & Figure 2-2 provide a summary of the infrastructure gaps that have been identified for the 2036 scenario and includes a summary of condition, operation and reliability concerns which were identified in the Gap Analysis Report. The evaluations of infrastructure alternative solutions were reviewed for six different categories.

1. Sewer Conveyance and Capacity Alternatives
2. Pumping Station Conveyance and Capacity Alternatives
3. Combined Sewer Area Collection System Alternatives (Central Collection System Only)
4. Wastewater Treatment Plant Capacity Alternatives
5. Condition and Reliability Alternatives
6. I/I Reduction by Area Alternatives
7. Ultimate Scenario Servicing Alternatives



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Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

SANITARY PUMP STATION LEVEL OF SERVICE

- PS — DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
- PS — PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
- PS — PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
- PS — NOT MODELLED

GRAVITY SEWER LEVEL OF SERVICE

- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS

SANITARY FORCEMAIN LEVEL OF SERVICE

- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
- VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
- VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR

WASTEWATER TREATMENT PLANT LEVEL OF SERVICE

- WWTP — 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
- WWTP — ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

Data Source: Ontario Base Mapping, Minisitry of Natural Resources, August 2013. Water and Waste Water Systems, Utilties Kingston, April 2015, City of Kingston.

Scale: 0 200 400 800 Meters

1:30,000

N W E S

Project:
Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title:
LEVEL OF SERVICE - KINGSTON WEST 2036

Project No.:	Date:		
151-02944-00	DECEMBER 2016		
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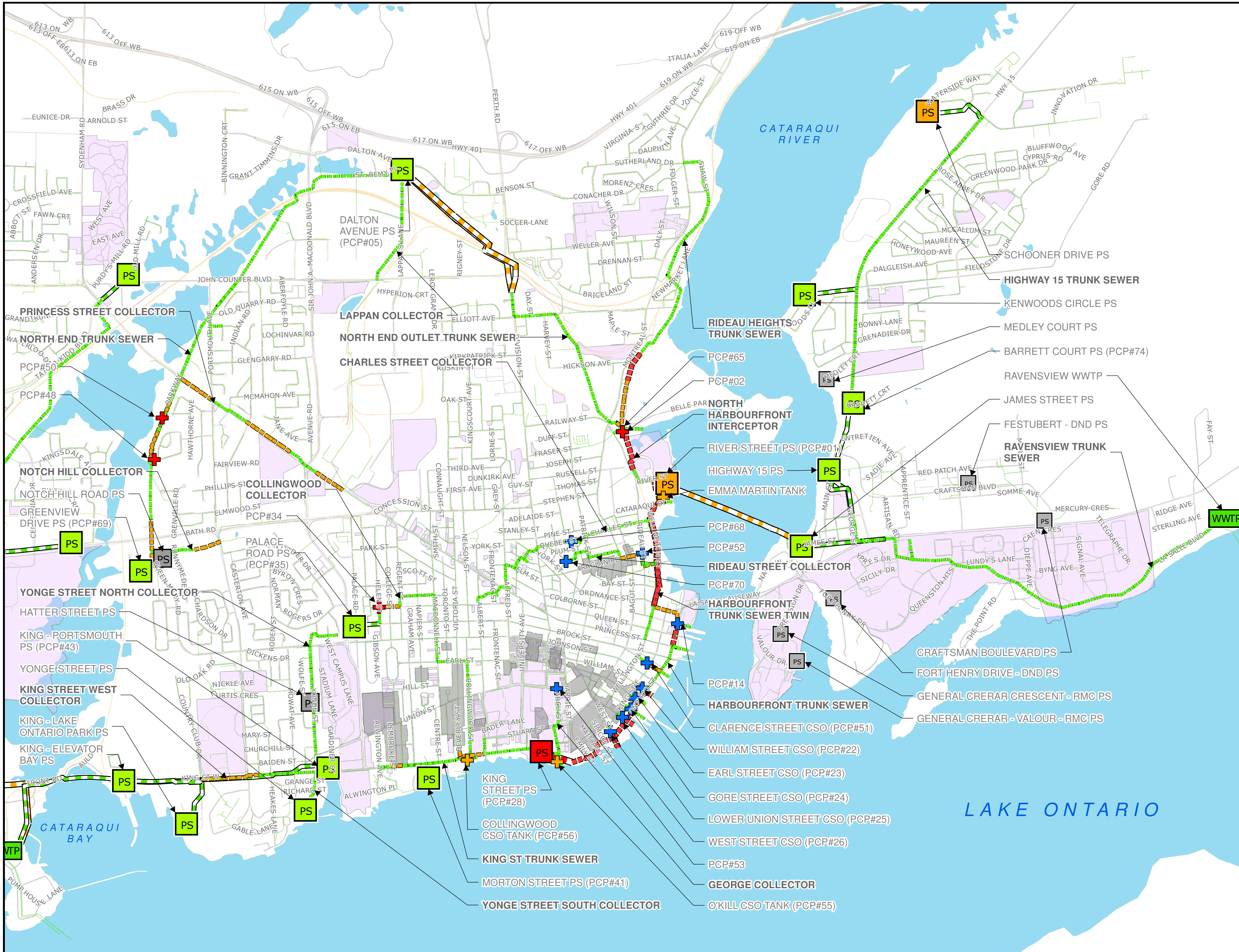

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Legend

- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA
- PROJECTED DEVELOPMENT

SANITARY PUMP STATION LEVEL OF SERVICE

- PS (red): DRY WEATHER INFLOW EXCEEDS FIRM CAPACITY OR WET WEATHER INFLOW INCLUDING THE 1:10 YEAR STORM EXCEEDS PEAK CAPACITY
- PS (orange): PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH PEAK CAPACITY
- PS (green): PUMPS UP TO AND INCLUDING THE 1:10 YEAR STORM WITH FIRM CAPACITY
- PS (grey): NOT MODELLED

GRAVITY SEWER LEVEL OF SERVICE

- HGL WITHIN 2M OF FINISHED GROUND. CANNOT CONVEY DRY WEATHER FLOW WITHOUT SURCHARGING
- SEVERE CONDITIONS > 1:10 YEAR STORM AND/OR MODERATE CONDITIONS ≥ 1:10 YEAR STORM UP TO AND INCLUDING THE 1:100 YEAR STORM. NO SEVERE CONDITIONS

SANITARY FORCEMAIN LEVEL OF SERVICE

- VELOCITY > 3 M/S FOR STORMS ≤ 1:10 YEAR
- VELOCITY > 2 M/S FOR STORMS ≤ 1:100 YEAR
- VELOCITY < 3 M/S FOR STORMS ≤ 1:100 YEAR

WASTEWATER TREATMENT PLANT LEVEL OF SERVICE

- WWTP (green): 1:10 YEAR STORM ≤ RATED PEAK FLOW CAPACITY AND ADF ≤ RATED ADF CAPACITY
- WWTP (red): ADF CAPACITY OR PEAK FLOW CAPACITY IS EXCEEDED

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.

Scale: 0 200 400 800 Meters
1:30,000

Project:
Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title:
LEVEL OF SERVICE - KINGSTON CENTRAL AND EAST 2036

Project No.:	Date:
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CM	MF	AS	2-2

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2.2 PROCESS FOR THE EVALUATION OF ALTERNATIVES

2.2.1 APPROACH TO EVALUATION OF ALTERNATIVES

The wastewater systems servicing alternatives were evaluated using the natural, social, cultural, technical and economic criteria to determine the preferred servicing alternatives. These criteria are included in an evaluation matrix to objectively assess the impacts and determine the preferred solution. Comparative assessments of the alternative wastewater servicing options were conducted to determine which solutions has the least overall impact.

The following evaluation approach was used to determine the preferred wastewater servicing solutions for the identified issues:

- **Step 1: Determine Evaluation Criteria** –Evaluation criteria for this project will include impact on the natural environment, impact on the social and cultural environments, technical & operational merit, and financial & economic impact. The individual impacts will typically fit into these four general categories. A breakdown of the impacts considered under each criterion is defined in the section below.
- **Step 2: Create an Evaluation System** –In order to be impartial, this system was developed prior to determining the potential impacts associated with each alternative. During the evaluation, each of the alternatives was assigned a colour rating: green for “preferred”, yellow for “less preferred” and orange for “least preferred”, for each of the evaluation criteria. The colour rating reflected how the alternative performs with respect to that criterion. The four evaluation categories were assigned equal weighting as they were considered to have equal importance in the evaluation.
- **Step 3: Document Potential Impacts** - The individual impacts associated with each alternative were determined and documented. These impacts were categorized under one of the four categories of evaluation criteria described above.
- **Step 4: Evaluate the Alternatives** - Each of the alternatives was assigned a colour rating for each of the four evaluation criteria using the methodology established in Step 2. The evaluation was based on a qualitative assessment of the individual impacts documented in the table created during Step 3.
- **Step 5: Determine the Preferred Alternative** - The servicing alternative with the least overall impact was recommended for implementation.

Identified Gaps which have an existing servicing strategy and typical or standard alterations (i.e. pipe is too small, upsize pipe; pumping station doesn’t pump enough, increase capacity) to increase capacity were determined based strictly on the technical merits to eliminate the Gap.

2.2.2 EVALUATION METHODOLOGY

In order to qualitatively evaluate the wastewater servicing alternatives, each of the criteria presented in the section below were assessed in a descriptive manner rather than a quantitative manner. Rather than having a numerical or weighted ranking system, the evaluation focuses instead on the strengths and weaknesses of each servicing alternative to identify the preferred alternative. For each evaluation criterion and for each system alternative, the potential effects on the environment were identified and evaluated relative to the other alternatives as being most preferred, less preferred and least preferred.

The evaluation is based on the relative advantages and disadvantages of the potential environmental effects for each system alternative.

As explained above, the evaluation approach involves the assessment of the impacts to the environment associated with implementing the water and wastewater system servicing alternatives. A more detailed breakdown of the specific criteria under each category is listed below:

NATURAL ENVIRONMENT CONSIDERATIONS

- Natural Features
- Watercourses and Aquatic Habitat
- Natural Heritage Areas
- Areas of Natural and Scientific Interest (ANSI)
- Designated Natural Areas

SOCIAL AND CULTURAL ENVIRONMENT CONSIDERATIONS

- Proximity of Facilities to Residences, Businesses and Institutions
- Public health
- Archaeological and Cultural Features
- Designated Heritage Features
- Wells or Wellhead Protection Areas
- Consistency with Land Use Designations, Approved Development Plans and Proposed Land Use Changes

TECHNICAL SUITABILITY AND OPERATIONAL SUITABILITY

- Design and Constructability
- Ease of Connection to Existing Infrastructure & Ease of Modifications Required to Existing Infrastructure
- Operations and Maintenance Requirements

FINANCIAL & ECONOMIC CONSIDERATIONS

- Operations and Maintenance Costs
- Total Capital Costs

2.3 OVERVIEW OF SYSTEM ANALYSIS

The main tool used to evaluate alternative solutions is the InfoSWMM wastewater model which was previously calibrated and used in the Gap Analysis. This model was updated with new scenarios representing conditions with future and upgraded infrastructure to demonstrate how the flow conveyance is possible to meet the desired LOS. Details on the alternative scenario development in the model is further described in the Wastewater Hydraulic Modelling Report (WSP, 2016). Discussions of the LOS results and recommendations for the West, Central and East collection systems are presented in sections 3, 4 and 5 respectively.

2.3.1 SEWER INFRASTRUCTURE ANALYSIS

In the trunk model alternatives for sewer infrastructure upgrades are typically simulated by either upsizing pipe diameters or by twinning pipes of similar dimensions until the capacity of the sewer is adequate to resolve the identified gap for the 100yr (Sewer LOS) design storm to meet the LOS. Redirection or new sewer infrastructure along alternate routes was generally not considered where an existing servicing strategy exists. These were not considered viable sewer alternatives due to the implications caused when considering land acquisition, land disturbance and maintenance of multiple infrastructure components.

The alternative analysis is limited to collector and trunk sewers. These sewers represent the primary conveyance infrastructure for City's collection systems. Sewers which are tributary to primary conveyance sewers are represented in the model through the calibration process. The recommended alternative solutions modeled may be assumed to improve tributary sewers through the improvements of downstream conveyance capacity and relief of "flow bottlenecks" in the collection system. The hydraulic profiles of the existing and upgraded conditions for the sewer alternatives are included in Appendix A.

2.3.2 PUMPING STATION AND SEWER INFRASTRUCTURE ANALYSIS

Both primary and secondary pumping stations are represented in the trunk sewer model, and alternative solutions were modeled based on meeting LOS criteria for the 10yr design storm. The 10yr storm was used since most stations have wet-weather controls able to alleviate surges in flow during major storms through local bypasses before causing flooding or sewer back-ups. The increased flow resulting from sewer conveyance capacity increases are represented in the model and pump station capacity is increased until a there is adequate capacity to convey the 10yr design storm peak wet-weather flow resulting in the required firm capacity upgrade. Given that the model is calibrated to simulate pump stations running at firm and peak conditions the model results are also reviewed for the number of pumps running in a given simulation to account for the dynamic relationship between the pumps, forcemain, and wet well storage. Alternative solution recommendations are derived based on the review of the pumping stations theoretical capacity and ability to convey flow through their forcemain(s).

Review of solutions included a review of forcemain upsizing/twinning or redirection or redirection where applicable.

2.3.3 COMBINED SEWER SYSTEM – INFRASTRUCTURE ANALYSIS

The combined sewer system was analyzed separately as there are controls and infrastructure in place to regulate the levels in the system that directly influence the different components (i.e. sewer & pumping station) and act a single system. The combined sewer system was reviewed based on two main criteria:

Objective 1. MOECC F-5-5 Guidelines & "Virtual Elimination" of CSOs

Objective 2. Long Term Goals – Level of Service

While source control was identified in previous studies and master plan as the most effective means of CSO reduction for the Kingston Central Collection system, this analysis was revisited to ensure that under current conditions and regulations it is still the most effective means. Once this is determined, a more detailed analysis of the preferred method is completed to provide guidance and recommendations to meet Objective 1.

In order to provide additional guidance and options for the combined sewer system, a long term goal was developed with the assumption that Objective 1 is achieved. This strategy was developed by comparing the combined sewer system to a LOS analysis to determine what upgrades would be required in the future for the sewers, pumping stations, and treatment plants. In order to review realistic and reasonable upgrades for the system, some of LOS criteria were reduced. The following table presents this long term LOS criteria:

Table 2-2 Level of Service to be met for Evaluated Alternative Solutions

COLLECTION SYSTEM TYPE	SEWERS LOS	PUMPING STATION LOS	WWTP LOS
Combined Sewer System	10yr Design Storm Flows	10yr Design Storm Flows	10yr Design Storm Flows

2.3.4 CONDITION & RELIABILITY REVIEW

The reliability review involves an analysis of key infrastructure and its current ability to maintain proper system operation during existing conditions, as well as its ability to continue to service future developments as the infrastructure ages. Unlike infrastructure gaps based on the capacity of the infrastructure; condition and reliability relate to the physical life-span remaining in existing structures, its need for continual operation and maintenance and its performance in the event of a failure. The Condition Assessment Report (WSP, 2016) was completed as part of the master plan to identify the condition rating of key infrastructure such as pumping stations. Pumping stations which are found to have poor condition scores or low reliability ratings mean they pose a greater risk to the proper operation of the sewer systems which is important when factoring development growth and future capital improvements.

2.3.5 I/I REDUCTION ANALYSIS

The I/I review involves an analysis based on drainage areas throughout the City to help evaluate where there is high wet weather influence and where there is a higher potential for reducing that inflow. This analysis uses the results from the model to determine the drainage area inflow influence along with the size of the area to help develop a framework for further detailed analysis.

2.3.6 ULTIMATE SCENARIO SERVICING ANALYSIS

For the ultimate scenario four major developments were identified for review in the master plan:

1. Westbrook Development (West Collection System)
2. Mile Square Development (West Collection System)
3. North-East Expansion Area (East Collection System)
4. South-East Expansion Area (East Collection System)

All of these development areas are located outside the existing Urban Boundary. The purpose of analyzing service options for these large development areas separately is that they are outside the current urban boundary and the timeframe for development is either unknown or not anticipated until beyond the 2036 projection. The alternative solutions evaluated for the Ultimate scenario servicing strategy include options for resolving general implications to sewers, pumping stations and wastewater treatment plants resulting from large increases in flow due to development.

2.3.7 REVIEW OF WASTEWATER TREATMENT PLANTS

The Cataraqui Bay WWTP and the Ravensview WWTP service the West and Central/East collection systems respectively. The WWTP review is based on comparing the projected sanitary inflows from the Gap analysis with the projected sanitary flow from infrastructure upgrades and recommended alternatives solutions from the collection system analysis to the rated capacities.

3 WEST COLLECTION SYSTEM ALTERNATIVES SOLUTIONS ANALYSIS

The City of Kingston West wastewater collection system comprises an area of approximately 3,953 ha. It is bordered by Westbrook Road to the west, Macdonald-Cartier Freeway to the north, Little Cataraqui Creek to the east and Lake Ontario to the south. There are approximately 44,400 people living in Kingston West. Wastewater is collected from Kingston West and conveyed via gravity and pump stations to Cataraqui Bay Wastewater Treatment Plant.

Table 3-1 Summary of West Collection System Infrastructure Gaps

INFRASTRUCTURE	TYPE	2036 LEVEL OF SERVICE	COMMENT
Bath Rd. Collector	Sewer	25-YR	→ Surcharging within 2m of surface during storms larger than the 25yr storm
Collins Bay Collector	Sewer	25-YR	→ Surcharging within 2m of surface during storms larger than the 25yr storm
North West Collector	Sewer	10-YR	→ Surcharging within 2m of surface during storms larger than the 10yr storm
Crerar Collector	Sewer	100-YR	→ Meets required LOS → Basement flooding in service area documented
McEwen Dr Collector	Sewer	100-YR	→ Meets required LOS → Basement flooding in service area documented
Bath – Collins Bay	Pump Station	2-YR	→ Peak capacity is not exceeded during wet weather → Operational concerns have not been noted
Crerar Blvd.	Pump Station	5-YR	→ Peak capacity is exceeded for the 50yr storm → Basement flooding in service area documented
Days Rd.	Pump Station	2-YR	→ Peak capacity is exceeded for the 25yr storm → Basement flooding in service area documented
Lakeshore Blvd.	Pump Station	100-YR	→ Meets required LOS → Basement flooding in service area documented

3.1 TRUNK CAPACITY AND SEWER SURCHARGE ANALYSIS

3.1.1 BATH ROAD COLLECTOR

3.1.1.1 RESULTS AND DISCUSSION

The Bath Road collector receives flow from the Bath Road Pumping Station. The sewer extends along Bath Road and through a R.O.W. across Correctional Services Canada property (Collins Bay Institution) and was observed to experience surcharging.

The surcharging is resulting from high wet-weather influence as indicated in the modeling results for major design storms. The sewer does not have observed capacity issues servicing dry-weather flow conditions. The location of the surcharging is in a low lying area on the CSC lands which is currently

an agricultural field with minimal service connections. There is little risk of sewer back-ups causing property damage in this area.

Based on the review of the results two different options were considered as alternative solutions:

Alternative 1. Upsize the Bath Rd Collector to accommodate the increased flow

Alternative 2. Redirection the Bath Rd Collector to the North East Collector.

ALTERNATIVE 1

This alternative involves upsizing of the sewers between manholes 763-030 to 764-030, along Bath Rd from just west of Centennial Dr to just east of Tanner Dr from a 250mm to a 300mm (500m) and between manholes 764-020 to 346-020, Tanner Dr. to Days Rd from a 450mm to a 600mm (1,100m). The identified upsize is required to meet 100yr storm LOS.

ALTERNATIVE 2

This alternative involves redirecting the flows from Bath Rd Collector to the North East Collector at Bath Rd and Tanner Dr where the sewers cross.

These two options were evaluated based on the table below:

Table 3-2 Bath Road Collector: Alternatives Evaluation

	Alternative 1 Sewer Upsizing	**Alternative 2 Redirection of North East Collector**
Natural Environmental Considerations		
Impacts to Animal & Vegetative Features	• Minimal Impacts as work is to be completed within R.O.W.	• Minimal Impacts as work is to be completed within R.O.W.
Impacts to Water Course	• Installation of new sewers near Creek	• Installation of new connection near Creek
Natural Environment Overall Rating	Minimal Overall Impact to the Natural Environment	Minimal Overall Impact to the Natural Environment
Social and Cultural Environmental Considerations		
Number of People Disrupted in Community	• Potential upgrade would affect a moderate number of people in a number of different locations based on the location of the existing infrastructure and road reconstruction requirements	• Potential Upgrade would affect small number of people in the Collins Bay Collector Service Area
Recent Disruptions to Communities by New Infrastructure	• Some recent infrastructure reconstruction/upgrades have occurred	• Minor infrastructure reconstruction has recently occurred

	Alternative 1 Sewer Upsizing	Alternative 2 Redirection of North East Collector
Traffic Disruption	• Construction would have disruptive effect to arterial roadway (Bath Rd)	• Construction of potential upgrades would have disruption to local traffic • Construction would have disruptive effect to the intersection of Tanner Dr and Bath Rd
Social Disruption	• Minor disruption to EMS	• Minor disruption to EMS
Social/Cultural Environment Overall Rating	Some Disruption to the commuter traffic along Bath Rd	Minor impacts to commuter traffic but significantly less duration.
Technical Suitability		
Capacity of Existing Linear Infrastructure	• Sections of existing sewers do not currently have capacity to meet the 2036 LOS.	• North East Collector has sufficient capacity to accommodate additional flows.
Approximate Amount and Ease of Construction of New Required Infrastructure	• Reconstruction of 1600m of sewer, partial along arterial road • Moderate ease of construction for these upgrades	• Installation of a manholes and connecting pipes • Minimal complex of construction
Full Build – Out Capacity	• Upgrades for the 2036 flow can accommodate the full build out flows	• Redirection of the full buildout can be accommodated in the North East Collector sewers
Technical/Operational Rating	Moderate roadway reconstruction to upsize required sections	Utilizes existing sewer with installation of minimal additional infrastructure
Financial Considerations		
Operational/Maintenance Costs	• Minimal operational and maintenance costs above current levels	• Minimal operational and maintenance above currently levels • Minor additional energy costs (i.e. additional head to overcome at Westbrook PS)
Capital Costs (incl. Constructability Risk)	• Moderate capital cost to install sewer and reconstruction some roadway. • Moderate constructability risk (common type of work)	• Minimal capital cost to install manhole and piping. • Minor constructability risk
Financial Overall Rating	Significantly more capital cost	Minor capital cost costs
OVERALL PREFERENCE RATING	**2 – Less Preferred**	**1 - Preferred**

Legend:

Most Preferred | Less Preferred | Least Preferred

3.1.1.2 RECOMMENDATIONS

By connecting the Bath Rd Collector to the North East Collector at the intersection of Bath Rd and Tanner Dr surcharging can be eliminated. As demonstrated in the evaluation this is the preferred option. There is minimal work required to complete this connection as the two sewers cross and there is sufficient fall to allow the flow to be directed into the North East Collector.

TIMING

As this has been identified as an issue in 2015 and progressively gets worse through the analysis period, it is recommended to complete this work by 2021.

3.1.2 COLLINS BAY COLLECTOR

3.1.2.1 RESULTS AND DISCUSSION

The Collins Bay Collector was observed from the modeling results to have pipe surcharging during major storm events for the 2036 scenario simulations. This collector sees an increase in dry-weather flow from projected growth development. The sewer receives the majority of its dry-weather flow from multiple service areas and pumping stations including Westbrook Rd PS, Rankin PS, Bath-Collings Bay PS and Bath-Lower Drive PS. The surcharging was observed at various locations along the length of the sewer and is mainly caused by the upgrades to the Westbrook Rd PS.

Based on the review of the results two different options were considered as alternative solutions:

Alternative 1. Upsize the Collins Bay Collector to accommodate the increased flow

Alternative 2. Redirection the Westbrook Rd PS discharge to the High Gate Park Drive Collector.

ALTERNATIVE 1

This alternative involves upsizing the Collins Bay Collector between manholes 34166-020 to 34026-061 (along Beaver Cres to south side of Taylor Kidd Blvd) from a 250mm to a 300mm (900m) and increasing the 375/400mm section between 34024-010 to 33492-030 (Aylmer Cres from Waverley Cres to the west side of Collins Bay Rd) to 450mm (950m).

ALTERNATIVE 2

This alternative involves redirecting the flow from Westbrook Rd PS that currently discharges into the Collins Bay Collector at Beaver Cres by extending the forcemain approximately 100m across Collins Bay Rd to connect into the High Gate Park Drive Collector.

In both of these alternatives, Hillview pumping station requires an increase in peak capacity due to either the increase in flow resulting from the elimination of sewer bottlenecks (Collins Bay Collector) or the flow is able to get to the Hillview PS quicker and therefore the observed peak is higher (High Gate Park Drive Collector). As an upgrade of similar magnitude for both of these alternatives would be

required, the Hillview PS upgrade and the related downstream effects have not been considered in the evaluation.

These two options were evaluated based on the table below:

Table 3-3 Collins Bay Collector: Alternatives Evaluation

	Alternative 1 Sewer Upsizing	Alternative 2 Redirection of Westbrook PS
Natural Environmental Considerations		
Impacts to Animal & Vegetative Features	• Potential upgrades may impact vegetative features due to potential work within woodland/park area; work to remain mostly within Right of Way (R.O.W.)	• Minimal Impacts as work is to be completed within R.O.W.
Impacts to Water Course	• Installation of new sewers near Little Cataraqui Creek	• Installation of new forcemain is near Little Cataraqui Creek
Natural Environment Overall Rating	• Minimal Overall Impact to the Natural Environment	• Minimal Overall Impact to the Natural Environment
Social and Cultural Environmental Considerations		
Number of People Disrupted in Community	• Potential upgrade would affect a moderate number of people in a number of different locations based on the location of the existing infrastructure and road reconstruction requirements	• Potential Upgrade would affect small number of people in the Collins Bay Collector Service Area
Recent Disruptions to Communities by New Infrastructure	• Some recent infrastructure reconstruction/upgrades have occurred	• Minor infrastructure reconstruction has recently occurred
Traffic Disruption	• Construction of potential upgrades would have disruption to local traffic • Construction would have disruptive effect to arterial roadway (Taylor Kidd Blvd)	• Construction of potential upgrades would have disruption to local traffic • Construction would have disruptive effect to arterial roadway (Collins Bay Rd)
Social Disruption	• Minor disruption to EMS	• Minor disruption to EMS
Social/Cultural Environment Overall Rating	Significant Disruption to the Collins Bay residential area as well as commuter traffic	Some impacts to local and commuter traffic but significantly less duration.
Technical Suitability		

	Alternative 1 Sewer Upsizing	Alternative 2 Redirection of Westbrook PS
Capacity of Existing Linear Infrastructure	• Sections of existing sewers do not currently have capacity to meet the 2036 LOS.	• High Gate Park Drive Collector has sufficient capacity to accommodate Westbrook Flows. • Westbrook PS current pump upgrades would need to be larger to overcome additional head to maintain peak flow rate.
Approximate Amount and Ease of Construction of New Required Infrastructure	• Reconstruction of 1850m of residential roadway • Moderate ease of construction for these upgrades • Some more complex construction activities to cross Taylor Kidd Blvd	• Installation of 100m of forcemain. • Some more complex construction activities to cross Collins Bay Rd • Moderate complexity to tie-in to a pressurized forcemain
Full Build Out Capacity	• Upgrades for the 2036 flow can accommodate the full build out flows	• Redirection of the Westbrook PS full buildout can be accommodated in the existing High Gate Park Drive sewers
Technical/Operational Rating	Significant roadway reconstruction to upsize required sections	Utilizes existing sewer with installation of minimal additional forcemain infrastructure
Financial Considerations		
Operational/Maintenance Costs	• Minimal operational and maintenance costs above current levels	• Minimal operational and maintenance above currently levels • Minor additional energy costs (i.e. additional head to overcome at Westbrook PS)
Capital Costs (incl. Constructability Risk)	• Significant capital cost to install and reconstruction residential roadway. • Moderate constructability risk (common type of work)	• Minimal capital cost to install 100m of forcemain. • Moderate constructability risk due to crossing of major roadway
Financial Overall Rating	Significantly more capital cost	Moderate capital cost and minimal increase in operational costs
OVERALL PREFERENCE RATING	**2 – Less Preferred**	**1 - Preferred**

Legend:

Most Preferred Less Preferred Least Preferred

3.1.2.2 RECOMMENDATIONS

As it can be seen from the above evaluations, by installing a small section of forcemain, significant reconstruction of gravity sewer can be avoided. In addition, as the Westbrook pumping station is currently in the process of being upgraded, there would be minimal cost to revise the pumps to account for the additional head. It is recommended that a new section of forcemain being installed to redirect the flow along with a valve to permit the flexibility of discharging into either sewer. Providing flexibility in the event that the flow along the High Gate Park Drive Collector needs to be reduced.

TIMING

As the Westbrook pumping station upgrades are currently being designed, it is recommended to complete this work with the recommended upgrades before 2021 to ensure the dynamic between the pumps and forcemain are considered.

3.1.3 NORTH WEST COLLECTOR

3.1.3.1 RESULTS AND DISCUSSION

The section located just upstream of the McKay St. Diversion on the North West Collector was observed through model simulations to experience surcharging during major storms in the 2036 scenario.

The North West collector is anticipated to receive additional growth and development in its service area towards the North. The sewer is currently projected to be able to service the simulated dry-weather flow in its existing condition. The North West collector along Pembridge Ave. has a high flow diversion maintenance hole located at the Days Road Inlet Trunk Sewer. During high flow or surcharging events it is observed that flow is diverted from the Days Road Inlet Trunk Sewer into the North West Collector. Even with the diversion of this flow from the North West collector the LOS for the 100YR design storm is still not met.

Upgrades to this section of sewer were recommended in the last wastewater master plan. Currently, there have been no reported or documented issues with the sewer in terms of sewer back-ups or flooding.

Based on a review of the simulation results for the North West Collector a section of sewer should be upsized to meet the LOS for the 1:100yr storm. This upsizing should be completed between manholes 33306-010 & 33022-031 (along Bayridge from Lincoln Dr to Mayfair Cres to just east of Pembridge Cres and Truedell Rd) from a 450mm to a 600mm, approximately 1,300m.

The full buildout scenario was also reviewed to determine if upsizing to accommodate the projected growth would be reasonable. The upgrades to the sewers required to service the 2036 flows accommodate the full build out scenario as well. This is mainly due to the standard pipe sizes for sewers vs. the theoretical size required.

3.1.3.2 RECOMMENDATIONS

To ensure that capacity conveyance is not restricted, the North West Collection should be upgraded between Lincoln Dr. to just east of Pembridge Cres to a 600mm sewer.

TIMING

The LOS for the Northwest collector decreases from the 1:50yr storm under existing conditions to the 1:25yr storm under the 2021 scenario and 1:10yr storm by 2026 scenario. In order to provide sufficient timing to complete the downstream upgrades, as well as minimize the risk of hydraulic issues, it is recommended to complete the upgrades by 2026.

3.1.3.3 CRERAR COLLECTOR

3.1.3.4 RESULTS DISCUSSION

The Crerar Blvd collector which is tributary to the Crerar Blvd Pumping Station has been documented in the past of having sewer back-up and basement flooding. The results do not currently indicate a capacity issue in the service area. Local circumstances in sewers tributary to the collector may be attributed to the back-ups or potential issues not able to be simulated at the Crerar PS (i.e. equipment failure) may be the cause. Based on empirical data collected for this master plan study, this has not been observed.

