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INVESTIGATION INTO THE ORIGIN AND CAUSE OF SEWAGE SPILLS – HAMILTON HARBOUR

Location: Wentworth Street North and Burlington Street, Hamilton, ON
Our File: 230089CON

Prepared for:

City of Hamilton – Office of the Auditor General
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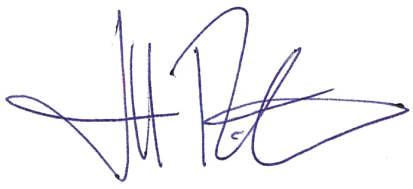

Jeff Reitsma, P.Eng., PMP, MBA

November 2, 2023

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1.0 SUMMARY

We were contacted by the City of Hamilton (the 'City'), specifically the City's Office of the Auditor General ('Auditor General'), regarding the discovery of sewage spills that had been flowing into Hamilton Harbour since 1996. The sewage came from a storm sewer line cross-connected with a sanitary sewer located at the intersection of Wentworth Street North and Burlington Street, in Hamilton, Ontario. Subsequently, two smaller-scale spills were identified, one that began in 1996 and another one from 1982. All three of the identified cross-connections were resolved by the City of Hamilton Water Department ('Hamilton Water').

We were retained by the Auditor General to conduct an origin and cause and risk assessment investigation of the incident sewage spills and to undertake a peer review of the Hamilton Water investigation and the report by Stantec Consulting responding to elements of the MECP's Order. We were specifically requested to comment on the following concerns:

- "*What happened to cause the spills, including immediate and root causes, and how Hamilton Water remediated the spills.*"
- "*What systemic issues may exist within Hamilton Water (or City) that may have contributed to the causes (e.g., process, control, or technology deficiencies, resource constraints, etc.).*"
- "*What challenges may exist to mitigate or remediate the issues*."

Our work plan was delineated in two proposed action plans issued in response to The City's RFPs (included in Appendix A), and our report is based on our review of the reported information and provided materials (a complete list of which is attached as Appendix C) and our engineering analysis. This report is therefore limited to the aforementioned scope.

Based on our investigation, it is our opinion that:

- The sewage spills were caused by the following factors:
    - The drawings used in the design and construction were incorrect, which resulted in improper instructions being provided to the design and construction teams.
    - The lack of recognition that the cross-connections were being constructed – and were not deemed a significant risk – during the construction process.
    - The physical piping networks and the drawings illustrating them were large, complex, and interconnected, which made it difficult to identify issues once they existed.
- The Hamilton Water response to the spills and investigation into the origin and cause was appropriate, thorough, and in accordance with the industry's best practice.
- The MECP Order was reasonable, and the ongoing response to the Order by Hamilton Water and Stantec is appropriate, thorough, and in accordance with the industry's best practice.

- There do exist other issues related to the City's operation that had indirect contributions to the historic spills and/or continue to present risks, as follows:
    - The legacy approach to water quality from the earlier part of the 20th century resulted in a mixed sewer system that incorporated combined sewers and interconnections, increasing the risk of untreated sewage spills.
    - The City's large and complex system of sanitary-, storm- and combined-sewer lines made the potential for accidental cross-connections and mislabelled lines more likely.
    - The legacy pre-digital drawings remain in service and may provide misleading information. The drawings that were used may have been of relatively poor quality due to age, had multiple naming conventions, and used inconsistent standards.
    - Addressing Combined Sewer Overflow (CSO) interconnections with stormwater systems, as a means to reduce the risk of upstream flooding due to storms (e.g., to protect against residential basement flooding during storms) has been a policy priority for the City with significant improvement over time. This will drive overflows into the natural environment when infrastructure capacity is overwhelmed and reflects a value- and risk-based decision to extreme stormwater flow management.
    - The availability and application of expert staff – both for construction project oversight and CCTV inspection review – is limited. There remains a relative shortage of personnel with optimal and timely expertise involved in higher-risk projects by Hamilton Water and Hamilton ES.
    - Asset and data management systems are currently spread across three platforms at the City of Hamilton, which are integrated in a limited fashion, meaning that certain parties may have limited or no access to information that may help reduce risk.

Going forward, 30FE recommends that:

- The approach prescribed in the Stantec report – which was in many respects already underway within Hamilton Water – be continued, namely:
    - The Existing Sewer Lateral Cross-Connection Program.
    - Existing passive monitoring and complaints-driven processes to identify and investigate suspected cross-connections and spills;
    - Continue and expand the Risk-Based Proactive Pilot Program in the high-risk central Hamilton combined sewer system and use this as a launching pad for a permanent System-wide Unauthorized Discharges Removal and Inspection Program (SUDRIP); and
    - Review and revise these programs over time to ensure they remain a good value from a risk-reward program as infrastructure is renewed, cross-connections are repaired, and high-risk areas are cleared.

- Use and refine Hamilton Water's risk-scaled communication and response (for as-yet-undiscovered leaks/cross-connections). As it is likely that residual risk exists that new leaks/spills may be uncovered; therefore, transparency and response planning remain important.
- Continue with protocols for the validation and integration of asset management information across the IPS, WIMS, and SPIDER systems during design, construction, and maintenance activities. Long-term establishment of a unified asset management database should remain a priority to facilitate inter-divisional collaboration and communication which were a hallmark of the excellent response to the three identified spills.
- Consider the incorporation of risk-based inclusion of Hamilton Water and Hamilton ES expertise across divisions on design and construction projects at key milestones (e.g., pre-tender design reviews, pre-construction field surveys, CCTV inspections) to increase the frequency of personnel with optimal and timely expertise being part of projects, particularly those wastewater projects with higher risks of cross-connections, spills, or other community impacts.
- Continue to evaluate opportunities for improvement on a cost-benefit basis including costs to the natural environment and community, for policies associated with infrastructure investment and operation as they relate to stormwater management.

2.0 INTRODUCTION

2.1 Incident as Understood

We were contacted by the City of Hamilton (the 'City'), specifically the City's Office of the Auditor General ('Auditor General'), regarding the discovery of sewage spills that had been flowing into Hamilton Harbour since 1996. The sewage came from a storm sewer line cross-connected with a combined sanitary sewer located at the intersection of Wentworth Street North and Burlington Street, in Hamilton, Ontario. Subsequently, two smaller-scale spills were identified, one that began in 1996 and another one from 1982. All three identified cross-connections were resolved by the City of Hamilton Water Department ('Hamilton Water').

Following the discovery and remediation of the spills, the City was directed by the Ontario Ministry of Environment, Conservation and Parks ('MECP') to undertake a detailed risk assessment and gap analysis intended to prevent future spills, as described in MECP Order 1-142403769. Subsequently, Hamilton Water engaged Stantec Consulting Ltd. ('Stantec') to carry out the MECP-ordered independent reviews. In parallel, the City requested an independent peer review of both of the Hamilton Water and Stantec activities, as described in RFP 60228, which 30 Forensic Engineering ('30FE') was selected to undertake.

2.2 Investigation

We were retained by the Auditor General to conduct an origin and cause and risk assessment investigation of the incident sewage spills and to undertake a peer review of the Hamilton Water investigation and the report by Stantec Consulting responding to elements of the MECP's Order. We were specifically requested to comment on the following concerns:

- "*What happened to cause the spills, including immediate and root causes, and how Hamilton Water remediated the spills.*"
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Our work plan was delineated in two proposed action plans issued in response to The City's RFPs (included in Appendix A), and our report is based on our review of the reported information and provided materials (a complete list of which is attached as Appendix C) and our engineering analysis. This report is therefore limited to the aforementioned scope.

2.3 Duty of Experts

This report has been prepared by Mr. Jeff Reitsma, P.Eng., PMP, MBA. A summary of the author's pertinent employment and educational experience is provided within the Curriculum Vitae included as Appendix B. Specific to this investigation, Mr. Reitsma's experience in roughly 15 years of municipal infrastructure design and construction related to wastewater and stormwater management is particularly relevant, in terms of the means and methods that capital projects are conceived, designed, and constructed, as well how such infrastructure is managed and maintained by sophisticated municipalities such as the City of Hamilton and its various technical departments. Further, Mr. Reitsma's activities as an independent forensic engineer from 2014 onward have afforded him extensive experience in reviewing failure situations, opining on standards of care, risk management, and the origin and cause of failure events.

The findings reached as a result of this investigation, and the reasons and basis for these findings, including any assumptions made or research performed, will be discussed in the following sections. The author acknowledges his duty to provide evidence that is objective, non-partisan, and related to areas within his expertise, to assist with an understanding of the matters at hand.

2.4 Background

Beginning in the 1980s, the City implemented several initiatives to improve the water quality in Hamilton Harbour ('the Harbour') and promote clean water in the area. Stormwater management played a crucial role in these efforts, specifically relating to the reduction of untreated stormwater runoff entering the harbour. Stormwater management infrastructure in the City includes a combination of storm sewers, detention ponds, and treatment facilities. Most parts of the City are connected to dedicated storm sewers, which convey stormwater from streets, parking lots, and other impervious surfaces to collection points – some of these are currently connected to treatment systems.

2.4.1 City of Hamilton Organization

The operation and maintenance of the City's water, wastewater, and stormwater systems is the responsibility of Hamilton Water and is governed by the MECP. Engineering and construction support services within the City of Hamilton are provided by The City of Hamilton's Engineering Services ('ES').

