Report to Civic Works Committee

To: **Chair and Members**
Civic Works Committee
From: **Kelly Scherr, P.Eng., MBA, FEC**
Managing Director, Environmental & Engineering Services and City Engineer
Subject: **Federation of Canadian Municipalities' Municipal Asset Management Program Grant Application**
Date: **March 30, 2021**

Recommendation

That, on the recommendation of the Managing Director, Environmental and Engineering Services & City Engineer, the following actions be taken:

- Civic Administration **be directed** to apply for a grant from the Federation of Canadian Municipalities' (FCM) Municipal Asset Management Program (MAMP) to assist with expenditures related to a watermain risk evaluation project. Should the City of London be successful with its grant application, an external consultant, CANN Forecast Software Inc., will lead the project based on their workplan proposal included in Appendix A and the City commits to undertake the activities and associated costs proposed in its application to FCM.

- The Mayor and City Clerk **be authorized** to execute any contract or other documents, if required, to give effect to these recommendations.

Executive Summary

Purpose

This report recommends that the City of London, in conjunction with CANN Forecast Software Inc., apply for the Federation of Canadian Municipalities' Municipal Asset Management Program to complete a watermain risk evaluation project utilizing the Consultant's Artificial Intelligence and Machine Learning software.

Context

Asset management of water infrastructure plays a critical role in ensuring that safe and clean drinking water is being distributed to the City of London's customers. It also ensures that the lifespan of water infrastructure is maximized by utilizing the most appropriate maintenance, repair, and replacement methods. Some assets, like watermains are difficult to directly inspect so advanced software to predict the degradation of these assets is an important tool for evaluating these assets.

Linkage to the Corporate Strategic Plan

Municipal Council's 2019-2023 Strategic Plan identifies "Building a Sustainable City" and "Leading in Public Service" as strategic areas of focus. The recommendation in this report will support drinking water delivery and quality and maximize the lifespan of watermains in the City through effective maintenance, repair and replacement practices based on the project results.

Analysis

1.0 Background Information

1.1 Previous Reports Related to this Matter

- January 23, 2018 – Report to Civic Works Committee – FCM Municipal Asset Management Program Grant Application

2.0 Discussion and Considerations

2.1 FCM Municipal Asset Management Program

The Federation of Canadian Municipalities' (FCM) Municipal Asset Management Program (MAMP) is an eight-year, $110-million program that supports Canadian cities and communities to make improved decisions about infrastructure. The MAMP program provides funding for projects that will help Canadian cities and communities of all sizes enhance their asset management practices. Examples of the types of activities funded by the program are:

- Asset management assessments
- Asset management plans, policies and strategies
- Data collection and reporting
- Training and organizational development
- Knowledge transfer

If successful, a MAMP grant will provide one-time funding of up to 80 per cent of total eligible costs, to a maximum of $50,000, for any project meeting the program's eligibility requirements. The project must be completed within 12 months of approval notice.

FCM accepts applications for MAMP projects year-round on a continuous basis; there are no deadlines to apply. Recipients may only apply for one project in any fiscal year (April-March) and all applications must include a resolution from Council supporting the submission. While there is no limit to the number of applications a municipality can make, FCM will give preference to first-time applicants.

3.0 Financial Impact/Considerations

The City of London did previously apply for and obtain an FCM MAMP grant in 2018 to assist with the Corporate Asset Management Plan update. The Corporate Asset Management Plan incorporated all City of London assets, where this FCM MAMP application is water asset specific. The Corporate Asset Management service area supports this grant application for the water specific project. A request in the amount of $49,500 (excluding applicable tax) is being made of FCM via this application, resulting in a balance of $9,900 (excluding applicable tax) to be covered by the City.

4.0 Key Issues and Considerations

The City of London’s Water Engineering division previously worked with the Consultant, CANN Forecast, on a research project in 2019. The previous project studied the impact of water pressure on pipe breakage in our water distribution system. The previous project was also predominately funded by taking advantage of grant money. The grants for the 2019 project came from MITACS and the National Research Council of Canada (NRC). Water Engineering was pleased with CANN Forecast’s work on the project and found the work to be of significant value for the financial commitment that was required of the City of London.

