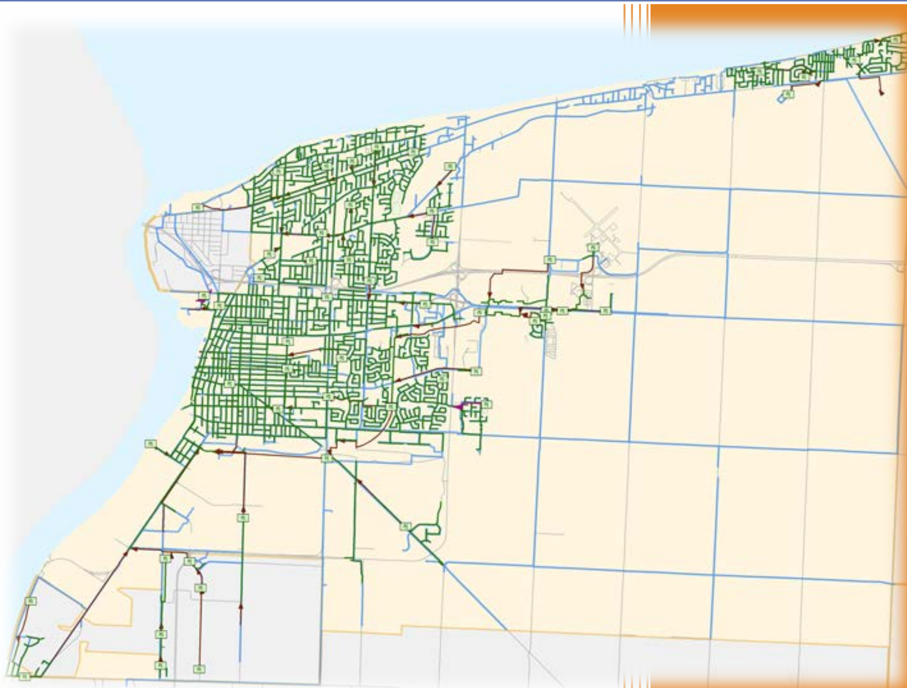
THE CORPORATION
OF THE
CITY OF SARNIA

2013

Asset Management Plan



CORE INFRASTRUCTURE SERVICES

Prepared by the

Engineering and Finance

Departments

The Corporation

of

The City of Sarnia

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1. Executive Summary

This Asset Management Plan document has been prepared for the core services of the City of Sarnia, including water, wastewater, roads and bridges. The Plan is intended to provide a comprehensive reference for renewing, operating, maintaining, building, replacing and disposing of the City's core Infrastructure Assets. The plan is based on the guidelines provided in the Province of Ontario Ministry of Infrastructure's Building Together Guide for Municipal Asset Management Plans.

The Asset Management Planning process is driving a change in philosophy regarding capital improvement. The old approach of "worst first" is being replaced with a more proactive approach focused on rehabilitation based on the window of opportunity; as the saying goes "A reconstruction today is a reconstruction tomorrow, rehabilitation today is a reconstruction tomorrow".

This Plan reflects on the current and desired system condition, level of service, optimal asset management and financial strategies based on currently available data and information on the core infrastructure services of the City.

The City's data collection programs and data updating processes are ongoing and the plan will be updated over time as more data in terms of condition, capacity, expansion and risks are available through ongoing data collection, modelling and master planning programs.

The total replacement cost, current needs, and rehabilitation needs based on windows of opportunity for the core infrastructure assets of the City are summarized as follows.

Table 1 Total Replacement Cost of Core Infrastructure Assets

Asset Type	Total Length /Quantitiy	Replacement Cost
Roads	439 KM	$598,994,645
Watermains	496 KM	$358,541,104
Sanitary Sewer	336 KM	$304,005,369
Storm Sewer	293 KM	$345,547,560
Forcemains	51 KM	$34,640,902
Pump Stations	57	$52,663,000
Wastewater Treatment Facilities	2	$99,288,000
Bridges	27	$67,053,899
Total		**$1,860,734,480**

Figure 1 Percentage of Replacement Cost of the Core Infrastructure

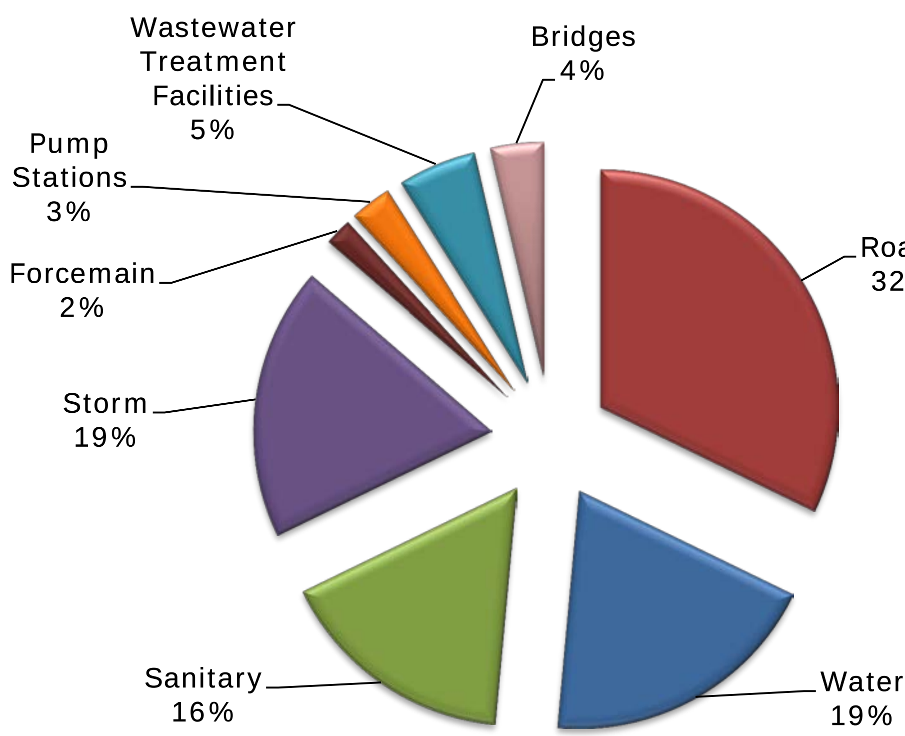


Table 2 Current Need of all Core Infrastructure Assets

Asset Type	% Current Need	Estimated Cost	Length
Roads	13.2%	$51,289,568	57.9 KM
Water Distribution System	14.2%	$43,340,309	70.4 KM
Sanitary and Combined Sewers	11.4%	$32,919,227	38.2 KM
Storm Sewers	8.0%	$21,489,004	25.2 KM
Forcemains	16.0%	$11,546,751	7.8 KM
Pump Stations	36.9%	$25,453,249	
Wastewater Treatment Facilities	8.4%	$8,300,000	
Bridges	3.7%	$2,469,785	
Total Needs		**$196,807,894**	

Table 3 Rehabilitation Need Based on Window of Opportunity

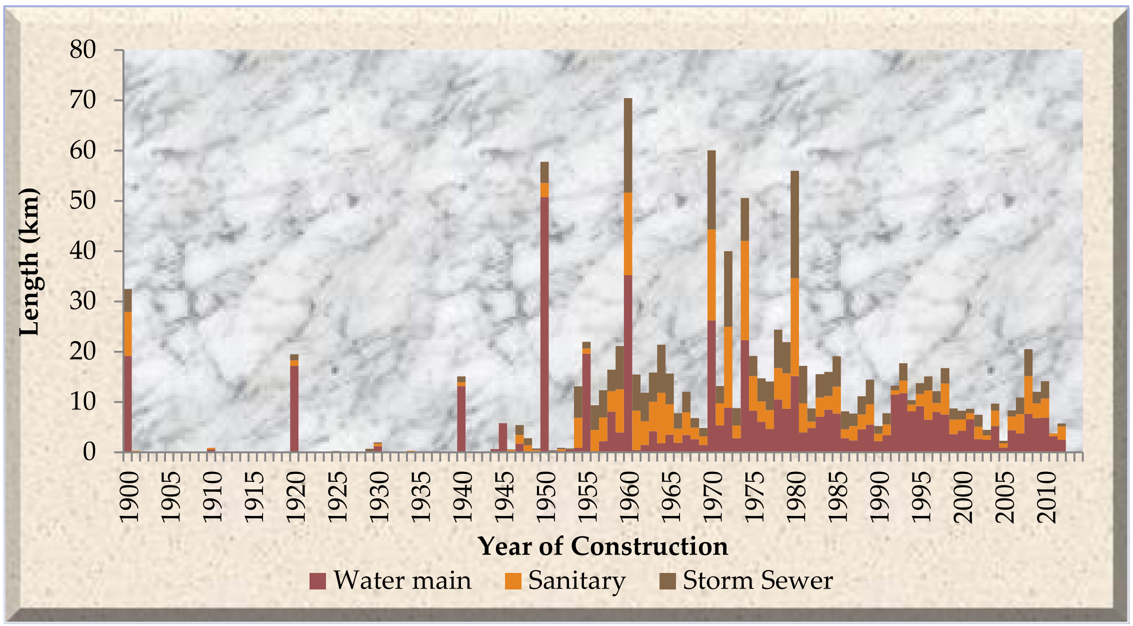
Asset Type	Length	% Rehabilitation Need	Estimated Cost
Roads	35.7 KM	8.1%	$10,082,167
Water Distribution System	80.2 KM	16.2%	$19,928,453
Sanitary and Combined Sewers	13.6 KM	4.1%	$4,351,997
Storm Sewers	6.3 KM	2.1%	$4,030,509
Total			**$38,393,125**

2. Introduction

2.1 The City and Infrastructure Assets

The City of Sarnia is situated on the south shore of Lake Huron at the headwaters of the St. Clair River. The current population of the City is approximately 72,000 people. The City has been confronted with increasing needs due to aging infrastructure and limited financial resources. Most of the City's infrastructures were installed and paid for during previous economic boom periods, in the 1950's; 1960's and 1970's. An "echo" effect is now occurring as infrastructure is reaching the end of its service life (American Water Works Associations, 2001).

Figure 2 Linear Assets Age Distribution



The City completed an initial inventory assessment and identification of Capital Needs for the Linear Assets through Dillon Consulting Limited in 2005. As a result of the recommendations from the above study, the City implemented its current GIS system and initiated data collection programs.

A complete Road Condition Assessment was completed by the City through IMS Infrastructure Management Services in 2012. The City has also completed Master Plan study including system modelling for the sanitary sewer collection system through Stantec Consulting Limited.

2.2 Core Infrastructure Services

The municipal core services as defined by the Province of Ontario include water, sewer, drainage, and road networks. As per recommendations of the Building Together Guide for Municipal Asset Management Plans, maintaining roads, bridges, water, wastewater and social housing assets should be a top priority.

The City of Sarnia is a lower-tier municipality within the County of Lambton. The social housing services are managed by the County of Lambton, and Water treatment and supply services are managed by the Lambton Area Water Supply System (LAWSS).

As a starting point, the following core infrastructures have been included in this asset management plan:

i. Water Distribution System
ii. Wastewater Collection System and Wastewater Treatment Systems
iii. Storm Sewer System
iv. Pumping Stations and Forcemains
v. Roads and Bridges

2.3 Objectives of the Asset Management Plan

The City formed an Asset Management Committee in September 2012; initially consisting of City staff from the Engineering and Finance Departments, to put together this Asset Management Plan based on the Building Together Guide for Municipal Asset Management Plans. Engineering and Finance Departmental Heads chaired the committee with sub working groups.

The overall objectives of the plan are as follows:

i. To provide a comprehensive reference for council, managers and City staff for renewing, operating, maintaining, building, replacing and disposing of the City's assets; and
ii. To reflect the current and desired system conditions, levels of service and safety; and
iii. To recommend optimal asset management and financial strategies; and
iv. To set strategic priorities to optimize decisions; and

v. Maximize benefits, manage risks and provide satisfactory levels of service.

2.4 Guiding Principles

Guiding Principles, for developing this plan, were established consistent with the goals set out in the City's official Plan and the City's Integrated Community Sustainability Plan.

As per City's Draft official Plan: "Infrastructure tends to be capital intensive and carries high fixed costs that do not go down with reductions in population density. The Official Plan of the City promotes the optimal use and functioning of existing infrastructure in ways that reduce current costs and minimize future obligations, while preserving opportunities for future development."

The City of Sarnia has also completed the Integrated Community Sustainability Plan (ICSP). Sarnia City Council adopted the Sarnia ICSP in March 2013. This plan is aimed at helping the City build a socially, economically, culturally and environmentally sustainable community. As per the Sarnia ICSP, "The Sarnia Integrated Community Sustainability Plan is a reference and resource document that will be used by those planning and developing sustainable community projects to ensure that the targets, goals and outcomes for a sustainable community can be achieved."

The Guiding Principles established for the Asset Management Plan are summarized as follows:

i. Maintaining Integrity of the City's Infrastructure and recognizing infrastructure life cycle costs; and
ii. Mitigate combined sewer overflows and reduce basement flooding; and
iii. Maintaining adequate fire flows and pressures in the City's water distribution system, supplying safe drinking water and protecting the receiving water quality; and
iv. Maintaining or exceeding the current service levels to citizens; and
v. Encouraging and implementing measures and activities that reduce resource consumption, waste and pollution; and
vi. Ensuring whenever feasible, that those who benefit from municipal infrastructure pay for the services provided.

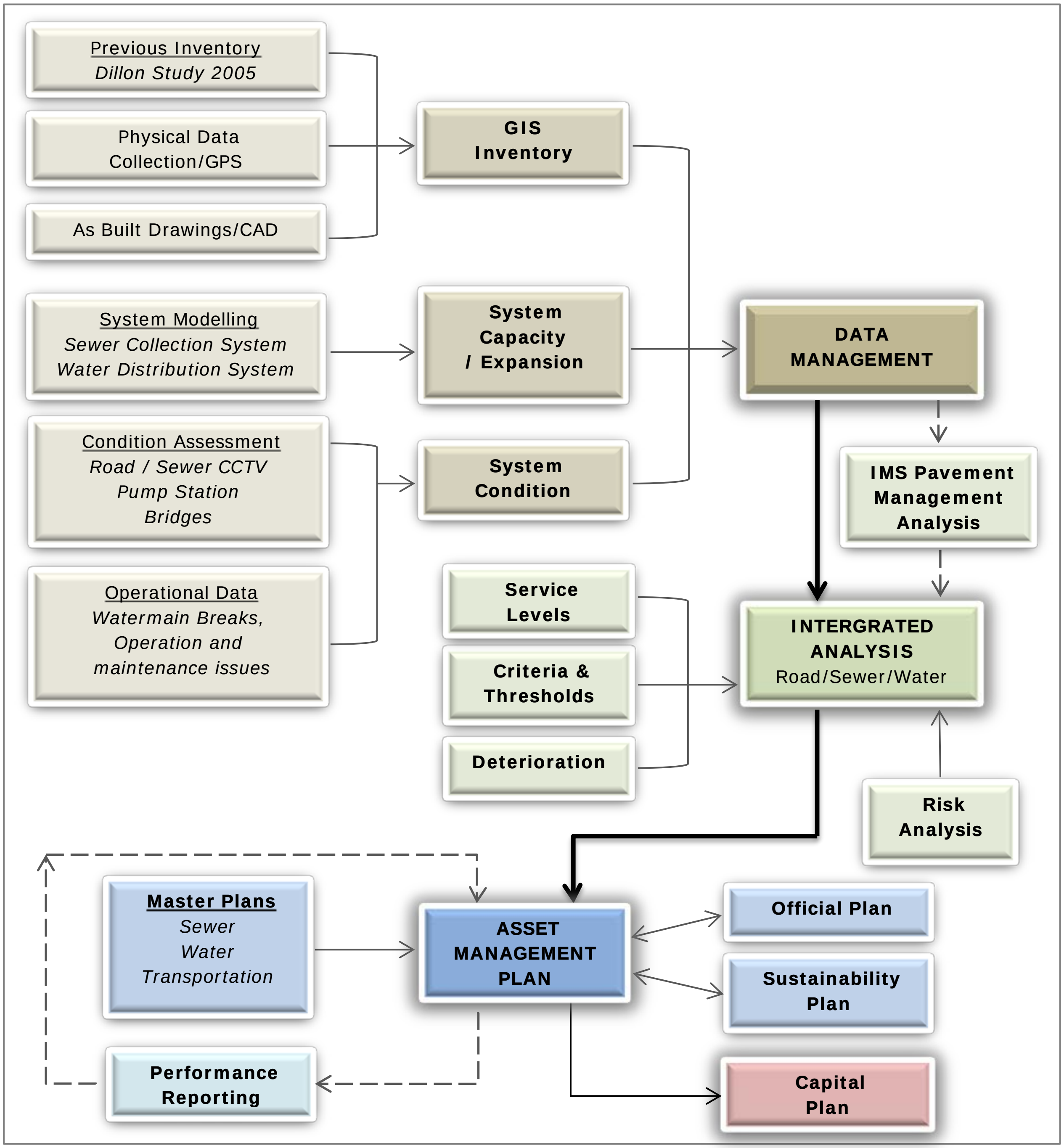
2.5 GIS and Data Management

The City has a comprehensive inventory of characteristics, attributes and conditions of the core infrastructure assets in our Geographic Information System (GIS). The City maintains ongoing data collection programs.

In July 2004, the City retained Dillon Consulting Limited to undertake the implementation of an Asset Management System including creating inventory of the linear assets and identification of capital needs. Due to limitations of budget and the availability of data, a sampling approach was adopted to carryout assessments. The timeline and progress of the City's asset management system is given as follows:

i. The City completed an initial inventory assessment and identification of Capital Needs for the Linear Assets through Dillon Consulting Limited in 2005.
ii. The City acquired Autodesk Map Guide "Mi-Town GIS Application" in 2006 and upgraded to ESRI Enterprise" Geo cortex" GIS system in 2010. The City also initiated data collection programs, along with hydrant flushing, water valve turning and sewer flushing programs.
iii. A complete Road Condition Assessment was done by IMS Infrastructure Management Services in 2012.
iv. The Sewer Condition Assessment is a challenging task for the City due to the uncertainty and the extent of sewer cleaning required. The sewer inspection program is currently ongoing in a phased approach.
v. The City has completed a Sewer Collection System Modelling and Sewer Master Plan study through Stantec Consulting Ltd. in 2012.
vi. The City is also undertaking a Water System Modelling and Water Distribution System Master Plan study through Stantec Consulting Ltd.
vii. The Pumping Station Condition Assessment for the City was completed by R. V. Anderson Associates in 2009.
viii. The City also has a regular bridge inspection program every 2 years as per Provincial regulation.
ix. The infrastructure data in the GIS System is being updated on a regular basis.

Figure 3 The City of Sarnia Asset Management Process



The majority of the information required for this Asset Management Plan, was available in the form of drawings, reports, GIS inventory, GIS maps, capacity assessments, condition assessments, infrastructure master plans, etc. All this information was integrated in the GIS system, and was analysed and assessed using the Integrated Analysis Engine (IAE).

2.6 General

The City's current practice for prioritization of the capital projects are mainly based on combined sewer separation (combined sewers, sewer overflows, water quality and basement flooding), sewer and watermain breaks, known system capacity issues, operation and maintenance issues, known sewer back-ups, flooding complaints and design and construction constraints. These issues are discussed in various capital project meetings and projects are prioritized accordingly. All of the above factors have been incorporated, and analysed in developing this plan.

The Asset Management Plan Committee began by establishing various criteria for Linear Infrastructures Assets, namely road, water and sewers for the Asset Management Plan and added Pump Stations, Forcemains, Waste Water Treatment Facilities and Bridges thereafter. The integrated spreadsheet program was also developed to analyse various factors across the asset types and generate the priority lists of the projects, replacement costs, and capital improvement plans based on the established service levels.

The City has been actively exploring the opportunities of consolidating and sharing services with other municipalities to improve the service level and reduce cost to users. Recently the City of Sarnia entered into two separate agreements with the Township of St. Clair for interconnections of our water distribution systems, at two different locations along the southern boundary, thereby improving pressures, redundancy and water securities in the distribution systems.

In this Asset Management Plan the condition assessments of the sewer system are primarily based on accepted age and material based deterioration curves, as the condition assessments of the sewers are ongoing in phases. Once the actual condition assessments of all infrastructures assets are completed, the plan will be updated to fully reflect actual conditions rather than using projections based on deterioration curves.

This Plan addresses the short term and long term strategies for infrastructure rehabilitation, reconstruction, and renewal for the City's roads, bridges, water, and wastewater infrastructure. This plan is a living document and will be updated on a regular basis.

3. State of Local infrastructure

3.1 Existing Infrastructure network

The City of Sarnia currently manages approximately 439 kilometers of roads, 336 kilometers of sanitary and combined sewers, 293 kilometers of storm sewers, 53 sanitary pump stations, 4 stormwater pump station, 53 kilometers of sanitary and storm forcemains, 496 kilometers of watemains, two wastewater treatment facilities, and 25 bridges and culverts.

Most of the City's linear infrastructures were built from the 1950's through to the 1980's. The high growth years of 1900, 1920, and 1950 are a result of assumed construction years for some of the buried infrastructure where no as-built drawings were available. The assumed construction years were primarily based on the age of infrastructure. The following figure shows the age distribution of all the existing linear infrastructure assets.

Figure 4 Age Distribution of Existing Networks

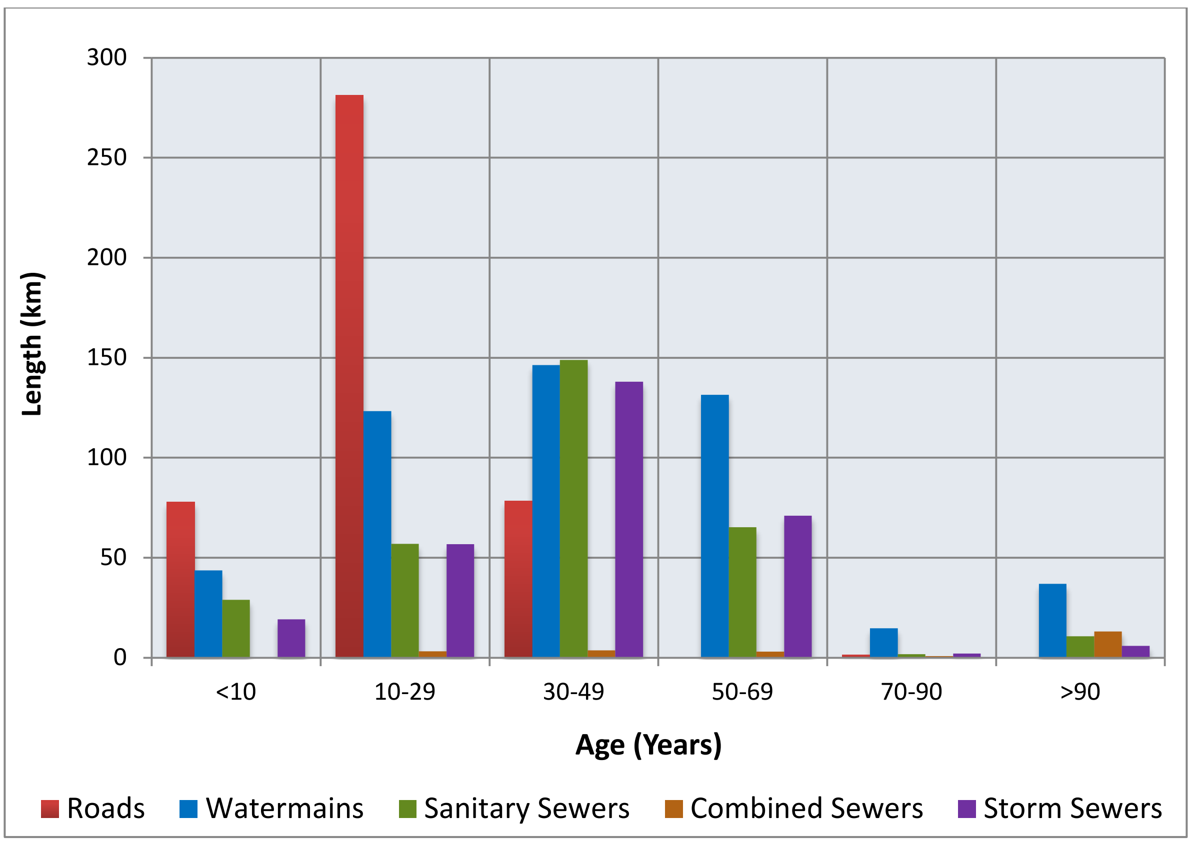


Table 4 Percent Age Distribution of Existing Networks

Precent Age Distribution (Years)	Road (km)	Water (km)	Sanitary (km)	Combined (km)	Storm (km)
>10	82%	91%	91%	100%	93%
>30	18%	66%	73%	87%	74%
>50	0%	37%	25%	71%	27%
>70	0%	10%	4%	59%	3%
>90	0%	7%	3%	56%	2%

3.1.1 Replacement Cost and Valuation

The Following tables summarize the current replacement cost and the financial accounting valuation of the City's core infrastructure Assets. The financial valuation is based on historical cost and the depreciations assumptions. The replacement cost is based on the present current unit rates, and will be updated annually.

Table 5 Current Replacement Cost of Core Infrastructures

Asset Type	Total Length /Quantitiy	Replacement Cost
Roads	439 KM	$598,994,645
Watermains	496 KM	$358,541,104
Sanitary Sewer	336 KM	$304,005,369
Storm Sewer	293 KM	$345,547,560
Forcemains	51 KM	$34,640,902
Pump Stations	57	$52,663,000
Wastewater Treatment Facilities	2	$99,288,000
Bridges	27	$67,053,899
Total		$1,860,734,480

Table 6 Financial Valuation of City's Core Infrastructures

Asset Type	Sum of TOTAL ORIGINAL COST	Sum of Current Accumulated Amortization	Sum of Net Book Value 2012
Roads	$308,771,534.80	$93,540,289.94	$215,231,244.86
Roads - Bridges and Culverts	$9,559,800.83	$4,129,951.02	$5,429,849.81
Storm - Urban	$79,449,543.91	$32,689,689.63	$46,759,854.28
Wastewater Collection	$56,621,631.94	$21,990,891.48	$34,630,740.46
Wastewater Treatment	$69,544,331.34	$29,786,864.85	$39,757,466.49
Water Distribution	$74,124,749.03	$29,584,073.39	$44,540,675.64
Total:	$598,071,591.85	$211,721,760.30	$386,349,831.55

3.2 Methodology

3.2.1 Data Collection and Data Management

The City recognizes that data collection and data management is one of the most critical aspects of the Asset Management Planning Process. Accuracy, reliability and consistency of the data are extremely important in developing a sound Asset Management Plan.

As a result of the initial inventory of linear assets and identification of capital needs by Dillon Consulting Limited in 2005, the City initiated several data collection programs and continues to refine data flow protocols. Most of the City's infrastructure data is stored in a GIS Geodatabase.

3.2.2 Network Segmentation

Network segmentation and establishment of a spatial relationship among assets is a critical step in the asset management analysis. Separate unique identifiers were assigned to each unique section of the linear infrastructure; each block of the road were segmented from intersection to intersection and were assigned unique identifiers; watermain network segments were assigned unique identifiers established based on location of main line valves, hydrant laterals and connection tees; sewer network segments were assigned unique identifiers established based on location of manholes, main connections and pipe size changes.

Figure 5 Sample Integrated Segment for Linear Assets

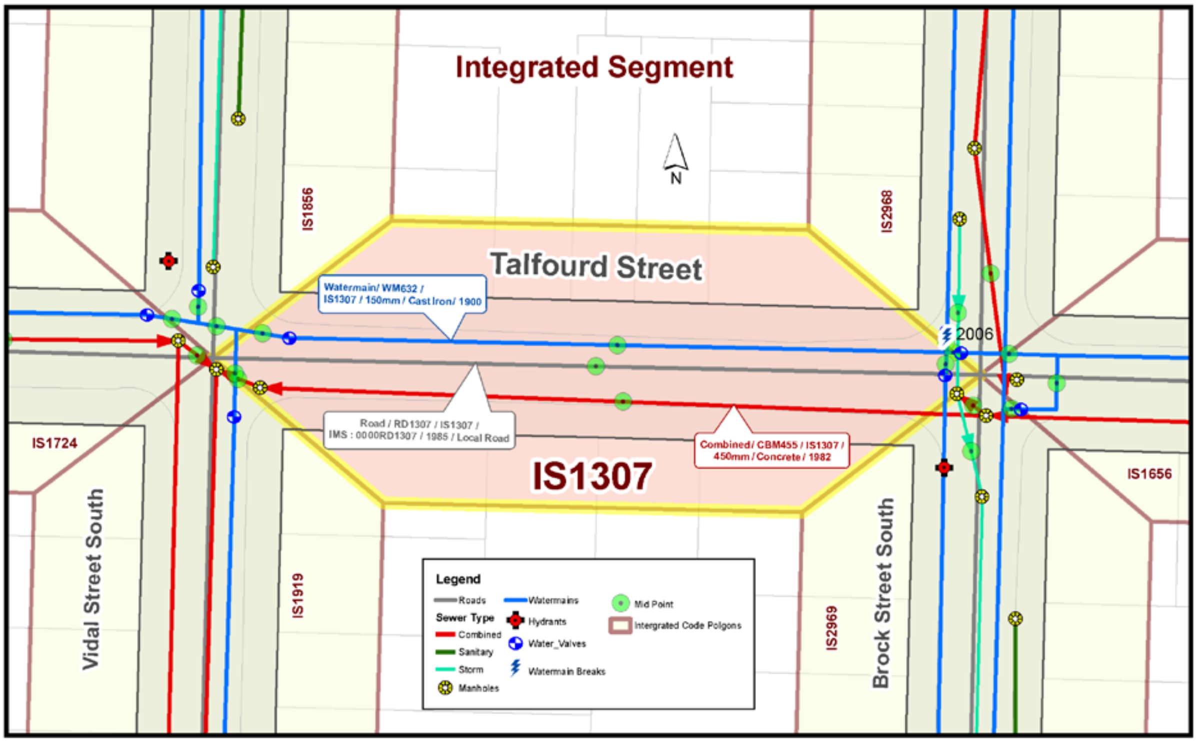


Table 7 Sample Data Attributed Linear Assets

Road		**Watermain**		**Sewer**	
Shape	Polyline	Shape	Polyline	Shape	Polyline
OBJECTID	1307	OBJECTID	632	OBJECTID	179
Asset_NO	1307	Type	Watermain	Type	Combined
RD_ASSETID	**RD1307**	Code	WM	Code	CBM
IntegrCode	IS1307	Asset_NO	632	Asset_NO	455
Block	200	Asset_ID	**WM632**	Asset_ID	**CBM455**
SubBlkArea	A	IntegrCode	IS1307	IntegrCode	IS1307
STREETNAME	Talfourd Street	Block	200	Block	200
FromStreet	Brock Street South	SubBlkArea	A	SubBlkArea	A
ToStreet	Vidal Street South	Street	Talfourd Street	Street	Talfourd Street
JURISDICTN	City of Sarnia	FromStreet	Brock Street South	FromStreet	Brock Street South
MUN_LEFT	Sarnia	ToStreet	Vidal Street South	ToStreet	Vidal Street South
MUN_RIGHT	Sarnia	Owner	Sarnia	Owner	Sarnia
LEFTFROM	168	Mun_Area	Urban	Mun_Area	Urban
LEFTTO	190	Material	Cast Iron	Sewer_Area	Devine Street
RIGHTFROM	167	Diam_m	150	Material	Asbestos Cement
RIGHTTO	189	DiammLabel	150mm	Diam_m	450
STREET_LBL	Talfourd St	Diam_Imper	6	DiammLabel	450mm
BASE_NAME	Talfourd	DiamImpLab	6"	Diam_Imper	18
STTYPE	Street	Depth	1.5	DiamImpLab	18"
SUFFIX_TYP	St	INST_YEAR	1900	UpStreamIn	179.71
SUB_AREA	Urban	Asset_Date	07/01/1900	DownStream	179.09
DIRECTION	BOTH	GENCOMMENT	Operation Staff / Age of bldgs	InstYear	1982
Class_Type	Local Road	Status		Asset_Date	07/01/1982
NBRLANES	2	Edit_Date	27/01/2012	GenComment	Material source= Assumed by Project Team.
SPEED_ZONE	50	Edit_By	RJ		Installation Year source= As-built drawings.
PAVEMTYEAR	1985	Edit_Notes			Condition Index source= Old CCTV inspection.
PAVSTATUS	Paved Surface	NoWMBreaks	0	Status	Last Inspected on 01/01/2000
LENGTH	114.269195	RD_AssetID	RD1307	CCTVStrucI	0.7
PAVEMENTWI	10.8	Shape_Length	97.795177	InspecLen	111.06
SURFACE	1234.107311			InspecDate	01/01/2000
GENCOMMENT	Width source= RIMS.			Edit_Date	19/06/2013
	Condition Index source=			Edit_By	RJ
	Based on Condition Index.			Edit_Notes	
UPDATED	07/05/2008			RD_AssetID	RD1307
UPDATEDBY	RJ			Shape_Length	108.174001
IMS Section NO	0000RD1307				
Shape_Length	114.269195				

An Integrated Segment (IS) ID was then created using the road segments. Using GIS, a buffered polygon data layer was created from intersection to intersection. Also a mid-point dataset was created for each of the water and sewer segments and was spatially assigned the 'IS' ID from the polygons. These datasets were later joined back to original linear segments.

For a given road section there may be multiple segments of watermain, sanitary or storm sewers. The integrated ID's allow different asset types within a close proximity to be compared and are essential in the data collection process. The overall goal is to have all of the City's linear assets assigned with a unique integrated code.

3.2.3 Condition Assessment and Analysis

IMS Infrastructure Management Services was hired by the City in 2012 to carry out a detailed pavement condition assessment of its entire road network including a road needs study. The IMS Laser Road Surface Tester (RST) was used for this assessment. All of the road data was provided by City staff to IMS from our Geo database. IMS Pavement Management System was used by the consultant to analyse the pavement data and provide information on measured conditions, road classification, construction cost estimates, and construction needs. The analysis also identified critical deficiencies, and provided a list of the roads in order of a priority rating with respect to reconstruction and/or upgrades.

The Sanitary Sewers and Storm Sewers were evaluated using a combination of the actual condition rating of the infrastructure and partly utilizing the system deterioration curves based on age and material wherever actual conditions were unavailable. Once the actual condition assessment of all the infrastructure assets is completed, the plan will be updated to fully reflect actual condition rating rather than using some data based on system deterioration curves.

The City's water network was analysed based on the watermain break data, age, material, known operation and maintenance issues, and capacity issues identified through the water distribution network modelling.

An Integrated Analysis Engine (IAE) was developed using Microsoft Excel, to carryout integrated analysis for all linear infrastructures to obtain the required results, including; Current Needs, Future Needs, Budget Scenarios and Schematic Mapping.

A composite index method was used to determine the condition score of assets. Each asset was assessed based on a condition score from 0 to 100, with a score of 100 representing a perfect condition. The score is based on actual condition data or the use of deterioration curves and localized factors. It is also beneficial to consider the possibility of rehabilitating infrastructure to extend the overall service life based on the available windows of opportunity.

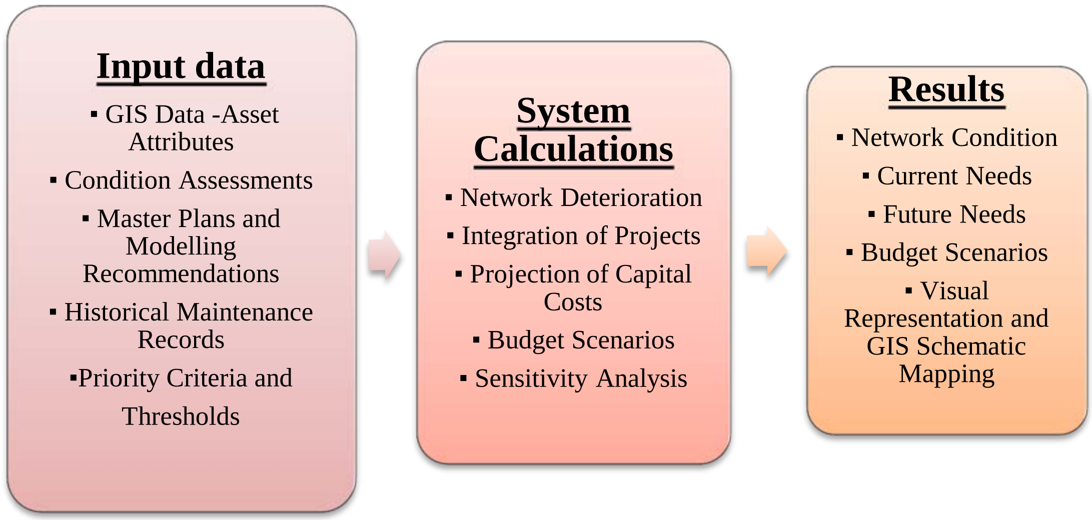
The main purpose of the IAE was to assess the condition, estimate the replacement costs and timeline for all linear assets, and carryout integrated analysis for the linear infrastructure falling within the range of 15 year rehabilitation and reconstruction windows of opportunity.

The IAE processes data automatically and performs a network of calculations. The program was developed with separate input files, analysis files and output files that link to the IAE and GIS.

Input data files included internal GIS databases, Road assessment data from IMS infrastructure Management services, maintenance records, previous assessment studies and master plan recommendations. Analysis files were developed to conduct sensitivity, financial, current need and future need analysis. The Integrated Analysis Engine is setup to automatically update as the Geodatabase in the GIS system is updated.

Results of the program were also exported back to GIS for schematic mapping. The following figure summarizes the IAE system process.

Figure 6 Integrated Analysis Process



The following figure and table represent the general state of the City's linear infrastructure as calculated by the IAE.