The City was amalgamated in 2001, following the dissolution of the Regional Municipality of Hamilton–Wentworth, merging its six constituent municipalities into a single-tier city of Hamilton. The amalgamation resulted in the combination of the wastewater and stormwater infrastructure which had prior to that point been the responsibility of the City and Region, respectively.

2.4.2 Circumstances of Wastewater Spill Events

The details of the spills of wastewater that are the subject of this report are described in detail in the Hamilton Water presentations to the City's Public Works Committee ('PWC'), on November 28, 2022 – discussing the first spill and subsequent response – and again on February 13, 2023 – discussing the two additional spills discovered. The presentations are extensively referenced herein, and the contents of those reports are not reproduced in the interest of brevity (Table 1).

Table 1: Summary of the spill events.

Spill Discovery Date	Location	Nature of Issue	Est. Leak Volume
22-Nov-22	Wentworth & Burlington	Cross-connection	337 ML
9-Jan-23	Rutherford & Myrtle	Cross-connection	59 ML
19-Jan-23	Kinrade Avenue	Design issue	0.47 ML

2.4.3 City of Hamilton Response to Spill Events

As described in the same presentations to the City's PWC, once the issue was identified, the City undertook rapid activities to a) disconnect the source of the spill, b) contain the active in-pipe spill already in progress using vacuum trucks, and c) install modifications to return the system to normal service while eliminating the potential for future spills. This work was undertaken with coordination between Hamilton Water and Hamilton ES, and all spills were reported to the MECP via their spill reporting processes. The documents provided to the PWC suggest that the total time from the identification of the leak to the restoration of service was less than 48 hours.

2.4.4 MECP Order

Following the discovery of the first spill, the MECP undertook inspections and investigations into the City's operation of its collection system. Following the second spill in early January, an Order was issued by Mr. Tyler Kelly of the MECP on January 18, 2023. The third spill was identified the next day by the City and is not listed in the MECP Order.

Order – 1-142403769 – prescribes several activities to be executed and reported on to the MECP, along with deadlines. These are paraphrased below (Table 2).

Table 2: MECP's Order task list.

Item Number	Description	Deadline
1	Retain a qualified consultant to support with the necessary activities	6-Feb-23
2	Make formal confirmation to the MECP that said consultant has been engaged	6-Feb-23
3	Develop a sampling program to identify potential spills and trigger investigations when necessary	17-Mar-23

Item Number	Description	Deadline
4	Make formal submittal of the sampling program to the MECP	17-Mar-23
5	Develop enhancements to the existing sewer inspection programs to better identify potential spills and undertake a gap analysis, while updating digital records	12-May-23
6	Make formal submittal of the updated inspection and gap analysis to the MECP	12-May-23
7	Create or update policies and procedures for the identification and prevention of spills, including remedies for identified gaps as identified	30-Jun-23
8	Make formal submittal of the policies/procedures to the MECP	30-Jun-23

2.4.5 Hamilton Water Investigation

As described in the presentation to the PWC in November 2022, Hamilton Water and Hamilton ES immediately undertook a risk-based assessment to prioritize potential similar cross-connections from the 1996 contract which could discharge untreated wastewater into the Harbour. These inspections resulting from this plan identified the two subsequent spill locations.

As required in the MECP Order, the City also began immediate investigations into broader issues and engaged Stantec Consulting Ltd. (‘Stantec’) to provide design expertise in support of the ordered tasks, as required in Order items 1 & 2. Stantec’s final report was issued on May 9, 2023.

3.0 OBSERVATIONS

Our observations comprise information collected during our various meetings and a review of the provided materials. The following sections outline the information deemed relevant to our analysis.

3.1 Meetings with the City of Hamilton

We participated in several virtual meetings with members of the Hamilton Water and Hamilton ES teams familiar with the project. Each of these meetings had a defined purpose and the key topics of discussions are listed below.

3.1.1 Meeting of April 11, 2023 – Hamilton Water

The purpose of our initial meeting with Hamilton Water was to receive a general background on the incident and both the identification and response to the discovered spill.

Invitees from the City were:

- Manager of Water Distribution & Wastewater Collection, Hamilton Water;
- Supervisor Wastewater Collection, Hamilton Water; and
- Superintendent Water Distribution, Hamilton Water.

The following key topics were discussed, among others:

- Existing cross-connection identification programs in place and general arrangement of City's stormwater and combined sewer system, especially related to more aged elements of central Hamilton;
- Collaboration with the Infrastructure Renewal teams and Hamilton Water;
- Review of the specifics of the first spill identification and response activities; and
- General update on the evolution of the City of Hamilton's approach to maintenance and proactive investigations.

3.1.2 Meeting of April 13, 2023 – Engineering Services

The purpose of our meeting with Hamilton ES was to review the internal process for validating deliverables from designers (tender drawings for use in construction) and contractors (post-construction as-builts). The goal was to better understand how the sewer in question was mislabelled prior to 1996 and how processes have evolved and are used in the maintenance of the City's master drawings.

Invitees from the City were:

- Director of Engineering Services, Hamilton ES;
- Senior Project Manager, Technical Services, Hamilton ES;

- Senior Project Manager-Infrastructure, Hamilton ES;
- Manager, Geomatics and Corridor Management, Hamilton ES;
- Senior Project Manager Infrastructure Program and Planning, Hamilton ES;
- Manager, Design, Hamilton ES; and
- Manager, Construction, Hamilton ES.

The following key topics were discussed, among others:

- The Geomatics team manages the City's GIS database for the City using the Spatially Indexed Engineering Records ('SPIDER') database, which consolidates all information across departments into a single master database.
- Each division is responsible for updating the information. Hamilton Water maintains its internal Water Infrastructure Management Systems ('WIMS') system and provides updates to be made available for review via SPIDER as new projects are constructed or repairs/modifications are made that are appropriate to be reflected in the overall City model.
- In the past, the system was paper-based using a card-catalogued library of drawings, but Hamilton Water began digitizing in the mid-1990s.
- Prior to the amalgamation in 2001, the City (responsible for water and wastewater assets) and the Region (responsible for stormwater assets) would work on projects separately, but now all plans are merged in the SPIDER system.
- Consultants are overseen by the City's internal teams, with around 10% of major projects involving consultants for construction administration.
- New projects involve a planning phase, where a field survey is done and records from SPIDER are consolidated with any other relevant information from WIMS into a master base plan for use by external design consultants. At this phase, any conflicting or missing information is identified and field-reconciled prior to issuing a design RFP.

3.1.3 Meeting of April 13 – Hamilton Water

The purpose of our meeting with Hamilton Water was to understand the historic digitization and ongoing record-updating process of the City's master drawings and/or inventory of subsurface assets within the City's asset management system by Hamilton Water.

Invitees from the City were:

- Manager of Water Distribution & Wastewater Collection, Hamilton Water;
- Director - Water & Wastewater Operations, Hamilton Water; and
- Superintendent, Plant Maintenance, Hamilton Water.

The following key topics were discussed, among others:

- We reviewed the purpose and contents of WIMS and how it is not geospatially accurate and is focused more on linear (i.e., piping) rather than on vertical (i.e., structures and equipment) assets.
- As new assets are constructed, items are added to WIMS over time, which may lag. Relevant items added or modified in WIMS are made available for download via the City's master database in SPIDER when exported via the Geomatics Group.
- Operational records are maintained in the Hamilton Water work-order maintenance and asset management operational tool Infor Public Sector ('IPS'), informally known as Hansen. IPS includes notes, photographs, work orders, and field observations from Hamilton Water's operation and maintenance activities.
- The possible future use of Enterprise Asset Management ('EAM') to integrate these systems is being explored.

3.1.4 Meeting of April 14 – Hamilton Water

The purpose of our meeting with Hamilton Water was to understand the internal process for reviewing the reports and deliverables from Close-Circuit Television ('CCTV') investigations and how that information may influence infrastructure repair/rehab prioritization.

Invitees from the City were:

- Manager of Water Distribution & Wastewater Collection, Hamilton Water;
- Supervisor Wastewater Collection, Hamilton Water;
- Superintendent Water Distribution, Hamilton Water; and
- Senior Project Manager-Infrastructure, Hamilton ES.

The following key topics were discussed, among others:

- CCTV inspections are typically used:
    - In advance of capital work projects to confirm the integrity of the linear system;
    - In response to emergencies where on-site investigation is needed; and
    - For general asset management on small or critical systems.
- Inspections are done by external consultants using standard processes and with data, video, and reporting provided in a standardized format and logged into the IPS (Hansen) system. Emergency repair needs – if identified – are escalated to Hamilton Water for immediate action.
- Proactive maintenance of access holes and chambers is not done by CCTV but manually. CCTV is used only for piping which cannot be safely accessed.
- A limited number of trained operators are available to support in the field (i.e., during a CCTV inspection) or to review video afterwards. They are looking to increase this capacity and proactively assess more items over time.

3.2 Provided Materials

Materials were provided to 30FE via secured electronic document sharing and email. These were undertaken from March through May 2023 and a full list of all provided documents is included in Appendix C.

The documents provided were reviewed and their relevance to the analysis is included as needed in Section 4.0 of this report.