3.1.3.5 RECOMMENDATIONS

It is recommended that flow monitoring continue for this service area prior to conducting any sewer upsizing to confirm reports and to update flow data when available.

TIMING

This analysis should be completed by 2021 and re-evaluated during the next master plan update.

3.1.4 MCEWEN DR COLLECTOR

3.1.4.1 RESULTS DISCUSSION

The McEwen Dr collector which is tributary to the Days Rd Pumping Station has been documented in the past of having sewer back-up and basement flooding. The results currently do not indicate a capacity issue in the service area. Local circumstances in sewers tributary to the collector may be attributed to the back-ups or potential issues not able to be simulated at the Days Rd PS (i.e. equipment failure) may be the cause. Based on empirical data collected for this master plan study this has not been observed.

3.1.4.2 RECOMMENDATIONS

It is recommended that flow monitoring continue for this service area at the pumping station prior to conducting any sewer upsizing to confirm reports and to update flow data when available.

TIMING

This analysis should be completed by 2021 and re-evaluated during the next master plan update.

3.1.5 SUMMARY OF SEWER RECOMMENDATIONS

Table 3-4 summarizes the recommendations for the sewers that were evaluated:

Table 3-4 Summary of Sewer Recommendations: West Collection System

TRUNK / COLLECTOR SEWER	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	LOS PROVIDED	TIMING
Bath Road Collector	Some sewer surcharging throughout collector for major storm events	Connect to North East Collector at Bath Rd and Tanner Dr	Full Buildout 1:100yrs Storm	By 2021
Collins Bay Collector	Sewer surcharging throughout collector for major storm events after upgrading Westbrook PS.	Extend Westbrook PS forcemain 100m to the High Gate Park Drive Collector	Full Buildout 1:100yr Storm	By 2021
North West Collector	Sewer surcharging upstream of McKay Street Diversion	Upgrade sewer between manholes 33306-010 & 33022-031 from a 450mm to 600mm	Full Buildout 1:100yr Storm	By 2026
Crerar Collector	Basement flooding in service area documented	Continued Flow monitoring	Full Buildout 1:100yr Storm	By 2021
Mcewen Dr Collector	Basement flooding in service area documented	Continued Flow monitoring	1:100yr Storm	By 2021

3.2 PUMPING STATION ANALYSIS

3.2.1 CRERAR BOULEVARD PUMPINING STATION

3.2.1.1 RESULTS AND DISCUSSION

The Crerar Blvd PS results for the 2036 scenario showed an exceedance of firm capacity during the 10Yr storm and both the lead and lag pump were simulated to be in operation during peak conditions. There is a documented history of basement flooding in the Crerar Blvd PS service area upstream of this station. Currently the pumping station receives a large amount of inflow from process water produced by the Point Pleasant Water Treatment Plant. This process water has been removed in the 2036 scenario, however a firm capacity exceedance has still be observed.

The Crerar Blvd PS forcemains which include a 200mm and a 150mm section was observed to have adequate capacity to service the firm and peak demands while both in operation.

In order to meet the LOS for the 2036 scenario an upgrade to the pumping station of 13 L/s for a firm capacity of 90l/s is required to ensure the flow can be transferred. It should be noted that as the 1:10yr

flows are close to the ECA firm capacity of the station (ECA = 77l/s / tested = 57l/s). The cause of this decrease should be reviewed. Additionally as the WTP currently discharges its process water to this location (and the amount provided by UK was indicated to be an estimation), it can affect the flow monitoring data and therefore the results from the model.

3.2.1.1 RECOMMENDATIONS

As this station's firm capacity is lower than the ECA firm capacity and the ECA capacity is close to the 2036 peak flow for the 1:10yr storm, it is recommended that a detailed hydraulic review of the Crerar station be completed to determine the cause of the capacity reduction. Additionally, once the Point Pleasant process is removed, continue to monitor the flow to determine its true effects on the station. If it is determined that flows are still consistent with previous data and the firm capacity cannot be increased by eliminating the hydraulic restriction, then an upgrade would be recommended.

TIMING

This analysis should be completed by 2021 and re-evaluated during the next master plan update.

3.2.2 HILLVIEW ROAD PUMPING STATION

3.2.2.1 RESULTS AND DISCUSSION

The Hillview Road PS results for the 2036 scenario show a firm capacity exceedance of 141 l/s during the 1:10yr storm; however only one pump was observed to be in operation during these conditions in the model. This suggests that the wet well is able to accommodate the peak flow long enough for the firm capacity to transfer the flow.

This pumping station receives additional flow from development upstream of the station and modifications to the High Gate Park Drive Collector increase in peak flows as a result of upgrades upstream. Before the upstream upgrades, the station was experiencing a peak flow of approximately 175L/ and with the upgrades the 1:10yr peak flow was approximately 180L/s.

In addition to the exceedance of firm capacity it was also observed that a short section of forcemain experiences velocities above the recommended levels (>3m/s). This would only be the case for a short (10m) 200mmø section of the forcemain leaving the pumping station before the size increases to 350mmø for the remaining length. Replacing the smaller section of forcemain to a 300mm can reduce the dynamic head in the system by approximately 3-4m at peak flow. Based on the pumps in Hillview, this decrease in head would increase the overall capacity by 35 to 45l/s and provide a firm capacity of 175-185l/s. Increasing the forcemain size above 300mm causes the Days Rd Inlet sewer to exceed its capacity.

The full build – out scenario was also reviewed and if the upstream upgrades were completed the station would experience a peak flow of approximately 185l/s.

3.2.2.2 RECOMMENDATIONS

To optimize the current configuration of the PS and to meet the 2036 LOS it is recommended that the firm capacity be increased to approximately 185L/s by replacing the 10m of forcemain from just outside the wet well to the existing 350mm forcemain. The pump performance should then be verified to ensure sufficient increased capacity has been obtained. Additionally, by completing this upgrade, the full buildout flow should also be able to be accommodated.

TIMING

As the existing forcemain velocity is above the recommended level, and to ensure that there are no negative effect when the North West collector upgrades are completed, it is recommended that the upgrades be completed by 2021.

3.2.3 DAYS ROAD PUMPING STATION

3.2.3.1 RESULTS AND DISCUSSION

The Days Road PS is a primary station located in the west collection system that receives a large amount of inflow from upstream sources. During major storm events during the 2036 scenario it was observed that this station receives approximately 1,077L/s of inflow, exceeding the reported 990 L/s firm capacity. It was observed in the model that during these storm events it did exceed its pump firm capacity (i.e. 4 pumps were running). After simulating alternative upgrades for infrastructure upstream of the station the peak flows were simulated to increase to approximately 1,100L/s.

The station outlets into two forcemains (600mm & 900m) for approximately 1,530m until they combine into a single 900m forcemain which then outlets to the Cataraqui Bay Wastewater Treatment Plant. In this forcemain configuration there is currently adequate capacity to service the peak inflows observed from model simulations for the 2036 scenario.

In the condition assessment (WSP, 2015) Days Rd PS had the worst condition rating and needed significant refurbishment within 5-10years.

There were also reported cases of flooding upstream of the station during a major storm event in 2011.

The full build – out scenario was also reviewed and if the upstream upgrades were completed the station would experience approximately 1,165l/s.

3.2.3.2 RECOMMENDATIONS

Based on the results from model simulations, the importance of this station to the system, it is recommended that a firm capacity be increased to approximately 1,200L/s to meet the full buildout LOS as it is only an additional increase of 10%.

TIMING

As Days Rd pumping station reaches its firm capacity by 2021 and based on the condition of the station, it is recommended that Days Rd PS be upgraded by 2021.

3.2.4 BATH-COLLINS BAY ROAD PUMPING STATION

3.2.4.1 RESULTS AND DISCUSSION

The Bath-Collins Bay Rd PS is a small station which outlets into the Collins Bay Collector, it services a small area in the west sewer collection system. During the model simulation of 10yr storms in the 2036 scenario there were observed firm capacity exceedances and cases where both of the pumps were in operation. While this was observed in the model simulations, there have been no reports of basement flooding or sewer back-up.

It has been noted that the data used to calibrate this station in the model is limited and may need further analysis to verify results.

The Bath-Collins Bay Road PS forcemain currently has the capacity to service the peak inflow observed from model simulations.

3.2.4.2 RECOMMENDATIONS

It is recommended that additional flow monitoring at Bath-Collins Bay PS include Rankin St PS and Bath-Lower Dr PS to verify the results before further upgrades are recommended. If the results are verified the station would be recommended to increase its firm capacity to 22L/s.

TIMING

This analysis should be completed by 2021 and re-evaluated during the next master plan update.

3.2.5 LAKESHORE BOULEVARD PUMPING STATION

3.2.5.1 RESULTS AND DISCUSSION

The Lakeshore Boulevard PS was not observed to exceed 2036 LOS during model scenario simulations for dry and wet-weather conditions. The pumps were observed to be operating in a lead/lag configuration. There have been reported issues of basement flooding in the service area from documented cases in the past during major storm events. However, based on the information provided, there are no results to validate this observation. Flow monitoring of the station should continue to provide more information.

3.2.5.2 RECOMMENDATIONS

Continue flow monitoring. Currently the PS meets LOS for capacity. No upgrades are recommended.

TIMING

This analysis should be completed by 2021 and re-evaluated during the next master plan update.

3.2.6 SUMMARY OF PUMPING STATION RECOMMENDATIONS

Table 3-5 summarizes the recommendations for the pumping stations that were evaluated.

Table 3-5 Summary of Pumping Station Recommendation: West Collection System

PUMPING STATION	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	LOS PROVIDED	TIMING
Crerar Blvd. PS	PS firm capacity exceedance during major storm events. Reported basement flooding in service area.	Hydraulic Review and Continued Flow Monitoring after WTP process water is removed	Full Buildout 1:5yr Storm	By 2021
Hillview Road PS	PS firm capacity exceedance during major storm events. FM velocity exceedance observed for 200mm section. Condition rating of C reported.	FM upsizing for Hillview PS (200mm to 300mm). Firm capacity increased to approximately 185L/s by forcemain upgrades	Full Buildout 1:10yr Storm	By 2021
Days Road PS	PS firm capacity exceedance during major storm events. Condition rating of D reported. Basement flooding in service area documented.	Firm capacity increase to 1200l/s	Full Buildout 1:10yr Storm	By 2021
Bath-Collins Bay Road PS	PS firm capacity exceedance during major storm events	Additional Flow monitoring	Full Buildout 1:2yr Storm	By 2021
Lakeshore Boulevard PS	Reported issues of basement flooding in service area	Continued Flow monitoring	Full Buildout 1:100yr	By 2021

3.3 WASTEWATER TREATMENT PLANT ANALYSIS

3.3.1 RESULTS AND DISCUSSION

Currently the Cataraqui Bay Wastewater Treatment plant was not observed to exceed the upgraded plant capacity for the 1:10yr storm or the ADF by 2036. It did slightly exceed 80% of the rated ADF by 2026. This was indicated to be the trigger for the commencement the planning and design of the required upgrades to ensure that they are in place by the time they are needed.

As previously indicated the ADF values have been calculated. Dry weather flow only considers base I/I and does not consider the effects of extraneous flow as a result of rainfall in a typical year. The ADF value has been determined by comparing the observed ADF from 2014 to the modeled dry weather flow. The comparison results saw approximately a 36% increase in flow as a result of normal annual rainfall at Cataraqui Bay WWTP. This increase is applied to the calculated dry weather flow to obtain the ADF for comparison to the rated ADF of the plant. In addition to this, the D-5-1 calculation was completed that demonstrate the available capacity of the plant by the committed scenario (2026). Using this comparison, it can be seen that in 2026 under current conditions, the ADF from the model is

46,326m3/day and the D-5-1 calculation indicates an ADF of 45,898m3/day, demonstrating that the results for the plant appear to be a reasonable projection.

A large variable in this analysis is the weather conditions in any given year. Municipalities need to plan for certain levels of risk and therefore using the calculated ADF and the 1:10yr storm design storms for future projections ensures that variations in flows and rainfall are not underestimated and serve to minimize the risk to the environment and public safety. Detailed analysis of the plants during the EA and design phases are completed to ensure that the projections and flows are accurate before upgrades are implemented.

After simulating the recommended alternatives from the west collection system the flows to the plant were as follows:

Legend:

< 80% of Rated ADF
or
<Rated Peak Daily Flow

80 - 100% of Rated ADF

>ADF
or
>Peak Daily Flow

Table 3-6 Cataraqui Bay WWTP - ADF with Recommended Alternatives

Scenario	Cataraqui Bay WWTP - Daily Flow Analysis Period				
	2021	2026	2036	Full Buildout	Rated Capacity
DRY	29,746	36,025	40,552	47,569	ADF 55,000
ADF	39,189	46,272	51,223	58,740	
2 Year	54,554	61,195	66,252	73,112	PDF 141600
5 Year	63,500	70,280	75,296	82,369	
10 Year	69,327	76,238	81,414	88,359	
25 Year	76,807	83,618	88,931	96,119	
50 Year	82,106	88,886	94,237	101,537	
100 Year	86,964	93,830	99,329	106,487	

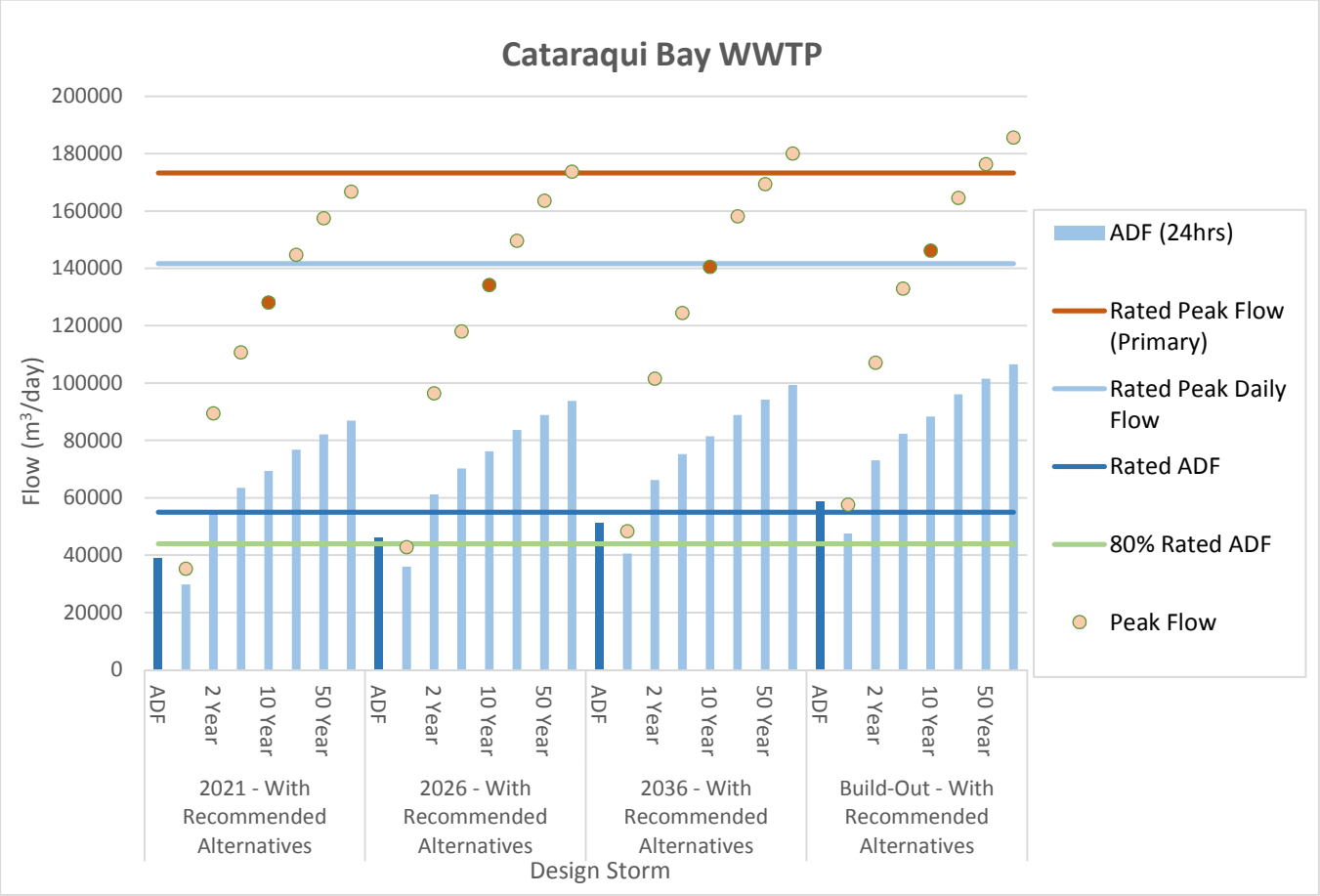
Table 3-7 Cataraqui Bay WWTP - PF with Recommended Alternatives

Scenario	Cataraqui Bay WWTP - Peak Flows Analysis Period				
	2021	2026	2036	Full Buildout	Rated Capacity
DRY	35,366	42,830	48,452	57,699	PF 173,200
2 Year	89,572	96,471	101,635	107,217	
5 Year	110,798	118,126	124,486	133,006	
10 Year	128,083	134,204	140,474	146,150	
25 Year	144,839	149,728	158,154	164,624	
50 Year	157,513	163,640	169,468	176,361	
100 Year	166,780	173,817	180,136	185,725	

<Rated Peak Flow >Peak Flow

The figure below displays the ADF and peak flow values at the Cataraqui Bay WWTP with the recommended updates for the west against the current rated capacities.

Figure 3-1 Cataraqui Bay WWTP Capacity with Alternatives



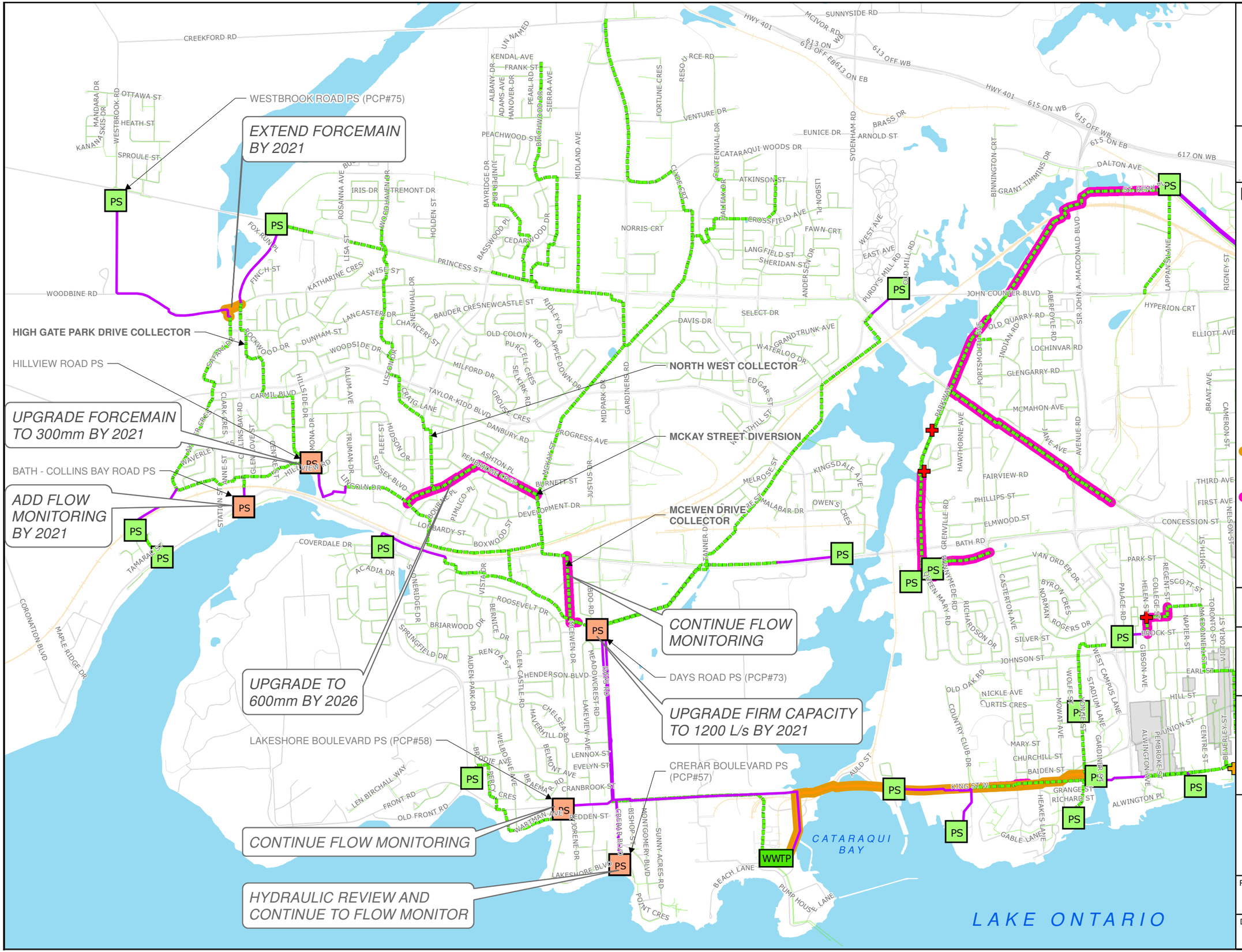
It can be seen that the upgrades to the west system do transfer slightly more flows to the WWTP than without the upgrades. By 2026 the ADF has exceeded the 80% of the rated ADF by approximately 7%. The 80% of the rated ADF is only a guideline for starting the planning and design phase of the upgrades. Additionally, the EA for the Cataraqui Bay WWTP upgrades had a two (2) phased upgrade for this WWTP to 55,00m³/day in phase 1 and 68,000m³/day in phase 2.

3.3.1.1 RECOMMENDATIONS & TIMING

As the planning for this upgrade has already been completed as well as allowances in the Phase 1 design for the future upgrades, it is recommended that the planning and design for the next upgrade commence by 2026. This timing will still meet the goal of completing the implementation of the upgrades by 2036. Additionally, as the 2036 flows are not currently expected to exceed the plant capacity, the ADF for the plant should be compared to the projections to determine if flows are increasing as anticipated and if the full buildout flow projection should be used for the next upgrade. If they are consistent with the projection, then an upgrade to the Phase 2 capacity of 68,000m³/day is recommended.

3.4 SUMMARY AND CONCLUSIONS

In summary a compilation of all the recommendations is presented in Figure 3-2 for the west collection system.



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Legend

- WWTP — WASTEWATER TREATMENT PLANT
- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- PS — ALTERNATIVE PUMPING STATION
- PS — PUMPING STATION
- PS — NOT MODELLED
- FORCEMAIN
- TRUNK SEWER
- ALTERNATIVE FORCEMAIN
- EXISTING SANITARY SEWER
- ALTERNATIVE TRUNK SEWER
- COMBINED SEWER AREA TO BE REMOVED
- Lake

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilties Kingston, April 2015, City of Kingston.

Scale:
0 200 400 800 Meters
1:30,000

N W E S

Project:
Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title:
WEST COLLECTION SYSTEM RECOMMENDED ALTERNATIVE SOLUTIONS SUMMARY

Project No.:	Date:		
151-02944-00	DECEMBER 2016		
Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	AS	3-2

File Location:M:\2015\151-02944-00 UK Water and Wastewater Masterplan\3.0 Technical\3.7 Reports\3.7.5_Alternate Solutions\Wastewater\Map\151-02944-00_AS_Fig3-1_West_Collection_System_Recommended_Alternative_Solutions_Summary.mxd

3.5 PREVIOUS MASTER PLAN RECOMMENDATIONS

The previous Master Plan provided recommendations for pumping station in the central collection system that were not currently recommend. Below is a summary of those recommendation and comments based on the current analysis:

Table 3-8 Summary of Previous Master Plan Recommendations – West System

INFRASTRUCTURE	RECOMMENDATION	COMMENT
Collins Bay Collector Upsizing	→ Upgrade P555 to P563 to 300 mm (539 m) → Upgrade P564 TO P568 to 375 mm (367 m)	Review options and commended alternative solution (extend Westbrook PS forcemain to High Gate Trunk Sewer)
Hillview (Mona Dr) PS	Increase firm capacity by approximately 10 L/s to handle 10-year peak flow to future build out condition	Upgrade recommended with forcemain upsizing.
Lakeshore Blvd (Front Rd) PS	Increase firm capacity by 33 L/s to meet minimum requirement to handle 10-year peak flow up to future build out condition	No issues observed based on updated modelling.

4 CENTRAL SYSTEM ALTERNATIVE SOLUTIONS ANALYSIS

The City of Kingston Central wastewater collection system comprises an area of approximately 2,919 ha. It is generally bordered by Little Cataraqui Creek to the west, Macdonald-Cartier Freeway to the north, Cataraqui River to the east and Lake Ontario to the south. There are approximately 54,600 people living in Kingston Central (Baseline Report, WSP 2016).

Wastewater flow from Kingston Central is pumped to the Kingston East collection system via the River Street Pumping station and flows are conveyed to Ravensview Wastewater Treatment Plant.

Table 4-1 shows a summary of Gap's identified for the 2036 scenario from the Gap Analysis Report (WSP, 2016) which identifies the central system sewer and pumping stations assets that were triggered for alternative solution review. This system also includes the City's partially separated and combined sewers which service large expanses of the catchment areas. These sewers combine storm water directly with the sanitary flow during wet-weather.

Table 4-1 Summary of Central Collection System Infrastructure Gap Analysis Results

INFRASTRUCTURE	TYPE	2036 LEVEL OF SERVICE	COMMENT
Notch Hill Collector	Sewer	10-YR	→ Surcharging within 2m of surface during storms larger than the 10yr storm
North End Trunk Sewer	Sewer	10-YR	→ Surcharging within 2m of surface during storms larger than the 10yr storm → Flooding in service area documented and overflows
Princess St Collector	Sewer	10-YR	→ Surcharging within 2m of surface during storms larger than the 10yr storm
King St West Collector	Sewer	50-YR	→ Surcharging within 2m of surface during storms larger than the 50yr storm
Collingwood Collector	Sewer	50-YR	→ Surcharging within 2m of surface during storms larger than the 50yr storm → Flooding in service area documented and overflows
Charles St Collector	Sewer	100-YR	→ Surcharging within 2m of surface during storms large than the 2yr between 2015 and 2026
Dalton Ave. PS	Pump Station	10-YR	→ Meets required LOS → Basement flooding in service area documented
King-Portsmouth PS	Pump Station	50-YR	→ Meets required LOS after PS upgrade (Imminent project) → Basement flooding in service area documented
Palace Rd. PS	Pump Station	10-YR	→ Meets required LOS

INFRASTRUCTURE	TYPE	2036 LEVEL OF SERVICE	COMMENT
			→ Flooding in service area documented and overflows
Rideau Heights Trunk	Combined Sewer System	10-YR	→ Surcharging within 2m of surface during storms larger than the 10yr storm
North Harbourfront Interceptor	Combined Sewer System	5-YR	→ Surcharging within 2m of surface during storms larger than the 5yr storm
Harbourfront Trunk	Combined Sewer System	Dry	→ Surcharging within 2m of surface during wet weather
Harbourfront Trunk Twin	Combined Sewer System	Dry	→ Surcharging within 2m of surface during wet weather
King St. Trunk	Combined Sewer System	5-YR	→ Surcharging within 2m of surface during storms larger than the 5yr storm
George St. Collector	Combined Sewer System	100-YR	→ Meets desired LOS → Basement flooding in service area documented
King St.PS	Combined Sewer System Pump Station	Dry	→ Peak capacity is exceeded during the 2 year storm → Services a large combined sewer area → Once combined sewer areas are eliminated (full buildout scenario) it is estimated that the peak capacity will be capable of pumping up to the 5yr storm
	Combined Sewer System Forcemain	Dry	→ During wet weather events the forcemain is expected to exceed 2 m/s.
River St. PS	Combined Sewer System	Dry	→ Firm Capacity is exceeded during the 2 year storm. Peak Capacity is not

INFRASTRUCTURE	TYPE	2036 LEVEL OF SERVICE	COMMENT
	Pump Station		exceeded during weather. (Weir controlled) → Services a large combined sewer area

4.1 SEWER ANALYSIS

4.1.1 NOTCH HILL COLLECTOR

4.1.1.1 RESULTS DISCUSSION

The hydraulic modeling shows that the Notch Hill Collector experiences surcharging during major design storms. This collector is simulated with large amounts of wet-weather influence as calibrated from flow monitors. The North End Trunk Sewer (NETS) surcharging influences sections of the Notch Hill Collector that experience surcharging and appears to be directly correlated; surcharging in the Notch Hill Collector only occurs when NETS is surcharged.

By eliminating the issues in the NETS, the capacity issue in the lower section of Notch Hill collector is alleviated, however there is still a section that is surcharged.

To correct the remaining capacity issue in the sewer, upsizing of the sewers between manholes 9716-010 to 3942-030 (along Notch Hill Rd from Portsmouth to Runnymede Rd) from a 450mm to a 600mm, for an approximate length of 350m would be required to meet 100yr design storm LOS.

The full buildout scenario was also considered to determine if the required upsizing, to accommodate the additional growth, would be economical. The upgrades to the sewers based on the 2036 flows accommodate the full build out scenario as well.

4.1.1.1 RECOMMENDATIONS

To ensure that hydraulic capacity is not restricted, the Notch Hill Collector should be upgraded between Portsmouth Ave. and Runnymede Rd. to a 600mm sewer.

TIMING

There is minor surcharging in this sewer under the 1:10yr storm for all scenarios with more significant surcharging during the 1:100yr storm. In order to accommodate the capacity upgrade, the downstream sewers need to be able to handle the additional flows. Therefore, it is recommended that this section be completed by 2026 after the correction of NETS upstream surcharging (refer to NETS section below). It should be noted that as this collector appears to have a significant response to wet weather, if significant I&I reduction can be achieved, the upgrade should be re-evaluated.

4.1.2 PRINCESS ST. COLLECTOR

4.1.2.1 RESULTS AND DISCUSSION

Surcharging along the length of the Princess St. Collector was observed during major design storm events in the 2036 scenario. The Princess St. Collector runs North-West along the Princess St. and is tributary to the NETS. The Princess St Collector is a fully separated sewer shed with no combined sewer contribution to the system flows. This collector is projected to receive a large amount of development growth by the 2036 projection.

To correct the surcharging, upsizing of the sewers between manholes 0823-020 to (along Princess St. from just west of Concession St to Portsmouth Ave) from a 375/300/375mm to a 450/525mm, for an approximate length of 1800m would be required to meet the 100yr storm LOS.

The full build – out scenario was also considered to determine if increasing the pipe to accommodate the additional growth would be economical. The upgrades to the sewers based on the 2036 scenario flows are sufficient for the full build out scenario as well. This is largely due to the difference between the theoretical size required and the standard pipe sizes for sewers.

4.1.2.1 RECOMMENDATIONS

To ensure that hydraulic capacity is not restricted, the Princess St. Collector should be upgraded between Concession St. and Portsmouth Ave. to a 450/525mm sewer.