Figure 7 State of Linear Infrastructure

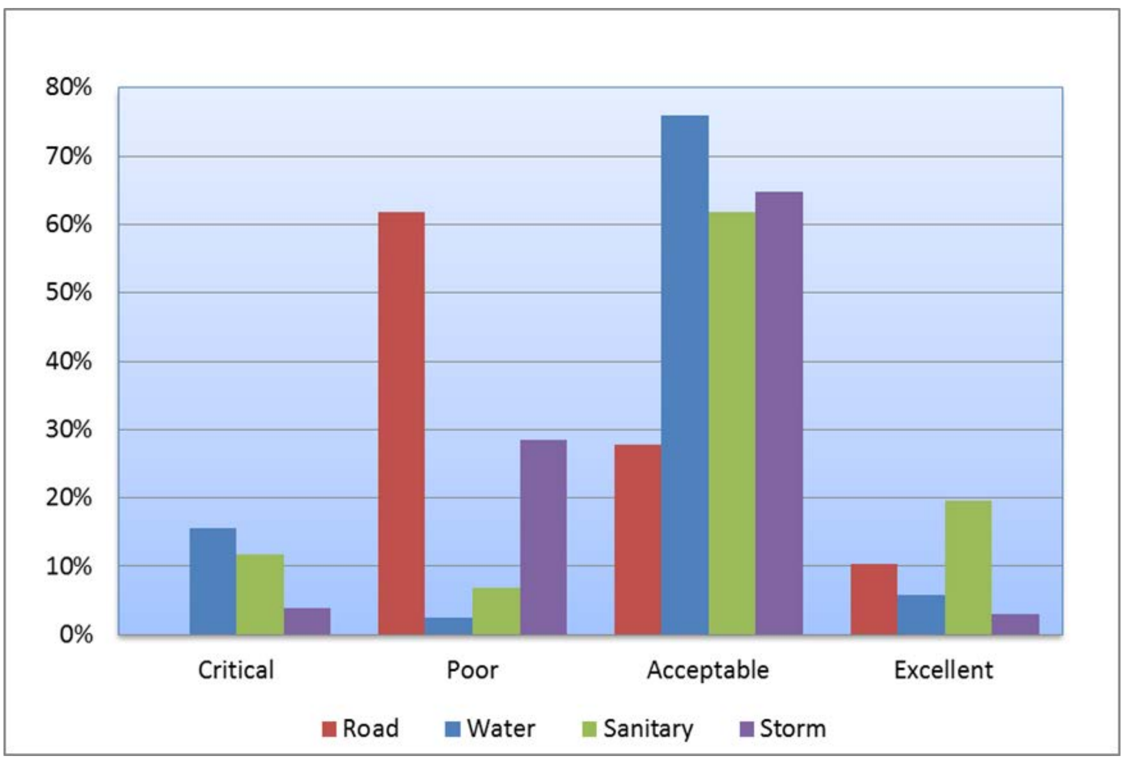


Table 8 Evaluation Criteria for the State of Linear Infrastructures

Evaluation	Road (Remaining Service Life)	Water/Sanitary/Storm (Remaining Service Life)
Excellent	≥ 30 years	≥ 80 years
Acceptable	30 -25 years	80 - 45 years
Poor	25 - 10 years	45 - 30 years
Critical	10 - 0 years	30 - 0 years

The deterioration curves were developed for the linear infrastructure materials based on the previous study by Dillon Consulting Limited. These deterioration curves were further modified as more information was collected on the age and type of material of the linear assets. These deterioration curves were used for current condition ratings and the future condition projections. These deterioration curves will be further revised and updated as more data is collected on the condition of the assets.

Various triggers and criteria used for identifying the replacement and reconstruction need; were mostly adopted from the previous study by Dillon Consulting Limited and modified during discussions in various committee meetings to accommodate the specific needs of the individual assets. The following figure is an example of watermain deterioration curves for various pipe materials.

Figure 8 Watermain Pipe Deterioration Curves

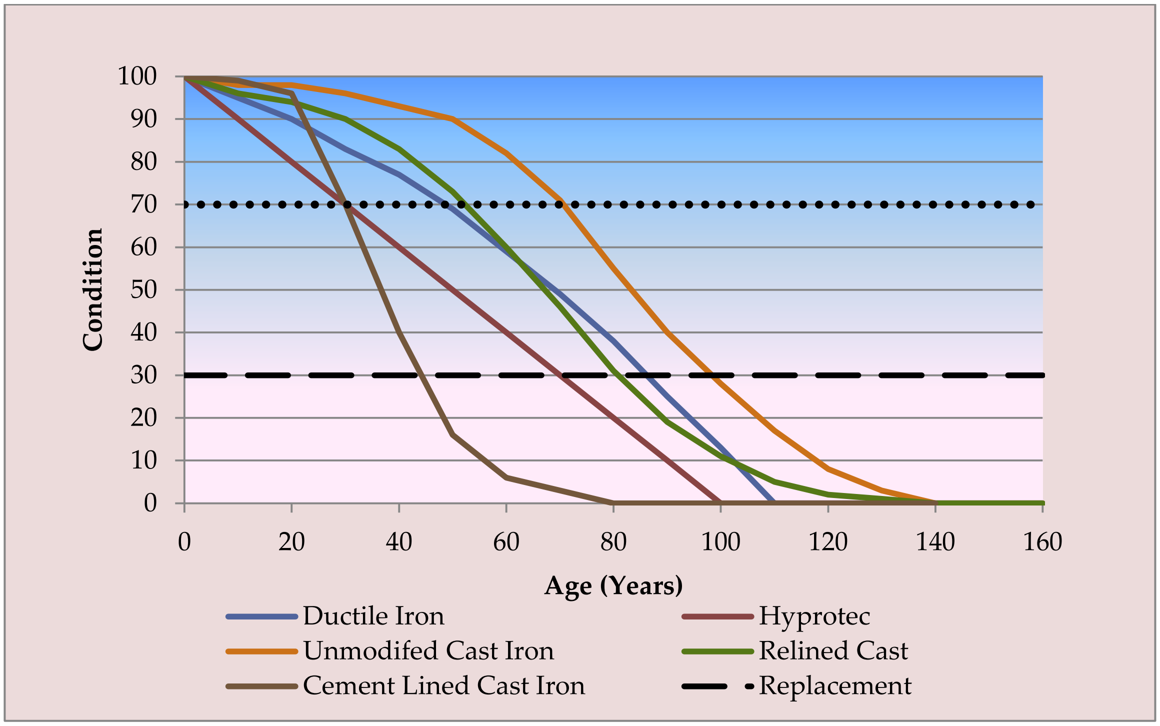


Figure 9 Rehabilitation and Replacement Thresholds for Sewer Network

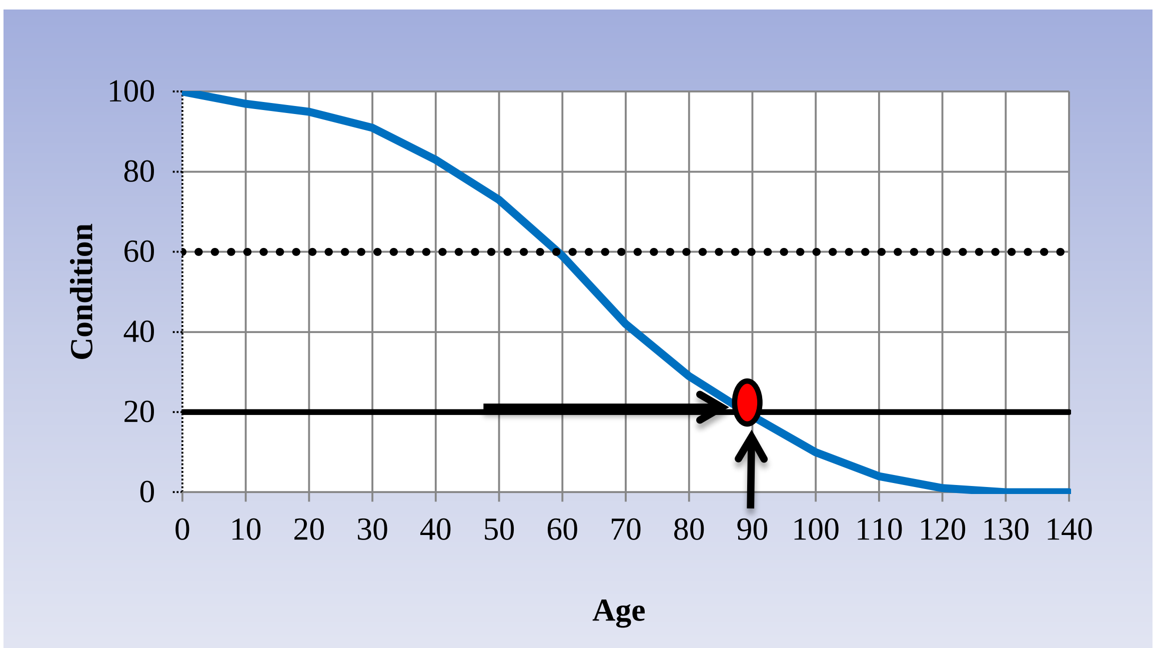


Table 9 Quick Facts about the City's Core Infrastructure Assets

No.	Description	Measurement	Unit
1	**Water Distribution System**		
	Watermains	496	km
	Fire Hydrants	2639	number
	Valves	3492	number
2	**Road Network**		
	Road	439	km
	Sidewalk	321	km
3	**Stormwater and Waste Water Collection System**		
	Sanitary Sewer	312	km
	Combined Sewer	24	km
	Storm Sewer	293	km
	Sanitary and Combined Sewer Manholes	4295	number
	Storm Sewer Manholes	3745	number
	Catchbasins	7889	number
	CSO Tank	1	number
	Sanitary Forcemains	50	km
	Storm Forcemain	1	km
	Sanitary Pump Stations (In -service)	49	number
	Sanitary Pump Stations (Out of -service)	4	number
	Storm Pump Station	4	number
4	**Wastewater Treatment Facilities**	2	number
5	**Stormwater Management Facilities**	7	number
6	**Bridges and Culverts**	27	number

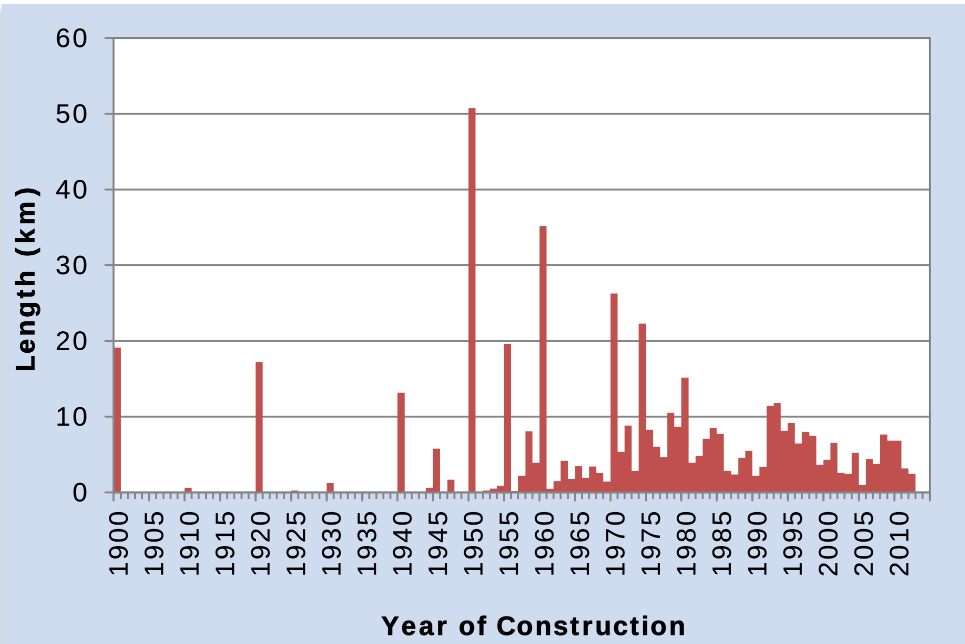
3.3 Water Distribution System

The City of Sarnia Water Distribution System (Sarnia WDS) is an integral part of Lambton Area Water Supply System (LAWSS). The water is supplied to the City's Distribution System from the 'LAWSS Water Treatment Plant' located within City of Sarnia's municipal boundary. Vertical turbine high lift pumps deliver the water from the treatment plant into four transmission mains, which extend through The Village of Point Edward towards Sarnia. The Sarnia WDS is a large Municipal Water Distribution System serving approximately 25,000 customers (approximately 72,000 people).

3.3.1 Inventory

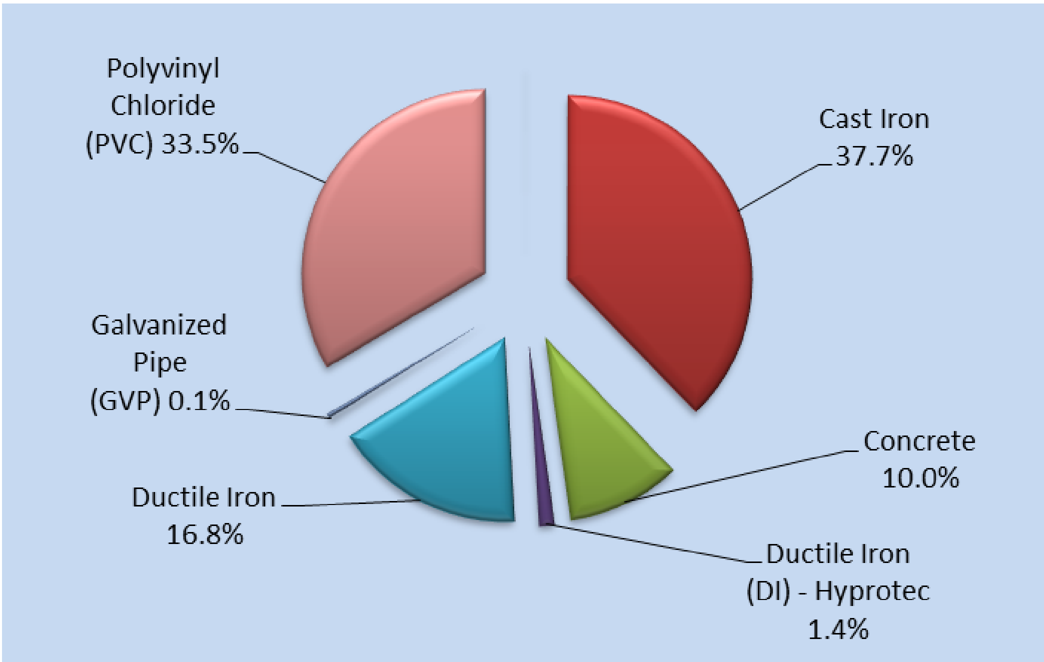
The complete Sarnia WDS consists of a total of approximately 496 kilometres of watermains ranging from 100mm (4") to 600mm (24") in diameter with a total of 2639 hydrants and 3492 main valves. Within the City of Sarnia Water Distribution System, there are 47 kilometres of LAWSS supply watermains integrally connected to the Sarnia WDS at 56 locations. In addition to the above, 36 hydrants are owned by LAWSS and 43 hydrants are privately owned.

Figure 10 Watermain Installation Years Distribution Hyetograph



The inventory and maping of most of the City's Water Distribution System including location, size, length, type of watermain pipe, fire hydrants, valves, connections, watermain breaks etc., are available in our ESRI's GIS System – Geodatabase.

Figure 11 Watermain Material Distribution by Percentage



3.3.2 Condition

The City of Sarnia had a total of 105 watermain breaks in 2011, this equates to 21 breaks per 100 kilometres. This is very high compared to the provincial average. Based on the annual water loss audit carried-out by the City, the watermain breaks have increased consistently in the past few years. This is reflected in the significant reconstruction and rehabilitation needs for the water distribution system.

The following figures compares the results of the water loss audit conducted in 2008, 2009, 2010 and 2011; and watermains age & material distributions. The gross water loss includes accounted and unaccounted water loss, and the net water loss is only unaccountable water losses that could be attributable to meter inaccuracies, leakages water theft, etc.

Figure 12 Annual Water Loss from 2008 to 2011

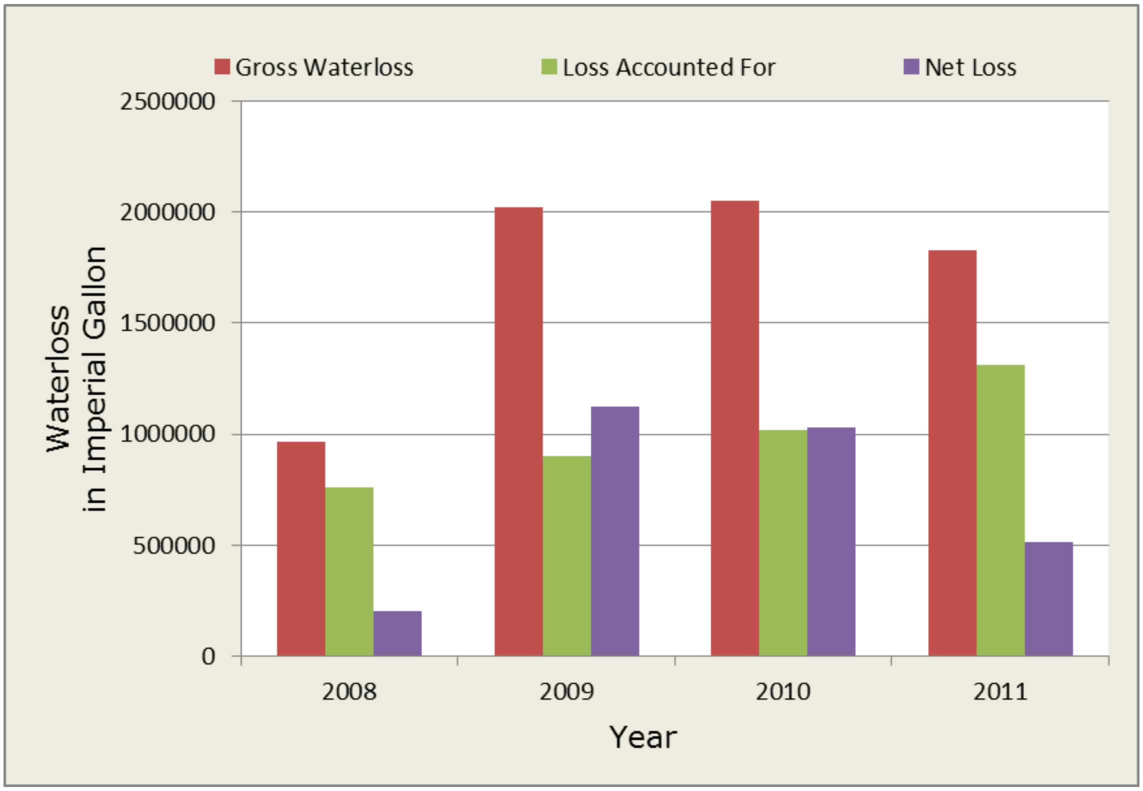
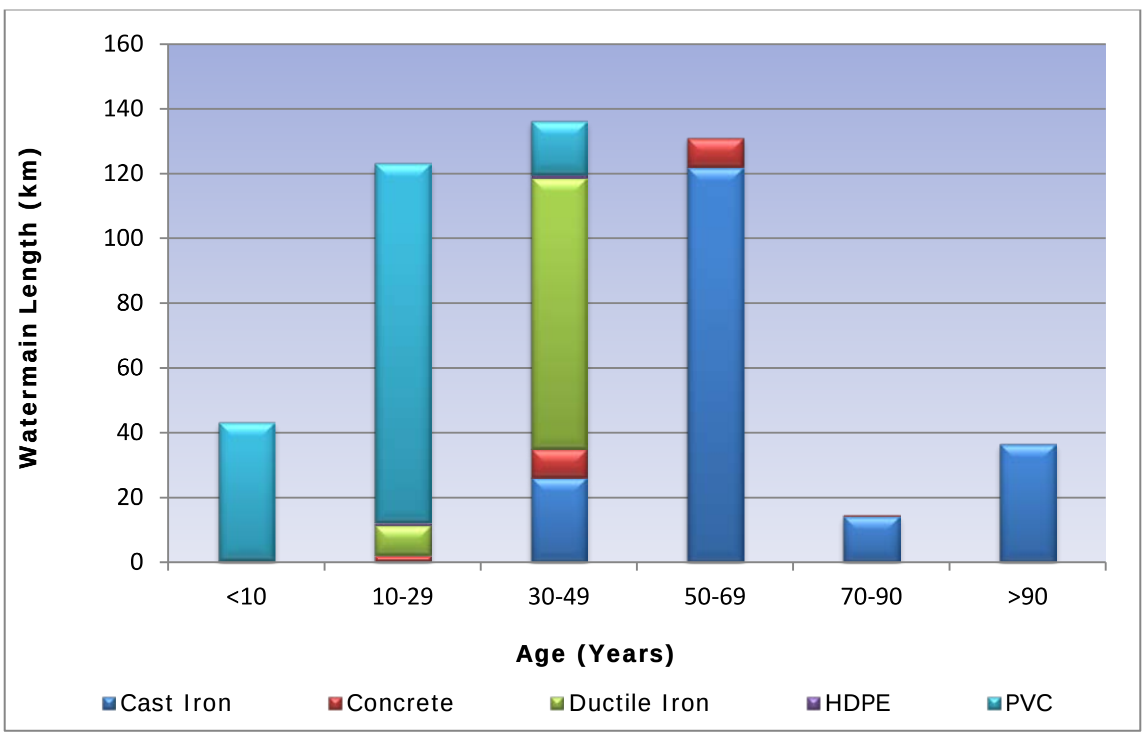


Figure 13 Watermain Age and Material



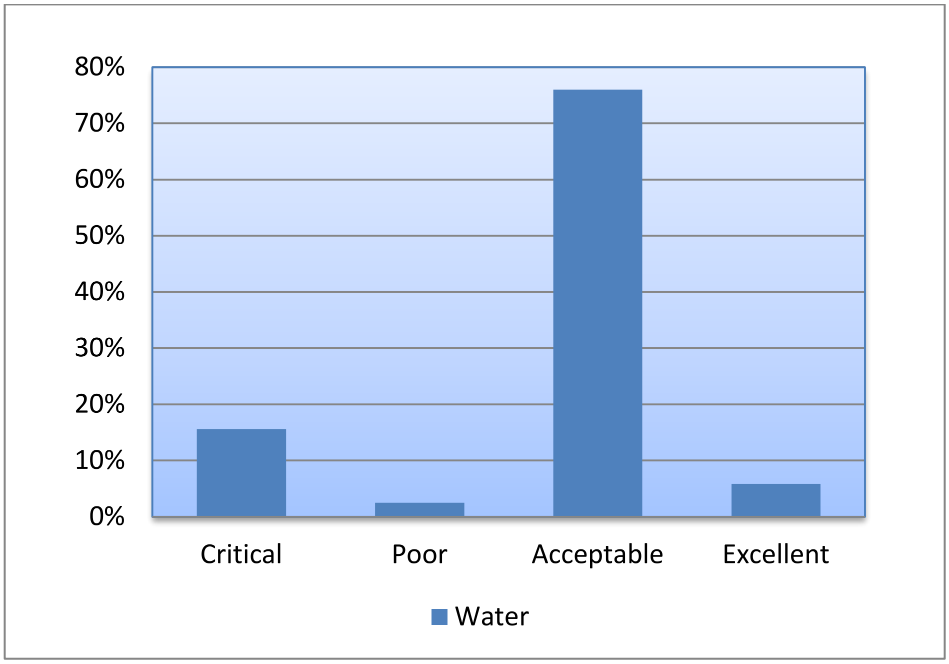
The water network was assessed based on a variety of factors including age, material, watermain breaks, pressure and flow, capacity constraints etc.

Table 10 Factors for Determining Watermain Condition

Factor	Comments
Age and Material	"Age and Material" is the most significant criterion. As a watermain ages its condition deteriorates by a combination of increased calcium deposits, low flows, low pressure, rusting, and breakage. The type of material significantly impacts the rate of deterioration.
Watermain Breaks per 100 m	The number of watermain breaks provides an accurate measure of operational decline. Watermains that have a history of breakage are a significant burden on the operational budget.
Fire Flow	Several areas in the City experience very low flows and are an operational and safety concern. Low flows are also directly correlated to poor water quality.
Pipe Diameter	Large pipes are often transmission lines that bring large quantities of water, therefore problems with larger pipes are considered high social and economic risks. Small pipes, less than 150 mm, are also a priority due to low pressure and potential lead services. Lead services need to be removed due to water quality concerns.

The following figure represents the state of water infrastructure of the City.

Figure 14 State of Water Infrastructure



3.3.3 System Capacity and Expansion

The Water Distribution System Master Plan and Hydraulic Modelling of the City's Water Distribution System are currently being completed by Stantec Consulting Limited.

The objective of this study is to undertake a detailed hydraulic assessment of the City's Water Distribution System and to develop a hydraulic model for the Distribution System including establishing the pattern of the water movement throughout the City. In addition, the availability of required fire flows at all the points during average day and maximum daily demands; water quality analysis; identifying deficient fire flow areas and areas with water quality concerns in the Distribution System and provides recommendations for improvements.

The Water Distribution System Master Plan will provide direction to the long-term management and operation of water infrastructure. Specifically it will provide input to the City's long-term capital planning by prioritizing water projects, assisting in long term planning, Official Plan Amendments and Zoning By-Law development.

The system capacity constraints identified through the modelling process will be incorporated during the next update of this plan.

3.3.4 Data Flow Verification Policy

The City's Engineering Department (Public Works Division) has an annual valve-turning program and a hydrant flushing and inspection program, which have both been in place since 2010. Staff currently flushes all (2639) hydrants annually, and exercises (turns) on average 300 watermain gate valves annually.

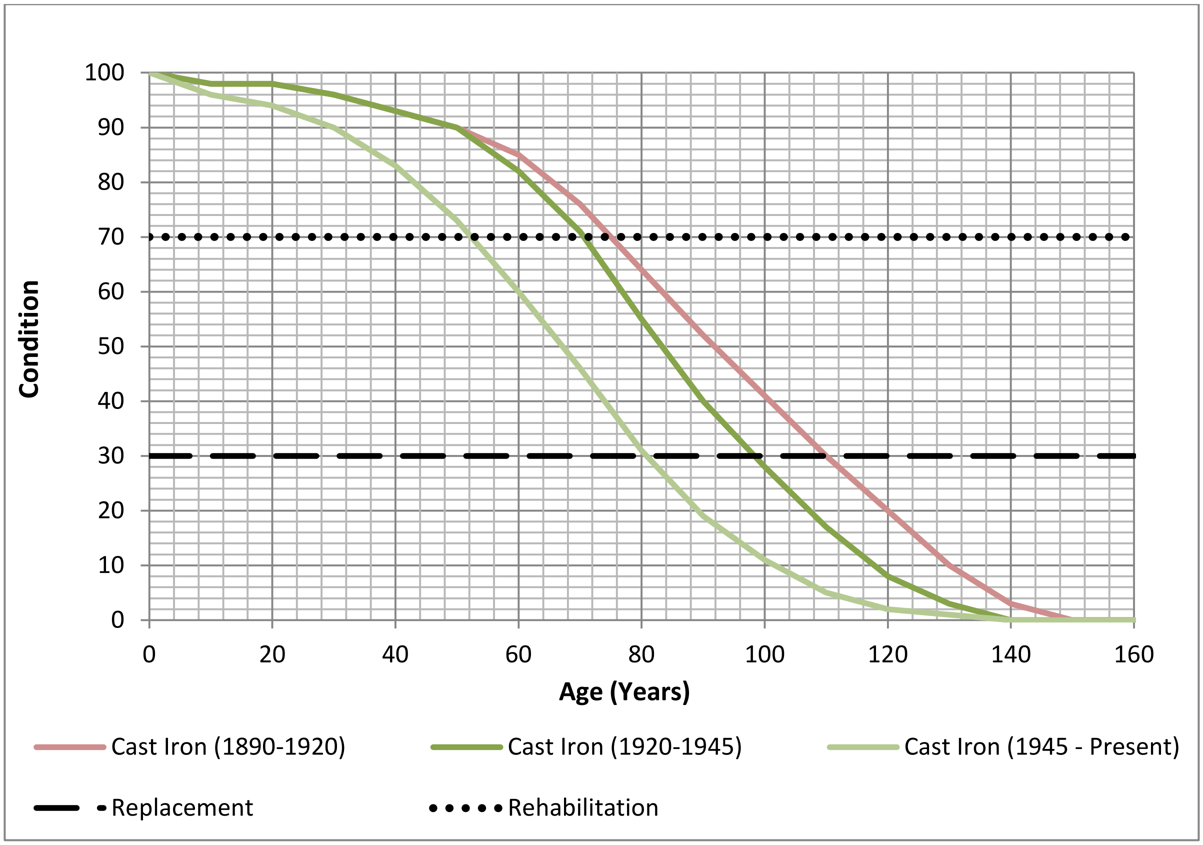
In addition to the above activities, the field location of the hydrants and valves are recorded using hand held Global Positioning System (GPS) devices and information collected is uploaded into the GIS system on a regular bases. A data integrity check and flow protocol are being developed to ensure reliability, consistency and accuracy of the data.

3.3.5 Analysis

The state of the City's Water Distribution System has been analysed based on the watermain breaks data, age, material, size, and available pressure and fire flow issues of the water distribution system. The risk analysis was carried-out based on probability of failure and consequence of the failure. More weightage was assigned to the higher diameter watermains as well as watermains with a higher number of breaks.

Capacity and fire flow issues in the distribution system are separately assessed and incorporated into the above. The above factors were further modified based on known issues and other risks specific to certain sections of the water distribution system.

Figure 15 Water Network Deterioration Curves-Modified Cast Iron



Deterioration curves for the water distribution system were modified from the Dillon Study based on more available information on the age and type of material. These deterioration curves were used for the current condition index and future condition projections.

3.4 Wastewater Collection Systems

3.4.1 Inventory

The City of Sarnia owns and operates two Waste Water Treatment Facilities, one located in the south end of the City's urban area, the Sarnia Pollution Control Centre on St. Andrew's Street, which services approximately 65,000 people; and a second facility located in the community of Bright's Grove, the Bright's Grove Sewage Lagoons, which services approximately 5000 people.

The wastewater collection system servicing the City's Wastewater Treatment Plant Facility includes approximately 286 kilometres of gravity sanitary sewer, 24 kilometres of combined sewers, 49 sanitary pumping stations and approximately 49 kilometres of sanitary forcemains. The Bright's Grove Wastewater Treatment System is serviced by approximately 26 kilometres of gravity sanitary sewers, 4 sanitary pumping stations and 3.5 kilometres of sanitary forcemains.

The stormwater collection system consists of 293 kilometres of storm sewers, 4 storm pumping stations, and 7 stormwater management facilities.

The inventory and mappings of most of the City's wastewater collection system including location, size, lengths, type of sewer pipe; manholes, service connections, condition etc.; are available in our ESRI GIS System – Geodatabase. This Geodatabase was created based on the previous inventories from the 2005 Dillon Consulting Study and further data collection programs initiatives by the City.

Figure 16 Sanitary Pipe Material Distribution

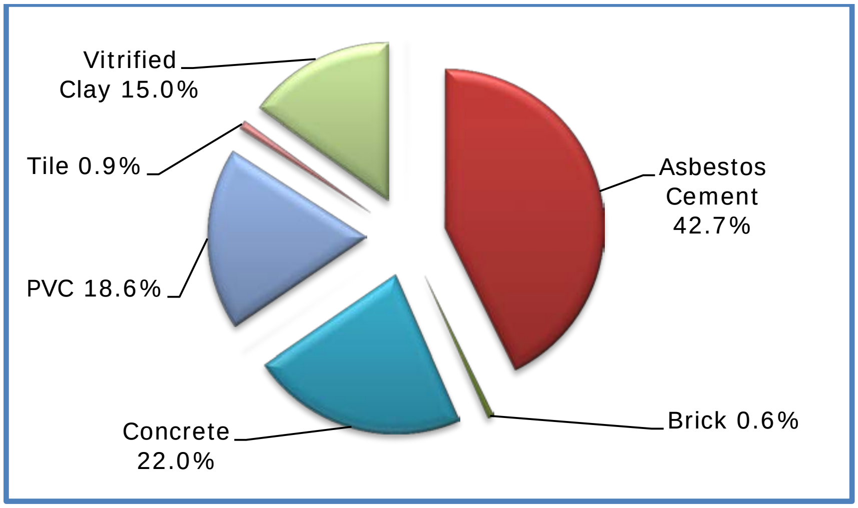


Figure 17 Combined Sewer Pipe Material Distribution

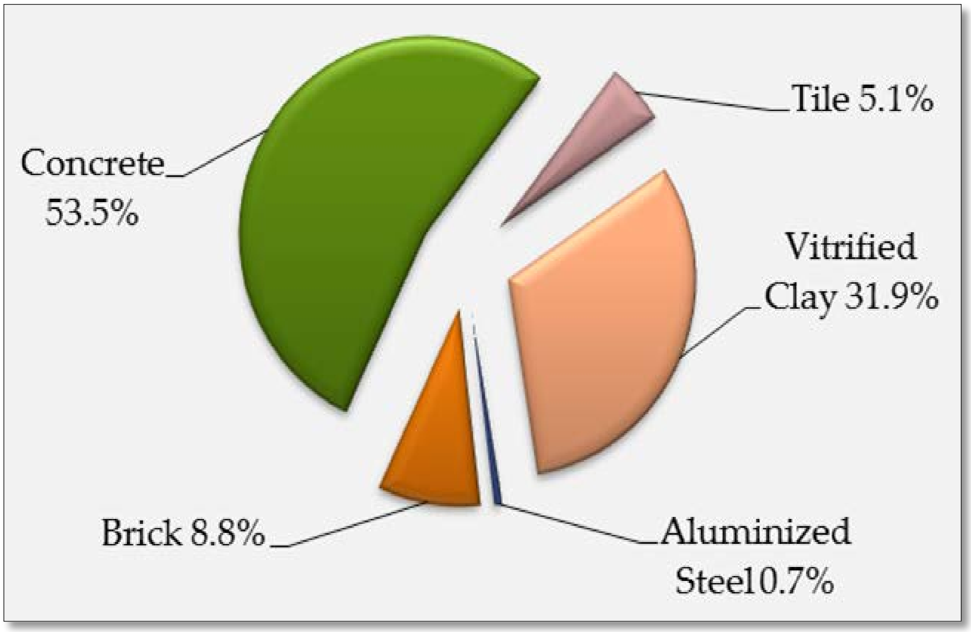
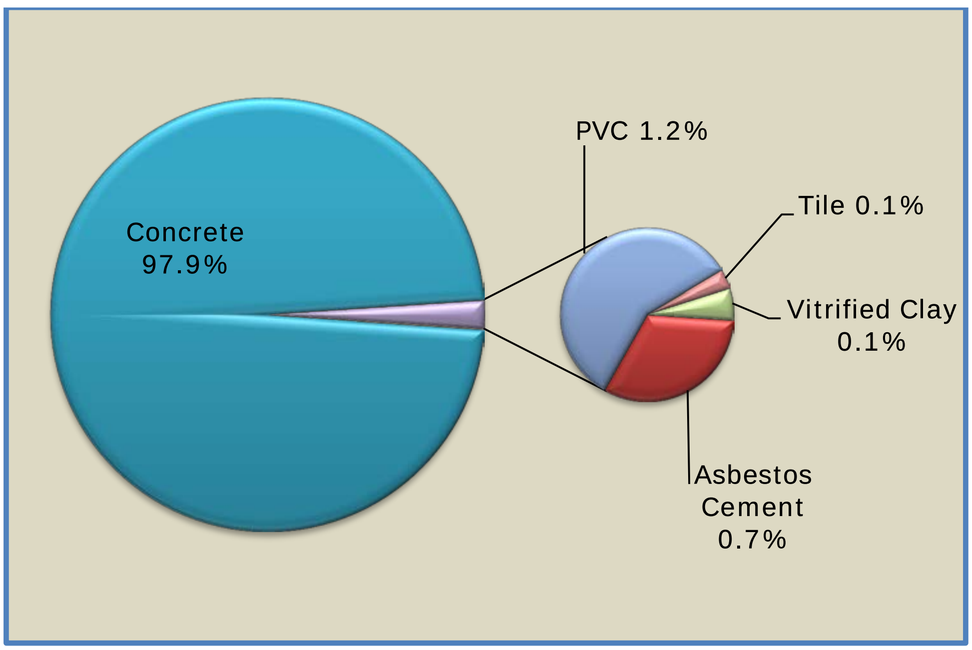


Figure 18 Storm Sewer Pipe Material Distribution



3.4.2 Condition

3.4.2.1 Sewers

Most of the City's separated sewer systems were built in the 1950's; 1960's and 1970's. A significant portion of the core area of the City is still serviced by an existing combined sewer system. The combined sewers were mostly installed prior to 1900. The distribution of linear infrastructure of the City by age of installation and state of linear wastewater infrastructure is as shown below.

Figure 19 Sanitary and Combined Sewers Installation Age Distribution

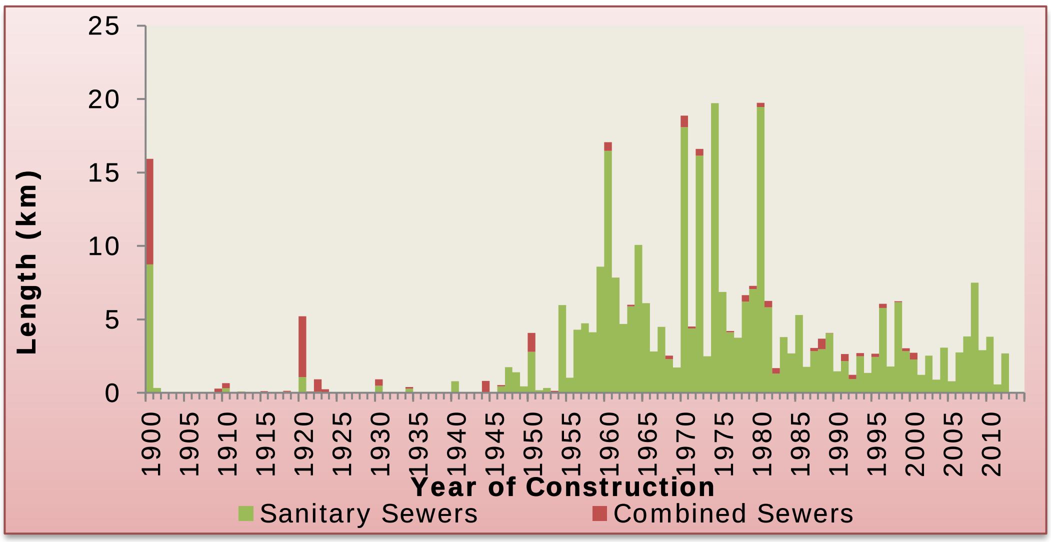
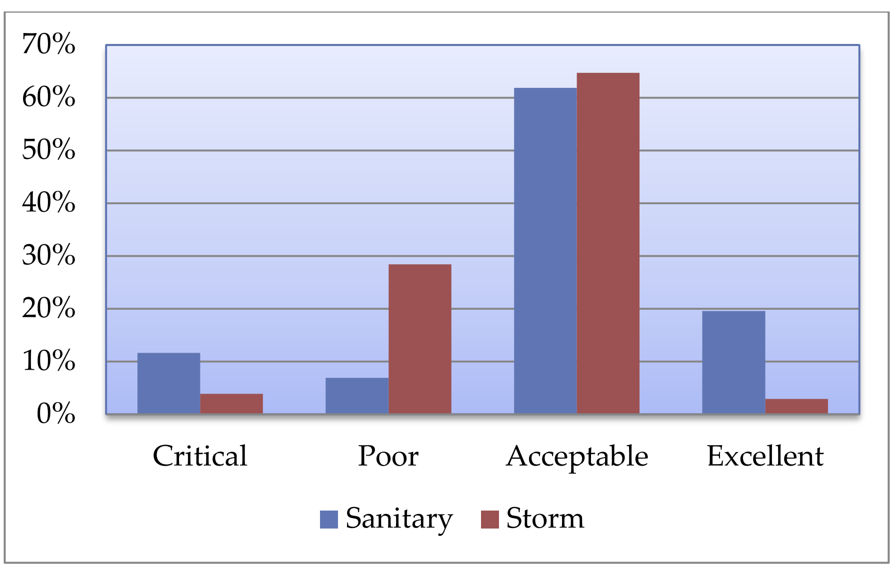


Figure 20 State of Linear Wastewater Infrastructure



Combined sewer overflows to the St. Clair River and basement flooding have been the long standing major concerns of the City of Sarnia. The City has undertaken major sewer separation projects in the past five years with the help of funding from senior level government, thereby achieving reduction in combined sewer overflows to the St. Clair River and mitigation of basement flooding in the core area of the City. This has also resulted in improved water quality in the St. Clair River.