3.2.1 Document Batch 1 – March 2, 2023 – General Background:

- Public Works meeting PW22088(a) report and supporting materials; and
- MECP Order 1-142403769.

3.2.2 Document Batch 2 – April 3, 2023 – Burlington Street and Wentworth Street North Cross-Connections:

- Internal Hamilton Water Investigation notes and videos;
- 1996 contract materials – Contract RHW-96-20 (HSW); and
- MECP correspondence related to the spill event.

3.2.3 Document Batch 3 – April 19, 2023 – Hamilton Water Asset Transfer Procedures

- April 2022 Transfer of Assets– PW-WW-P-004-003 Issue 5.1; and
- September 2022 Management of Asset Transfer - PW-WW-P-026-004 Issue 1.1.

3.2.4 Document Batch 4 – April 25, 2023 – Master Drawing Procedures

- City of Hamilton Geomatics & Corridor Management Baseplan checklist – 18-Jan-19; and
- City of Hamilton Geomatics & Corridor Management Sectional guidebook – 15-Oct-19.

3.2.5 Document Batch 5 – May 11, 2023 – Sewer Inspection and Maintenance Procedures

- CCTV inspection standards;
- Sample City of Hamilton Proposal for Sewer Inspections (C13-59-21); and
- Hamilton Water internal prioritization criteria and standards.

3.2.6 Document Batch 6 – May 15, 2023 – Master Drawing Management

- PRISM Interactive Mapping Guide; and
- Drawing Management Requirements v0.1, 17-Jan-01.

3.3 Discussions with Other Municipal Experts

In addition to conversations with City of Hamilton professionals, we undertook informal conversations with others within the water and wastewater community in order to seek their opinions and experience on wastewater-stormwater spill events. These conversations were neither recorded nor intended to be definitive standards of each individual, but rather to understand common practices and establish a greater understanding of the level of action by owners and operators of such systems.

The organizations with whom discussions were had included:

- City of Toronto (ON);
- Region of Peel (ON);
- Region of Halton (ON);
- Region of York (ON);
- Ontario Clean Water Agency (ON);
- City of Calgary (AB); and
- Capital Regional District (BC).

From these discussions, we can confirm the following themes and issues were raised:

- Spills of raw wastewater and combined sewage overflow are a common occurrence, especially in locations where sewer systems were constructed prior to the mid-20th century. This can include both overflow spills during heavy storm events as well as cross-connection-related spills, such as those investigated in the City of Hamilton.
- It is common to use passive approaches such as outfall sampling and reliance on complaints from the public to identify leaks and spills.
- Canada's relative abundance of fresh water has historically reduced the value placed on risks related to contamination of discharge water bodies such as Lake Ontario, especially related to stormwater systems, though this has been steadily changing over the past 30 to 50 years.
- Cities and regions are facing multiple pressures related to stormwater management where trade-offs must often be made regarding protection of upstream property (e.g., basement flood protection) against protection of the natural environment during storm events, in the context of climate change, and increased insurance and municipal operation costs.
- Asset management is a central risk and source of complexity for owners and operators of linear infrastructure, insofar as the management of data related to design, construction, and operation and maintenance of water, wastewater, and stormwater systems.

4.0 ANALYSIS

The following sections discuss the relevant aspects of the wastewater spills into the stormwater system, grouped by area of investigation as prescribed by the Auditor General's RFP document.

4.1 Root Cause Analysis of the Spills

As described in the Hamilton Water reports and presentations to the Public Works Committee and the Stantec report, the origin and cause of the three spill events are well understood.

The first – and largest – of the spills was the cross-connection at Burlington Street and Wentworth Street North, identified in December 2022. It is clearly shown in the CC Parker Consultants Ltd. ('Parker') issued for tender drawing 96-H-11, associated with the reconstruction and widening of Burlington Street, that the Contractor was directed to make a connection to the misidentified pipe, as shown in the annotated Figure 1.

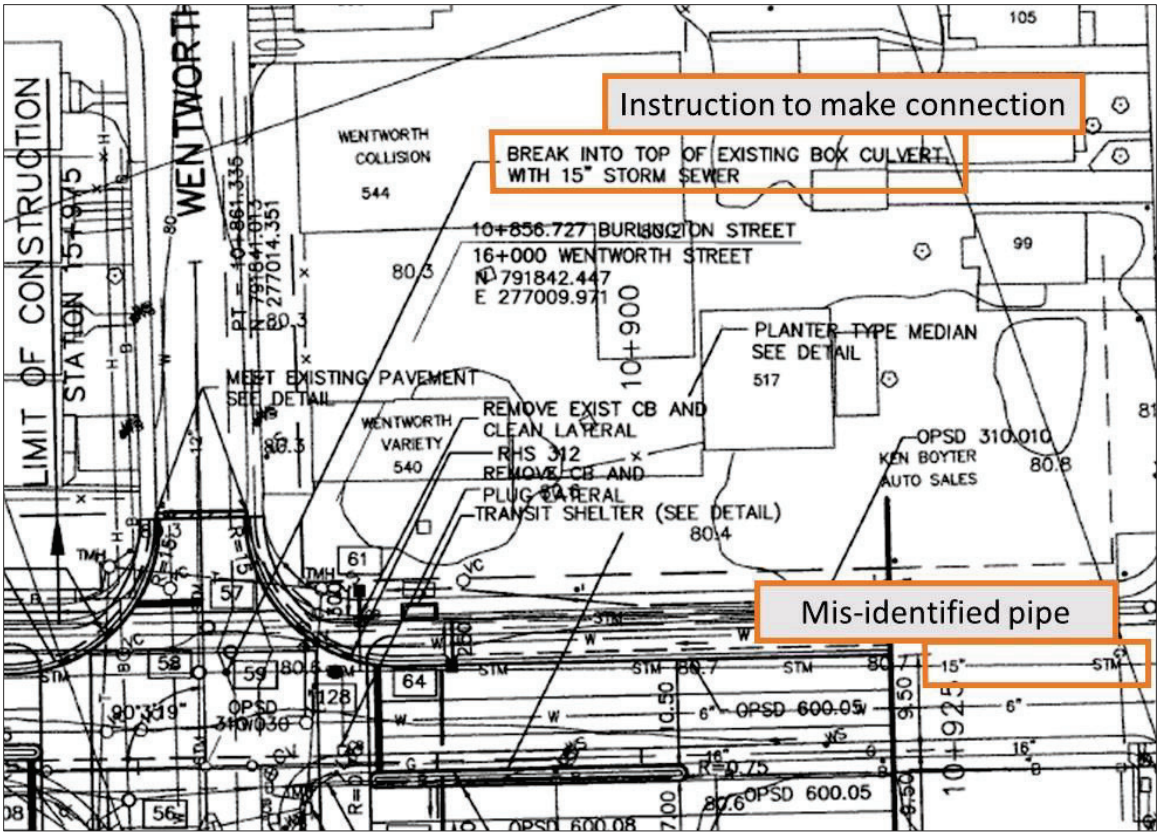

Figure 1: Selection of Parker Drawing 96-H-11 (annotated by 30FE).

Similarly, the second and lesser spill at Rutherford Avenue and Myrtle Avenue was the result of a cross-connection between the combined sewer and the stormwater pipes. The arrangement was clear, as shown in Figure 2, field-verified, and resolved. Fundamentally, this second spill was related to a direct and purposeful connection between combined and storm sewer lines.

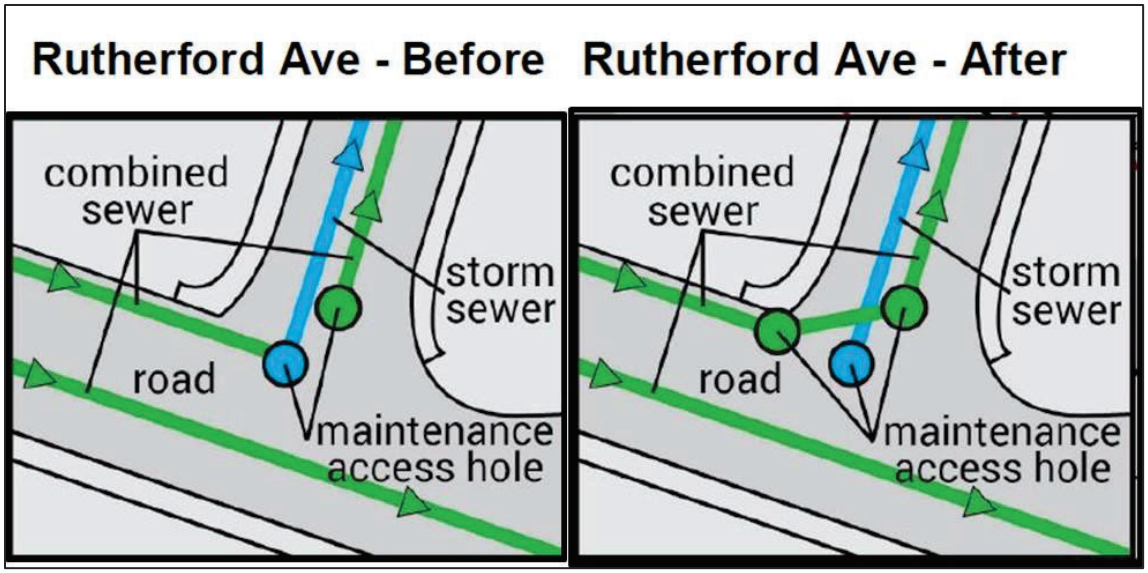

Figure 2: Drawing of Rutherford Avenue before/after (taken from the presentation to the Public Works Committee, Appendix D).

