Employing a Unique Procurement Process for the City of Ottawa Combined Sewage Storage Tunnel

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ABSTRACT

The City of Ottawa's Combined Sewage Storage Tunnel consists of two interconnected tunnels totaling 6.2 km with a diameter of 3m including access shafts and hydraulic structures which connect to the City's most critical sewers. This tunnel will be built 15m to 30m below ground in the downtown core adjacent to, and crossing below, the Light Rail Tunnel, which introduces additional considerations in terms of sequencing and risk mitigation. The City embarked on a unique Procurement Process to address the risks involved with a large tunnel project and those associated with tunneling below downtown, underneath and adjacent to UNESCO World Heritage Sites, and connecting to live critical sewers. This paper describes the unique procurement approach employed and the contractual risk mitigation measures developed to provide the best value while minimizing risk. Specific features include Market Sounding, using a Fairness Commissioner, Contractor Prequalification and Risk Mitigation Measures in the Tender documents.

INTRODUCTION

This paper describes how the City of Ottawa (the City) and the project design team developed a strategic Procurement Process and Tender that incorporated industry best practices for technical and contractual risk management for the Combined Sewage Storage Tunnel (CSST) project. The process was unique in that, while it employed a systematic review of project risks, it also solicited input from industry, stakeholders and provincial and federal partners to develop the request for Tender for this traditional design-bid-build project. Key drivers for this approach were initiated from the City's concerns for cost control, cost certainty and overall project risk mitigation. To address these concerns, the City implemented the risk review and mitigation process right from the project design team selection. It was critical that the project design team embraced this risk management philosophy and carried it through each phase of the project.

This paper serves as an excellent resource for municipalities or other owners embarking on a similar tunnel project, on how to properly apply industry best practices and the benefits of using them.

PROJECT OVERVIEW

The CSST project is part of Canada's Capital City's Ottawa River Action Plan (ORAP), a collection of 17 projects to improve the overall health of the river. The CSST is ORAP's hallmark project and will drastically reduce Combined Sewer Overflows (CSOs) to the river. This project consists of two inter-connected tunnels and associated shafts, flow control/diversion structures, odor control, and operational support facilities. The East West Tunnel (EWT) is 4,100m long, 3.0m inside diameter rock tunnel below sensitive clay zones interconnected with a 2,200m long, 3.0m inside diameter North South Tunnel (NST). When implemented, the project will reduce CSOs to the Ottawa River, provide enhanced protection against flooding risks in the City's historic downtown core, and provide the City with added operational and maintenance flexibility. Figure 1 illustrates the tunnel configuration along with the 11 shaft sites required either for flow control or construction access.

The project design team consisted of Stantec Consulting Ltd. in conjunction with CH2M. Subconsultants to Stantec are Golder Associates (geotechnical consultant for the design team) and Jacobs Associates (part of the team's Quality and Risk Review Panel). The project is currently in the Tendering Phase and construction is anticipated to be completed by late2019.

KEY PROJECT CHALLENGES

The challenges, risks and constraints of this project are numerous, largely as a result of the project being spread across a wide geographic area in the City of Ottawa's historic downtown core. The challenges, risks and constraints are related to subsurface conditions, stakeholder coordination and associated site constraints, adjacent projects including the Ottawa Light Rail Transit (OLRT) currently under construction, and operational considerations.

From the planning stage of the project, it was critical that the project design team adopt a risk management philosophy focusing on how to structure the Procurement Process and the Tender to mitigate key challenges and risks including: quality, budget and schedule objectives. The intent was to produce a Procurement Process and Tender that would attract quality based contractors, allow for a fair and transparent process in selecting the best qualified contractor, at an affordable value for the City. Based on this philosophy, the following goals were developed for planning and preparation of the Procurement Process and Tender.