TIMING

The severity of the surcharging increases between the existing and 2036 scenarios, with the most significant surcharging occurring in 2036. During the 2015 and 2021 scenarios there is a short section that experiences minor surcharging in the 1:10yr storm. By 2026, the surcharging at the aforementioned location becomes more severe with minor surcharging being observed upstream and downstream of this location. As this is a long length of sewer, it is recommended to divide the upgrades of this sewer into 3 phases as follows:

- Indian Rd to Parkway (manholes 0826-010 to 2284-020) from 375/300/375mm to a 525mm for an approximate length of 550m by 2021
- West of Sir John A MacDonald Blvd to Indian Rd (manholes 0825-070 to 0826-010) from a 375mm to a 525mm (manholes 0825-040 to 0826-010) and a 450mm (manhole 0825-040 to 0825-070) for an approximate length of 750m by 2026
- East of Mooalim Pl to west of Sir John A MacDonald Blvd to (manholes 0823-020 to 0825-070) from a 375mm to a 450mm for an approximate length of 500m by 2036

4.1.3 NORTH END TRUNK SEWER

4.1.3.1 RESULTS AND DISCUSSION

The NETS services a large area of separated sewer located in the central collection system that has undergone previous upgrades including sewer twinning and I&I reduction programs. This sewer has two SSOs (PCP#48 & 50) which have a documented history of overflows during major storm events. Model simulations show for the 2036 scenario that surcharging occurs during major storms.

To correct the surcharging in the NETS, twining of the sewers would be required from manhole 9341-010 to 2284-131 (along Queen Mary heading north from Greenview Dr to Sherwood Cres), approximately 900m, from manhole 2284-010 to 509081 (From Princess St heading north to Portsmouth Ave), approximately 700m and from manhole 614091 to 1760-010 (John Counter Blvd heading north to Dalton Ave), approximately 1,900m. Twinning of the sewer, between the locations identified above, has already been completed and by completing the remaining three sections identified above, the model simulations show an elimination of sewer surcharging in the 2036 scenario.

By completing the twinning, it would eliminate sanitary sewer overflows (SSO) that may occur in this trunk sewer.

The full buildout scenario was also reviewed to determine if twinning to accommodate growth would be reasonable. The upgrades to the sewers based on the 2036 flows will accommodate the full build out scenario as well.

4.1.3.1 RECOMMENDATIONS

To ensure that hydraulic capacity is not restricted, the remaining single pipe sections of the NETS should be twinned. Once this is complete the SSO can be eliminated.

TIMING

The severity of the surcharging increases between today and 2036, with 2036 seeing the majority of the sewer surcharging. 2015 to 2036 sees two small sections (each end) that have minor surcharging in the 1:10yr. Moderate to severe surcharging is seen throughout the scenarios during the 1:100yr storms. As this is a long section of sewer it is recommended to phase the twinning of this sewer into 2 phases as follows:

- → Twinning of sewer from Greenview Dr to Sherwood Cres & Princess St to Portsmouth – by 2021
- → Twinning of sewer from John Counter Blvd to Dalton Ave – by 2036

The SSOs should be monitored once the first sections are twinned to ensure that no further overflows are seen before permanently plug these locations.

4.1.4 KING ST. WEST COLLECTOR

4.1.4.1 RESULTS AND FINDINGS DISCUSSION

The King St. West Collector located upstream of the King-Portsmouth PS is a separated sewer that in the 2036 scenario was observed to surcharge during major storm events during model simulations. The collector features two smaller PS upstream King-Lake Ontario Park PS and King-Elevator bay PS and receives additional flow in the 2036 scenario from projected development.

To correct the surcharging in the sewer, upsizing of the sewer would be required from manhole 0054-030 to 0051-104 (along King St W just east of County Club Dr to McDonald Ave.) from a 400/350mm to a 450mm, approximately 550m that would provide 1:100yr storm LOS.

There is minor surcharging in 2015 during the 1:50yr storms and larger. With significant development in the area beginning in 2021, the level of surcharging increases and causes issues during the 1:25yr storm.

The full buildout scenario was also reviewed to determine if upsizing to accommodate that growth would be reasonable. The upgrades to the sewers based on the 2036 flows accommodate the full build out scenario as well.

4.1.4.1 RECOMMENDATIONS

To ensure that capacity conveyance is not restricted, the King St West Collector should be upgraded between County Club Dr. and McDonald Ave to a 450mm sewer.

TIMING

As some of the development in this service area is scheduled to online by 2021, it is recommended to complete this work by 2021. This work should be coordinated with the Portsmouth redirection project that has been indicated as an imminent project.

4.1.5 COLLINGWOOD ST. COLLECTOR

4.1.5.1 RESULTS AND DISCUSSION

The Collingwood St. Collector is a partially separated sewer that is projected to become fully separated by 2036. It is upstream of the King St. Trunk Sewer. During the 1:100yr storm analysis it was observed that the sewer surcharging causes sanitary sewer overflows (SSO) at PCP#34 which is an overflow control structure located at the intersection of Helen and Mack streets. There have been documented combined sewer overflows at this location from Utilities Kingston flow monitoring program.

Upstream of the Collingwood St. Collector is the Palace Road PS which is a station that currently has had documented limitations with its operation; only one pump is able to operate at a time. When this station pumps at its firm capacity and the collector sewer is subject to major storms the collector reaches its peak flow conditions.

Based on the review of the results two different options were considered as alternative solutions:

Alternative 1. Upsize the section of the Collingwood St Collector to accommodate the increased flow

Alternative 2. Redirection the Palace Rd PS discharge to a local sewer on Johnston St that ties into the Collingwood St Collector further downstream.

ALTERNATIVE 1

This alternative involves upsizing of the sewer from manhole 0423-010 to 04511-020(along Helen St to Mack, along Mack to Regent St and along Regent St to Dundas St) from a 300mm to a 375mm, approximately 400m that would provide 1:100yr storm LOS. This would also allow the SSO (PCP#34) to be plugged.

ALTERNATIVE 2

This alternative involves redirecting the flows from Palace Rd that currently discharges into the Collingwood Collector at Helen St and Brock St and redirecting the forcemain by approximately 210m along Palace Rd and Johnston St to connect to the local sewer at Oakridge Ave and Johnston St. This local sewer, which is a 225mm and upsizes to 450mm at the connection to the Collingwood Collector downstream of the surcharging. The Collingwood Collector was analyzed with the additional flow

connecting at Johnston Ave and MacDonald St and surcharging was no longer observed. The local sewer was not reviewed and may require upsizing to accept the flows.

Additional alternatives were discussed including redirecting a portion of the Place Rd pumping station service area (Oakridge & Gibson) away from the pumping station. As this station is a VFD station, this would reduce the amount of peak flow being directed to the Collingwood St Collector. A preliminary technical review of this option was completed by reducing the output of Palace Rd PS relative to the service area that Oakridge & Gibson represent. Even with this reduction there is surcharging with the Collingwood St Collector and sewer upsizing would be required; therefore this option was not evaluated further.

The two options were evaluated based on the table below:

Table 4-2 Collingwood St. Collector: Alternatives Evaluation

	Alternative 1 Sewer Upsizing	**Alternative 2 Redirection of Palace Rd PS**
Natural Environmental Considerations		
Impacts to Animal & Vegetative Features	• Minimal Impacts as work is to be completed within R.O.W.	• Minimal Impacts as work is to be completed within R.O.W.
Impacts to Water Course	• No water course in the area	• No water course in the area
Natural Environment Overall Rating	Minimal Overall Impact to the Natural Environment	Minimal Overall Impact to the Natural Environment
Social and Cultural Environmental Considerations		
Number of People Disrupted in Community	• Potential upgrade would affect a moderate number of people in a number of different locations based on the location of the existing infrastructure and road reconstruction requirements	• Potential upgrade would affect a moderate number of people in a number of different locations based on the location of the existing infrastructure and road reconstruction requirements
Recent Disruptions to Communities by New Infrastructure	• Upsizing should be coordinated with rehabilitation of these sewer schedule to occur. • Some recent infrastructure reconstruction/upgrades have occurred	• Installation of the forcemain and potential upsizing of local sewer should be coordinated with the reconstruction of Johnston St • Some recent infrastructure reconstruction/upgrades have occurred

	Alternative 1 Sewer Upsizing	Alternative 2 Redirection of Palace Rd PS
Traffic Disruption	• Construction of potential upgrades would have disruption to local traffic • Disruption to traffic will occur due to rehabilitation of sewer along these streets	• Construction of potential upgrades would have disruption to local traffic • Construction would have disruptive effect to arterial roadway (Johnston St) • Disruption to traffic will occur due to reconstruction of Johnston St
Social Disruption	• Minor disruption to EMS	• Signification disruption to EMS as fire station and ambulance center located along Palace Rd.
Social/Cultural Environment Overall Rating	Some disruption to local traffic and residents	Significant impacts to EMS.
Technical Suitability		
Capacity of Existing Linear Infrastructure	• Sections of existing sewers do not currently have capacity to meet the 2036 LOS. • Section of sewer that is surcharging is scheduled for rehabilitation	• Redirection of Palace Rd PS provides sufficient capacity throughout the Collingwood Collector for 2036 • New tie in location would have similar static and dynamic hydraulic characteristics
Approximate Amount and Ease of Construction of New Required Infrastructure	• Minimal increase in amount of construction to upsize pipes compare to rehabilitation that is currently scheduled. • Moderate ease of construction for these upgrades	• Installation of 210m of forcemain. • Moderate complexity to tie-in to a pressurized forcemain
Full Build Out Capacity	• Upgrades for the 2036 flow can accommodate the full build out flows	• Redirection of the Palace Rd PS full buildout can be accommodated in the existing Collingwood Collector sewers
Technical/Operational Rating	Moderate additional work to upsize pipes	Installation of a new forcemain
Financial Considerations		
Operational/Maintenance Costs	• Minimal operational and maintenance costs above current levels	• Minimal operational and maintenance above currently levels • Decommissioning of an existing forcemain with no reported issues

	Alternative 1 Sewer Upsizing	Alternative 2 Redirection of Palace Rd PS
Capital Costs (incl. Constructability Risk)	• Minimal additional capital cost to upsize pipes. • Moderate constructability risk (common type of work)	• Moderate additional capital cost to install 210m of forcemain. • Minimal additional capital cost to potential upsize local sewer. • Moderate constructability risk due to crossing of major roadway
Financial Overall Rating	Minimal Capital Costs	Moderate capital cost and decommissioning of existing forcemain
OVERALL PREFERENCE RATING	**1 – Preferred**	**2 – Less Preferred**

Legend:

Most Preferred Less Preferred Least Preferred

4.1.5.1 RECOMMENDATIONS

As the section of surcharging along the Collingwood Collector is already scheduled for rehabilitation and upsizing of the pipes has minimal cost, this alternative was recommended. Additionally, as there are more impacts to EMS services and that an existing asset (forcemain) that has no reported issues will be decommissioned, the upsizing of the sewers was the preferred option. Therefore the pipes along Helen, Mack and Regent St are recommended to be upsized to a 375mm to provide 1:100yr storm LOS. This would also allow the removal of PCP#34 during this reconstruction.

TIMING

As it has been identified by UK that the elimination of SSO is a priority, completing the upsizing by 2021 is recommended.

4.1.6 CHARLES ST. COLLECTOR

4.1.6.1 RESULTS AND DISCUSSION

The Charles St. Collector is currently being upgraded as part of an imminent infrastructure improvement project which includes the installation of upsized pipes along Alfred and Elm Streets. Prior to this work Utilities Kingston has temporarily plugged four CSO control locations (PCP# 08,09,67,71) as significant reductions in combined sewer areas have been achieved in this area through the sewer separation and source control programs. Additionally, there is a remaining CSO on the Charles St Collector at Quebec and Barrie St (PCP#68). During the 2036 scenario there are no combined sewers projected to remain which are tributary to this sewer.

During the 2015 to 2026, there is surcharging within the upstream sewers. However, it has been determined in discussions with UK that the catchment area west of Alfred St, is a combined sewer area and does not drain directly into the Charles St Collector but into a local sewer along Princess St. The upstream manhole of that local sewer does however connect to the Charles St Collector. If this area is removed from this collector this sewer would meet the LOS for all scenarios. However, as we have not reviewed the local sewers, a review of this section of local sewer should be completed to ensure that there are no capacity issues.

4.1.6.2 RECOMMENDATIONS

If it is confirmed that the local sewer is able to handle the flows from this combined sewer area and there are no backwater effects causing flows into the Charles St Collector from the upstream manhole on the local sewer (MH0812-010) than the modeling shows that there are no overflows from PCP#68. Therefore the temporarily plugged overflows and PCP#68 can be eliminated.

TIMING

The remaining overflow (PCP#68) should be plugged by 2036 once all remaining combined sewer areas are eliminated.

4.1.7 SUMMARY OF SEWER RECOMMENDATIONS

Table 4-3 summarizes the recommendations for the sewers that were evaluated:

Table 4-3 Summary of Sewer Recommendations: Central Collection System

TRUNK / COLLECTOR SEWER	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	LOS PROVIDED	TIMING
Notch Hill Collector	Surcharging within 2m of surface during storms larger than the 10yr storm	Upgraded the sewer between Portsmouth Ave and Runnymede Rd to a 600mm sewer	Full Buildout 1:100yrs Storm	2026
North End Trunk Sewer (NETS)	Surcharging within 2m of surface during storms larger than the 10yr storm Flooding in service area documented and overflows	Twin the following sections of sewers: 1. Greenview Dr. to Sherwood Cres. 2. Princess St to Portsmouth Ave. 3. John Counter Blvd to Dalton Ave. Confirm no SSO and Plug PCP #48 & #50	Full Buildout 1:100yr Storm	Phased completion by the following dates: 1. By 2021 2. By 2021 3. By 2036

TRUNK / COLLECTOR SEWER	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	LOS PROVIDED	TIMING
Princess St Collector	Surcharging within 2m of surface during storms larger than the 10yr storm	Upgrade the following sections of sewers: 1. Indian Rd to The Pkwy Rd to a 525mm 2. West of Sir John A MacDonald Blvd to Indian Rd to a 450/525mm 3. East of Mooalim Pl to west of Sir John A MacDonald to a 450mm	Full Buildout 1:100yr Storm	Phased completion by the following dates: 1. By 2021 2. By 2026 3. By 2036
King St West Collector	Surcharging within 2m of surface during storms larger than the 50yr storm	Upgrade the sewers between County Club Dr. and McDonald Ave to a 450mm sewer	Full Buildout 1:100yr Storm Full Buildout 1:100yr Storm	By 2021
Collingwood Collector	Surcharging within 2m of surface during storms larger than the 50yr storm Flooding in service area documented and overflows	Upgrade the sewers between Helen and Regent St to a 375mm	Full Buildout 1:100yr Storm	By 2021
Charles St Collector	Surcharging within 2m of surface during storms large than the 2yr between 2015 and 2026	Confirm Local Sewer Capacity Plug PCP#68	Full Buildout 1:100yr Storm	By 2036

4.2 PUMPING STATION ANALYSIS

4.2.1 DALTON AVE PUMPING STATION

4.2.1.1 RESULTS AND DISCUSSION

The Dalton Ave PS located at the downstream end of the NETS and is a large capacity pumping station. The Dalton PS was not observed to exceed 2036 LOS during model scenario simulations for dry and wet-weather conditions. There have been reported issues of basement flooding in the service area during major storm events, however based on the information provided, there are no results to validate this observation. Additional information regarding this station was provided that indicated potential issues with the pump sizing and operation of the station.

Utilities Kingston is currently undertaking a study to determine the cause of the issues with the station.

4.2.1.2 RECOMMENDATIONS

Continue with study and flow monitoring.

4.2.1 KING-PORTSMOUTH PUMPING STATION

4.2.1.1 RESULTS AND DISCUSSION

The King-Portsmouth PS is located in the Central Collection System; however in future scenarios the PS is modeled to convey flow via a new forcemain directly to the Cataraqui Bay WWTP. The upgraded firm capacity of the station is adequate to convey flows to meet the 2036 LOS. Historically there have been documented cases of basement flooding sewer back-ups upstream of the PS, however currently there is a Yonge St. reconstruction project being completed as an imminent project and the service area is undergoing an I/I reduction program to alleviate the supposed dry-weather/wet-weather effects.

4.2.1.2 RECOMMENDATIONS

Continue with Portsmouth redirection and I&I reduction program.

4.2.1 PALACE ROAD PS

4.2.1.1 RESULTS AND DISCUSSION

The Palace Road PS located upstream of the Collingwood St. Collector. It is a small PS that currently is simulated to run a single pump with a firm capacity of 22L/s. During model simulations for the 2036 scenario the PS currently is able to meet the LOS. This PS has reports of some sewer back-ups upstream of its service area, however they have been attributed to power outages.

The PS forcemain which was reported to have a high gradient and has been described by operators to cause operating restrictions when using two pumps. Currently, the PS is configured to only be able to run a single pump under normal conditions.

4.2.1.2 RECOMMENDATIONS

Continue to monitor and if power outages are a regular occurrence, consider permanent back-up power at this location.

4.2.2 SUMMARY OF PUMPING STATION RECOMMENDATIONS

Table 4-44 summarizes the recommendations for the pumping station that were evaluated:

Table 4-4 Summary of Infrastructure Gaps for 2036 Level of Service: Central Collection System

PUMPING STATION	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	LOS PROVIDED	TIMING
Dalton Road PS	Meets required LOS Basement flooding in service area documented	Continue with study and flow monitoring	Full Buildout 1:10yr Storm	N/A
King-Portsmouth PS	Meets required LOS after PS upgrade (Imminent project) Basement flooding in service area documented	Continue with Portsmouth Redirection and I&I reduction program.	Full Buildout 1:50yr Storm	N/A
Palace Road PS	Meets required LOS Flooding in service area documented and overflows	Continue to monitor and if power outages are a regular occurrence, consider permanent back-up power at this location.	Full Buildout 1:10yr Storm	N/A

4.3 COMBINED SEWER SYSTEM

The combined sewer system was analyzed separately from the rest of the central system as there are controls and parameters in place to control the levels in the system that all affect the different components (i.e. sewer & pumping station) and act as a single system. Therefore, to ensure that all aspect of the combined sewer system are evaluated, the system was analyzed concurrently. From the gap results and review of the alternative solution from the trunk sewer and pumping station perspective, the following assets were identified to be included in the combined sewer system:

- North Harbourfront Interceptor, Rideau Heights Trunk, Rideau St. Collector, Harbourfront Trunk, King St. Trunk, Hwy 15 Trunk and Ravensview Trunk Sewers.
- King St. and River St. Pumping Station Forcemains
- Collingwood, King and Emma Martin Tank
- CSO/SSO Control Structures

4.3.1 COMBINED SEWER ANALYSIS

The CSO analysis was completed for the Central Collection System to evaluate servicing strategies and recommendations to ensure the system meets the MOECC F-5-5 regulation requirements. This regulation outlines the permitted CSO allowance for a sewer system in Ontario. Utilities Kingston's current objective is to meet and exceed this criterion with a goal to "virtually eliminate" CSOs from the system. Evaluating "virtual elimination" alternatives in the master plan allows for a servicing strategy to be developed which address measures to reduce CSO volumes and prepares the collection system to be reviewed against a level of service similar to the rest of the system.

4.3.2 COMBINED SEWER SEPARATION

One of the larger overall capital projects that the City is undertaking is the reduction of combined sewer areas. In 2006, the Combined Sewer Critical Evaluation was completed with the purpose of developing a guiding policy for the rehabilitation of combined sewer areas. The study concluded that the preferred option was to separate sewers and not replace the combined sewers. The City of Kingston's Council have since adopted a policy that incorporates local sewer separation. A longer longer term goal of "virtual elimination" of CSOs, where "virtual elimination" is deemed to be the containment of all combined sewer flows under a wetter than average year, was established in the 2010 Master Plan.

However, as policies and regulations change, it was determined that the effectiveness of these types of projects should be re-evaluated. A high level analysis of the sewer separation was completed to ensure that this objective was still the most effective and appropriate for the City of Kingston.

In order to complete an evaluation of sewer separation, high level alternatives were developed. The alternatives were grouped into 3 main categories to mitigate the occurrence and impacts of CSOs that include:

- **Source Controls** – the method of removing stormwater that may be directed to the sanitary system by water conservation or lot level methods (i.e. sewer separation)
- **Conveyance Control** - the method of transferring the flows through the sanitary system to the treatment facility
- **End of Pipe Controls** – the method of containing the flows within the conveyance system or at the outfalls. These typically include some form of storage or treatment.

Based on these categories, the following alternatives were developed with the goal of each alternative to meeting MOECC F-5-5 and virtually eliminate CSOs in the central system:

Alternative 1. Do nothing: Status quo or to stop any further upgrades in the central system.

Alternative 2. Source Control: Eliminate all combined sewers in the central system

Alternative 3. Conveyance Control: Upsize/Upgrade the sewers and pumping station within the central system

Alternative 4. End of Pipe Control: Increase/add storage facilities within the central system to contain the flows

Alternative 5. Conveyance & End of Pipe Control: A combination of alternative 3 and 4.

Table 4-5 shows the results of the alternatives evaluation.

Table 4-5 Combined Sewers: Alternatives Evaluation

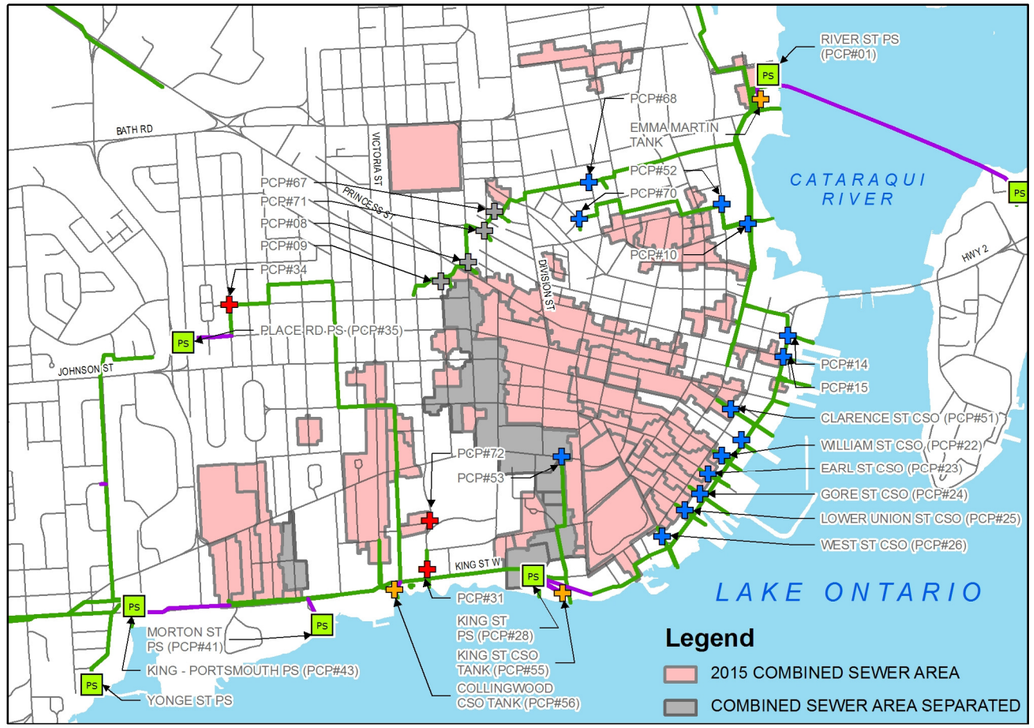
	Alternative 1 Do Nothing	Alternative 2 Source Control	Alternative 3 Conveyance Control	Alternative 4 End-of-Pipe Control	Alternative 5 Conveyance & End-of-Pipe Control
Natural Environmental Considerations					
Impacts to Animal & Vegetative Features	• No reduction in CSO overflow volume has moderate impact on aquatic life in Lake Ontario.	• With reduced CSO volumes will have minor impact on aquatic life in Lake Ontario	• With reduced CSO volumes will have minor impact on aquatic life in Lake Ontario	• With reduced CSO volumes will have minor impact on aquatic life in Lake Ontario	• With reduced CSO volumes will have minor impact on aquatic life in Lake Ontario
Impacts to Water Course	• No reduction in CSO overflow volume has moderate impact to Lake Ontario	• With reduced CSO will have minor impacts to Lake Ontario	• With reduced CSO will have minor impacts to Lake Ontario	• With reduced CSO will have minor impacts to Lake Ontario	• With reduced CSO will have minor impacts to Lake Ontario
Natural Environment Overall Rating	Moderate impacts to Natural Environment	With reduced CSOs will have minimal overall impact to the Natural Environment	With reduced CSOs will have minimal overall impact to the Natural Environment	With reduced CSOs will have minimal overall impact to the Natural Environment	With reduced CSOs will have minimal overall impact to the Natural Environment
Social and Cultural Environmental Considerations					
Number of People Disrupted in Community	• Minor effect to people due to combined sewer overflows into Lake Ontario. No reported issues currently caused by overflows • No effect due to construction	• Potential upgrade would affect significant number of people in a number of different downtown communities based on the location of the combined sewers areas	Potential upgrade would affect moderate number of people in a number of different downtown communities based on the location of the existing infrastructure	• Potential upgrade would affect moderate number of people in a number of different downtown communities based on the location of the existing infrastructure	• Potential upgrade would affect moderate number of people in a number of different downtown communities based on the location of the existing infrastructure
Recent Disruptions to Communities by New Infrastructure	• No effect due to construction	• Some recent infrastructure reconstruction/upgrades have occurred	• Some recent infrastructure reconstruction/upgrades have occurred	• Some recent infrastructure reconstruction/upgrades have occurred	• Some recent infrastructure reconstruction/upgrades have occurred
Traffic Disruption	• No effect due to construction	• Construction of potential upgrades would have significant disruption to local traffic within the downtown core • Multiple traffic congestion periods (i.e. spread out over several years) due to multiple potential upgrades • Potential upgrades would have minimal disruption to commuter traffic as majority of combined sewer area are local roadways	• Construction of potential upgrades would have disruption to local traffic within the downtown core • Multiple traffic congestion periods (i.e. spread out over several years) due to multiple potential upgrades • Potential upgrades would have significant disruption to commuter traffic based on location and size of existing infrastructure	• Construction of potential upgrades would have disruption to local traffic within the downtown core • Multiple traffic congestion periods (i.e. spread out over several years) due to multiple potential upgrades • Potential upgrades would have minimal disruption to commuter traffic based on location and size of potential tanks	• Construction of potential upgrades would have disruption to local traffic within the downtown core • Multiple traffic congestion periods (i.e. spread out over several years) due to multiple potential upgrades • Potential upgrades would have significant disruption to commuter traffic based on location and size of existing infrastructure
Social Disruption	• No disruption to EMS • Negative impact to quality of recreational activities on waterfront from washed up debris	• Moderate disruption to local business as majority of remaining combined sewers are in residential areas • Moderate disruption to EMS	• Significant disruption to local business as majority of existing infrastructure is along commercial corridors • Moderate disruption to EMS	• Moderate disruption to local business as majority of end-of-pipe upgrades would be localized areas • Moderate disruption to EMS	• Significant disruption to local business as majority of conveyance infrastructure is along commercial corridors • Moderate disruption to EMS
Social/Cultural Environment Overall Rating	Minor to little overall disruption to social and cultural aspects	Significant impact as majority of combined sewers areas are local residential street; however significant amount of area is required to be reconstructed.	Significant impacts to people and traffic due to local of existing infrastructure (i.e. along major routes)	Moderate impacts to people and traffic as localize construction for tank installations	Significant impacts to people and traffic due to local of existing infrastructure (i.e. along major routes)
Technical Suitability					
Capacity of Existing Linear Infrastructure	• Existing infrastructure would operate as it currently does and has identified capacity issues.	• Moderate upgrades to existing infrastructure would be required once areas have been separated to eliminate CSOs • Ravensveiw WWTP would have sufficient capacity	• Significant upgrades to the existing infrastructure would be required (i.e. 2 or more time the capacity) to eliminate CSOs • Ravensview WWTP would require a significant upgrade (2 or more time the capacity) to treat peak flows	• Significant upgrades/additions to the existing tanks and/or additional tanks (≈30,000m^3) would be required to eliminate CSOs • Additional infrastructure would be required to be able to fill the tanks as	• Significant upgrades to the existing infrastructure would be required (i.e.

	Alternative 1 Do Nothing	Alternative 2 Source Control	Alternative 3 Conveyance Control	Alternative 4 End-of-Pipe Control	Alternative 5 Conveyance & End-of-Pipe Control
				quickly as required and empty them when flows subside • Ravensview WWTP would require an upgrade to treat the additional ADF	2 or more time the capacity) to eliminate CSOs • Significant upgrades/additions to the existing tanks and/or additional tanks would be required to eliminate CSOs • Ravensview would require a significant upgrade (2 or more time the capacity) to treat flows
Approximate Amount and Ease of Construction of New Required Infrastructure	• No addition construction completed	• Significant amount of area required to be reconstructed to separate all combined sewer areas • Some difficulties anticipated to reconstruct of existing infrastructure due to high level of development present in the area (Downtown)	• Significant upgrades to the majority of existing combined sewer system infrastructure. • Some difficulties anticipated to reconstruct/upgrade existing infrastructure due to its location. Limited space and high levels of development present in the area (Downtown) • Complex WWTP upgrades required	• Significant tank storage required to eliminate CSO • Significant difficulties anticipated to upgrade/ add addition tank storage based on limited space, location of required storage and high levels of development present in the area (Downtown)	• Significant upgrades to the majority of existing combined sewer system infrastructure • Some difficulties anticipated to reconstruct/upgrade existing infrastructure due to its location. Limited space and high levels of development present in the area (Downtown) • Complex WWTP upgrades required
Ability to reduce CSO's and meet MOECC F-5-5 target and virtual elimination goal	• Does Not reduce CSO's	• Reduces CSO's • Would meet F-5-5 criteria • Would virtually eliminate	• Reduces CSO's • Would meet F-5-5 criteria • Would virtually eliminate	• Reduces CSO's • Would meet F-5-5 criteria • Would virtually eliminate	• Reduces CSO's • Would meet F-5-5 criteria • Would virtually eliminate
Technical/Operational Rating	Does not reduce of CSO volumes	Significant reconstruction of combined sewer areas in downtown core.	Significant upgrades of existing infrastructure. Significant difficulties with installation and limited space in downtown core.	Significant tank size increase/addition and complex infrastructure required to fill and empty.	Significant upgrades of existing infrastructure. Significant difficulties with installation and limited space in downtown core.
Economic Considerations					
Operational/Maintenance Costs	• The same operational and maintenance cost as current levels	• Significantly less operational and maintenance costs above current levels as less flow is pumped and treated. No additional facilities	• Significant increase in operational and maintenance above current levels as more flow would be pumped and treated	• Significant increase in operational and maintenance above current levels as more flow would be pumped and treated	• Significant increase in operational and maintenance above current levels as more flow would be pumped and treated
Capital Costs (incl. Constructability Risk)	• No additional capital costs	• Significant capital cost to install and reconstruction combined sewer areas (Opinion of Probable Cost ≈ 75M) • Moderate constructability risk (common type of work)	• Significant capital cost to upgrade existing combined sewer system (Opinion of Probable Cost ≈ 75M) & upgrade WWTP (Opinion of Probable Cost ≈ 175M), totaling approx. 250M • High constructability risk (large infrastructure and complex WWTP work).	• Significant capital cost to upgrade/add storage tanks (Opinion of Probable Cost ≈ 30M with potential land acquisition in downtown core) & upgrade WWTP (Opinion of Probable Cost ≈ 50M), totaling approx. 80M • High constructability risk as tanks need to be installed in areas near the Lake and there is complex WWTP work	• Significant capital cost to upgrade existing combined sewer system and additional tanks (Opinion of Probable Cost ≈ 50M) & upgrade WWTP (Opinion of Probable Cost ≈ 75M), totaling approx. 125M. • High constructability risk (significant flows and WWTP work).
Economical Overall Rating	Operational and maintenance cost remain the same as current levels	Significant capital cost but less overall operational and maintenance costs	Significant capital cost and operational costs	Significant capital cost but significantly more operational and maintenance costs	Significant capital cost and operational costs
OVERALL PREFERENCE RATING	**5 – Least Preferred**	**1 – Preferred**	**4 – Least Preferred**	**2 – Less Preferred**	**3 – Less Preferred**

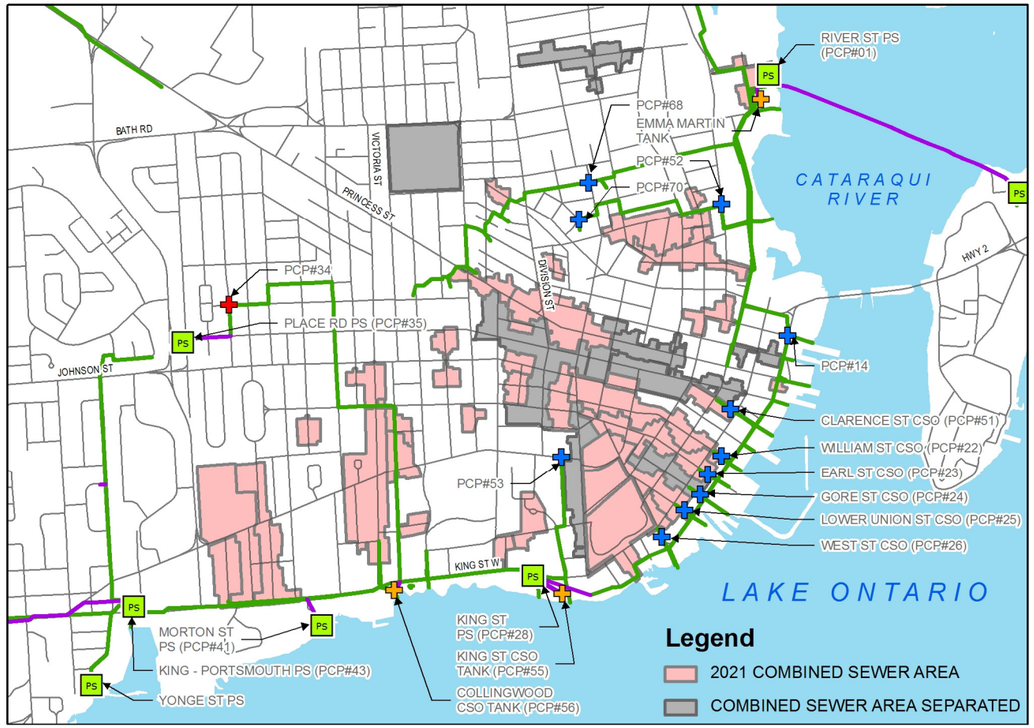
As it can be seen from the evaluation, the sewer separation alternative is still the best option for reducing the CSO's. It is the best technical option as it reduces the amount of flow within the sanitary sewer as well as having the lowest overall capital and operation costs.