Water Engineering does currently utilize software to assist with the asset management of watermains. However, the technology being used was developed over a decade ago and many advancements have been made in the asset management software field since then. CANN Forecast has developed data analysis software which utilizes Artificial Intelligence and Machine Learning, which has the potential to provide more accurate asset management decision making practices. Due to the low cost to the City of London and high value received from this project, it would be of value to have CANN Forecast analyze the City of London’s watermain data. We can then compare it to the software that is currently used and see if there are efficiencies to be gained. The Corporate Asset Management service area has endorsed Water Engineering in

pursuing this project and indicated it could possibly be applied to other service areas if it is found to be beneficial.

Conclusion

Asset management of water infrastructure plays a critical role in ensuring that safe and clean drinking water is being distributed to the City of London's customers. It also ensures that the lifespan of water infrastructure is maximized by utilizing the most appropriate maintenance, repair, and replacement methods. This project will allow the City of London to utilize a more advanced asset management software for watermains and determine if our current software should be permanently upgraded. The software being utilized in this project could also be applied to other service area's assets if found to be effective.

Prepared by: **Aaron Rozentals, GDPA, P.Eng., Division Manager, Water Engineering**

Submitted by: **Scott Mathers, MPA, P. Eng., Director, Water and Wastewater**

Recommended by: **Kelly Scherr, P. Eng., MBA, FEC**
Managing Director, Environmental and Engineering Services and City Engineer

CC: **Stephen Romano, P.Eng, Environmental Services Engineer, Water Engineering**
Naysan Saran, CEO (CANN Forecast Solutions Inc.)

Appendix 'A' - Workplan

CANN FORECAST
Smart Water Management

Consulting Services Proposal

Prepared for the City of London

February 2021
Version : 2.0

Table of Contents

Introduction

Water pipe networks are ageing and failure rates are increasing in an environment where public utilities have limited funds. This means that there is pressure on public utilities to use their available funds in the most efficient possible manner.

CANN Forecast builds reliable decision support tools that enable clients to protect public health, reduce their operating costs, and better understand their impact on the environment by using data already available (open data and customer data). InteliPipes is a water data analysis software solution developed by CANN Forecast which utilizes Artificial Intelligence and Machine Learning to identify the water main pipeline cohorts that are most at risk of failure, allowing decision-makers to better predict the remaining asset life and prioritize renewal programs.

InteliPipes' Smart Cohorts Framework

What is a pipe cohort?

A pipe cohort is a relatively homogenous population of pipes that are expected to have similar physical, environmental, and operational characteristics, and therefore similar performance[1].

The value of Identifying the cohorts within your water network

The importance of identifying the different pipe cohorts within a given water network, has been stressed in many studies over the last few years[2][3].

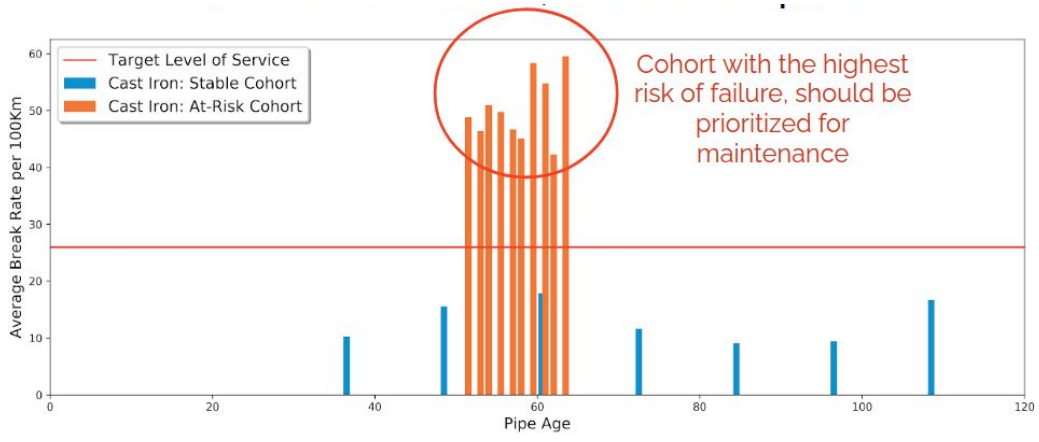

Figure 1: The failure rate and risk profile can vary significantly depending on the cohort