- **Attract Top Tier Contractors to Bid:** Gauge the market and tailor the Contract Document to attract qualified Contractors and encourage competitive bidding.
- **Select the Best Contractor(s) to Complete the Work:** Prequalify a pool of Contractors to bid on the project to produce a high quality finished product while minimizing constructability and contractual risks during construction.
- **Place an Emphasis on Continuous Risk Assessment and Adaptation of Mitigation Measures:** Continuously update the overall project Risk Register throughout the planning and design stages and incorporate key mitigation measures into the design and Tender.
- **Make Stakeholders Part of the Process:** Engage stakeholders and provincial and federal partners throughout the design and incorporate their input where appropriate.

The key challenges, risks and constraints to the project that had to be addressed to meet the project's ultimate objectives as shown in Figure 1 are provided in more detail below.

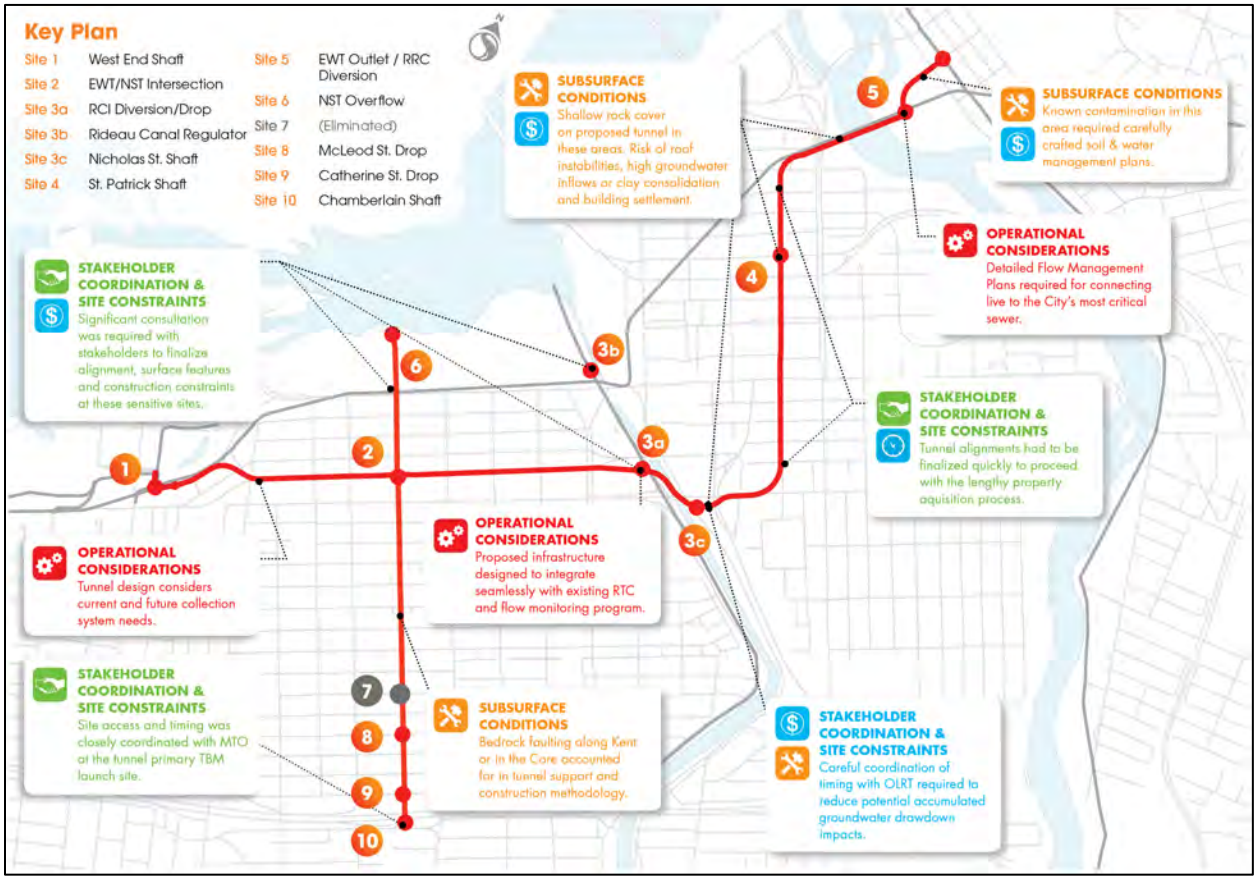

Figure 1. Overall CSST alignments and locations of all system components with project key challenges, risks and constraints