4.3.3 DEVELOPMENT OF CSO REDUCTION STRATEGIES AND ALTERNATIVES

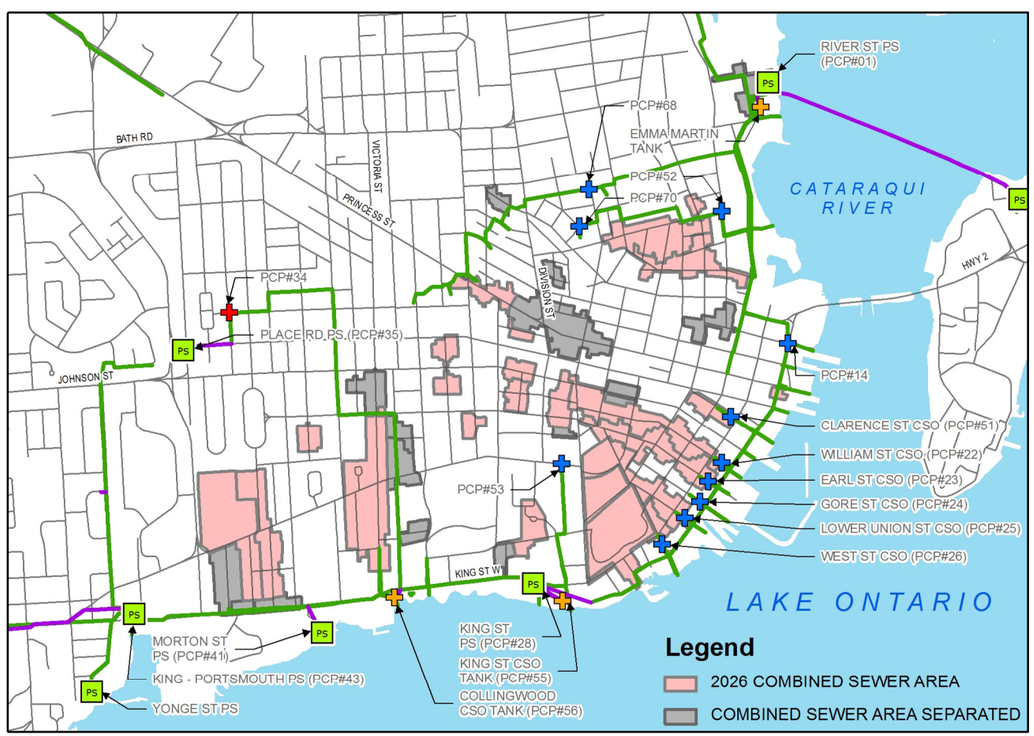
A CSO reduction plan was developed to project how, when and where the source control measures would be implemented. This reduction plan was developed to estimate the pace and location of future sewer separation work for the purposes of the master plan. The estimation is based on an approach consistent with that used during the development of last eight years of capital reconstruction plans. This takes into consideration such things as infrastructure age, priority separation areas and risk assessment based on the condition of all features within the right-of-way, including road and other utilities. This reduction plan projections were used to identify initial gaps in the system as it was the current strategy for the City. As it can be seen in the analysis above, combined sewer reduction is still the preferred method for reducing combined sewer volumes. Figure 4-2 shows an overview of the combined sewer area projections by scenario in the central collection system and existing overflow locations.



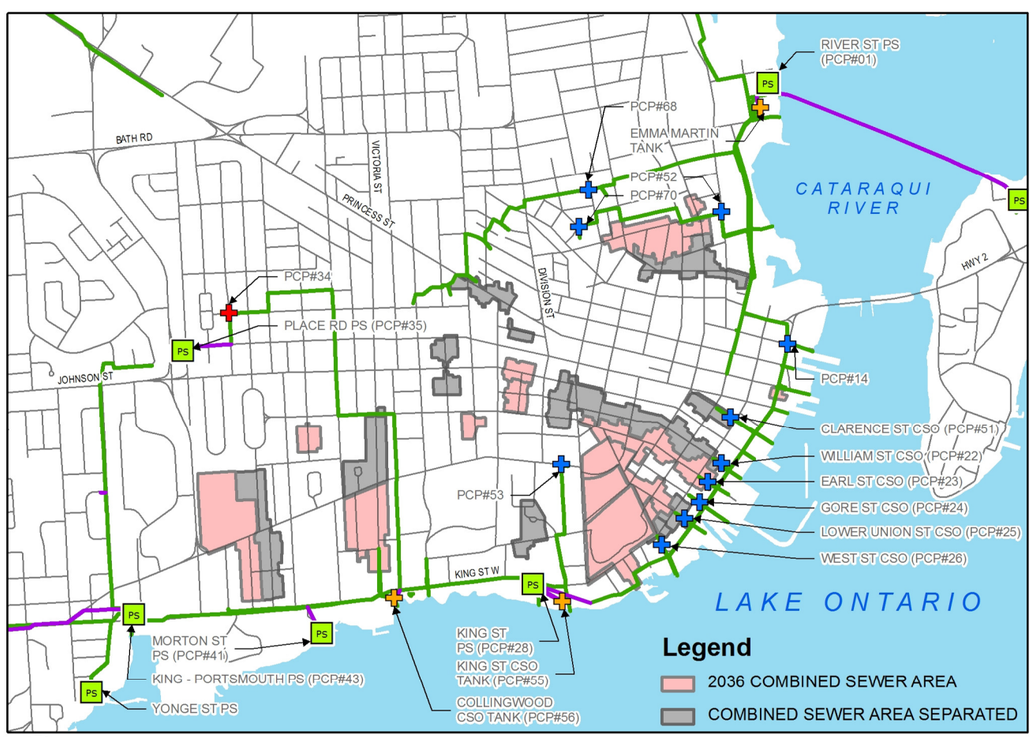
1 / 4-1 2015 COMBINED SEWER AREA
1:27,500



2 / 4-1 2021 COMBINED SEWER AREA
1:27,500



3 / 4-1 2026 COMBINED SEWER AREA
1:27,500



4 / 4-1 2036 COMBINED SEWER AREA
1:27,500

WSP
1224 GARDINERS RD, SUITE 201
KINGSTON, ONTARIO,
CANADA, K7P 0G2
WWW.WSPGROUP.COM

Utilities Kingston
UTILTIES KINGSTON
P.O. BOX 790,
KINGSTON, ONTARIO,
K7L 4X7

Legend

- SANITARY PUMPING STATION
- COMBINED SEWER OVERFLOW (CSO)
- TANK OVERFLOW (TO)
- SANITARY SEWER OVERFLOW (SSO)
- PLUGGED CSO
- SANITARY SEWER (MODELLED)
- FORCEMAIN
- ROAD

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilties Kingston, April 2015, City of Kingston.

Scale:
0 200 400 800 Meters
1:27,500

Project:
Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title:
COMBINED SEWER OVERVIEW

Project No.:	Date:
151-02944-00	DECEMBER 2016

Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	AS	4-1

File Location:M:\2015\151-02944-00 UK Water and Wastewater Masterplan\3.0 Technical\3.7 Reports\3.7.5_Alternate Solutions\Wastewater\Map\151-02944-00_AS_Fig4-1_Combined_Sewer_Overview.mxd

4.3.3.1 REDUCTION PLAN

One of the difficulties with developing a reduction plan that provides projections of roadway reconstruction and combined sewer separation is the certainty of that plan as you move further into the future. Policy and priorities of a City can change based on many factors and criteria that may not be evident today. Therefore, to provide additional understanding of the effects of variations in the reduction plan by 2036, an analysis was completed that reviewed the following alternatives:

Scenario 1. No additional sewer separation between 2015 and 2036 with 2036 growth (Base Case)
Scenario 2. 2026 projected sewer separation with 2036 growth (Slower Case)
Scenario 3. 2026 project sewer separation + 50% of projected sewer separation between 2026 and 2036 with 2036 growth (Slow Case)
Scenario 4. 2036 projected sewer separation with 2036 growth (Projected Case)
Scenario 5. All combined sewers separated with 2036 growth (Faster Case)

The table below summarizes the CSO analysis under the typical rainfall year for the different alternatives. The analysis was completed for each individual CSO for duration, time and volume. However, accumulative totals for duration and time have been shown in the table and the results have been flagged if any of the individual CSO location do not meet the F-5-5 criteria (orange) or if all of the CSO locations are meeting the MOECC F-5-5 criteria (green). The MOECC F-5-5 criteria for duration and time are that the combined total duration of CSO events at any one CSO location shall not exceed 48hrs and controlling overflows to not more than two events per season. The volume criteria is a system criterion indicating that 90% of the Wet Weather Volume of the system (for an Average Year) above the dry weather flow shall be treated. Refer the Appendix B for the results of the individual CSOs not meeting the F-5-5 criteria.

Table 4-6 Reduction Plan Scenarios - Average Year

	SCENARIO 1 BASE CASE 2036 GROWTH WITH NO SEPARATION	SCENARIO 2 SLOWER CASE 2036 GROWTH WITH 2026 SEPARATION PROJECTIONS	SCENARIO 3 SLOW CASE 2036 GROWTH WITH 2026 + 50% OF 2036 SEPARATION PROJECTIONS	SCENARIO 4 PROJECTED CASE 2036 GROWTH WITH 2036 SEPARATION PROJECTIONS	SCENARIO 5 FASTER CASE 2036 GROWTH WITH ALL SEWER SEPARATED
Approximately Combined Sewer Area Remaining (ha)	174	90	72	54	0
% of Remaining Combined Area relative to Base Case	-	51.7%	41.4%	31.0%	0.00%
Total Cumulative Duration Bypass (hrs)	348.5	238.5	227.5	73.5	25.0
% Reduction relative to Base Case	-	31.6%	34.7%	78.9%	92.8%
Total Number of Bypass Events	37	24	23	14	2

	SCENARIO 1 BASE CASE 2036 GROWTH WITH NO SEPARATION	SCENARIO 2 SLOWER CASE 2036 GROWTH WITH 2026 SEPARATION PROJECTIONS	SCENARIO 3 SLOW CASE 2036 GROWTH WITH 2026 + 50% OF 2036 SEPARATION PROJECTIONS	SCENARIO 4 PROJECTED CASE 2036 GROWTH WITH 2036 SEPARATION PROJECTIONS	SCENARIO 5 FASTER CASE 2036 GROWTH WITH ALL SEWER SEPARATED
% Reduction relative to Base Case	-	35.1%	37.8%	62.2%	94.6%
Total By Pass Volume(m^3)	29,173	8,205	5,816	3,565	266
% Reduction relative to Base Case	-	71.9%	80.0%	87.8%	99.1%
Total Wet Weather Volume at Ravensview (m^3)	1,310,602	913,797	860,949	819,183	794,965
% Reduction relative to Base Case	-	30.3%	34.3%	37.5%	39.3%
Wet Weather Capture (Bypass / Wet Weather) (m^3)	97.8%	99.1%	99.3%	99.6%	99.9%

Similar to above the table, below presents the results for a wetter than average year for the different alternatives:

Table 4-7 Reduction Plan Scenarios - Wetter than Average Year

	SCENARIO 1 BASE CASE 2036 GROWTH WITH NO SEPARATION	SCENARIO 2 SLOWER CASE 2036 GROWTH WITH 2026 SEPARATION PROJECTIONS	SCENARIO 3 SLOW CASE 2036 GROWTH WITH 2026 + 50% OF 2036 SEPARATION PROJECTIONS	SCENARIO 4 PROJECTED CASE 2036 GROWTH WITH 2036 SEPARATION PROJECTIONS	SCENARIO 5 FASTER CASE 2036 GROWTH WITH ALL SEWER SEPARATED
Approximately Combined Sewer Area Remaining (Ha)	174	90	72	54	0
% of Remaining Combined Area relative to Base Case	-	51.7%	41.4%	31.0%	0.00%
Total Cumulative Duration Bypass (Hrs)	750.0	634.0	624.0	92.5	5.0
% Reduction relative to Base Case	-	15.5%	16.8%	87.7%	99.3%

	SCENARIO 1 BASE CASE 2036 GROWTH WITH NO SEPARATION	SCENARIO 2 SLOWER CASE 2036 GROWTH WITH 2026 SEPARATION PROJECTIONS	SCENARIO 3 SLOW CASE 2036 GROWTH WITH 2026 + 50% OF 2036 SEPARATION PROJECTIONS	SCENARIO 4 PROJECTED CASE 2036 GROWTH WITH 2036 SEPARATION PROJECTIONS	SCENARIO 5 FASTER CASE 2036 GROWTH WITH ALL SEWER SEPARATED
Total Number of Bypass Events	63.0	41.0	39.0	24.0	1.0
% Reduction relative to Base Case	-	34.9%	38.0%	61.9%	98.4%
Total By Pass Volume(m^3)	82,538	36,480	30,441	20,449	1,050
% Reduction relative to Base Case	-	55.8%	63.1%	75.2%	98.7%
Total Wet Weather Volume at Ravensview (m^3)	1,800,624	1,212,304	1,137,885	1,080,651	795,749
% Reduction relative to Base Case	-	32.7%	36.8%	40.0%	55.8%
Wet Weather Capture (Bypass / Wet Weather) (m^3)	95.4%	97.00%	97.3%	98.1%	99.9%

It can be seen from the tables above that in the average year, and more so in the wetter than average year, continuing with the projected sewer separation has significant benefits to becoming fully compliant with MOECC F-5-5 and the City's goal of "virtually elimination". By continuing with the projected sewer separation plan and beyond, a significant reduction in treatment volume can be achieved that could have significant operational and maintenance cost reductions. Additionally in both scenarios there is a significant change in the duration and number of events between the slow case and projected case. This appears to mainly be due to the overall levels in the system and a situation where the levels drop below a "tipping point" that significantly reduces these factors. This is also shown in the by-pass reduction as this does not reduce as much, meaning that large wet weather events still have overflows, however the system seems to be able to handle some of the smaller events that would increase the number and duration but have less effect on the total volumes.

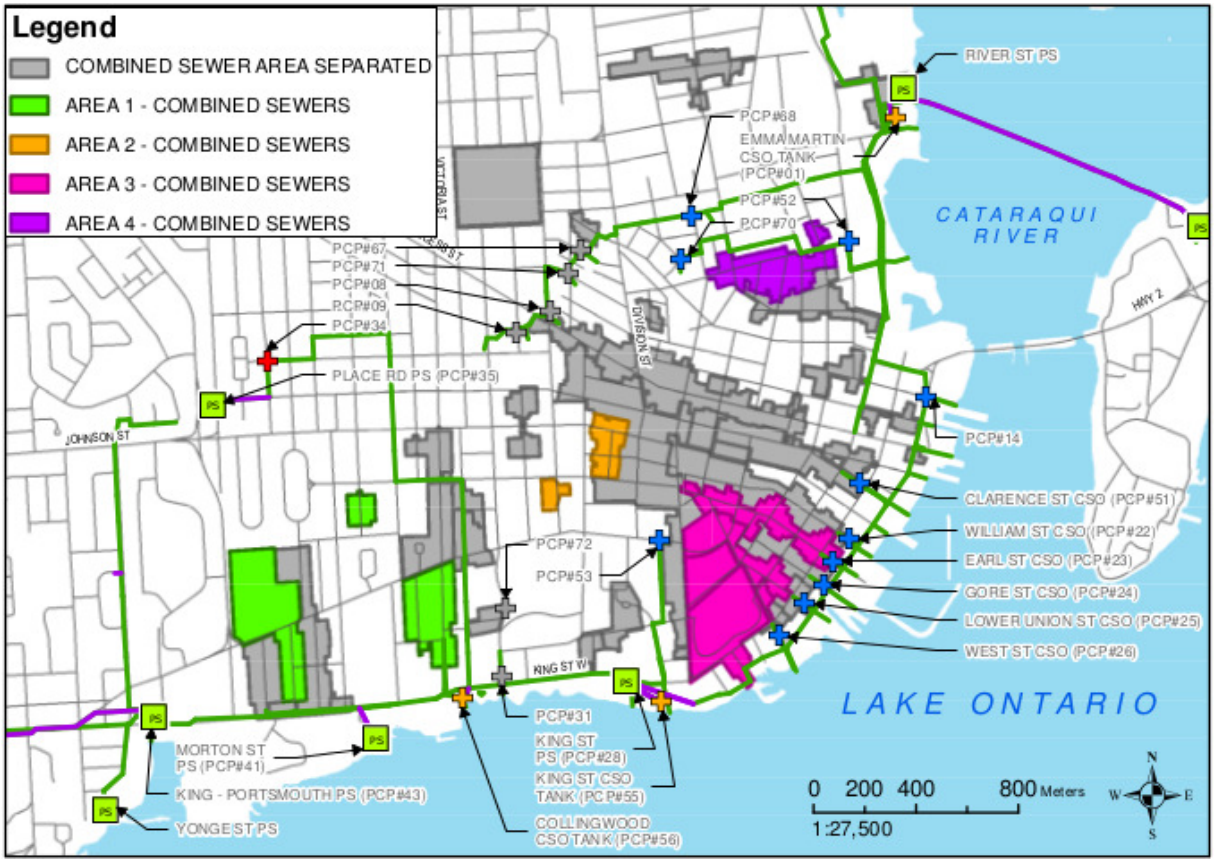
In consultation with the Ministry of Environment and Climate Control (MOECC) and the Cataraqui Region Conservation Authority (CRCA), while all criteria are important, the volume and duration criteria are typically the more important aspects with the volume being the most important criteria. This is because those criteria are what impact the environment the most. The projected case does meet these MOECC F-5-5 criteria but only exceeds on the number of events at 2 locations.

4.3.3.2 REMAINING COMBINED SEWER AREAS

Currently, based on the projected combined sewer separation plan, by 2036 scenario there are combined sewer areas which are projected to remain. To compare the effectiveness of sewer separation for the remaining areas, the model was used to simulate the 2015, 2036 and Build-Out sewer separation with alternative increases in the separation of areas to review the effectiveness of CSO area reduction. This was completed to assist in developing further reduction strategies for the remaining area.

This sensitivity analysis was completed for the 2036 grow scenario by eliminating one of the four remaining areas as indicated in the figure below. Each area was eliminated while the remaining areas were left unseparated.

Figure 4-2 Remaining Combined Sewer Areas



As indicated above the CSO analysis is done based on two criteria, (1) To meet F-5-5 and (2) to "virtually eliminate" CSO's under a wetter than average year. To review this, the CSO were analyzed using the average rainfall year (2014) and wet rainfall year (2008).

The table below summarizes the totals from the CSO analysis under the typically rainfall year. The same format and criteria that were used in the previous section were used to displace the results in relation to MOECC F-5-5 guidelines. Refer the Appendix B for the results of the individual CSO:

Table 4-8 Average Year CSO By-pass Volume, Duration and Frequency by Scenario for 2036 Growth Projection

		2036 GROWTH WITH 2036 SEWER SEPARATION PLUS				
	BASE CASE NO ADDITIONAL SEWER SEPARATION	AREA 1: SEWER SEPARATION	AREA 2: SEWER SEPARATION	AREA 3: SEWER SEPARATION	AREA 4: SEWER SEPARATION	FULL SEWER SEPARATION
Approximately Combined Sewer Area Remaining (ha)	54	36	51	29	47	0
% of Remaining Combined Area relative to Base Case	-	70.6%	94.4%	53.7%	87.0%	0.0%
Total Cumulative Duration Bypass (hrs)	73.5	30.5	45.0	40.0	48.5	25.0
% Reduction relative to Base Case	-	58.5%	38.8%	45.6%	34.0%	66.0%
Total Number of Bypass Events	14.0	6.0	11.0	10.0	12.0	2.0
% Reduction relative to Base Case	-	57.1%	21.4%	28.6%	14.3%	85.7%
Total By Pass Volume(m^3)	3,565	571	1,903	1,456	2,539	334
% Reduction relative to Base Case	-	84.0%	46.6%	59.2%	28.8%	90.6%
Total Wet Weather Volume at Ravensview (m^3)	819,183	720,356	743,151	720,968	730,943	695,033
% Reduction relative to Base Case	-	12.0%	9.3%	12.0 %	10.8%	15.1%
Wet Weather Capture Ratio (Bypass / Wet Weather) (m^3)	99.6%	99.9%	99.7%	99.8%	99.6%	99.9%
Rate of By-Pass Reduction (m3/ha)	-	166.3	554.0	66.5	146.6	61.1

The findings from the CSO sensitivity analysis further shows the effectiveness of sewer separation for an average rainfall year. It shows that Area 1 is the most effective area to reduce the total amount of by-pass, Area 2 is the most effective area from a reduction per hectare point of view (i.e. cost). Conversely Area 4 is the least effective area to reduce the overall amount of by-pass, however is the second most effective area from a reduction per hectare. The full separated system demonstrates that a fully separated system would meet the F-5-5 criteria for all parameters, demonstrating that full separation of the system is an effective long term goal to meet the F-5-5 criteria

The table below shows the results of the CSO during the wetter than average year.

Table 4-9 Wet Year CSO By-pass Volume, Duration and Frequency by Scenario for 2036 Growth Projection

	2036 GROWTH WITH 2036 SEWER SEPARATION PLUS					
	BASE CASE NO ADDITIONAL SEWER SEPARATION	ALT1 AREA 1: SEWER SEPARATION	ALT2 AREA 2: SEWER SEPARATION	ALT3 AREA 3: SEWER SEPARATION	ALT4 AREA 4: SEWER SEPARATION	ALT5 FULL SEWER SEPARATION
Approximately Combined Sewer Area Remaining (ha)	54	36	51	29	47	0
% of Remaining Combined Area relative to Base Case	-	70.6%	94.4%	53.7%	87.0%	0.0%
Total Cumulative Duration Bypass (hrs)	92.5	30.5	86.5	67.5	81.0	5.0
% Reduction relative to Base Case	-	67.0%	6.5%	27.0%	12.4%	66.0%
Total Number of Bypass Events	24.0	10.0	22.0	16.0	21.0	1.0
% Reduction relative to Base Case	-	58.3%	8.3%	33.3%	12.5%	85.7%
Total By Pass Volume(m^3)	20,449	6,193	18,170	14,595	17,426	1,050
% Reduction relative to Base Case	-	69.7%	11.1%	28.6%	14.8%	94.9%
Total Wet Weather Volume at Ravensview (m^3)	1,080,651	947,306	987,815	956,474	1,077,628	795,749
% Reduction relative to Base Case	-	12.3%	8.6%	11.5 %	0.3%	26.4%
Wet Weather Capture Ratio (Bypass / Wet Weather) (m^3)	98.1%	99.4%	98.2%	98.5%	98.4%	99.9%
Rate of By-Pass Reduction (m3/ha)	-	792.0	759.6	234.2	431.9	359.2

From the table above similar results to the average year are evident. They emphasize even further that by completing the sewer separation as planned, it has a significant reduction in the volume of sewer overflows. In the wetter than average year results show that Area 1 is the most effective area to eliminate both from a total by-pass reduction as well as a reduction per hectare point of view. Area 2 is the second most effective area to eliminate from a reduction per hectare point of view, behind Area 1 but only by a small amount. Additionally as in the average rainfall year, it shows by eliminating combined sewers it meets the goal of "virtually eliminating" combined sewer overflows. There are some variations in the results between the wetter than average year and the average rainfall year that are mainly due to the rain events that are

occurring over these periods. While the wetter than average year overall had more rainfall, how close together the storms are and the individual severity of the storms varies causing some variation in the results.

4.3.4 FUTURE SYSTEM

As demonstrated above, sewer separation is the most effective and responsible combined sewer overflow reduction plan. By implementing the combined sewer reduction plan, the combined sewer system begins to operate as a typical separated system. In order to understand what upgrades would be required for the system in the long term and help with future planning, an analysis of the system was completed to a similar standard that used for the rest of the system. For pumping stations and sewers a 1:10yr storm LOS was selected. The following alternatives were developed to provide potential servicing strategy and identify some common or reasonable upgrades that can be completed within the currently Master Plan horizon so when the majority of combined sewers are removed the system can then be reviewed as a separated system:

Scenario 1. Sewer Separation as planned
Scenario 2. Aggressive Sewer Separation
Scenario 3. Redirect Northern Central Flow to East

SCENARIO 1

In this scenario, there would be no more sewer separation beyond what is planned for the 2036 development scenario. This option is considered the do nothing or base case options.

SCENARIO 2

In this scenario, the remaining combined sewer areas would be eliminated by 2036. This option would be an aggressive reduction program as it would be above what UK has deemed to be reasonable sewer separation to complete.

SCENARIO 3

In this scenario, the sewer separation would be as currently planned to 2036 and the flows from the north portion of the City (North End Truck Sewer, Dalton, North End Outlet sewer and the Rideau Heights trunk sewer) would be re-directed away from the downtown combined sewer system with a new pumping station and forcemain at the intersection of the North End Outlet sewer and the Rideau Height Trunk sewer pumping across the Cataraqui River between John Counter Blvd. and Gore Rd (i.e. Third Crossing) to the Highway 15 trunk sewer. This option was developed to provide and understanding of the upgrades to the downtown system if some flows were diverted away from River St PS.

Each component of infrastructure was reviewed in each of the alternatives to determine the level of upgrade required to meet the 2036 1:10yr LOS. The following table illustrates those upgrades:

Table 4-10 Scenario Strategies for Conveyance Improvements

INFRASTRUCTURE	SCENARIO 1: SEWER SEPARATION AS PLANNED	SCENARIO 2: FULLY SEPARATED SEWER	SCENARIO 3. REDIRECT NORTHERN CENTRAL FLOW TO EAST
River St. PS	Firm capacity Increase by approximately 110% to 3600 L/s (Peak Flow)	Firm capacity Increase by approximately 90% to 3200 L/s (Peak Flow)	Firm capacity Increase by approximately 40% to 2400 L/s (Peak Flow)

King St. PS	Firm capacity Increase by approximately 50% to 1050L/s (Peak Flow) Forcemain Twinning	No Upgrade Required	Firm Capacity Increase by Approximately 50% to 1050L/s (Peak Flow) Forcemain Twinning
North Harbourfront Interceptor	Twinning or Sewer Upsizing (Approximately 750m) From MH9227-041 to 7114-010 (Rideau to Cataraqui St)	No Upgrade Required	No Upgrade Required
Harbourfront Trunk Sewer	Twinning Required (Approximately 2200m) MH6051-010 to 9903-010 (Emily St to Wellington St) and MH7114-030 to River St. PS (Cataraqui St to River St PS)	Twinning Required (Approximately 250m) MH7114-030 to River St. PS (Cataraqui St to River St PS)	Twinning Required (Approximately 2200m) MH6051-010 to 9903-010 (Emily St to Wellington St) and MH7114-030 to River St. PS (Cataraqui St to River St PS)
Rideau St Collector	Upsizing of Sewer Required (Approx 350m) MH7455-025 to 7106-020) (Wellington St to Reglan Rd) from a 375mm to a 600mm	Upsizing of Sewer Required (Approx 350m) MH7455-025 to 7106-020) (Wellington St to Reglan Rd) from a 375mm to a 600mm	Upsizing of Sewer Required (Approx 350m) MH7455-025 to 7106-020) (Wellington St to Reglan Rd) from a 375mm to a 600mm
George St. Collector	No Upgrade Necessary	No Upgrade Necessary	No Upgrade Necessary
Ravensview Trunk Sewer	Twinning or Sewer Upsizing of Entire Length (Approximately 3400m)	Twinning or Sewer Upsizing of Entire Length (Approximately 3400m)	Twinning or Sewer Upsizing of Entire Length (Approximately 3400m)
Barret Crt PS.	No Upgrade Required	No Upgrade Required	Firm Increase by Approximately 80% to 1350L/s (Peak flow) Forcemain upsizing/ twinning
Ravensview WWTP	Capacity Increase for Peak flow (1:10yr Strom) by approximately 75% to 335,000m3/day.	No Upgrade Required	Capacity Increase for Peak flow (1:10yr Strom) by approximately 30% to 250,000m3/day.

As it can be seen from the different servicing strategies above, there is a variety of upgrades that would be required to assess the current combined sewer system as a separated system and meet the 1:10yr storm LOS.

4.3.4.1 RECOMMENDATIONS

Based on the analysis above there are some common factors and infrastructure upgrades that would be required to fully service the central area in the future. The following infrastructure upgrades are recommended in the current Master Plan horizon to ensure this is achievable.

KING ST FORCEMAIN TWINNING

The King St PS forcemain is a short length forcemain 282 m that is currently experiencing high velocities. The twinning will provide the additionally capacity that is required in each of the servicing strategies as well as relieve the high velocities currently being seen in the forcemain under peak conditions and provides redundancy to a critical pumping station.

HARBOURFRONT TRUNK SEWER TWINNING

There is a small section of sewer between Cataraqui St and River St pumping station that was not twinned when the section upstream was completed. It is recommended that this 250m section be completed.