Sewer condition assessment is one of the major challenges for the City due to the uncertainty and extent of sewer cleaning required. Hence, the cost associated with this is high and uncertain. Therefore, the sewer condition assessment work is ongoing in phases and will be completed over the next three to four years.

In this Plan, the condition of the existing sewer network has been mostly analysed based on the age and material and partly based on sample condition assessment of the sewer network done previously by Dillon Consulting. The plan will be updated once more sewer condition assessment data is collected.

3.4.2.2 Pumping Stations

The pumping station assessment for the City was completed by R. V. Anderson Associates in 2009.

The following table shows the weighted average service life of different components of a pump station based on the above report. The condition analysis of all the pump station has been calculated using the declining straight-line method based on this weighted average service life and any major upgrades done to the pump station.

Table 11 Wastewater Pump Stations Components Service Life.

Discipline	% Cost of Facility	Wastewater Pumping Stations Expected Service Life (yrs)
Architectural	10	30
Electrical	15	25
Life Safety	5	50
Mechanical	10	30
Process	25	40
Site Elements	5	50
Structural	30	100
	100	**55**

The capacity score of the pump station was calculated based on the actual design capacity versus the modelled flow received by the pump station. The compound score was calculated as 80% condition and 20% capacity. The risk score was assigned proportional to the actual capacity of the pump station and the overall score was lowered by a maximum of 25%.

The overall score after override has been adjusted for three pump stations with known operational and developmental issues within the City.

The priority list of pump stations with capacity, condition and risk score is provided in the following table:

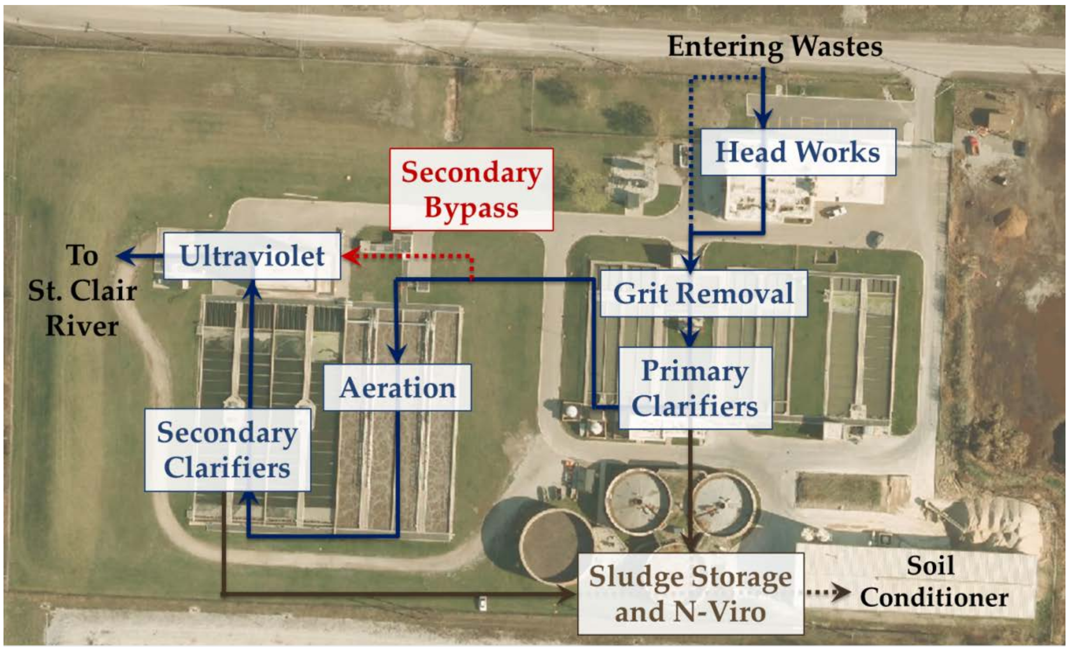
Table 12 Wastewater Pump Station Capacity and Condition Assessment

Station ID	Pump Station	Condition Score	Capacity Score	Compound Score	Normalized Risk Score (75-100)	Overall Score	Known Operational and Development Issues	Overall Score After Override
33	CNR Tracks at Bedford	34	29	33	75.0	25	Yes	0
41	Green Street	67	0	54	81.5	44	Yes	0
35	Murphy Road at 402	34	66	41	75.0	30	Yes	0
18	Giffel Road	11	N/A	11	100.0	11		11
6	East St at Maple	12	N/A	12	100.0	12		12
1	Holland Street	11	35	15	90.4	14		14
2	Briarfield	14	N/A	14	100.0	14		14
13	McCaw	18	25	19	86.6	17		17
14	Rosedale	14	69	25	82.9	21		21
8	Errol Road	23	N/A	23	100.0	23		23
9	Exmouth West of Indian	32	21	30	84.2	25		25
17	Mayfair	29	46	32	80.8	26		26
16	Talfourd Street	34	48	37	75.0	28		28
5	East St at Huey's	29	N/A	29	100.0	29		29
10	Forsyth	32	48	36	95.2	34		34
15	Scott Road	25	81	36	95.7	35		35
32	Exmouth St. (Lambton Mall)	34	82	44	81.6	36		36
12	Lecaron	53	23	47	77.4	36		36
3	Clifford	27	94	40	93.0	37		37
28	1801 London @ Blackwell	34	77	43	91.7	39		39
44	Chippewa Park	40	N/A	40	100.0	40		40
29	London Line at Briarwood	34	89	45	88.0	40		40
37	Cathcart at Rutherglen	42	N/A	42	100.0	42		42
7	Elrick at Vye	53	43	51	82.4	42		42
30	Blackwell @ Sim's	34	72	42	100.0	42		42
24	River Road	45	N/A	45	100.0	45		45
20	Tashmoo Ave (North)	49	N/A	49	100.0	49		49
23	Sandy Lane	49	N/A	49	100.0	49		49
31	Airport Road North of 402	43	92	53	96.9	51		51
36	1642 Murphy Road	67	82	70	75.0	53		53
38	Penhuron Lane (Hamilton)	67	12	56	96.4	54		54
25	161 Nelson Street	54	N/A	54	100.0	54		54
34	Plank Road at Indian Road	71	98	76	75.0	57		57
46	Rapids Parkway	69	78	71	81.5	58		58
21	Plain Lane	58	N/A	58	100.0	58		58
22	Berkshire Road	58	N/A	58	100.0	58		58
26	1350 Plank	67	51	64	94.3	60		60
27	1569 London Line(Lou's)	85	66	81	76.6	62		62
11	Lasalle	67	62	66	98.9	65		65
39	Kaymar	67	N/A	67	100.0	67		67
40	Huronview (Lakeshore)	67	N/A	67	100.0	67		67
47	Devine Street	96	N/A	96	75.0	72		72
4	ARI	73	N/A	73	100.0	73		73
43	1264 Tashmoo (South)	73	N/A	73	100.0	73		73
50	Michigan Avenue	80	80	80	92.7	74		74
51	Heritage Park	80	79	80	95.2	76		76
45	Augusta Drive	76	N/A	76	100.0	76		76
49	5960 Blackwell Side Road	76	N/A	76	100.0	76		76
53	London Rd Industrial Park	85	96	88	88.3	77		77
52	Stone Hedge Park	84	N/A	84	100.0	84		84

3.4.2.3 Wastewater Treatment Facilities

The condition scores for various components of the Water Pollution Control Centre have been calculated based on average age of the components identified in the following figure.

Figure 21 Water Pollution Control Centre



Every component of the Water Pollution Control Centre was divided into three major categories; Process, Structural and Equipment. A service life of 25 years for Process and Equipment, and a service life of 100 years for Structural were assumed. The condition score will be updated once the actual condition assessment of the plant is carried-out in the future.

The original plant built in 1959 used an anaerobic process and had only primary treatment capabilities. The plant was upgraded in 2000, to add secondary treatment and changed to an aerobic process.

The Bright's Grove treatment facility consists of the lagoon system and has been identified as top need based of capacity constraints, and legislative requirement. More description on this facility is included under 'System Capacity and Expansion' section.

Figure 22 Water Pollution Control Centre Upgrades

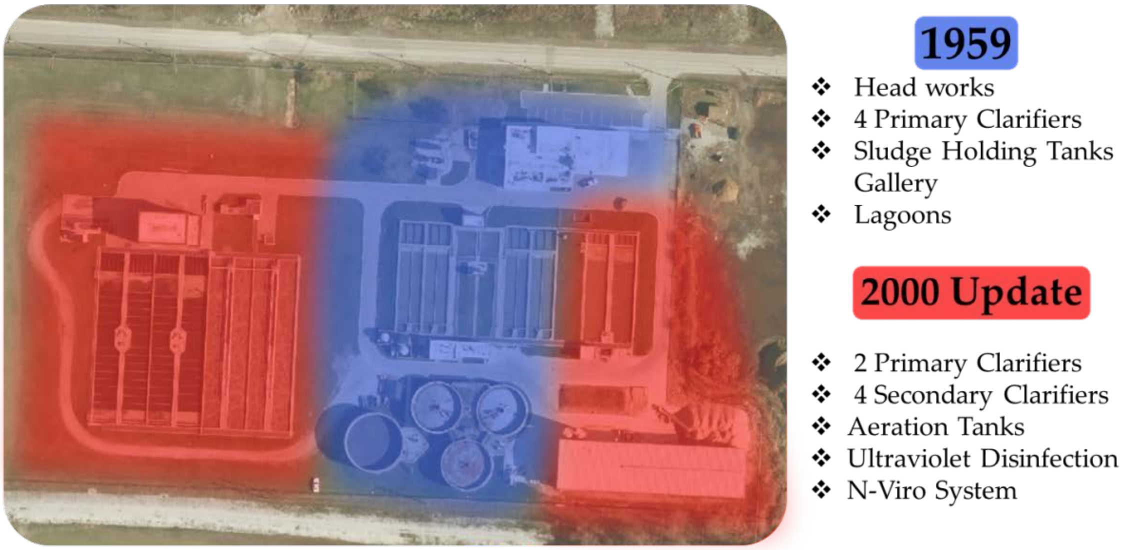


Figure 23 Average Condition Score of Water Pollution Control Centre

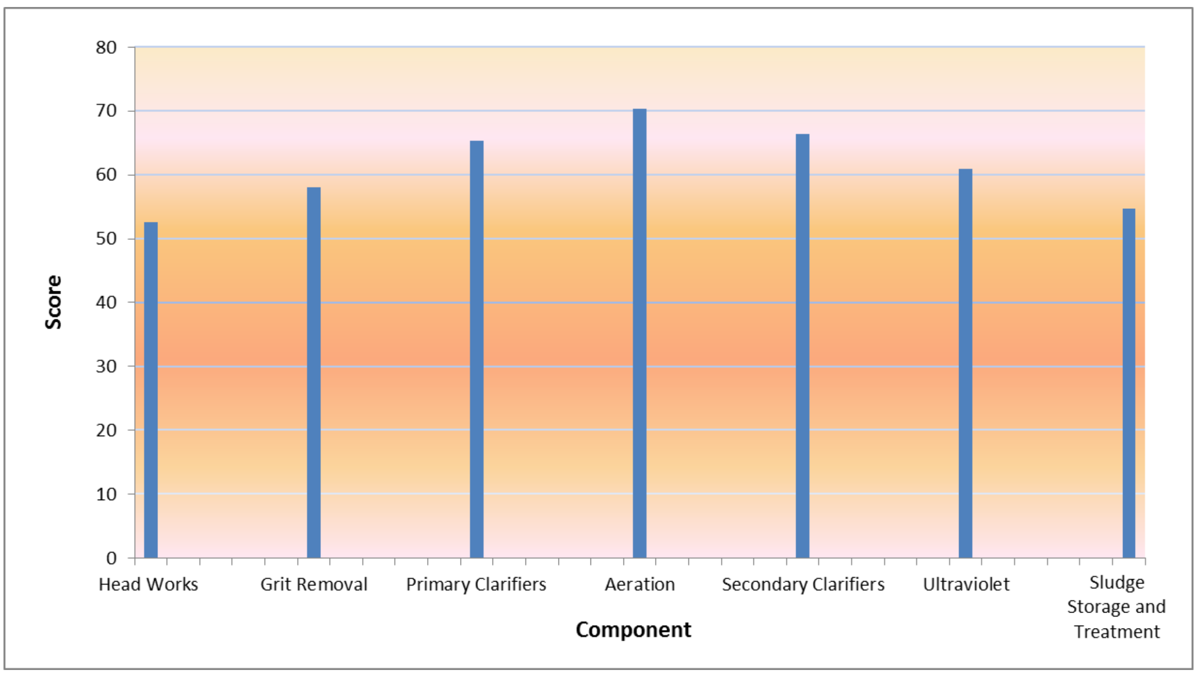


Table 13 Water Pollution Control Centre Condition Assessment

Section	Category	Year built	Age	Condition Score
Head Works	Process	2004	9	64
	Structural	1959	54	46
	Equipment	2000	13	48
	Average			53
Grit Removal	Process	2008	5	80
	Structural	1959	54	46
	Equipment	2000	13	48
	Average			58
Primary Clarifiers	Process	2005	8	68
	Structural	1973	40	60
	Equipment	2005	8	68
	Average			65
Aeration	Process	2005	8	68
	Structural	2000	13	87
	Equipment	2002	11	56
	Average			70
Secondary Clarifiers	Process	2004	9	64
	Structural	2000	13	87
	Equipment	2000	13	48
	Average			66
Ultraviolet	Process	2000	13	48
	Structural	2000	13	87
	Equipment	2000	13	48
	Average			61
Sludge Storage and Treatment	Process	2002	11	56
	Structural	1973	40	60
	Equipment	2000	13	48
	Average			55

3.4.3 System Capacity and Expansion

In 2009, the City undertook an assessment of the reserve capacity of each wastewater treatment facility. The resulting report (City of Sarnia – Wastewater Treatment Systems Reserve Capacity Calculations 2009) concluded that limited uncommitted reserve capacity existed at both facilities. The report recommended that the City undertake a detailed hydraulic assessment of the wastewater collection systems.

Hydraulic modelling of the City's wastewater collection system has also been recently completed by Stantec Consulting Limited. The objectives of this study were as follows:

i. To undertake a detailed hydraulic assessment of the City's wastewater collection system; and
ii. To develop a hydraulic model for the collection system including a review of the wastewater collection system and identify trunk sewer service areas; and
iii. To initiate a sanitary flow monitoring program to permit a more detailed determination of actual flows in the trunk sewer systems under low and peak flow events; and
iv. To identify hydraulically deficient trunk sewers as well as identifying areas of high Infiltration/Inflow (I/I) including recommendations for improvements.

Hydraulic modelling of the wastewater collection system included pumping stations, forcemains, and analysis to identify trunk sewer systems that were hydraulically deficient and an assessment of the impact of future development on the hydraulic capacity of existing infrastructure.

The Wastewater Collection System Master Plan was developed by Stantec to provide direction to the long term management and operation of wastewater infrastructure specific to providing input to the City's long term capital planning by prioritizing water projects, assisting in long term planning, Official Plan and Zoning By Law Amendments.

In 2010, a Ministry of Environment (MOE) report indicated that the capacity of the Bright's Grove treatment facility is approaching 85% of its designed capacity. The facility also experiences operational issues, as the current treatment system does not allow for the discharge of flows during the winter period. The MOE required the City to develop a plan to expand its capacity (current rated capacity is 2,045m3/d). As recommended by the Master Plan, further environmental study was undertaken for the Bright's Grove Sewage Treatment Facility by Stantec to evaluate the expansion upgrades and options available to meet future demand.

The top two identified projects for expansion from the above study are the Bright's Grove Sewage Treatment Facility and the Bedford Pump Station.

The system capacity constraints identified through the Wastewater Collection System Master Plan have been incorporated during the development of this Asset Management Plan.

3.4.4 Data flow verification policy

The City's Engineering Department (Public Works Division) has a regular sewer inspection and flushing program. The sewer network data is being collected on a regular basis by operations staff using hand held GPS devices and the database is being updated using established protocols.

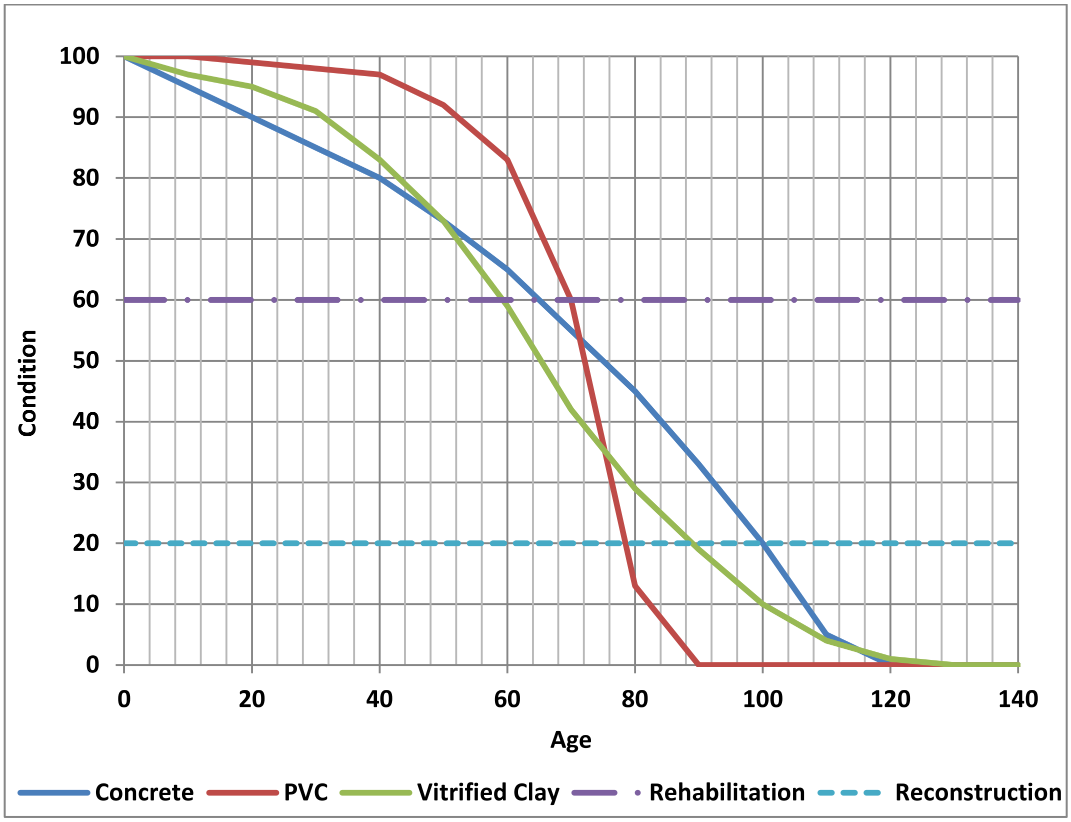
The flushing of the sewer network is being done by our operations staff and equipment; and Consultants are hired to undertake CCTV and condition assessment and provide an overall condition rating of the pipe network based on Pipeline Assessment Certification program (PACP) coding system. The sewer condition data is being collected in phases over the next 3 to 4 years.

3.4.5 Analysis

The state of the City's wastewater collection system has been analysed based on age, material, size, receiving water quality and basement flooding, available CCTV ratings from previous studies, known operational and capacity issues based on the modelling of the collection system completed by Stantec.

Deterioration curves for the wastewater collection system were also modified from the Dillon Study based on more available information on the age and type of material. These deterioration curves were used for the current condition rehabilitation window of opportunity and future condition projections.

Figure 24 Sewer Network Deterioration Curves



3.5 Road network

3.5.1 Inventory, Condition and Analysis

Infrastructure Management Services (IMS) carried out a detailed pavement condition assessment and road need analysis using IMS pavement management program. The analysis provided information on measured conditions; road classification; construction cost estimates; construction needs; identified critical deficiencies; and provided a list of the roads in order of priority rating with respect to reconstruction and/or upgrades.

Traditionally collected road need assessments within the City were done visually in terms of current need in a very generalized and subjective manner. The approach adopted by IMS Infrastructure for the pavement condition assessment was fully automated. The detailed distress and roughness survey was using Ministry of Transportation and Ontario Good Road Association Methodology.

The state of road infrastructure is shown in the following figure.

Figure 25 State of Road Network

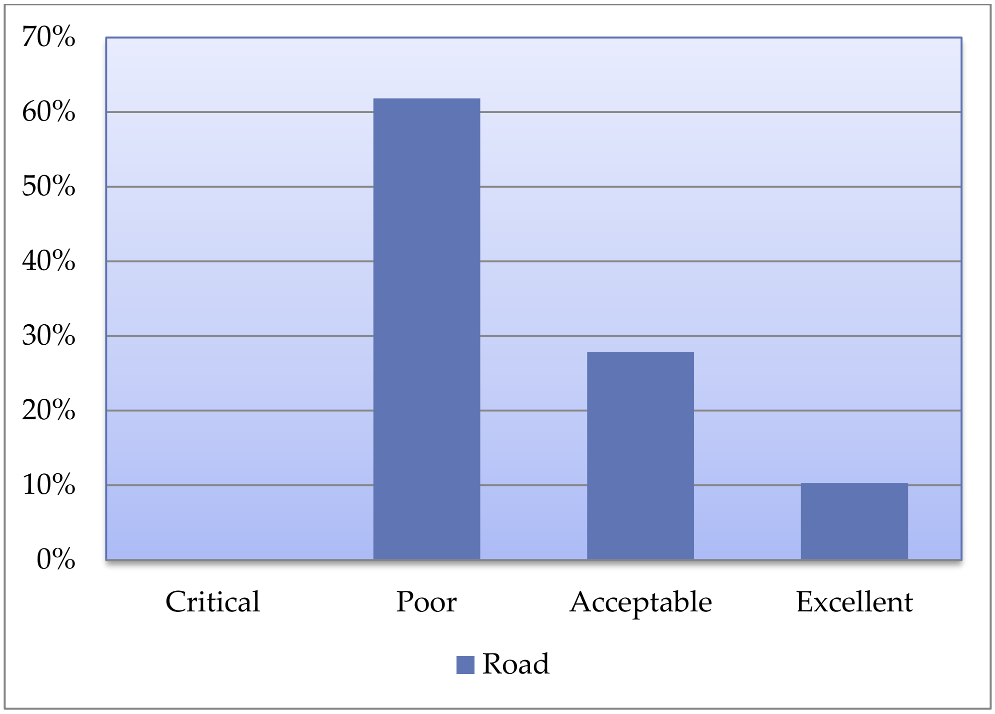
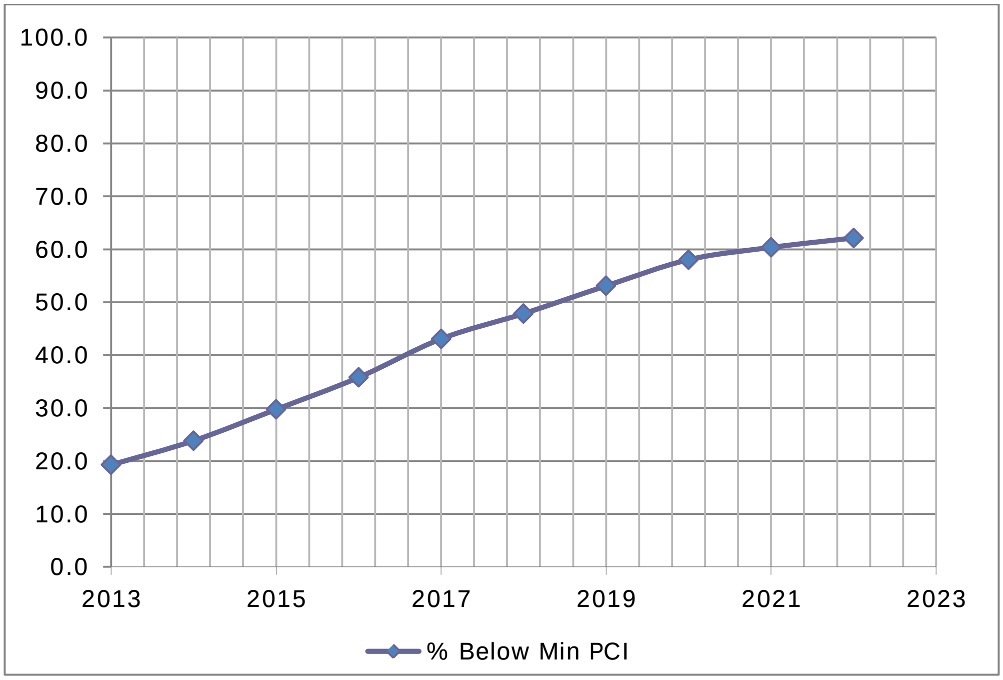


Figure 26 Percentage of Road Network below Minimum PCI



The surface distress and roughness data collected by IMS is aggregated to the sectional level for each pavement management section in the City's inventory database in the form of a distress manifestation index (DMI) and Riding Comfort Index (RCI). These indices were then combined into overall Pavement Condition Index or PCI which provides an overall condition of each section and forms the basis of required rehabilitation need.

3.5.2 System Expansion

The City is currently in the process of carrying-out its Transportation Master Plan Study. The future expansion needs will be assessed as part of this study based on the future growth and population projection. The outputs and recommendations from this plan will also be incorporated into future iterations of this Asset Management Plan.

3.5.3 Data flow verification policy

The City plans to carry out the road assessment and need study for its entire road network on a five-year interval. This plan will be updated to reflect the conditions and need of the road network accordingly.

Some of the results of the pavement assessment are included in this plan as annexures.

3.6 Bridges and Culverts

The City hired Engineered Management System in 2012 to carry out assessment of all its Bridges and Culverts in accordance with the Ontario Structure Inspection Manual. The Bridge and Culvert assessment are done by the City every two years as mandated by Public Transportation and Highway Improvement Act. Engineered Management System also prepared the 20 years Capital Improvement Plan for all the bridges and culverts using Bridge Management System.

The study report contains a summary of findings, recommendations and prioritization of rehabilitative maintenance for the bridge and culvert structures in The City of Sarnia. This report summarizes findings and explains in detail how the recommended programs have been determined. The summary of the findings of the assessment are attached with this plan as annexures.

The following table and chart summarize key aspects of the City of Sarnia's Bridge and Culvert inventory.

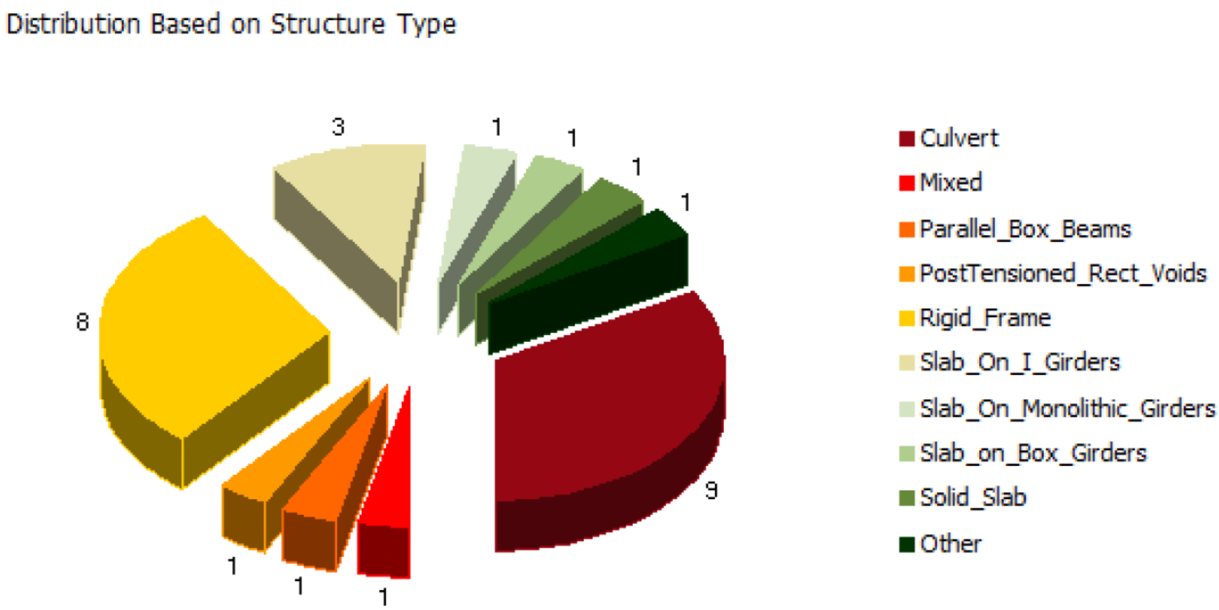
Table 14 Summary of Bridge Inspections

Structure ID	MTO Site No.	Bridge Name	Road Name	Stucture Location	Condition Index (BCI)	Inpection Date
000260	14-0000	Telfer Road	Telfer Road	0.38km South of Confederation Line	0	08/27/2012
000270	14-0000	Waterworks Road	Waterworks Road	0.63km North of Churchill Line	0	08/23/2013
000280	14-0000	Brigden Road	Brigden Road	1.06km South of Churchill Line	0	08/27/2012
000310		Old Lakeshore Road Over Cull Drain	Old Lakeshore Road	0.67 km East of Huron Shores Drive	0	09/05/2012
000200	14-0000	Blackwell Sideroad	Blackwell Sideroad	0.69km North of Michigan Line	27	08/27/2012
000320		Vidal Street Walkway	Vidal Street	0.25 km West of Donahue Bridge	39.6	08/24/2012
000160-3-3	14S-76	Donohue Bridge (North Structure)	Vidal Street	0.35km South of Confederation Street	43.3	08/23/2012
000230	14-0000	Confederation Line	Confederation Line	0.2km West of Blackwell Sideroad	47.6	08/22/2012
000160-1-3	14S-76	Donohue Bridge (South Structure)	Vidal Street	0.35km South of Confederation Street	59.3	08/23/2012
000090	14S-84	Perch Creek Bridge	Telfer Sideroad	0.10km North of Churchill Road	60.9	08/24/2012
000160-2-3	14S-76	Donohue Bridge (Centre Structure)	Vidal Street	0.35km South of Confederation Street	72.5	08/23/2012
000060	14S-41	Perch Creek Bridge	Blackwell Sideroad	0.20km South of Michigan Avenue	76.7	08/24/2012
000070	14S-373	Jackson Road Bridge	Jackson Road	0.60km East of Telfer Sideroad	79.3	08/22/2012
000150	14S-343	Kenny Bridge	Vidal Street	0.1km North of Kenny Street	79.6	08/24/2012
000040	14S-374	Michigan Avenue Bridge	Michigan Avenue	0.60km East of Telfer Sideroad	79.8	08/22/2012
000300		McGregor Sideroad Over Cole Drain	McGregor Sideroad	0.01 km South of Plank Road	82.9	08/27/2012
000250	14-0000	Confederation Line Over Waddel Creek	Confederation Line	0.27km West of Telfer Road	85.1	08/23/2012
000050	14S-43	Perch Creek Bridge	Michigan Avenue	0.20km East of Blackweel Sideroad	90.8	08/22/2012
000180	14S-381	CSX Overpass	River Road	0.6km West of Churchill Road	91.5	08/24/2012
000030	14S-51	Cow Creek Bridge	Michigan Avenue	0.3km West of Mandaumin Avenue	92.1	08/22/2012
000020	14S-46	Perch Creek Bridge	Telfer Sideroad	0.20km South of Blackwell Road	92.4	08/22/2012
000100	14S-81	Scott Road Bridge	Scott Road	0.18 km North of LaSalle Road	96.3	08/24/2012
000010	14S-49	Cow Creek Bridge	Old Lakeshore Road	0.80km West of Maudaumin Sideroad	97.5	08/22/2012
000240	14-0000	Confederation Line Over Perch Creek	Confederation Line	1km East of Blackwell Sideroad	98.7	08/23/2012
000110	14S-556	Scott Road Culvert	Scott Road	0.50km South of St. Andrew	100	08/27/2012
000190	14S-0000	Michigan Road	Michigan Road	0.62 km East of Blackwell Sideroad	100	08/27/2012
000210	14-0000	Finch Drive	Finch Drive	0.19km South of London Road	100	08/27/2012
000220	14-0000	Wellington Street	Wellington Street	0.5km West of Finch Drive	100	08/27/2012
000290	14-0000	Marshall Line	Marshall Line	0.25km West of Brigden Road	100	08/27/2012

Table 15 Bridge and Culvert Capital Needs

Structure Type / Usage	Count	Replacement $	Identified Rehab. Needs $
Vehicular	**25**	**$64,078,457**	**$16,843,613**
Solid Slab	1	$512,572	$572,257
Rigid Frame	8	$13,534,145	$1,870,775
Slab on I Girders	3	$5,415,968	$793,549
Slab on Monolithic Girders	1	$1,192,238	$466,749
Parallel Box Beams	1	$2,609,060	$607,242
Post-Tensioned Voided	1	$7,712,902	$652,518
Mixed	1	$25,862,056	$10,526,911
R/C Culvert	4	$4,903,654	$95,089
CSP Culvert	5	$2,335,862	$1,258,523
Pedestrian	**2**	**$2,975,442**	**$3,016,358**
Slab on Box Girders	1	$1,092,001	$659,271
Truss	1	$1,883,441	$2,357,087
Overall	**27**	**$67,053,899**	**$19,859,971**

Figure 27 Bridge and Culvert Structure Distribution



4. Desired Levels of Service

The expected levels of service in terms of various criteria and thresholds for the linear infrastructures were determined in the initial inventory assessment and identification of Capital Needs for the Linear Assets by Dillon Consulting Limited in 2006 and modified afterwards during asset management committee meetings. For the purpose of this plan, the following desired service level criteria for replacement and rehabilitation are being proposed.

Service levels continue to be discussed at the steering committee level and the plan will again be updated in the future to incorporate any changes.

Table 16 Linear Infrastructure Service Level Thresholds

Time of Improvement	Road (Arterial)	Road (Collector)	Road (Local)	Water	Sanitary	Storm
Rehabilitation	≤55	≤50	≤45	≤70	≤60	≤60
Replacement	≤45	≤35	≤30	≤30	≤20	≤20

The City aims at achieve major reductions in combined sewer overflows and basement flooding. The City also aims to provide adequate fire flows and pressure in the entire water distribution system.

The City has achieved significant progress in mitigating the combined sewer overflows and the basement flooding by carrying out its sewer separation programs. This has also resulted in improved receiving water quality in the St. Clair River.

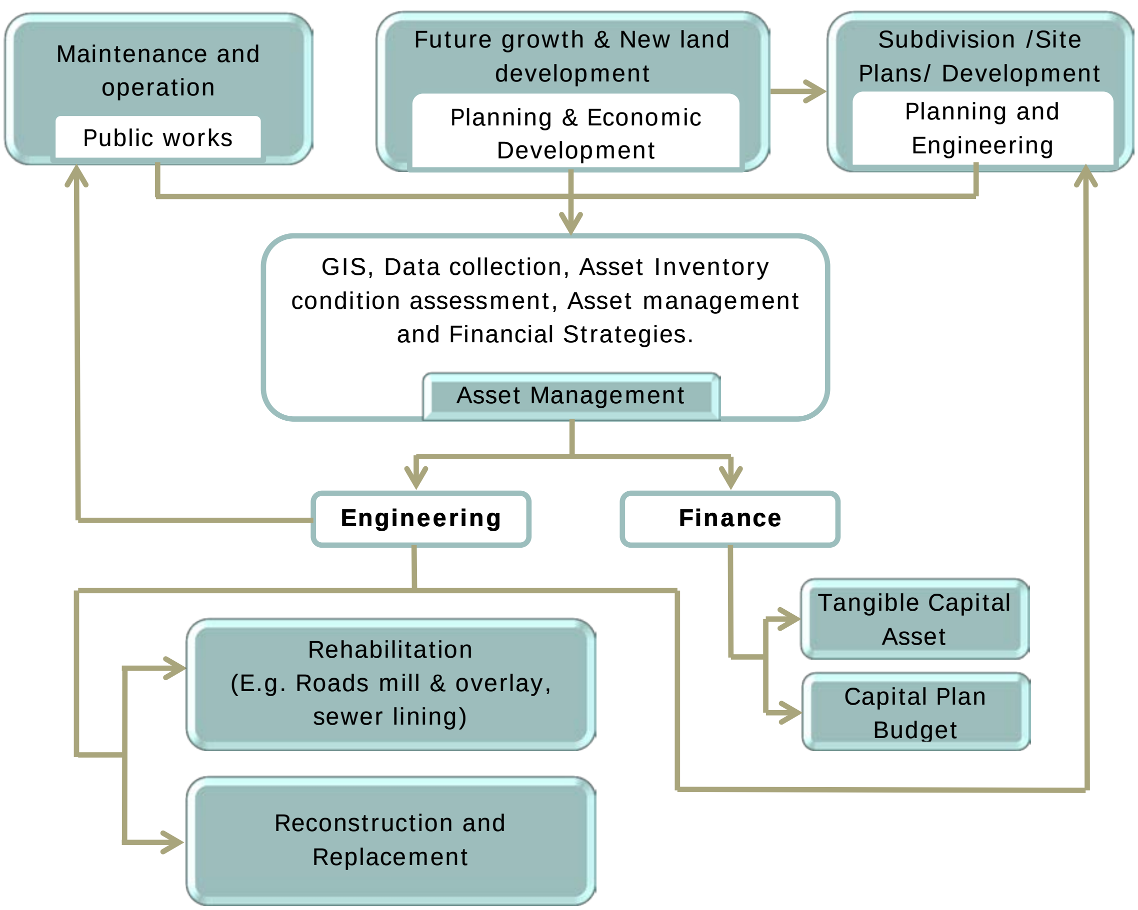
Over the next 10 years, the City plans to significantly reduce the watermains break levels from the current level of over 21 breaks per 100 kilometres.