In order to improve the practices of pipeline asset management, the United States Environmental Protection Agency advises that a variety of condition curve scenarios should be generated for each

[1] Primer on Condition Curves for Water Mains, EPA, 2013
[2] Water Main Break Rates In the USA and Canada: A Comprehensive Study, Utah State University, 2018
[3] BURIED NO LONGER: Confronting America's Water Infrastructure Challenge, AWWA

pipe cohort of interest. Once these condition curves are computed for each cohort, it becomes clear and possible to prioritize the most at-risk pipes for leak detection programs, replacement, or rehabilitation.

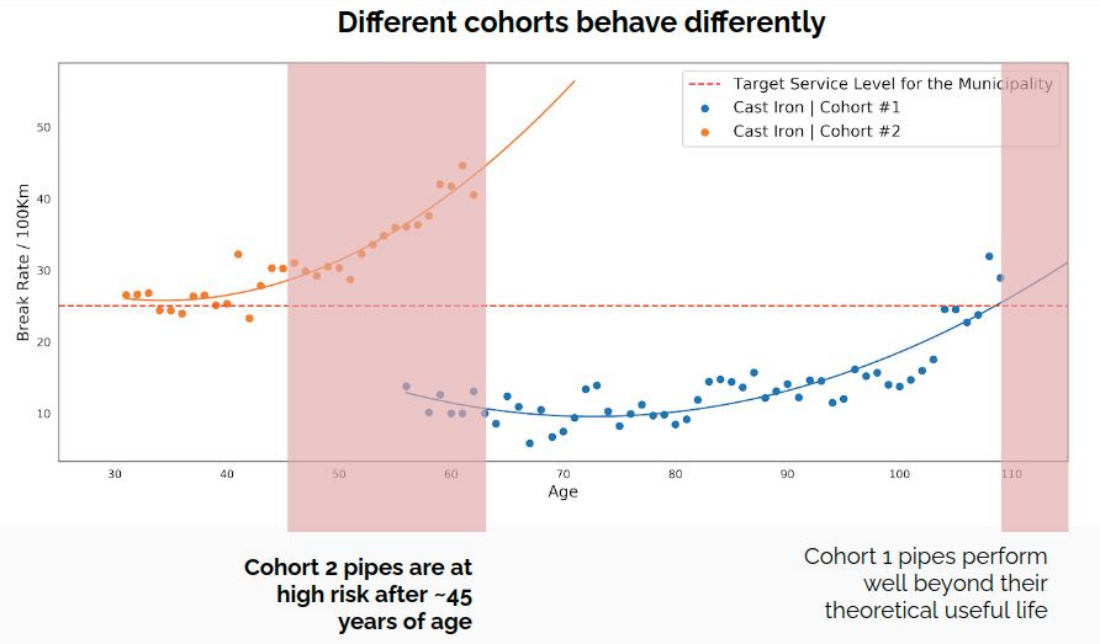

Figure 2: Condition curve scenarios should be generated by cohort

The data challenge: Why InteliPipes leverages Machine Learning

According to the EPA, the accuracy of a cohort-based approach is determined by how well the pipe cohorts are grouped in terms of common factors[4]. However, water mains can fail due to many different factors, including:

1. **Structural Factors**
   Installation date, Age, Diameter, Length, Break history, Pipe location
2. **Operational & Environmental Factors**
   Pressure average and fluctuation, Seasonal patterns of temperature, Frost and thaw, Pipe lining, Soil type, Road type, Traffic loads etc.