RIDEAU ST COLLECTOR

There is a 250m section of the sewer at the downstream end before it connects in the Harbourfront Trunk sewer that reduces from a 600m to a 375mm. Replacing this section of the sewer with a 600mm will relieve this issues. Once this upgrade is complete, PCP#70 should be monitored for a period of time and if no overflows are experienced could be removed.

RAVENSVIEW TRUNK SEWER

The trunk sewer takes all of the flow from the central and east systems and transfers it to the Ravensview WWTP. By transferring more flow from the central area, the Ravensview trunk sewer is required to be twinned. Additionally, an EA was already completed for this project that recommended a twinning along Hwy 2.

TIMING

Based on the current issues at these locations, the status of the sewer separation the following timing is recommended:

- → King St Forcemain Twinning – by 2026
- → Harbourfront Trunk sewer twinning – by 2036
- → Rideau Collector upgrades – by 2036
- → Ravensview Trunk – by 2036

4.3.5 SUMMARY OF COMBINED SEWER SYSTEM RECOMMENDATIONS

Table 4-11 summarizes the recommendations for the combined sewer system that were evaluated:

Table 4-11 Summary of Infrastructure Gaps for 2036 Level of Service: Central Combined Sewer System

INFRASTRUCTURE	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	TIMING
Combined Sewers	Combined Sewer overflows	Continue with sewer separation plan	By 2036
King St PS	Velocities in Forcemain above 3m/s	Twin forcemain	By 2026

INFRASTRUCTURE	GAP/ISSUE IDENTIFIED	UPGRADE RECOMMENDED	TIMING
Harbourfront Trunk Sewer	Surcharging under all scenarios between the 1:2 to the 1:100yr storm	Twin sewer between Cataraqui St to River St PS (MH7114-030 to River St. PS) approximately 250m.	By 2036
Rideau St Collector	Surcharging under all scenarios between the 1:2 to the 1:100yr storm	Upsizing of Sewer between Wellington St to Reglan Rd (MH7455-025 to 7106-020), approximately 350m Confirm no CSO and Plug PCP #70	By 2036
Ravensview Trunk Sewer	Capacity increase in central system cause surcharging	Twinning of Entire Length, Approximately 3400m	By 2036

4.4 WASTEWATER TREATMENT PLANT ANALYSIS

4.4.1 RESULTS AND DISCUSSION

Currently the Ravensview wastewater treatment plant was not observed to exceed the plant capacity for the 1:10 storm or the ADF by 2036. It did just reach the 80% of the rated ADF by full buildout which was indicated to be the trigger for the commencement the planning and design of required upgrades to ensure that they are in place by the time they are needed.

As previously indicated, the ADF values have been calculated using a factor of 15% increase in dry weather flow to account for normal annual rainfall at Ravensview WWTP. Similar to the Cataraqui Bay WWTP results, the D-5-1 calculation shows that in 2026, the ADF from the model is 61,537m3/day and the D-5-1 calculation indicates an ADF of 59,545m3/day. This demonstrates that the model results appear to be a reasonable projection.

After simulating the recommended alternative from the central and east collection system, the flows to the plant were as follows in Table 4-12:

Table 4-12 Ravensview WWTP - ADF with Recommended Alternatives

< 80% of Rated ADF or <Rated Peak Daily Flow

80 - 100% of Rated ADF

>ADF or >Peak Daily Flow

Scenario	Ravensview WWTP - Average Daily Flow Analysis Period				
	2021	2026	2036	Full Buildout	Rated Capacity
DRY	54,345	56,736	63,273	67,984	ADF 95,000
ADF	62,484	65,190	72,470	77,627	
2 Year	133,183	131,535	131,708	121,605	PDF 168,000
5 Year	147,720	146,484	145,708	137,716	
10 Year	154,303	153,110	151,584	145,615	
25 Year	159,274	159,391	157,456	151,547	
50 Year	162,253	162,427	161,015	155,134	
100 Year	165,060	165,240	163,983	158,354	

Table 4-13 Ravensview WWTP - PDF with Recommended Alternatives

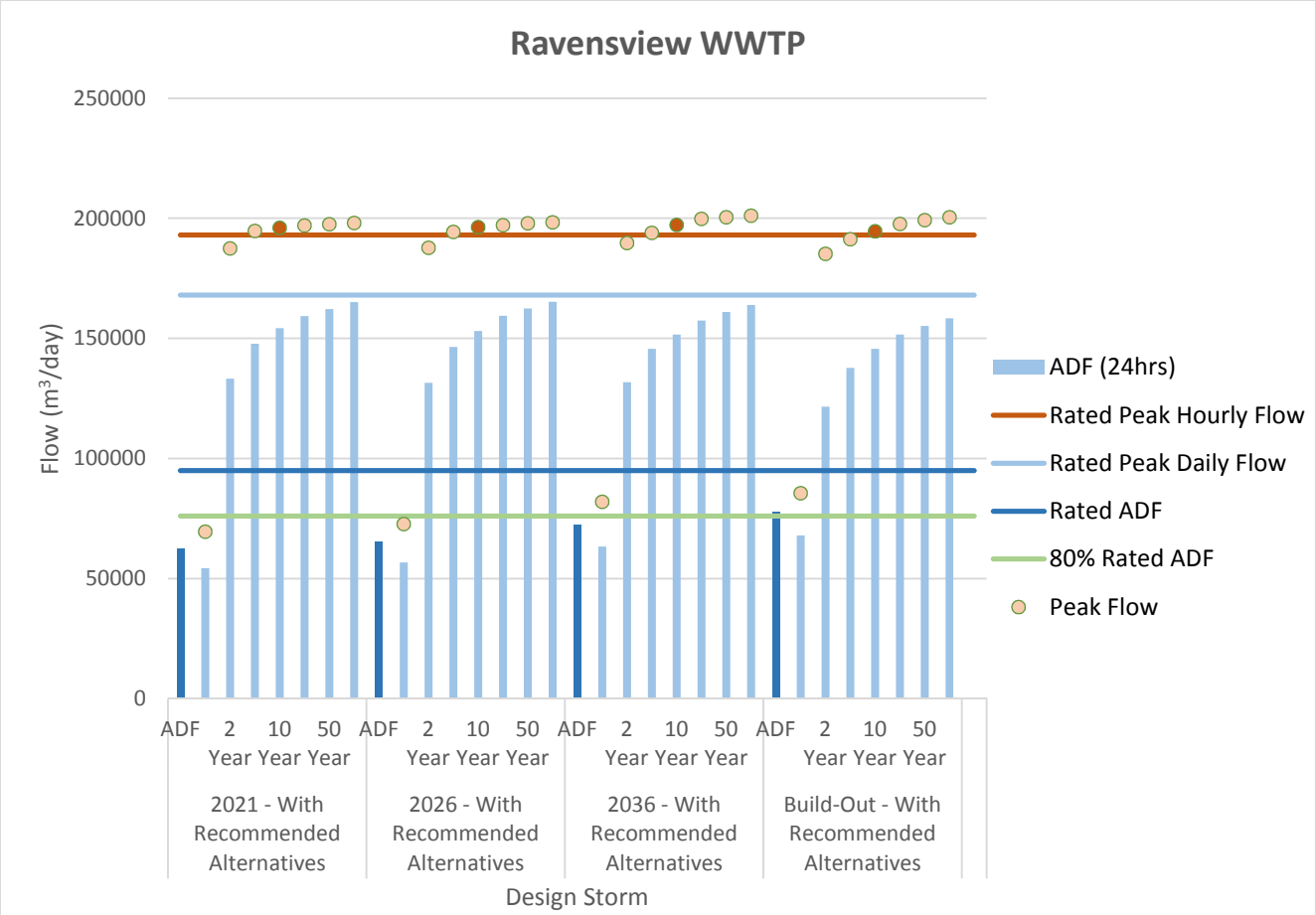
<Rated Peak Flow

>Peak Flow

Scenario	Ravensview WWTP - Peak Daily Flow Analysis Period				
	2021	2026	2036	Full Buildout	Rated Capacity
DRY	69,511	72,698	81,930	85,521	PF 193,000
2 Year	187,438	187,773	189,730	185,295	
5 Year	194,771	194,339	193,980	191,331	
10 Year	195,970	196,336	197,247	194,553	
25 Year	196,974	197,205	199,772	197,688	
50 Year	197,506	197,908	200,469	199,306	
100 Year	198,117	198,395	201,101	200,509	

The figure below displays the ADF and peak flow values at the Ravensview WWTP with the recommended updates for the central and east against the current rated capacities

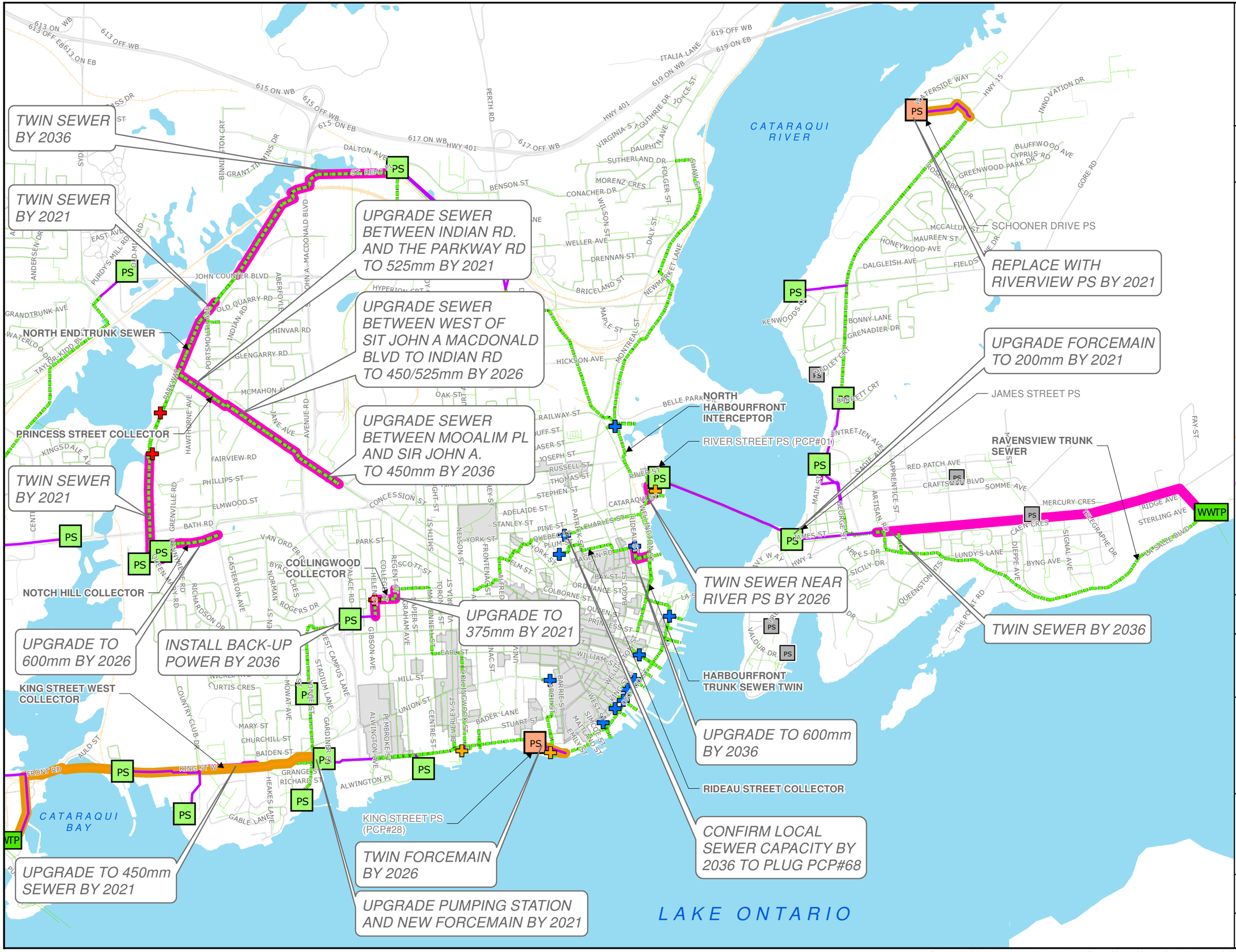
Figure 4-3 Ravensview Capacity with Alternatives



It can be seen that the upgrades to the central and east system do increase the wastewater flow to the WWTP slightly. The ADF flows between 2021 and 2036 are below the 80% limit and reach the limit by full build out. The 1:10yr peak flow does exceed the rated capacity by 1.5% in 2021 and increases to 2.2% by 2036 and then by full buildout is reduced down to within less than 1% of the rated capacity. Based on this marginal exceedance of the limit for peak flow and as the ADF is below the limit, an upgrade is not recommended at this time.

4.5 SUMMARY AND RECOMMENDATIONS

In summary a compilation of all the recommendations is presented in Figure 4-4 for the central collection system.



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Legend

- WWTP — WASTEWATER TREATMENT PLANT
- COMBINED SEWER OVERFLOW
- SANITARY SEWER OVERFLOW
- TANK OVERFLOW
- PS — ALTERNATIVE PUMPING STATION
- PS — PUMPING STATION
- PS — NOT MODELLED
- FORCEMAIN
- ALTERNATIVE FORCEMAIN
- TRUNK SEWER
- ALTERNATIVE TRUNK SEWER
- EXISTING SANITARY SEWER
- COMBINED SEWER AREA TO BE SEPARATED (ONGOING)
- Lake

Data Source: Ontario Base Mapping, Ministry of Natural Resources, August 2013. Water and Waste Water Systems, Utilities Kingston, April 2015, City of Kingston.

Scale:
0 205 410 820 Meters
1:30,000

N W E S

Project:
Water and Wastewater Master Plan Updates

City of Kingston, Ontario

Title: CENTRAL-EAST COLLECTION SYSTEM RECOMMENDED ALTERNATIVE SOLUTIONS SUMMARY

Project No.:	Date:		
151-02944-00	JANUARY, 2017		
Drawn By:	Checked By:	Code:	Figure No.:
CM	MF	AS	4-4

File Location:M:\2015\151-02944-00 UK Water and Wastewater Masterplan\3.0 Technical\3.7 Reports\3.7.5_Alternate Solutions\Wastewater\Map\151-02944-00_FIG4-3_Central-East_Collection_System_Recommended_Alternative_Solutions_Summary.mxd

4.6 PREVIOUS MASTERPLAN RECOMMENDATIONS

The previous Masterplan provide recommendations for the central collection system that were not currently recommend. Below is a summary of those recommendation and comments based on the current analysis:

Table 4-14 Summary of Previous Master Plan Recommendations – Central System

INFRASTRUCTURE	RECOMMENDATION	COMMENT
North Habourfront Trunk Sewer Twinning	1220 mm sewer (840 m)	Currently modelling shows that capacity issue in this sewer is related to capacity issues at River St and backup effect. Not recommended based on: • Increase in River St PS would relieve issue (i.e. not sewer capacity issue) • Twinning of sewer still saw overflows at Belle Park • Reduction of combined sewer provides equal benefit.

5 EAST COLLECTION SYSTEM ALTERNATIVE SOLUTIONS ANALYSIS

The City of Kingston East wastewater collection system comprises an area of approximately 1,386 ha. It is generally bordered by Great Cataraqui River to the west, Macdonald-Cartier Freeway to the north,

Ravensview WWTP access road to the east and Lake Ontario to the south. There are approximately

10,200 people living in Kingston East. Wastewater flow from Kingston East is conveyed to Ravensview Wastewater Treatment Plant

Table 5-1 Summary of East Collection System Infrastructure Gaps

INFRASTRUCTURE	TYPE	COLLECTION SYSTEM	2036 LEVEL OF SERVICE	COMMENT
Schooner Dr.	Pump Station	East	Dry	→ Peak capacity is exceeded during the 50yr storm → PS scheduled for removal

5.1 PUMPING STATIONS

5.1.1 SCHOONER DR PUMPING STATION

5.1.1.1 RESULTS AND DISCUSSION

The Schooner Dr PS results indicate that it exceeds its current firm capacity by 2036; which is a result of significant development in the area. It has been reported by UK that Schooner Dr pumping station is scheduled to be decommissioned and a new pumping station (Riverview PS) is to be installed to service the existing service area as well as the new development.

5.1.1.2 RECOMMENDATIONS

Continue with the replacement of Schooner Dr PS with new Riverview PS.

5.2 SUMMARY AND RECOMMENDATIONS

A summary of all the recommendations is presented in Figure 4-4 for the east system.

5.3 PREVIOUS MASTERPLAN RECOMMENDATIONS

The previous Masterplan provided recommendations for the east collection system that were not currently recommend. Below is a summary of those recommendation and comments based on the current analysis:

Table 5-2 Summary of Previous Master Plan Recommendations – East System

INFRASTRUCTURE	RECOMMENDATION	COMMENT
Barrett Ct (Butternut Creek) PS	Upgrade to handle projected urban growth in Rideau Community beyond year 2026 - increase firm capacity by 40 L/s	A more detail modelling analysis was completed of the east end collection system with more accurate information and data. No issues were observed at this station
Hwy 15 (B40) PS	Increase firm capacity by 30 L/s to meet 10-year capacity under existing conditions	A more detail modelling analysis was completed of the east end collection system with more accurate information and data. No issues were observed at this station

6 WET WEATHER INFLOW REDUCTION

6.1 APPROACH TO WET WEATHER INFLOW REDUCTION

An important component of future servicing needs is to reduce the amount of wet weather inflow and, therefore, free-up capacity for future development and reduce maintenance and operational costs. However, wet weather inflow reduction is a difficult process to fully identify and quantify within a specific area. Many causes can impact the inflow to a sanitary system including:

- Inflow to pipes at damaged joints or broken pipe sections
- Connections of building foundation/footing drains, roof leaders and/or sump pump connections
- Direct inflow from manhole lids or manholes in poor condition (i.e. leaks)
- Unknown direct connections of storm system component to the sanitary system (i.e. within a site)

Typically, in order to reduce the amount of inflow in a system, a systematic investigation is required that uses a variety of inputs to identify the issues including:

- Sewer flow monitoring
- Condition assessments of manholes
- Smoke and dye tests of sewers
- CCTV inspection of sewers
- Property surveys of storm connections system monitoring

With this information, a wet-weather reduction strategy can be developed. However, these types of studies take time and need to be focused on specific areas to provide meaningful results. To provide a guide for focused investigations, an analysis of the catchment area has been completed. The City of Kingston still has a number of combined sewer area which would have a direct impact on inflow. Utilities Kingston has developed a combined sewer separation plan to eliminate these areas. This section is mainly related to areas that do not have known combined sewers in order to identify areas with higher inflow influence than others. Existing flow monitoring data and the InfoSWMM model was used to analyze inflow.

The InfoSWMM model uses a dynamic approach to rainfall response or Rain Derived Infiltration and Inflow (RDII). RDII in the InfoSWMM model is customized for unique rainfall responses based on area and location. This process assigns rainfall loading into the sanitary system using the combination of short, medium and long term responses intended to represent the natural behavior of direct rainfall runoff, delayed rainfall runoff with initial infiltration, and saturated ground infiltration over a longer time period respectively. Based on the catchment area size for each model element, wet-weather calibration was based on the adjustment of these for Kingston West, Central and East. The adjustment of parameters was made to ensure that the model response matches the anecdotal information provided by UK staff in combination with flow monitoring data. This RDII process ensures that the responses or results from the model for wet weather are consistent with actual events and are somewhat correlated to the specifics of that catchment area.

Using the results from the modeling for 2015 for the dry weather and a 2yr return period provides an indication of the wet weather response of the system. In order to provide a meaningful review, a system has been developed to flag or prioritize catchment areas. This system was developed to include two factors:

1. Overall benefit
2. Inflow vs. Area

OVERALL BENEFIT

Some areas have significant wet weather flow and some have small amounts and therefore the overall potential reduction or wet weather amount is a considered. Once this was determined it was scored using the following criteria:

Wet Weather Flow (L/s)	Score
0-10	1
11 -100	2
101 – 250	3
>250	4

INFLOW VS AREA

In order to determine the scale of the potential repairs to the system (i.e. a large catchment area and a small catchment area have the same amount of inflow but larger areas would potentially need more repairs for the same reduction) the wet weather flow (2yr peak flow minus the Dry peak flow) was compared to the area. Once this was calculated a scoring using the following ranges was used:

Inflow Rate (L/s/ha)	Score
0.0 – 0.15	1
0.16 – 0.45	2
0.46 – 1.0	3
>1.0	4

Based on these criteria the following Table 6-1 provides a summary of this analysis. Note that in order to focus on specific catchment area, any catchment area draining into downstream catchment areas have been removed.

Table 6-1 Wet Weather Flow Review by Area

REGION	CATCHMENT AREA	SERVICE AREA (HA) A	ADJUSTED SERVICE AREA (HA) A1	DW PEAK INFLOW (L/S) B	2-YR PEAK INFLOW (L/S) C	WET WEATHER FLOW L/S D=C-B	ADJUSTED WET WEATHER FLOW L/S D1	WET WEATHER E	INFLOW RATE L/S/HA F=D/A	ADJUSTED INFLOW RATE L/S F1=D1/A1	INFLOW G	I&I RATING H=E*G
West	Bath Rd.	31.2	31.2	4.45	15.12	10.67	10.67	2.00	0.342	0.342	2.00	4.00
West	Bath – Collins Bay+	7.6	7.6	1.55	14.22	12.67	12.67	2.00	1.668	1.668	4.00	8.00
West	Bath – Lower	4.9	4.9	0.32	2.45	2.13	2.13	1.00	0.435	0.435	2.00	2.00
West	Bayridge Dr.	10.8	10.8	0.82	8.44	7.62	7.62	1.00	0.706	0.706	3.00	3.00
West	Collins Bay Rd.	15.5	15.5	0.58	2.67	2.09	2.09	1.00	0.135	0.135	1.00	1.00
West	Coverdale Dr.	59.7	59.7	5.67	14.42	8.75	8.75	1.00	0.147	0.147	1.00	1.00
West	Crerar Blvd.	59	59.0	14.56	63.93	49.37	49.37	2.00	0.837	0.837	3.00	6.00
West	Days Rd.	1998.9	1425.4	221.02	623.31	402.29	235.38	3.00	0.201	0.165	2.00	6.00
West	Hillview Rd.	317.8	215.3	53.01	118.23	65.22	37.99	2.00	0.205	0.176	2.00	4.00
West	John Counter Blvd.	3.3	3.3	0.47	6.13	5.66	5.66	1.00	1.716	1.716	4.00	4.00
West	Lakeshore Blvd.	142.9	132.1	44.99	72.38	27.39	19.77	2.00	0.192	0.150	1.00	2.00
West	Rankin Cres.	15.6	10.7	8.60	10.94	2.34	0.21	1.00	0.150	0.020	1.00	1.00
West	Westbrook Rd.*	58.9	58.9	2.61	10.61	8.00	8.00	1.00	0.136	0.136	1.00	1.00
Central	Dalton Ave.	827.9	821.1	124.61	588.55	463.94	453.33	4.00	0.560	0.552	3.00	12.00
Central	Greenview Dr.	6.8	6.8	1.62	12.22	10.60	10.60	2.00	1.559	1.559	4.00	8.00
Central	King St.3	607.1	258.1	329.52	859.09	529.56	363.00	4.00	0.872	1.406	4.00	16.00
Central	King – Elevator Bay+	5.4	5.4	1.11	7.15	6.04	6.04	1.00	1.119	1.119	4.00	4.00
Central	King – Lake Ontario	15.2	15.2	0.64	3.04	2.40	2.40	1.00	0.158	0.158	2.00	2.00
Central	King - Portsmouth2	291.5	291.5	70.17	206.81	136.64	136.64	3.00	0.469	0.469	3.00	9.00
Central	Morton St.	9.8	9.8	0.55	10.10	9.55	9.55	1.00	0.974	0.974	3.00	3.00
Central	Palace Rd.	26	26.0	1.683	12.923	11.24	11.24	2.00	0.432	0.432	2.00	4.00
Central	River St.3	2224.9	789.9	709.50	1978.60	1269.09	275.59	4.00	0.570	0.349	2.00	8.00
Central	Yonge St.	1.1	1.1	0.58	1.28	0.70	0.70	1.00	0.633	0.633	3.00	3.00
East	Barrett Ct.+	292.2	266.6	36.41	64.01	27.61	17.48	2.00	0.094	0.066	1.00	2.00
East	Highway 15+	69	69.0	3.52	11.94	8.42	8.42	1.00	0.122	0.122	1.00	1.00
East	James St.+	76.9	76.9	49.74	51.11	1.37	1.37	1.00	0.018	0.018	1.00	1.00
East	Kenwoods Cir.	6.9	6.9	1.28	3.20	1.92	1.92	1.00	0.278	0.278	2.00	2.00
East	Schooner Dr.	18.7	18.7	1.90	10.10	8.20	8.20	1.00	0.439	0.439	2.00	2.00

Good	Moderate	High	Very High

6.2 DISCUSSION

While the intent of the above analysis was not specifically for areas with combined sewers, they were reviewed as indicators for the benefits of sewer separation. It can be seen that King St has the highest overall rating, as it has significant combined sewers in its catchment area. While River St does not rate as high as King St., it also has significant number of combined sewers, however it has more overflow control that reduces the amount of flow at the pumping station and, therefore, reduce its overall rating.

Dalton Ave PS is the second highest rated and has had reports of high wet weather influence. Greenview PS that drains into Dalton Ave PS, also has a high rating which could have an influence on the Dalton Ave PS rating. Both of these stations have significant piping in low lying areas near the Little Cataraqui Creek and therefore are more likely to be susceptible to wet weather influences.

Bath Collins Bay PS does indicate a high rating, however, it has been noted that the data used to calibrate this station in the model is limited and may need further analysis.

Crerar PS has a high rating, and has been noted as having significant wet weather influence. Part of this high flow is due to the discharge of water from the Point Pleasant water treatment plant. This discharge is being removed and, therefore, may need further analysis once removed.

King- Portsmouth also has a high rating. This area was indicated as having high wet weather influence in the 2010 Master Plan and Utilities Kingston is currently in the process of completing an I&I study and improvements in the drainage area.

Days Rd PS also indicate a high rating, however based on the process of eliminating upstream drainage areas and the number of upstream drainage areas it is difficult to fully eliminate their influence based on the process used in the table above. Therefore a separate analysis of the main tributary areas has been completed below to provide additional information:

Table 6-2 Wet Weather Flow Review For Days Rd PS Catchment Areas

CATCHMENT AREA	SERVICE AREA	DW PEAK INFLOW	2-YR PEAK INFLOW	WET WEATHER FLOW	WET WEATHER	INFLOW RATE	INFLOW	I&I RATING
	(HA)	(L/S)	(L/S)	L/S		L/S/HA		
	A	B	C	D=C-B	E	F=D/A	G	H=E*G
Day Rd Inlet	420	49.9	117.3	67.4	2	0.160	2	4.00
Northwest Collector	305.4	45.5	123.5	78	2	0.255	2	4.00
Northcentral Collector	869.4	67.5	180.2	112.7	3	0.130	1	3.00
Northeast Collector	269.8	23.7	60.3	36.6	2	0.136	1	2.00
Remaining Area	134.3	34.42	142.01	107.588	3	0.801	3	9.00

As it can be seen from the analysis above, the area around the Days Rd pumping station has the highest rating while the other areas, mainly north of Bath Rd have a moderate to good rating.

6.3 SUMMARY

Based on the results, below is a summary of the conclusions:

- Complete additional localized flow monitoring for Bath-Collins Bay to verify the wet weather influence.
- Complete additional flow monitoring for Crerar PS once Point Pleasant discharge is removed to verify the wet weather influence.
- Develop I&I strategy for the localized high wet weather area for the Days Rd PS.
- Develop I&I strategy for Greenview and Dalton PS.
- Continue with Portsmouth I&I reduction program.

It should be noted that I&I investigations do not always identify the sources and therefore do not always lead to a wet-weather reduction to the extent that a capacity increase could be avoided. Therefore the recommended upgrades to meet the indicated LOS should be complete but if work is completed to reduce wet weather influence, these results should be considered during the design of these upgrades.

7 CONDITION & RELIABILITY ANALYSIS

Reliability refers to the system's ability to handle routine upsets such as pipe breaks or planned maintenance to pumps or equipment. Resiliency refers to the ability to recover from major upsets such as the loss of components with long replacement lead times or the upset of complex processes. The amount of reliability is dependent on many factors and is ultimately up to the operating authority with respect to the level of risk they are willing to take with the system based on unexpected events. To provide some guidance on this component a number of items were reviewed and the following items were determined to be valuable to the overall system:

- Back-up
- Forcemain Redundancy
- Condition of Facilities

In order to provide a framework for Utilities Kingston to improve reliability these aspects were reviewed and improvements recommended.

7.1 BACKUP POWER

Back-up power is an important aspect to provide reliability to that service area. Water supply is typically supplied during power outages and, therefore, sewage flows occur during power outage. Additionally, power outages often occur during storms when the wet weather flows contribute to higher flow rates.

In order to prioritize the reliability of the system the facility risk of the station was reviewed. As detailed in the condition assessment report (WSP, 2015), the Facility Risk involved a review of each facility – the type of customer the facility services, the quantity of customers and the outcome (if any) a failure could cause to customers health, property and safety and to the environment of the surrounding area. Based on this analysis the following station had the highest facility risk:

- River St PS
- King Street PS
- Dalton Ave PS
- Days Road PS

The other stations have a lower facility risk, however as other stations are replaced and/or upgraded, back-up power should be considered to these facilities to improve reliability in the overall system.

It should also be noted that while the wastewater plants were not specifically reviewed in the facility risk assessment, they would have the highest risk rating of all of the facilities. Both of the wastewater treatment plants have full back-up power to ensure they are able to treatment the flow as it is received.

7.2 FORCEMAINS

Another important aspect of system reliability is the system ability to continue to transfer wastewater to the wastewater treatment when repairs to forcemains are needed due to breaks. As sewers are not a pressurized system, a break or leak has less impact on the system's ability to continue to operate. While this is not desirable it is not catastrophic. Having a forcemain break or leak is more serious as the system is under pressure. Having a large enough break or leak can impede the system ability to transfer that wastewater. As such, the facility risk was used as a guideline to determine the associated risk to the system. This in conjunction with the forcemain velocities and reported problems were used to determine a framework for potential upgrades. As indicated above the four highest risk stations are River St, King St, Dalton and Days Rd PS. Each of these is reviewed below based on the noted criteria:

River St PS

The River St 1050mm forcemain has recently been twinned its entire length and, therefore, if there was an issue with one of the forcemains the required the flow to be directed to a single forcemain. The peak flow velocities would range from 0.77m/s to 2.25m/s for the dry weather flow to the 1:10yr storm flows between 2015 and 2036. While these velocities are higher than typically desired, they would only be seen in peak flow conditions and would not be destructive to the forcemain. Additionally, as these are newer mains, there has been few reported problems with these mains and appear to be in reasonable condition.

King St PS

The King St PS has a single 600mm forcemain. This forcemain has been recommended to be twinned to provide addition capacity and reduce the overall velocity under normal condition. While the velocity would be higher than 3m/s under peak flow conditions, if one of the forcemain was unavailable when only considering the incoming flow. The King St PS has a dynamic pump system between the Harbourfront trunk sewer and the King St. storage tank that could reduce the flows and therefore the velocities can be maintained below 3m/s.

Dalton Ave PS

The Dalton Ave PS has a 600mm and 450mm forcemain. If all flows were directed to the 600mm forcemain the velocities would range from 0.44m/s to 2.92m/s for the dry weather flow to the 1:10yr storm flows between 2015 and 2036. While these velocities are higher than typically desired, they would only be seen in peak flow conditions and would not be destructive to the forcemain. Additionally, there have been not reported issues with the 600mm forcemain.