Subsurface Conditions:

During the design phases, an extensive subsurface investigation was completed. This was considered a critical first step in the project to protect the interests of both the City and the Contractor. Key findings and subsequent design recommendations included:

- Sensitive marine clay overlying bedrock with limited bedrock cover in certain sites.
- A number of faults along the tunnel alignment.
- Environmental concerns relating to contaminated soil and groundwater in certain shaft and tunnel locations.
- Risk of potential settlement to structures and / or utilities in areas of the deeper sensitive marine clay deposits due to depressurization and/or dewatering of the bedrock.
- The OLRT Tunnel located near the proposed alignment was identified as a risk for accumulated impacts to area structures and utilities if not properly addressed.

The information was collected and assessed, which guided the design and factored heavily into decisions regarding construction sequencing.

Stakeholder Coordination and Site Constraints:

The project design sought to locate the tunnel under City right of way as much as possible, however as the project is located in the City's core, some of the tunnel and a number of critical tie-ins and shaft sites were located on private, provincial and federal lands. Monthly meetings with stakeholders were required to ensure engagement throughout the planning and design phase to solicit input on conditions and constraints that would be critical to the success of the project. Key considerations which were then factored into the project schedule, technical specifications and general conditions, included:

- **Property Negotiations/ Property Acquisition**: Site access and use during construction was required to several high profile locations including the Supreme Court of Canada, Confederation Park (adjacent to the Rideau Canal UNESCO World Heritage Site that is a major tourist destination), and public lands owned and/ or administered by various Federal Agencies. Conditions included site use restrictions/limitations, noise and vibration considerations, working hours, access, and ultimate site restoration and improvements.
- **Adjacent Projects:** Construction of the CSST coincides with the construction of the OLRT tunnel, which is considered Ottawa's most high profile project, at several locations in the project alignment (the CSST passes under the OLRT at two locations). Concurrent impacts to the surrounding infrastructure and properties from both projects were considered and the CSST Tender was modified to address this. The Tender adopted sequencing constraints to avoid concurrent and potentially accumulated groundwater drawdowns, the use of precast segmental liner to line the tunnel as it progresses and the use of pressurized mode tunneling in key areas.
- **Site Use Timing Restrictions:** The site of the tunnel staging and tunnel launch area for the NST is owned by the Ministry of Transportation of Ontario (MTO), who requires use of the site for rapid bridge replacements before and after CSST construction. Scheduling of the work for the CSST needed to occur in a constrained window and include specific design considerations due to the close proximity to Ottawa's primary highway.
- **Considerations for Tourism:** Canada is celebrating its 150th Anniversary in 2017 and there are large scale festivities planned throughout Ottawa as Canada's capital city. A number of sites have considerable restrictions on what work, if any, can be performed during all or parts of 2017. These restrictions limit the flexibility of constructing the CSST which required clearly defined schedule constraints in the Tender for the contractors.

Operational Considerations:

The City's Environmental Services Department, who will ultimately operate the CSST and other departments, provided considerable input to the project throughout the various stages based on their needs. From the comprehensive involvement by these groups, various measures were adopted into the design and Tender.

Construction activities will incorporate mitigation measures to minimize impacts on tourist amenities, natural heritage features, local residences, businesses and institutions, and traffic. Of critical importance is effectively and safely constructing new structures and tie-in facilities to existing combined sewer systems. At numerous locations, this project ties into critical infrastructure within the City where there is a risk of increasing CSOs, causing unwarranted sanitary sewer overflows or causing basement flooding in upstream catchment areas. As such, the Tender needed to accurately convey this criticality

to Contractors and clearly identify construction constraints, while not overly narrowing the Contractor's means and methods for construction.