Due to its complexity and the number of the factors involved, the Smart Cohorts methodology; at the heart of InteliPipes, leverages Machine Learning to identify the pipe cohorts of interest within a water network, and sorts them by likelihood of failure. In doing so, this method allows municipalities to do more with less; identifying the minimum length of water mains that have to be replaced, to prevent the maximum number of future breaks.

[4] Ibid

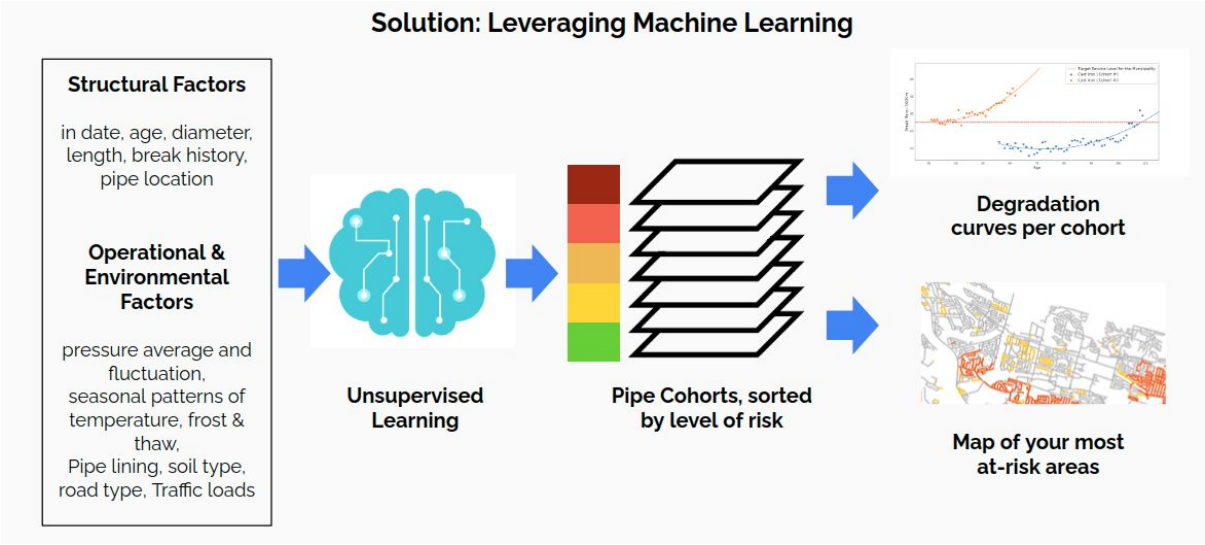

Figure 3: The Smart Cohorts Framework by CANN Forecast

Proposal

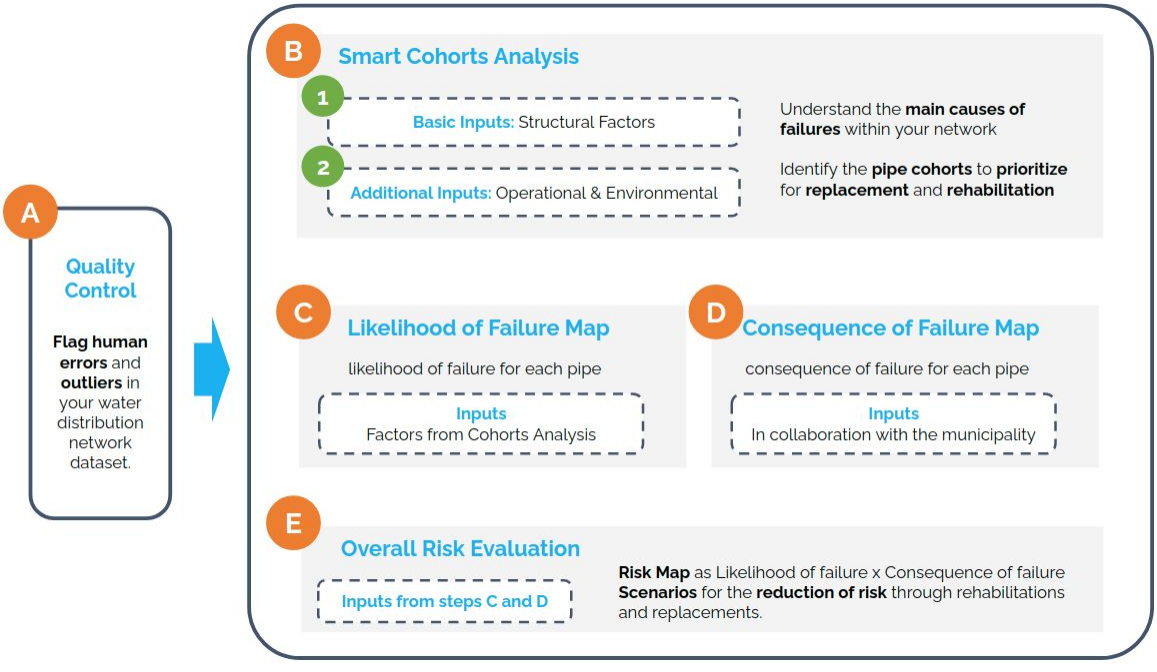

Figure 4: Overview of the Services offered

Proposal Modules

A - Quality Control

Figure 5: Overview of the data quality control step

Value for your utility

Maintaining good quality water network data is an important step in mitigating the risk of pipe failures. To prevent data errors from flowing through the process and ultimately leading to suboptimal or poor decisions, our team carries out a quality control step to flag human errors and identify outliers within your water distribution network dataset.

Summary of the work done

- Identify potential human errors, spelling mistakes, misclassifications and inconsistencies in pipe installation date, diameter, material, and break history datasets
- Alert the utility of missing data or inconsistencies that may flaw the decision making process

Pricing

Data quality control is included with the purchase of each of options B, C and D.

B - Smart Cohorts Analysis

Figure 6: Overview of the Smart Cohorts Analysis