If all flows were direct to the 450mm forcemain the velocities would range from 0.78m/s to 5.19m/s from the dry weather flow to the 1:10yr storm flows between 2015 and 2036. Additionally even under the 1:2yr storm event in all scenarios the velocities are exceeding 3m/s. Reports of leaks and breaks on the 450mm forcemain have also been reported. Therefore, if there is a minor storm event during the repair of the 600mm forcemain, velocities in the main would adversely impact the forcemains integrity. To increase reliability, the 450mm forcemain could be replaced with a 600mm forcemain.

Days Rd PS

Day Rd PS has a 900mm and 600mm forcemain with the 600mm forcemain discharging back into the 900m forcemain downstream of the PS or has the ability to re-direct that flow to the sewer discharging to the WWTP. If all flows were directed to the 900mm forcemain the velocities would range from 0.35m/s to 1.69m/s for the dry weather flow to the 1:10yr storm flows between 2015 and 2036. These velocities are typical velocities for peak flow and would not be destructive to the forcemain. In discussion with operations, it was noted that there is currently no ability to isolate the 900mm forcemain from the grit tank at the WWTP headworks. This should be reviewed to develop an isolation plan for this forcemain. No additional issues with the 900mm forcemain have been reported.

Flows are not able to be isolated directly into the 600mm forcemain as the influence pumping station at the WWTP that would receive this flow is not adequate to handle the full flows for Days Rd. Therefore, if there is a problem with the forcemain along the alignment after the flow has combined, there is no redundancy available. If reliability was desired to be increased, this should be looked at in conjunction with any Day Rd PS upgrades to ensure the dynamic relationship between the pumps and forcemain are considered.

The other stations have a lower facility risk, however as other forcemains are replaced and/or upgraded, reliability should be considered during the design to improve reliability in the overall system.

7.3 CONDITION

As detailed in the condition assessment (WSP, 2015) each facility was rated based on facility risk, equipment risk and condition rating. Based on these, Days Rd PS was the only facility with a low rating. This station is recommended for an upgraded and renewal of the other equipment should be completed at that time. The remaining facilities have a moderate rating with minor improvements that should be completed to maintain their operation as recommended in the condition report.

8 ULTIMATE SCENARIO ANALYSIS

The ultimate servicing strategy is intended to provide general guidance and direction with how to best service the large development areas outside of the existing urban boundary. Given the scale of these areas, significant upgrades are required to service them when fully developed. Interim upgrades and/or phasing of the infrastructure should be evaluated when firm development plans begin to be submitted. The guidance with respect to this scenario is limited to major infrastructure; trunk sewer, pumping station and treatment plants. The servicing for the areas for the ultimate developments were developed with the concept of utilizing the overall existing servicing scheme where possible to minimize the overall infrastructure that is required.

Based on the location of these developments the following table outlines the upgrade in the west that would be required:

Table 8-1 Ultimate Servicing Upgrades West

INFRASTRUCTURE	WEST COLLECTION SYSTEM UPGRADES TO SERVICE ULTIMATE SCENARIO
Rankin St. PS	PS Firm Capacity Increase approximately 1300% to 250L/s Forcemain Upsizing to 600mm (Approximately 560m)
Westbrook PS	PS Firm Capacity Increase by approximately 200% to 60L/s Forcemain Twinning (Approximately 1930m)
Hillview Ave. PS	PS Firm Capacity Increase by Approximately 300% to 420L/s Forcemain Twinning (Approximately 575m)
Days Road PS	PS Firm Capacity Increase by Approximately 140% to 1400L/s
High Gate Park Dr. Collector	Sewer Upsizing to 600mm between MH 33461-020 to 33383-020 (Approximately 100m)
Collins Bay Collector	Sewer Twinning and Upsizing to 450/600mm between MH94024-030 to Hillview PS (Approximately 1500m)
Days Road Inlet Trunk Sewer	Sewer Upsizing to 675mm between MH 33310-010 to 33125-010 (Approximately 825m)
Cataraqui Bay WWTP	WWTP ADF Capacity Increase to 95,000m^3/day.

The west areas were reviewed and it was determined based on topography that the areas would drain to Rankin St and Westbrook PS. Once the flow reaches their areas, the existing infrastructure would be upgraded to the required level. As it can be seen there are significant upgrades that would be required to service these areas.

Based on the location of these developments the following table outlines the upgrade in the central/east that would be required:

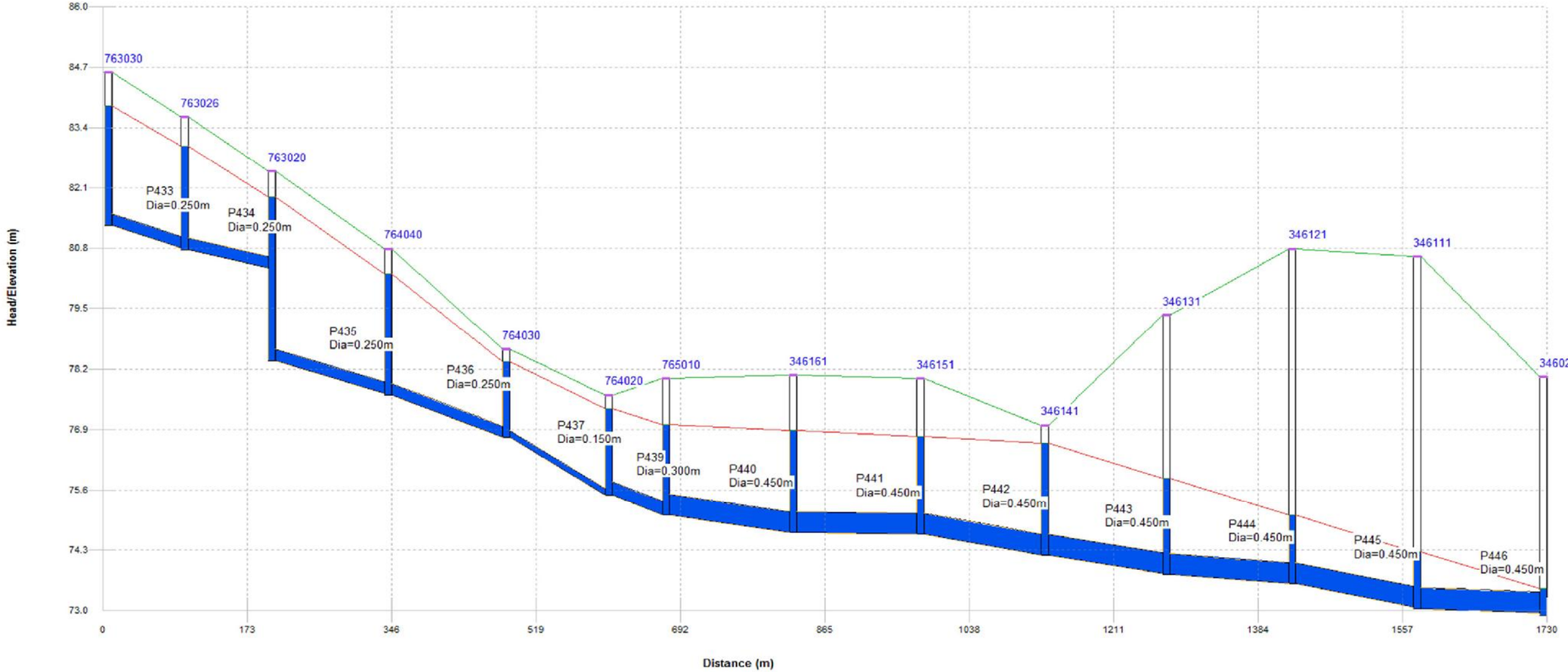
Table 8-2 Ultimate Servicing Upgrades Central/East

INFRASTRUCTURE	CENTRAL/EAST COLLECTION SYSTEM UPGRADES TO SERVICE ULTIMATE SCENARIO
Barret Crt PS	PS Firm Capacity Increase by approximately 10% to 200L/s
HWY 15 Trunk Sewer	Sewer Twinning between MH 637056 and Barret Crt PS (Approximately 2900m)
Ravensview WWTP	WWTP ADF Capacity Increase to 100,000m3/day and a Peak Flow increase to 225,000m3/day

Similar to the west system the existing infrastructure would be used as much as possible. The ultimate development area to the north east would be serviced along the Hwy 15 corridor and the area to the east would go directly to the Ravensview.

Appendix A

SEWER PROFILES



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

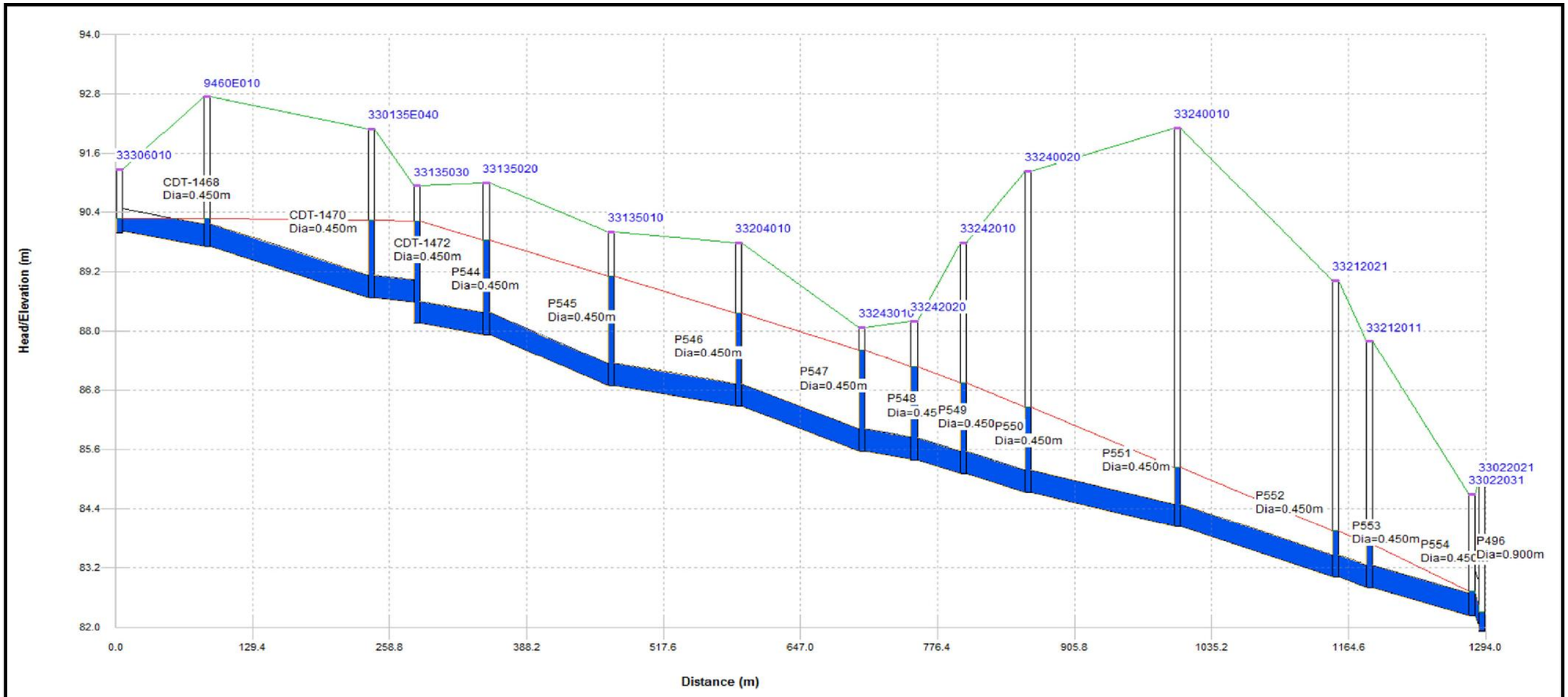
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

Bath Road Collector

Figure W1.1



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

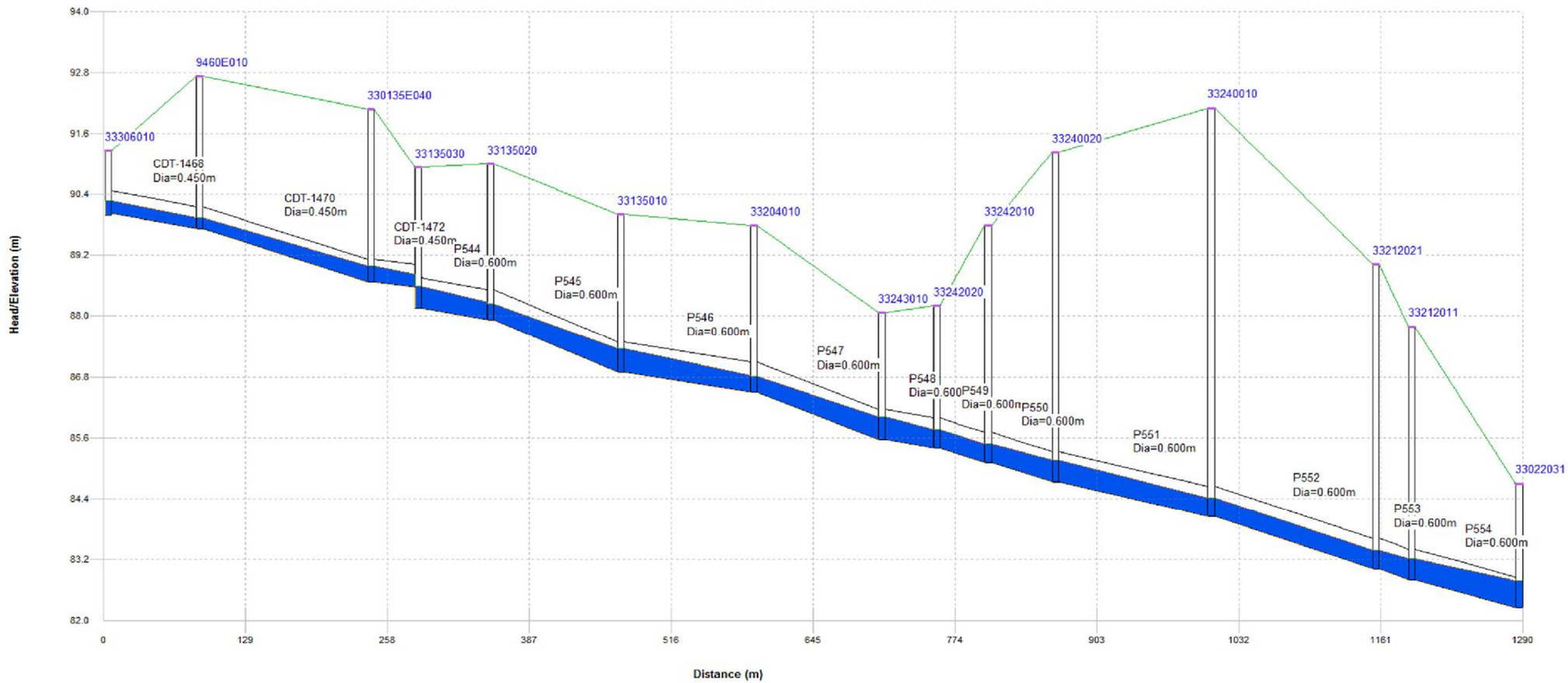
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

North West Collector

Figure W2.1



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

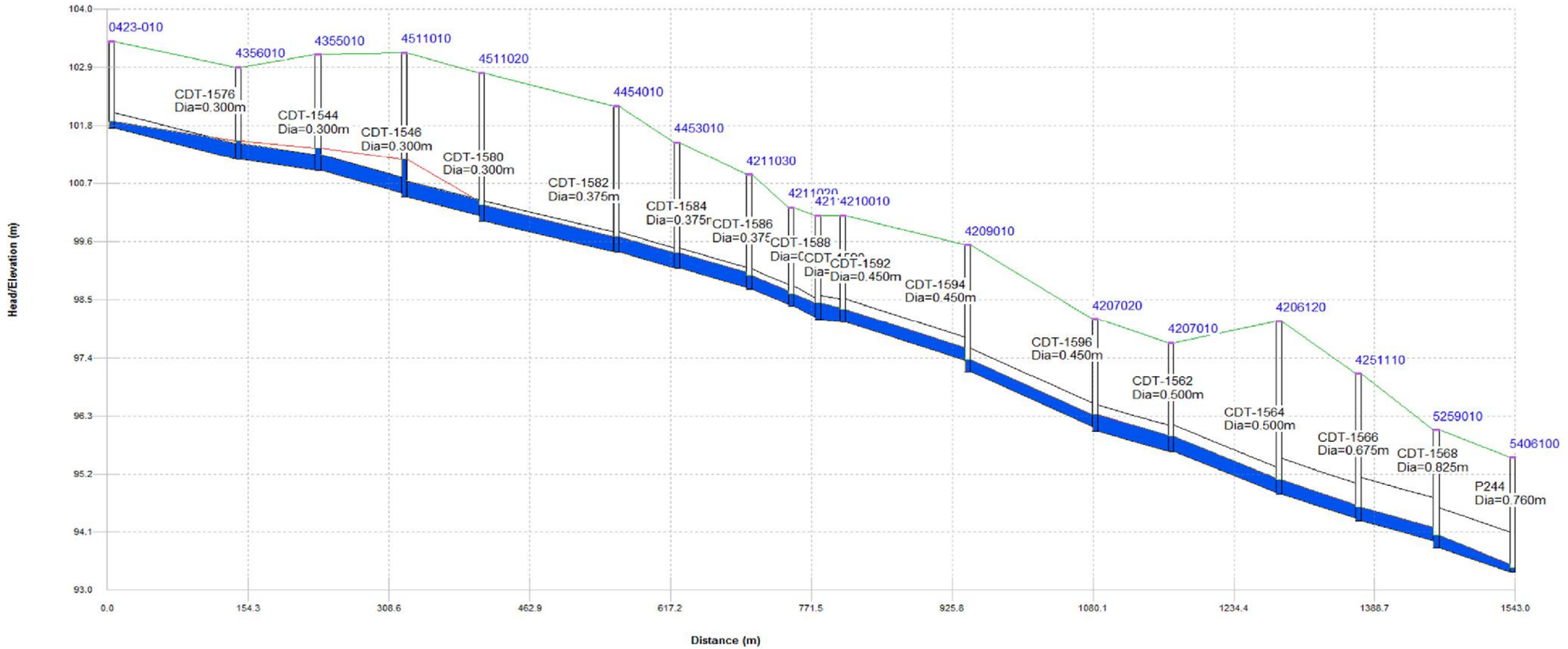
WSP

Date:	**October, 2016**
Scale:	**N.T.S.**
Project:	**151-02944-00**

1:100 Year Storm Simulation, 2036 Scenario

North West Collector - With LOS Upgrades

Figure W2.2



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

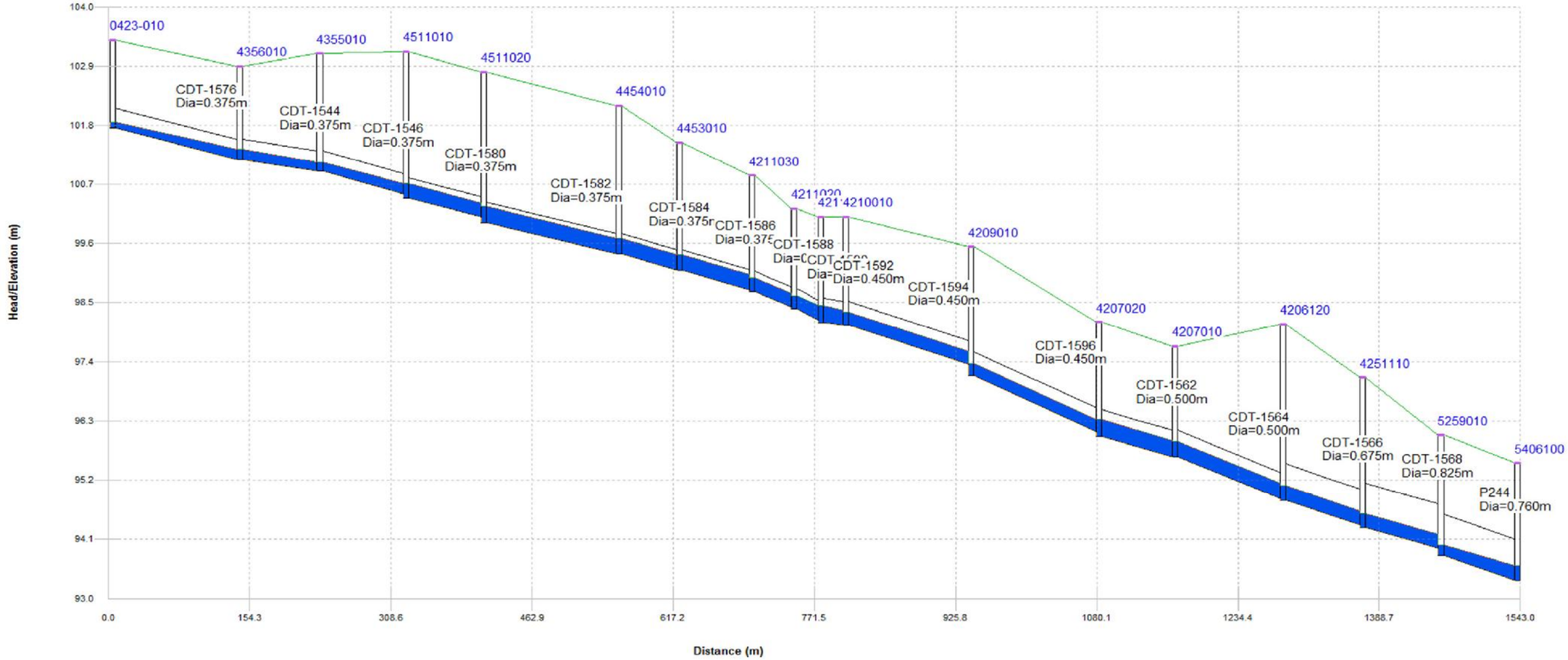
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

Collingwood Collector - Part 1 of 2

Figure C1.1



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

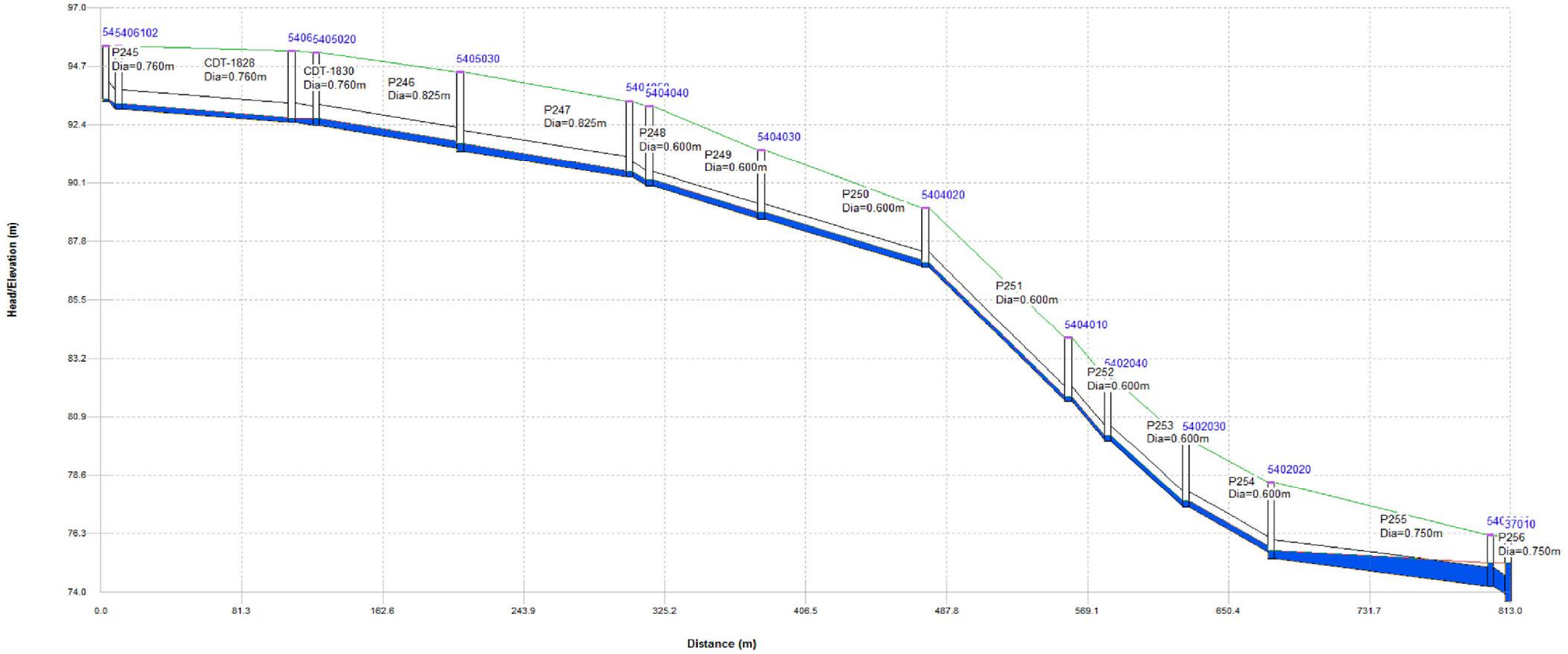
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

Collingwood Collector - With LOS Upgrades Part 1 of 2

Figure C1.2



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

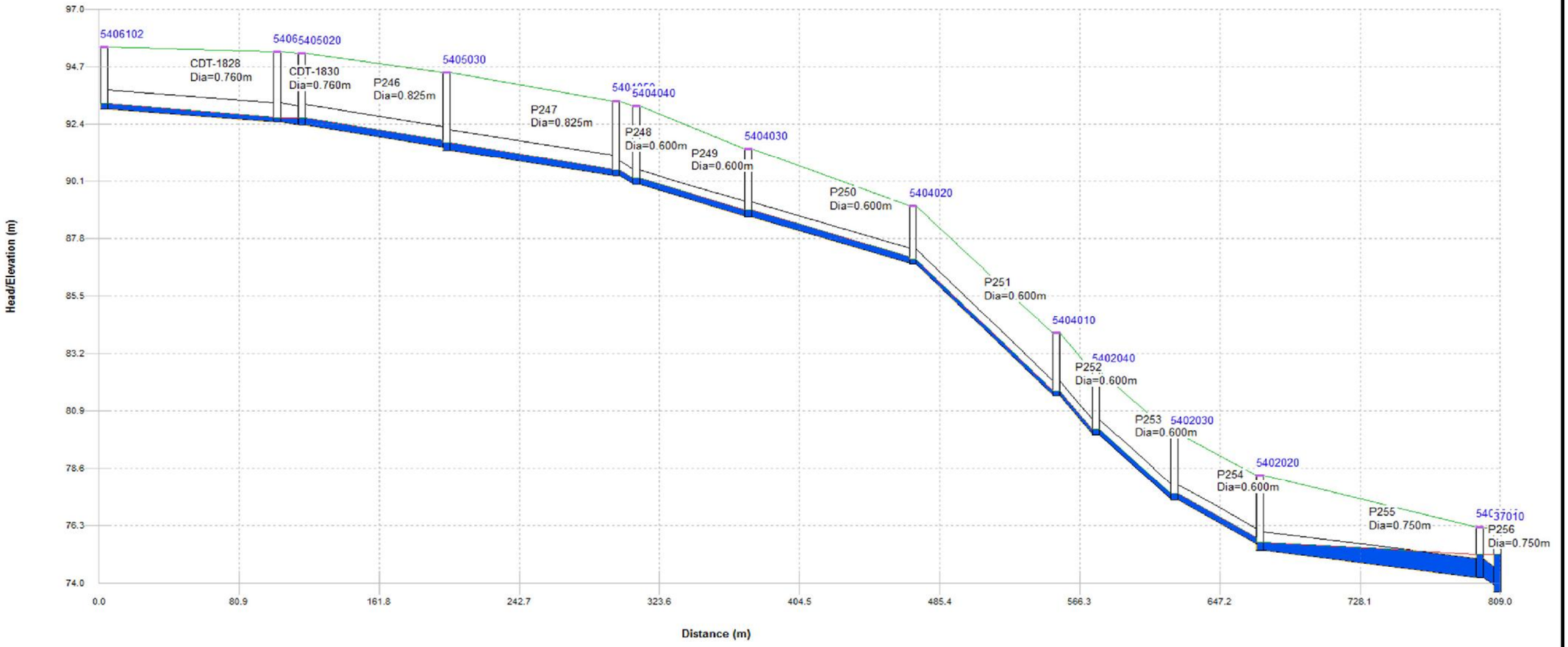
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

Collingwood Collector - Part 2 of 2

Figure C1.3



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

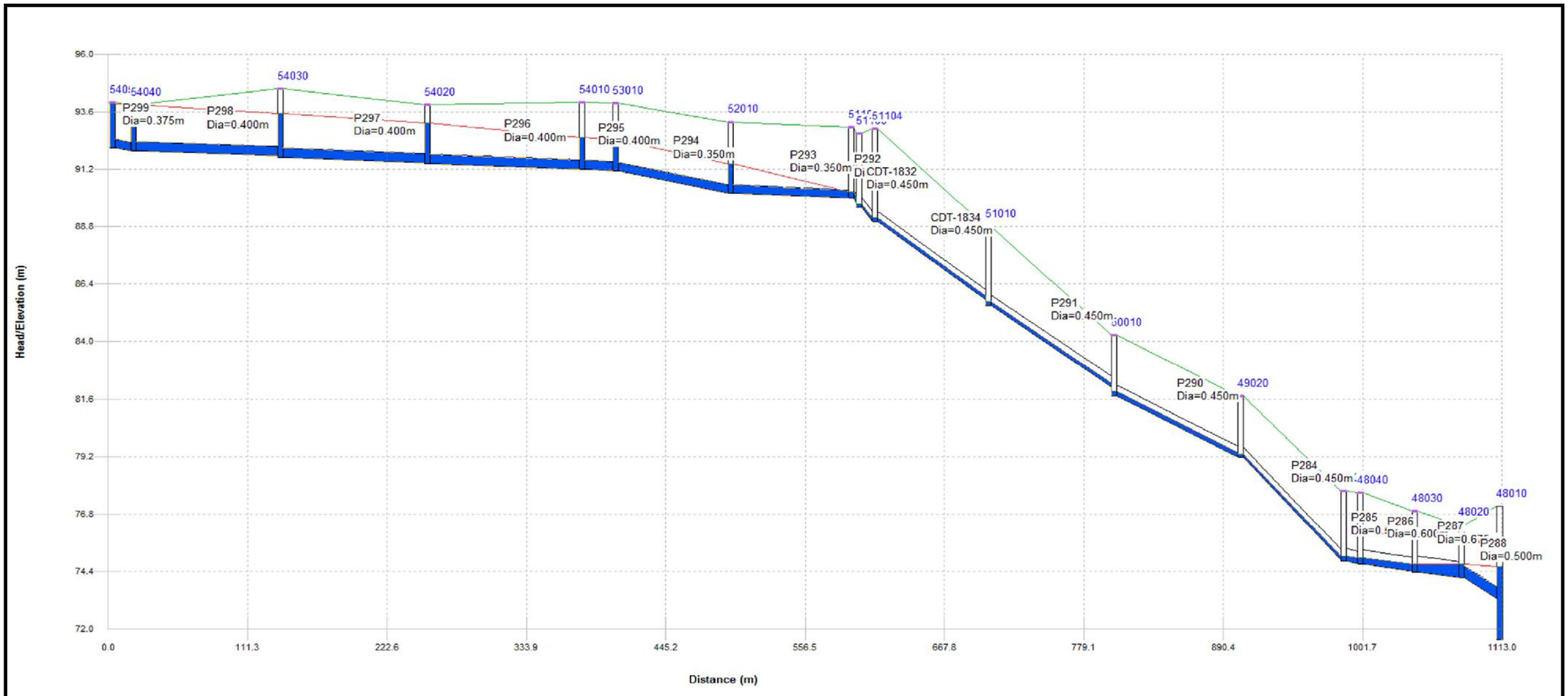
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