The third spill was slightly different and a result of the unique arrangement whereby the overflow connection between the combined and storm sewers was located in the precise spot where flows were prone to discharge directly into the overflow connection even under dry weather (i.e., low-flow) situations, as shown in Figure 3. In this instance, a lack of consideration of the risk of wastewater flowing into the storm sewer contributed to the origin of the spill.

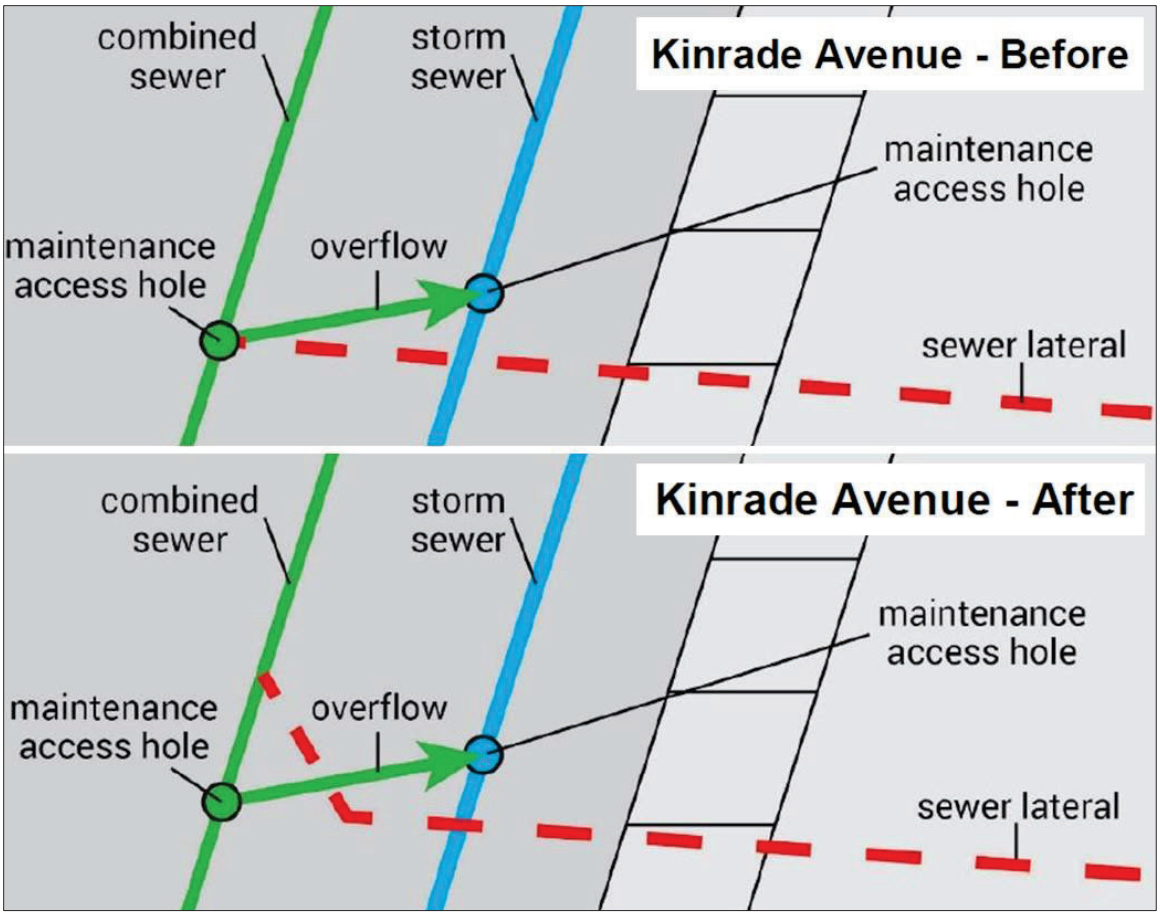

Figure 3: Drawing of Kinrade Avenue before/after (taken from the presentation to the Public Works Committee, Appendix E).

We agree with the root cause investigation undertaken by Hamilton Water, as well as the comments from Hamilton ES. There are themes across all three of the identified spill events which are summarized below.

Broadly, the cause of the spill events was due to:

- The existence of historic cross-connections between combined sewers and storm sewers;
- Design errors instructing Contractors to:
    - Make new cross-connections that were wholly inappropriate (in the case of the first and second spill events); or
    - The arrangement of the piping with a high potential for short-circuiting flow into the stormwater system (in the case of the third spill event); and
- The lack of understanding (or valuation) of the risk caused by these connections for sewage to enter the stormwater system by the construction teams, including the contractors and inspectors at the time of construction.

4.1.1 Legacy Approach to Water Quality

The central theme in all three cases observed is that they are related to older combined sewer systems, which was until relatively recently, a standard approach not in Hamilton but broadly across the world. There has been historically minimal – if any – distinction made between dedicated sewer and combined sewer systems. All sewer wastes were discharged to the nearest body of water and treatment was often simple or non-existent until relatively recently.

Thus, it should not be surprising that these systems may have cross-connections resulting from these legacy approaches, which are systematically being rectified as environmental sustainability and water quality concerns have steadily increased as infrastructure priorities. This general attitude from the early/mid-20th century contributed to these spills due to the relative lack of distinction between combined sewers and dedicated wastewater sewers, resulting in a lower valuation of risk from cross-connections or mislabelling in drawings.

4.1.2 Complexity of Below-Grade Linear Systems

As stated in the Stantec report, the City currently has 3,080 km of sewer pipe, of which 40% is dedicated wastewater/sanitary, 41% is dedicated stormwater, and 19% is combined. The combined sewers are located almost exclusively within the original pre-amalgamated City of Hamilton (Stantec project 163401837, Section 2.1, 9-May-23). This is a vast and complex network of buried infrastructure providing services over a complex topography servicing residential, commercial, and heavy industrial users.

From a practical perspective, this can manifest in two ways, which in this instance were contributors to the spill events:

1) The drawings – especially prior to digitization in the 1990s – included a high amount of information that can simply be hard to accurately draw and/or read, leading to a risk of misunderstanding of the design or constructed system.
2) The pipes in the field may not be easily identified even by sophisticated users. Indeed, the review of the CCTV video where the main spill was identified was due to "*something seeming off*" in the words of an experienced operator.

Complex systems are equally prone to error when compared to simple systems, but identifying those issues can be far more difficult in complex situations. A re-visitation of Drawing 96-H-11 illustrates this complexity, as shown in Figure 4. There are numerous pipes intersecting and overlapping at the intersection of Burlington Street and Wentworth Street North; identifying these is not simple either in the field or with an ink-and-paper drawing, increasing the risk of a design or construction error.

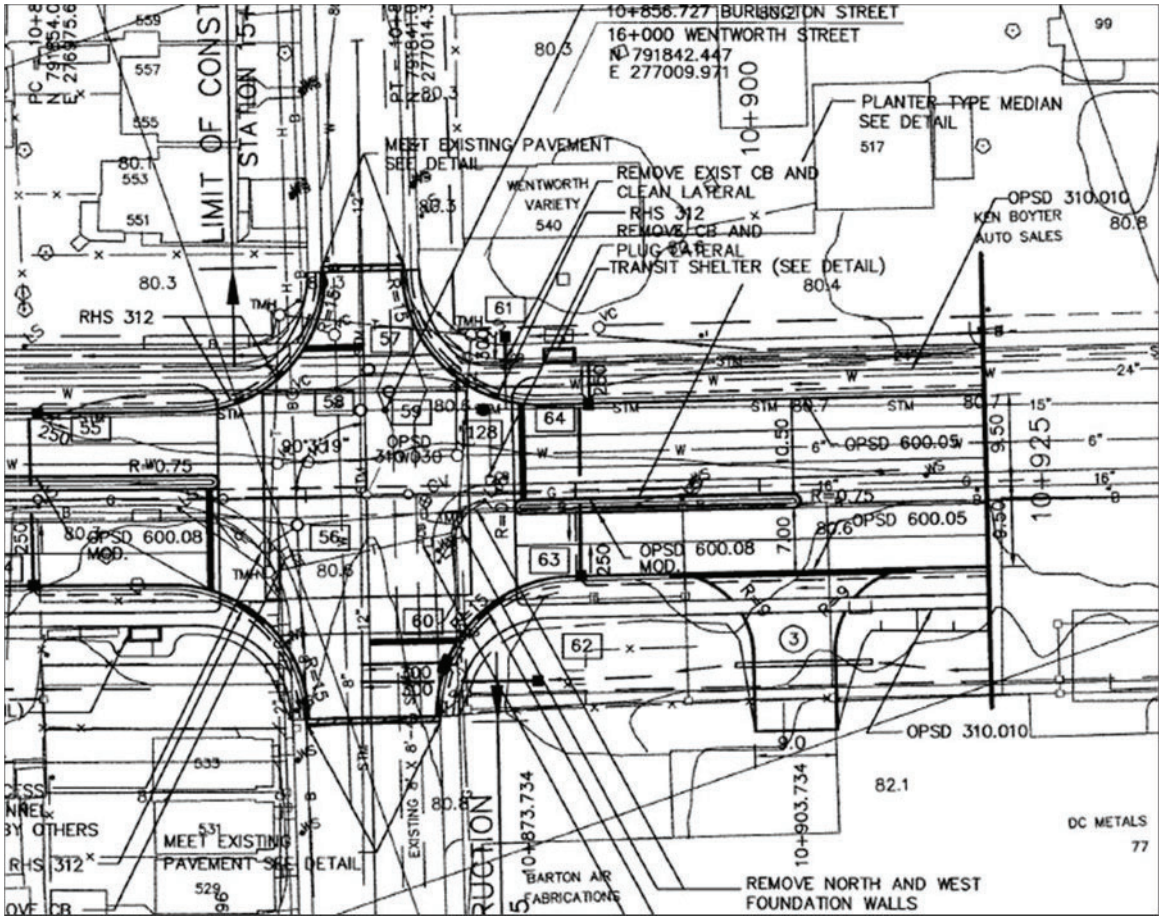

Figure 4: Selection from Parker Drawing 96-H-11.