Value for your municipality

Once the condition curves are computed for each cohort, it becomes possible to prioritize the most at-risk pipes in leak detection programs, or for replacement or rehabilitation.

Summary of the work done

- Evaluate the impact of each factor of interest on the historical failure rate
- Identify the main causes of failure within your water network
- Leverage Unsupervised Learning algorithms to identify the cohorts of interest
- For each such cohort
    a. Compute its condition curve as a function of age
    b. Evaluate its level of criticality given the target level of service of your municipality
- Overall decision tree so each water main can be associated with its cohort
- Suggest best practices for future data collection, management and analysis

Pricing **(option selected)**

* Because the City of London has already collaborated with CANN Forecast in a research project on the impact of pressure on watermain breaks, CANN will include pressure in the cohorts analysis at no additional cost to the City.

	< 50,000 inhabitants	< 150,000 inhabitants	**150,000 + inhabitants**
Report with Structural factors only	$7,500	$15,000	**$20,000**
Additional factors: pressure	$5,000	$6,000	**included*
Additional factors: temperature	$5,000	$6,000	**$7,000**

C - Likelihood of Failure Map

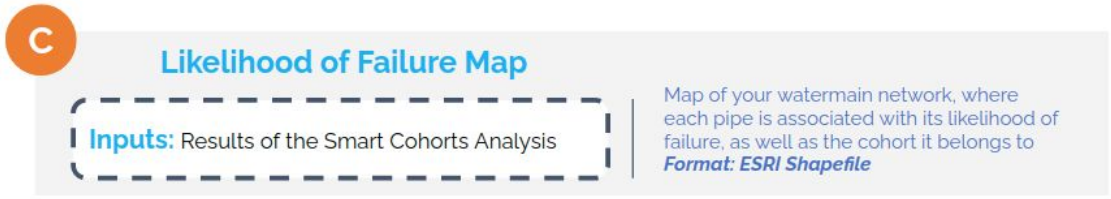

Figure 7: Overview of LoF step

Value for your water utility

Map of the probability of failure for each pipe within your water network, in a format that can be uploaded to any ESRI-compatible software.