Collingwood Collector - With LOS Upgrades Part 2 of 2

Figure C1.4



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

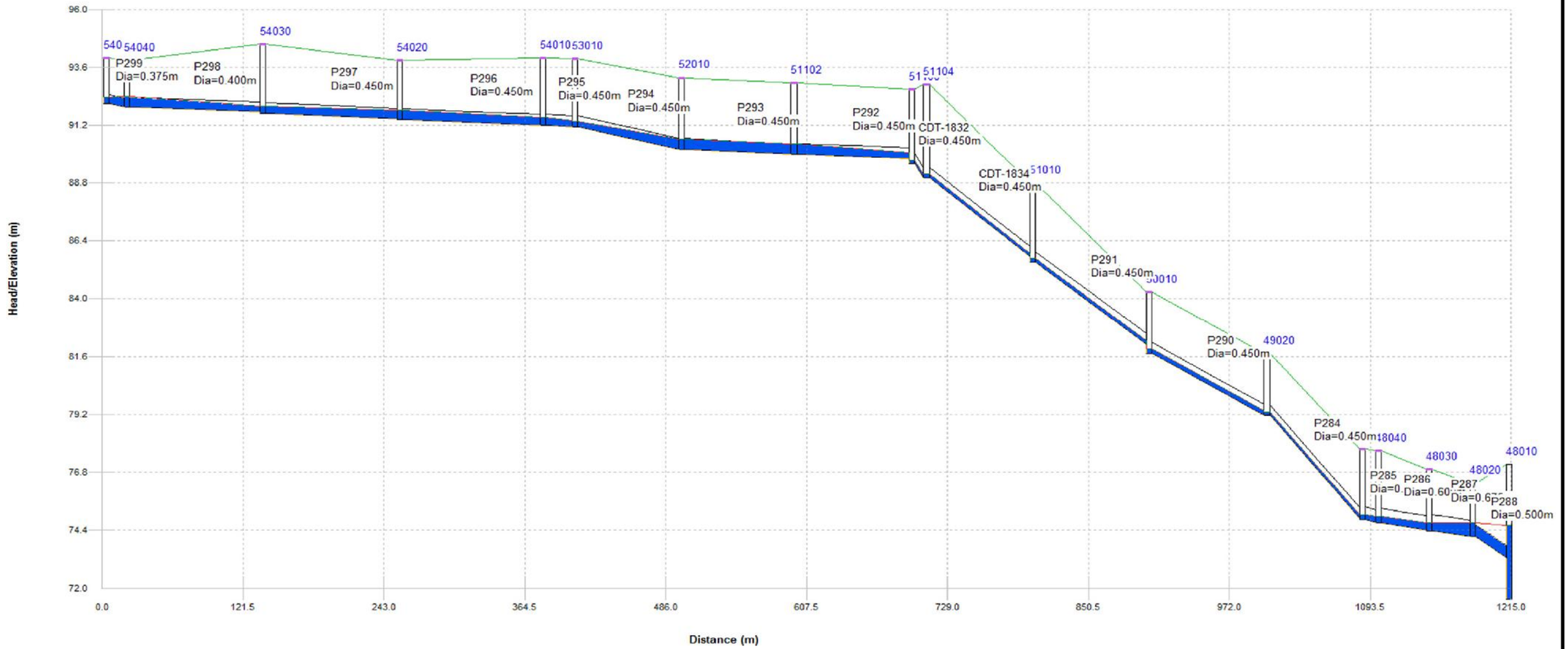
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

King Street West Collector

Figure C2.1



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

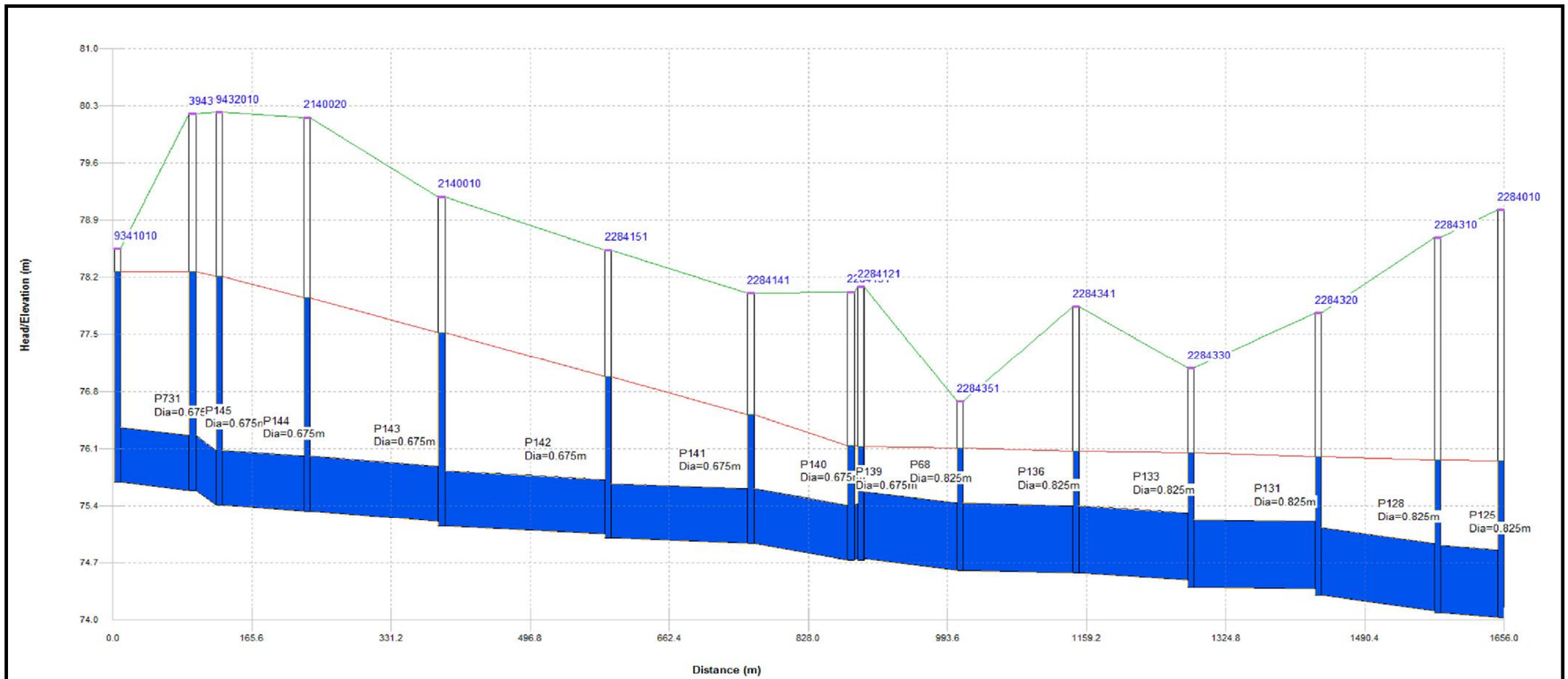
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

King Street West Collector - With LOS Upgrades

Figure C2.2



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

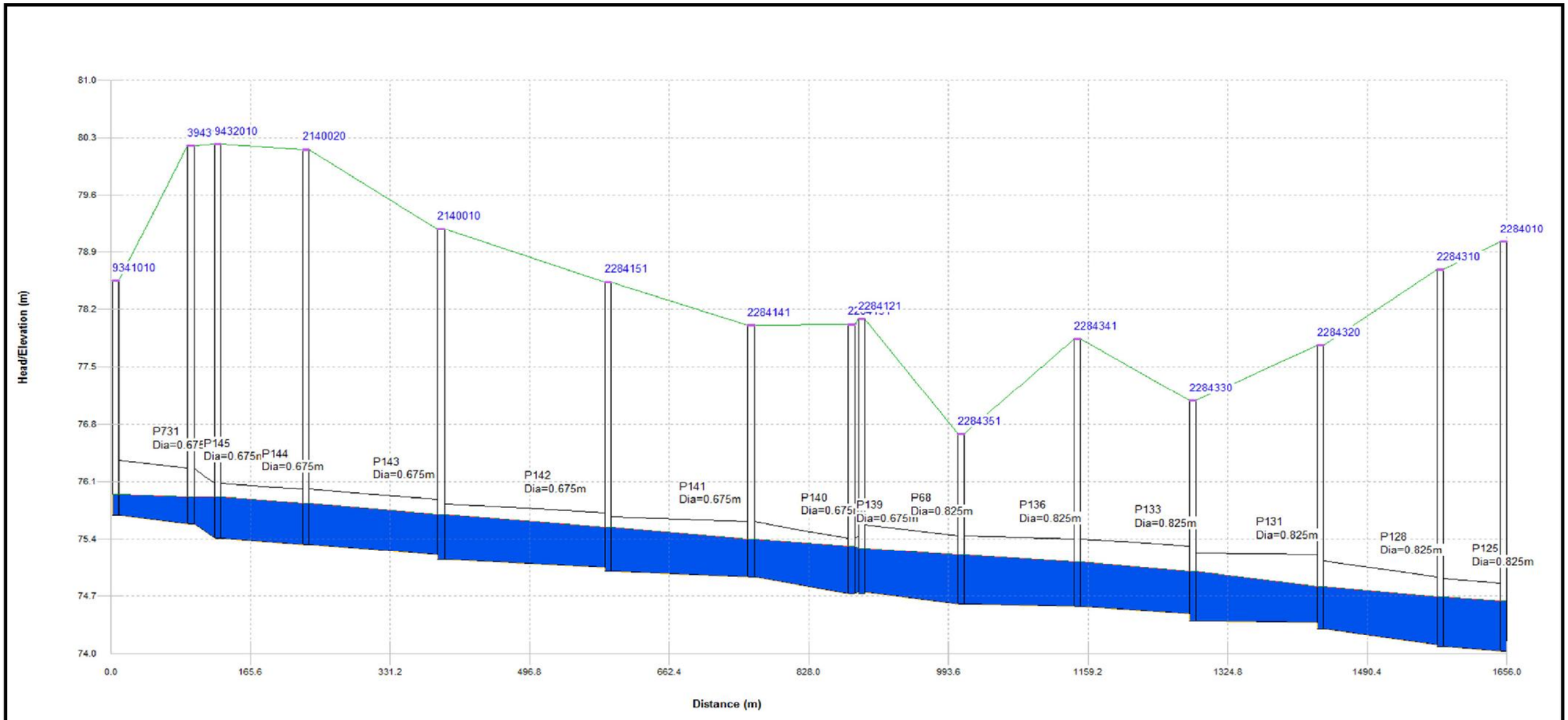
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

North End Trunk Sewer - Part 1 of 2

Figure C3.1



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

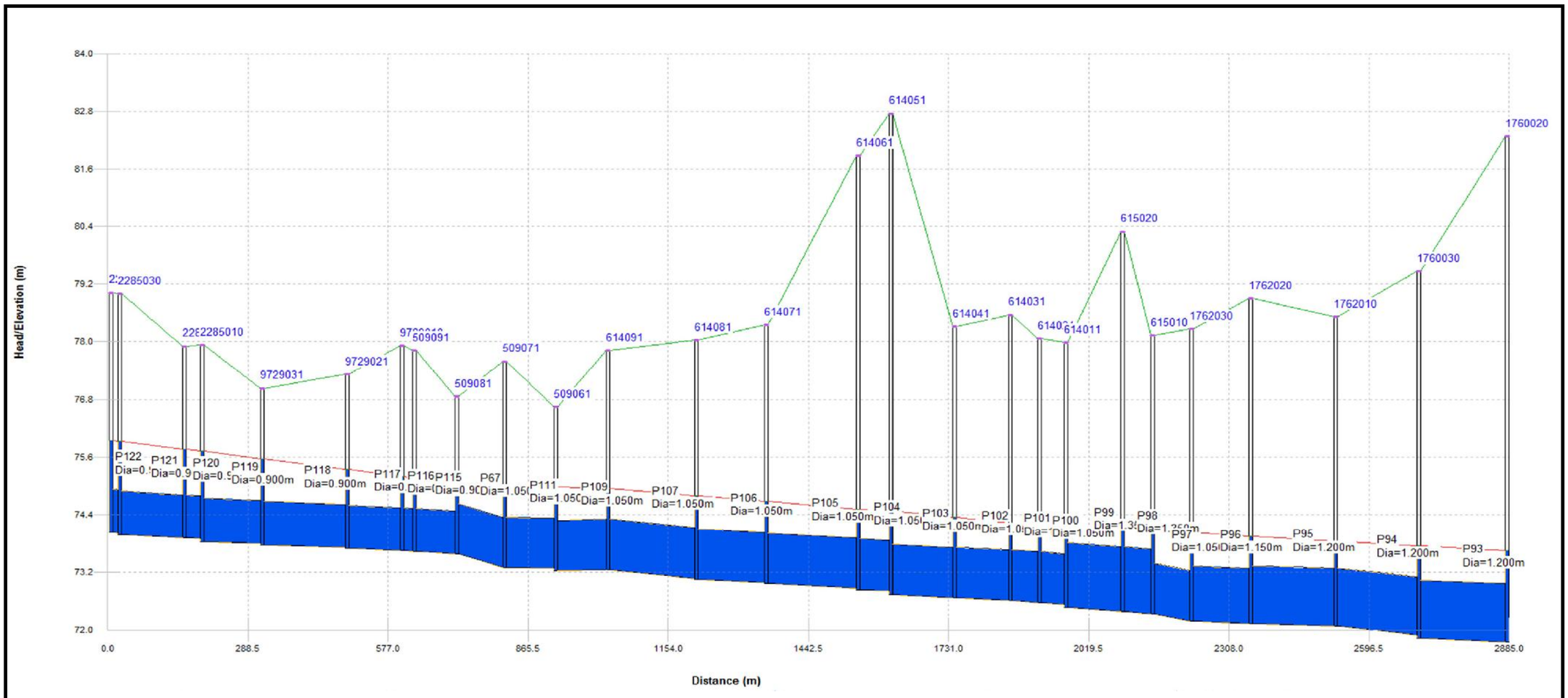
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

North End Trunk Sewer -
With LOS Upgrades Part 1 of 2

Figure C3.2



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

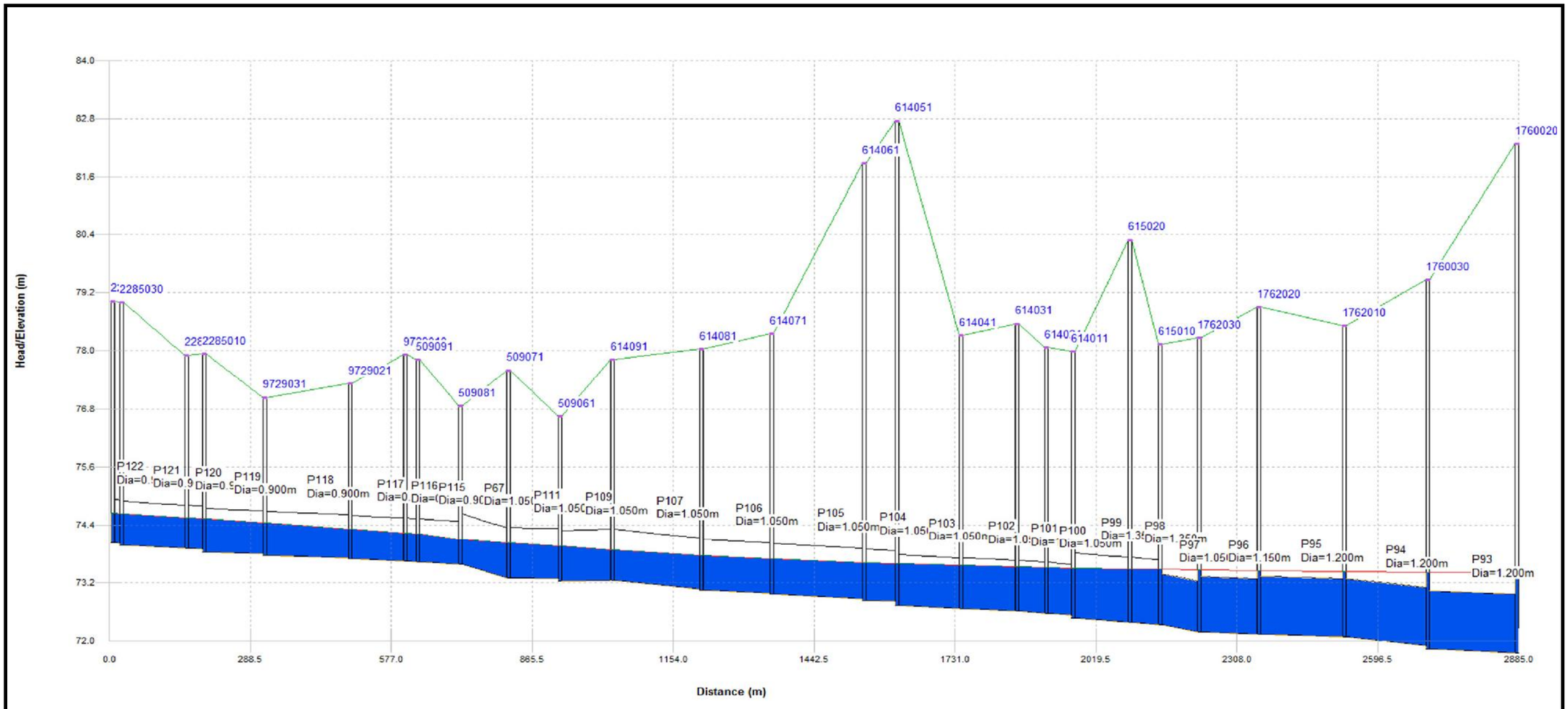
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

North End Trunk Sewer - Part 2 of 2

Figure C3.3



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

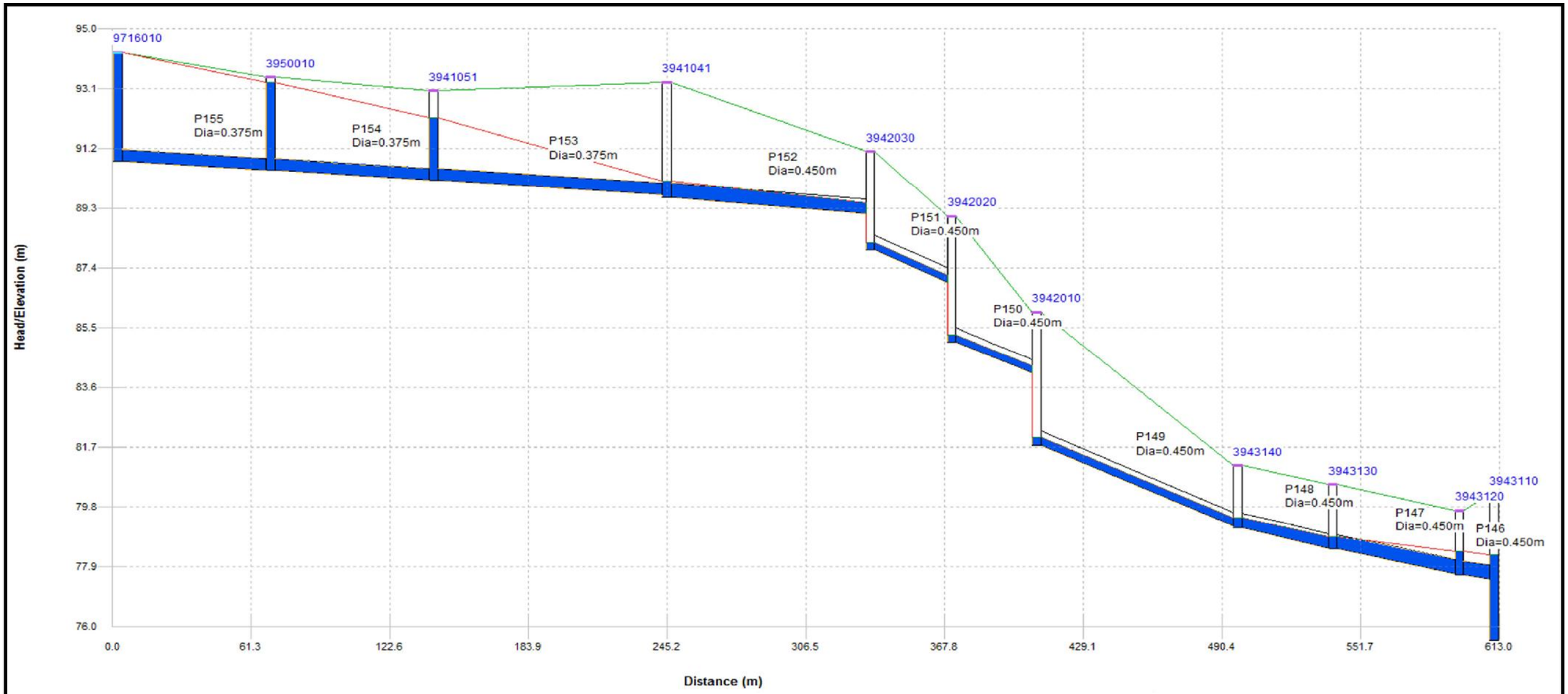
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

North End Trunk Sewer
- With LOS Upgrades Part 2 of 2

Figure C3.4



Legend:

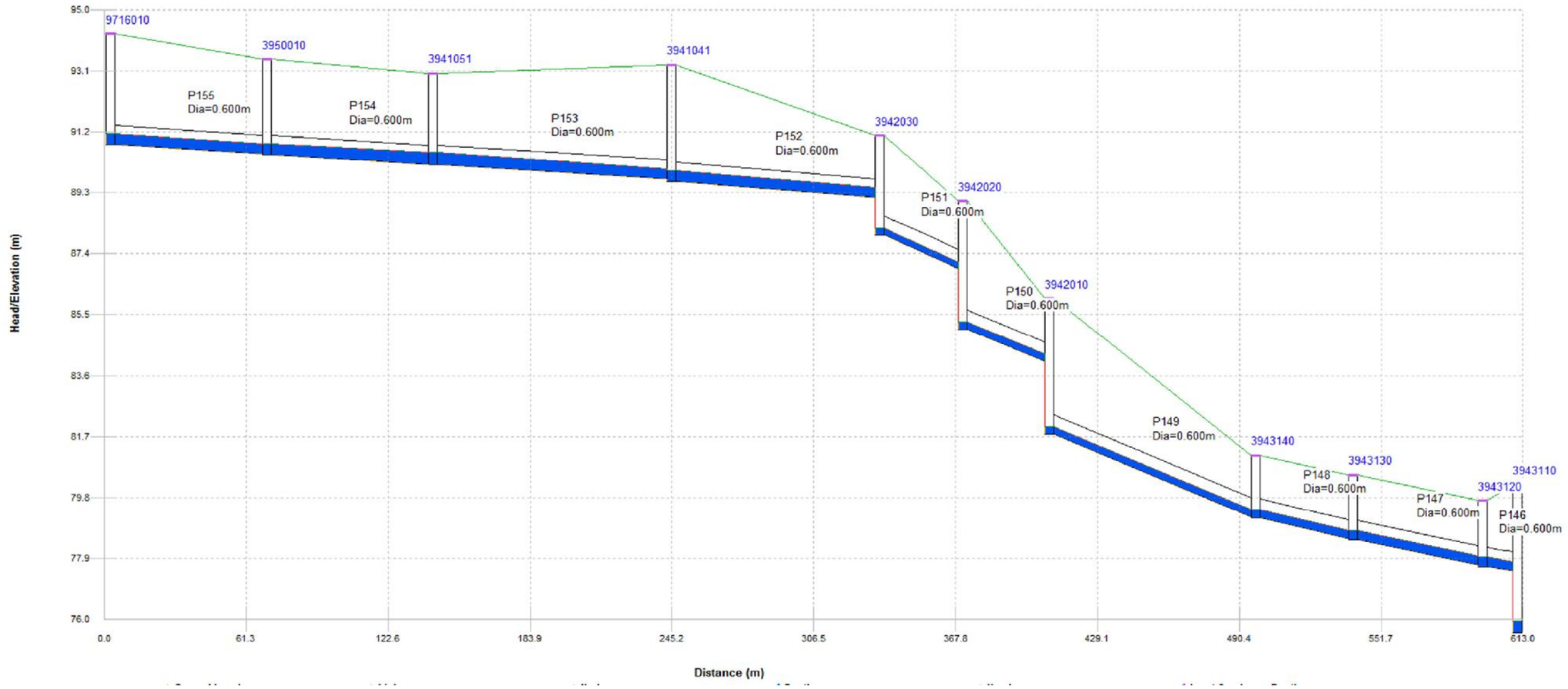
- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Conditions

Notch Hill Collector

Figure C4.1



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

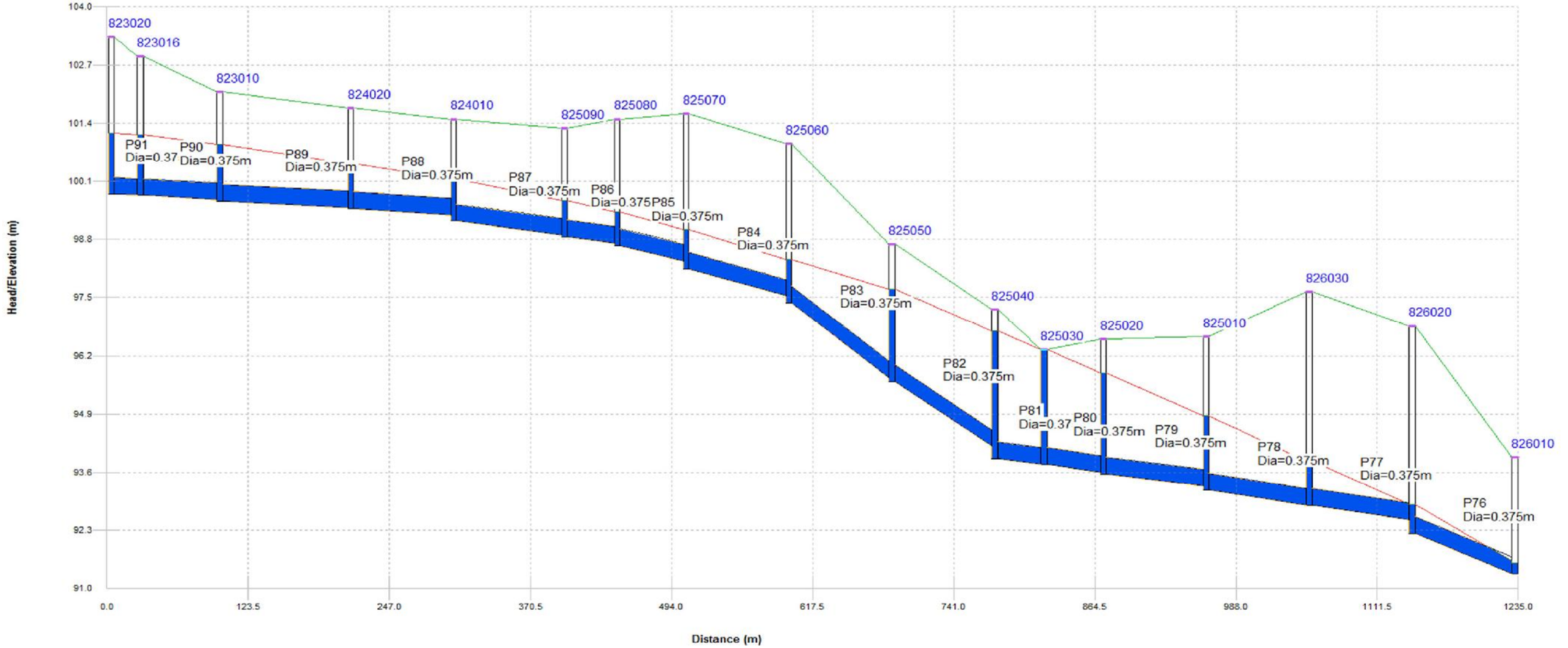
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Conditions

Notch Hill Collector - With LOS Upgrades

Figure C4.2



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

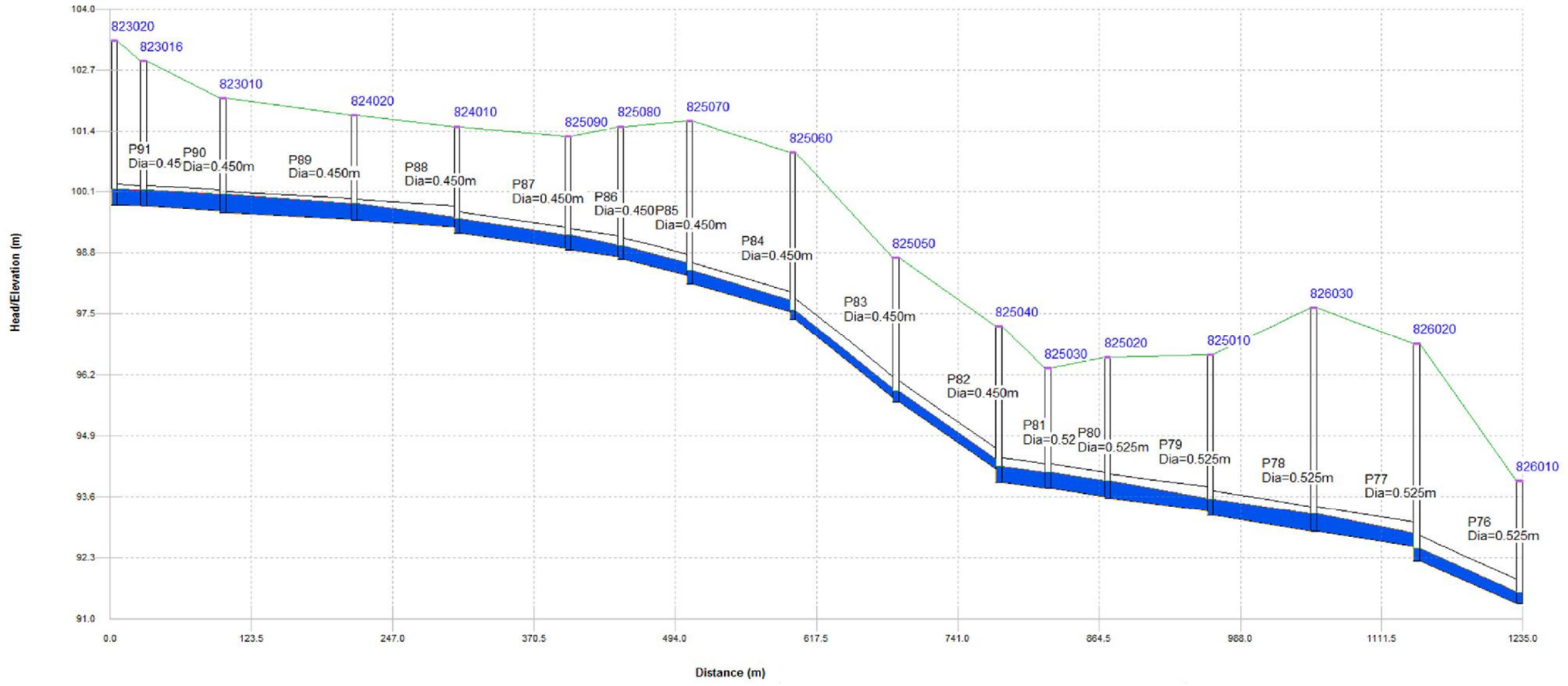
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