4.1.3 Legacy Pre-Digital Drawings

As noted above, it is clear that in Drawing 96-H-11, a combined sewer was mislabelled as a storm sewer, which led to instructions to the Contractor to make the inappropriate connection, which led to the spill event. The origin of the incorrect labelling of the line in question is unclear, but it is likely that a combination of the following factors contributed to the issue being carried forward over time:

- The sewage system in question – related to the first spill event – was originally constructed in the 1910s and was modified repeatedly during the 20th century. Hand-drawn (manual) drawings are prone to aging over time, physically making them harder to read due to fading, degradation of paper/vellum, and environmental impacts such as staining or smudging.
- The City water review identifies manual drawings through to 1987 associated with this location and the first digital drawing is shown in 1994.
- Terms such as "*sewer*," "*sanitary*," and "*interceptor*" are used to describe multiple lines at different points in time.

- Prior to the amalgamation in 2001, the Region of Hamilton-Wentworth was responsible for stormwater systems, while the City of Hamilton was responsible for wastewater systems. There would therefore be two parallel sets of both physical and digital records to assess to consolidate a ‘master’ drawing showing all services.

The timing of the 1996 contract, where the cross-connection led to the first spill event, is at a precise time when both digitization and consolidation of records are underway. It is quite plausible that the designer at this time (i.e., Parker) made a mistake due to one of the above-noted issues that was not identified at the time of the tender in a quality assurance process.

4.2 Review of Hamilton Water Response

The Hamilton Water response to the first identified spill, and the subsequently discovered second and third spills, is well-documented in the submittals to the Public Works Committee, particularly in the materials related to meeting 22-105 on November 28, 2022, and 22-088(a) on February 13, 2023.

4.2.1 Immediate Response

The Hamilton Water team undertook the following activities in response:

- Immediate isolation of flows to prevent ongoing discharges;
- Immediate modifications to the physical arrangements to prevent future spills;
- Communication with relevant partners (public, MECP, City departments); and
- Initiation of a risk-based inspection process (identified as a pilot program) to identify additional spills (resulting in the identification of spills 2 and 3).

The response to the spills represents best-in-class practice and the speed of resolution (in all cases less than 48 hours elapsed from identification to reconstruction) is exceedingly commendable.

4.2.2 Response to MECP Order

In parallel, the MECP issued its Order 1-142403769 and instructed Hamilton Water to undertake several activities. Some of these were already underway prior to the issuance of the MECP Order.

The MECP’s directions and associated deadlines are reasonable given the MECP’s mandate to ensure that owners & operators take all reasonable precautions to protect the natural environment and to ensure good and proper operation and maintenance of their water, wastewater and stormwater systems.

As prescribed in the Order, Hamilton Water acted and engaged Stantec as a first step, who then led the following on the City’s behalf:

- Assessed the feasibility of a City-wide in-pipe inspection plan;

- Assessed the feasibility of a risk-based inspection plan;
- Undertook a gap analysis of current programs and procedures; and
- Assessed physical and analytical inspection programs.

The Stantec report appears to comply with the MECP Order and identifies several proactive steps to take – considering feasibility and resource constraints in a very risk and solution-focused manner. While some of the Stantec recommendations are longer-term or experimental in nature, many are focused on high-value risk-focused measures. The report lays out a roadmap for improvement using both new and expanded programs (such as the Sewer Lateral Cross-Connection Program) and confirmation that the City's approach is consistent with industry good practice.

4.3 Systemic Issues and Contributors to Spills

As listed in 4.1, there are several issues associated with the root causes of the spills in question. Namely, that:

1) The drawings used in the design and construction were incorrect.
2) It was not recognized at the time of construction that a cross-connection was made even though the line identified as a stormwater pipe was indeed a combined sewer pipe. There is no evidence that such a cross-connection was considered a significant risk.
3) The physical piping networks and the drawings illustrating them were large, complex, and interconnected, making it hard to identify these issues once they existed.

Beyond these root cause issues, there do exist other considerations and issues which are ancillary to the specific situations, but which bear discussion as they may have longer-term implications and risks for the City.

4.3.1 CSO-Storm Interconnections

As listed in Section 4.1.1, there remains an inherent risk-based value calculation that requires the City to balance multiple facets of the challenges posed by stormwater infrastructure, namely:

- Climate change is driving an increase in the frequency and severity of storm events globally.
- Combined systems are intermittently subject to overflow loadings from these storms.
- Overflow can be directed either out of the system downstream into the natural environment or upstream toward the source, namely residential, commercial, or industrial users.

Investment in new infrastructure – be it 'grey' infrastructure in the form of pipes, holding tanks and treatment facilities, or 'green' in the form of natural stormwater management ponds, parks, or marshes – is costly. Balancing the net costs between overflow-driven back-ups in combined systems into the built environment against the overflow of combined systems downstream into the natural environment is a value-based situation. To date, improvements to both of these

situations may have been possible, and the City has made significant strides in reducing the frequency and impact of upstream back-ups as well as outfall water quality, in part by adding greater wet-weather stormwater management and treatment capabilities. However, as long as the City continues to have combined storm- and waste-water systems with overflow connections during wet weather events into the stormwater network, there remains a potential for spill events and tension between the extent that upstream or downstream users will bear any impacts.

4.3.2 Availability and Application of Expert Staff

One of the central themes in both the initial identification of the spill cause (i.e., the cross-connection at Burlington Street and Wentworth Street North), as well as in discussion with Hamilton Water and Hamilton ES, was the issue of expertise being applied in critical situations – having the "*right eyes at the right time.*" Specifically, this was noted as the key moment in the review of the 2013 CCTV inspection video leading to the discovery of the first spill in December 2022.

Construction Project Oversight

Implied but not explicitly stated, the lack of optimal expertise during construction in 1996 would have prevented (or immediately diagnosed) the connection from the combined sewer line into the storm sewer. This issue speaks to the quantity of staff available with valuable expertise, their roles and responsibilities, and the balance between the need for technical specialization and collaboration across teams. In our opinion, both Hamilton Water and Hamilton ES house best-in-class experts, who expressed in our meetings and demonstrated in their response to the spill events and subsequent investigations a strong sense of pride, ownership, and responsibility for good outcomes in operation and project execution along with a desire for continuous improvement.

However, not all parties with highly specialized expertise can be everywhere at all times. As noted in our discussion with Hamilton ES, in most projects, the City will use in-house construction supervision during projects, as opposed to engaging outside consultants for this role, as is common in other jurisdictions. Engagement of outside consultants to oversee construction would not have changed the likelihood of a spill event, but it confirms that Hamilton ES and Hamilton Water staff have additional demands and requirements as part of their core service requirements. To have the maximum ability to oversee a breadth of projects – which may involve multiple technical activities and nuances that change from day to day – it is not possible (or frankly necessary) to have at all times the most senior and expert construction administration team in place. This may result in instances when subtle clues related to cross-connections are missed during construction.

In our discussions, Hamilton Water and Hamilton ES demonstrated transparency and a cooperative outcome-focused approach to the resolution of the spill events and discussions of potential root cause issues, but it may be that a greater level of staffing or review of risk-based project support across the two divisions may be of benefit to increase the likelihood of personnel with optimal expertise being in place at critical moments in construction projects.

CCTV Inspections

As described in both our discussions with Hamilton Water and the presentations to the Public Works Committee, it was the review of a CCTV inspection by a senior member of the team which led to the "*something doesn't look right*" observation, which led to the identification of the cross-connection and spill. This was a moment of chance. Had that video not been reviewed, the cross-connection and all three of the spill situations would likely remain ongoing.

Generally, Hamilton Engineering Services use CCTV inspections only to assess the structural integrity of relatively large-diameter pipes in advance of capital works projects or in response to emergencies, relying on a specialty contractor using a standardized approach for assessment of pipe condition as part of the Hamilton Water asset renewal program. This is a reasonable approach but also presents a missed opportunity for insights. As many inspections occur, having some measure of either a) involvement of senior members of Hamilton Water and/or Hamilton ES, or b) adding additional scope to the contractor's inspection may be beneficial. There is further potential for use of automated AI-based tools to supplement or screen video in advance of a risk-based approach.