Summary of the work done

- Using the decision tree developed in phase B, map each pipe with its corresponding cohort
- For each pipe, compute the 5 and/or 10-year likelihood of failure given its age and cohort condition curve

Pricing (option selected)	< 50,000 inhabitants	< 150,000 inhabitants	**150,000 + inhabitants**
5-year AND 10-year likelihood of failure	$3,000	$4,000	**$5,000**

D - Consequence of Failure Map

Figure 8: Overview of CoF step

Value for your water utility

Map of the consequence of failure for each pipe within your water network, in a format that can be uploaded to any ESRI-compatible software.

Summary of the work done

- With the input from the city, assign values to the following costs
    a. **Cost of lost water**
    Based on the pipe diameter, pressure, and time to repair.
    b. **Costs of repair**
    Costs of material, equipment, and worker salaries necessary in the repair process.
    c. **Costs of supply outage**
    Based on a density map of customers affected by water supply outage
    d. **Sector criticality**
    Our team will work with the utility to identify high-impact sectors within the municipality
    e. **Property Damage**
    Estimated physical damage caused to buildings in the vicinity due to the water main burst.
- Work in collaboration with the utility to build the cost a failure equation that aligns with the priorities and target level of service
- Based on the cost of failure equation elaborated for the client, map every pipe in the water network to its associated consequence of failure

Pricing **(option selected)**	< 50,000 inhabitants	< 150,000 inhabitants	**150,000 + inhabitants**
Consequence of failure map	$6,500	$12,500	**$15,000**

E - Overall Risk Evaluation

Value for your municipality

The Likelihood of Failure and Consequence of Failure maps can be combined using a risk matrix to judge the efficiency of future repair and rehabilitation scenarios in terms of overall risk reduction and level of service improvement for your utility.

Summary of the work done

- Compute the 5-year and/or 10-year risk map
- Optional: provide an online dashboard to test potential repair and rehabilitation scenarios and compare their overall risk reduction.

Pricing **(option selected)**

*As part of our collaboration with the City of London, CANN will include the Online InteliPipes Dashboard licence at no additional cost to the City for the duration of this project.

	< 50,000 inhabitants	< 150,000 inhabitants	150,000 + inhabitants
5-year AND 10-year risk map	$1,500	$2,000	**$2,500**
Online InteliPipes Dashboard (12 month licence)	$5,000	$7,500	***included**

Tentative Timeline and Pricing

A		Data formatting and quality control	*Included*
B	**B1**	Smart Cohorts Analysis: structural factors	$20, 000
	B2	Smart Cohorts Analysis: temperature and pressure	$7, 000
C		Likelihood of Failure: 5-year and 10-year likelihood of failure map	$5, 000
D		Consequence of failure map	$15, 000
E	**E1**	Overall risk evaluation: 5 and 10-year overall risk map1y	$2, 500
	E2	Online Intellipipes Dashboard (12-month license)	*Included*
		Total before taxes	**$49, 500$**
		HST Fed. (5%) Prov. (8%)	$2, 475 $3, 960
		Total after tax	**$55, 935**

A detailed project work plan Excel document is attached to this proposal for more information.

Modules	2021					2022					
	08	09	10	11	12	01	02	03	04	05	06
A	**Data transfer, formatting and analysis**			Available & updated through the dashboard							
B1			**Smart Cohorts Analysis: structural factors**			Available & updated through the dashboard					
B2				**Additional factors: pressure & temperature**			Available & updated through the dashboard				
C						**LoF maps**		Available through the dashboard			
D				**Consequence of Failure Model & Map**							
E.1								**5 and 10-year overall risk maps**			
E.2		**Online Intellipipes Dashboard**									
Invoicing		***$11,187***		***$11,187***		***$11,187***		***$11,187***		***$11,187***	