5. Asset Management Strategy

5.1 Organization Overview of Asset Management Strategy

At an organization level, the City of Sarnia's asset management process for the core infrastructure services involves interactions among various departments of the City. The interactions and decision making is shown in the flow chart below. Information related to maintenance, operation and repair activities, (through maintenance management system), condition assessment data, future growth, subdivision and site plan development, (through modelling and master planning process) flow into the asset management system. The output from the asset management plan will serve as a framework for the City's capital project planning; capital project financial planning; reconstruction and rehabilitation strategies; and maintenance, operation and repair activities.

Figure 28 City of Sarnia Asset Management Strategy Flowchart



The City's maintenance management system is still being implemented and once implemented will be fully integrated with the asset management process. The City is also in the process of carrying out water distribution system and transportation system master planning studies.

5.2 Integrated Approach for Linear Infrastructures

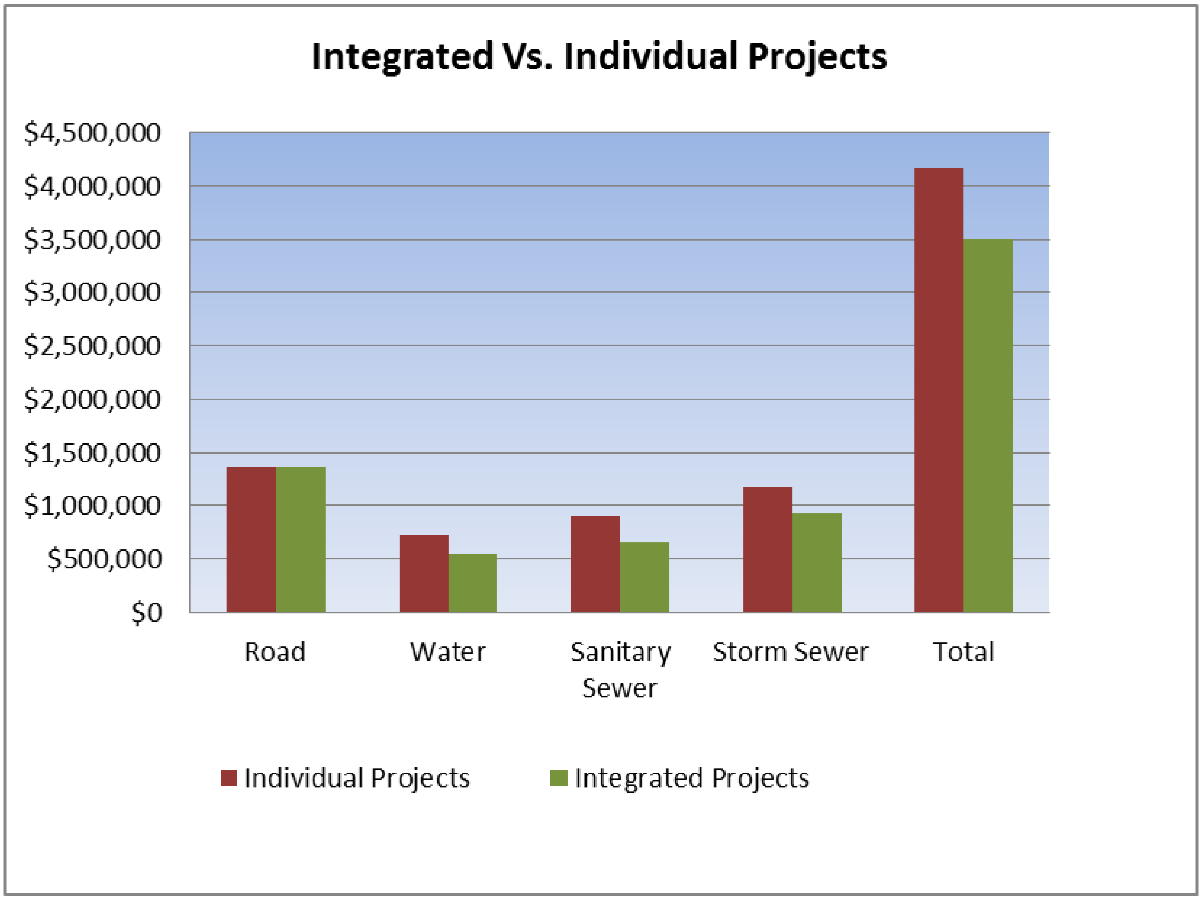
The City of Sarnia owns, operates and maintains all major core infrastructures within the right of way to make the most cost-effective decisions for the reconstruction and rehabilitation of infrastructure assets it is extremely beneficial to use an integrated approach.

An integrated approach involves simultaneously analyzing assets that are located in a close proximity to each other, such as a road and the buried infrastructure beneath it (i.e. watermains, sanitary sewers and storm sewers).

Figure 29 Integrated Approach for Linear Infrastructures

Infrastructures requiring attention can be postponed or accelerated in order to coordinate the timing with other improvements. Capital projects are the most economical when the road and buried infrastructures are reconstructed at the same time, essentially reducing road reconstruction costs.

Figure 30 Sample Project Replacement Cost



5.3 Planned Actions

5.3.1 Non-infrastructure Solutions

Through hydraulic modelling of the City's wastewater collection system, recently completed by Stantec, it has been established that the City has major storm runoff inflow and infiltration (I/I) issues with its wastewater collection system. During a rain event, the wet weather flows are significantly high in the wastewater collection system even in separated sewer areas, causing capacity constraints on the downstream infrastructure including pump stations and wastewater treatment facilities. Engineering Staff are currently establishing a plan for Inflow and Infiltration (I/I) reduction.

Some of the measures recommended for reduction of I/I are as follows:

i. Roof leader disconnection programs,
ii. Green programs for reducing storm water runoff,
iii. Sump pump disconnection from sanitary to storm
iv. Flow monitoring programs to isolate and identify the areas contributing runoff inflows into the system.

The City has revised its stormwater management standards incorporating the potential impact of climate change and Low Impact Development stormwater management practices.

5.3.2 Maintenance, Renewal and Rehabilitation

5.3.2.1 Road Network

Currently the City carries out regular maintenance activities of its road network based on minimum maintenance standards and customer complaints. This asset management plan recommends carrying out preventive maintenance activities based on windows of opportunity.

Currently, the City carries out rehabilitation/resurfacing of roads every time they are in need. Due to funding limitations, no independent reconstructions of road were done in the past unless other assets in close proximity underneath the road section were to be reconstructed.

The following road maintenance, rehabilitation and reconstruction options/alternatives are recommended based on the window of opportunity/remaining service life of the road section.

Table 17 Road Treatment Options/Alternatives

	Activities	Trigger in Years			Average Unit Price per Meter
		Arterial	Collector	Local	
Maintenance	1st Rout & Seal	10	12	14	-
	2nd Rout & Seal	16	17	18	-
Rehabilitation and Reconstruction Options	Resurfacing (Top Layer)	20	21	22	$225.81
	Complete Asphalt Replacement (Top & Bottom Layers)	22	23	24	$369.20
	Minor Rehabilitation (Top and Bottom Layers) with spot curb and gutter repairs	24	25	26	$401.20
	Major Rehabilitation (Top and Bottom Layers) with full curb and gutter repairs	26	27	28	$601.20
	Major Reconstruction	28	31	34	$1,320.24

The maintenance options stated in the preceding table based on window of opportunity are proposed to be carried out on a regular basis in the future. For rehabilitation and reconstruction activities, if one of the rehabilitation or reconstruction option is carried out on a section of road, the road service life will be extended corresponding to the treatment. Therefore, any one of the rehabilitation options will be implemented for individual sections of road within the window of opportunity according to the current road conditions.

The following graphs illustrate the extended service life and estimated cost per running meter for local roads corresponding to each rehabilitation and reconstruction options.

Figure 31 Deterioration Curve Road Rehabilitation Option 1

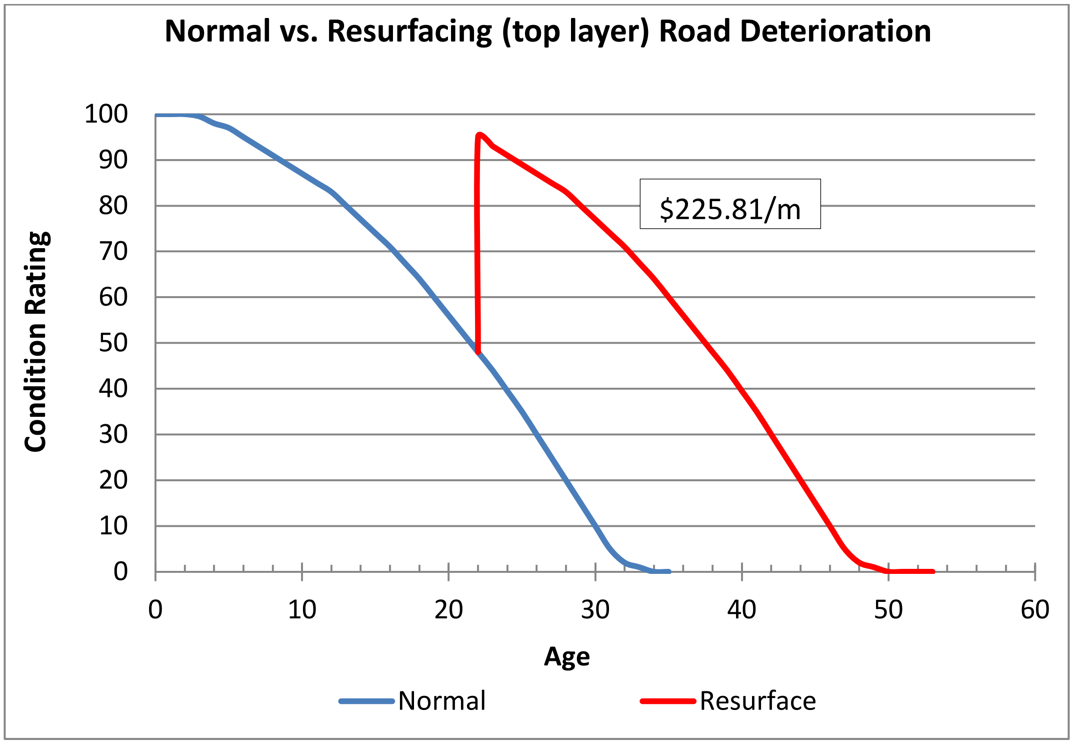


Figure 32 Deterioration Curve for Road Rehabilitation Option 2

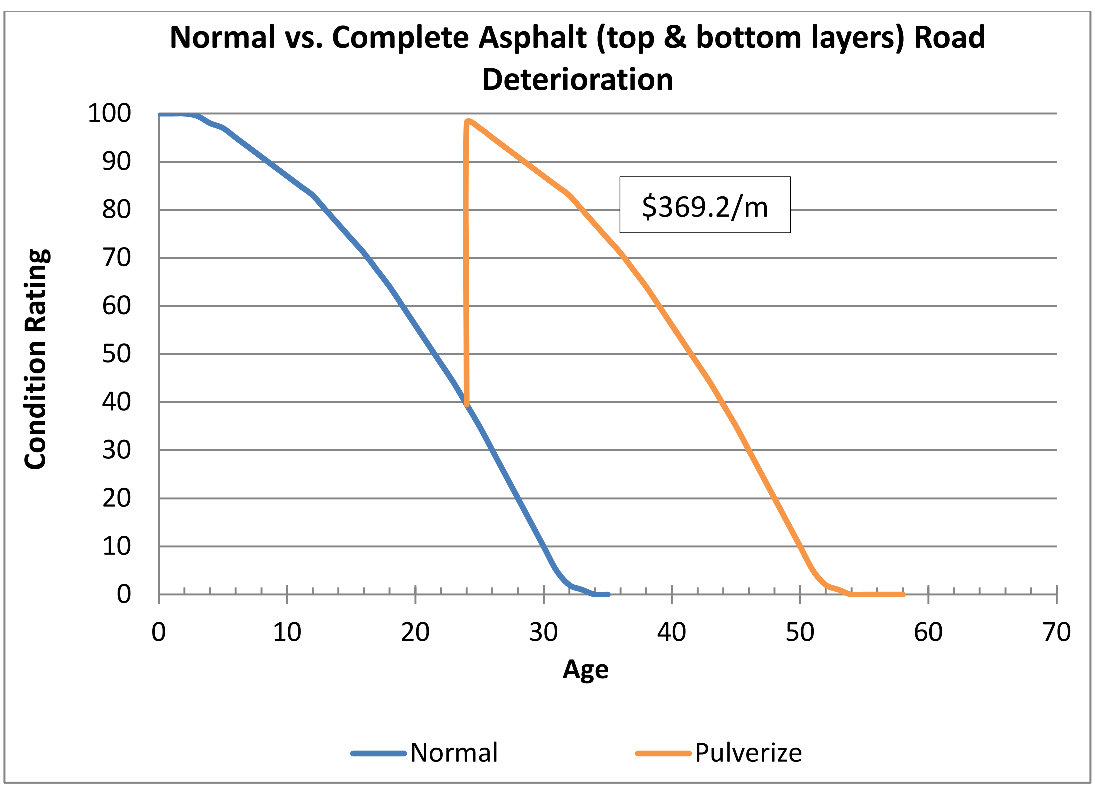


Figure 33 Deterioration Curve for Road Rehabilitation Option 3

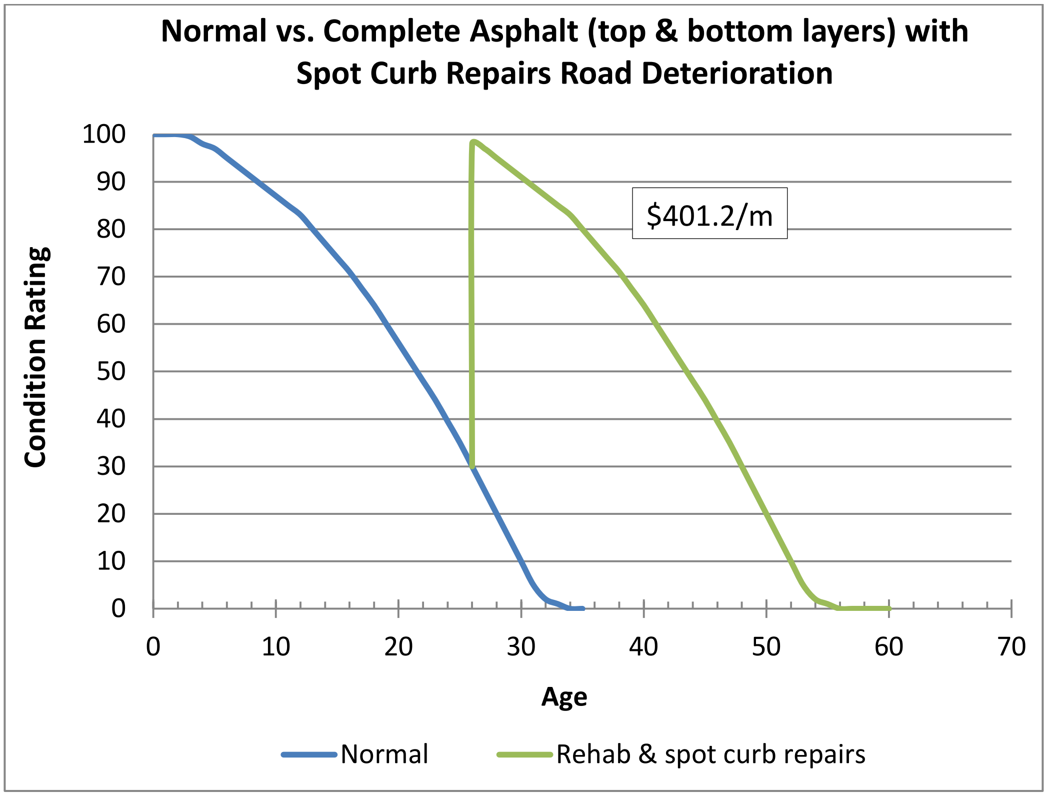


Figure 34 Deterioration Curve for Road Rehabilitation Option 4

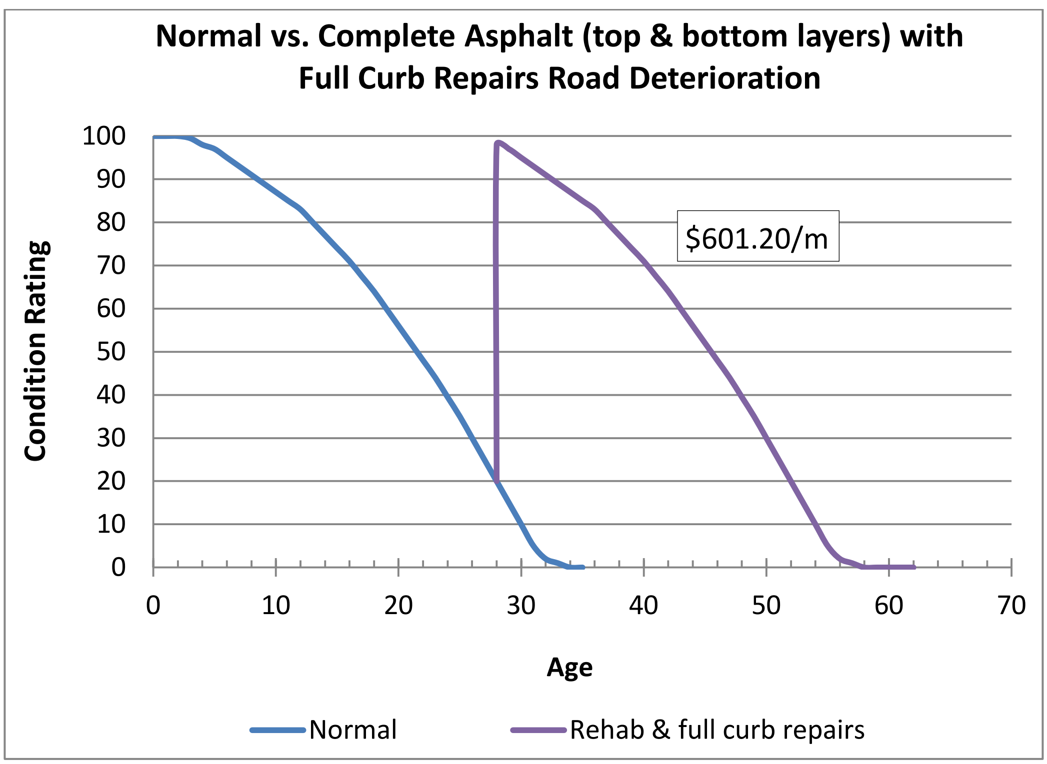
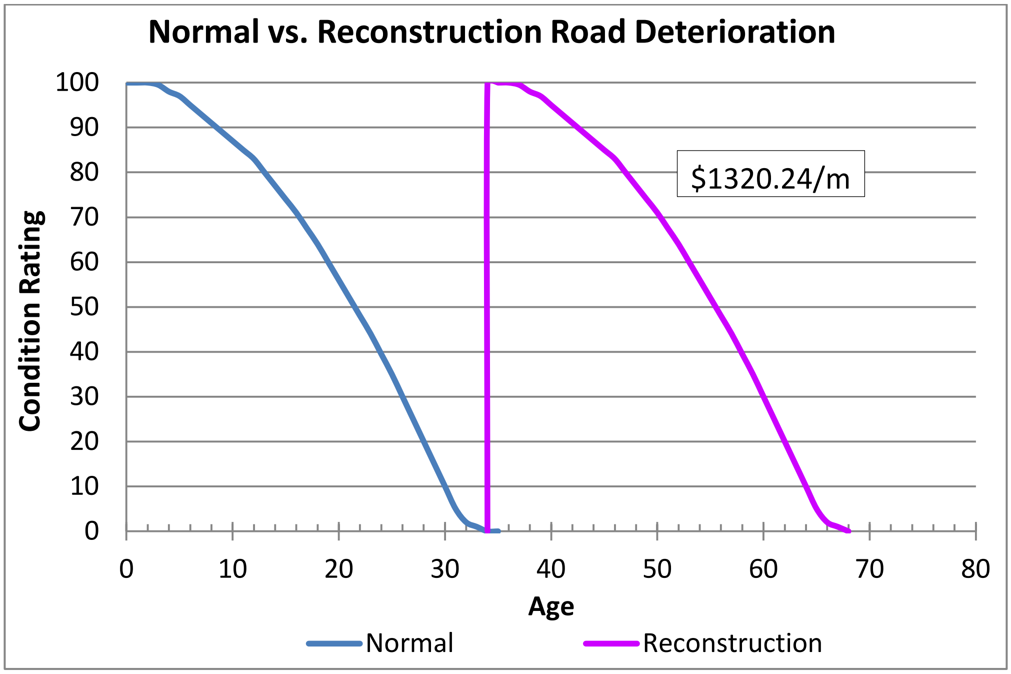


Figure 35 Deterioration Curve for Road Reconstruction



The following strategies/scenarios have been proposed for future road rehabilitation and replacement based on the overall condition of the road:

1. Resurface top layer of asphalt a road section one time, then carry out complete asphalt replacement (top and bottom layer) on the road section until other assets in close proximity underneath are due for reconstruction

2. Resurface top layer of a road section, then carry out complete asphalt replacement (top and bottom layer) with spot curve repairs, until other assets in close proximity underneath are due for reconstruction

3. Resurface top layer of a road section, then carry out complete asphalt replacement (top and bottom layer) two times until other assets in close proximity underneath are due for reconstruction

4. Resurface top layer of a road section three times until other assets in close proximity underneath are due for reconstruction

5. Resurface two times, then carry out complete asphalt replacement (top and bottom layer) on the road section one time until other assets in close proximity underneath are due for reconstruction

The following graphs represent the extended road service life with cost per running meter by each strategy:

Figure 36 Proposed Strategy I for Road Rehabilitation

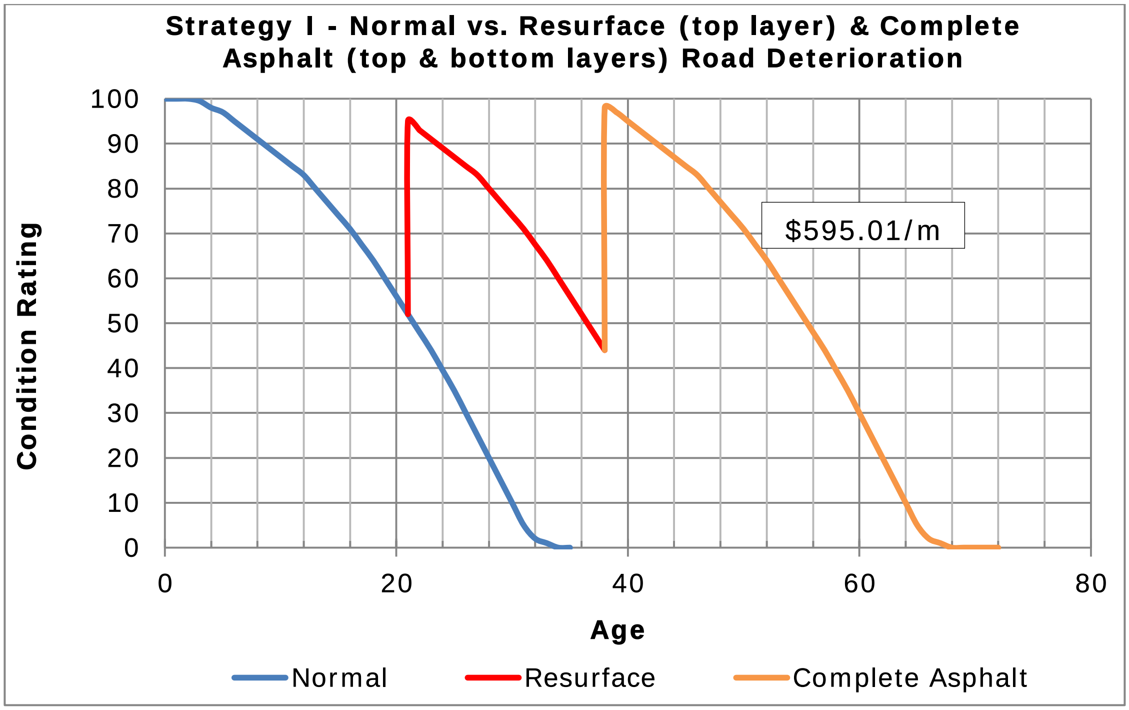


Figure 37 Proposed Strategy II for Road Rehabilitation

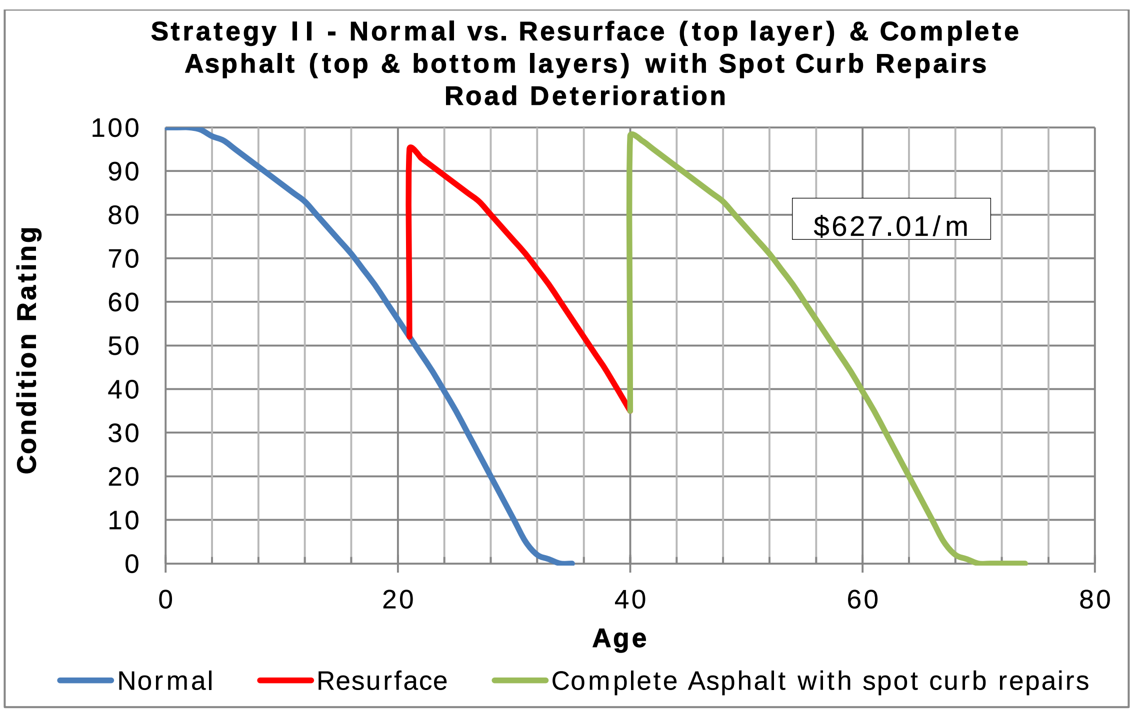


Figure 38 Proposed Strategy III for Road Rehabilitation

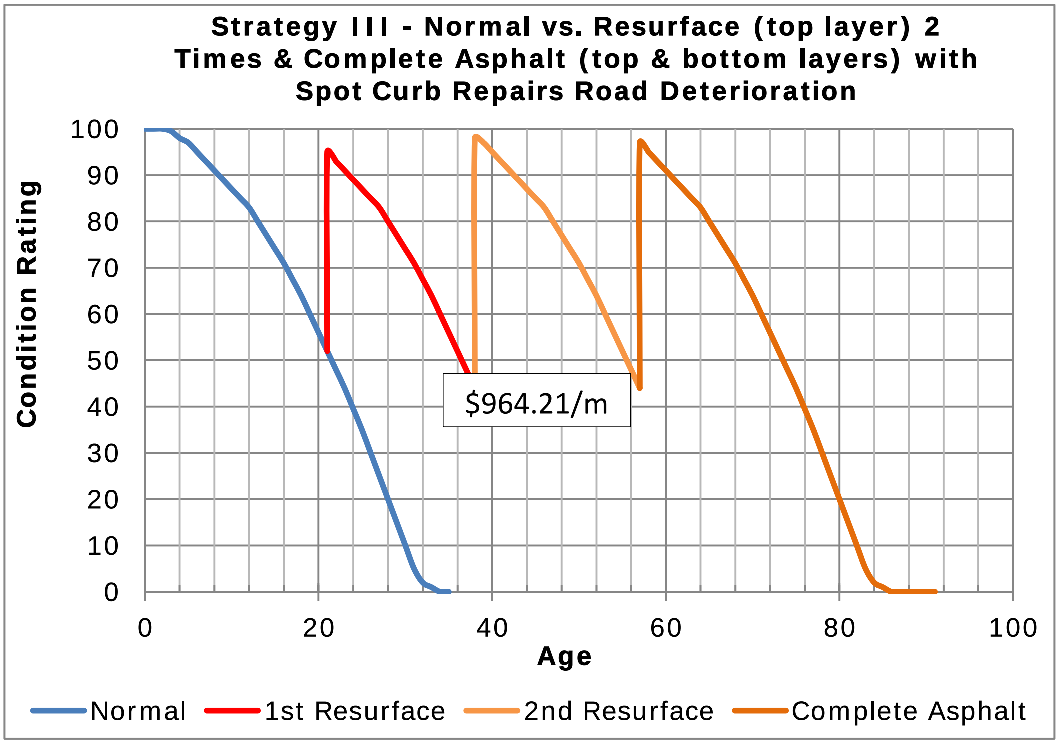


Figure 39 Proposed Strategy IV for Road Rehabilitation

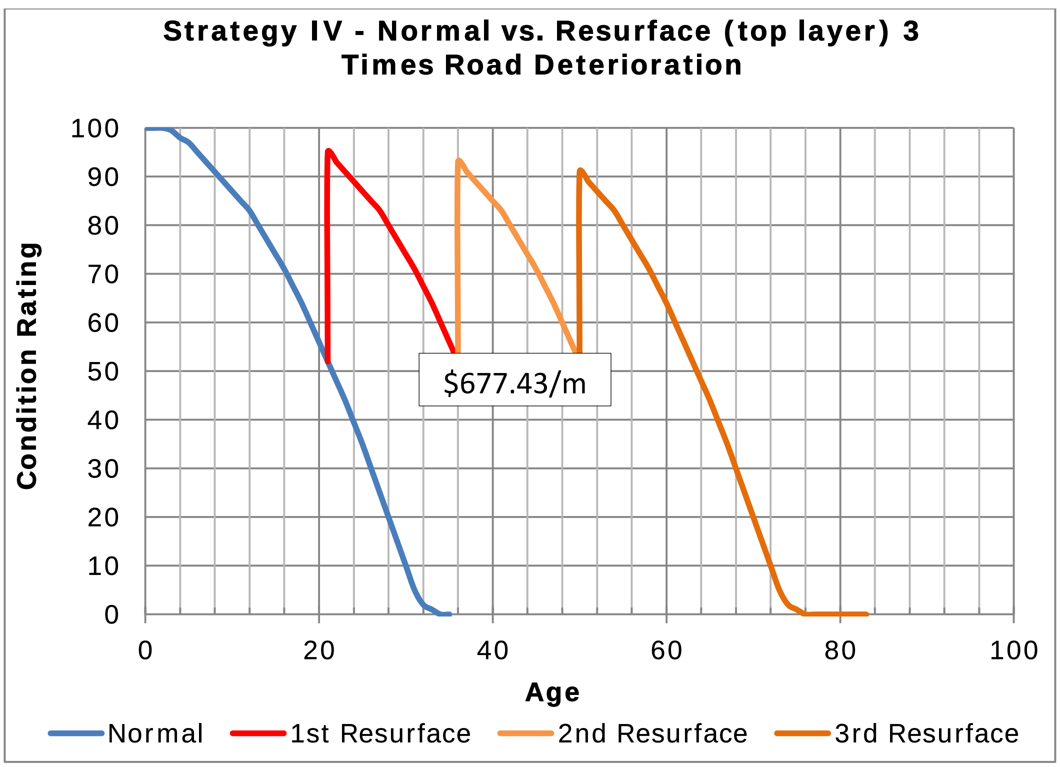


Figure 40 Proposed Strategy V for Road Rehabilitation

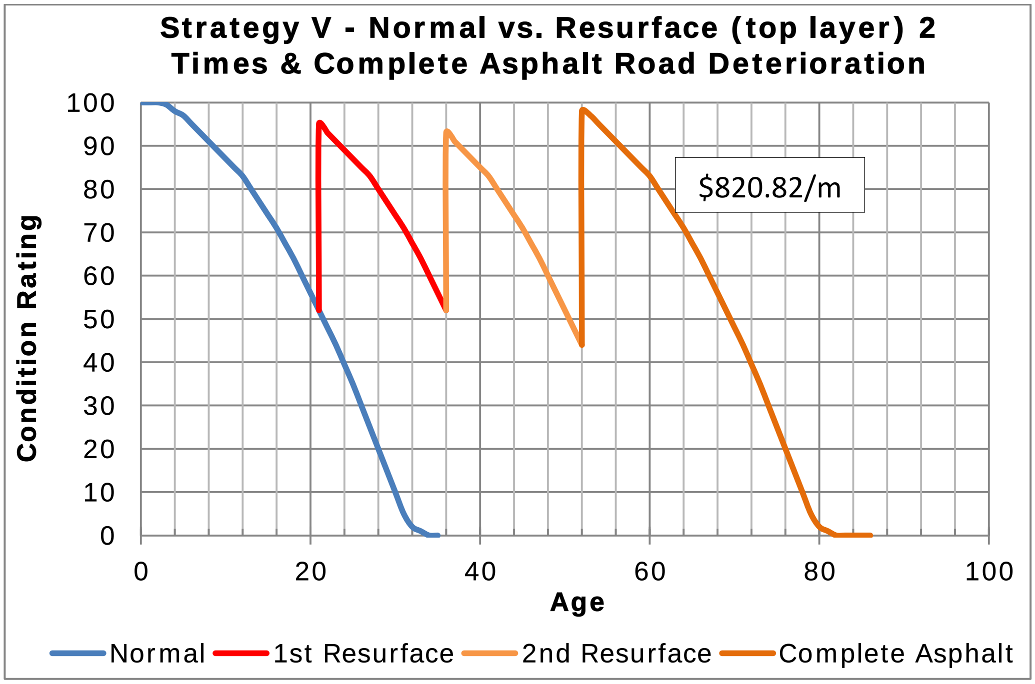


Table 18 Rehabilitation Strategies for Roads

	Strategies	Unit Cost per metre	Extended Road Service Life Years	Unit Cost / Year
I	Resurfacing (top layer) at 21 years + Complete Asphalt (top and bottom layers) at year 38	$595.01	34	$17.50
II	Resurfacing (top layer) at 21 years + Complete Asphalt (top and bottom layers) with Spot Curb Repairs at year 40	$627.01	36	$17.42
III	Resurfacing (top layer) at 21 years + Complete Asphalt (top and bottom layers) at year 38 and year 57 respectively	$964.21	52	$18.54
IV	Resurfacing (top layer) at year 21, year 36 and year 50 respectively	$677.43	42	$16.13
V	Resurfacing (top layer) at year 21 and year 36 respectively + Complete Asphalt at year 52	$820.82	48	$17.10

Based on the road deterioration graphs and strategy cost table, strategy IV appears to be the most economical alternative, however, strategies will be adjusted according to individual road conditions. Notwithstanding that, it is not the City's preference to reconstruct a road alone, some rural road sections such as Blackwell SideRoad, Waterworks Road, and Plank Road are recommended for reconstruction as there are no buried infrastructures on these roads except watermains on some roads.

5.3.2.2 Sewer Network

Separating the existing old combined sewers has been one of the major focuses of the City since 2004. The combined sewer overflows to the St. Clair River and basement flooding in the core area of the City have been major concerns for the City. Therefore, the objectives of the sewer separation projects are to achieve reduction in the combined sewer overflows to the St. Clair River and mitigate basement flooding in the core area of the City. This will also result in improved water quality in the St. Clair River. The St. Clair River in Sarnia is also listed under Area of Concern for the receiving water quality, and hence one of the recommendations under the St. Clair River Remedial Action Plan is to carry on the sewer separation work within the City.

Most of the combined sewers are concentrated in the core area of the City. To achieve the City's objective of complete sewer separation, the existing combined sewers are replaced with a new storm sewer and a new sanitary sewer, eliminating the option of sewer rehabilitation.

A combined sewer project will generally include the complete reconstruction of all infrastructures within the right of way including installation of new storm sewer, new sanitary sewer, new watermains, new curb and gutters, sidewalks etc.

The City has recently started relining of its old concrete sewers to extend the service life for sewers that have a diameter 500mm or higher. There are two relining strategies the City currently explores, non-structural and structural relining. The following graphs compare the extended service life for non-structural, structural relining technologies with reconstruction of concrete sewers.