4.3.3 Asset and Data Management

As noted in Stantec's report, the City maintains over 3,000 km of buried linear infrastructure and relies on – in the case of Hamilton Water alone – three separate data management tools (IPS, SPIDER and WIMS), which are used to store and disseminate data to be shared among those responsible for the overall water, wastewater, and stormwater systems. This is over and above the financial systems and tools and beyond the scope of this investigation.

This multi-system approach is better than the legacy paper-based systems, but still is prone to siloed information storage, if not mismatching information, as individual systems may be updated. The systems related to WIMS and IPS appear well synchronized but do not always export detailed information for download via SPIDER and gaps may exist. Moreover, for those new to the City, the potential may be to presume that these systems are fully integrated and to not actively verify other sources of information. Consequently, there may well be information not available to important parties that ought to be; design consultants, internal City staff, and contractors engaged in various activities all rely on a shared understanding of the work being done. As was noted, the development of an integrated EAM system would facilitate greater data-sharing across divisions in the City and a greater chance of identifying issues.

A secondary consideration is one of departmental collaboration. Within even the simplest of organizations, there are risks that information is not shared, particularly across groups or departments. It is reasonable to assume that part of the data gaps that led to the misunderstanding of the stormwater and combined sewer systems at Burlington Street and Wentworth Street North in the mid-1990s was simply related to the fact that the information was in two separate organizations, namely the City of Hamilton and Region of Hamilton-Wentworth. Consolidating these organizations certainly led to better information sharing over time, but this would have taken place after 1996 when the construction occurred. As the City is presently a fully amalgamated entity, this should remain a non-issue.

5.0 CONCLUSIONS & RECOMMENDATIONS

Based on our investigation, it is our opinion that:

- The cause of the sewage spills were:
    - The drawings used in the design and construction were incorrect, which resulted in improper instructions being provided to the design and construction teams.
    - The lack of recognition that the cross-connections were being constructed – and were not deemed a significant risk – during the construction process.
    - The physical piping networks and the drawings illustrating them were large, complex, and interconnected, which made it difficult to identify issues once they existed.
- The Hamilton Water response to the spills and investigation into the origin and cause was appropriate, thorough, and in accordance with the industry's best practice.
- The MECP Order was reasonable, and the ongoing response to the Order by Hamilton Water and Stantec is appropriate, thorough, and in accordance with the industry's best practice.
- There do exist other issues related to the City's operation that had indirect contributions to the spills, as follows:
    - The legacy approach to water quality from the earlier part of the 20th century resulted in a mixed sewer system that incorporated combined sewers and interconnections, increasing the risk of untreated sewage spills.
    - The City's large and complex system of sanitary storm- and combined-sewer lines made the potential for accidental cross-connections and mislabelled lines more likely.
    - The legacy pre-digital drawings remain in service and may provide misleading information. The drawings that were used may have been of relatively poor quality due to age, had multiple naming conventions, and used inconsistent standards.
    - Addressing Combined Sewer Overflow (CSO) interconnections with stormwater systems, as a means to reduce the risk of upstream flooding due to storms (e.g., to protect against residential basement flooding during storms) has been a policy priority for the City with significant improvement over time. This will drive overflows into the natural environment when infrastructure capacity is overwhelmed and reflects a value- and risk-based decision to extreme stormwater flow management.
    - The availability and application of expert staff – both for construction project oversight and CCTV inspection review – is limited. There remains a relative shortage of personnel with optimal and timely expertise involved in higher-risk projects by Hamilton Water and Hamilton ES.

- Asset and data management systems are currently spread across three platforms at the City of Hamilton, which are integrated in a limited fashion, meaning that certain parties may have limited or no access to information that may help reduce risk.

Going forward, 30FE recommends that:

- The approach prescribed in the Stantec report – which was in many respects already underway within Hamilton Water – be continued, namely:
  - The Existing Sewer Lateral Cross-Connection Program.
  - Existing passive monitoring and complaints-driven processes to identify and investigate suspected cross-connections and spills;
  - Continue and expand the Risk-Based Proactive Pilot Program in the high-risk central Hamilton combined sewer system and use this as a launching pad for a permanent System-wide Unauthorized Discharges Removal and Inspection Program (SUDRIP); and
  - Review and revise these programs over time to ensure they remain a good value from a risk-reward program as infrastructure is renewed, cross-connections are repaired, and high-risk areas are cleared.
- Use and refine Hamilton Water's risk-scaled communication and response (for as-yet-undiscovered leaks/cross-connections). As it is likely that residual risk exists that new leaks/spills may be uncovered; therefore, transparency and response planning remain important.
- Continue with protocols for the validation and integration of asset management information across the IPS, WIMS, and SPIDER systems during design, construction, and maintenance activities. Long-term establishment of a unified asset management database should remain a priority to facilitate inter-divisional collaboration and communication which were a hallmark of the excellent response to the three identified spills.
- Consider the incorporation of risk-based inclusion of Hamilton Water and Hamilton ES expertise across divisions on design and construction projects at key milestones (e.g., pre-tender design reviews, pre-construction field surveys, CCTV inspections) to increase the frequency of personnel with optimal and timely expertise being part of projects, particularly those wastewater projects with higher risks of cross-connections, spills, or other community impacts.
- Continue to evaluate opportunities for improvement on a cost-benefit basis including costs to the natural environment and community, for policies associated with infrastructure investment and operation as they relate to stormwater management.

APPENDIX A: CITY OF HAMILTON RFP

Hamilton
Office of the City Auditor

Mailing Address:
71 Main Street West
Hamilton, Ontario
L8P 4Y5

Office Location:
50 Main Street East, 3rd Floor
Hamilton, Ontario
L8N 1E9

Fraud and Waste Report #60228
Request for Proposal

Background

- On November 22, 2022, Hamilton Water maintenance staff uncovered a hole in a combined sewer pipe spilling into a large storm sewer that was discharging into Hamilton Harbour. The section of pipe is in the area of Burlington Street and Wentworth Street North.
- After a preliminary investigation and consultation of City records, Hamilton Water staff believe the hole was put in the combined sewer pipe in 1996. It appears that the contractor at the time was under the impression that all pipes were storm sewers and were designed to directly connect to box culverts leading out to the harbour. The catchment area for the combined sewer system is approximately 50 properties that are tied into this pipe.
- The volume of this discharge was estimated by Hamilton Water to be approximately $337 million liters of sanitary sewage discharge over a duration oof 26 years.
- Hamilton Water completed a repair and sewer realignment of this leak on November 23, 2022.
- Since the first spill in November 2022, Hamilton Water piloted a risk-based inspection program that focuses on other areas of the combined sewer system where similar sewer cross connections could be present. This program includes 292 maintenance hole inspections, of which 150 inspections had been completed as of January 18, 2023.
- As a result of the proactive inspections, two more spills have been detected to date. Immediate action was taken to stop the leaks and permanent fixes were being worked on. Continued inspections are on-going to detect other possible leaks.
- On January 9, 2023 a second spill was discovered near Rutherford Avenue and Myrtle Avenue. A 100-year-old combined sewer pipe was connected into a newly constructed storm sewer, also traced back to work done in 1996. As many as 11 residential properties have been discharging wastewater directly to the storm sewer and into the harbour. The volume of this second discharge was estimated by Hamilton Water to be approximately $59 million liters of sewage into the harbour.
- On January 19, 2023 a third spill was discovered from a single home on Kinrade Avenue. Hamilton Water staff found there was a design issue that allowed some of the sanitary sewage from this home to impact a storm sewer. At the location there is a designed overflow connection from the combined sewer to the storm sewer that can be active during wet weather. Based on preliminary investigations by Hamilton Water, it looks like sewage from the home has been leaking into the storm sewer since 1982.

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- On January 18, 2023, the Ministry of the Environment, Conservation and Parks (MECP) issued a Provincial Officer's Order to the City of Hamilton to address the sewage spills identified as of that date.

Scope of Work

- Prepare a proposed investigation plan focused on the sewage spills noted above as well as any which may be subsequently discovered for review and approval by the Office of the City Auditor.
- The plan should include but not be limited to gaining an understanding of-
    - What happened to cause the spills, including immediate and root causes, and how Hamilton Water remediated the spills.
    - What systemic issues may exist within Hamilton Water (or City) that may have contributed to the causes (e.g. process, control, or technology deficiencies, resource constraints, etc.).
    - What challenges may exist to mitigate or remediate the issues.
- Prepare investigation report, including relevant recommendations and best practices.

Proposal Requirements

- An overall estimated cost for the planning phase is to be provided, with hourly rates to be provided for future phases.
- The pricing includes all costs associated with the work being done by the vendor such as salary, benefits, overhead, general administrative costs such as photocopying, courier costs, travel expenses, payroll burden and other related costs.
- Proposal to break down work by service roles (e.g. engagement lead, manager, senior professional, professional) with an estimate of the number of hours for each role and the hourly rate for each role for the planning phase.
- Details of staff being put forward for this potential assignment to be provided, summary of relevant professional experience to be included in proposal.