Fully understanding these aspects allowed the team to develop a Tender that met the needs of the various stakeholders and that defined the various conditions and constraints in the Tender allowing the contractors to bid on equal terms.

The following sections outline the key stages in the procurement planning process and key components that were implemented to address the project challenges, risks and constraints.

PROCUREMENT AND CONTRACT PLANNING

To meet the needs of the City and to effectively manage the challenges, risks and constraints outlined in the previous sections, numerous procurement components were reviewed and considered for applicability to this traditional design-bid-build project. Key components that were deemed appropriate to the Procurement Process were reviewed in detail by the project design team, and implemented where it added value to the project. The following provides detail on the various steps taken during the planning and design process that ultimately led to the CSST's unique Procurement Process and Tender.

Risk Registry

At the onset of the project, a detailed Risk Registry was developed and considered the numerous project components through input from tunnel industry experts, third party reviewers, various City of Ottawa departments and the project design team. The risks were categorized into components: Approvals, Procurement, Financial, Design, Construction, and Constructability. Once the initial registry was prepared, each risk category was assigned to one or more project technical experts, who were deemed the risk custodian for the life of the design process. The risk custodian then developed measures/strategies to mitigate the risks to an acceptable level to the City and carried through with implementing these measures within the Tender. Throughout the project this Risk Registry was updated and modified when new information or approaches were developed and at key junctures of the project. This allowed the project team to continuously assess and address the project risks on an ongoing basis.

Risk Workshops

At key points in the design cycle, risk workshops were held to solicit input from tunnel industry experts, third party reviewers, City of Ottawa senior management, various City of Ottawa departments and the project design team. These workshops acted like Value Engineering or Third Party reviews as it allowed for scrutiny of the project structure by groups not intimately familiar with the design, as well as an unbiased assessment. Key features that were incorporated into the design included line as you go tunneling, pressurized face capable tunneling methodology and a detailed groundwater and settlement monitoring program. Additional features adopted are outlined later in this paper.

Subsurface Investigations

A thorough and clearly articulated subsurface investigation program was considered critical to protecting both the Owner and Contractor. A transparent program helps attract Contractors to bid on the project as it limits potential claims due to uncertainty of ground conditions. The City recognized this importance and ensured that this was a key component of the design assignment.

During the preparation of the proposal, the design team partnered with a local geotechnical consultant that had extensive background knowledge of the project limits. The first step was a detailed

desktop geotechnical review which identified key areas for field investigations focusing on the high risk components, data gaps, and conflicting information. The field program was completed in three phases, allowing for the team to hone in on uncertainties and areas of risk after each phase. Each set of data was reviewed as the raw data became available, assessed and the program was modified as required. The result was a cost effective program that focused on areas of geotechnical or tunneling concern. Investigations confirmed the bedrock surface profile and evaluated the bedrock quality, strength, hardness, and abrasivity as these parameters could have an impact on crown stability, temporary support requirements, and TBM type and productivity. As there are a number of known faults in the project area, boreholes focused on defining faults by strategically locating them, the orientation of boreholes, geophysics of boreholes, material within the faults, and the width of the faults.

Higher hydraulic conductivity bedrock has the potential to occur in zones of low rock cover and where faults cross the tunnel. In addition, the risk of drainage of the bedrock around the tunnel and at the shafts was evaluated, to assess the potential for wide-spread under-drainage of the marine clay deposits within the potential zone of drawdown. This, in turn, could lead to consolidation of the clay and settlement of buildings founded on the clay if not properly mitigated. In the end this drove the requirement for sealed shafts, installation of segmental liners as tunneling progresses and identification of key areas where pressurized face tunneling was required.