Figure 41 Sewer Non-Structural Relining Deterioration Curve

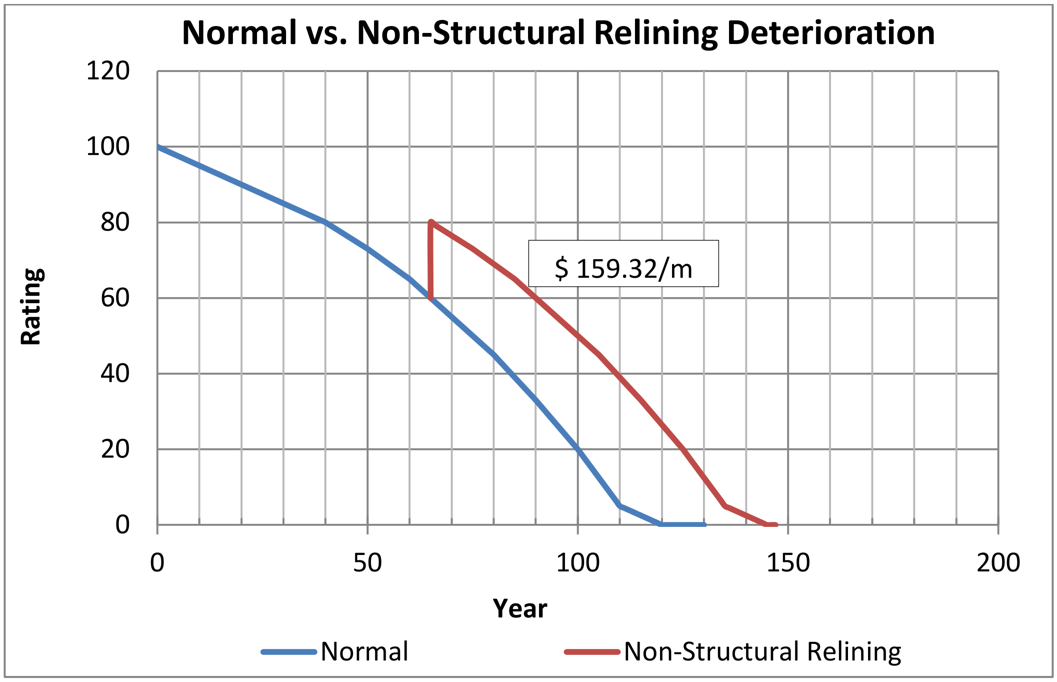


Figure 42 Sewer Structural Relining Deterioration Curve

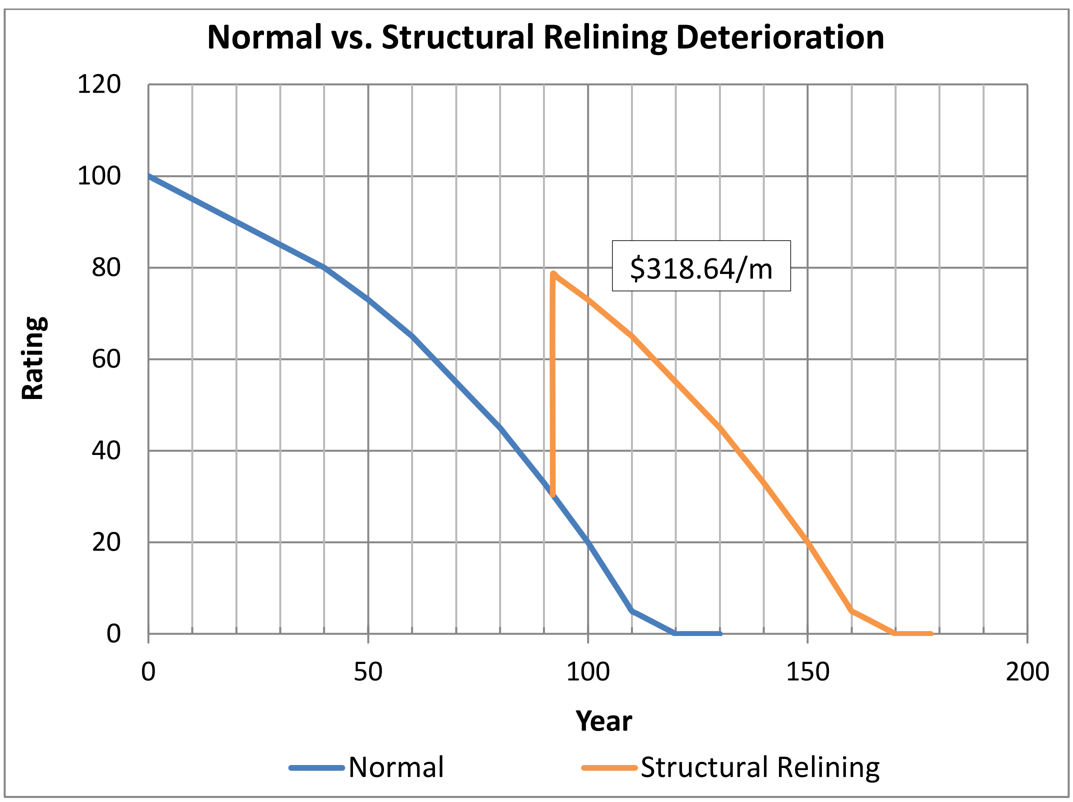
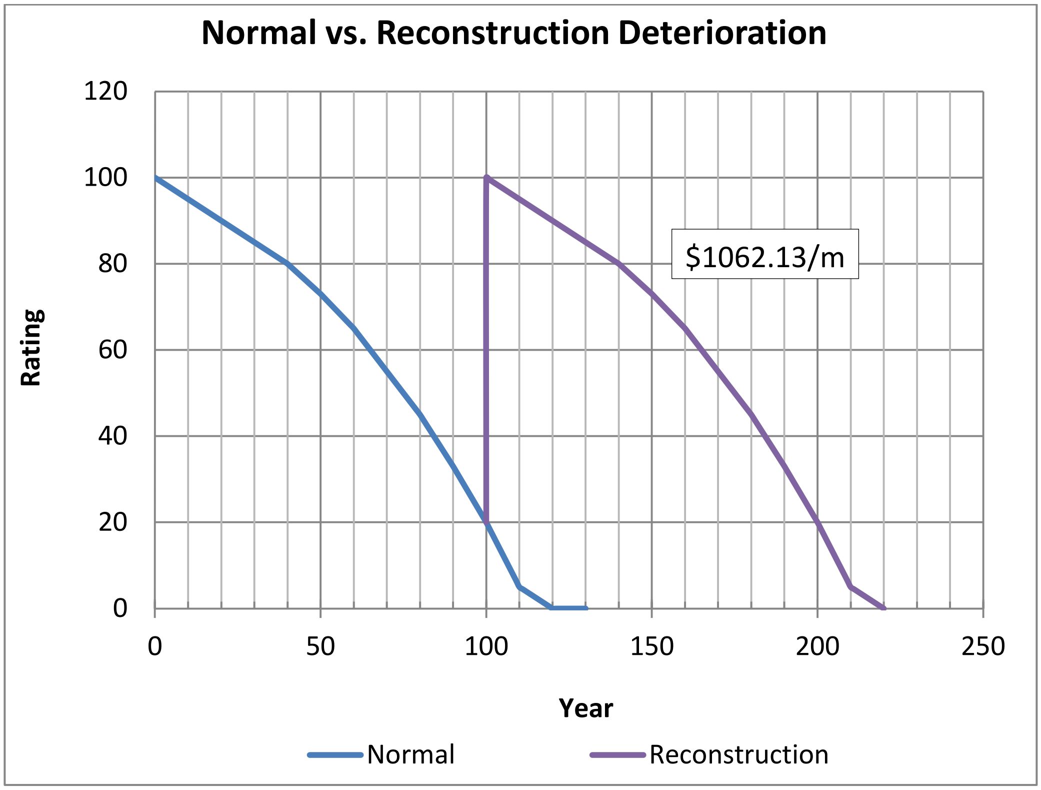


Figure 43 Sewer Reconstruction Deterioration Curve



The table below provides an example of cost comparison of sewer relining and reconstruction. It is recommended to continue doing relining on sewers based on the window of opportunity. Currently the condition assessment of the sewer network is ongoing, and the sewer reconstruction and rehabilitation strategies will be revised to reflect the actual condition of the sewer in future.

Table 19 Typical Cost of Sewer Rehabilitation Strategies

Options	Cost (500 mm concrete sewer)	Extended Service Life (years)
Reconstruction	$1,062.13	100
Non-Structural Relining	$159.32	25
Structural Relining	$318.64	50

5.3.2.3 Water Network

The City has been exploring alternative rehabilitation technologies such as pipe bursting, spray on coating and internal relining. However, there are several reasons that the City does not carry out rehabilitation activities for watermains:

1. The City of Sarnia is an open area where trench excavations are very easy to conduct without disturbing the surrounding environment or residences.

2. The City of Sarnia only maintains the water distribution system, where the watermain sizes are not big enough to apply rehabilitation activities.

3. The City found that replacing a watermain is actually more economical and prudent option than rehabilitating it with rehabilitation techniques that the City had looked into.

The City will continue exploring new alternative rehabilitation options in the future. The City carries out regular watermain maintenance activities to extend the watermain service life. The following table represents activities that the City has done in the past:

Table 20 Past Maintenance Activities for Watermains

Water	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Water Main Breaks	171	113	85	113	150	88	98	104	105	98
Water Main Valve Replaced or Repaired	23	27	17	21	22	15	30	43	31	20
Water Main BV Replaced or Repaired	1	0	0	0	0	1	2	0	1	0
Valve Chambers Serviced	-	-	-	-	-	-	-	10	2	10
Service Repairs (Excavation)			93	93	122	138	133	108	73	128
Lead Services Replaced	-	-	1	2	2	12	9	5	3	17
Hydrant Repair (Excavation)	7	10	14	13	13	11	13	20	9	8
Hydrant Repair (Internal)	-	-	177		103	121	91		42	20
Hydrant Repair (External)		0							24	14
Hydrant Internal Anode		-							3	4
Hydrants Flushed	0	13	2560	2560	2560	2560	2560	2560	2599	2600
Explored. Excavation	-	-	-	-	3	0	2	0	6	1
Hydrant Back Flow Installations	4	-	24	26	35	38	32	40	37	51
Checked After Fire Use	-	-								29
Valves Operated (Program & repairs)	-	-	-	-	-	-	-		420	641
Water Quality Inquiries	-	-	-	-	-	-	-	38	42	58
Water Pressure Inquiries	-	-	-	-	-	-	-	12	28	34
Monitor Re-occurrence	-	-	-	-	-	-	-	7	9	5
Anodes Installed	0	0	0	0	0	0	0	3	33	12
Accountable Water Loss	-				8.29%	7.33%	8.25%	9.13%	4.86%	
Auto Flusher Installed	0	0	0	0	0	1	2	0	1	1
Water Adverse Reports			1	0	0	1	0	0	2	
QA Water Tests (bacT)										7
Locates							-	-	-	3905

5.4 Risks Associated with the Strategies

The City recognizes that the accuracy of data is extremely crucial to the reliability of an Asset Management Plan. Therefore, the City plans to continue ongoing data collection programs, upgrading, and refining our infrastructure database for an improved and more reliable Asset Management Plan.
The City is planning to collect data on road maintenance through implementation of a works management system on an ongoing basis to develop the road deterioration curves for various road classes. The detailed road inspection survey is planned to be carried out every five years.

The City plans to implement flow-monitoring programs to further calibrate the water and sewer modelling and measure the performance in terms of targeted reduction in combined sewer overflows, basement flooding, etc. The City will continue closed circuit television (CCTV) inspections on the sewers to further update the sewer condition data and the deterioration curves. The asset management plan will be updated to reflect the actual deterioration curve and strategies will be revised accordingly as more data is being collected and accuracy being improved. A contingency plan will be developed to address any risk associated with the strategies.

The bridge inspection is planned to be carried-out at regular intervals as per the provincial requirements.

5.5 Risk Analysis

Risk analysis is conducted across the project types based on consequence of failure and potential of failure. Potential of failure is analysed during the condition assessment of assets, which are based on criteria such as material, age, etc. Consequence of failure assesses the impact of asset failure in six primary factors, human health and safety, environment, financial, economic development, legislative requirements, and efficiency. An Analytical Hierarchy Process (AHP) was used to determine the consequence of failure index for each asset type. The weightages of each of the six factors were analyzed based on a pair-wise comparison method, and then each asset type was assigned a certain score from 0 to 10 where 10 represents the highest risk under each factor.

The top five priority projects across the asset types identified based on risk analysis are identified in Section 7 Recommendations.

6. Financing Strategy

6.1 Introduction

The financial strategy has been broken into two sections; linear and non-linear assets.

By splitting the linear infrastructure from the non-linear, this report can better identify how all the linear infrastructure components can be integrated within the right of way as recommended in the Integrated Approach to Linear Infrastructure section.

The current needs identified in the executive summary for linear and non-linear infrastructure are summarized in the following tables.

Table 21 Current Need of all Linear Core Infrastructure Assets

Asset Type	% Current Need	Estimated Cost	Length (km)
Roads	13.17%	$51,289,568.34	57.888
Water Distribution System	14.18%	$43,340,309.10	70.353
Sanitary and Combined Sewers	11.36%	$32,919,227.27	38.184
Storm Sewers	7.96%	$21,489,004.10	25.193
Total Needs		**$149,038,108.81**	

Table 22 Current Need of all None Linear Core Infrastructure Assets

Asset Type	% Current Need	Estimated Cost	Length (km)
Forcemains	16.01%	$11,546,750.55	7.822
Pump Stations	36.94%	$25,453,249.45	
Wastewater Treatment Facilities	8.36%	$8,300,000.00	
Bridges	3.68%	$2,469,785.00	
Total Needs		**$47,769,785.00**	

6.2 Funding Sources

The city utilizes the following sources of funding for capital projects:

1. Federal Gas Tax
2. Tax Levy/Operating
3. Retired Debt
4. User Fees (water and sewer fees)

Federal gas tax funding has been a stable source of funding for a variety of projects including complete road, water, sanitary, and storm reconstruction, pump station upgrades and wastewater treatment facilities upgrades. It is assumed that federal gas tax will be a steady contribution for the duration of this financial plan.

Regular contributions have been transferred from the operating budget to reserves for capital spending. In 2009 the contribution was $800,000 and, in the 2013 budget this contribution has increased to $2,030,000. Growth of $100,000 per annum has been assumed in the financial plan so that by the end of the 20 year plan the estimated contribution will be $3,830,000.

Retired debt is another key component in the funding strategy. In prior decades the majority of capital work was financed by debt. In the mid 2000's a pay as you go strategy was adopted and most projects were funded from city reserves and also grants from the federal and provincial governments. As the debt is paid off, the City is re-directing debt payments to reserves. The re-directed debt payments in 2011 were $702,538. By 2020 the anticipated re-directed debt payments will be $3,520,373. By the end of the plan re-directed payments are projected to be $4,818,673.

User fees consist of water and sewer charges utilized for capital projects. A growth of 2% per year has been assumed for the duration of this plan.

Figure 44 Linear Asset Funding Sources Breakdown 2014

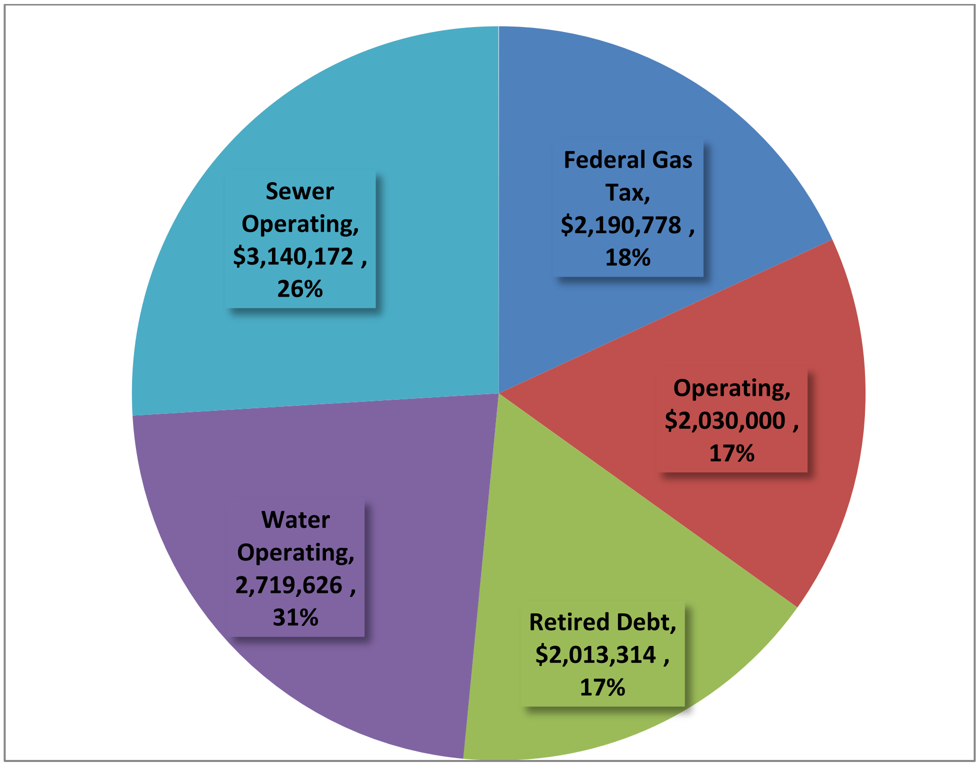


Figure 45 Linear Asset Funding Sources Breakdown 2019

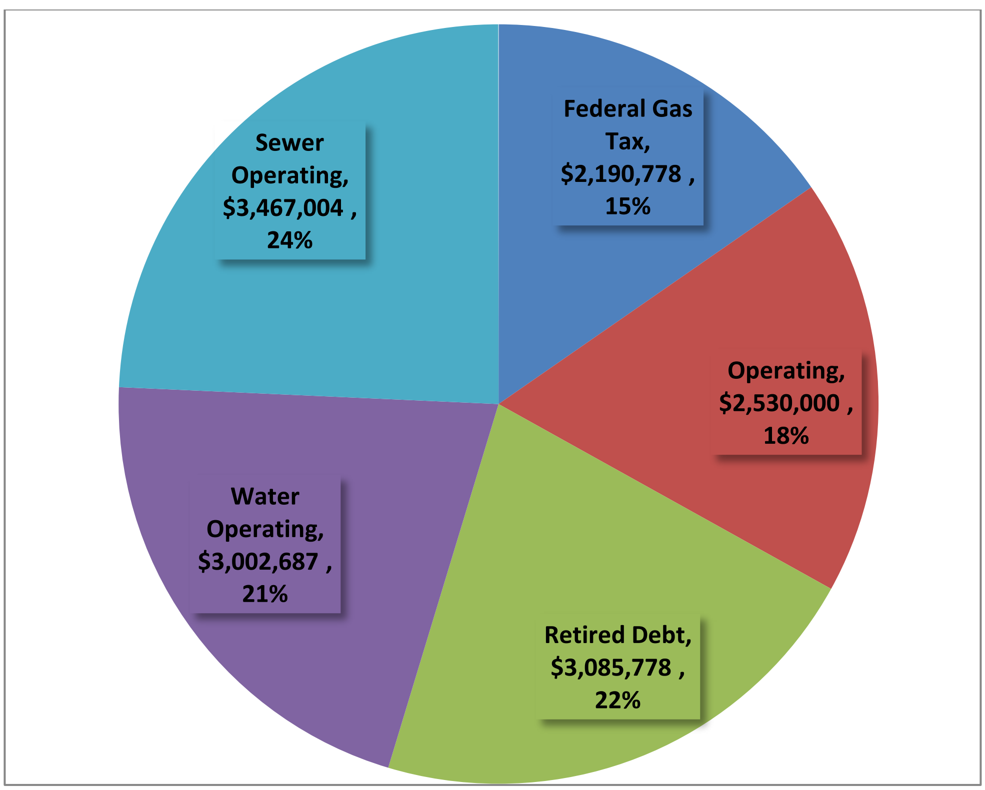


Figure 46 Linear Asset Funding Sources Breakdown 2024

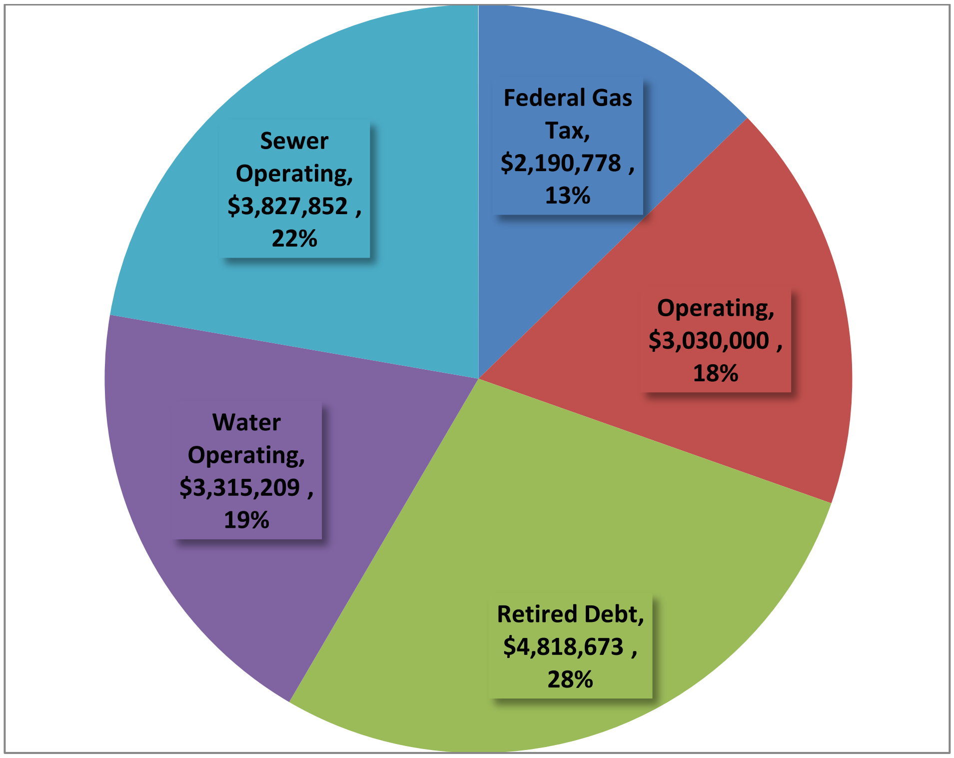
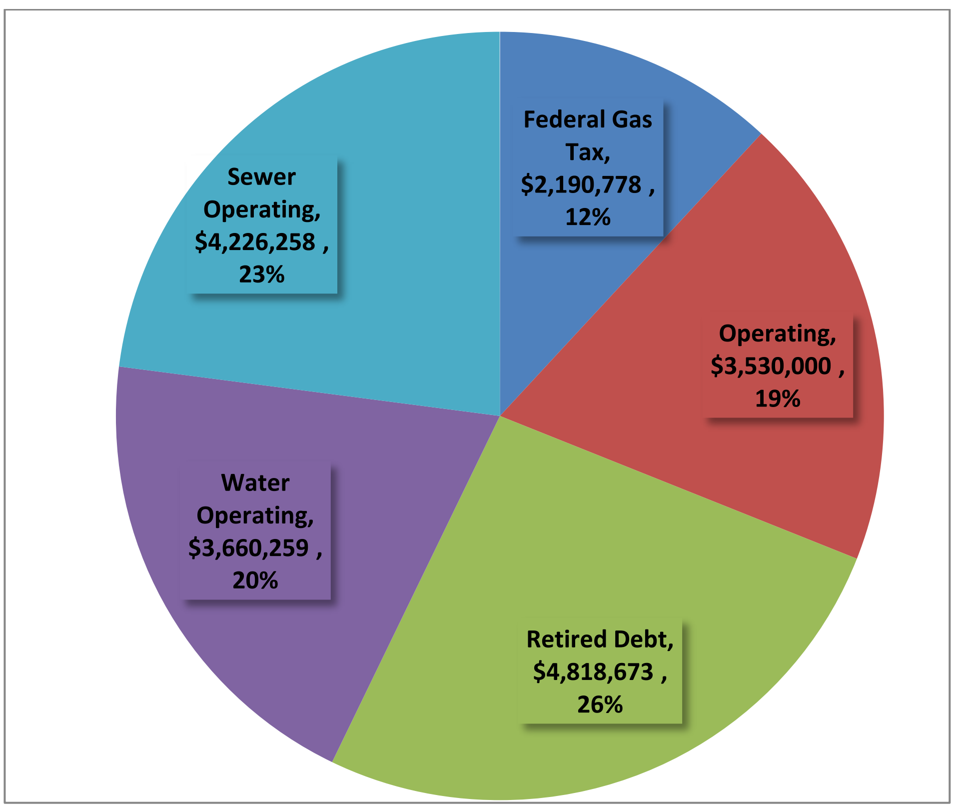


Figure 47 Linear Asset Funding Sources Breakdown 2029



6.3 Linear Assets

The asset management system developed by the City of Sarnia has calculated the current infrastructure needs for linear infrastructure as well as the future needs. For the financial plan, three scenarios for a twenty-year period forecast were created to illustrate how the City can best manage its assets. Each scenario shifts priorities and funding among asset types to show the effect on the current and future deficit as well as the replacement cycle of each asset. In each scenario, assumptions have been made to arrive at the figures in the tables and projections.

To get a more precise funding forecast for linear infrastructure only, the projected budget of pump stations, water pollution control centre (WPCC), roads resurfacing, rural roads resurfacing, water meters, storm water management ponds, shoreline protection and bridges are subtracted from the original twenty-year forecasted funding. Funding then is distributed among the reconstruction of roads, watermains, sanitary sewers and storm sewers. The following table illustrates the prior year's actual expenditures for linear assets, followed by the projected funding for the 20-year plan.

Table 23 Prior Years Actual Linear Expenditures

Asset Type	Description	2009	2010	2011	2012
	Total Length of System (KM)	439	439	439	439
Road Reconstruction	Cost	$5,650,617.09	$2,902,506.40	$953,487.79	$3,688,010.54
	Kilometers of System Replaced	5.33	2.48	1.09	2.72
Resurfacing	Cost	$2,604,068.87	$611,689.35	$838,954.31	$929,284.86
	Kilometers of System Replaced	12.72	4.32	4.04	4.41
	Percentage of System Replaced	4.11%	1.55%	1.17%	1.62%
	Replacement Cycle	24.33	64.60	85.62	61.57
	Total Length of System (KM)	496	496	496	496
Watermains	Cost	$2,673,027.26	$2,916,245.72	$2,040,207.84	$2,254,596.01
	Kilometers of System Replaced	7.77	6.29	3.71	4.42
	Percentage of System Replaced	1.57%	1.27%	0.75%	0.89%
	Replacement Cycle	63.82	78.83	133.84	112.20
	Total Length of System (KM)	388	388	388	388
Sewer - Sanitary	Cost	$3,258,232.21	$2,237,506.07	$3,896,307.53	$2,107,963.23
	Kilometers of System Replaced	5.46	4.60	3.87	3.40
	Percentage of System Replaced	1.41%	1.18%	1.00%	0.88%
	Replacement Cycle	71.12	84.40	100.19	114.05
	Total Length of System (KM)	293	293	293	293
Sewer - Storm	Cost	$2,046,197.50	$3,773,699.76	$2,049,786.91	$1,687,162.64
	Kilometers of System Replaced	2.88	5.01	2.18	2.35
	Percentage of System Replaced	0.98%	1.71%	0.74%	0.80%
	Replacement Cycle	101.86	58.53	134.26	124.79

Table 24 Projected Funding Sources for 20 Years

Year	Federal Gas Tax	Operating	Retired Debt	Water Operating	Sewer Operating	Total
2013	$ 2,190,778.00	$ 2,330,000.00	$ 1,141,716.91	$ 2,516,300.00	$ 1,278,600.00	$ 9,457,394.91
2014	$ 2,190,778.00	$ 1,830,000.00	$ 1,813,314.31	$ 2,569,626.00	$ 1,340,172.00	$ 9,743,890.31
2015	$ 2,190,778.00	$ 1,780,000.00	$ 2,240,706.97	$ 2,624,018.52	$ 1,402,975.44	$ 10,238,478.93
2016	$ 2,190,778.00	$ 1,780,000.00	$ 2,695,510.79	$ 2,679,498.89	$ 1,467,034.95	$ 10,812,822.63
2017	$ 2,190,778.00	$ 1,880,000.00	$ 2,705,847.75	$ 2,736,088.87	$ 1,532,375.65	$ 11,045,090.27
2018	$ 2,190,778.00	$ 1,980,000.00	$ 2,750,415.27	$ 2,793,810.65	$ 1,599,023.16	$ 11,314,027.08
2019	$ 2,190,778.00	$ 2,080,000.00	$ 2,885,778.41	$ 2,852,686.86	$ 1,667,003.62	$ 11,676,246.89
2020	$ 2,190,778.00	$ 2,180,000.00	$ 3,320,373.25	$ 2,912,740.60	$ 1,736,343.70	$ 12,340,235.54
2021	$ 2,190,778.00	$ 2,280,000.00	$ 3,801,692.43	$ 2,973,995.41	$ 1,807,070.57	$ 13,053,536.41
2022	$ 2,190,778.00	$ 2,380,000.00	$ 4,618,672.80	$ 3,036,475.32	$ 1,879,211.98	$ 14,105,138.10
2023	$ 2,190,778.00	$ 2,480,000.00	$ 4,618,672.80	$ 3,100,204.82	$ 1,952,796.22	$ 14,342,451.84
2024	$ 2,190,778.00	$ 2,580,000.00	$ 4,618,672.80	$ 3,165,208.92	$ 2,027,852.15	$ 14,582,511.86
2025	$ 2,190,778.00	$ 2,680,000.00	$ 4,618,672.80	$ 3,231,513.10	$ 2,104,409.19	$ 14,825,373.09
2026	$ 2,190,778.00	$ 2,780,000.00	$ 4,618,672.80	$ 3,299,143.36	$ 2,182,497.37	$ 15,071,091.53
2027	$ 2,190,778.00	$ 2,880,000.00	$ 4,618,672.80	$ 3,368,126.23	$ 2,262,147.32	$ 15,319,724.35
2028	$ 2,190,778.00	$ 2,980,000.00	$ 4,618,672.80	$ 3,438,488.75	$ 2,343,390.27	$ 15,571,329.82
2029	$ 2,190,778.00	$ 3,080,000.00	$ 4,618,672.80	$ 3,510,258.53	$ 2,426,258.07	$ 15,825,967.40
2030	$ 2,190,778.00	$ 3,180,000.00	$ 4,618,672.80	$ 3,583,463.70	$ 2,510,783.23	$ 16,083,697.73
2031	$ 2,190,778.00	$ 3,280,000.00	$ 4,618,672.80	$ 3,658,132.97	$ 2,596,998.90	$ 16,344,582.67
2032	$ 2,190,778.00	$ 3,380,000.00	$ 4,618,672.80	$ 3,734,295.63	$ 2,684,938.88	$ 16,608,685.31

6.3.1 Linear Asset Scenario 1

Table 25 Projected Project Completion Scenario 1

Year	Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	Total Length of System (KM)	439	439	439	439	439	439	439	439	439	439
Road Reconstruction	Budget	$2,853,380.25	$2,949,470.81	$3,081,815.83	$3,190,600.71	$3,234,963.28	$3,291,624.68	$3,379,573.21	$3,568,735.00	$3,774,436.11	$4,093,603.32
	Kilometers of System Replaced	2.16	2.19	2.24	2.28	2.26	2.26	2.27	2.35	2.44	2.59
Road Resurfacing	Budget	$950,000.00	$950,000.00	$1,050,000.00	$1,300,000.00	$1,400,000.00	$1,500,000.00	$1,600,000.00	$1,700,000.00	$1,800,000.00	$1,900,000.00
	Kilometers of System Replaced	4.21	4.12	4.47	5.43	5.73	6.02	6.29	6.55	6.80	7.04
	Percentage of System Replaced	1.45%	1.44%	1.53%	1.75%	1.82%	1.88%	1.95%	2.03%	2.11%	2.19%
	Replacement Cycle	68.93	69.52	65.39	57.00	54.93	53.05	51.26	49.29	47.49	45.56
	Total Length of System (KM)	496	496	496	496	496	496	496	496	496	496
Water mains	Budget	$1,947,342.69	$2,012,921.49	$2,103,242.83	$2,177,485.10	$2,207,761.16	$2,246,430.80	$2,306,452.91	$2,435,549.92	$2,575,934.48	$2,793,756.11
	Kilometers of System Replaced	3.16	3.20	3.28	3.33	3.31	3.30	3.32	3.44	3.57	3.79
	Percentage of System Replaced	0.64%	0.65%	0.66%	0.67%	0.67%	0.67%	0.67%	0.69%	0.72%	0.77%
	Replacement Cycle	156.91	154.83	151.15	148.91	149.81	150.17	149.19	144.11	138.98	130.71
	Total Length of System (KM)	388	388	388	388	388	388	388	388	388	388
Sewer - Sanitary	Budget	$1,863,119.49	$1,925,861.98	$2,012,276.89	$2,083,308.16	$2,112,274.77	$2,149,271.93	$2,206,698.07	$2,330,211.58	$2,464,524.47	$2,672,925.24
	Kilometers of System Replaced	2.16	2.19	2.24	2.28	2.26	2.26	2.27	2.35	2.44	2.59
	Percentage of System Replaced	0.56%	0.56%	0.58%	0.59%	0.58%	0.58%	0.59%	0.61%	0.63%	0.67%
	Replacement Cycle	179.54	177.16	172.95	170.39	171.42	171.83	170.71	164.89	159.03	149.56
	Total Length of System (KM)	293	293	293	293	293	293	293	293	293	293
Sewer - Storm	Budget	$1,843,552.48	$1,905,636.03	$1,991,143.38	$2,061,428.66	$2,090,091.06	$2,126,699.67	$2,183,522.70	$2,305,739.04	$2,438,641.34	$2,644,853.43
	Kilometers of System Replaced	2.16	2.19	2.24	2.28	2.26	2.26	2.27	2.35	2.44	2.59
	Percentage of System Replaced	0.74%	0.75%	0.77%	0.78%	0.77%	0.77%	0.78%	0.80%	0.83%	0.89%
	Replacement Cycle	135.56	133.77	130.59	128.66	129.43	129.75	128.90	124.51	120.07	112.93

Year	Description	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
	Total Length of System (KM)	439	439	439	439	439	439	439	439	439	439
Road Reconstruction	Budget	$4,139,658.35	$4,186,634.48	$4,234,550.13	$4,283,424.10	$4,333,275.55	$4,384,124.02	$4,435,989.47	$4,488,892.22	$4,542,853.03	$4,597,893.05
	Kilometers of System Replaced	2.57	2.55	2.53	2.51	2.49	2.47	2.45	2.43	2.41	2.39
Road Resurfacing	Budget	$2,000,000.00	$2,100,000.00	$2,200,000.00	$2,300,000.00	$2,400,000.00	$2,500,000.00	$2,600,000.00	$2,700,000.00	$2,800,000.00	$2,900,000.00
	Kilometers of System Replaced	7.27	7.48	7.68	7.87	8.06	8.23	8.39	8.54	8.68	8.82
	Percentage of System Replaced	2.24%	2.28%	2.33%	2.36%	2.40%	2.44%	2.47%	2.50%	2.53%	2.55%
	Replacement Cycle	44.62	43.77	42.99	42.29	41.64	41.05	40.52	40.03	39.58	39.17
	Total Length of System (KM)	496	496	496	496	496	496	496	496	496	496
Water mains	Budget	$2,825,187.23	$2,857,246.97	$2,889,947.90	$2,923,302.85	$2,957,324.90	$2,992,027.40	$3,027,423.94	$3,063,528.41	$3,100,354.97	$3,137,918.07
	Kilometers of System Replaced	3.76	3.73	3.70	3.67	3.64	3.61	3.58	3.55	3.52	3.50
	Percentage of System Replaced	0.76%	0.75%	0.75%	0.74%	0.73%	0.73%	0.72%	0.72%	0.71%	0.70%
	Replacement Cycle	131.84	132.97	134.09	135.21	136.33	137.44	138.55	139.66	140.76	141.86
	Total Length of System (KM)	388	388	388	388	388	388	388	388	388	388
Sewer - Sanitary	Budget	$2,702,996.95	$2,733,670.10	$2,764,956.71	$2,796,869.05	$2,829,419.63	$2,862,621.23	$2,896,486.86	$2,931,029.80	$2,966,263.60	$3,002,202.08
	Kilometers of System Replaced	2.57	2.55	2.53	2.51	2.49	2.47	2.45	2.43	2.41	2.39
	Percentage of System Replaced	0.66%	0.66%	0.65%	0.65%	0.64%	0.64%	0.63%	0.63%	0.62%	0.62%
	Replacement Cycle	150.85	152.14	153.43	154.71	155.99	157.27	158.54	159.80	161.06	162.32
	Total Length of System (KM)	293	293	293	293	293	293	293	293	293	293
Sewer - Storm	Budget	$2,674,609.31	$2,704,960.32	$2,735,918.35	$2,767,495.53	$2,799,704.27	$2,832,557.17	$2,866,067.13	$2,900,247.30	$2,935,111.06	$2,970,672.11
	Kilometers of System Replaced	2.57	2.55	2.53	2.51	2.49	2.47	2.45	2.43	2.41	2.39
	Percentage of System Replaced	0.88%	0.87%	0.86%	0.86%	0.85%	0.84%	0.84%	0.83%	0.82%	0.82%
	Replacement Cycle	113.90	114.88	115.85	116.82	117.78	118.75	119.71	120.66	121.61	122.56

6.3.1.1 Scenario 1 Background

The focus of this scenario is road rehabilitation and full reconstruction of all other assets. With the projected available funding, the City of Sarnia can achieve the following quantity of reconstruction and rehabilitation work.