Princess Street Collector - Part 1 of 2

Figure C5.1



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

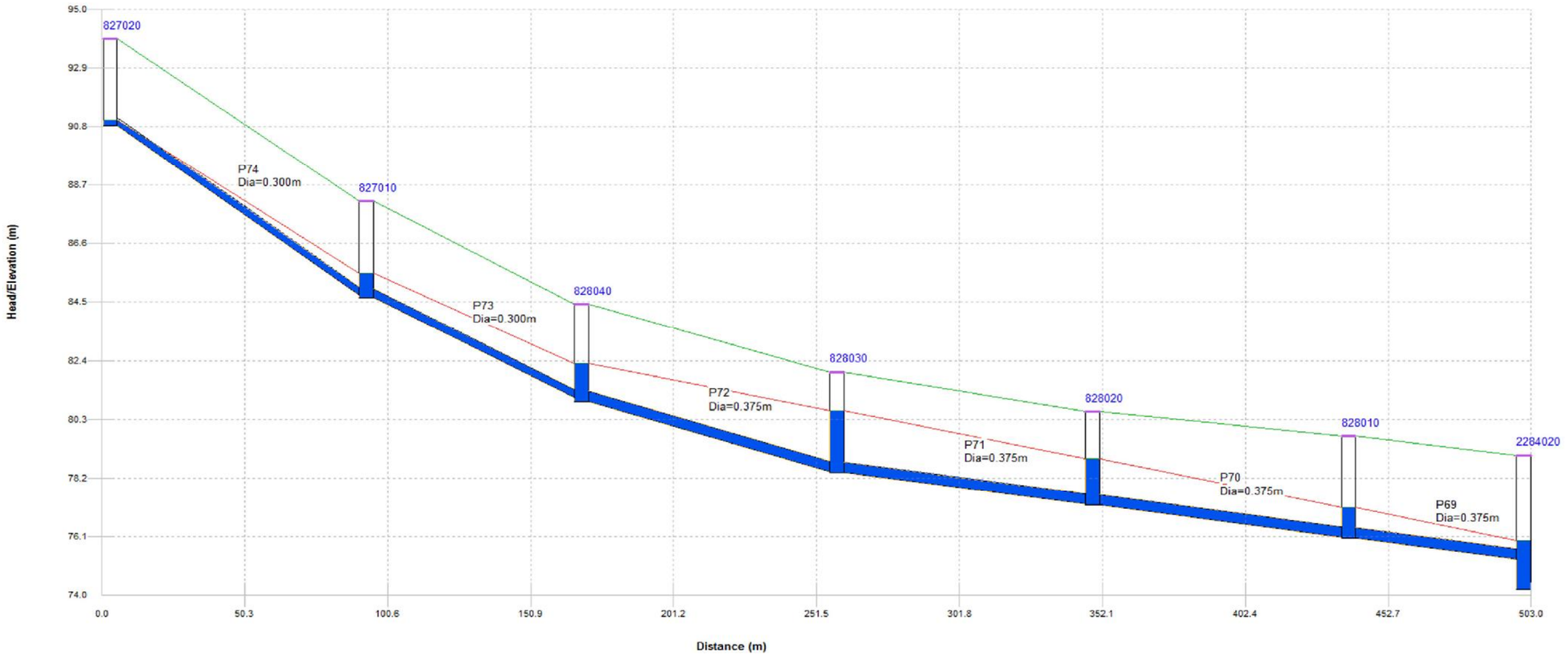
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

Princess Street Collector
- With LOS Upgrades Part 1 of 2

Figure C5.2



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

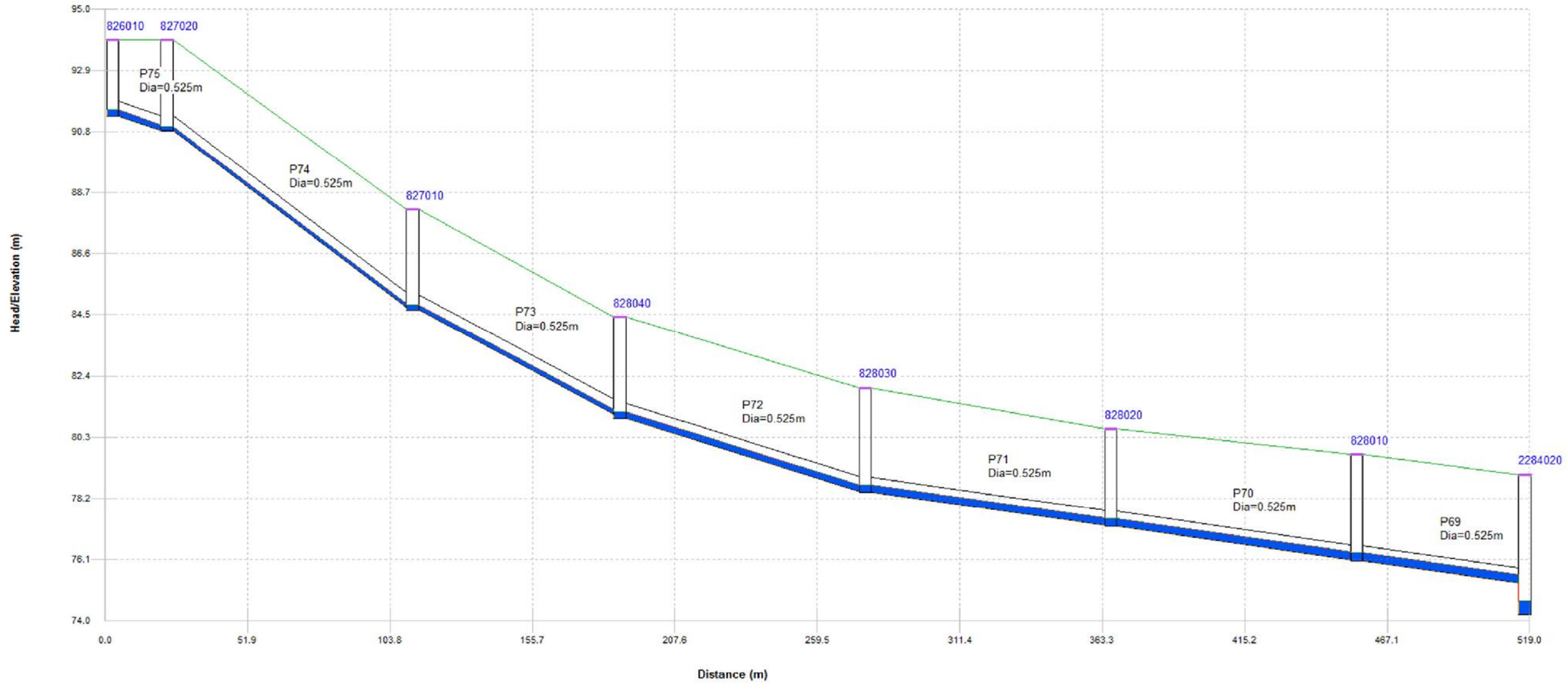
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

Princess Street Collector - Part 2 of 2

Figure C5.3



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

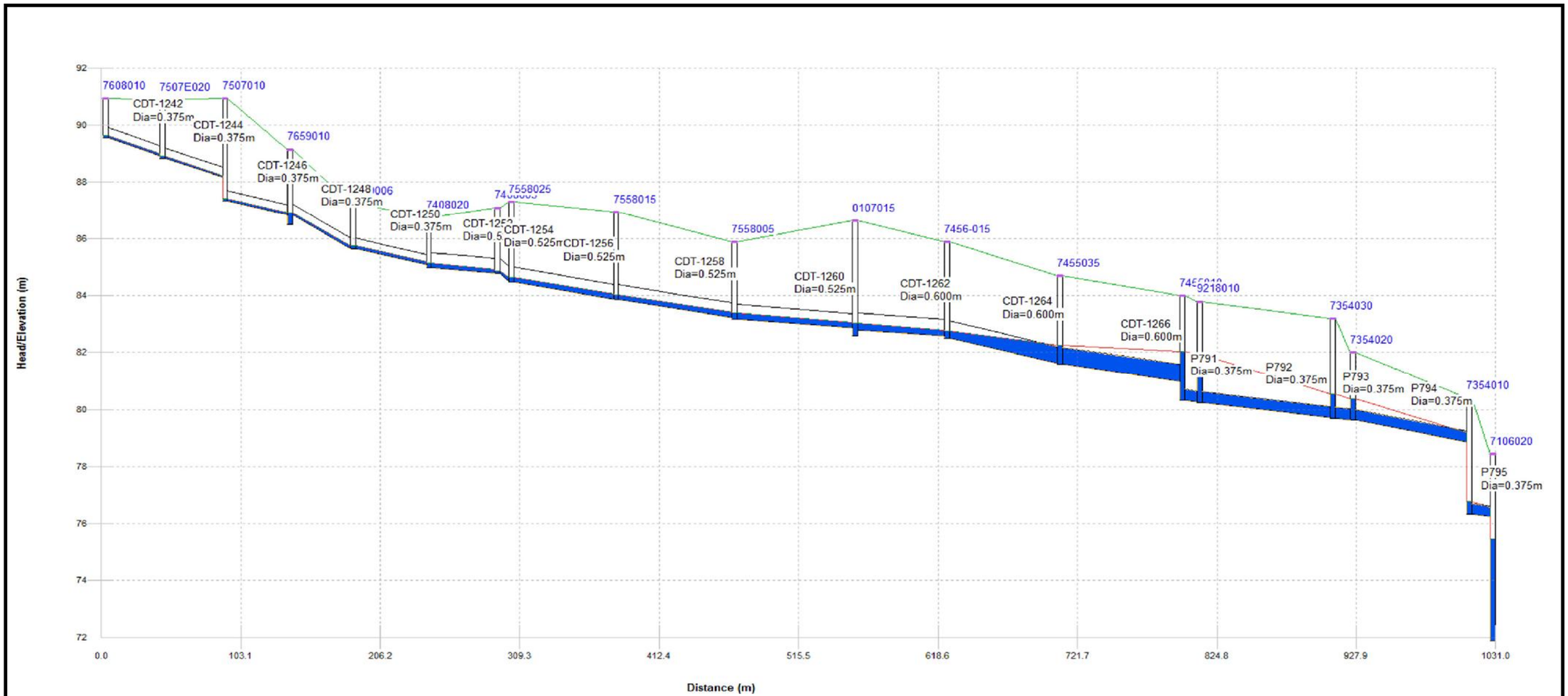
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:100 Year Storm Simulation, 2036 Scenario

Princess Street Collector
- With LOS Upgrades Part 2 fo 2

Figure C5.4



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

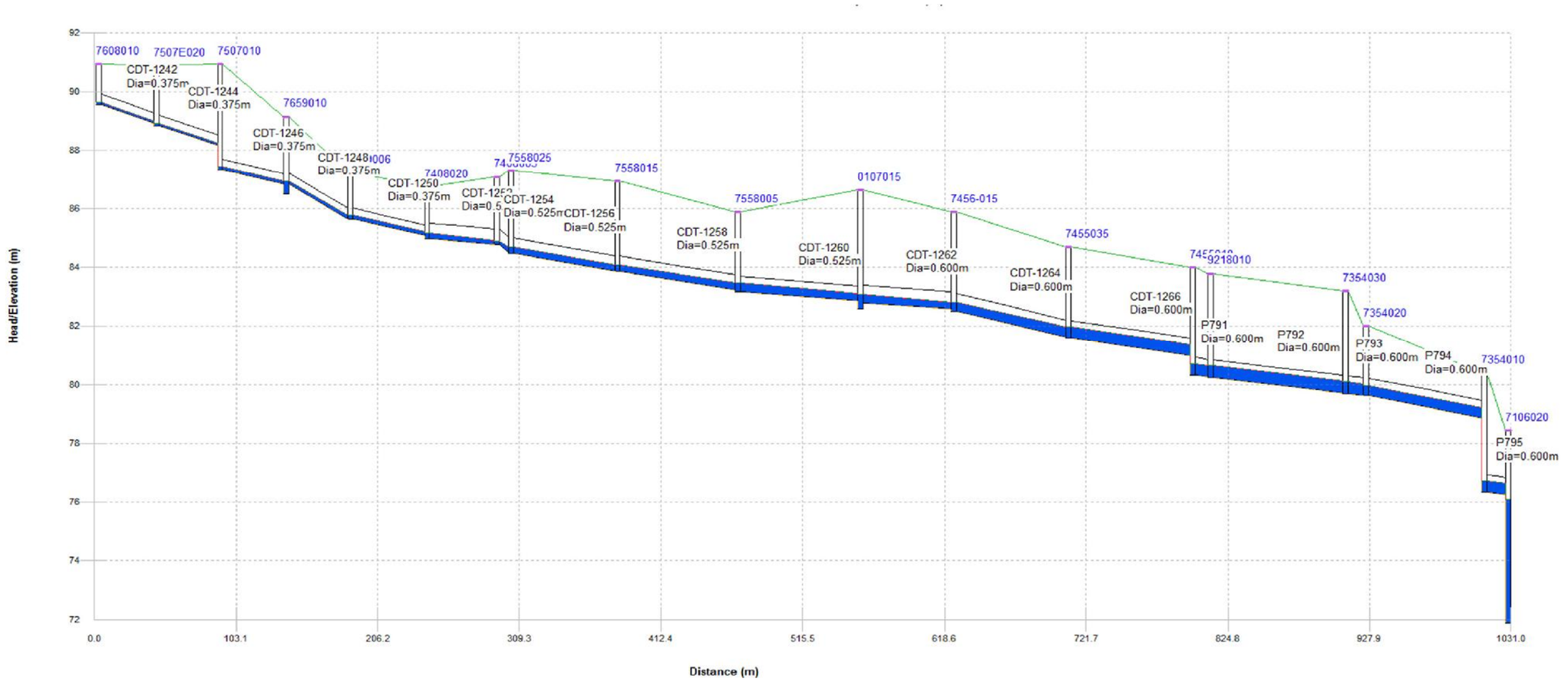
WSP

Date:	October, 2016
Scale:	N.T.S.
Project:	151-02944-00

1:10 Year Storm Simulation, 2036 Scenario

Rideau Street Collector

Figure C6.1



Legend:

- Pipe
- Ground Elevation
- Depth
- Head
- Input Surcharge Depth

WSP

Date:	**October, 2016**
Scale:	**N.T.S.**
Project:	**151-02944-00**

1:10 Year Storm Simulation, 2036 Scenario

Rideau Street Collector - With LOS Upgrades

Figure C6.2

Appendix B

CSO RESULTS

Average Rainfall Year (2014)		2036 - 2015 Sewer Separation							2036 - 2036 Sewer Separation							2036 - Area 1: Sewer Separation						
PCP#	Location	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m^3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m^3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)
COMBINED SEWER OVERFLOW (CSO)																						
14	Ontario and Barrack	6.0	1	750	11,482,615	9,537,777	1,944,838	0.04%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
22	William St Vortex	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
23	Earl d/s of vortex	5.5	2	176	11,482,615	9,537,777	1,944,838	0.01%	4	2	162	12,751,794	11,455,434	1,296,360	0.01%	4.0	2	162	12,443,249	11,455,434	987,815	0.02%
24	Gore St vortex	5.0	2	44	11,482,615	9,537,777	1,944,838	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
25	Lower Union d/s of vortex	5.0	1	127	11,482,615	9,537,777	1,944,838	0.01%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
26	West and Ontario	53.5	7	30,456	11,482,615	9,537,777	1,944,838	1.56%	39	4	982	12,751,794	11,455,434	1,296,360	0.08%	25.5	3	406	12,443,249	11,455,434	987,815	0.04%
51	d/s of Clarence St in-line CSO	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
52	Raglan and Rideau	10.5	4	63	11,482,615	9,537,777	1,944,838	0.00%	1	1	4	12,751,794	11,455,434	1,296,360	0.00%	1.0	1	4	12,443,249	11,455,434	987,815	0.00%
53	Division and Union	17.5	2	387	11,482,615	9,537,777	1,944,838	0.02%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
65	Belle Park Local SA1200	18.0	4	1,785	11,482,615	9,537,777	1,944,838	0.09%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
68	Quebec at Barrie St	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
70	Carlisle & Chest Nut	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
PUMP STATION OVERFLOW (PSO)																						
1	River Street Pump Station	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
5	Dalton Pumping Station	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
28	King St Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
35	Palace Road pump station	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
41	Morton Street Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
57	Crerar Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
58	Lakeshore Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
59	Coverdale Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
61	Bath-Collins Bay**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
62	Rankin Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
63	Bath Rd Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
73	Days Road Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
74	Barrett Court Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
75	Westbrook Pump Station**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
SANITARY SEWER OVERFLOW (SSO)																						
2	Belle Park Chamber, Trunks	1.5	1	1,256	11,482,615	9,537,777	1,944,838	0.06%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
34	Helen and Mack	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
48	NETS at Sherwood**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
50	NETS at Parkway S**	0.0	0	0	11,482,615	9,537,777	1,944,838	0.00%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
TANK OVERFLOW (TO)																						
55	O'Kill CSO Tank	215.0	10	2,248	11,482,615	9,537,777	1,944,838	0.11%	0.0	0	0	12,751,794	11,455,434	1,296,360	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
56	Collingwood CSO Tank	72.5	13	41,125	11,482,615	9,537,777	1,944,838	2.01%	30.5	7	2,417	12,751,794	11,455,434	1,296,360	0.19%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
	TOTAL OVERFLOW VOLUME	**410.0**	**47.0**	**78,418**	**11,482,615**	**9,537,777**	**1,944,838**	**4.03%**	**73.5**	**14.0**	**3,565**	**12,751,794**	**11,455,434**	**1,296,360**	**0.28%**	**30.5**	**6.0**	**571**	**12,443,249**	**11,455,434**	**987,815**	**0.06%**

Average Rainfall Year (2014)		2036 - Area 2: Sewer Separation							2036 - Area 3: Sewer Separation							2036 - Area 4: Sewer Separation						
PCP#	Location	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)
COMBINED SEWER OVERFLOW (CSO)																						
14	Ontario and Barrack	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
22	William St Vortex	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
23	Earl d/s of vortex	4.0	2	162	12,411,908	11,455,434	956,474	0.02%	0.5	1	3	12,443,249	11,455,434	987,815	0.00%	4.0	2	132	12,443,249	11,455,434	987,815	0.01%
24	Gore St vortex	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
25	Lower Union d/s of vortex	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	4.5	2	391	12,443,249	11,455,434	987,815	0.04%
26	West and Ontario	27.0	3	840	12,411,908	11,455,434	956,474	0.09%	25.5	3	551	12,443,249	11,455,434	987,815	0.06%	27.0	3	1,117	12,443,249	11,455,434	987,815	0.11%
51	d/s of Clarence St in-line CSO	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
52	Raglan and Rideau	1.0	1	4	12,411,908	11,455,434	956,474	0.00%	1.0	1	4	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
53	Division and Union	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
65	Belle Park Local SA1200	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
68	Quebec at Barrie St	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
70	Carlisle & Chest Nut	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
PUMP STATION OVERFLOW (PSO)																						
1	River Street Pump Station	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
5	Dalton Pumping Station	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
28	King St Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
35	Palace Road pump station	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
41	Morton Street Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
57	Crerar Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
58	Lakeshore Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
59	Coverdale Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
61	Bath-Collins Bay**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
62	Rankin Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	***	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
63	Bath Rd Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
73	Days Road Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
74	Barrett Court Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
75	Westbrook Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	***	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
SANITARY SEWER OVERFLOW (SSO)																						
2	Belle Park Chamber, Trunks	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
34	Helen and Mack	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
48	NETS at Sherwood**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
50	NETS at Parkway S**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
TANK OVERFLOW (TO)																						
55	O'Kill CSO Tank	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
56	Collingwood CSO Tank	13.0	5	898	12,411,908	11,455,434	956,474	0.09%	13.0	5	898	12,443,249	11,455,434	987,815	0.09%	13.0	5	898	12,443,249	11,455,434	987,815	0.09%
	TOTAL OVERFLOW VOLUME	**45.0**	**11.0**	**1,903**	**12,411,908**	**11,455,434**	**956,474**	**0.20%**	**40.0**	**10.0**	**1,456**	**12,443,249**	**11,455,434**	**987,815**	**0.15%**	**48.5**	**12.0**	**2,539**	**12,443,249**	**11,455,434**	**987,815**	**0.26%**

Average Rainfall Year (2014)		2036 - Full Sewer Separation						
PCP#	Location	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m^3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)
COMBINED SEWER OVERFLOW (CSO)								
14	Ontario and Barrack	0.0	0	0	11,455,434	11,455,434	1,350,131	0.00%
22	William St Vortex	0.0	0	0	11,455,434	11,455,434	1,350,131	0.00%
23	Earl d/s of vortex	0.0	0	0	11,455,434	11,455,434	1,350,131	0.00%
24	Gore St vortex	0.0	0	0	11,455,434	11,455,434	1,350,131	0.00%
25	Lower Union d/s of vortex	0.0	0	0	11,455,434	11,455,434	1,350,131	0.00%
26	West and Ontario	2.0	1	334	11,455,434	11,455,434	1,350,131	0.02%
51	d/s of Clarence St in-line CSO	0.0	0	0	11,455,434	11,455,434	1,350,131	0.00%
52	Raglan and Rideau	0.0	0	0	11,455,434	11,455,434	1,350,131	0.00%
53	Division and Union	0.0	0	0	11,455,434	11,455,434	1,350,131	0.00%
65	Belle Park Local SA1200	0.0	0	0	11,455,434	11,455,434	1,350,131	0.00%
68	Quebec at Barrie St	0.0	0	0	11,455,434	11,455,434	1,350,131	0.00%
70	Carlisle & Chest Nut	0.0	0	0	11,455,434	11,455,434	1,350,131	0.00%
PUMP STATION OVERFLOW (PSO)								
1	River Street Pump Station	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
5	Dalton Pumping Station	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
28	King St Pump Station**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
35	Palace Road pump station	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
41	Morton Street Pump Station**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
57	Crerar Pump Station**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
58	Lakeshore Pump Station**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
59	Coverdale Pump Station**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
61	Bath-Collins Bay**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
62	Rankin Pump Station**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
63	Bath Rd Pump Station**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
73	Days Road Pump Station**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
74	Barrett Court Pump Station**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
75	Westbrook Pump Station**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
SANITARY SEWER OVERFLOW (SSO)								
2	Belle Park Chamber, Trunks	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
34	Helen and Mack	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
48	NETS at Sherwood**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
50	NETS at Parkway S**	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
TANK OVERFLOW (TO)								
55	O'Kill CSO Tank	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
56	Collingwood CSO Tank	0.0	0	0	13,751,858	11,455,434	1,350,131	0.00%
	TOTAL OVERFLOW VOLUME	**25.0**	**2.0**	**266**	**13,751,858**	**12,401,727**	**1,350,131**	**0.02%**

2008 Rainfall Year		2036 - 2015 Sewer Separation							2036 - 2036 Sewer Separation							2036 - Area 1: Sewer Separation						
PCP#	Location	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)
COMBINED SEWER OVERFLOW (CSO)																						
14	Ontario and Barrack	17.0	3	4,456	13,104,452	11,455,434	1,649,018	0.27%	2.5	1	360	12,402,740	11,455,434	947,306	0.04%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
22	William St Vortex	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
23	Earl d/s of vortex	15.0	4	1,890	13,104,452	11,455,434	1,649,018	0.11%	12.5	4	1,322	12,402,740	11,455,434	947,306	0.14%	12.0	4	1,291	12,443,249	11,455,434	987,815	0.13%
24	Gore St vortex	17.0	5	1,602	13,104,452	11,455,434	1,649,018	0.10%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
25	Lower Union d/s of vortex	13.5	4	2,769	13,104,452	11,455,434	1,649,018	0.17%	7.0	2	616	12,402,740	11,455,434	947,306	0.07%	4.5	2	338	12,443,249	11,455,434	987,815	0.03%
26	West and Ontario	56.0	11	62,367	13,104,452	11,455,434	1,649,018	3.78%	10.0	2	8,310	12,402,740	11,455,434	947,306	0.88%	8.0	2	3,545	12,443,249	11,455,434	987,815	0.36%
51	d/s of Clarence St in-line CSO	7.0	3	789	13,104,452	11,455,434	1,649,018	0.05%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
52	Raglan and Rideau	19.0	5	1,309	13,104,452	11,455,434	1,649,018	0.08%	6.0	2	1,019	12,402,740	11,455,434	947,306	0.11%	6.0	2	1,019	12,443,249	11,455,434	987,815	0.10%
53	Division and Union	33.0	5	2,209	13,104,452	11,455,434	1,649,018	0.13%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
65	Belle Park Local SA1200	29.5	8	10,987	13,104,452	11,455,434	1,649,018	0.67%	1.5	1	140	12,402,740	11,455,434	947,306	0.01%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
68	Quebec at Barrie St	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
70	Carlisle & Chest Nut	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
PUMP STATION OVERFLOW (PSO)																						
1	River Street Pump Station	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
5	Dalton Pumping Station	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
28	King St Pump Station**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
35	Palace Road pump station	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
41	Morton Street Pump Station**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
57	Crerar Pump Station**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
58	Lakeshore Pump Station**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
59	Coverdale Pump Station**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
61	Bath-Collins Bay**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
62	Rankin Pump Station**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
63	Bath Rd Pump Station**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
73	Days Road Pump Station**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
74	Barrett Court Pump Station**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
75	Westbrook Pump Station**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
SANITARY SEWER OVERFLOW (SSO)																						
2	Belle Park Chamber, Trunks	4.5	2	2,421	13,104,452	11,455,434	1,649,018	0.15%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
34	Helen and Mack	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
48	NETS at Sherwood**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
50	NETS at Parkway S**	0.0	0	0	13,104,452	11,455,434	1,649,018	0.00%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
TANK OVERFLOW (TO)																						
55	O'Kill CSO Tank	893.0	18	5,998	13,104,452	11,455,434	1,649,018	0.36%	0.0	0	0	12,402,740	11,455,434	947,306	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
56	Collingwood CSO Tank	118.0	13	71,578	13,104,452	11,455,434	1,649,018	4.34%	53.0	12	8,682	12,402,740	11,455,434	947,306	0.92%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
TOTAL OVERFLOW VOLUME		**1,222.5**	**81.0**	**168,375**	**13,104,452**	**11,455,434**	**1,649,018**	**10.21%**	**92.5**	**24.0**	**20,449**	**12,402,740**	**11,455,434**	**947,306**	**2.16%**	**30.5**	**10.0**	**6,193**	**12,443,249**	**11,455,434**	**987,815**	**0.63%**

2008 Rainfall Year		2036 - Area 2: Sewer Separation							2036 - Area 3: Sewer Separation							2036 - Area 4: Sewer Separation						
PCP#	Location	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m^3)	Total Dry Weather Volume at Ravensview (m3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)
COMBINED SEWER OVERFLOW (CSO)																						
14	Ontario and Barrack	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
22	William St Vortex	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
23	Earl d/s of vortex	12.0	4	1,291	12,411,908	11,455,434	956,474	0.14%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	12.0	4	1,291	12,443,249	11,455,434	987,815	0.13%
24	Gore St vortex	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
25	Lower Union d/s of vortex	5.0	2	395	12,411,908	11,455,434	956,474	0.04%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	4.5	2	391	12,443,249	11,455,434	987,815	0.04%
26	West and Ontario	10.5	2	6,783	12,411,908	11,455,434	956,474	0.71%	8.5	2	4,894	12,443,249	11,455,434	987,815	0.50%	11.5	3	7,061	12,443,249	11,455,434	987,815	0.71%
51	d/s of Clarence St in-line CSO	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
52	Raglan and Rideau	6.0	2	1,019	12,411,908	11,455,434	956,474	0.11%	6.0	2	1,019	12,443,249	11,455,434	987,815	0.10%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
53	Division and Union	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
65	Belle Park Local SA1200	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
68	Quebec at Barrie St	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
70	Carlisle & Chest Nut	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
PUMP STATION OVERFLOW (PSO)																						
1	River Street Pump Station	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
5	Dalton Pumping Station	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
28	King St Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
35	Palace Road pump station	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
41	Morton Street Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
57	Crerar Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
58	Lakeshore Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
59	Coverdale Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
61	Bath-Collins Bay**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
62	Rankin Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	***	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
63	Bath Rd Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
73	Days Road Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
74	Barrett Court Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
75	Westbrook Pump Station**	0.0	0	0	12,411,908	11,455,434	956,474	***	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
SANITARY SEWER OVERFLOW (SSO)																						
2	Belle Park Chamber, Trunks	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
34	Helen and Mack	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
48	NETS at Sherwood**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
50	NETS at Parkway S**	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
TANK OVERFLOW (TO)																						
55	O'Kill CSO Tank	0.0	0	0	12,411,908	11,455,434	956,474	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
56	Collingwood CSO Tank	53.0	12	8,682	12,411,908	11,455,434	956,474	0.91%	53.0	12	8,682	12,443,249	11,455,434	987,815	0.88%	53.0	12	8,682	12,443,249	11,455,434	987,815	0.88%
TOTAL OVERFLOW VOLUME		**86.5**	**22.0**	**18,170**	**12,411,908**	**11,455,434**	**956,474**	**1.90%**	**67.5**	**16.0**	**14,595**	**12,443,249**	**11,455,434**	**987,815**	**1.48%**	**81.0**	**21.0**	**17,426**	**12,443,249**	**11,455,434**	**987,815**	**1.76%**

2008 Rainfall Year		2036 - Buildout Sewer Separation						
PCP#	Location	Cumulative Duration Bypass (Hrs)	Number of Bypass Events	Total Bypass (m^3)	Total Volume (m3)	Total Dry Weather Volume at Ravensview (m^3)	Total Wet Weather Volume at Ravensview (m^3)	Ratio (Bypass / Wet Weather) (m^3)
COMBINED SEWER OVERFLOW (CSO)								
14	Ontario and Barrack	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
22	William St Vortex	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
23	Earl d/s of vortex	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
24	Gore St vortex	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
25	Lower Union d/s of vortex	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
26	West and Ontario	5.0	1	1,050	12,443,249	11,455,434	987,815	0.11%
51	d/s of Clarence St in-line CSO	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
52	Raglan and Rideau	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
53	Division and Union	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
65	Belle Park Local SA1200	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
68	Quebec at Barrie St	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
70	Carlisle & Chest Nut	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
PUMP STATION OVERFLOW (PSO)								
1	River Street Pump Station	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
5	Dalton Pumping Station	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
28	King St Pump Station**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
35	Palace Road pump station	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
41	Morton Street Pump Station**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
43	King-Portsmouth Pump Station	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
57	Crerar Pump Station**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
58	Lakeshore Pump Station**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
59	Coverdale Pump Station**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
61	Bath-Collins Bay**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
62	Rankin Pump Station**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
63	Bath Rd Pump Station**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
69	Greenview Drive Pump Station**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
73	Days Road Pump Station**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
74	Barrett Court Pump Station**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
75	Westbrook Pump Station**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
SANITARY SEWER OVERFLOW (SSO)								
2	Belle Park Chamber, Trunks	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
34	Helen and Mack	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
48	NETS at Sherwood**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
50	NETS at Parkway S**	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
TANK OVERFLOW (TO)								
55	O'Kill CSO Tank	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
56	Collingwood CSO Tank	0.0	0	0	12,443,249	11,455,434	987,815	0.00%
TOTAL OVERFLOW VOLUME		**5.0**	**1.0**	**1,050**	**12,443,249**	**11,455,434**	**987,815**	**0.11%**