Project Advertising

As part of the planning process, the City began advertising the project through poster and paper presentations at a number of Trenchless and Tunneling conferences. The locations and venues were strategically determined to maximize the projects visibility to the tunneling industry thus garnering interest to potential bidders and to solicit feedback on proposed contracting methods from industry peers.

Market Sounding and Affordability Study

The City of Ottawa hired Ernest & Young (EY) and Infrastructure Ontario (IO) to support the Procurement Process and to provide advice on other unique Procurement Processes that could provide value or cost certainty for the City.

The EY scope involved preparing an affordability study. This assisted the City with reviewing procurement options such as: comparison of traditional design-bid-build versus alternative financing procurement (AFP), financing options, funding considerations and risk management tools.

As part of IO's mandate, a market sounding exercise was developed to reach out to a representative industry sampling on the project. The intent was to determine the industry interest for this project based on a number of variables such as: comparison of traditional design-bid-build versus alternative financing procurement, financing options, and risk management tools included in the Tender.

A briefing package was provided to 11 companies that participated which included background information on the project and the series of questions to be answered. IO moderated the interviews, collected the data and prepared a report outlining the findings.

Key feedback obtained included the desire for reasonable risk sharing of geotechnical and hydrogeological risks, maintaining flexibility for the Contractors ideas by not providing overly prescriptive specifications with respect to tunnel liners, TBM design and excavation protection systems, and the desire for the City to acquire property agreements in advance of Tendering and obtain permits and approvals wherever possible. Contractors were also generally satisfied that the schedule for the project was not overly aggressive and provided sufficient flexibility to stage their works. The project

design team adopted many of the recommendations that were solicited from Contractors during this process.

The market sounding produced considerable interest in the project, which led to 10 world class firms submitting for the pre-qualification phase.

Value Engineering Session

A two day value engineering session was held with the project team, City of Ottawa and specific industry experts and Contractors. The intent was to have the group review the project key components, constructability, operational aspects, and project risks and determine if other options could be considered that added value to the project while still achieving the overall project objectives. A series of considerations were prepared and submitted to the project team. Those deemed of value were incorporated into the design making the project more desirable to the tunneling construction industry.

Procurement Workshops

Similar in nature to the risk workshops, procurement workshops were held at several points throughout the design with a strict focus on how to structure the Tender, what key risk mitigation items would be included and to outline the overall Procurement Process. Key components that were adopted following these workshops were Tender components that share the project risks between the Owner and Contractor.

Risk management tools that are consistent with tunnel industry practice, can result in reduced bid scatter, increased bidder pool, Contractor trust in client, reduced contingencies, reduced claims, and reduced longevity of conflicts. A key take away from these workshops was that a fair and equitable sharing of risks between the Owner and Contractor further promotes these benefits because it is known that contractors will not take on risk, they will price risk. Therefore, without such risk management tools, bid prices will be higher, and contractors may still file claims or pursue remedies relating to unknown or differing conditions, potentially causing a project owner to, in effect, pay twice.

Independent Cost Estimating

To increase cost certainty for the City of Ottawa, the design team engaged a Contractor with over 30 years of experience in the tunneling industry to produce a bottom up cost estimate for the project. This also provided guidance on the structure of the schedule of prices for bidding.

Peer Review

The City hired a third party fully-qualified design firm to perform a peer review the 95% design and then the final Tender to ensure a quality product would form the basis of the Tender.

Third Party Support from Infrastructure Ontario

One process that was recommended by IO, was a ‘White Paper Process’, which aims to solicit input from Contractors during the Tender bidding process on areas that could reduce risk or cost for the City of Ottawa. Although it lengthens the Procurement Process, the use of White Papers has been shown to provide value on design-build and private-public-partnership projects elsewhere in Ontario. IO also recommended Commercially Confidential Meetings (CCMs), to be held in tandem with the White Paper Process to allow for Contractors to propose unique ideas for the CSST construction to determine the

City's appetite for their ideas in the construction phase. A white paper process with CCMs is included in the Tendering process.