Table 26 Summary of Project Completion Scenario 1

Asset Type	Length of Work (km)	Cost of Work ($)	% Funding	Total % System Replaced	Average Replacement Cycle
Road Reconstruction	47.84	$77,045,497.59	33.54%	42.26%	48.90
Watermain Reconstruction	69.98	$52,581,140.12	22.89%	14.11%	142.17
Sanitary Sewer Reconstruction	47.84	$50,306,988.59	21.90%	12.33%	162.68
Storm Sewer Reconstruction	47.85	$49,778,650.35	21.67%	16.33%	122.83
Road Rehabilitation	137.67	$38,650,000.00			
Total	351.18	$268,362,276.65	Average Replacement Cycle		119.15

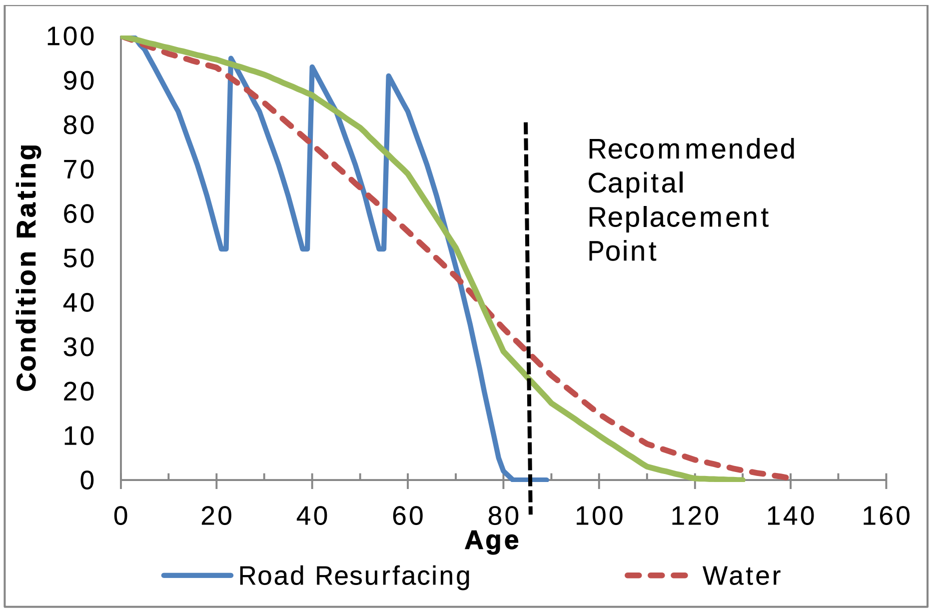
The City has focused the majority of its recent capital spending on combined sewer separation. This continues to be an important philosophy as it is anticipated that most of the needs addressed in the twenty-year forecast will be combined sewer separation projects. Watermain replacement continues to be a focus of the City's capital spending. Not only do watermains make up the largest portion of City's assets at 496 KM, but they are also the largest asset in our current need at 70KM. This strategy completes approximately 1 km of watermain per year besides the standard reconstruction projects. Another core element of this scenario is the aggressive increase in road rehabilitation funding. Road Rehabilitation Strategy IV proved to be the most efficient method of upgrading our road infrastructure and is our recommended practice. As shown in the following Integrated Asset life Cycles figure, this method lengthens the life of the road to approximately match that of the underground infrastructure. This allows the entire infrastructure to be reconstructed at the same time, therefore providing maximum benefit with the least cost.

Table 27 Comparative Replacement Cost of Individual vs Integrated

Project Type	Road	Water	Sanitary Sewer	Storm Sewer	Total
Individual Projects	$1,363,550	$722,870	$904,200	$1,179,770	$4,170,390
Integrated Projects	$1,363,550	$552,870	$656,200	$931,770	$3,504,390
Savings on Integrated Projects	-	**$170,000**	**$248,000**	**$248,000**	**$666,000**

Road, Sanitary, and Storm reconstruction are all shown as combined reconstruction projects at approximately 48km for the 20 year projection.

Figure 48 Integrated Asset life Cycles



6.3.1.2 Current Linear Asset Deficit for Scenario 1

The current linear asset deficit for this scenario is made up of the following costs.

Table 28 Scenario 1 Current Linear Asset Deficit

Asset Type	Cost
Road Reconstrution	$46,103,406.34
Road Rehabilitation	$5,186,162.00
Watermain	$43,340,309.10
Sanitary Sewer	$32,919,227.27
Storm Sewer	$21,489,004.10
Total	**$149,038,108.81**

Two road costs have been considered in this scenario. If the road and underground infrastructure for that segment need replacement, the full road reconstruction cost of $1,320.24 per meter was used. If the road segment needs replacement but the underground infrastructure does not then the road resurfacing cost of $225.81 per meter was used. Although resurfacing the stand-alone road network included in the current need is not an ideal practice; historically this has had a positive impact on the overall condition of the road network and given the funding restrictions it is recommended to continue this practice. At the end of the projection, the current linear asset deficit will decrease to $342,908.

Table 29 Current Linear Asset Deficit Addressed in Scenario 1

Year	Linear Asset Opening Deficit	Inflation	Funding	Linear Asset Closing Deficit
2013	$149,038,108.81	$2,791,614.28	$9,457,394.91	$142,372,328.18
2014	$142,372,328.18	$2,652,568.76	$9,743,890.31	$135,281,006.63
2015	$135,281,006.63	$2,500,850.55	$10,238,478.93	$127,543,378.25
2016	$127,543,378.25	$2,334,611.11	$10,812,822.63	$119,065,166.74
2017	$119,065,166.74	$2,165,225.72	$10,803,880.65	$110,426,511.81
2018	$110,426,511.81	$2,012,249.69	$9,814,027.08	$102,624,734.43
2019	$102,624,734.43	$1,850,969.75	$10,076,246.89	$94,399,457.29
2020	$94,399,457.29	$1,675,184.43	$10,640,235.54	$85,434,406.18
2021	$85,434,406.18	$1,483,617.40	$11,253,536.41	$75,664,487.17
2022	$75,664,487.17	$1,269,186.98	$12,205,138.10	$64,728,536.05
2023	$64,728,536.05	$1,056,768.23	$11,890,124.45	$53,895,179.83
2024	$53,895,179.83	$882,352.57	$9,777,551.54	$44,999,980.85
2025	$44,999,980.85	$702,210.52	$9,889,454.74	$35,812,736.63
2026	$35,812,736.63	$516,182.81	$10,003,596.00	$26,325,323.45
2027	$26,325,323.45	$351,344.16	$8,758,115.28	$17,918,552.33
2028	$17,918,552.33	$241,278.07	$5,854,648.62	$12,305,181.78
2029	$12,305,181.78	$185,142.95	$3,048,034.31	$9,442,290.42
2030	$9,442,290.42	$127,575.24	$3,063,528.41	$6,506,337.25
2031	$6,506,337.25	$68,119.65	$3,100,354.97	$3,474,101.92
2032	$3,474,101.92	$6,723.68	$3,137,918.07	$342,907.53

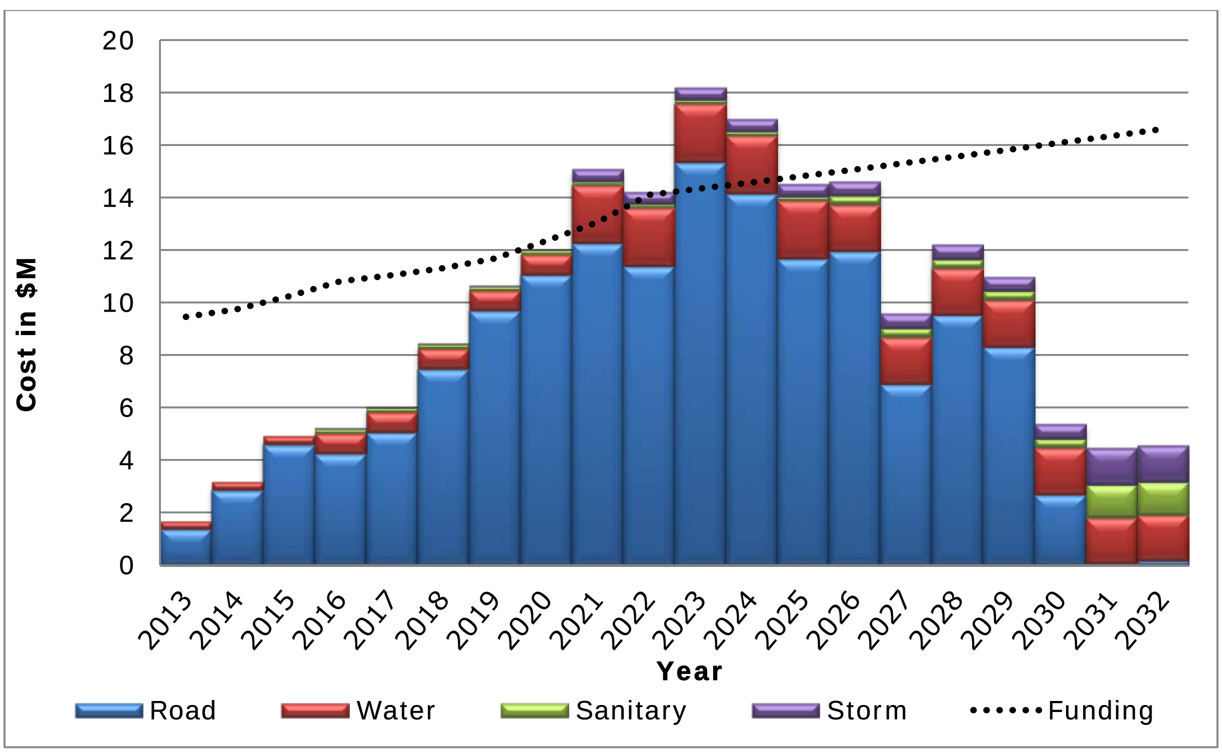
6.3.1.3 Overall Linear Asset Deficit for Scenario 1

By the end of the projection, it is estimated that the linear asset deficit will be $126,129,725. This is a decrease of $22,908,384 over the 20-year term. Because the life cycle of the road network is considerably shorter than that of the underground infrastructure, significantly more of the future needs are road network needs (see following figure).

Table 30 Overall Linear Asset Deficit Addressed in Scenario 1

Year	Linear Asset Opening Deficit	Inflation	Future Need	Funded	Linear Asset Closing Deficit
2013	$149,038,108.81	$2,791,614.28	$1,699,240.51	$9,457,394.91	$144,071,568.69
2014	$144,071,568.69	$2,686,553.57	$3,177,298.74	$9,743,890.31	$140,191,530.68
2015	$140,191,530.68	$2,599,061.04	$4,925,691.21	$10,238,478.93	$137,477,803.99
2016	$137,477,803.99	$2,533,299.63	$5,241,811.88	$10,812,822.63	$134,440,092.87
2017	$134,440,092.87	$2,467,900.05	$6,049,770.24	$11,045,090.27	$131,912,672.90
2018	$131,912,672.90	$2,411,972.92	$8,471,763.73	$11,314,027.08	$131,482,382.48
2019	$131,482,382.48	$2,396,122.71	$10,681,863.23	$11,676,246.89	$132,884,121.52
2020	$132,884,121.52	$2,410,877.72	$12,054,936.97	$12,340,235.54	$135,009,700.67
2021	$135,009,700.67	$2,439,123.29	$15,100,473.12	$13,053,536.41	$139,495,760.67
2022	$139,495,760.67	$2,507,812.45	$14,234,469.14	$14,105,138.10	$142,132,904.16
2023	$142,132,904.16	$2,555,809.05	$18,204,222.64	$14,342,451.84	$148,550,484.00
2024	$148,550,484.00	$2,679,359.44	$16,994,322.71	$14,582,511.86	$153,641,654.28
2025	$153,641,654.28	$2,776,325.62	$14,521,821.89	$14,825,373.09	$156,114,428.71
2026	$156,114,428.71	$2,820,866.74	$14,645,153.51	$15,071,091.53	$158,509,357.43
2027	$158,509,357.43	$2,863,792.66	$9,590,760.19	$15,319,724.35	$155,644,185.94
2028	$155,644,185.94	$2,801,457.12	$12,216,162.05	$15,571,329.82	$155,090,475.29
2029	$155,090,475.29	$2,785,290.16	$11,003,852.07	$15,825,967.40	$153,053,650.12
2030	$153,053,650.12	$2,739,399.05	$5,377,642.83	$16,083,697.73	$145,086,994.26
2031	$145,086,994.26	$2,574,848.23	$4,462,042.82	$16,344,582.67	$135,779,302.64
2032	$135,779,302.64	$2,383,412.35	$4,575,695.46	$16,608,685.31	$126,129,725.15

Figure 49 Yearly Linear Asset Need Forecast



6.3.1.4 Scenario 1 Replacement Life Cycle

The desired replacement life cycle for road and underground infrastructures (watermains, sanitary sewers and storm sewers) are 35 years and 100 years respectively. In this projection, significant progress is made to lower the replacement life cycle in all asset types. However, as shown in the following table, the replacement cycles of all four types of assets are well above the desired replacement cycle, especially watermains and sanitary sewers.

Table 31 Scenario 1 Average Replacement Life Cycles

	Average Replacement Cycle	Expected Life Cycle
Road	48.90	35.00
Watermains	142.17	100.00
Sanitary Sewer	162.68	100.00
Storm Sewer	122.83	100.00
Average	119.15	83.75

6.3.2 Linear Asset Scenario 2

Table 32 Projected Project Completion Scenario 2

Year	Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	Total Length of System (KM)	439	439	439	439	439	439	439	439	439	439
Road Reconstruction	Budget	$2,722,366.37	$2,814,044.90	$2,940,313.26	$3,044,103.24	$3,086,428.89	$3,140,488.66	$3,320,399.01	$3,532,875.37	$3,761,131.65	$4,097,644.19
	Kilometers of System Replaced	2.06	2.09	2.14	2.17	2.16	2.15	2.23	2.33	2.43	2.60
Road Resurfacing	Budget	$950,000.00	$950,000.00	$1,050,000.00	$1,300,000.00	$1,400,000.00	$1,500,000.00	$1,300,000.00	$1,300,000.00	$1,300,000.00	$1,300,000.00
	Kilometers of System Replaced	1.63	1.70	1.73	2.84	3.15	3.43	2.53	2.43	2.33	2.24
	Percentage of System Replaced	0.84%	0.86%	0.88%	1.14%	1.21%	1.27%	1.09%	1.08%	1.08%	1.10%
	Replacement Cycle	119.06	115.72	113.53	87.52	82.74	78.55	92.16	92.24	92.17	90.85
	Total Length of System (KM)	496	496	496	496	496	496	496	496	496	496
Water mains	Budget	$2,552,218.47	$2,638,167.09	$2,756,543.68	$2,853,846.79	$2,893,527.08	$2,944,208.12	$3,112,874.07	$3,312,070.66	$3,526,060.92	$3,841,541.43
	Kilometers of System Replaced	4.14	4.20	4.30	4.37	4.34	4.33	4.49	4.68	4.89	5.22
	Percentage of System Replaced	0.84%	0.85%	0.87%	0.88%	0.87%	0.87%	0.90%	0.94%	0.98%	1.05%
	Replacement Cycle	119.72	118.14	115.33	113.62	114.30	114.58	110.54	105.97	101.53	95.06
	Total Length of System (KM)	388	388	388	388	388	388	388	388	388	388
Sewer - Sanitary	Budget	$1,956,700.83	$2,022,594.77	$2,113,350.15	$2,187,949.20	$2,218,370.76	$2,257,226.23	$2,386,536.79	$2,539,254.17	$2,703,313.37	$2,945,181.76
	Kilometers of System Replaced	2.27	2.30	2.36	2.39	2.38	2.37	2.46	2.56	2.68	2.86
	Percentage of System Replaced	0.58%	0.59%	0.61%	0.62%	0.61%	0.61%	0.63%	0.66%	0.69%	0.74%
	Replacement Cycle	170.95	168.69	164.68	162.24	163.22	163.62	157.85	151.32	144.98	135.73
	Total Length of System (KM)	293	293	293	293	293	293	293	293	293	293
Sewer - Storm	Budget	$1,276,109.24	$1,319,083.55	$1,378,271.84	$1,426,923.39	$1,446,763.54	$1,472,104.06	$1,556,437.03	$1,656,035.33	$1,763,030.46	$1,920,770.71
	Kilometers of System Replaced	1.50	1.52	1.55	1.58	1.57	1.56	1.62	1.69	1.76	1.88
	Percentage of System Replaced	0.51%	0.52%	0.53%	0.54%	0.53%	0.53%	0.55%	0.58%	0.60%	0.64%
	Replacement Cycle	195.84	193.25	188.65	185.87	186.98	187.44	180.83	173.35	166.09	155.50

Year	Description	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
	Total Length of System (KM)	439	439	439	439	439	439	439	439	439	439
Road Reconstruction	Budget	$4,173,584.59	$4,250,403.80	$4,328,119.39	$4,406,749.29	$4,486,311.79	$4,566,825.54	$4,648,309.57	$4,730,783.27	$4,814,266.45	$4,898,779.30
	Kilometers of System Replaced	2.59	2.59	2.58	2.58	2.58	2.57	2.56	2.56	2.55	2.55
Road Resurfacing	Budget	$1,300,000.00	$1,300,000.00	$1,300,000.00	$1,300,000.00	$1,300,000.00	$1,300,000.00	$1,300,000.00	$1,300,000.00	$1,300,000.00	$1,300,000.00
	Kilometers of System Replaced	2.14	2.05	1.96	1.87	1.78	1.70	4.19	4.11	4.03	3.95
	Percentage of System Replaced	1.08%	1.06%	1.03%	1.01%	0.99%	0.97%	1.54%	1.52%	1.50%	1.48%
	Replacement Cycle	92.73	94.66	96.64	98.68	100.77	102.91	64.96	65.81	66.68	67.55
	Total Length of System (KM)	496	496	496	496	496	496	496	496	496	496
Water mains	Budget	$3,912,735.55	$3,984,753.56	$4,057,611.93	$4,131,327.46	$4,205,917.30	$4,281,398.95	$4,357,790.22	$4,435,109.32	$4,513,374.80	$4,592,605.59
	Kilometers of System Replaced	5.21	5.20	5.19	5.18	5.17	5.16	5.15	5.14	5.13	5.12
	Percentage of System Replaced	1.05%	1.05%	1.05%	1.05%	1.04%	1.04%	1.04%	1.04%	1.03%	1.03%
	Replacement Cycle	95.19	95.34	95.50	95.68	95.86	96.05	96.26	96.47	96.69	96.92
	Total Length of System (KM)	388	388	388	388	388	388	388	388	388	388
Sewer - Sanitary	Budget	$2,999,763.92	$3,054,977.73	$3,110,835.81	$3,167,351.05	$3,224,536.60	$3,282,405.86	$3,340,972.50	$3,400,250.48	$3,460,254.01	$3,520,997.62
	Kilometers of System Replaced	2.85	2.85	2.85	2.84	2.83	2.83	2.82	2.82	2.81	2.80
	Percentage of System Replaced	0.74%	0.73%	0.73%	0.73%	0.73%	0.73%	0.73%	0.73%	0.72%	0.72%
	Replacement Cycle	135.93	136.14	136.37	136.62	136.88	137.15	137.45	137.75	138.07	138.40
	Total Length of System (KM)	293	293	293	293	293	293	293	293	293	293
Sewer - Storm	Budget	$1,956,367.78	$1,992,376.78	$2,028,805.96	$2,065,663.73	$2,102,958.65	$2,140,699.47	$2,178,895.11	$2,217,554.66	$2,256,687.40	$2,296,302.80
	Kilometers of System Replaced	1.88	1.88	1.88	1.87	1.87	1.86	1.86	1.86	1.85	1.85
	Percentage of System Replaced	0.64%	0.64%	0.64%	0.64%	0.64%	0.64%	0.64%	0.63%	0.63%	0.63%
	Replacement Cycle	155.72	155.97	156.23	156.51	156.81	157.13	157.46	157.81	158.17	158.55

6.3.2.1 Scenario 2 Background

Scenario 2 illustrates how the City of Sarnia can eliminate the current backlog in 15 years with the same funding available as scenario 1. The other major change in scenario 2 is how roads have been accounted for in the current deficit. Scenario 1 considers stand-alone road projects at the resurfacing cost of $225.81 per metre. In scenario 2 the road cost for stand-alone projects has been calculated using the major rehabilitation cost including full curb and gutter repairs at $590.20 per meter. Much of the road network in the current need is below the reconstruction point. Thus, to properly rehabilitate the road network, ideally major rehabilitation or full reconstruction should be done to achieve the desired service level. This scenario follows the “worst first” philosophy and therefore much more road reconstruction is done and rehabilitation funding is relatively low.

Table 33 Summary of Project Completion Scenario 2

Asset Type	Length of Work (km)	Cost of Work ($)	% Funding	Total % System Replaced	Average Replacement Cycle
Road Reconstruction	48.09	$77,763,928.53	32.00%	23.34%	88.86
Watermain Reconstruction	96.62	$72,903,682.99	30.00%	19.48%	103.44
Sanitary Sewer Reconstruction	52.93	$55,892,823.63	23.00%	13.64%	147.70
Storm Sewer Reconstruction	34.89	$36,451,841.50	15.00%	11.91%	169.21
Road Rehabilitation	54.37	$25,350,000.00			
Total	286.89	$268,362,276.65	Average Replacement Cycle		127.30

To achieve the goal of eliminating the current linear asset deficit in 15 years a reallocation in funding was necessary. The watermain network has largest quantity in current need and therefore requires the greatest reallocation of funding. To accommodate the watermain needs, funding was transferred from road rehabilitation and storm sewers. Under this method the road network would be rehabilitated to a higher service level and the asset in greatest need (watermains) would receive a larger share of funding compared to scenario 1. But unlike scenario 1; Road, Sanitary, and Storm reconstruction are not shown as combined reconstruction projects. Approximately 35km would be combined reconstruction projects; however 92 km would be more costly individual network projects. Although scenario 2 focuses on improving the watermain network which is significantly improved in the projection, over time it would significantly deteriorate the road network.

6.3.2.2 Current Linear Asset Deficit for Scenario 2

The current linear asset deficit in scenario 2 is made up of the following costs.

Table 34 Scenario 2 Current Linear Asset Deficit

Asset Type	Cost
Road Reconstrution	$46,103,406.34
Road Rehabilitation	$13,807,986.18
Watermain	$43,340,309.10
Sanitary Sewer	$32,919,227.27
Storm Sewer	$21,489,004.10
Total	**$157,659,932.99**

The current linear asset deficit is completely addressed by 2027 in scenario 2.

Table 35 Current Linear Asset Deficit Addressed in Scenario 2

Year	Linear Asset Opening Deficit	Inflation	Funding	Linear Asset Closing Deficit
2013	$157,659,932.99	$2,964,050.76	$9,457,394.91	$151,166,588.84
2014	$151,166,588.84	$2,828,453.97	$9,743,890.31	$144,251,152.50
2015	$144,251,152.50	$2,680,253.47	$10,238,478.93	$136,692,927.05
2016	$136,692,927.05	$2,517,602.09	$10,812,822.63	$128,397,706.50
2017	$128,397,706.50	$2,347,052.32	$11,045,090.27	$119,699,668.56
2018	$119,699,668.56	$2,167,712.83	$11,314,027.08	$110,553,354.32
2019	$110,553,354.32	$1,977,542.15	$11,676,246.89	$100,854,649.57
2020	$100,854,649.57	$1,770,288.28	$12,340,235.54	$90,284,702.31
2021	$90,284,702.31	$1,544,623.32	$13,053,536.41	$78,775,789.22
2022	$78,775,789.22	$1,293,413.02	$14,105,138.10	$65,964,064.15
2023	$65,964,064.15	$1,032,432.25	$14,342,451.84	$52,654,044.55
2024	$52,654,044.55	$761,430.65	$14,582,511.86	$38,832,963.34
2025	$38,832,963.34	$494,864.90	$14,089,718.44	$25,238,109.79
2026	$25,238,109.79	$229,340.37	$13,771,091.53	$11,696,358.63
2027	$11,696,358.63	$0.00	$11,696,358.63	$0.00
2028	$0.00	$0.00	$0.00	$0.00
2029	$0.00	$0.00	$0.00	$0.00
2030	$0.00	$0.00	$0.00	$0.00
2031	$0.00	$0.00	$0.00	$0.00
2032	$0.00	$0.00	$0.00	$0.00

6.3.2.3 Overall Linear Asset Deficit for Scenario 2

The overall linear asset deficit is reduced to $138,941,302 by the end of the projection. This reduces the deficit by $18,718,630. The majority of the remaining overall deficit is the road network.

Table 36 Overall Linear Asset Deficit Addressed in Scenario 2

Year	Linear Asset Opening Deficit	Inflation	Future Needs	Funded	Linear Asset Closing Deficit
2013	$157,659,932.99	$2,964,050.76	$1,699,240.51	$9,457,394.91	$152,865,829.35
2014	$152,865,829.35	$2,862,438.78	$3,177,298.74	$9,743,890.31	$149,161,676.56
2015	$149,161,676.56	$2,778,463.95	$4,925,691.21	$10,238,478.93	$146,627,352.79
2016	$146,627,352.79	$2,716,290.60	$5,241,811.88	$10,812,822.63	$143,772,632.64
2017	$143,772,632.64	$2,654,550.85	$6,049,770.24	$11,045,090.27	$141,431,863.46
2018	$141,431,863.46	$2,602,356.73	$8,471,763.73	$11,314,027.08	$141,191,956.85
2019	$141,191,956.85	$2,590,314.20	$10,681,863.23	$11,676,246.89	$142,787,887.38
2020	$142,787,887.38	$2,608,953.04	$12,054,936.97	$12,340,235.54	$145,111,541.85
2021	$145,111,541.85	$2,641,160.11	$15,100,473.12	$13,053,536.41	$149,799,638.67
2022	$149,799,638.67	$2,713,890.01	$14,234,469.14	$14,105,138.10	$152,642,859.72
2023	$152,642,859.72	$2,766,008.16	$18,204,222.64	$14,342,451.84	$159,270,638.67
2024	$159,270,638.67	$2,893,762.54	$16,994,322.71	$14,582,511.86	$164,576,212.05
2025	$164,576,212.05	$2,995,016.78	$14,521,821.89	$14,825,373.09	$167,267,677.64
2026	$167,267,677.64	$3,043,931.72	$14,645,153.51	$15,071,091.53	$169,885,671.34
2027	$169,885,671.34	$3,091,318.94	$9,590,760.19	$15,319,724.35	$167,248,026.12
2028	$167,248,026.12	$3,033,533.93	$12,216,162.05	$15,571,329.82	$166,926,392.27
2029	$166,926,392.27	$3,022,008.50	$11,003,852.07	$15,825,967.40	$165,126,285.44
2030	$165,126,285.44	$2,980,851.75	$5,377,642.83	$16,083,697.73	$157,401,082.29
2031	$157,401,082.29	$2,821,129.99	$4,462,042.82	$16,344,582.67	$148,339,672.43
2032	$148,339,672.43	$2,634,619.74	$4,575,695.46	$16,608,685.31	$138,941,302.33

6.3.2.4 Scenario 2 Replacement Life Cycle

The replacement cycle for watermains is drastically reduced due to the reallocation of funding in scenario 2. However, as shown in the following table, the replacement cycles for the other asset types are above the desired replacement cycle. The road network is critically underfunded in this scenario causing its replacement cycle to be twice its suggested length.

Table 37 Scenario 2 Average Replacement Life Cycles

	Average Replacement Cycle	Expected Life Cycle
Road	88.86	35.00
Watermains	103.44	100.00
Sanitary Sewer	147.70	100.00
Storm Sewer	169.21	100.00
Average	127.30	83.75

6.3.3 Linear Asset Scenario 3

Table 38 Projected Project Completion Scenario 3

Year	Description	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	Total Length of System (KM)	439	439	439	439	439	439	439	439	439	439
Road Reconstruct	Budget	$4,642,366.37	$4,734,044.90	$4,860,313.26	$4,964,103.24	$5,006,428.89	$5,060,488.66	$5,144,399.01	$5,324,875.37	$5,521,131.65	$5,825,644.19
	Kilometers of System Replaced	3.52	3.52	3.54	3.54	3.50	3.47	3.46	3.51	3.57	3.69
Road Resurfacing	Budget	$1,442,887.46	$1,471,745.21	$1,501,180.12	$1,531,203.72	$1,561,827.79	$1,593,064.35	$1,600,000.00	$1,700,000.00	$1,800,000.00	$1,900,000.00
	Kilometers of System Replaced	2.40	2.40	2.40	2.40	2.40	2.40	2.30	2.56	2.81	3.05
	Percentage of System Replaced	1.35%	1.35%	1.35%	1.35%	1.34%	1.34%	1.31%	1.38%	1.45%	1.54%
	Replacement Cycle	74.20	74.21	73.93	73.87	74.37	74.77	76.19	72.26	68.78	65.10
	Total Length of System (KM)	496	496	496	496	496	496	496	496	496	496
Watermains	Budget	$4,352,218.47	$4,438,167.09	$4,556,543.68	$4,653,846.79	$4,693,527.08	$4,744,208.12	$4,822,874.07	$4,992,070.66	$5,176,060.92	$5,461,541.43
	Kilometers of System Replaced	7.06	7.06	7.11	7.12	7.04	6.98	6.95	7.05	7.17	7.42
	Percentage of System Replaced	1.42%	1.42%	1.43%	1.44%	1.42%	1.41%	1.40%	1.42%	1.45%	1.50%
	Replacement Cycle	70.21	70.22	69.77	69.68	70.47	71.11	71.35	70.31	69.17	66.86
	Total Length of System (KM)	388	388	388	388	388	388	388	388	388	388
Sewer - Sanitary	Budget	$3,336,700.83	$3,402,594.77	$3,493,350.15	$3,567,949.20	$3,598,370.76	$3,637,226.23	$3,697,536.79	$3,827,254.17	$3,968,313.37	$4,187,181.76
	Kilometers of System Replaced	3.87	3.87	3.89	3.90	3.86	3.82	3.81	3.86	3.93	4.06
	Percentage of System Replaced	1.00%	1.00%	1.00%	1.01%	0.99%	0.98%	0.98%	1.00%	1.01%	1.05%
	Replacement Cycle	100.25	100.27	99.62	99.49	100.62	101.54	101.88	100.40	98.76	95.47
	Total Length of System (KM)	293	293	293	293	293	293	293	293	293	293
Sewer - Storm	Budget	$2,176,109.24	$2,219,083.55	$2,278,271.84	$2,326,923.39	$2,346,763.54	$2,372,104.06	$2,411,437.03	$2,496,035.33	$2,588,030.46	$2,730,770.71
	Kilometers of System Replaced	2.55	2.55	2.57	2.57	2.54	2.52	2.51	2.55	2.59	2.68
	Percentage of System Replaced	0.87%	0.87%	0.88%	0.88%	0.87%	0.86%	0.86%	0.87%	0.88%	0.91%
	Replacement Cycle	114.85	114.87	114.13	113.98	115.27	116.32	116.71	115.01	113.14	109.37

Year	Description	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
	Total Length of System (KM)	439	439	439	439	439	439	439	439	439	439
Road Reconstruct	Budget	$3,949,584.59	$3,994,403.80	$4,040,119.39	$4,086,749.29	$4,134,311.79	$4,182,825.54	$4,232,309.57	$4,282,783.27	$4,334,266.45	$4,386,779.30
	Kilometers of System Replaced	2.45	2.43	2.41	2.39	2.37	2.35	2.34	2.32	2.30	2.28
Road Resurfacing	Budget	$2,000,000.00	$2,100,000.00	$2,200,000.00	$2,300,000.00	$2,400,000.00	$2,500,000.00	$2,600,000.00	$2,700,000.00	$2,800,000.00	$2,900,000.00
	Kilometers of System Replaced	8.87	9.08	9.28	9.47	9.66	8.23	8.39	8.54	8.68	8.82
	Percentage of System Replaced	2.58%	2.62%	2.66%	2.70%	2.74%	2.41%	2.44%	2.47%	2.50%	2.53%
	Replacement Cycle	38.78	38.13	37.54	36.99	36.50	41.49	40.94	40.44	39.98	39.56
	Total Length of System (KM)	496	496	496	496	496	496	496	496	496	496
Watermains	Budget	$3,702,735.55	$3,744,753.56	$3,787,611.93	$3,831,327.46	$3,875,917.30	$3,921,398.95	$3,967,790.22	$4,015,109.32	$4,063,374.80	$4,112,605.59
	Kilometers of System Replaced	4.93	4.89	4.85	4.81	4.77	4.73	4.69	4.65	4.62	4.58
	Percentage of System Replaced	0.99%	0.99%	0.98%	0.97%	0.96%	0.95%	0.95%	0.94%	0.93%	0.92%
	Replacement Cycle	100.59	101.45	102.31	103.17	104.02	104.87	105.72	106.56	107.40	108.24
	Total Length of System (KM)	388	388	388	388	388	388	388	388	388	388
Sewer - Sanitary	Budget	$2,838,763.92	$2,870,977.73	$2,903,835.81	$2,937,351.05	$2,971,536.60	$3,006,405.86	$3,041,972.50	$3,078,250.48	$3,115,254.01	$3,152,997.62
	Kilometers of System Replaced	2.70	2.68	2.66	2.63	2.61	2.59	2.57	2.55	2.53	2.51
	Percentage of System Replaced	0.70%	0.69%	0.68%	0.68%	0.67%	0.67%	0.66%	0.66%	0.65%	0.65%
	Replacement Cycle	143.64	144.87	146.09	147.32	148.53	149.75	150.96	152.16	153.36	154.55
	Total Length of System (KM)	293	293	293	293	293	293	293	293	293	293
Sewer - Storm	Budget	$1,851,367.78	$1,872,376.78	$1,893,805.96	$1,915,663.73	$1,937,958.65	$1,960,699.47	$1,983,895.11	$2,007,554.66	$2,031,687.40	$2,056,302.80
	Kilometers of System Replaced	1.78	1.77	1.75	1.74	1.72	1.71	1.69	1.68	1.67	1.65
	Percentage of System Replaced	0.61%	0.60%	0.60%	0.59%	0.59%	0.58%	0.58%	0.57%	0.57%	0.56%
	Replacement Cycle	164.55	165.96	167.37	168.76	170.16	171.55	172.93	174.31	175.69	177.06

6.3.3.1 Scenario 3 Background

Scenario 3 is an extension of scenario 2, except the current deficit is targeted to be fully addressed in 10 years by assuming outside funding of approximately 62 million dollars to further improve the City of Sarnia's service levels. Similar to scenario 2, scenario 3 adopts road major rehabilitation with full curb and gutter repairs at a cost of $590.20 per meter to treat stand-alone road projects.

Table 39 Summary of Project Completion Scenario 3

Asset Type	Length of Work (km)	Cost of Work ($)	% Funding	Total % System Replaced	Average Replacement Cycle
Road Reconstruction	58.97	$92,707,928.53	32.00%	39.43%	55.90
Watermain Reconstruction	118.49	$86,913,682.99	30.00%	23.89%	87.17
Sanitary Sewer Reconstruction	64.91	$66,633,823.63	23.00%	16.73%	124.48
Storm Sewer Reconstruction	42.79	$43,456,841.50	15.00%	14.60%	142.60
Road Rehabilitation	114.14	$40,601,908.66			
Total	399.29	$330,314,185.30	Average Replacement Cycle		102.54

To achieve the goal of eliminating the current deficit in 10 years, more funding needs to be allocated to the road and watermain network since their current need is significantly higher than sanitary and storm sewers network.

6.3.3.2 Current Linear Asset Deficit for Scenario 3

The current linear asset deficit in this scenario is made up of the following costs.

Table 40 Scenario 3 Current Linear Asset Deficit

Asset Type	Cost
Road Reconstruction	$46,103,406.34
Road Resurfacing	$13,807,986.18
Watermains	$43,340,309.10
Sanitary Sewer	$32,919,227.27
Storm Sewer	$21,489,004.10
Total	**$157,659,932.99**

The current linear asset deficit is completly addressed in ten years by the end of year 2022 in this scenario.

Table 41 Current Linear Asset Deficit Addressed in Scenario 3

Year	Linear Asset Opening Deficit	Inflation	Funding	Linear Asset Closing Deficit
2013	$157,659,932.99	$2,834,193.01	$15,950,282.37	$144,543,843.63
2014	$144,543,843.63	$2,565,564.16	$16,265,635.52	$130,843,772.27
2015	$130,843,772.27	$2,283,082.26	$16,689,659.05	$116,437,195.49
2016	$116,437,195.49	$1,987,863.38	$17,044,026.35	$101,381,032.52
2017	$101,381,032.52	$1,683,482.29	$17,206,918.06	$85,857,596.75
2018	$85,857,596.75	$1,369,010.11	$17,407,091.43	$69,819,515.43
2019	$69,819,515.43	$1,042,865.37	$17,676,246.89	$53,186,133.91
2020	$53,186,133.91	$696,917.97	$18,340,235.54	$35,542,816.34
2021	$35,542,816.34	$329,785.60	$19,053,536.41	$16,819,065.53
2022	$16,819,065.53	$0.00	$16,819,065.53	$0.00
2023	$0.00	$0.00	$0.00	$0.00
2024	$0.00	$0.00	$0.00	$0.00
2025	$0.00	$0.00	$0.00	$0.00
2026	$0.00	$0.00	$0.00	$0.00
2027	$0.00	$0.00	$0.00	$0.00
2028	$0.00	$0.00	$0.00	$0.00
2029	$0.00	$0.00	$0.00	$0.00
2030	$0.00	$0.00	$0.00	$0.00
2031	$0.00	$0.00	$0.00	$0.00
2032	$0.00	$0.00	$0.00	$0.00

6.3.3.3 Overall Linear Asset Deficit for Scenario 3

The overall linear asset deficit is reduced to $56,102,435 by the end of the projection. This reduces the deficit by $101,557,498. The majority of the remaining overall deficit is the road network.

Table 42 Overall Linear Asset Deficit Addressed in Scenario 3

Year	Linear Asset Opening Deficit	Inflation	Future Needs	Funded	Funding Deficit	Assumed Funding Total	Linear Asset Closing Deficit
2013	$157,659,932.99	$2,964,050.76	$1,699,240.51	$9,457,394.91	$6,492,887.46	$15,950,282.37	$146,372,941.89
2014	$146,372,941.89	$2,732,581.03	$3,177,298.74	$9,743,890.31	$6,521,745.21	$16,265,635.52	$136,017,186.13
2015	$136,017,186.13	$2,515,574.14	$4,925,691.21	$10,238,478.93	$6,451,180.12	$16,689,659.05	$126,768,792.43
2016	$126,768,792.43	$2,319,119.40	$5,241,811.88	$10,812,822.63	$6,231,203.72	$17,044,026.35	$117,285,697.36
2017	$117,285,697.36	$2,124,812.14	$6,049,770.24	$11,045,090.27	$6,161,827.79	$17,206,918.06	$108,253,361.69
2018	$108,253,361.69	$1,938,786.69	$8,471,763.73	$11,314,027.08	$6,093,064.35	$17,407,091.43	$101,256,820.69
2019	$101,256,820.69	$1,791,611.48	$10,681,863.23	$11,676,246.89	$6,000,000.00	$17,676,246.89	$96,054,048.50
2020	$96,054,048.50	$1,674,276.26	$12,054,936.97	$12,340,235.54	$6,000,000.00	$18,340,235.54	$91,443,026.19
2021	$91,443,026.19	$1,567,789.80	$15,100,473.12	$13,053,536.41	$6,000,000.00	$19,053,536.41	$89,057,752.69
2022	$89,057,752.69	$1,499,052.29	$14,234,469.14	$14,105,138.10	$6,000,000.00	$20,105,138.10	$84,686,136.02
2023	$84,686,136.02	$1,406,873.68	$18,204,222.64	$14,342,451.84	$0.00	$14,342,451.84	$89,954,780.50
2024	$89,954,780.50	$1,507,445.37	$16,994,322.71	$14,582,511.86	$0.00	$14,582,511.86	$93,874,036.72
2025	$93,874,036.72	$1,580,973.27	$14,521,821.89	$14,825,373.09	$0.00	$14,825,373.09	$95,151,458.80
2026	$95,151,458.80	$1,601,607.35	$14,645,153.51	$15,071,091.53	$0.00	$15,071,091.53	$96,327,128.12
2027	$96,327,128.12	$1,620,148.08	$9,590,760.19	$15,319,724.35	$0.00	$15,319,724.35	$92,218,312.04
2028	$92,218,312.04	$1,532,939.64	$12,216,162.05	$15,571,329.82	$0.00	$15,571,329.82	$90,396,083.91
2029	$90,396,083.91	$1,491,402.33	$11,003,852.07	$15,825,967.40	$0.00	$15,825,967.40	$87,065,370.91
2030	$87,065,370.91	$1,419,633.46	$5,377,642.83	$16,083,697.73	$0.00	$16,083,697.73	$77,778,949.47
2031	$77,778,949.47	$1,228,687.34	$4,462,042.82	$16,344,582.67	$0.00	$16,344,582.67	$67,125,096.96
2032	$67,125,096.96	$1,010,328.23	$4,575,695.46	$16,608,685.31	$0.00	$16,608,685.31	$56,102,435.34

6.3.3.4 Scenario 3 Replacement Life Cycle

Due to the external funding in this scenario the replacement life cycle for all assets is drastically reduced in the projection. The desired replacement cycle is achieved for watermain network in this scenario, but replacement cycle for the road, sanitary and storm sewer networks are still above the desired replacement cycle.