APPENDIX B: CURRICULUM VITAE

CURRICULUM VITAE

Jeff Reitsma, MBA, PMP, P.Eng. *(he/him)*

(604) 674-1100 | jreitsma@30fe.com

555 Burrard Street, 15th Floor, Suite 110, Vancouver, BC V7X 1M8

PROFESSIONAL SUMMARY

Mr. Jeff Reitsma is Vice President and Practice Lead of 30 Forensic Engineering's Construction group, with over 20 years of experience in the engineering consulting and construction industries. Jeff specializes in leadership of multidisciplinary forensic investigations and post-loss remediation projects nationwide and has led design and construction teams for some of the biggest engineering firms in North America. He has overseen municipal capital infrastructure projects from conception to completion and has designed and directed environmental assessment works involving indoor air quality, chemical engineering, mould, asbestos, and fire and flood impact mapping. Jeff is an ODACC-Registered adjudicator supporting dispute resolution under the Construction Act in Ontario.

In his role as Vice President and Practice Lead at 30 Forensic Engineering, Jeff provides leadership across multiple business lines in support of both small-scale forensic investigations and large-scale remediation, environmental, construction claims, and catastrophic event support projects. Jeff's position on the Board of 30 Forensic Engineering allows him to conceive and oversee the execution of strategic initiatives and continuous improvement in the operation and sustainability of the firm. Jeff's commitment to collaboration, mentorship and project management best practices allows him to continually build highly effective project teams and deliver innovative solutions to clients across Canada.

SPECIALIZED PROFESSIONAL COMPETENCIES

Construction

- Project Management – Roles, Responsibilities and Standards of Care
- Contract Administration – Bid and Tender, Scope, Cost and Schedule Review
- Project Scheduling and Financial Controls
- Multidisciplinary Design Coordination and Delivery
- Construction and Demolition Sequencing
- Peer Review and Forensic Analysis of Remediation Scope, Schedule and Cost
- Construction Dispute Resolution (ODACC and ADRIO-registered)

CURRICULUM VITAE

Jeff Reitsma, MBA, PMP, P.Eng.

Environmental / Chemical Engineering

- Indoor and Outdoor Air Quality and Odour Control
- Environmental Hazards, Designated Substances and Health and Safety
- Industrial Ventilation, Pollution Controls and HVAC
- Chemical and Process Engineering
- Regulatory Framework – Permits and Approvals, Pollution Controls and Monitoring
- Resilient Design and Sustainable Infrastructure
- Stormwater and Wastewater Management and Design

Catastrophic Loss

- Disaster Response and Emergency Management (ICS/IMS-certified)
- Multi-team Logistics and Program Management
- Multidisciplinary Investigations, Triage and Remediation Design
- Large-scale and Complex Municipal and Transportation Infrastructure Assessment

Infrastructure

- Infrastructure Analysis and Design – Water, Wastewater and Stormwater Conveyance and Treatment
- Climate Change and Flood Risk Analysis and Design
- Municipal Asset Management and Emergency Response

ACADEMIC BACKGROUND

Master of Business Administration (With Distinction), University of Adelaide, 2003

Bachelor of Applied Sciences (With Honours) — Environmental-Chemical Engineering, University of Waterloo, 2000

ADDITIONAL COURSES

- Adjudication for Administrative Agencies, Boards & Tribunals, York University Law School, 2019
- Incident Management System (IMS-100), OFMEM, Toronto, 2017
- Incident Command System (ICS-100, -200), AEMA, Calgary, 2017
- B&V Project Management Essentials, B&V, Kansas City, 2014
- Joint Health & Safety Committee Member Certification, OSG, Toronto, 2014
- B&V Engineering Management Essentials, B&V, Kansas City, 2012
- Project Management for Construction, University of Toronto SCS, Toronto, 2010

CURRICULUM VITAE

Jeff Reitsma, MBA, PMP, P.Eng.

- Essentials of Project Management, University of Toronto SCS, Toronto, 2009
- Technical & Proposal Writing, IWCC, Markham, 2008
- Comprehensive Project Management, Procept, Markham, 2008

EMPLOYMENT BACKGROUND

30 Forensic Engineering

Vice President & Practice Lead, Construction
2023 – Present, Vancouver, BC

- Member of the executive leadership team responsible for the management, strategic planning, and governance of 30 Forensic Engineering.
- Provide technical project leadership, senior review and program management services on construction, environmental, health & safety, CAT Loss, multi-disciplinary, large-scale and complex loss projects.
- Lead property team marketing, sales and client delivery efforts across multiple business lines.
- General business leadership including forecasting, strategic planning, quality, team performance management, liaison with human resources, accounting and finance.
- Construction responsibilities include:
    - Provision of expert opinion related to schedule, scope and pricing of construction and remediation-related disputes
    - Peer review of cost submittals in multi-disciplinary claims, subrogation, surety, and dispute reviews
    - Dispute resolution activities in support of construction and insurance administrative justice settings (appraisal, adjudication, mediation)
    - ODACC-registered adjudication of disputes under the Construction Act in Ontario
- Environmental & Chemical Engineering responsibilities include:
    - Direction of environmental assessment works including indoor air quality, mould, asbestos
    - Loss impact assessment – smoke, soot, and water impact mapping
    - Review of analytical results and process information (e.g. MSDS, toxicological data, designated substance testing results) in the development of cleaning & access protocols and assessment of health & safety risks
    - Oversight of environmental abatement & remedial construction contractors
    - Coordination with internal practice leads to help manage talent development and workload
    - Provision of construction, infrastructure, chemical and environmental engineering expertise in support of legal dispute files; certified as Expert Witness
- Remediation responsibilities include:
    - Leadership of multi-discipline engineering teams
    - Management of quality, scope, budgets and schedule
    - Provision of project and construction management expertise across client service delivery groups

  - Liaison with owners, contractors and regulators in development of permits and project execution plans
- Leadership team responsibilities include:
  - Secretary of Board of Directors
  - Chair – Finance, Planning & Risk Management; and Joint Health & Safety Committees
  - Board Sponsor – 30 Ventures and Innovation Committee
  - Provision of strategic, marketing and governance input into overall firm operations in conjunction with leadership
  - Ongoing review of risks, opportunities, and liaison on financial and strategic opportunities in collaboration with the leadership team

Vice President & Practice Lead, Remediation
2018 – 2023, Toronto, ON

Practice Lead, Remediation Group
2016 – 2018, Toronto, ON

Senior Associate
2014 – 2016, Toronto, ON

Black & Veatch Canada

Civil Infrastructure Team
2010 – 2014, Markham, ON

- Provided full-range of project and engineering management services for projects ranging from small investigations and studies through to complex multidisciplinary municipal capital infrastructure upgrades.
- Stewarded projects through life cycle, including management aspects such as business development and client relationship management, development of project budgets and schedules, management of contractual, schedule, and financial issues and general conformance with client and internal QA/QC requirements. Technical execution aspects included leadership of internal team including coordination of workloads and design activities and incorporation of inputs from external sub-consultants and specialty service providers.
- Lead project reviews of constructability, health and safety, designated substances & hazardous materials, operations and maintenance, risk, and procurement within broader best-practices project management framework.

AECOM Canada (formerly EarthTech Canada)

Environmental & Air Quality Group
2003 – 2010, Markham, ON

- Provided project management services for small- and medium-sized environmental and air quality projects, and engineering management leadership on large municipal capital infrastructure upgrades. Project responsibilities included oversight of scope, budget and schedules, satisfaction of client invoicing, progress- and earned-value-reporting requirements.

- Design & assessment work within air quality team (indoor air quality, odour control, demolition and process-mechanical) included on-site investigation, testing and data gathering, review of chemical and environmental hazards, design of control systems, process engineering calculations (exposure limits, flow-rate calculations, process design, drawings and specifications as well as identifying and obtaining required permits and approvals.

Stantec Consulting

Industrial Group, Environment & Air Quality Team
2000 – 2002, Mississauga, ON

- Supported small scale industrial ventilation and air quality projects by executing site assessments (mould & IAQ assessments, process analyses), design calculations and sketches, writing reports, review of MSDS and toxicological reports and development of air quality control systems.
- Lead execution of permits and approvals (Ontario Air & Noise, NPRI, TRCA Development, municipal building permits) and leading air contaminant dispersion modelling for commercial and industrial clients and review of applicable air quality codes and standards.

Co-op Assignments

- Stantec Consulting – Air Quality Team, Mississauga, ON – ventilation system design and air permitting for chemical, steel & metals, and automotive industrial clients.
- Petro-Canada (Lubricants) – Environmental Team, Mississauga, ON – logistics optimization and hazardous emissions management.
- Polycon Canada – Process Improvement Team, Guelph, ON – chemical optimization team and paint shop H&S review.
- Domtar Fine Papers – Quality Control, Cornwall, ON – quality trials coordination and support to production team.
- Tunnel Systems Inc. – Steel & Welding Team, Guelph, ON – materials handling & production support.
- Environment Canada – Hazardous Materials Branch, Hull, QC – review and support of federal regulatory framework development for life-cycle analyses.