Fairness Commissioner

The City of Ottawa has used a Fairness Commissioner (FC) on this project in order to ensure transparency in the Procurement Process. The role of the Fairness Commissioner on the CSST project consisted of reviewing front end Tender, the Contractor prequalification document and overseeing the prequalification evaluation committee. The FC is involved throughout the Procurement Process including the white paper / CCM discussions.

PREFERRED PROCUREMENT PROCESSES AND RISK MANAGEMENT TOOLS ADOPTED

After soliciting input from stakeholders, third parties, industry experts, and governmental agencies, the project team reviewed the most appropriate tools that would complement the CSST project. Key risk management tools that were adopted and incorporated into the Tender to mitigate key project challenges and risks are provided below with additional explanation on their value to the project.

- **Contractor Pre-Qualification:** Time and again during the planning process, the risk of having unqualified Contractors complete the project was highlighted as a major risk to the City. The City has had great success with using Contractor prequalification in the past for large and complex projects to reduce risks during construction and ensure a quality end product. As a result the project team proceeded with a design-bid-build process coupled with Contractor prequalification. The Contractor prequalification process was implemented to select the best available Contractors to bid on the Tender, while keeping the pool of bidders large enough for competitive pricing, yet small enough to make the bidding attractive to Contractors. The prequalification process for CSST placed an emphasis on:
    - Experience on projects of similar scope, complexity and magnitude to demonstrate their ability to successfully manage and schedule the work;
    - Experience specifically relating to projects with the use of pressurized face tunneling in limestone and shale; and
    - Team and structure to manage the various complex components including shaft construction, tunneling, process/electrical/mechanical sub trades, and working on large live combined sewer networks.
- **Tunneling Methodology Selection:** Throughout the design phase, a key project risk was defined as groundwater drawdown resulting in consolidation of the overlying clay and subsequent building and structure impacts. To mitigate this risk and the potential cumulative impact of CSST and OLRT groundwater drawdown, a pressurized capable TBM was specified with segmental pre-cast concrete tunnel lining (PCTL) installed within the tail shield of the TBM as excavation advances to limit groundwater drawdown. In addition, the use of pressurized tunneling was specified in areas of concern (high groundwater, low rock cover, fault zones, etc.).
- **Geotechnical Data Report (GDR):** This is a comprehensive factual document which presents all data relating to subsurface conditions through the project alignment. As there is no interpretation of the data or recommendations/requirements for construction

methodology, the data remains strictly factual. This allows for an unbiased review of the subsurface conditions based on the investigations completed and complements other risk management tools for resolving disputes relating to subsurface conditions.

- **Geotechnical Baseline Report (GBR):** This report interprets the ground and water subsurface conditions presented in the GDR and provides a level playing field for all Contractors to bid on. This also protects both the Owner and Contractor as determining whether conditions qualify for additional compensation is more easily defined. The GBR was not overly conservative and provided details on areas where pressurized face tunneling was required in areas of low rock cover and high groundwater infiltration.
- **White Paper and Confidential Meetings:** The City included a request for non-mandatory White Paper submissions to solicit input and engage the Tenderers in discussions related to the feasibility of delivering the project within an identified budgetary limit. Recognizing the desire of many Contractors to provide design input, White Paper submissions were strongly encouraged to solicit and provide forum for Tenderers to provide suggestions and explore the viability of their ideas for improved cost-effectiveness in delivery of the project as they relate to project design and construction, cost and schedule control as well as risk management in view of the Owner's budgetary and schedule constraints.
- **Detailed Constraints Specifications and Modified General Conditions:** These specification sections were tailored specifically to address the needs and site specific constraints identified by stakeholders in addition to construction schedule constraints and operational requirements. These are critical to providing clear and concise direction to the Contractor to base their bid price on. The general conditions and technical specifications were tailored to a tunneling project and provide clear instruction with respect to dispute resolution and risk sharing. Some key components adopted included:
    - **Differing Site Conditions (DSC) Clauses:** These are incorporated into the General and Supplemental Conditions of the Contract and they provide an upfront definition of what constitutes a DSC and the methods for resolution if encountered during the course of construction.
    - **Dispute Review Board (DRB):** The DRB consists of three industry experts, one selected by the Owner, one selected by the Contractor, and a third selected by the Owner and Contractor's experts. The DRB is used to review key claims and disputes on the project, and is used to fairly settle disputes before they escalate to the point of arbitration or beyond. The use of a DRB is attractive to potential bidders as they know that claims will be dealt with in a fair and reasonable manner. Likewise, this provides the Owner with a level of certainty that claims will ultimately be justified and will reduce frivolous claims.
    - **Escrow Bid Documents (EBD):** Provides an opportunity for the contractor to define their assumptions that were made during the bidding process as well as provides the design engineers a resource (if needed) to understand how the contractor determined their original bid.
    - **Value Engineering Change Proposal (VECP):** This allows the Contractor to propose alternative practices, methods or designs for components of the project, where it will provide a cost savings to the Owner. In order to provide an incentive to the