Table 43 Scenario 3 Asset Average Replacement Life Cycles

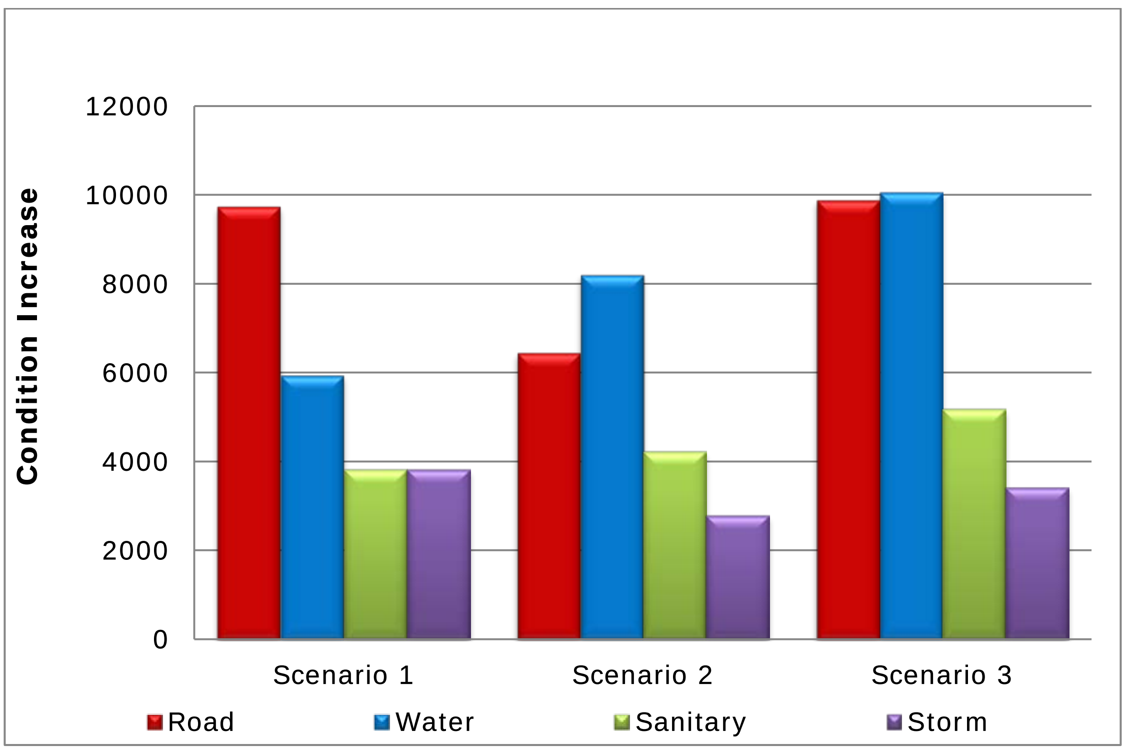
	Average Replacement Cycle	Expected Life Cycle
Road	55.90	35.00
Watermains	87.17	100.00
Sanitary Sewer	124.48	100.00
Storm Sewer	142.60	100.00
Average	102.54	83.75

6.3.4 Linear Asset Scenario Conclusion

When comparing the scenarios it is critical to understand what impact each scenario has on the entire network as well as each individual network. Each network is a vital component to the City's infrastructure. The major focus of the City has been watermain replacement and combined sewer separation to eliminate combined sewer overflows to the St. Clair River and mitigate basement flooding. However the road network proved to be the most challenging due to the option of rehabilitation and the large cost of reconstruction. Although Scenario 3 would be preferred, it cannot be implemented without external funding therefore the focus will be on scenario 1 and 2.

In keeping the City's infrastructure focus in mind, it is recommended that scenario 1 be implemented. Scenario 1 focuses more on road network rehabilitation; this allows more of the road network to be upgraded at a lower overall cost. The road network has the shortest life cycle and costs more to replace on a per meter basis than any other network. As shown in the following figure, the road network is improved by 9,747 points compared to scenario 2 where the road network is improved by 6,453 points.

Figure 50 Condition Increase across Asset Type



The length of road network upgraded in scenario 1 is 186 km, versus 102 km in scenario 2. Combined projects are more cost effective than individual network projects. In scenario 1 approximately 48km of combined projects are completed compared to approximately 35km in scenario 2. The overall length of network upgraded is 351km for scenario 1 compared to 287km for scenario 2; a difference of 64km.

Table 44 Quantitiy of Work Breakdown in 3 Financial Scenarios

	Scenario 1		Scenario 2		Scenario 3	
	Reconstruction (km)	Rehabilitation (km)	Reconstruction (km)	Rehabilitation (km)	Reconstruction (km)	Rehabilitation (km)
Road	47.84	137.67	48.09	54.37	58.97	114.14
Watermains	69.98		96.62		118.49	
Sanitary Sewer	47.84		52.93		64.91	
Storm Sewer	47.85		34.89		42.79	

The Asset Management Planning process is driving a change in philosophy regarding capital improvement. The old philosophy of “worst first” is being replaced with a more proactive approach focused on rehabilitation based on the window of opportunity; as the saying goes, “A reconstruction today is a reconstruction tomorrow, rehabilitation today is a reconstruction tomorrow”.

Therefore, the recommended Financial Scenario in this plan firmly sets the City of Sarnia on a proactive and fiscally responsible path.

6.3.5 Optional Scenario

This scenario is an alternate approach to scenario 1 using the same current road need but, instead of considering future road need cost as rehabilitation cost, the full reconstruction cost has been considered in this scenario. As shown in the following table the total overall linear closing deficit went up to $535,641,663.19 from the original deficit of $126,129,725.15 shown in scenario 1. The City of Sarnia's practice is to resurface/ rehabilitate roads and not reconstruct until the buried infrastructure needs to be rebuilt. Due to the complexity of Asset Management Strategies and the high costs associated with roads, this scenario is being included in this plan to better compare with other plans.

Table 45 Overall Linear Asset Deficit Addressed in Optional Scenario

Year	Linear Asset Opening Deficit	Inflation	Future Need	Funded	Linear Asset Closing Deficit
2013	$149,038,108.81	$2,791,614.28	$3,604,276.61	$9,457,394.91	$145,976,604.79
2014	$145,976,604.79	$2,724,654.29	$9,906,001.09	$9,743,890.31	$148,863,369.86
2015	$148,863,369.86	$2,772,497.82	$15,552,389.74	$10,238,478.93	$156,949,778.49
2016	$156,949,778.49	$2,922,739.12	$15,229,247.61	$10,812,822.63	$164,288,942.58
2017	$164,288,942.58	$3,064,877.05	$17,516,859.31	$11,045,090.27	$173,825,588.67
2018	$173,825,588.67	$3,250,231.23	$20,839,632.29	$11,314,027.08	$186,601,425.11
2019	$186,601,425.11	$3,498,503.56	$30,048,325.31	$11,676,246.89	$208,472,007.10
2020	$208,472,007.10	$3,922,635.43	$36,811,586.08	$12,340,235.54	$236,865,993.06
2021	$236,865,993.06	$4,476,249.13	$43,082,302.62	$13,053,536.41	$271,371,008.40
2022	$271,371,008.40	$5,145,317.41	$41,907,620.51	$14,105,138.10	$304,318,808.22
2023	$304,318,808.22	$5,799,527.13	$57,670,930.15	$14,342,451.84	$353,446,813.66
2024	$353,446,813.66	$6,777,286.04	$54,595,022.24	$14,582,511.86	$400,236,610.06
2025	$400,236,610.06	$7,708,224.74	$41,281,298.53	$14,825,373.09	$434,400,760.25
2026	$434,400,760.25	$8,386,593.37	$38,279,524.12	$15,071,091.53	$465,995,786.21
2027	$465,995,786.21	$9,013,521.24	$21,086,367.61	$15,319,724.35	$480,775,950.72
2028	$480,775,950.72	$9,304,092.42	$35,479,764.09	$15,571,329.82	$509,988,477.40
2029	$509,988,477.40	$9,883,250.20	$29,560,157.74	$15,825,967.40	$533,605,917.95
2030	$533,605,917.95	$10,350,444.40	$5,424,821.86	$16,083,697.73	$533,297,486.49
2031	$533,297,486.49	$10,339,058.08	$7,248,871.10	$16,344,582.67	$534,540,832.99
2032	$534,540,832.99	$10,358,642.95	$7,350,872.56	$16,608,685.31	$535,641,663.19

6.4 Non-Linear Assets

The current need for most of the Pump Station and Wastewater Treatment Facilities projects were identified as part of the Wastewater Master Plan study by Stantec Consulting. The top projects identified were Bedford Pump Station replacement and Bright's Grove Sewage Lagoons.

Most of the future need for pump stations was identified in the City's pump station assessment carried out by R. V. Anderson in 2009. Historically it has been the City's focus to upgrade electrical and pump components of the pump station to maximise the service life. Therefore, only these components have been included in this plan.

Future need for Water Pollution Control Centre was based on the City's 10-year capital plan compiled by City staff.

The bridge condition and future needs were in the bridge inspection report carried out by Engineered Management Systems in 2012 in accordance with Ontario structure inspection manual. The following table illustrates the prior year's actual expenditures for non-linear assets.

Table 46 Prior Years Actual Non-Linear Expenditures

Asset Type	Description	2009	2010	2011	2012
Bridges					
	Donohue Bridge North Bound Lanes		$3,601,581		
Pump Stations					
	Devine Street Pumping Station			$8,988,928	
	Business Park PS			$645,800	
Water Pollution Control Centre					
	New Raw Sewage Pumps	$242,112			
	Clarifier Rehabilitation		$288,565		$181,239
	New VFD's for Blowers			$230,973	
	New Controls for Scada System			$154,602	

Table 47 Projected Project Completion Pump Stations

Station ID	Pump Station	Condition	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
33	CNR Tracks at Bedford	0																				
41	Green Street	0																				
35	Murphy Road at 402	0																				
18	Giffel Road	11	10,000																			
6	East St at Maple	12																				
1	Holland Street	14	20,000																20,000			
2	Briarfield	14	10,000																20,000			
13	McCaw	17	20,000																			
14	Rosedale	21	10,000																20,000			
8	Errol Road	23						15,000														
9	Exmouth West of Indian	25			75,000																	
17	Mayfair	26													20,000							
16	Talfourd Street	28																				
5	East St at Huey's	29																				
10	Forsyth	34	10,000																			10,000
15	Scott Road	35	20,000	15,000																		
32	Exmouth St. (Lambton Mall)	36	20,000																			
12	Lecaron	36																				
3	Clifford	37					10,000	20,000														
28	1801 London @ Blackwell	39	20,000				15,000															
44	Chippewa Park	40	20,000		10,000																	
29	London Line at Briarwood	40	10,000				15,000															
37	Cathcart at Rutherglen	42	20,000			5,000																
7	Elrick at Vye	42						20,000														
30	Blackwell @ Sim's	42	10,000				15,000															
24	River Road	45	10,000					10,000														
20	Tashmoo Ave (North)	49	10,000												10,000							
23	Sandy Lane	49	20,000												25,000							
31	Airport Road North of 402	51	20,000				10,000															
36	1642 Murphy Road	53								20,000												20,000
38	Penhuron Lane (Hamilton)	54	20,000		10,000																	
25	161 Nelson Street	54																				
34	Plank Road at Indian Road	57																				
46	Rapids Parkway	58									15,000											
21	Plain Lane	58	10,000												10,000							
22	Berkshire Road	58																				
26	1350 Plank	60								20,000												15,000
27	1569 London Line(Lou's)	62																		20,000		
11	Lasalle	65																				
39	Kaymar	67	15,000		5,000																	
40	Huronview (Lakeshore)	67	15,000		10,000																	
47	Devine Street	72																				
4	ARI	73											10,000									15,000
43	1264 Tashmoo (South)	73											10,000									10,000
50	Michigan Avenue	74										15,000										
51	Heritage Park	76										15,000										
45	Augusta Drive	76													10,000							
49	5960 Blackwell Side Road	76								15,000												
53	London Rd Industrial Park	77													20,000							
52	Stone Hedge Park	84												15,000								
	Total Future Need		**320,000**	**15,000**	**110,000**	**5,000**	**65,000**	**65,000**	**-**	**55,000**	**15,000**	**30,000**	**20,000**	**15,000**	**95,000**	**-**	**-**	**-**	**60,000**	**20,000**	**-**	**70,000**

Legend	
Improvement	
Pumps	
Electrical	
Generator	
Stations	
To be Rebuilt	
To be Decomissioned	

Table 48 Projected Project Completion Wastewater Treatment Plant

Components of WPCC	Category	Condition Score	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Head Works	Process	64		170,000	240,000		90,000							170,000	240,000		90,000					
	Structural	46		40,000	100,000	100,000				100,000				40,000								
	Equipment	48		120,000	200,000				200,000	90,000				120,000					200,000			
Grit Removal	Process	80			50,000	90,000	40,000								50,000	90,000	40,000					
	Structural	46					80,000										80,000					
	Equipment	48							40,000	40,000	40,000								40,000	40,000	40,000	
Primary Clarifiers	Process	68	110,000	40,000		100,000	100,000		60,000	60,000			110,000	40,000		100,000	100,000		60,000	60,000		
	Structural	60		257,000	257,000		35,000	35,000	35,000	35,000		150,000		257,000	257,000		35,000	35,000	35,000	35,000		150,000
	Equipment	68	15,000									100,000	15,000									100,000
Aeration	Process	68				78,000	78,000	88,000	88,000							78,000	78,000	88,000	88,000			
	Structural	87																				
	Equipment	56				8,000	100,000	500,000								8,000	100,000	500,000				
Secondary Clarifiers	Process	64		52,000	52,000	52,000	112,000	150,000	160,000	160,000	100,000			52,000	52,000	52,000	112,000	150,000	160,000	160,000	100,000	
	Structural	87	600,000				35,000	35,000	35,000								35,000	35,000	35,000			
	Equipment	48				70,000										70,000						
Ultraviolet	Process	48	12,000	12,000		46,000	30,000	16,000		18,000			12,000	12,000		46,000	30,000	16,000		18,000		
	Structural	87										800,000										
	Equipment	48																				
Sludge Storage and Treatment	Process	56		30,000	30,000	60,000	60,000	90,000						30,000	30,000	60,000	60,000	90,000				
	Structural	60				150,000		150,000	150,000	180,000												
	Equipment	48	120,000	120,000									120,000	120,000								
Total Future Need			**857,000**	**841,000**	**929,000**	**754,000**	**760,000**	**1,064,000**	**768,000**	**683,000**	**140,000**	**1,050,000**	**257,000**	**841,000**	**629,000**	**504,000**	**760,000**	**914,000**	**618,000**	**313,000**	**140,000**	**250,000**

Table 49 Projected Project Completion Bridges

Structure ID	Bridge Name	Condition Index (BCI)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
000260	Telfer Road	0																				
000270	Waterworks Road	0																				
000280	Brigden Road	0																				
000310	Old Lakeshore Road Over Cull Drain	0					600,000															
000200	Blackwell Sideroad	27																				
000320	Vidal Street Walkway	39.6																				
000160-3-3	Donohue Bridge (North Structure)	43.3						6,000,000														
000230	Confederation Line	47.6																				
000160-1-3	Donohue Bridge (South Structure)	59.3																				
000090	Perch Creek Bridge	60.9															723,000					
000160-2-3	Donohue Bridge (Centre Structure)	72.5																				
000060	Perch Creek Bridge	76.7																			3,420,000	
000070	Jackson Road Bridge	79.3																	1,665,000			
000150	Kenny Bridge	79.6													1,130,000							
000040	Michigan Avenue Bridge	79.8																1,530,000				
000300	McGregor Sideroad Over Cole Drain	82.9																				
000250	Confederation Line over Waddel Creek	85.1																				
000050	Perch Creek Bridge	90.8																			448,000	
000180	CSX Overpass	91.5													2,400,000							
000030	Cow Creek Bridge	92.1													354,000							
000020	Perch Creek Bridge	92.4															363,000					
000100	Scott Road Bridge	96.3																				
000010	Cow Creek Bridge	97.5													135,000							
000240	Confederation Line over Perch Creek	98.7																				
000110	Scott Road Culvert	100																				
000190	Michigan Road	100																				
000210	Finch Drive	100																				
000220	Wellington Street	100																				
000290	Marshall Line	100																				
	Total Future Need		**-**	**-**	**-**	**-**	**600,000**	**6,000,000**	**-**	**-**	**-**	**-**	**-**	**-**	**4,019,000**	**-**	**1,086,000**	**1,530,000**	**1,665,000**	**-**	**3,868,000**	**-**

The following tables illustrate the funding available and the opening and closing deficit for each non-linear asset. The opening deficit for pump stations and wastewater treatment facilities consist of the top two identified projects in the plan; being Bright's Grove Waste Water Treatment Facility project and Bedford and Murphy Road Pump Stations project. The City is considering several alternate funding approaches to address these needs, as currently the City does not have the resources to fund these projects.

Table 50 Current Pump Station Deficit

Year	Opening Pump Station Deficit	Future Need	Funding	Closing Pump Station Deficit
2013	37,000,000	320,000	800,000	36,520,000
2014	36,520,000	15,000	800,000	35,735,000
2015	35,735,000	110,000	800,000	35,045,000
2016	35,045,000	5,000	800,000	34,250,000
2017	34,250,000	65,000	800,000	33,515,000
2018	33,515,000	65,000	800,000	32,780,000
2019	32,780,000	-	800,000	31,980,000
2020	31,980,000	55,000	800,000	31,235,000
2021	31,235,000	15,000	800,000	30,450,000
2022	30,450,000	30,000	800,000	29,680,000
2023	29,680,000	20,000	800,000	28,900,000
2024	28,900,000	15,000	800,000	28,115,000
2025	28,115,000	95,000	800,000	27,410,000
2026	27,410,000	-	800,000	26,610,000
2027	26,610,000	-	800,000	25,810,000
2028	25,810,000	-	800,000	25,010,000
2029	25,010,000	60,000	800,000	24,270,000
2030	24,270,000	20,000	800,000	23,490,000
2031	23,490,000	-	800,000	22,690,000
2032	22,690,000	70,000	800,000	21,960,000

Table 51 Current Wastewater Treatment Facilities Deficit

Year	Opening WPCC Deficit	Future Need	Funding	Closing WPCC Deficit
2013	8,300,000	857,000	1,000,000	8,157,000
2014	8,157,000	841,000	1,000,000	7,998,000
2015	7,998,000	929,000	1,000,000	7,927,000
2016	7,927,000	754,000	1,000,000	7,681,000
2017	7,681,000	760,000	1,000,000	7,441,000
2018	7,441,000	1,064,000	1,000,000	7,505,000
2019	7,505,000	768,000	1,000,000	7,273,000
2020	7,273,000	683,000	1,000,000	6,956,000
2021	6,956,000	140,000	1,000,000	6,096,000
2022	6,096,000	1,050,000	1,000,000	6,146,000
2023	6,146,000	257,000	1,000,000	5,403,000
2024	5,403,000	841,000	1,000,000	5,244,000
2025	5,244,000	629,000	1,000,000	4,873,000
2026	4,873,000	504,000	1,000,000	4,377,000
2027	4,377,000	760,000	1,000,000	4,137,000
2028	4,137,000	914,000	1,000,000	4,051,000
2029	4,051,000	618,000	1,000,000	3,669,000
2030	3,669,000	313,000	1,000,000	2,982,000
2031	2,982,000	140,000	1,000,000	2,122,000
2032	2,122,000	250,000	1,000,000	1,372,000

Table 52 Current Bridge Deficit

Year	Opening Bridge Deficit	Future Need	Funding	Closing Bridge Deficit
2013	2,469,785	-	200,000	2,269,785
2014	2,269,785	-	200,000	2,069,785
2015	2,069,785	-	200,000	1,869,785
2016	1,869,785	-	200,000	1,669,785
2017	1,669,785	600,000	200,000	2,069,785
2018	2,069,785	6,000,000	200,000	7,869,785
2019	7,869,785	-	200,000	7,669,785
2020	7,669,785	-	200,000	7,469,785
2021	7,469,785	-	200,000	7,269,785
2022	7,269,785	-	200,000	7,069,785
2023	7,069,785	-	200,000	6,869,785
2024	6,869,785	-	200,000	6,669,785
2025	6,669,785	4,019,000	200,000	10,488,785
2026	10,488,785	-	200,000	10,288,785
2027	10,288,785	1,086,000	200,000	11,174,785
2028	11,174,785	1,530,000	200,000	12,504,785
2029	12,504,785	1,665,000	200,000	13,969,785
2030	13,969,785	-	200,000	13,769,785
2031	13,769,785	3,868,000	200,000	17,437,785
2032	17,437,785	-	200,000	17,237,785

7. Recommendations

The following table represents the top five priority projects across the asset types identified based on risk analysis.

Table 53 Top Identified Priority Projects across Asset Type

Rank	Project	Consequence of Failure Index (0 to 10)	Potential of Failure (0 to 10)	Overall Index (consequence x failure)	Comments	Estimated Cost
1	Bright's Grove Wastewater Treatment Facility	6.97	10	69.7	Includes upgrades to Green Street Pump Station and Forcemain	$11,000,000
2	Bedford and Murphy Road Pump Stations	7.48	7.5	56.1	Includes forcemains, associated sewers and WPCC upgrades	$34,300,000
3	Exmouth and Devine Drainage Areas Road, Water and Sewer Project	4.91	8.4	41.24	Combined Sewer Separation Project Areas	$34,411,803
4	Donohue Bridge	6.76	5.67	38.33	Substructure Rehabilitation	$2,469,785
5	Watermain Only Project	5.66	5.36	30.34	Coronation Ln Area, Copland Rd, Rosedale Ave, Oldham Pl and Exmouth St	$8,202,289

While the Bedford, Murphy Road Pump Stations and Bright's Grove Wastewater Treatment Facility along with Green Street Pump Station (total cost $45,300,000) is considered one sewer capacity upgrade project by the City, due to different risks associated with these projects they have been separated in this plan.

The construction/upgrade of the Bright's Grove Wastewater Treatment Facility and upgrade of the existing Green Street Pump Station was identified as a top priority project due to capacity constraints. The existing sewage lagoons are operating at close to full capacity with no discharge capable during winter months, which limits new development and causes environmental concerns.

The Bedford Pump Station was also identified through modelling as a top priority project. The Bedford Pumping Station is one of the largest pumping stations in the City of Sarnia. It receives the flow from 23 other pumping stations, which is all the flow east of Murphy Road (excluding Bright's Grove). There are multiple issues with the Bedford Pumping Station including capacity constraints, operational problems, economic development and future growth concerns.

The top identified Road, Water and Sewer project are the Exmouth and Devine Drainage Areas. Both these areas are older sections of the city containing combined sewers and aged linear infrastructure that is due for replacement.

Donohue Bridge is an ongoing project started in 2010. The Northbound lanes are scheduled for a full deck replacement in 2018.

The top identified Watermain only project is the Copland Rd, Rosedale Ave, Oldham Pl and Exmouth St area. These watermains have been identified as having low pressure and fire flow issues, and a high number of watermain breaks.

Appendix: A

Priority Listings of Linear Infrastructures

Road Only Priority Listing Top 50 Sections

Priority Listing	Section ID	Street	From	To	Length	Width	2013 PCI	Treatment Text	Cost ($)
1	0000RD2464	Errol Road East	Windemere Crescent	McCrie Street	83.8	12.2	20	Reconstruct	$145,124
2	0000RD3164	Hamilton Road	Kenwick St. (N. side)	East to Kenwick Street	37.4	9.8	20	Reconstruct	$52,114
3	0000RD3165	Hamilton Road	Wildwood Drive	Kenwick Street	98.8	11.0	20	Reconstruct	$154,354
4	0000RD0308	Lougar Avenue	Evett Street	Roper Street	597.9	11.0	20	Reconstruct	$933,934
5	0000RD2520	Lougar Avenue	Roper Street	west end	247.6	11.0	20	Reconstruct	$386,808
6	0000RD1821	Mackenzie Street N.	Penrose Street	London Road	114.7	9.0	20	Reconstruct	$146,544
7	0000RD1874	Sycamore Drive	Evergreen Drive	Oak Avenue	306.9	9.1	20.1	Reconstruct	$396,606
8	0000RD1247	Ontario Street	Phillip Street W.	East Street S.	76.1	12.2	20.3	Reconstruct	$131,776
9	0000RD0567	Confederation Street	Christina Street S.	west end	114.2	12.2	20.5	Reconstruct	$197,806
10	0000RD0576	Kenny Street	Tashmoo Avenue	544m South	544.8	6.7	20.5	Reconstruct	$518,300
11	0000RD2764	Huron Boulevard	Tashmoo Avenue	Vidal Street S.	426.6	7.3	20.7	Reconstruct	$442,188
12	0000RD1902	Ontario Street	Stockwell Street	Phillip Street W.	78.8	12.2	20.7	Reconstruct	$136,462
13	0000RD1529	Blackwell Sideroad	Waubuno Road	Churchill Line	1360.2	6.0	20.8	Reconstruct	$1,158,862
14	0000RD2126	Aberdeen Avenue	Lorne Crescent	Sycamore Drive	88.6	9.1	21	Reconstruct	$114,452
15	0000RD0645	Errol Road East	McCrie Street	Giffel Road	49.6	12.2	21	Reconstruct	$85,910
16	0000RD0257	Palmerston Street N.	Cobden Street	Cameron Street	81.2	7.3	21.1	Reconstruct	$84,206
17	0000RD1744	Lewis Road	Lakeshore Road	Clearwater Court	75.8	9.1	21.2	Reconstruct	$97,980
18	0000RD1853	Maxwell Street	Stacy Court	Roger Street	86.8	11.0	21.2	Reconstruct	$135,610
19	0000RD1327	Maxwell Street	Roger Street	Indian Road N.	95.1	11.0	21.5	Reconstruct	$148,532
20	0000RD2934	Cathcart Boulevard	Oakridge Trail	Marianna Place	146.6	13.4	21.7	Reconstruct	$278,888
21	0000RD0497	Clifford Street	Christina Street S.	west end	313.2	11.0	21.7	Reconstruct	$489,190
22	0000RD1323	Essex Street	Forsyth Street N.	College Avenue N.	77.9	9.1	21.8	Reconstruct	$100,678
23	0000RD2766	Campbell Street	Under Vidal Street S	Brock Street S.	97.9	11.0	21.9	Reconstruct	$152,934
24	0000RD1194	Cathcart Boulevard	Hogan Street	Dell Avenue	117.2	13.4	21.9	Reconstruct	$222,940
25	0000RD1425	George Street	Front Street N.	west end	77.7	12.1	21.9	Reconstruct	$133,480
26	0000RD1624	Hamilton Road	Wildwood Drive	Kaymar Crescent	140.6	11.0	21.9	Reconstruct	$219,674
27	0000RD3168	Huron Boulevard	Tashmoo Avenue	east end	61.2	7.3	21.9	Reconstruct	$63,474
28	0000RD1814	Poplar Avenue	Evergreen Drive	north end	39.4	9.1	21.9	Reconstruct	$50,978
29	0000RD0385	Hickory Avenue	Montcalm Avenue	Indian Road N.	80.9	9.1	22	Reconstruct	$104,512
30	0000RD0967	Davis Street	Victoria Street S.	Julia Street	74.3	10.4	22.3	Reconstruct	$109,766
31	0000RD1858	Palmerston Street N.	Cromwell Street	Cobden Street	81.4	7.3	22.3	Reconstruct	$84,348
32	0000RD3043	Walnut Avenue S.	Wellington Street	Kathleen Avenue	102.9	9.1	22.5	Reconstruct	$132,912
33	0000RD3377	Gladwish Drive	Prescott Drive	Plank Road	606.2	6.0	22.6	Reconstruct	$516,454
34	0000RD0353	Hickory Avenue	Montcalm Avenue	Aberdeen Avenue	96.1	9.1	22.6	Reconstruct	$124,250
35	0000RD0223	Mack Avenue	Kintail Street	Ontario Street	237.9	9.1	22.6	Reconstruct	$307,430
36	0000RD3160	Gladwish Drive	Prescott Drive	651m N of Prescott Dr.	651.1	6.0	22.7	Reconstruct	$554,794
37	0000RD1341	Birch Avenue	Walnut Avenue N.	Cherry Drive	90.4	9.1	22.8	Reconstruct	$116,866
38	0000RD0463	Bruce Street	Hansard Lane	Mulberry Street	111.0	9.1	22.8	Reconstruct	$143,420
39	0000RD1267	Palmerston Street N.	Cameron Street	Bright Street	83.4	7.3	22.9	Reconstruct	$86,478
40	0000RD3406	Imperial Avenue	Vidal Street S.	57m E of Vidal Street S.	57.1	6.5	23.2	Reconstruct	$52,682
41	0000RD0705	Old Lakeshore Road	Kathleen Avenue	James Street W.	70.2	6.7	24.4	Reconstruct	$66,740
42	0000RD3338	Westbury Court	Westbury Court	west end	43.6	9.1	24.4	Reconstruct	$56,374
43	0000RD1554	Old Lakeshore Road	Beachwood Avenue	Strathuron Avenue	61.3	6.7	24.7	Reconstruct	$58,362
44	0000RD1600	Aberdeen Avenue	Sycamore Drive	Oak Avenue	78.4	9.1	25	Reconstruct	$101,246
45	0000RD1049	Errol Road East	Tawny Road	Concordia Drive	172.2	11.0	25.1	Reconstruct	$268,948
46	0000RD1596	Errol Road East	Indian Road N.	Windemere Crescent	413.7	12.2	25.1	Reconstruct	$716,674
47	0000RD1224	Kintail Street	Russell Street S.	Conrad Street	164.8	9.1	25.3	Reconstruct	$213,000
48	0000RD1445	Palmerston Street N.	Davis Street	Cromwell Street	75.2	7.3	25.3	Reconstruct	$77,958
49	0000RD2750	Scott Road	Williams Drive	18m S of Highway 40	156.0	6.5	25.5	Reconstruct	$143,988
50	0000RD0373	Talfourd Street	Elsfield Crescent	Lansdowne Avenue S.	86.2	9.2	26.1	Reconstruct	$112,606

Note: Road Only Priority List will be updated based on future updated data

Road Only Priority Listing Based on Known Problems

Priority Listing	Section ID	Street	From	To	Problem Known	Cost ($)
1	0000RD2700	Blackwell Sideroad	Brookview Court	Augusta Boulevard	Yes	$28,116
2	0000RD0016	Blackwell Sideroad	Confederation Line	south service entrance	Yes	$257,502
3	0000RD2811	Blackwell Sideroad	Glen Abbey Drive	north service entrance	Yes	$24,620
4	0000RD0978	Blackwell Sideroad	Lakeshore Road	Lake Huron Shore	Yes	$15,004
5	0000RD2356	Blackwell Sideroad	Michigan Line	Blackwell Road	Yes	$221,933
6	0000RD2699	Blackwell Sideroad	north service entrance	Brookview Court	Yes	$140,296
7	0000RD1529	Blackwell Sideroad	Waubuno Road	Churchill Line	Yes	$1,158,862
8	0000RD1598	Plank Road	Duff Drive	Highway 40	Yes	$330,718
9	0000RD3348	Plank Road	Gladwish Drive	Duff Drive	Yes	$320,494
10	0000RD0317	Plank Road	Gladwish Drive	McGregor Sideroad	Yes	$1,639,816
11	0000RD0480	Plank Road	Indian Road South	Indian Road South	Yes	$71,852
12	0000RD3210	Plank Road	McGregor Sideroad	69m W of Indian Road / ramps	Yes	$732,010
13	0000RD1603	Waterworks Road	Churchill Line	1353m S Churchill Line (CL)	Yes	$178,662
14	0000RD1765	Waterworks Road	Michigan Line	Lakeshore Road	Yes	$2,243,032
15	0000RD2551	Scott Road	LaSalle Line	365m north	Yes	$550,000

Sanitary Sewer Only Top 10 Priority Listing

Priority Listing	Integr Code	Road	To	From	Drainage Area	Santiary Sewer Score	Sanitary Cost
1	IS1345	Cromwell Street	Vidal Street N.	Victoria Street N.	Cromwell Street	3.79	$200,088.77
2	IS1882	Front Street N.	Davis Street	Ferry Dock Hill	Cromwell Street	4.53	$261,220.79
3	IS1388	London Road	Mackenzie Street N.	Mitton Street N.	-	24.37	$180,811.98
4	IS3192	London Road	College Avenue N.	Fleming Street	-	24.45	$91,154.93
5	IS3027	Front Street S.	Johnston Street	Front Street N.	Devine Street	26.07	$1,091,926.75
6	IS3000	Vidal Street N.	Davis Street	Cromwell Street	Cromwell Street	31.17	$85,509.17
7	IS2033	George Street	Russell Street N.	Mackenzie Street N.	Cromwell Street	31.92	$445,310.78
8	IS1243	George Street	Palmerston Street N.	Russell Street N.	Cromwell Street	31.92	$242,027.07
9	IS2349	Ontario Street	East Street South	Mack Avenue	Devine Street	36.55	$92,294.87
10	IS2220	Ontario Street	Palmerston Street S.	Devine Street	Devine Street	40.99	$237,968.24

Note: Sanitary Sewer Only Priority List will be updated based on future updated data

Combined Complete Reconstruction Priority Listing Top 50 Sections

Priority Listing	Integr Code	Road	To	From	Project Type				Drainage Area	Combined cost (2012 Dollar Value)
1	IS2018	Capel Street	Nelson Street	Admiral Avenue	Road	Water	Sanitary	Storm	Exmouth Street	$528,760.81
2	IS1118	Capel Street	Maxwell Street	Nelson Street	Road	Water	Sanitary	Storm	Exmouth Street	$406,629.38
3	IS1386	East Street N.	Lincoln Park Avenue	Maxwell Street	Road	Water	Sanitary	Storm	Exmouth Street	$596,539.75
4	IS2286	Lydia Street	Nelson Street	Felix Street	Road	Water	Sanitary	Storm	Exmouth Street	$207,117.78
5	IS1258	Nelson Street	Felix Street	Lydia Street	Road	Water	Sanitary	Storm	Exmouth Street	$257,442.71
6	IS1809	Lydia Street	Maxwell Street	Nelson Street	Road	Water	Sanitary	Storm	Exmouth Street	$660,799.87
7	IS2300	Maxwell Street	Capel Street	Lydia Street	Road	Water	Sanitary	Storm	Exmouth Street	$284,779.77
8	IS1724	Talfourd Street	Vidal Street S.	Queen Street	Road	Water	Sanitary	Storm	Devine Street	$308,924.00
9	IS2565	Talfourd Street	Stuart Street	Emma Street	Road	Water	Sanitary	Storm	Devine Street	$370,809.11
10	IS1707	Talfourd Street	Queen Street	Christina Street S.	Road	Water	Sanitary	Storm	Devine Street	$408,176.19
11	IS1270	Talfourd Street	Crawford Street	Margaret Street	Road	Water	Sanitary	Storm	Devine Street	$227,697.43
12	IS1277	Talfourd Street	Emma Street	Crawford Street	Road	Water	Sanitary	Storm	Devine Street	$399,627.14
13	IS1656	Talfourd Street	Margaret Street	Brock Street S.	Road	Water	Sanitary	Storm	Devine Street	$434,775.57
14	IS1280	Talfourd Street	Mitton Street S.	Stuart Street	Road	Water	Sanitary	Storm	Devine Street	$520,447.18
15	IS1818	Talfourd Street	Proctor Street	Mitton Street S.	Road	Water	Sanitary	Storm	Devine Street	$321,342.41
16	IS1307	Talfourd Street	Brock Street S.	Vidal Street S.	Road	Water	Sanitary	Storm	Devine Street	$344,419.16
17	IS1920	Queen Street	Devine Street	Talfourd Street	Road	Water	Sanitary	Storm	Devine Street	$394,323.04
18	IS1115	Margaret Street	Richard Street	Talfourd Street	Road	Water	Sanitary	Storm	Devine Street	$350,093.49
19	IS1119	Margaret Street	Devine Street	Richard Street	Road	Water	Sanitary	Storm	Devine Street	$459,223.82
20	IS1298	Johnston Street	Queen Street	Christina Street S.	Road	Water	Sanitary	Storm	Devine Street	$194,680.66
21	IS2217	Queen Street	Talfourd Street	Johnston Street	Road	Water	Sanitary	Storm	Devine Street	$347,173.95
22	IS1284	Queen Street	Confederation Street	Devine Street	Road	Water	Sanitary	Storm	Devine Street	$568,586.56
23	IS1919	Vidal Street S.	Devine Street	Talfourd Street	Road	Water	Sanitary	Storm	Devine Street	$1,292,917.19
24	IS0841	Emma Street	Richard Street	Talfourd Street	Road	Water	Sanitary	Storm	Devine Street	$308,714.46
25	IS1242	Emma Street	Devine Street	Richard Street	Road	Water	Sanitary	Storm	Devine Street	$458,315.54
26	IS2911	John Street	Mary Street	Devine Street	Road	Water	Sanitary	Storm	Devine Street	$554,296.07
27	IS1655	Mary Street	John Street	Brock Street S.	Road	Water	Sanitary	Storm	Devine Street	$454,088.73
28	IS1290	Stuart Street	Talfourd Street	Wellington Street	Road	Water	Sanitary	Storm	Devine Street	$1,364,287.42
29	IS2912	John Street	Confederation Street	Mary Street	Road	Water	Sanitary	Storm	Devine Street	$308,311.05
30	IS2483	Emma Street	Confederation Street	Devine Street	Road	Water	Sanitary	Storm	Devine Street	$986,326.06
31	IS1238	Richard Street	Emma Street	Margaret Street	Road	Water	Sanitary	Storm	Devine Street	$562,218.52
32	IS1354	Richard Street	Stuart Street	Emma Street	Road	Water	Sanitary	Storm	Devine Street	$384,112.00
33	IS1708	Stuart Street	Richard Street	Talfourd Street	Road	Water	Sanitary	Storm	Devine Street	$511,677.15
34	IS3007	East Street S.	Confederation Street	Ontario Street	Road	Water	Sanitary	Storm	Devine Street	$291,226.53
35	IS1872	Stuart Street	Devine Street	Richard Street	Road	Water	Sanitary	Storm	Devine Street	$483,574.93
36	IS2137	Richard Street	Mitton Street S.	Stuart Street	Road	Water	Sanitary	Storm	Devine Street	$370,191.36
37	IS3209	Ontario Street	Devine Street	Gibson Street	Road	Water	Sanitary	Storm	Devine Street	$181,987.43
38	IS2349	Ontario Street	East Street South	Mack Avenue	Road	Water	Sanitary	Storm	Devine Street	$242,409.22
39	IS2220	Ontario Street	Palmerston Street S.	Devine Street	Road	Water	Sanitary	Storm	Devine Street	$402,054.44
40	IS1802	Ontario Street	Mack Avenue	Palmerston Street S.	Road	Water	Sanitary	Storm	Devine Street	$315,438.78
41	IS1917	Wellington Street	Russell Street S.	Mackenzie Street S.	Road	Water	Sanitary	Storm	East Street	$1,004,766.73
42	IS1117	Wellington Street	East Street S.	Russell Street S.	Road	Water	Sanitary	Storm	East Street	$854,281.08
43	IS1450	Cromwell Street	Palmerston Street N.	Russell Street N.	Road	Water	Sanitary	Storm	East Street	$457,499.80
44	IS1281	Cromwell Street	East Street N.	Palmerston Street N.	Road	Water	Sanitary	Storm	East Street	$521,429.95
45	IS1851	Cameron Street	Palmerston Street N.	Russell Street N.	Road	Water	Sanitary	Storm	East Street	$598,818.97
46	IS1295	Cameron Street	East Street N.	Palmerston Street N.	Road	Water	Sanitary	Storm	East Street	$711,727.80
47	IS0690	Cobden Street	Palmerston Street N.	Russell Street N.	Road	Water	Sanitary	Storm	East Street	$567,991.02
48	IS1289	Cobden Street	East Street N.	Palmerston Street N.	Road	Water	Sanitary	Storm	East Street	$556,094.28
49	IS1772	Bright Street	East Street N.	Palmerston Street N.	Road	Water	Sanitary	Storm	East Street	$523,074.09
50	IS1086	Bright Street	Palmerston Street N.	Russell Street N.	Road	Water	Sanitary	Storm	East Street	$821,405.66