PROFESSIONAL SOCIETIES AND ASSOCIATIONS

- Society for Construction Law, Member
- Alternative Dispute Resolution Institute of Ontario (ADRIO), Member
- Ontario Dispute Adjudication for Construction Contracts (ODACC), Registered Adjudicator
- Society of Ontario Adjudicators and Regulators (SOAR), Member
- Ontario Association of Emergency Managers (OAEM), Member
- Professional Engineers of Ontario (PEO), Member & Licensed Professional
- Association of Professional Engineers and Geoscientists of Alberta (APEGA), Member, Licensed Professional, Responsible Member

- Association of Professional Engineers and Geoscientists of British Columbia (APEGBC), Member & Licensed Professional
- Ordre des ingénieurs du Québec, Member
- Team Rubicon, Member
- Project Management Institute (PMI), Member
- PMI Construction Community of Practice, Member

AWARDS AND ACHIEVEMENTS

- 30 Forensic Engineering 2016 Outstanding Leadership Award
- 30 Forensic Engineering 2016 Outstanding Innovation Award *(shared with J. Burns, S. d'Obrenan, P. Robalino, R. Parkinson)*
- EarthTech 2007 President's Award for Technical Excellence—Facilities (Gold)—OPG Darlington Dry Storage Facility

PUBLICATIONS AND SPEAKING ENGAGEMENTS

Speaking Engagements

- "*After the Smoke Has Cleared* – Secondary Risks in Fire Loss Events", Subject Matter Expert, CURIE Atlantic Canada Risk Management Conference, October 2019.
- "Environmental and Remediation Risks", Subject Matter Expert, Service Master Canada National Meetings (West, Central, East Sessions), March 2018.
- "Consulting at 30 Forensics", Subject Matter Expert & Lead Instructor, 30 University (Internal), November 2017.
- "The Future of Infrastructure", Presenter and Discussion Panel Member, JLT Canada Public Sector Summit, October 2017.
- "Project Management Boot Camp", Subject Matter Expert & Lead Instructor, GK University (Internal), June – August 2016.
- "Effective Communications & Soft Skills Workshop", Subject Matter Expert & Panel Member, WEAO Young Professionals, Ryerson University, January 2015.
- "Foundations of Project Management", Primary Technical Lead, B&V Water College (United Kingdom & Middle East), August – November 2014 (various engagements).
- "Foundations of Project Management", Subject Matter Expert – Integration, Quality, Procurement & Stakeholder Management, B&V Water College (Americas), January 2013 – November 2014 (various engagements).

Publications

- Gilkinson, M., Pelkman, D., Reitsma, J., "PV Systems Today—How They Fail & Why", In: CURIE Risk Management Newsletter, Volume 34 Issue 21, June 2019.
- Ciasnocha, C., Reid, J., Reitsma, J., "The Hazards of Adjusting", In: Canadian Underwriter, February 2018.

- Barrett, M., Reitsma, J., “Project Management in Large Loss Property Claims”, In: PLRB Claims Conference, March 2017.
- Reitsma, J., “Multi-disciplinary Approach to Remediation”, In: Insurance People, November 2016.
- Allan, W., Reitsma, J., “Odor Control System for Nashville Central WWTP Bio-solids Handling Facility”, In: WEF Odors and Air Emissions Conference, April 2008.
- Carciumaru, A., Reitsma, J., “Clarkson WWTP - Odour Control System Design and Installation”, In: WEAO Technical Symposium, April 2007.

APPENDIX C: LIST OF PROVIDED MATERIALS

List of Provided Materials

- Scope of Work, City of Hamilton #60228, received February 8, 2023;
- Report to Public Works Committee and Presentation, including appendices, received March 2, 2023;
- Provincial Officer's Order, dated January 18, 2023;
- Contractor Video Information;
    - C11-29-04 RFP for Zoom Camera *PDF;*
    - C11-39-15 - RFP Zoom Camera Inspections – FINAL *PDF;*
    - C11-86-10_HJ05E063 *Video;*
    - Contract No. RHW-96-20 (HSW) *PDF;*
    - HAMI-AZ-09_HJ05E063_2009-04-03_03-42-52_T-27_1 *Video;*
    - HJ05E002 - HJ05A061 Post Installation Conditions *Video;*
    - HJ05E063 Chamber *Image;*
    - Properties Connected to Combined Sewer *Image;*
    - smh inspection report (301-400) *PDF;*
- Investigation and Drawings;
    - Drawings;
        - 974(Burlington Widening Geotechnical) *PDF;*
        - 1910 W-41-S_1(Wentworth Local) *PDF;*
        - 1911 G-3_S(Burlington Local) *PDF;*
        - 1911 W-42_S - 1911 Drawing *PDF;*
        - 1912 N-8_S(Niagara Local) *PDF;*
        - 1924 B-130_S4(Western) *PDF;*
        - 1924 B-130_S4A (Western) *PDF;*
        - 1926 W-105-S_2(Storm) *PDF;*
        - 1930 B-195-S_1(Western) *PDF;*
        - 1958 S-269-H_1(1998 Inlets) *PDF;*
        - 1987 HAM SEW_J-05 *PDF;*
        - 1994 94-H-55_3(Hatch) *PDF;*
        - 1996 96-H-11_3 - Burlington @ Wentworth 1996 *PDF;*
        - 1996 96-H-11_3(Parker) *PDF;*
        - 1996 96-H-11_9(Parker) *PDF;*

        - 1996 96-H-11_9 *PDF;*
    - Investigation Notes;
        - Burlington and Wellington Intersection *Powerpoint;*
        - Burlington and Wentworth Intersection *Image;*
        - Open Notebook *Note;*
        - References *Note;*
    - Records;
        - 96-H-11_3 - Burlington @ Wentworth 1996 *PDF;*
        - 96-H-11_9 *PDF;*
        - Drawing and Pictures - FW_ Spill at Burlington St and Wentworth St N (HJ05E063) *Email Correspondence;*
        - ES Capital Sewer Inspection Program *Word Document;*
        - HAM SEW_J-05 *PDF;*
        - Initial Report - FW_ Spill at Burlington St and Wentworth St N (HJ05E063) *Email Correspondence;*
        - W-42_S - 1911 Drawing *PDF;*
- MOE;
    - Items 3 and 4 - Sampling Program;
        - 2023 March 16 Report on MECP Burlington St Order Task No. 3 *PDF;*
        - 2023 March16 Final Report on MECP Burlington StE Order task3_Clean FINAL *PDF;*
        - Preliminary CSS and Storm Sewer Overview _Figure 1 FINAL for report *PDF;*
        - Re Final Report attached - with updated Figure 1 *Email Correspondence;*
    - MOE Correspondence;
        - Burlington Wentworth Update *Email Correspondence;*
        - Burlington Street Spill - Contract Diaries Scans - Burlington Street Reconstruction *Email Correspondence;*
        - Burlington Street Spill - Contractor Inspection Reports for CCTV Videos *Email Correspondence;*
        - Burlington Street Spill - Follow-up Action Items from MECP Meeting - December 1 2022 *Email Correspondence;*
        - Burlington Street Spill - MECP Meeting - December 1 2022 *Email Correspondence;*
        - Burlington Street Spill - Reports and Videos *Email Correspondence;*

- Burlington Street Spill Samples - Final Reports Approved - November 28 2022 *Email Correspondence;*
- Burlington Wentworth Incident Provisional Results *Email Correspondence;*
- City of Hamilton - Burlington Street Estimated Sewage Spill Volume *Email Correspondence;*
- FW Response No. 2 - Burlington Street Spill - Follow-up Action Items from MECP Meeting - December 1 2022 *Email Correspondence;*
- FW Sewage Spill - FILE 1-29OZAO *Email Correspondence;*
- FW Spill at Burlington St and Wentworth St N (HJ05E063) *Email Correspondence;*
- Meeting Request - FILE 1-29OZAO1-106755872 *Email Correspondence;*
- RE Burlington Street Spill - Reports and Videos *Email Correspondence;*
- RE City of Hamilton - Burlington Street Estimated Sewage Spill Volume *Email Correspondence;*
- RE Notification of sample submission - SR#16685048 _ Provisional Results *Email Correspondence;*
- RE Sewage Spill - FILE 1-29OZAO *Email Correspondence;*
- Sewage Spill - FILE 1-29OZAO *Email Correspondence;*
- Update to Council Environmental and Infrastructure Issue - Burlington Street Sewage Spill *Email Correspondence*

- Received April 19, 2023;
  - Transfer of Assets (PW-11-P-004-003), dated April 2022;
  - Management of Asset Transfer V1.1;
- Email correspondence, dated April 20, 2023;
- Received April 25, 2023;
  - Pre-Engineering Baseplan Checklist, City of Hamilton, dated 2019;
  - Pre-Engineering Sectional Guidebook, dated 2019;
- Received May 11, 2023;
  - Appendix A – Specification for Sewer Pipe Materials and CCTV Inspection;
  - Proposal for Contractor Required for Maintenance Hole, Mainline and Lateral Sewer Inspection;
  - CCTV Decision Matrix;
  - City's Criteria Summary;
  - Sewer Inspection Prioritization Program;

- Received May 15, 2023;
    - Hamilton Drawing Management Req Definition V.2;
    - PRISM Interactive Mapping Guide;
- Received June 13, 2023;
    - Proposal for Services, City of Hamilton #60228; and
- Received July 18, 2023;
    - City of Hamilton Purchase Order.

30 Forensic Engineering

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