Contractor to produce VECPs, the VECP clauses include the Contractor being entitled to 50% of the cost savings realized through the VECP.

- **Adoption of a Reasonable Construction Schedule:** A reasonable construction duration was selected to reduce the risk to bidders and reduce the risk of claims to the City. Although the specifications contain schedule constraints at several high profile sites, the bidders will retain ample flexibility for scheduling the works.
- **Structure of the Schedule of Prices:** A combination unit price and stipulated price contract (CCDC4-2011) was identified as the preferred method for payment. This allowed for some portions of the work to be unit prices where a stipulated price would be onerous for bidders during Tendering or where variations and changes during construction were anticipated and would affect the owner's cost certainty.
- **Extensive Geotechnical Instrumentation and Monitoring Program during Construction:** Monitoring of groundwater levels during construction with pre-established alert levels was considered critical to verify that actual levels were similar to predicted levels and to allow for early warning to reduce the risk of overlying clay settlement. Locations of monitoring equipment was established following a detailed review of building permits to identify structures of concern (generally where structures were founded on clay using raft footings). Additional monitoring was selected to be provided using satellite technology (INSAR) for the year prior to commencement of construction to establish a baseline including expected seasonal movement of buildings founded on clay.

CONCLUSION AND NEXT STEPS

As the CSST project has numerous challenges and risks, a focus was placed on the use of procurement practices and contractual risk management tools to mitigate the risks to the City of Ottawa. Input was solicited from industry experts, third parties, stakeholders and governmental agencies to determine what tools could be best implemented successfully on the design-bid-build project.

As a result, the project's Tender includes risk management tools (GBR, DSC, VECP, EBD, White Papers etc.) that are consistent with tunnel industry practice, which can result in reduced bid scatter, increased bidder pool, reduced longevity of conflicts and provide a fair and equitable sharing of risks between the Owner and Contractor.

The risk management tools and Procurement Processes adopted for the CSST are used throughout industry, where appropriate. What is unique about this project is the planning process leading to their adoption and the degree to which the design and planning process focused on mitigating the key project challenges and risks with these tools. This holistic approach to risk mitigation right from the project onset is beneficial to other municipalities embarking on similar projects as evidenced by industry support demonstrated throughout market sounding and outreach process.

The Procurement Process employed to date has been well received by the industry as evidenced by 10 prequalification submissions by world class Contractors with great feedback in terms of the specific risk sharing approach to the contract. At the time of writing, the Contractor prequalification process was complete. The City received 10 separate submissions to the prequalification request. The top 5 scoring Contractors/Joint Ventures were shortlisted and received the Request for Tender packages in mid-December 2015. Construction is expected to commence by summer 2016 and be completed in late 2019.