Note: Combined complete reconstruction priority list will be updated based on future updated data

Watermain Only Reconstruction Priority Listing Top 50 Sections

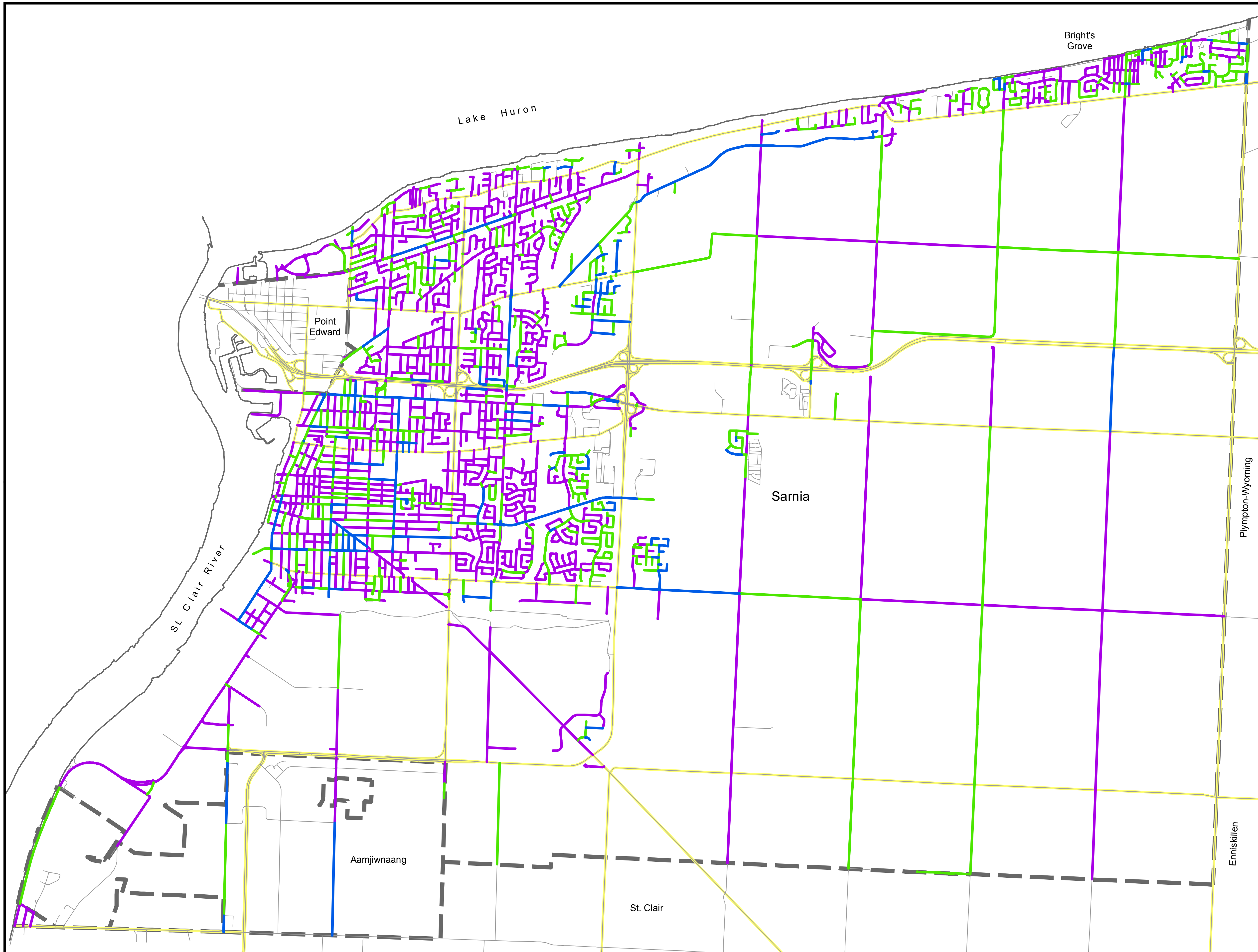
Priority Listing	Integr Code	Road	From	To	Water Score with Over-Ride	Water Cost
1	IS1812	Copland Road	Claxton Avenue	Alexander Street	2.73	$76,551.73
2	IS1176	Copland Road	Alexander Street	Maxwell Street	3.70	$123,929.46
3	IS2859	Copland Road	Maxwell Street	London Road	10.12	$195,146.75
4	IS0672	Charlesworth Drive	McKay Avenue	Amesbury Court	10.89	$258,877.33
5	IS2214	Rosedale Avenue	Colborne Road	Pineview Avenue	17.07	$161,152.12
6	IS0672	Charlesworth Drive	Amesbury Court	McKay Avenue	10.89	$258,877.33
7	IS1933	Kathleen Avenue	East Street South	Russell Street South	17.84	$340,095.93
8	IS1925	Cotterbury Street	Exmouth Street	Eddy Drive	19.25	$338,633.41
9	IS1557	Lakeshore Road	Blackwell Sideroad	Modeland Road	20.94	$1,260,619.51
10	IS1225	Devine Street	Stockwell Street	East Street South	21.57	$79,372.75
11	IS2275	Chudleigh Road	Rutherglen Drive	west end	21.83	$135,630.90
12	IS2368	Exmouth Street	Exmouth Street fork	Harbour Road	22.19	$353,760.48
13	IS1820	Copland Road	Exmouth Street	Claxton Avenue	23.68	$81,301.31
14	IS0712	Oldham Place	north end	Clarence Street	23.74	$48,723.54
15	IS2197	College Avenue North	George Street	Essex Street	25.02	$81,388.80
16	IS1716	Rutherglen Drive	Chudleigh Road	Hillcrest Nisbet Drive	26.22	$64,483.22
17	IS1968	Stuart Street	Confederation Street	Devine Street	26.25	$241,528.94
18	IS0393	Chippewa Street	Shamrock Street	Rose Street	27.24	$66,867.03
19	IS1720	Murphy Road	Haight Lane	north end (Lake Huron)	28.25	$19,983.20
20	IS1205	Exmouth Street	Venetian Boulevard	Harbour Road	30.02	$98,882.73
21	IS1197	Braemar Lane	Murphy Road	Wilgrun Drive	30.73	$60,167.60
22	IS2714	LaSalle Line	Virgil Avenue	Wahboose Circle	31.82	$234,094.72
23	IS0296	Plank Road	Kimball Road	NA	34.83	$1,558,861.01
24	IS2712	LaSalle Line	Virgil Avenue	Fairview Boulevard	35.15	$68,175.04
25	IS1479	LaSalle Line	Vidal Street South	Wahboose Circle	35.15	$80,162.86
26	IS0534	St. Clair Parkway	La Salle Line	Marlborough Lane	35.27	$217,534.14
27	IS2358	Hillcrest Drive	Hillcrest Drive	NA	35.64	$161,784.62
28	IS0707	Hillcrest Nisbet Drive	Rutherglen Drive	Hillcrest Drive	35.64	$157,957.89
29	IS1040	Lake Huron Parkway	Green Acres Road	NA	35.64	$128,996.17
30	IS2987	Christina Street South	St. Andrew Street	Tecumseh Street	35.88	$169,187.11
31	IS2087	LaSalle Line	Wayne Avenue	St. Clair Parkway	37.74	$73,803.77
32	IS1492	Superior Street	Germain Street	Hickory Avenue	52.89	$223,159.80
33	IS2083	Walnut Avenue North	Oak Avenue	Walnut Avenue South	54.31	$22,909.82
34	IS0937	Lecaron Avenue	Lakeshore Road	Charlesworth Drive	60.89	$337,432.79
35	IS2352	Woodrowe Avenue	east end	Christina Street North	60.89	$327,207.55
36	IS0588	Tweedsmuir Avenue	Germain Street	Mayfair Drive	61.25	$149,555.70
37	IS1677	Willa Drive	Sylvia Avenue	Woodhaven Avenue	61.56	$112,477.60
38	IS0345	Ontario Street	Agnes Street	Campbell Street	62.01	$306,757.08
39	IS1446	Siddall Street	Wellington Street	Ross Avenue	62.31	$ -
40	IS1149	Siddall Street	Ross Avenue	Talfourd Street	62.31	$ -
41	IS0352	Aberdeen Avenue	Hickory Avenue	Hemlock Avenue	63.25	$47,268.96
42	IS1861	Superior Street	London Road	Germain Street	64.23	$176,947.26
43	IS1648	Egmond Drive	Valleyfield Drive	Devonshire Road	64.23	$ -
44	IS1593	Kemsley Drive	Athena Avenue	Kim Street	64.23	$84,358.20
45	IS2108	Kemsley Drive	Kim Street	Coral Way	64.23	$84,358.20
46	IS0353	Hickory Avenue	Aberdeen Avenue	Montcalm Avenue	64.58	$73,416.89
47	IS0790	Charlesworth Drive	Evan Street	McKay Avenue	65.90	$ -
48	IS2126	Aberdeen Avenue	Sycamore Drive	Lorne Crescent	66.58	$62,292.18
49	IS0770	Egmond Drive	Charlesworth Drive	Valleyfield Drive	67.56	$ -
50	IS3102	Egmond Drive	Roosevelt Drive	Cathcart Boulevard	67.56	$133,487.96

Note: Watermain priority listing will be updated based on future updated data

Appendix: B

Linear Infrastructure Needs Maps

Appendix: B
Map 1
City of Sarnia
Asset Management Plan



Legend

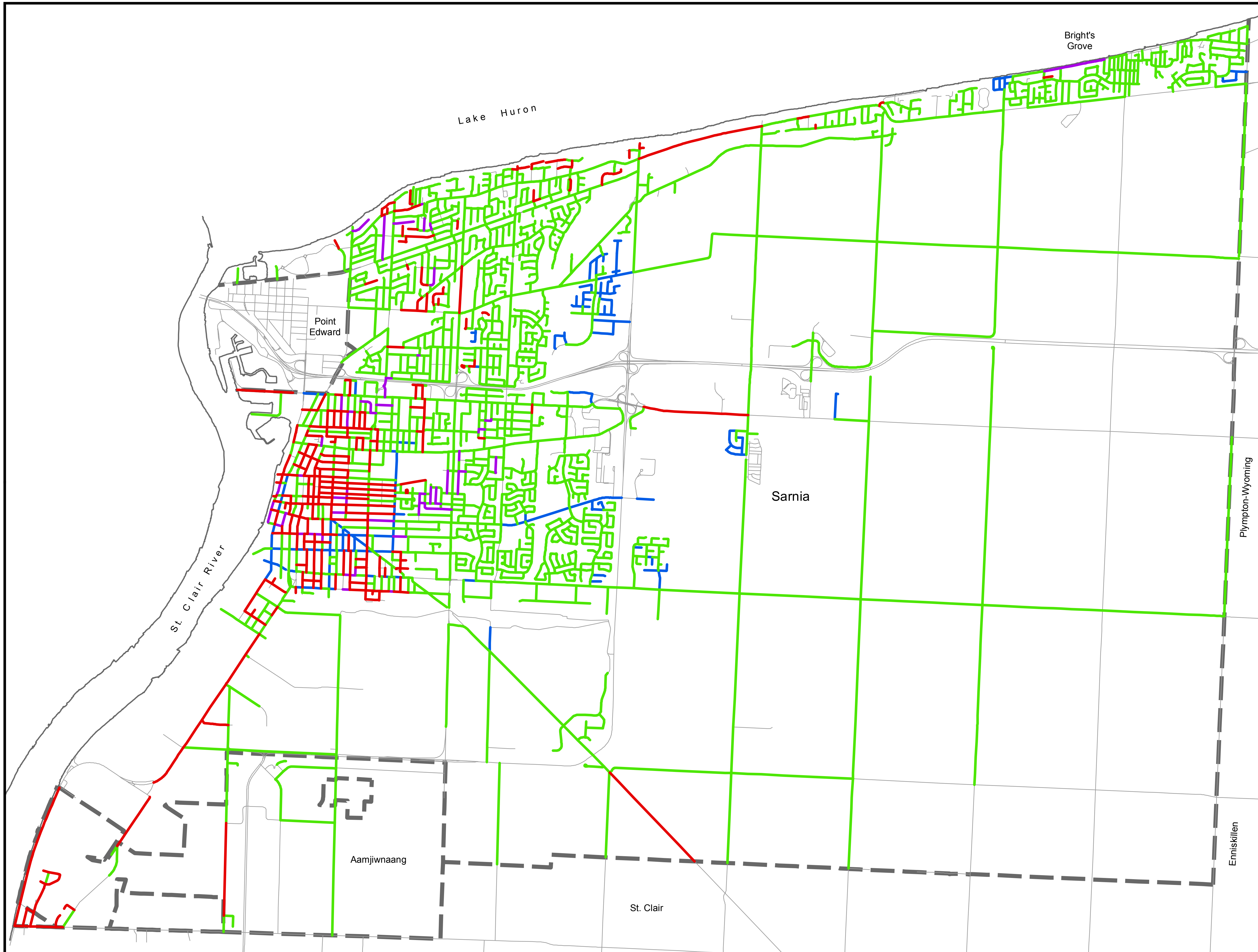
Roads

Remaining Service Life

- >= 30 years
- 30 - 25 years
- 25 - 10 years
- 10 - 0 years

County / MTO Roads

Prepared by:
Engineering Department,
City of Sarnia,
Dated December 16, 2013.



Appendix: B

Map 2

City of Sarnia

Asset Management Plan

Legend

Water

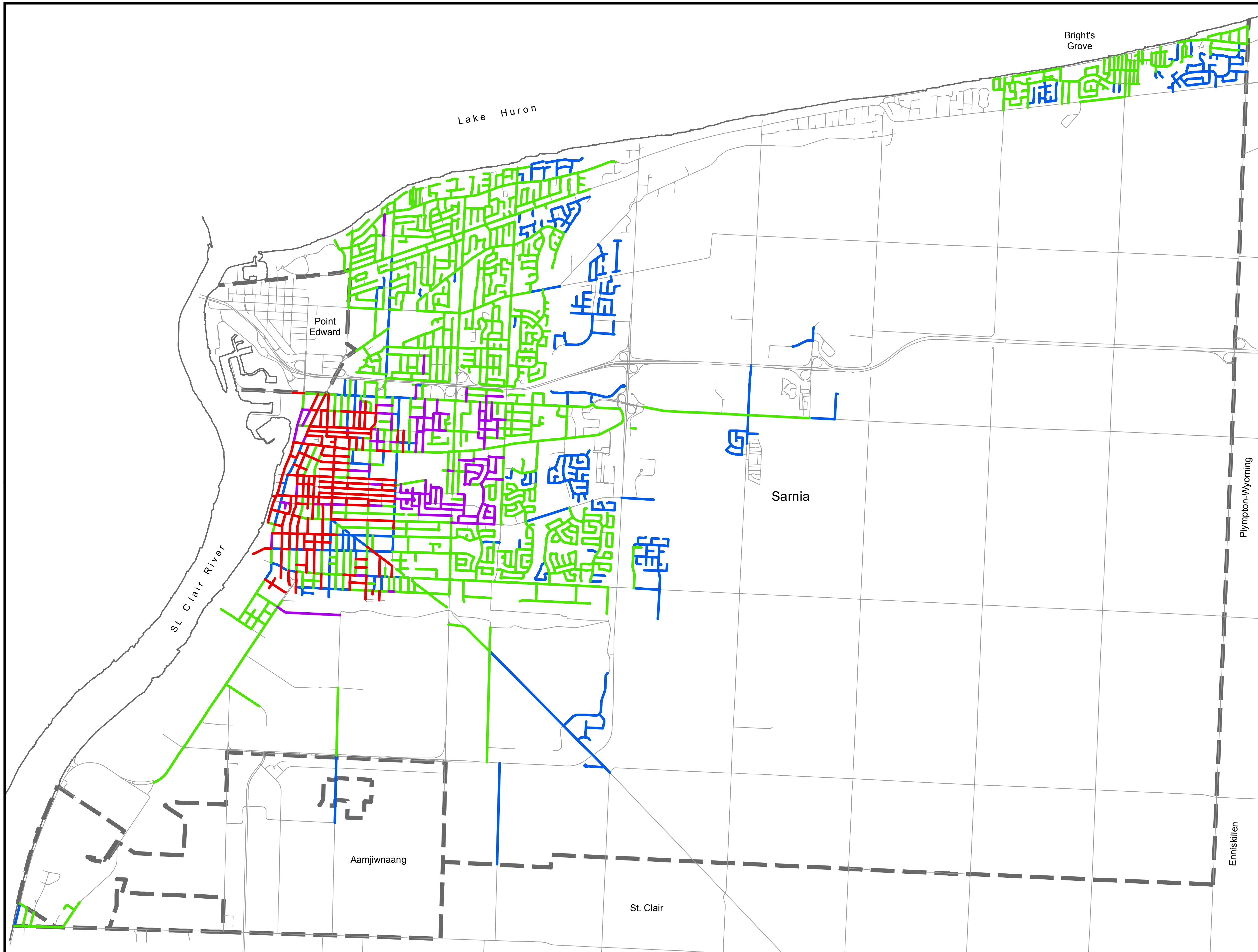
Remaining Service Life

- >= 80 years
- 80 - 45 years
- 45 - 30 years
- 30 - 0 years

N

0 500 1,000 2,000 Meters

Prepared by:
Engineering Department,
City of Sarnia,
Dated December 16, 2013.



Appendix: B
Map 3
City of Sarnia
Asset Management Plan

Legend

Sanitary

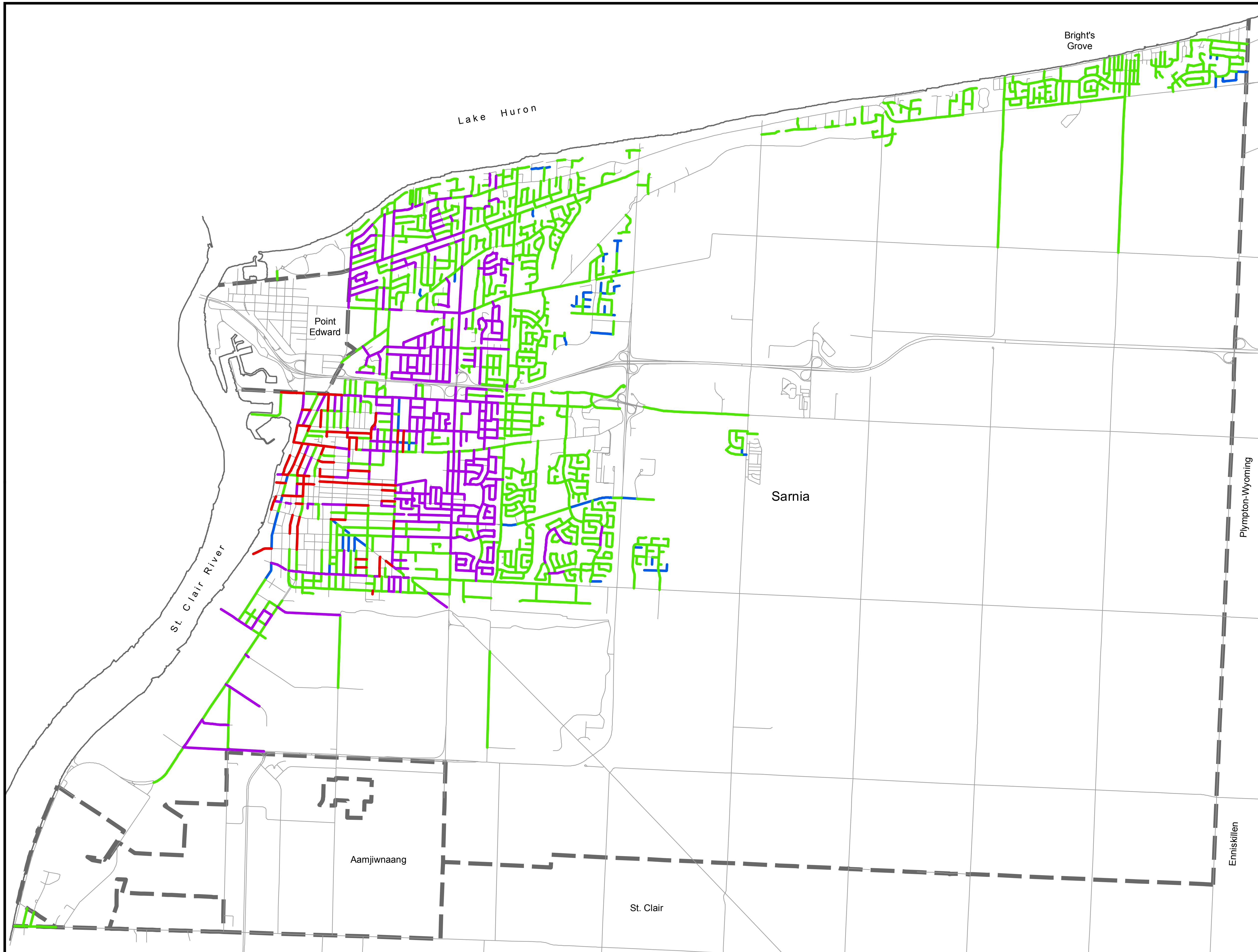
Remaining Service Life

- >= 80 years
- 80 - 45 years
- 45 - 30 years
- 30 - 0 years

N

0 500 1,000 2,000 Meters

Prepared by:
Engineering Department,
City of Sarnia,
Dated December 16, 2013.



Appendix: B

Map 4

City of Sarnia

Asset Management Plan

Legend

Storm

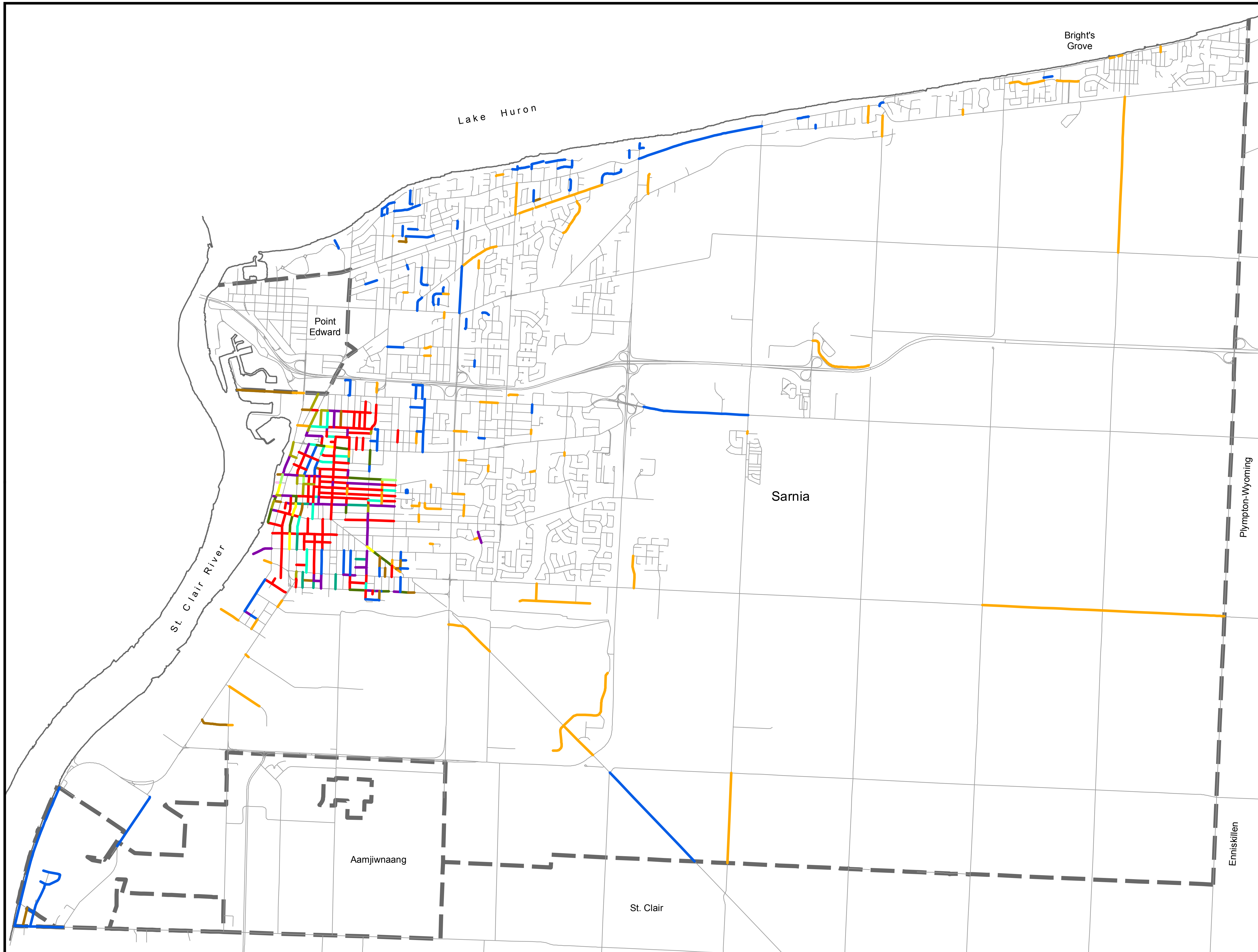
Remaining Service Life

- >= 80 years
- 80 - 45 years
- 45 - 30 years
- 30 - 0 years

N

0 500 1,000 2,000 Meters

Prepared by:
Engineering Department,
City of Sarnia,
Dated December 16, 2013.



Appendix: B

Map 5

City of Sarnia

Asset Management Plan

Legend

Current Need Project

Areas by Type

- Road
- Sanitary
- Water
- Road/Water
- Road/Sanitary
- Road/Sanitary/Storm
- Road/Water/Sanitary
- Road/Water/Storm
- Sanitary/Storm
- Water/Sanitary
- Water/Sanitary/Storm
- Road/Water/Sanitary/Storm

N

0 500 1,000 2,000 Meters

Prepared by:
Engineering Department,
City of Sarnia,
Dated December 16, 2013.

Appendix: C

Unit Prices of Linear Assets

Weighted Average Unit Price Used in Financing Strategies

Road Weigthed Average Unit Cost per Running Metre

Road Class	Length (km)	% Net Work	Reconstruction cost/m	Resurface cost/m	Major Rehabilitation with full curb repairs cost/m
Local	253	57.63%	$1,292.20	$200.20	$559.00
Collector	61	13.78%	$1,391.60	$215.60	$584.00
Arterial	64	14.62%	$1,917.00	$297.00	$719.00
Rural	61	13.96%	$1,050.80	$162.80	
Total	**439**	**100%**			
Average Cost			**$1,363.55**	**$211.25**	**$590.20**
Unit Price Used in Financial Plan = Current Need/Length = $46,103,406.34/34920.36m =			**$1,320.24**	**$225.81**	**$601.20**

Watermian Weighted Average Unit Cost per Running Metre

Water Diameter (mm)	Length (km)	% Net Work	Reconstruction Cost/m	Reconstruction Cost include Trench Repair/m
25	0.09	0.02%	$461.82	$631.82
38	0.04	0.01%	$461.82	$631.82
50	0.36	0.07%	$461.82	$631.82
75	0.07	0.01%	$461.82	$631.82
100	30.27	6.10%	$461.82	$631.82
150	220.07	44.37%	$461.82	$631.82
200	79.70	16.07%	$525.03	$695.03
250	14.25	2.87%	$595.98	$765.98
300	108.14	21.80%	$666.93	$836.93
350	1.68	0.34%	$711.89	$881.89
400	14.06	2.83%	$715.95	$885.95
450	16.21	3.27%	$795.93	$965.93
500	2.77	0.56%	$907.24	$1,077.24
600	7.77	1.57%	$1,091.34	$1,261.34
750	0.00	0.00%	$1,232.82	$1,402.82
900	0.51	0.10%	$1,428.18	$1,598.18
1050	0.00	0.00%	$1,623.53	$1,793.53
Total	**496**	**100%**		
Average Cost			**$552.87**	**$722.87**
Unit Price Used in Financial Plan = Current Need/Length = $43,340,309.10/70353.39m =				**$616.04**

Weighted Average Unit Price Used in Financing Strategies

Sanitary Sewers Weighted Average Unit Cost per Running Metre

Sanitary Diameter (mm)	Length (km)	% Net Work	Reconstruction Cost/m	Reconstruction Cost include Trench Repair/m	Cost split based on current need %
12	0.003	0.00%	$0.00	$0.00	$0.00
50	0.03	0.01%	$530.19	$778.19	$584.06
100	0.11	0.03%	$530.19	$778.19	$584.06
120	0.00	0.00%	$530.19	$778.19	$584.06
150	0.56	0.17%	$530.19	$778.19	$584.06
200	174.58	51.92%	$530.19	$778.19	$584.06
250	50.78	15.10%	$581.79	$829.79	$635.66
300	41.60	12.37%	$684.99	$932.99	$738.86
350	3.71	1.10%	$690.50	$938.50	$744.37
375	14.74	4.38%	$710.79	$958.79	$764.66
400	4.14	1.23%	$732.29	$980.29	$786.16
450	12.12	3.60%	$775.29	$1,023.29	$829.16
480	0	0.00%	$782.74	$1,030.74	$836.60
500	1.43	0.43%	$814.13	$1,062.13	$868.00
525	2.28	0.68%	$749.49	$997.49	$803.36
600	6.46	1.92%	$781.74	$1,029.74	$835.61
675	4.20	1.25%	$1,003.62	$1,251.62	$1,057.49
750	2.00	0.59%	$1,061.67	$1,309.67	$1,115.54
800	0.43	0.13%	$1,061.67	$1,309.67	$1,115.54
825	0.58	0.17%	$1,093.92	$1,341.92	$1,147.79
900	6.60	1.96%	$1,126.17	$1,374.17	$1,180.04
975	0.67	0.20%	$1,380.30	$1,628.30	$1,434.17
1050	2.26	0.67%	$1,638.30	$1,886.30	$1,692.17
1145	0.02	0.00%	$1,638.30	$1,886.30	$1,692.17
1200	1.45	0.43%	$2,141.40	$2,389.40	$2,195.27
1350	1.97	0.59%	$2,334.90	$2,582.90	$2,388.77
1400	0	0.00%	$2,429.33	$2,677.33	$2,483.19
1450	0	0.00%	$2,543.76	$2,791.76	$2,597.63
1500	2.11	0.63%	$2,592.90	$2,840.90	$2,646.77
1525	0.01	0.00%	$2,592.90	$2,840.90	$2,646.77
1575	0.27	0.08%	$2,592.90	$2,840.90	$2,646.77
1650	0.20	0.06%	$2,592.90	$2,840.90	$2,646.77
1800	0.89	0.26%	$2,592.90	$2,840.90	$2,646.77
Total	**336.22**	**100.00%**			
Average Cost			**$656.20**	**$904.20**	**$710.06**
Unit Price Used in Financial Plan = Current Need/Length = $32,919,227.27/38183.91m =				**$862.12**	

Weighted Average Unit Price Used in Financing Strategies

Storm Sewers Weighted Average Unit Cost per Running Metre

Storm Diameter (mm)	Length (km)	% Net Work	Reconstruction Cost/m	Reconstruction Cost include Trench Repair/m
50	0.00	0.00%	$657.90	$905.90
100	0.00	0.00%	$657.90	$905.90
150	0.05	0.02%	$657.90	$905.90
200	1.63	0.56%	$657.90	$905.90
250	28.59	9.76%	$657.90	$905.90
300	41.35	14.12%	$657.90	$905.90
350	0.37	0.13%	$679.40	$927.40
375	44.37	15.15%	$690.15	$938.15
400	1.21	0.41%	$700.90	$948.90
450	39.76	13.57%	$722.40	$970.40
500	0.11	0.04%	$739.60	$987.60
525	23.25	7.94%	$754.65	$1,002.65
600	23.88	8.15%	$761.10	$1,009.10
675	10.85	3.70%	$886.23	$1,134.23
750	14.28	4.87%	$976.53	$1,224.53
825	7.35	2.51%	$1,041.03	$1,289.03
900	13.20	4.51%	$1,105.53	$1,353.53
975	0.90	0.31%	$1,237.11	$1,485.11
1000	0.10	0.04%	$1,260.33	$1,508.33
1050	8.41	2.87%	$1,327.41	$1,575.41
1200	7.40	2.53%	$1,456.41	$1,704.41
1350	4.44	1.51%	$1,649.91	$1,897.91
1450	0.29	0.10%	$1,768.16	$2,016.16
1500	9.05	3.09%	$1,875.66	$2,123.66
1575	0.36	0.12%	$1,913.29	$2,161.29
1650	2.47	0.84%	$1,972.41	$2,220.41
1800	1.95	0.66%	$2,359.41	$2,607.41
1900	0.03	0.01%	$2,746.41	$2,994.41
1950	2.59	0.88%	$3,004.41	$3,252.41
2025	0.23	0.08%	$3,176.41	$3,424.41
2100	2.33	0.80%	$3,391.41	$3,639.41
2250	0.91	0.31%	$3,999.55	$4,247.55
2400	1.20	0.41%	$4,552.41	$4,800.41
Total	**292.89**	**100.00%**		
Average Cost			**$931.77**	**$1,179.77**
Unit Price Used in Financial Plan = Current Need/Length = $21,489,004.10/25,193.33m =				**$852.96**

Appendix: D

Assumptions

Assumptions

Current Needs Projected by System

- ***General***
    - Cost is based on individual asset length and unit prices derived from tender sheets
    - Unit prices are based on road class, watermains and sewer pipe diameters

- ***Combined Projects***
    - All the buried infrastructure projects due within 15-year window are combined.
    - Combined Projects cost include water installation, sewer installations and complete road reconstruction. The road reconstruction includes curb, gutter, sidewalk, boulevard, driveway repairs and etc.
    - Combined sewer separation projects are same as Combined projects (a combined sewer is replaced by a sanitary and a storm sewer; water and road will also be reconstructed at the same physical location)

- ***Road/Water/Sanitary/Storm Integrated costs***
    - Cost of either Road, Water, Sanitary or Storm includes their respective individual costs as well as the components from the combined project costs

- ***Road***
    - If only road is in need then road minor rehabilitation (top layer resurfacing and spot curb and gutter repairs) will be done
    - If one buried asset and the road are in need, then road minor rehabilitation (top layer resurfacing and spot curb and gutter repairs) will be done

- In addition to road if two or more of buried assets or a combined sewer underneath are in need, complete road reconstruction will be done
- If only one buried asset (and no road) is in need then only minor rehabilitation (top layer resurfacing of road) is counted
- If two or more buried assets (and no road) underneath are in need then complete road reconstruction will be done and road reconstruction cost will be distributed among the buried assets
- If a rural road is in need a complete reconstruction will be done
- The road future needs have been considered as 29% (weighted average of rehabilitation cost/weighted average of reconstruction cost) of the road reconstruction cost.

Financial Strategy

- ***General***
    - Needs for the financial strategy includes current needs of linear infrastructures as of end of year 2012 and forecasted future needs in each year for up to 20 years
    - Current needs costs used are from system projected output
    - Future needs costs are based on the system projected output
    - In the combined projects where the road is not in need and is to be constructed, the road costs in such cases are not included in the financial plan.
- ***Unit Price***
    - **Road**
        - The unit costs for the specific treatment options are based on system projected needs divide by length in need
        - For road needs in combined complete reconstruction projects, the unit price are calculated using system projected needs divide by length in need

Appendix: E

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